Module 4

Plants and the ESC and SWM Laws, Regulations and Minimum Standards

Module 4a.

Overview

The Overall Principle

Protect downstream properties and waterways!

From what?

Flooding, sediment deposition, erosive force of runoff, contamination

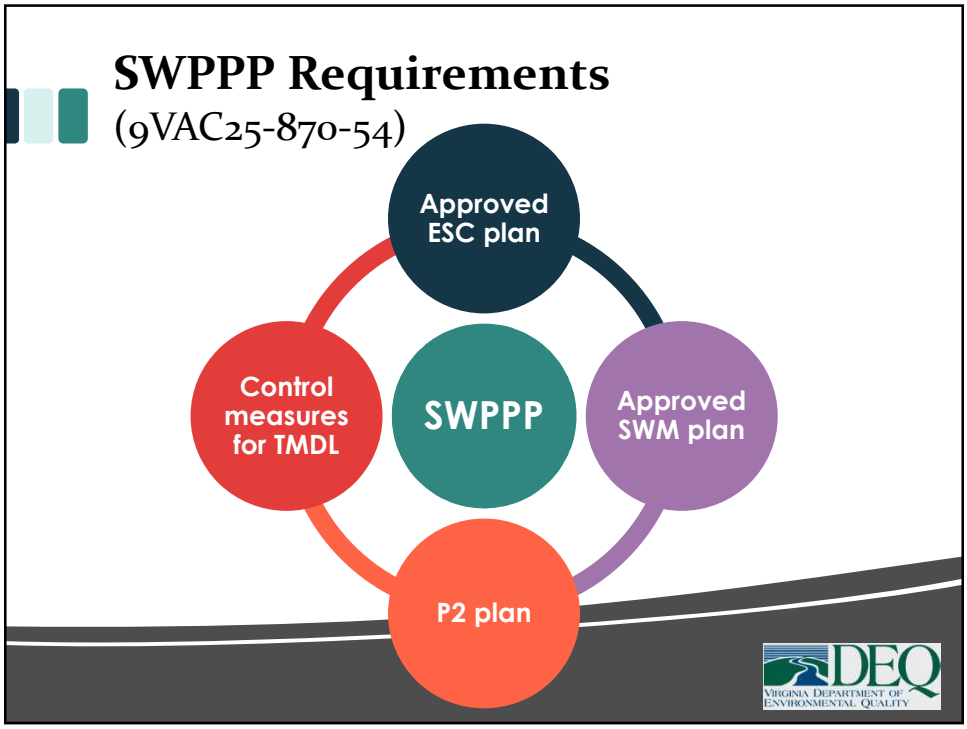
How do we do that?

Good house keeping, erosion control, sediment control, runoff reduction, infiltration, stormwater management, pollution prevention

Stormwater law and regulations

During Construction **Post-Construction**

Stormwater


SWPPP Requirements
(9VAC25-870-54)
Approved ESC plan
Control measures for TMDL
SWPPP
Approved SWM plan
P2 plan
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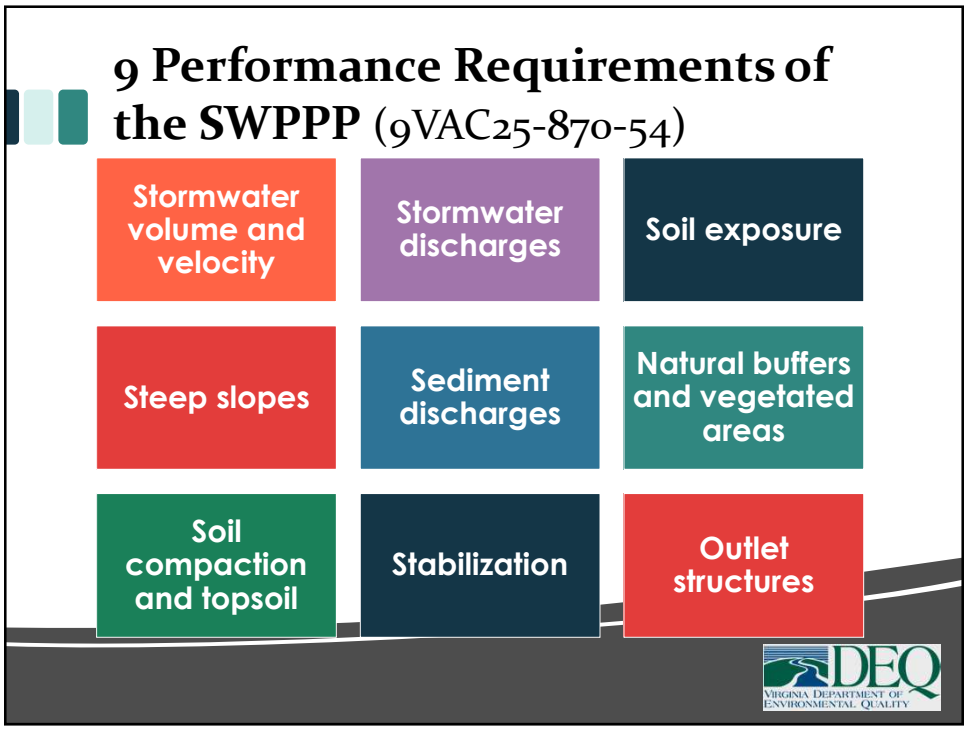
9 Performance Requirements of the SWPPP (9VAC25-870-54)
Stormwater volume and velocity
Stormwater discharges
Soil exposure
Steep slopes
Sediment discharges
Natural buffers and vegetated areas
Soil compaction and topsoil
Stabilization
Outlet structures
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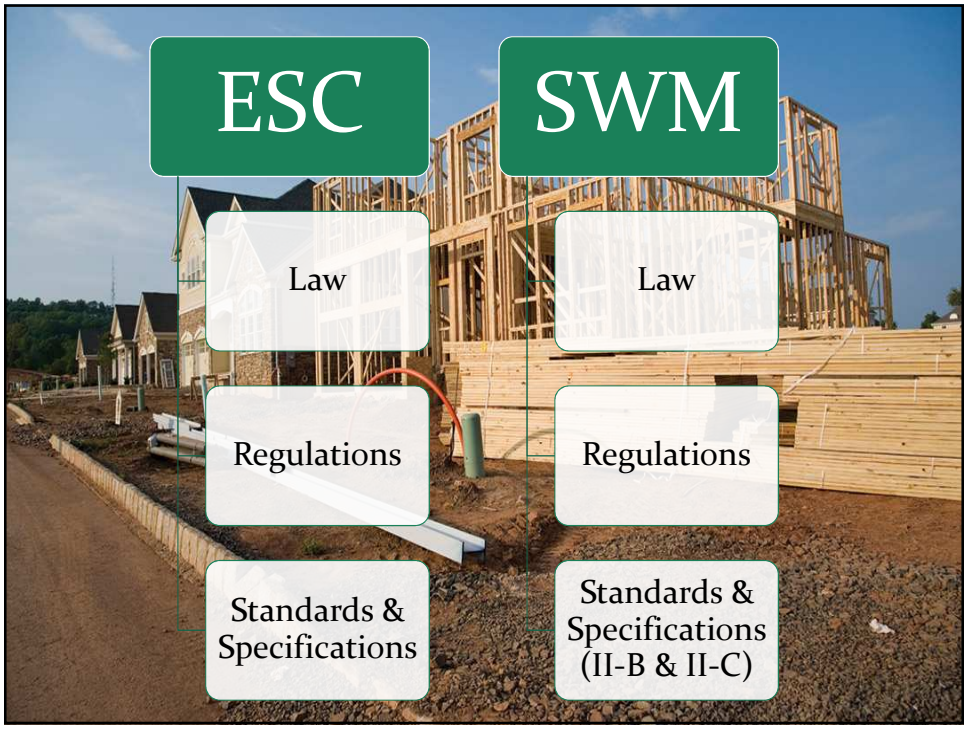

Regulated Activities & Overview of the ESC Law

The stated intent of the law is "for the effective control of soil erosion, sediment deposition, and non-agricultural runoff to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources"

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ESC Law and Regulations and Plants

Term	Mention	Where/how
Plant(s)	0	
Planting	1	Agriculture activity
Vegetative (cover)	3	Definitions (denuded areas & shore erosion) Regulations (MS-3)
Stabilization (with plants)	12	Definition (LDA & Natural Channel Design) Law (§ 62.1-44.15:57 Bonding) Regulations (Definitions) Regulations (MS-1, MS-2, MS-3, MS-5, MS-7, MS-16d/e, (and MS-18)

ESC and Plants

Definitions (Regulations)

"Stabilized" means land that has been treated to withstand normal exposure to natural forces without incurring erosion damage.

ESC and Plants

MS-3. A permanent vegetative cover shall be established on denuded areas not otherwise permanently stabilized. Permanent vegetation shall not be considered established until a ground cover is achieved that is uniform, mature enough to survive and will inhibit erosion.

ESC and Stabilization (Plants)

MS-1. Permanent or temporary soil stabilization shall be applied to denuded areas within seven days after final grade is reached on any portion of the site. Temporary soil stabilization shall be applied within seven days to denuded areas that may not be at final grade but will remain dormant for longer than 14 days. Permanent stabilization shall be applied to areas that are to be left dormant for more than one year.

ESC and Stabilization (Plants)

MS-2. During construction of the project, soil stock piles and borrow areas shall be stabilized or protected with sediment trapping measures. The applicant is responsible for the temporary protection and permanent stabilization of all soil stockpiles on site as well as borrow areas and soil intentionally transported from the project site.

ESC and Stabilization (Plants)

MS-5. Stabilization measures shall be applied to earthen structures such as dams, dikes and diversions immediately after installation.

ESC and Stabilization (Plants)

MS-7. Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion. Slopes that are found to be eroding excessively within one year of permanent stabilization shall be provided with additional slope stabilizing measures until the problem is corrected.

ESC and Stabilization (Plants)

MS-16d. Material used for backfilling trenches shall be properly compacted in order to minimize erosion and promote stabilization.

MS-16e. Restabilization shall be accomplished in accordance with this chapter.

ESC and Stabilization (Plants)

MS-18. All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization or after the temporary measures are no longer needed, unless otherwise authorized by the VESCP authority. Trapped sediment and the disturbed soil areas resulting from the disposition of temporary measures shall be permanently stabilized to prevent further erosion and sedimentation.

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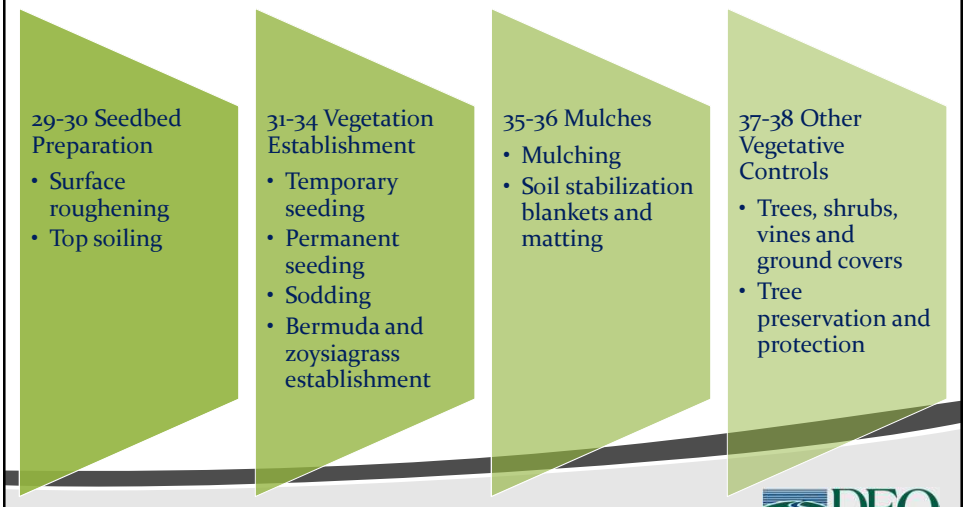
Vegetative Control Practices in the ESCH



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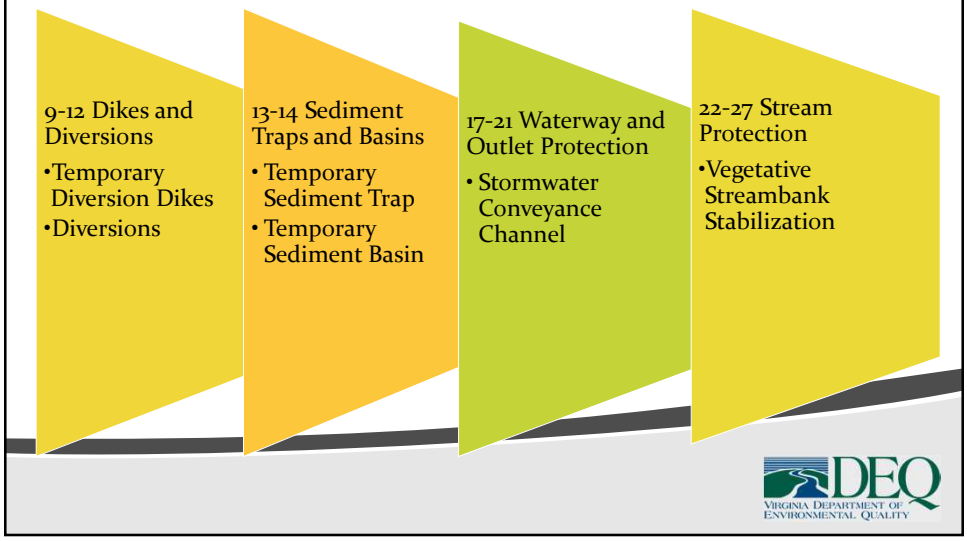
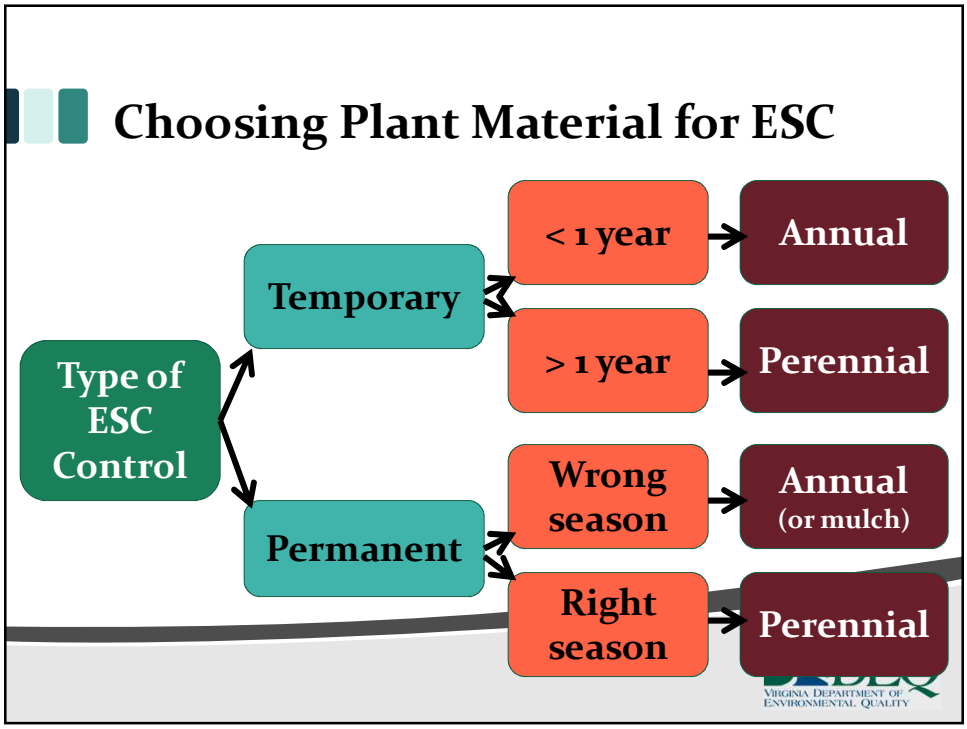
Vegetative needs with structural controls in ESCH



Choosing Plant Material for ESC



Differences between annuals and perennials

	Annual	Perennial
Germination	Fast (often 1 to 3 days)	Long (sometimes ½ year or longer)
Growth	Fast	Slow
Flowering	Early and Abundant	At least after one year of growing often much longer
Number of seeds	Many	Often few
Root system	Shallow	Extensive
Replanting	Every year	Long lived

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Annuals (Temporary Seeding) according to the ESC Handbook

TABLE 3.31-B

ACCEPTABLE TEMPORARY SEEDING PLANT MATERIALS

"QUICK REFERENCE FOR ALL REGIONS"

Planting Dates	Species	Rate (lbs./acre)
Sept. 1 - Feb. 15	50/50 Mix of Annual Ryegrass (Lolium multi-florum) & Cereal (Winter) Rye (Secale cereale)	50 - 100
Feb. 16 - Apr. 30	Annual Ryegrass (Lolium multi-florum)	60 - 100
May 1 - Aug 31	German Millet (Setaria italica)	50

Source: Va. DSWC

Winter (cold season) annual

Summer (warm season) annual

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Annuals (Temporary Seeding) according to the ESC Handbook

TABLE 3.31-C

TEMPORARY SEEDING PLANT MATERIALS, SEEDING RATES, AND DATES

SPECIES	SEEDING RATE		NORTH[a]			SOUTH[b]			PLANT CHARACTERISTICS
	Acre	1000 ft²	3/1 to 4/30	5/1 to 8/15	8/15 to 11/1	2/15 to 4/30	5/1 to 9/1	9/1 to 11/15	
OATS (Avena sativa)	3 bu. (up to 100 lbs., not less than 50 lbs.)	2 lbs.	X	-	-	X	-	-	Use spring varieties (e.g., Noble).
RYE[d] (Secale cereale)	2 bu. (up to 110 lbs., not less than 50 lbs.)	2.5 lbs.	X	-	X	X	-	X	Use for late fall seedings, winter cover. Tolerates cold and low moisture.
GERMAN MILLET (Setaria italica)	50 lbs.	approx. 1 lb.	-	X	-	-	X	-	Warm-season annual. Dies at first frost. May be added to summer mixes.
ANNUAL RYEGRASS[c] (Lolium multi-florum)	60 lbs.	1½ lbs.	X	-	X	X	-	X	May be added in mixes. Will mow out of most stands.
WEEPING LOVEGRASS (Eragrostis curvula)	15 lbs.	5½ ozs.	-	X	-	-	X	-	Warm-season perennial. May bunch. Tolerates hot, dry slopes and acid, infertile soils. May be added to mixes.
KOREAN LESPEDEZA[c] (Lespedeza stipulacea)	25 lbs.	approx. 1½ lbs.	X	X	-	X	X	-	Warm season annual legume. Tolerates acid soils. May be added to mixes.

[a] Northern Piedmont and Mountain region. See Plates 3.22-1 and 3.22-2.
[b] Southern Piedmont and Coastal Plain.
[c] May be used as a cover crop with spring seeding.
[d] May be used as a cover crop with fall seeding.
X May be planted between these dates.
- May not be planted between these dates.

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Annuals (Temporary Seeding) according to the ESC Handbook

OATS (Avena sativa)

RYE[d] (Secale cereale)

GERMAN MILLET (Setaria italica)

ANNUAL RYEGRASS[c] (Lolium multi-florum)

~~WEEPING LOVEGRASS (Eragrostis curvula)~~ ? Invasive ?

~~KOREAN LESPEDEZA[c] (Lespedeza stipulacea)~~ ? Suspect ?

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Perennials (Permanent Seeding) according to the ESC Handbook

Species	Type	Season	pH	Drought tolerance	Flooding tolerance
Tall Fescue	Grass	Cold	5.5-6.2	Fair	Low
Kentucky Bluegrass	Grass	Cold	6.0-6.5	Poor	Low
Perennial Ryegrass	Grass	Cold	5.8-6.2	Fair	Low
Hard Fescue	Grass	Cold	5.0-6.2	Good	Fair
Red Fescue	Grass	Cold	5.0-6.2	Good	Fair
Reed Canarygrass	Grass	Cold	5.8-6.2	Good	Good

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Perennials (Permanent Seeding) according to the ESC Handbook

But also:

Weeping lovegrass → Invasive
Orchard grass → Suspect/Potentially invasive
Sericea lespedeza → Invasive
Annual lespedeza → Suspect

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SWM Law and Regulations and Plants

Term	Mention	Where/how
Plant(s)	2	Agriculture activity Bioretention definition (Part II-C)
Planting	0	
Vegetative (cover)	9	Definitions (Hydrology - Regs) Definitions (SWM conveyance - Regs) Definition (Wetlands - Regs) SWPPP requirements (Part II-A) SWM plan (Part II-A) Part II-B Definitions (Part II-C) Table 1 (Part II-C) MS4 requirements (Regs)
Stabilization (with plants)	2	Definition (Regs) SWPPP requirements (Part II-A)

The BMP Minimum Standards and Specifications in Chapter 3 of the 1999 VSMH

1. Earthen Embankments
2. Principal Spillways
3. Vegetated Emergency spillways
4. Sediment Forebays
5. Landscaping
6. Retention Basins
7. Extended Detention Basins
8. Detention Basins
9. Constructed Wetlands
10. Infiltration Practices
11. Bio-Retention
12. Sand Filters
13. Grassed Swale
14. Vegetated Filter Strip
15. Manufactured BMP Systems

Components of BMP 6-15

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The BMP Minimum Standards and Specifications in Chapter 3 of the 1999 VSMH

1. Earthen Embankments
2. Principal Spillways
3. Vegetated Emergency spillways
4. Sediment Forebays
5. Landscaping
6. Retention Basins
7. Extended Detention Basins
8. Detention Basins
9. Constructed Wetlands
10. Infiltration Practices
11. Bio-Retention → table 3.11-7A – 7C
12. Sand Filters
13. Grassed Swale → Channel specifications of the VESCH
14. Vegetated Filter Strip → any plant as long as it is adapted to the Plant Hardiness Zone
15. Manufactured BMP Systems

Components of BMP 6-15

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Plants and the BMP Clearinghouse

BMP	Plants		Plants
1. Rooftop disconnection	No*	9. Bioretention	Yes
2. Sheetflow	Yes	10. Dry swale	Yes
3. Grass channels	Yes	11. Wet swale	Yes
4. Soil amendments	No	12. Filtering practices	No
5. Vegetated roof	Yes	13. Constructed wetland	Yes
6. Rainwater harvesting	No	14. Wet pond	Yes
7. Permeable pavement	No	15. Extended detention	Yes
8. Infiltration	No		

But which one recommend plants?

BMP	Plants		Plants
1. Rooftop disconnection	No	9. Bioretention	Yes
2. Sheetflow	No	10. Dry swale	No*
3. Grass channels	Yes	11. Wet swale	Yes (13)
4. Soil amendments	No	12. Filtering practices	No
5. Vegetated roof	Yes	13. Constructed wetland	Yes
6. Rainwater harvesting	No	14. Wet pond	Yes (E)
7. Permeable pavement	No	15. Extended detention	Yes (E)
8. Infiltration	No		

Module 4b

The details: Plants in the ESC Standards and Specifications

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ESC BMPs that may require vegetative (or other) stabilization

3.09 Temporary Diversion Dikes
3.12 Diversions
3.13 Temporary Sediment Trap
3.14 Temporary Sediment Basin
3.17 Stormwater Conveyance Channel
3.22 Vegetative Streambank Stabilization

Need to be stabilized before made operational (MS-5)

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ESC BMPs that may require vegetative (or other) stabilization

3.09 Temporary Diversion Dikes	- Vegetative
3.12 Diversions	- Veg./Structural
3.13 Temporary Sediment Trap	- Vegetative
3.14 Temporary Sediment Basin	- Vegetative
3.17 Stormwater Conveyance Channel	- Veg./Structural
3.22 Vegetative Streambank Stabilization	

Need to be stabilized before made operational (MS-5)

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Module 4c

The details: Plants in the SWM Standards and Specifications (II-C)

Minimum Standard 3.05 (VSMH)

Nearly similar as appendix E in the BMP Clearing house (Part II-B)

Minimum Standard 3.11 (VSMH)

Provides an outdates list of plants including:

English Ivy ➔ Invasive

Japanese Pachysandra ➔ non-native

Large Periwinkle ➔ Invasive

Module 4d

The details: Plants in the SWM Standards and Specifications (II-B)

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Part II-B of the Virginia Stormwater Regulations require treatment of water quality and quantity

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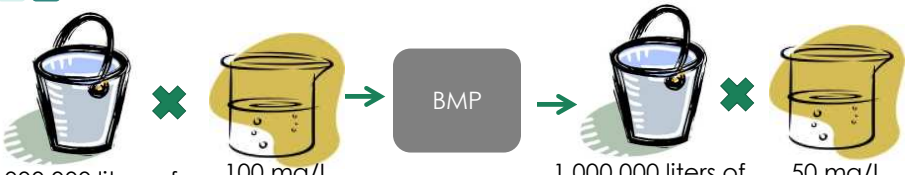
Traditional BMPs



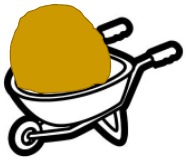
1,000,000 liters of stormwater (multiple storm events)

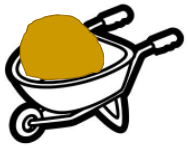
100 mg/L pollutant (average)

1,000,000 liters of stormwater (multiple storm events)

50 mg/L of pollutant (average)

100 kg Total pollutant load





50 kg Total pollutant load discharged over time

No volume reduction, only load reduction

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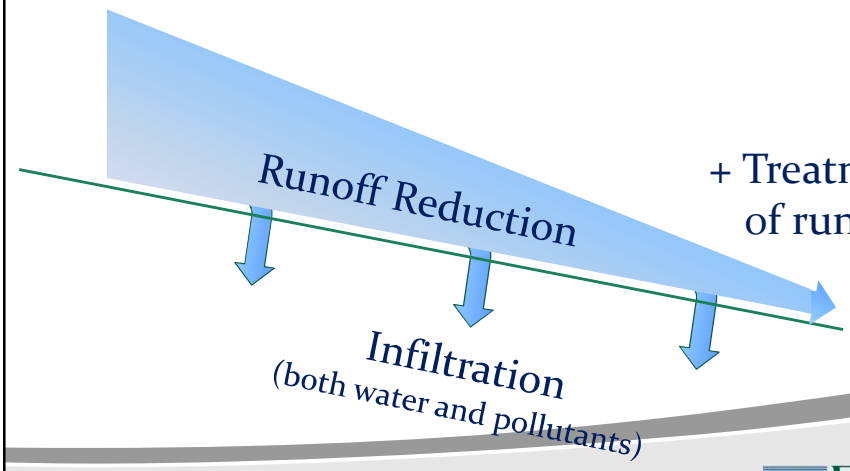
New Stormwater Paradigm



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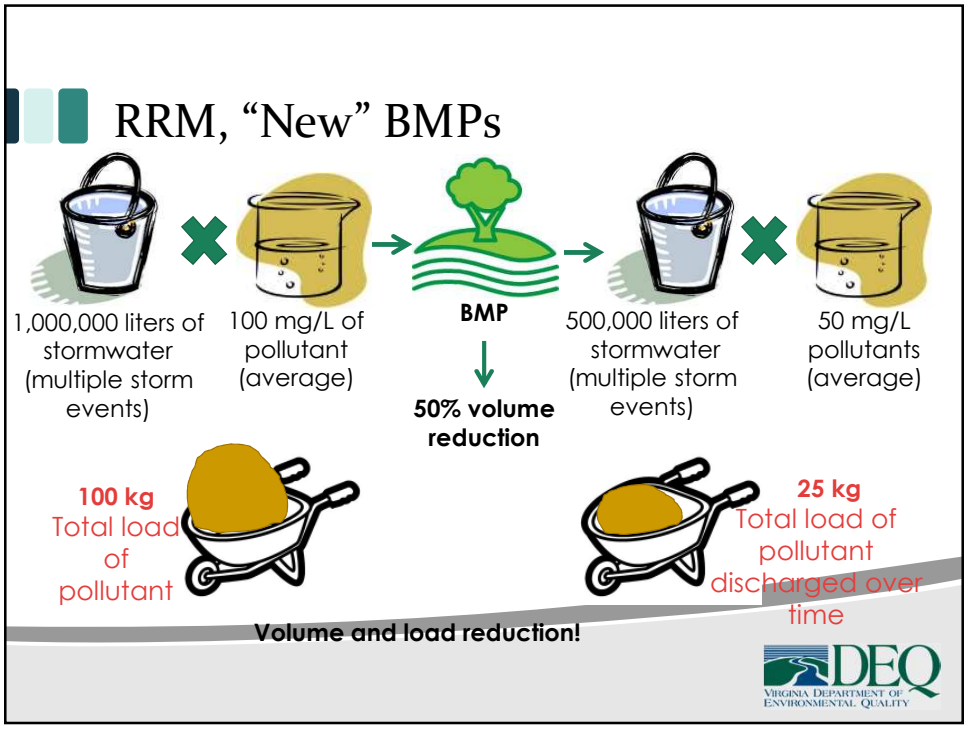
RRM, "New" BMPs
1,000,000 liters of stormwater (multiple storm events)
100 mg/L of pollutant (average)
BMP
50% volume reduction
500,000 liters of stormwater (multiple storm events)
50 mg/L pollutants (average)
100 kg
Total load of pollutant
25 kg
Total load of pollutant discharged over time
Volume and load reduction!
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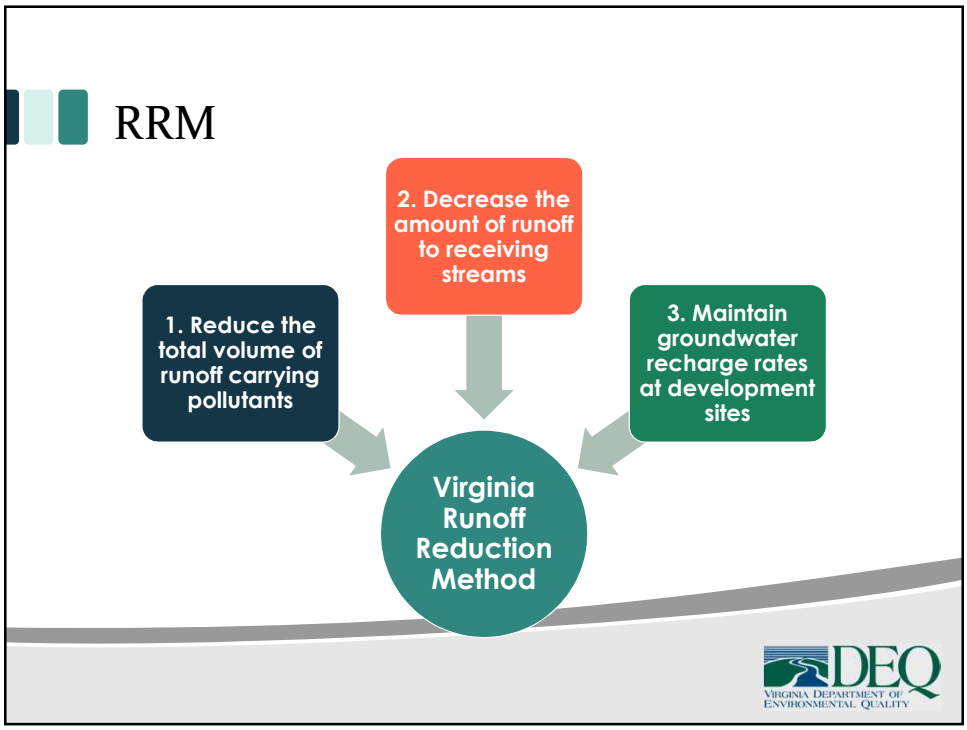
RRM
2. Decrease the amount of runoff to receiving streams
1. Reduce the total volume of runoff carrying pollutants
3. Maintain groundwater recharge rates at development sites
Virginia Runoff Reduction Method
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BMP: #2 – Sheet flow to vegetated filter strip or conserved open space

Conserved open space (may require reforestation)

(designed) Vegetated filter strip

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BMP: #2 – Sheet flow to vegetated filter strip or conserved open space

Vegetated filter strip requirements

1. Dense turf cover, or
2. Landscaped with herbaceous cover, shrubs and trees
3. 90% cover after the second growing season
4. Near roads need to use salt tolerant species
5. Plants should be able to withstand periodic wet and dry soils

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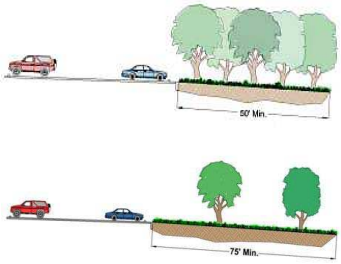
BMP: #2 – Sheet flow to vegetated filter strip or conserved open space



Reforested conserved open space (mostly buffers) requirements

1. Replace turf with native trees and shrubs, or
2. Transition between vegetation types (meadow to shrubs to woods)
3. Prefer deep rooting species
4. Over stock the area
5. Random spacing
6. Add ground cover

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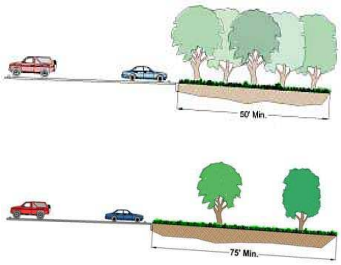
BMP: #2 – Sheet flow to vegetated filter strip or conserved open space



Benefits	
Removal of TP by Runoff Reduction	**Removal of TP by Treatment**
Yes	No

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BMP: #3 – Grass channels

- The local street right of way is the prime location to use channels

BMP: #3 – Grass channels

Table 3.3: Maximum Permissible Velocities for Grass Channels

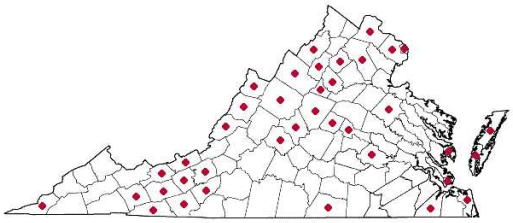
Cover Type	Slope (%)	Erosion Resistant Soils (ft./sec.)	Easily Eroded Soils (ft./sec.)
Bermudagrass*	0 – 5	6	4.5
Kentucky bluegrass * Reed canarygrass** Tall fescue*	0 – 5	5	3.8
Bermudagrass	5 – 10	5	3.8
Kentucky bluegrass Reed canarygrass Tall fescue	5 – 10	4	3
Grass-legume mixture	0 – 5 5 - 10	4 3	3 2.3
Kentucky bluegrass Reed canarygrass Tall fescue	> 10	3	2.3
Red fescue	0 - 5	2.5	1.9

Sources: Virginia E&S Control Handbook, 1992; Ree, 1949; Temple et al, 1987; NOVA, 2007

* **Introduced**

** **Native but does not grow in coastal plain and piedmont**

Red fescue
(http://vaplantatlas.org)



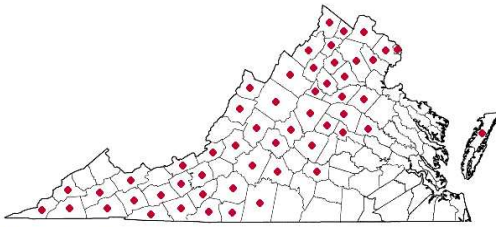
Show image with county labels

Detail

Family
Poaceae
Botanical Name
Festuca rubra L. ssp. rubra
Common Name
Red Fescue
Synonym(s)
Festuca rubra L.
Flora of Virginia Name/Status
Festuca rubra L. ssp. rubra
Comments
Habitat
Native races occur in dune grasslands, salt scrub, and borders of oligohaline to mesohaline marshes in the Coastal Plain, and in middle- to high-elevation forests, rocky woodlands, barrens, and bogs in the mountains; presumably introduced races occur in fields, pastures, weedy clearings, and other open, disturbed habitats. In our area, this species is considered to be partly native and partly introduced. As a whole, it varies from infrequent to locally common throughout.
Native Status
Native

Reed canary grass

Phalaris arundinacea L.



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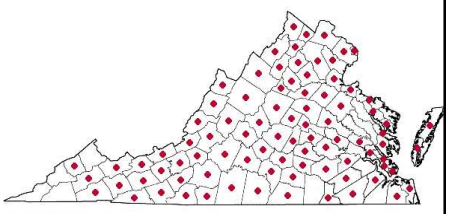
Detail

Family
Poaceae
Botanical Name
Phalaris arundinacea L.
Common Name
Reed Canary Grass, Ribbon Grass
Synonym(s)
Flora of Virginia Name/Status
Phalaris arundinacea L.
Comments
Habitat
Fens, calcareous spring marshes, river shores, wet meadows, wet fields, and low roadsides. Frequent to locally abundant in the mountains and inner Piedmont; infrequent in the outer Piedmont; rare in the Coastal Plain.
Native Status
Native

Kentucky bluegrass

Poa pratensis L. ssp. pratensis



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Detail

Family
Poaceae
Botanical Name
Poa pratensis L. ssp. pratensis
Common Name
Kentucky Bluegrass
Synonym(s)
Flora of Virginia Name/Status
Poa pratensis L. ssp. pratensis
Comments
According to FNA, the only vars. of Poa pratensis native to North America are those of the far northern / boreal region. Var. pratensis is introduced and naturalized from Eurasia.
Habitat
Fields, pastures, roadsides, clearings, lawns, and other open, disturbed habitats; also widespread but scattered in various natural forests, woodlands, and wetlands. Common in the mountains and Piedmont; more locally so in the Coastal Plain.
Native Status
Introduced

BMP: #3 – Grass channels

Benefits	
Removal of TP by Runoff Reduction	Yes
Removal of TP by Treatment	Yes

BMP: #5 – Vegetated roofs

Two types:

- Level 1 ➔ soil media <4”
- Level 2 ➔ soil media 4”-8”
- Specific drought/heat/ wind/sun tolerant plants (Sedums)

Table 5.3. Ground Covers for Vegetated Roofs in Chesapeake Bay Watershed

Plant Hardiness Zone 7	Plant Hardiness Zone 6
Delosperma 'Tiffendell Magenta'	*Delosperma cooperi*
Hieracium lanatum	*Delosperma ecklonis var.latifolia*
Sedum lineare 'Variegatum'	*Hieracium villosum*
Sedum makinoi	*Orostachys boehmeri*
Sedum tetractinum	*Sedum hispanicum*
Sedum stoloniferum	*Sedum pluricaule var. ezawe*
	Sedum urvillei
Note: Landscape architects should choose species based on shade tolerance, ability to sow or not, foliage height, and spreading rate. See Snodgrass and Snodgrass (2006) for definitive list of green roof plants, including accent plants.	

BMP: #5 – Vegetated roofs

Benefits	
Removal of TP by Runoff Reduction	Yes
Removal of TP by Treatment	No

BMP: #9 – Bioretention basins

- Surface runoff is directed into a shallow landscaped depression that incorporates many of the pollutant removal mechanisms that operate in natural ecosystems

Different types:

- Micro-bioretention/rain gardens
- Bioretention
- Urban bioretention

BMP: #9 – Bioretention basins

Design considerations:

- Size
- Level of design
- Proximity to structures and septic systems

BMP: #9 – Bioretention basins

	Level 1	Level 2
Micro	Vegetation: turf, herbaceous, or shrubs (min = 1 out of those 3 choices).	Vegetation: turf, herbaceous, shrubs, or trees (min = 2 out of those 4 choices).
Bio	Planting Plan (**Section 6.8**): a planting template to include turf, herbaceous vegetation, shrubs, and/or trees to achieve surface area coverage of at least 75% within 2 years.	Planting Plan (**Section 6.8**): a planting template to include turf, herbaceous vegetation, shrubs, and/or trees to achieve surface area coverage of at least 90% within 2 years. If using turf, must combine with other types of vegetation [1].

BMP: #9 – Bioretention basins

Table 9.4. Popular Native Plant Materials for Bioretention

Perennials/Herbaceous	Shrubs	Trees
Virginia Wild Rye *(Elymus virginicus)*	Common Winterberry *(Ilex verticillatta)*	River Birch *(Betula nigra)*
Redtop Grass *(Agrostis alba)*	Inkberry *(Ilex glabra)*	Red Maple *(Acer rubrum)*
Swamp Milkweed *(Asclepias incarnata)*	Sweet Pepperbush *(Clethra ainifolia)*	Pin Oak *(Quercus palustris)*
Switchgrass *(Panicum virgatum)*	Wax Myrtle *(Myrica cerifera)*	Willow Oak *(Quercus phellos)*
Cardinal Flower *(Lobelia cardinalis)*	Virginia Sweetspire *(Itea virginica)*	Sweetgum *(Liquidambar styraciflua)*
Common Three Square *(Scirpus americanus)*	Swamp Azeala *(Azeala viscosum)*	Black Willow *(Salix nigra)*
Sensitive Fern *(Onoclea sensibilis)*	Button Bush *(Cephalanthus occidentalis)*	Grey Birch *(Betula populifolia)*
Blue Flag *(Iris versicolor)*	Black Haw *(Virburnum prunifolium))*	Black Gum *(Nyassa sylvatica)*
Woolgrass *(Scirpus cyperninus)*	Indigo Bush *(Amorpha fruticosa)*	Sycamore *(Platanus occidentalis)*
Indian Grass *(Sorghastrum nutans)*	Arrowwood *(Virburum dentatum)*	Green Ash *(Fraxinus pennsylvanica*
Marsh Marigold *(Caltha palustris)*		Sweetbay Magnolia* *(Magnolia virginiana)*
Joe Pye Weed *(Eupatorium purpureum)*		Atlantic White Cedar* *(Charnaecyparis thyoides)*
Turk's cap lily *(Lilium superbum)*		Bald Cypress* *(Taxodium distichum)*
Bee Balm *(Monarda didyma)*		Grey Dogwood *(Cornus racernosa)*
Northern Sea Oats *(Chasmanthium latifolium)*		Smooth Alder *(Alnus serrulata))*
		Serviceberry *(Amelanchier canadensis)*
		Redbud *(Cercis candensis)*
		Box Elder *(Acer negundo)*
		Fringe Tree *(Chionanthus virginicus)*

Note: Prior to selection, please consult bioretention plant lists for more detailed information regarding inundation, drought and salt tolerance for each species.
* most applicable to the coastal plain

BMP: #9 – Bioretention basins

Benefits	
Removal of TP by Runoff Reduction	Yes
Removal of TP by Treatment	Yes

BMP: #10 – Dry swales

- Soil filter system that temporarily stores and then filters stormwater
- Level 1 → turf
- Level 2→ incorporates trees and shrubs

But no clear species recommendation, refers to ESCH.

BMP: #10 – Dry swales

Benefits	
Removal of TP by Runoff Reduction	Yes
Removal of TP by Treatment	Yes

BMP: # 11 – Wet swales

- Cross between a wetland and a swale
- Intercept shallow groundwater to maintain a wetland plant community
- Two levels:
  - Level 1 → No plants
  - Level 2 → Wetland plants

Refers to Spec. 13

BMP: # 11 – Wet swales

Benefits	
Removal of TP by Runoff Reduction	No
Removal of TP by Treatment	Yes

BMP: #13 – Constructed wetlands

- Runoff from each storm displaces runoff from previous storms
- Long residence time allows multiple pollutant removal processes to occur

Level 1 → emergent vegetation
Level 2 → mixed vegetation

BMP: #13 – Constructed wetlands

- **Zone 1:** -6 inches to -12 below the normal pool elevation
- **Zone 2:** -6 inches to the normal pool elevation)
- **Zone 3:** From the normal pool elevation to + 12 inches above it)
- **Zone 4:** +12 inches to + 36 inches above the normal pool elevation (i.e., above ED Zone)

BMP: #13 – Constructed wetlands

Table 13.3. Popular, Versatile and Available Native Trees and Shrubs for Constructed Wetlands

Shrubs		Trees	
Common & *Scientific* Names	**Zone**	**Common & *Scientific* Names**	**Zone**
Button Bush *(Cephalanthus occidentalis)*	2, 3	Atlantic White Cedar *(Charnaecyparis thyoides)*	2, 3
Common Winterberry *(Ilex verticillatta)*	3, 4	Bald Cypress *(Taxodium distichum)*	2, 3
Elderberry *(Sambucus canadensis)*	3	Black Willow *(Salix nigra)*	3, 4
Indigo Bush *(Amorpha fruticosa)*	3	Box Elder *(Acer Negundo)*	2, 3
Inkberry *(Ilex glabra)*	2, 3	Green Ash *(Fraxinus pennsylvanica)*	3, 4
Smooth Alder *(Alnus serrulata)*	2, 3	Grey Birch *(Betula populifolia)*	3, 4
Spicebush *(Lindera benzoin)*	3, 4	Red Maple *(Acer rubrum)*	3, 4
Swamp Azalea *(Azalea viscosum)*	2, 3	River Birch *(Betula nigra)*	3, 4
Swamp Rose *(Rosa palustris)*	2, 3	Swamp Tupelo *(Nyssa biflora)*	2, 3
Sweet Pepperbush *(Clethra ainifolia)*	2, 3	Sweetbay Magnolia *(Magnolia virginiana)*	3, 4
		Sweetgum *(Liquidambar styraciflua)*	3, 4
		Sycamore *(Platanus occidentalis)*	3, 4
		Water Oak *(Quercus nigra)*	3, 4
		Willow Oak *(Quercus phellos)*	3,4

Zone 1: -6 to -12 ***OR*** -18 inches below the normal pool elevation
Zone 2: -6 inches to the normal pool elevation
Zone 3: From the normal pool elevation to +12 inches
Zone 4: +12 to +36 inches; above ED zone

BMP: #13 – Constructed wetlands

Table 13.4. Popular, Versatile and Available Native Emergent and Submergent Vegetation for Constructed Wetlands

Plant	Zone	Form	Inundation Tolerance	Wildlife Value	Notes
Arrow Arum *(Peltandra virginica)*	2	Emergent	Up to 1 ft.	High; berries are eaten by wood ducks	Full sun to partial shade
Broad-Leaf Arrowhead (Duck Potato) *(Saggitaria latifolia)*	2	Emergent	Up to 1 ft.	Moderate; tubers and seeds eaten by ducks	Aggressive colonizer
Blueflag Iris* *(Iris versicolor)*	2, 3	Emergent	Up to 6 in.	Limited	Full sun (to flower) to partial shade
Broomsedge *(Andropogon virginianus)*	2, 3	Perimeter	Up to 3 in.	High; songbirds and browsers; winter food and cover	Tolerant of fluctuating water levels and partial shade
Bulltongue Arrowhead *(Sagittaria lancifolia)*	2, 3	Emergent	0-24 in	Waterfowl, small mammals	Full sun to partial shade
Burreed *(Sparganium americanum)*	2, 3	Emergent	0-6	Waterfowl, small mammals	Full sun to partial shad
Cardinal Flower * *(Lobelia cardinalis)*	3	Perimeter	Periodic inundation	Attracts hummingbirds	Full sun to partial shade
Common Rush *(Juncus spp.)*	2, 3	Emergent	Up to 12 in.	Moderate; small mammals, waterfowl, songbirds	Full sun to partial shade
Common Three Square *(Scipus pungens)*	2	Emergent	Up to 6 in.	High; seeds, cover, waterfowl, songbirds	Fast colonizer; can tolerate periods of dryness; ull sun; high metal removal
Duckweed *(Lemna sp.*	1, 2	Submergent / Emergent	Yes	High; food for waterfowl and fish	May biomagnify metals beyond concentrations found in the water
Joe Pye Weed *(Eupatorium purpureum)*	2, 3	Emergent	Drier than other Joe-Pye Weeds; dry to moist areas; periodic inundation	Butterflies, songbirds, insects	Tolerates all light conditions
Lizard's Tail *(Saururus cernus)*	2	Emergent	Up to 1 ft.	Low; except for wood ducks	Rapid growth; shade-tolerant
Marsh Hibiscus *(Hibiscus moscheutos)*	2, 3	Emergent	Up to 3 in.	Low; nectar	Full sun; can tolerate periodic dryness
Pickerelweed *(Pontederia cordata)*	2, 3	Emergent	Up to 1 ft.	Moderate; ducks, nectar for butterflies	Full sun to partial shade
Pond Weed *(Potamogeton pectinatus)*	1	Submergent	Yes	Extremely high; waterfowl, marsh and shore birds	Removes heavy metals from the water
Rice Cutgrass *(Leersia oryzoides)*	2, 3	Emergent	Up to 3 in.	High; food and cover	Prefers full sun, although tolerant of shade; shoreline stabilization
Sedges *(Carex spp.)*	2, 3	Emergent	Up to 3 in.	High; waterfowl, songbirds	Wetland and upland species
Softstem Bulrush *(Scipus validus)*	2, 3	Emergent	Up to 2 ft.	Moderate; good cover and food	Full sun; aggressive colonizer; high pollutant removal

BMP: #13 – Constructed wetlands

Benefits	
Removal of TP by Runoff Reduction	No
Removal of TP by Treatment	Yes

BMP: #14 – Wet ponds

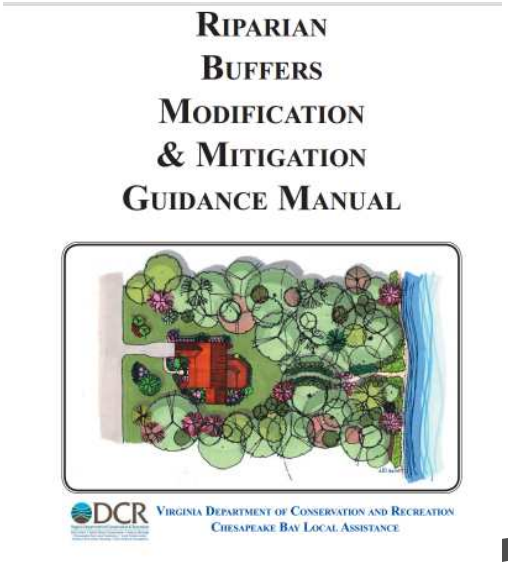
- Consist of a permanent pool of standing water that promotes a better environment for gravitational settling, biological uptake, and microbial activity

BMP: #14 – Wet ponds

Design considerations:

- 25 ft. buffer
- No trees or shrubs on embankment!
- No shade species
- No species susceptible to wind damage

BMP: #14 – Wet pond Species Selection



http://www.deq.virginia.gov/Portals/0/DEQ/Water/Publications/RiparianBufferManual.pdf

BMP: #14 – Wet ponds

Benefits	
Removal of TP by Runoff Reduction	No
Removal of TP by Treatment	Yes

BMP: # 15 – Extended detention pond

- Relies on 12 to 24 hour detention of stormwater runoff after each rain event
- Two levels:
  - Level 1 → turf cover on bottom
  - Level 2 → Trees and wetlands in planting plan

Appendix E

BMP: # 15 – Extended detention pond

Benefits	
Removal of TP by Runoff Reduction	Level 1: No Level 2: Yes
Removal of TP by Treatment	Yes for both levels

Appendix E: Landscaping

- Divides Virginia into 3 regions:
  - Coastal
  - Piedmont
  - Appalachian

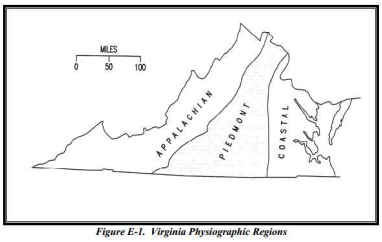


Figure E-1. Virginia Physiographic Regions

- Divides a site up into 6 zones:
  - Deep water
  - Shalow water
  - Shoreline fringe
  - Riparian fringe
  - Floodplain terrace
  - Upland slopes

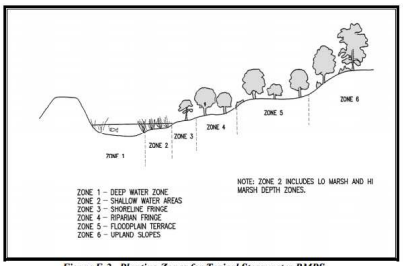


Figure E-2. Planting Zones for Typical Stormwater BMPS

Table E-1a. Native Tree/Shrub Guide for Stormwater Management Areas in the Mid-Atlantic -- USA Trees and Shrubs

Tree/Shrub	*Zone	Form	Available	Inundation Tolerance	Wildlife Value	Notes
American Beech *(Fagus grandifolia)*	5,6	Dec. Tree	No	no	High, mammals and birds.	Prefers shade and rich, well-drained soils.
American Holly *(Ilex opaca)*	5,6	Dec. Tree	Yes	some	High,songbirds, food, cover, nesting.	Coastal plain only. Prefers shade and rich soils.
American Hornbeam *(Carpinus caroliniana)*	4,5	Dec. Tree	Yes	yes	Moderate, food, browsing.	Most common in flood plains and bottom land of Piedmont and mountains.
Arrowwood Viburnum *(Viburnum dentatum)*	2,3,4	Dec. Shrub	Yes	no	High, songbirds and mammals.	Grows best in sun to partial shade.
Bald Cypress *(Taxodium distichum)*	3,4	Dec. Tree	Yes	yes	Little food value but good perching site for waterfowl.	Forested Coastal Plain wetlands. North of normal range. Tolerates drought.
Bayberry *(Myricia pensylvanica)*	4,5,6	Dec. Shrub	Yes	no	High, nesting, food cover. Berries last into winter.	Coastal Plain only. Roots fix N. Tolerates slightly acidic soil.
Bitternut Hickory *(Carya cordiformis)*	3,4,5	Dec. Tree	No	yes	High, food.	Moist soils or wet bottom land areas.
Black Cherry *(Prunus serotina)*	5,6	Dec. Tree	Yes	yes	High, fruit is eaten by many birds.	Temporarily flooded forested areas. Possible fungus infestation.
Black Walnut *(Juglans nigra)*	5,6	Dec. Tree	Yes	yes	High, food.	Temporarily flooded wetlands along flood plains. Well drained, rich soils.
Blackgum or Sourgum *(Nyssa sylvatica)*	4,5,6	Dec. Tree	Yes	yes	High, songbirds, egrets, herons, raccoons, owls.	Can be difficult to transplant. Prefers sun to partial shade.
Black Willow *(Salix nigra)*	3,4,5	Dec. Tree	Yes	yes	High, browsing and cavity nesters.	Rapid growth, stabilizes stream banks. Full sun.
Buttonbush *(Cephalanthus occidentalis)*	2,3,4,5	Dec. Shrub	Yes	yes	High, ducks and shorebirds. Seeds, nectar and nesting.	Full sun to partial shade. Will grow in dry areas.
Chestnut Oak *(Quercus prinus)*	5,6	Dec. Tree	No	no	High. Cover, browse and food.	Gypsy moth target. Dry soils.

***Zone 1:** Submergent Aquatic Vegetation*
***Zone 2:** Shallow Water Bench - 6-12 inches Deep*
***Zone 3:** Shoreline Fringe - Regularly Inundated Area*
***Zone 4:** Riparian Fringe - Periodically Inundated Area, Wet Soils*
***Zone 5:** Floodplain Terrace - Infrequently Inundated, Moist Soils*
***Zone 6:** Upland Slopes - Seldom or Never Inundated, Moist To Dry Soils*

Table E-1a (cont.)

Tree/Shrub	*Zone	Form	Available	Inundation Tolerance	Wildlife Value	Notes
Common Choke Cherry *(Prunus virginiana)*	5,6	Dec. Tree	no	some	High, birds, mammals. Fruit and cover.	Prefers drier conditions.
Common Spicebush *(Lindera benzoin)*	4,5	Dec. Shrub	yes	no	Very high, songbirds.	Shade and rich soils. Tolerates acidic soils. Good understory species.
Eastern Cottonwood *(Populus deltoides)*	4,5	Dec. Tree	yes	yes	Moderate, cover, food.	Shallow rooted, subject to windthrow. Invasive roots. Rapid growth.
Eastern Hemlock *(Tsuga conadensis)*	5,6	Conif. Tree	yes	yes	Moderate. Mostly cover and some food.	Tolerates all sun/shade conditions. Tolerates acidic soil.
Eastern Red Cedar *(Juniperus virginiana)*	4,5,6	Conif. Tree	yes	no	High. Fruit for birds. Some cover.	Full sun to partial shade. Common in wetlands, shrub bogs and edge of streams.
Elderberry *(Sambucus canadensis)*	4,5,6	Dec. Shrub	yes	yes	Extremely high for food and cover, for birds and mammals.	Full sun to partial shade.
Flowering Dogwood *(Cornus florida)*	4,5,6	Dec. Tree	no	yes	High, birds, food.	Prefers rich, moist soils. Dogwood anthracnose possible problem.
Fringe Tree *(Chionanthus viginicus)*	3,4,5	Dec. Shrub or small tree	yes	some	Moderate. Food and cover.	Full sun to partial shade. Tolerates acidic soil.
Green Ash, Red Ash *(Fraxinus pennsylvanica)*	4,5	Dec. Tree	yes	yes	Moderate, songbirds.	Rapid growing stream bank stabilizer. Full sun to partial shade.
Hackberry *(Celtis occidentalis)*	5,6	Dec. Tree	yes	yes	High, food and cover.	Full sun to partial shade.
Ironwood/ Hophornbeam *(Ostrya virginiana)*	5,6	Dec. Tree	yes	yes	Moderate, food and browse.	Tolerant of all sunlight conditions.
Larch, Tamarack *(Larix laricina)*	3,4	Conif. Tree	no	yes	Low, nest tree and seeds.	Rapid initial growth. Full sun, acidic boggy soils.
Loblolly Pine *(Pinus taeda)*	5,6	Conif. Tree	yes	yes	Moderate, food, nesting, squirrels.	Coastal Plain only. Tolerant of extreme soil conditions.

***Zone 1:** Submergent Aquatic Vegetation*
***Zone 2:** Shallow Water Bench - 6-12 inches Deep*
***Zone 3:** Shoreline Fringe - Regularly Inundated Area*
***Zone 4:** Riparian Fringe - Periodically Inundated Area, Wet Soils*
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