2024 DEQ Stormwater and ESC Guidance; What Soil Scientists Need to Know

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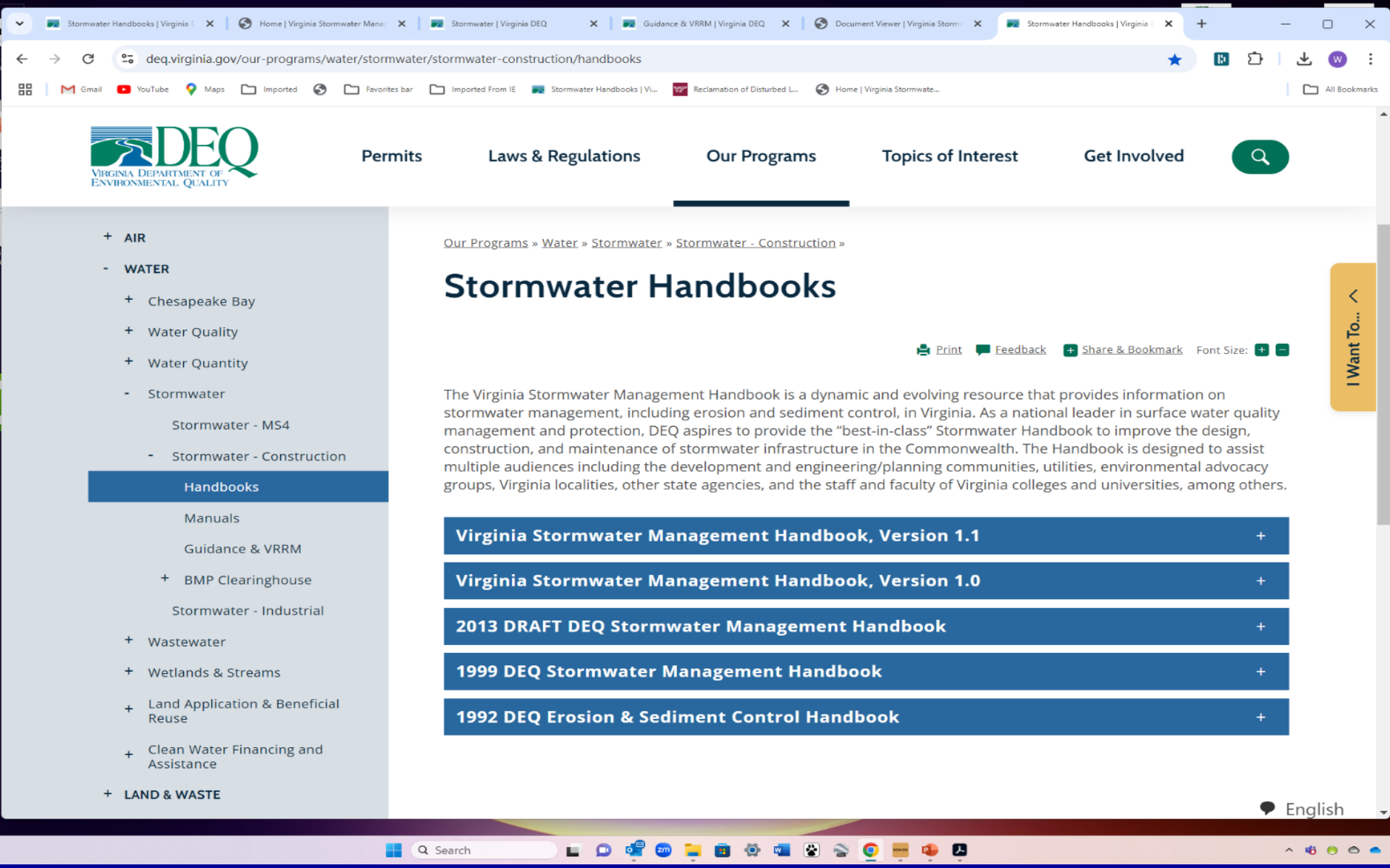
Topics for Today

- Review recent history of DEQ SW/ESC handbook(s)
- Introduce 7/1/24 combined Manual online version
- Focus on underlying definitions and guidance related to stabilization, soils and revegetation requirements
- Review certain SW applications, particularly CN adjustments for disturbance & solar, biofilter media
- New guidance for , solar and acid sulfate materials and related DEQ/VDOT regulatory changes
- What are the opportunities in soil science for VAPSS professionals?

The Short History!



2011 vs. 2013 Posted BMP Versions?

Many (but not all) SW BMPs were extensively revised in 2011 and those versions underwent public review.

In 2013, revised versions were posted and "presumed" by DEQ and others to be the guidance (not regulation) in force.

This was challenged by many and only the 2011 specifications and criteria were able to stand up to challenges where and when they occurred.

For some reason (?) the posted 2013 versions remained up (in track changes format!) on the DEQ x VT Stormwater Clearinghouse.

Tables 9.3 and 9.4 outline the Level 1 and 2 design guidelines for the two scales of bioretention design.

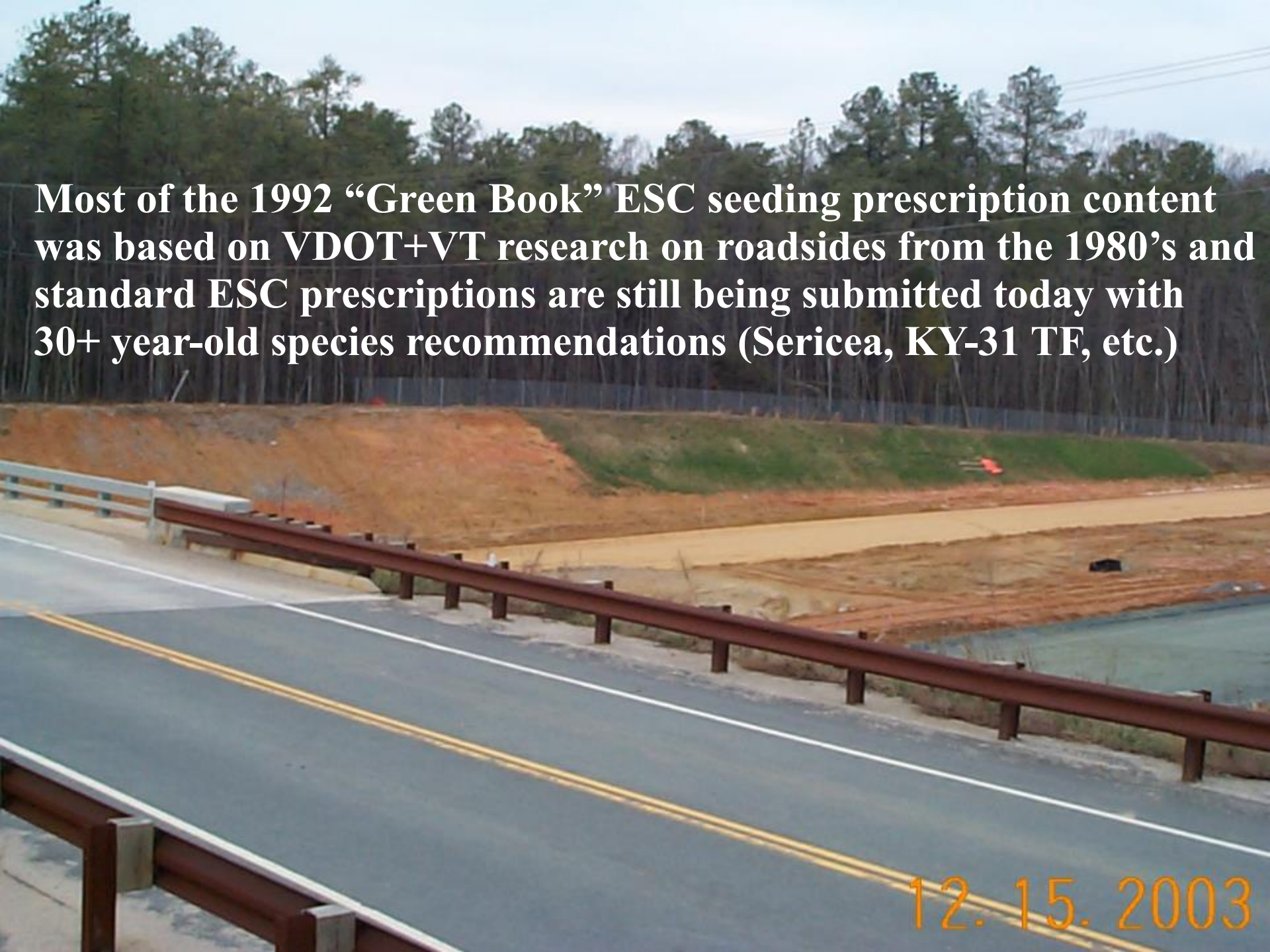
Table 9.3. Micro-Bioretention (Rain Garden) Design Criteria[1]

Level 1 Design (RR 40 TP: 25)	Level 2 Design (RR: 80 TP: 50)
Sizing: Tv_{BMP} = [(1)(Rv)(A) / 12] ~~Filter surface area (sq. ft.) = 3% [2] of the contributing drainage area (CDA).~~	Sizing: Tv_{BMP} = [(1.25)(Rv)(A) / 12] ~~Filter surface area (sq. ft.) = 4% [2] of the CDA~~ (can be divided into different cells at downspouts).
Maximum contributing drainage area = 0.5 acres; 25% Impervious Cover (IC) [2]	
One cell design (can be divided into smaller cells at downspout locations) [2]	
Maximum Ponding Depth = 6 inches	
Filter Media Depth minimum = 18 inches; Recommended maximum = 36 inches	Filter Media Depth minimum = 24 inches; Recommended maximum = 36 inches
Media: mixed on-site or supplied by vendor	Media: supplied by vendor
All Designs: Media mix tested for an acceptable hydraulic conductivity (or permeability) and phosphorus content (**Section 6.6**)	
Sub-soil testing: not needed if an underdrain is used;	Sub-soil testing: one per practice; Min infiltration rate > 1/2 inch/hour and > 1 inch/hour in order to remove the underdrain requirement.
Underdrain: corrugated HDPE or equivalent.	Underdrain: corrugated HDPE or equivalent, with a minimum 6-inch stone sump below the invert; ***OR*** none, if soil infiltration requirements are met
Clean-outs: not needed	
Inflow: sheetflow or roof leader	
Pretreatment: external (leaf screens, grass filter strip, energy dissipater, etc.).	Pretreatment: external *plus* a grass filter strip
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).
Building setbacks[3]: 10 feet	

[1] Consult **Appendix 9-A** for design criteria for Urban Bioretention Practices.

[2] Micro-Bioretention (Rain Gardens) can be located at individual downspout locations to treat up to ~~1,000~~2,500 sq. ft. of impervious cover (100% IC). ~~; the surface area is sized as 5% of the roof area (Level 1) or 6% of the roof area (Level 2), with the remaining Level 1 and Level 2 design criteria as provided in **Table 9.2**. If the Rain Garden is located so as to capture multiple rooftops, driveways, and adjacent pervious areas, the sizing rules within **Table 9.2** should apply~~.

[3] These are recommendations for simple building foundations. If an in-ground basement or other special conditions exist, the design should be reviewed by a licensed engineer. Also, a special footing or drainage design may be used to justify a reduction of the setbacks noted above.


Most of the 1992 “Green Book” ESC seeding prescription content was based on VDOT+VT research on roadsides from the 1980’s and standard ESC prescriptions are still being submitted today with 30+ year-old species recommendations (Sericea, KY-31 TF, etc.)
12. 15. 2003

2024 Online Version

You download the whole thing (89 Mb) or any individual sections or pages.

End product of a three-year process.

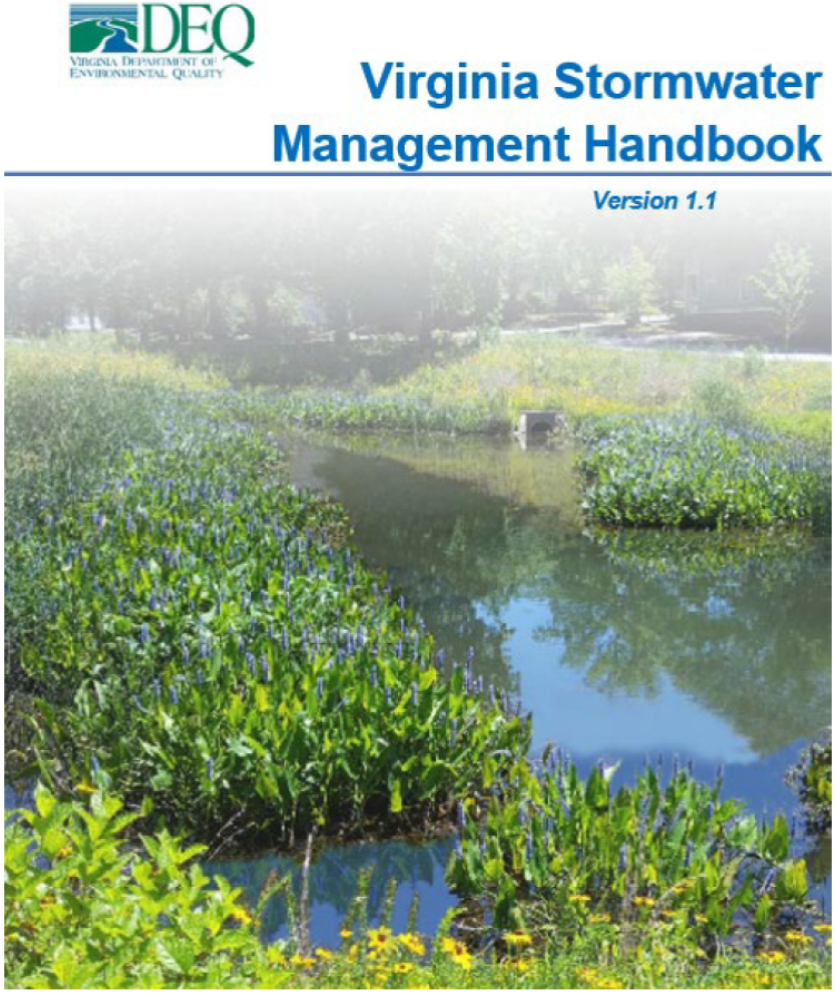
Initiated by DEQ in early 2021; over 5000 pages of separate manuals and BMPs edited and condensed down to around 1200 today counting appendices.

Overall process managed by Arcadis and DEQ via a long series of Scientific Advisory Group (SAG) meetings with 50+ stakeholders with sequential input over time.

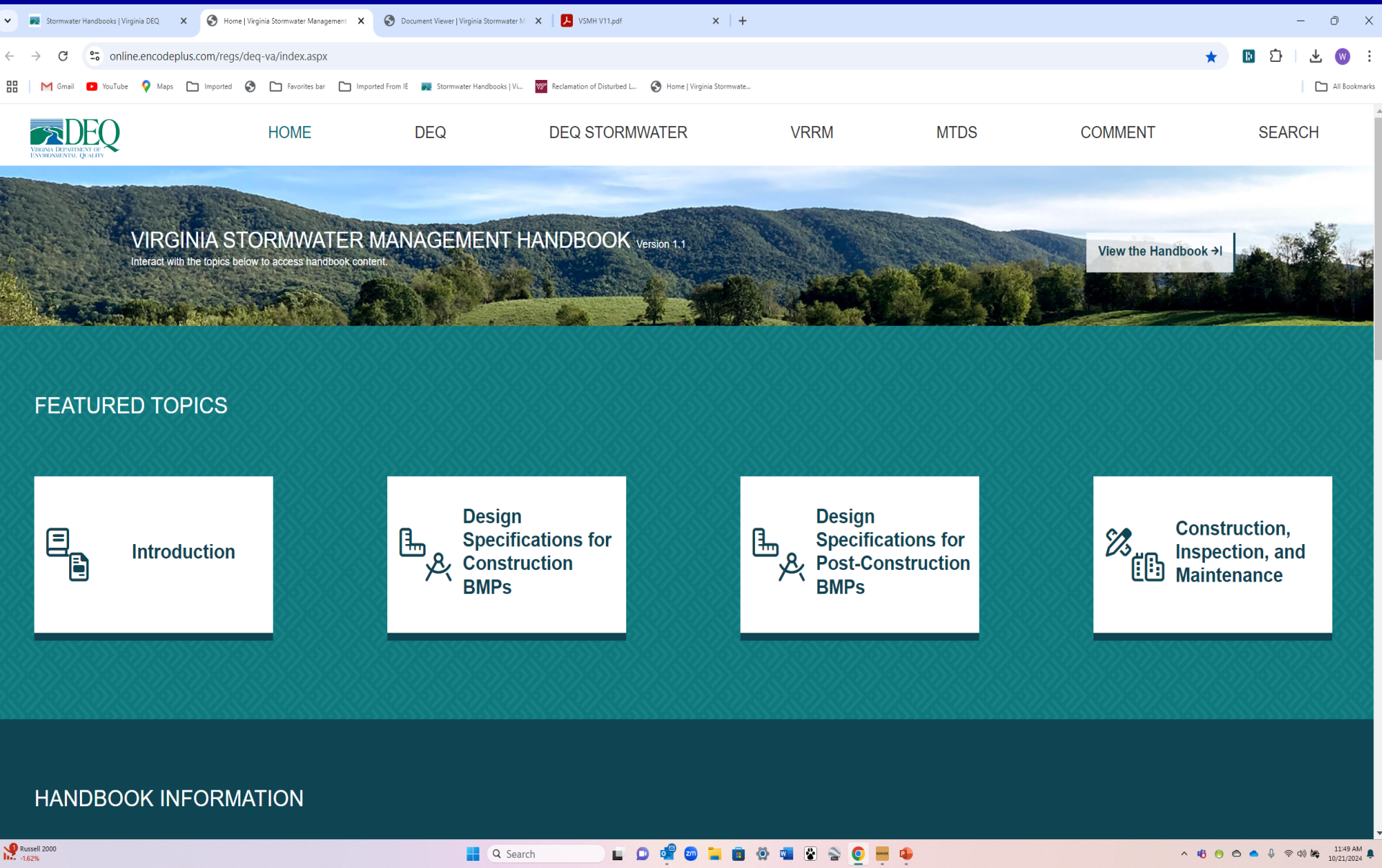
Final decisions/edits made by DEQ staff.

Online version will be updated over time; replaces older Virginia Tech Stormwater Clearinghouse site as "official source".

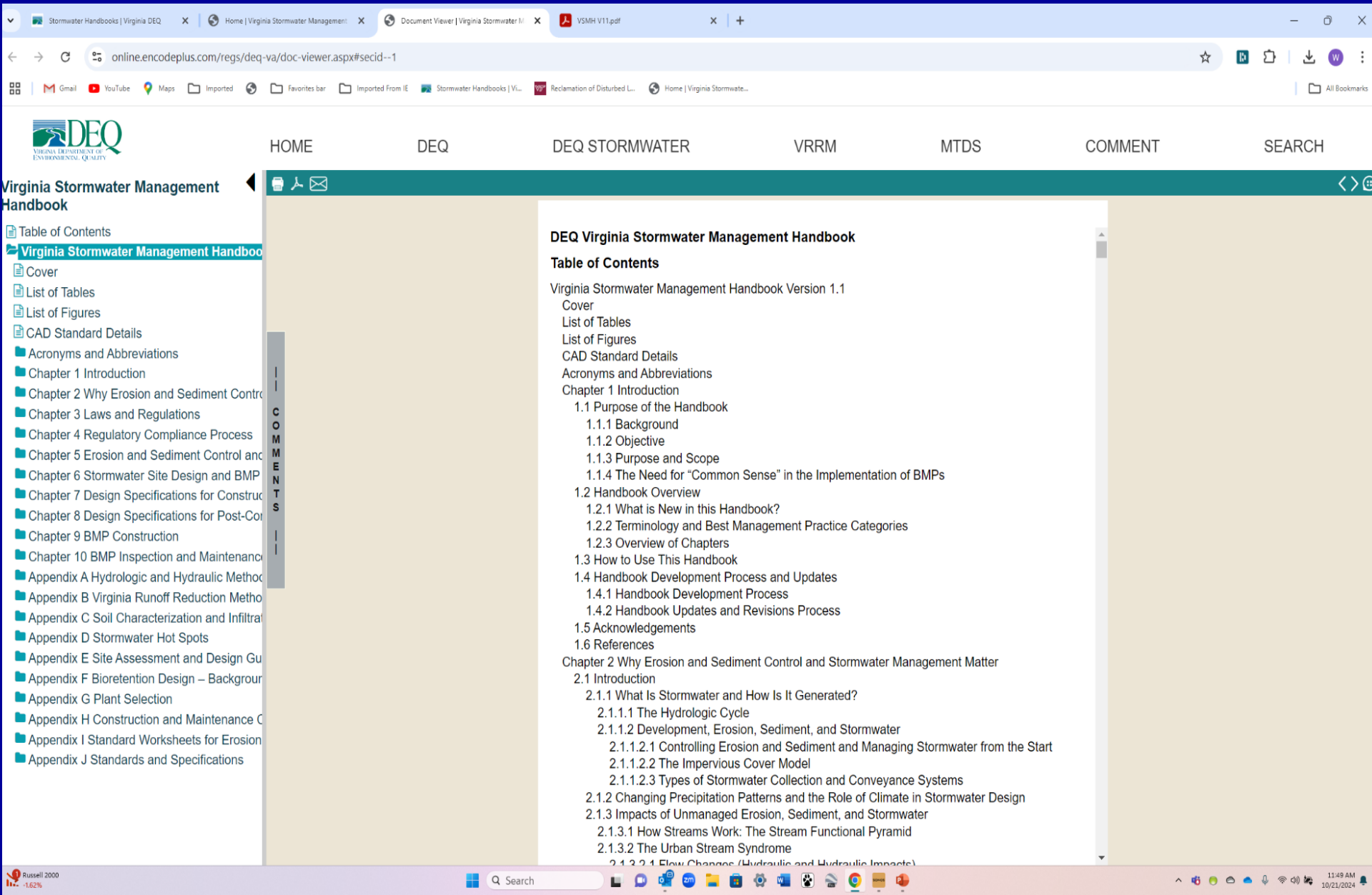
Older criteria applicable to permits issues and/ or under review to date. New criteria mandatory after July 1, 2025.



How do I get to the new one? https://online.encodeplus.com/regs/deq-va/index.aspx



All content is online and hotlinked!



Underlying Regulation and Definitions

- 9VAC25-875-10 to 9VAC25-875-1420; July 1, 2024

- "Denuded" means a term applied to land that has been physically disturbed and no longer supports vegetative cover.

- "Dormant" means denuded land that is not actively being brought to a desired grade or condition.

- "Land disturbance" or “land-disturbing activity” means a manmade change to the land surface that may result in soil erosion or has the potential to change its runoff characteristics, including construction activity such as the clearing, grading, excavating, or filling of land.

Underlying Regulation and Definitions

- **1. Land-disturbing activity that disturbs 10,000 square feet or more, although the locality may reduce this regulatory threshold to a smaller area of disturbed land, is less than one acre, not in an area of a locality designated as a Chesapeake Bay Preservation Area, and not part of a common plan of development or sale, is subject to criteria defined in Article 2**

- **2. Land-disturbing activity that disturbs 2,500 square feet or more, although the locality may reduce this regulatory threshold to a smaller area of disturbed land, is less than one acre, and in an area of a locality designated as a Chesapeake Bay Preservation Area is subject to criteria defined in Article 2 and Article 3**

- **3. Land-disturbing activity that disturbs less than one acre, but is part of a larger common plan of development or sale that disturbs one acre or more, is subject to criteria defined in Article 2 and Article 3 of Part V unless Article 4 of Part V of this chapter is applicable**

Underlying Regulation and Definitions

Major Exemptions:

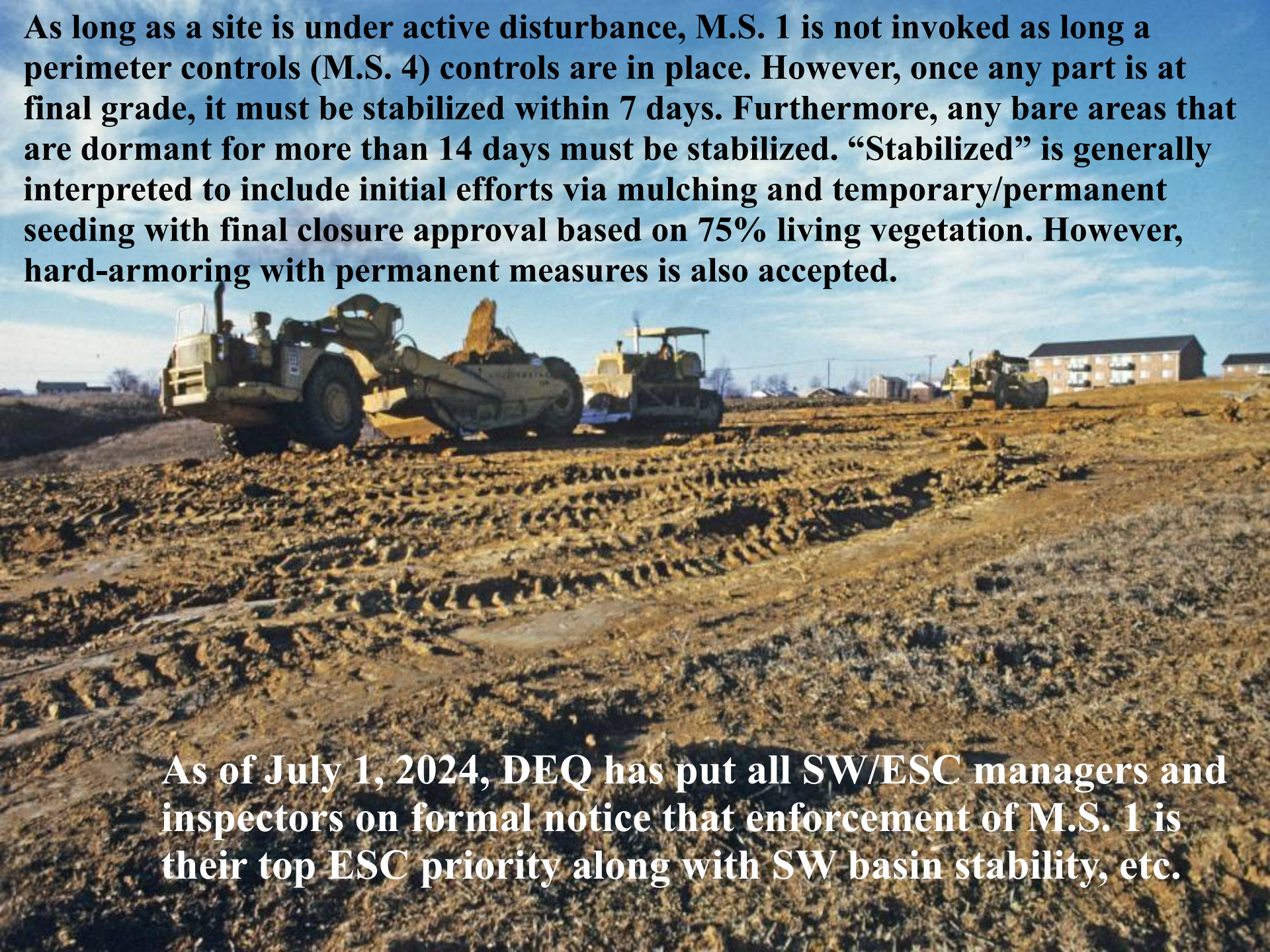
- Gardening & landscaping
- Routine maintenance/repair of sidewalks, etc.
- Permitting mining activities
- Agricultural clearing and management practices
- Forestry operations in compliance with other BMPs
- Emergency repairs
- Installation/repair of septic systems
- Approved shoreline/wetland protection projects
- Etc, Etc.

9VAC25-875-560. Erosion and sediment control criteria, techniques, and methods: minimum standards.

- **M.S. 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.

- **M.S. 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, is mature enough to survive, *and will inhibit erosion.*

As long as a site is under active disturbance, M.S. 1 is not invoked as long a perimeter controls (M.S. 4) controls are in place. However, once any part is at final grade, it must be stabilized within 7 days. Furthermore, any bare areas that are dormant for more than 14 days must be stabilized. "Stabilized" is generally interpreted to include initial efforts via mulching and temporary/permanent seeding with final closure approval based on 75% living vegetation. However, hard-armoring with permanent measures is also accepted.



As of July 1, 2024, DEQ has put all SW/ESC managers and inspectors on formal notice that enforcement of M.S. 1 is their top ESC priority along with SW basin stability, etc.

Typical initial land clearing operations on a central Piedmont USS site in Clifford soils. Topsoil here is being stripped and then returned following cut/fill grading to level slopes for arrays

So, it is clear that our first and primary challenge is one of relatively simple revegetation protocols for ESC during site development & early stabilization.

From presentation by Mike Rolband, VA DEQ Director, 4/6/23, CBF x STAC Workshop

DEQ

The Simple Stuff – Stabilization/Revegetation
Temporary Seeding – C - SSM - 09

This best management practice (BMP) applies where exposed soil surfaces are not to be fine-graded for periods longer than 14 days. Such areas include bare areas, soil stockpiles, dikes, dams, sides of sediment basins, temporary road banks, non-vegetated cuts and fills, and diversions (see MS #1 and MS #2).

Apply a permanent vegetative cover to areas that will be left dormant for a period of more than 1 year.

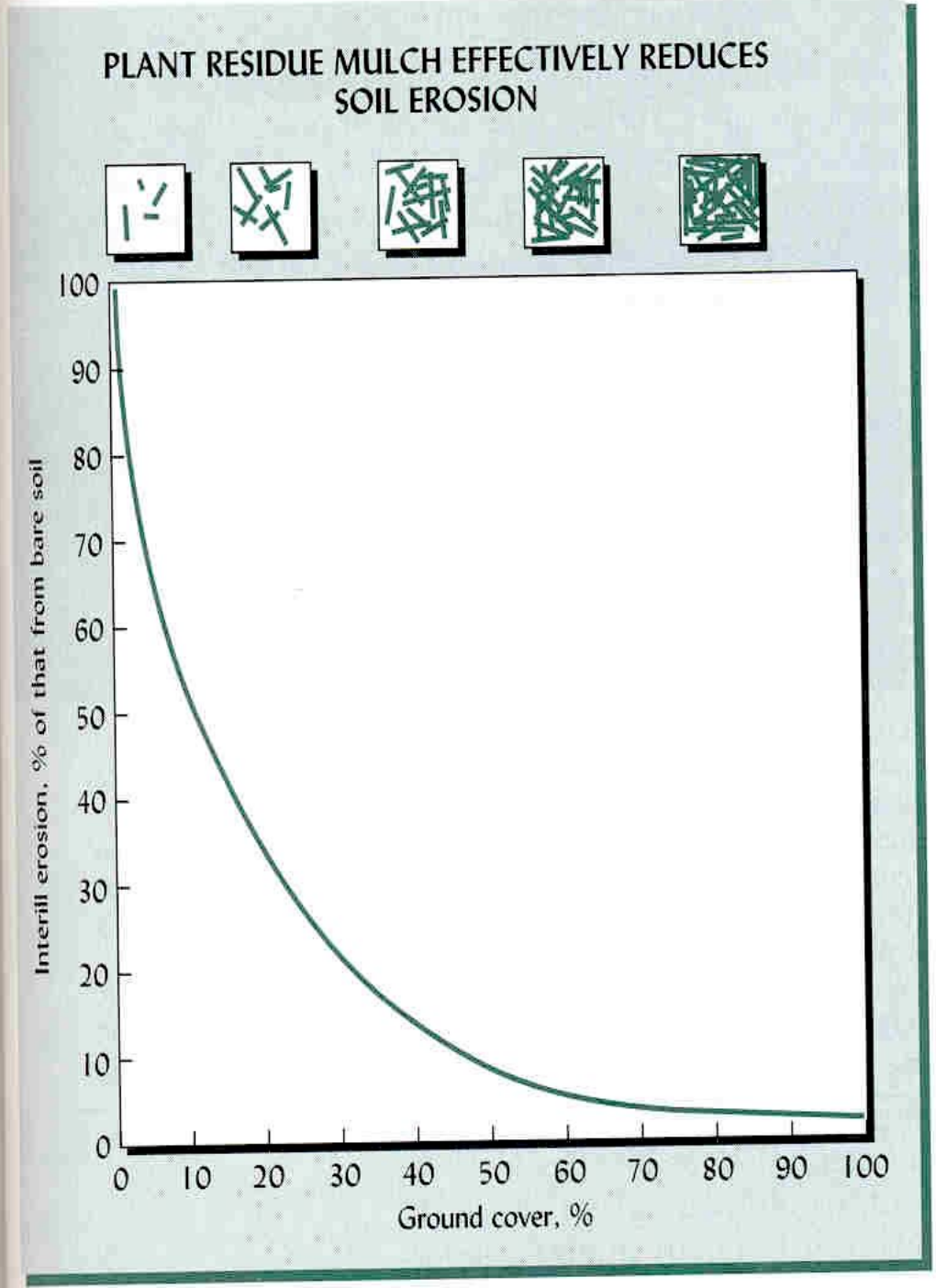
3.0 Planning and Considerations

Sheet erosion, caused by the impact of rain on bare soil, is the source of most fine particles in sediment. To reduce this sediment load in runoff, protection of the soil surface is necessary. The most efficient and economical means of controlling sheet and rill erosion is to establish vegetative cover with at least 75 percent living vegetative cover with a maximum contiguous bare area of less than 500 square feet. Annual plants that sprout rapidly and survive for only one growing season are suitable for establishing initial or temporary vegetative cover. Temporary seeding is encouraged when possible to aid in controlling sediment losses and sheet flow from construction sites and other partially disturbed and non-vegetated areas.

Initial and continuing response from reviewers and new users:

Where the hell did that 75% living cover value come from?

500 square feet; are you kidding me?



The effects of mulch residue or living vegetative covers on limiting interill soil erosion are well documented in dozens of studies. Note the "flattening" of response > 75%, but > 90% control at 60%.

Most erosion models and other regulations (e.g. mining) set the target at 90% cover with 90% confidence in the measurement.

Note that intact mulch counts for erosion protection here *as long as it holds up.*

FIGURE 17.12 Reduction in interrill erosion achieved by increasing ground cover percentage. The diagrams above the graph illustrate 5, 20, 40, 60, and 80% ground cover. Note that even a light covering of mulch has a major effect on soil erosion. The graph applies to interrill erosion. On steep slopes, some rill erosion may occur even if the soil is well covered. [Generalized relationship based on results from many studies]

The Simple Stuff – Stabilization/Revegetation

Temporary Seeding – C - SSM - 09

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

Activity	Notes on Proper Performance
Plant Selection	Select plants appropriate to the season and site conditions from Table C-SSM-09-3 and Table C-SSM-09-4. Note that Table C-SSM-09-3 presents plants that can be used without extensive evaluation of site conditions; Table C-SSM-09-4 presents more in- depth information on the plant materials.
Seedbed Preparation	To control erosion on bare soil surfaces, plants must be able to germinate and grow. Good seedbed preparation is essential to successful plant establishment. A good seedbed is loose and uniform, with at least 35 percent soil-sized particles (<2mm). Where hydroseeding methods are used, the surface may be left with a more irregular surface of large clods and stones. Minimize steep slopes because steep slopes challenge seedbed preparation and increase the erosion hazard.

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

Activity	Notes on Proper Performance
Surface Roughening	If the area has been recently loosened or disturbed, no further roughening is required. When the area is compacted, crusted, or hardened, loosen the soil surface by discing, raking, harrowing, or other acceptable means according to Surface Roughening (BMP C-SSM-03).
Tracking	Tracking with bulldozer cleats is most effective on sandy soils. This practice often causes undue compaction of the soil surface, especially in clayey soils, and does not aid plant growth as effectively as other methods of surface roughening.

The Simple Stuff – Stabilization/Revegetation

Permanent Seeding C – SSM – 10

3.0 Planning and Considerations

Vegetation controls erosion by reducing the velocity and volume of overland flow and protecting the bare soil surface from raindrop impact.

Areas that must be stabilized after the land has been disturbed require vegetative cover. The most common and economical means of establishing this cover is by seeding grasses and legumes. Permanent vegetative covers must meet the requirements of Minimum Standard #3.

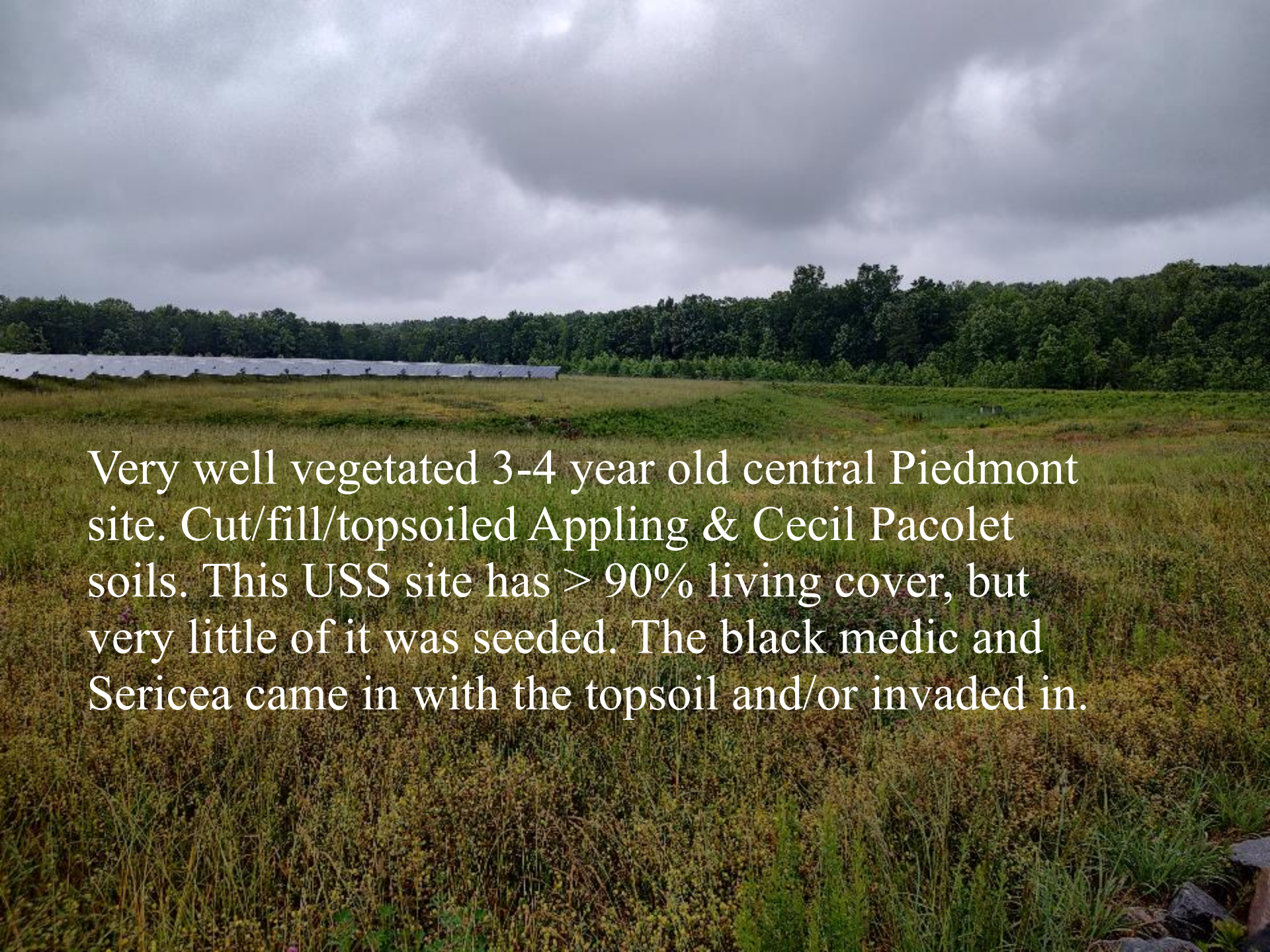
Advantages of seeding over other means of establishing plants include the small initial establishment cost, the wide variety of grasses and legumes available, low labor requirement, and ease of establishment in difficult areas.

Disadvantages include the potential for erosion during establishment, a need to reseed areas that fail to establish, limited periods during the year suitable for seeding, the potential need for weed control during establishment, and a need for water and appropriate climatic conditions during germination.

There are so many variables in plant growth that an ideal outcome cannot be guaranteed. Much can be done in the planning stages to increase the chances for successful seeding. Selection of the right plant materials for the site, good seedbed preparation, and conscientious maintenance are important.

An establishment and persistence of 75 percent or more living overall perennial vegetation of the intended species mix and a maximum contiguous bare area of < 500 square feet is required to effectively limit sheet and rill erosion and permanently stabilize the soil surface.

New criteria include the 75% living cover, intended species and no bare areas > 500 ft^2. Guidance language also allows inclusion of other "acceptable species" (e.g. non-seeded).


Very well vegetated 3-4 year old central Piedmont site. Cut/fill/topsoiled Appling & Cecil Pacolet soils. This USS site has > 90% living cover, but very little of it was seeded. The black medic and Sericea came in with the topsoil and/or invaded in.

The Simple Stuff – Stabilization/Revegetation
Permanent Seeding C – SSM – 10

Seedbed Preparation	Modification of the soil on a disturbed site provides the optimum environment for seed germination and seedling growth. For water infiltration and root penetration to occur, the surface soil needs to be loose and non-compacted to at least six inches. Deeper loosening (de-compaction) may be required on compacted fill or smeared cut slopes. To ensure that soil pH (balance of acidity vs. alkalinity) is adequate and reduce root toxicities, VDACS approved liming materials should be applied to adjust the pH to between 6.0 and 7.5. Sufficient N-P-K will need to be added as fertilizers or other approved soil amendments (e.g. compost). After the seed is in place, protect the new seedlings with mulch, applied over or with seeding, to retain moisture and moderate temperature extremes. Mulch also helps to stabilize the disturbed site against sediment losses until the vegetation establishes.
Non-Native, Invasive & Pollinator Friendly Plant Considerations	Many of the plant species commonly utilized for permanent seedings are not native to Virginia and are considered by Virginia DCR (20~~17~~22) to be invasive with respect to their ability to move into adjacent relatively natural areas. This is primarily due to their higher probability of success for establishing and persisting in highly disturbed environments vs. available native grasses and forbs. Therefore, revegetation planners and practitioners should take these concerns into account when determining seed mixtures for a given site. Greater emphasis is also being placed upon establishment of "pollinator friendly" flowering species into revegetation protocols for disturbed sites. In general, establishment and maintenance of native grasses and pollinator friendly species mixes requires a higher level of establishment and management inputs than the more conventional seeding mixtures described later in this guidance.

The Simple Stuff – Stabilization/Revegetation
Permanent Seeding C – SSM – 10

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The Simple Stuff – Stabilization/Revegetation
Permanent Seeding C – SSM – 10

Table C-SSM-10-6 Suggested and Example Site-Specific Seeding Mixtures for Appalachian/Mountain Area

Site Condition	Seed Mix		Application Rate (pounds per acre)
Minimum-Care Lawn Commercial or Residential	Turf-Type Tall Fescue	90-100%	150 – 200
	Improved Perennial Ryegrass*	0-10%	
	Kentucky Bluegrass	0-10%	
High-Maintenance Lawn	Bluegrass – minimum of three to five varieties from VCIA list for use in Virginia		125
	Improved VCIA Turf-Type Tall Fescue		150 – 200
General Slope (3H:1V or less)	Tall Fescue****		50 – 75
	Red Top and/or Hard Fescue		10 – 20
	White Clover and/or Birdsfoot Trefoil***		10 – 20
	Seasonal Nurse Crop **		30 – 40

*** All legume seed must be properly inoculated. Legumes recommended unless periodic N fertilization maintenance intended.

Flatpea at 20 lbs/acre may be utilized where warranted. All legume seed must be properly inoculated. Weeping lovegrass may also be included in any slope or low-maintenance mixture during warmer seeding periods; add 10 to 20 lbs/acre in mixes.

**** Increase seeding rate if Kentucky 31 is used rather than VCIA/VDOT improved varieties.

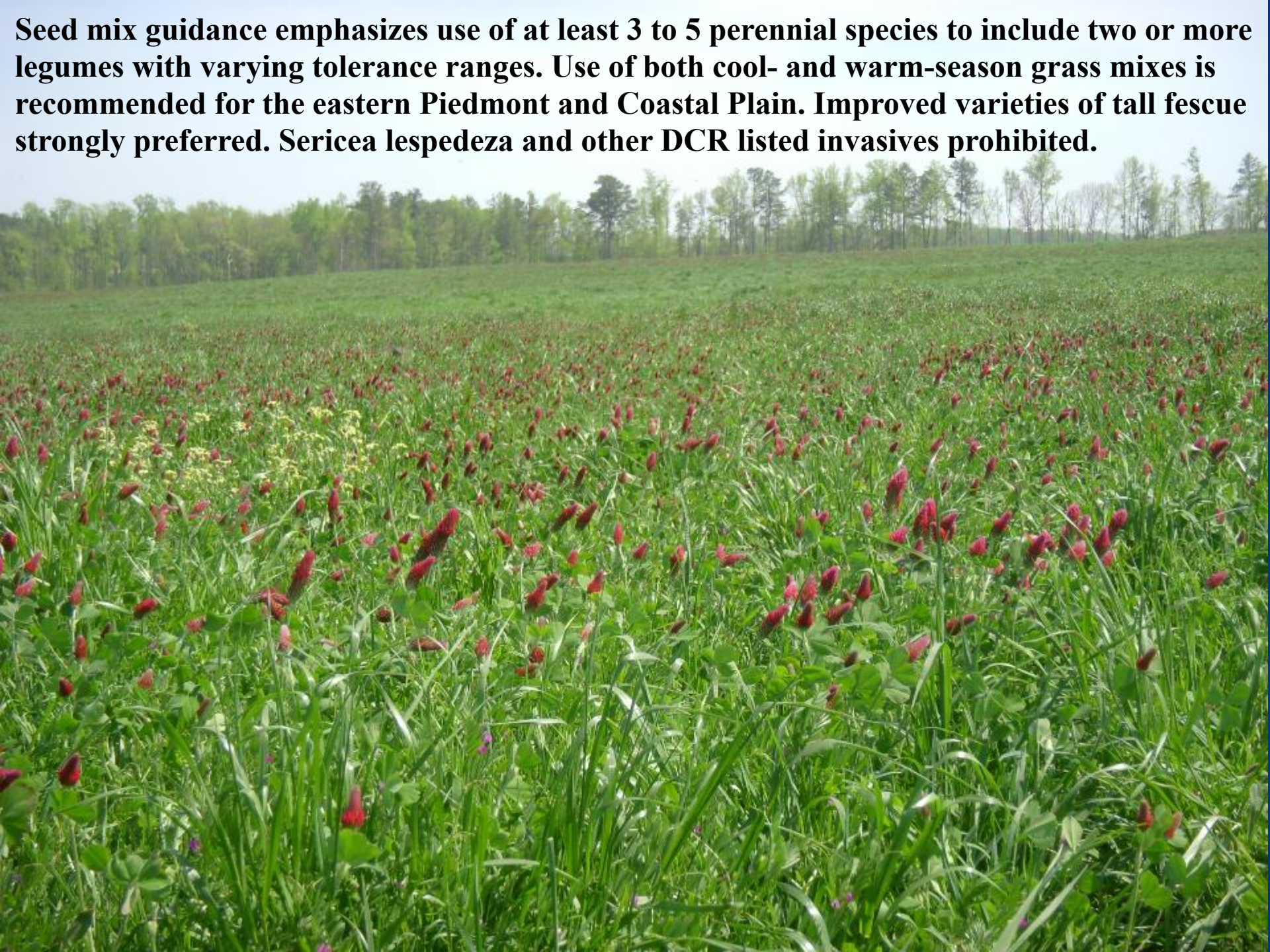
Note: Seed mixes are suggested and subject to modification based on site-specific conditions by an agronomist or other qualified revegetation professionals. All seed rates expressed as PLS (Pure Live Seed; see Table C-SSM-10-9).

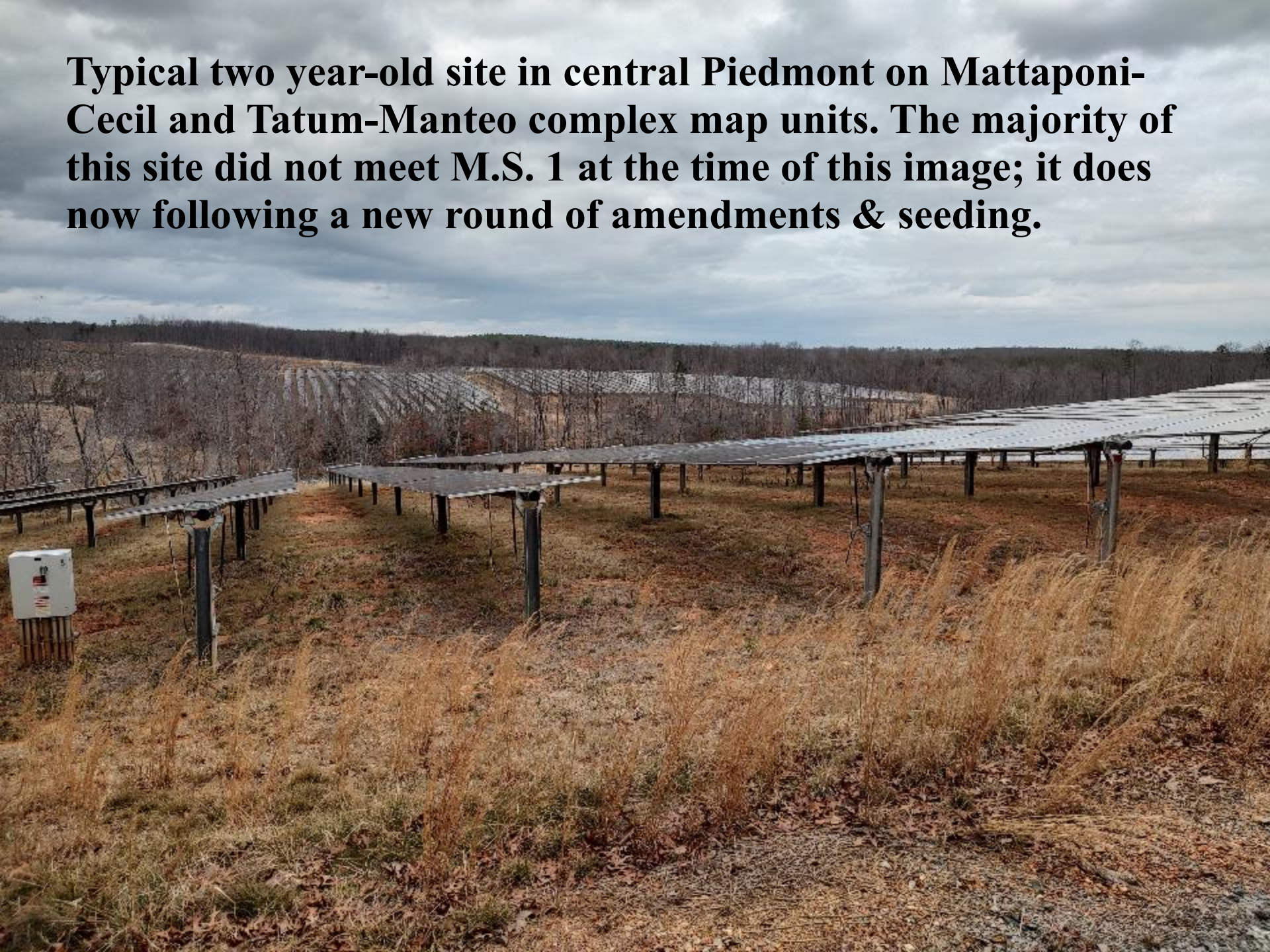
The Simple Stuff – Stabilization/Revegetation
Permanent Seeding C – SSM – 10

Table C-SSM-10-5 Characteristics of Legumes Appropriate for Erosion Control

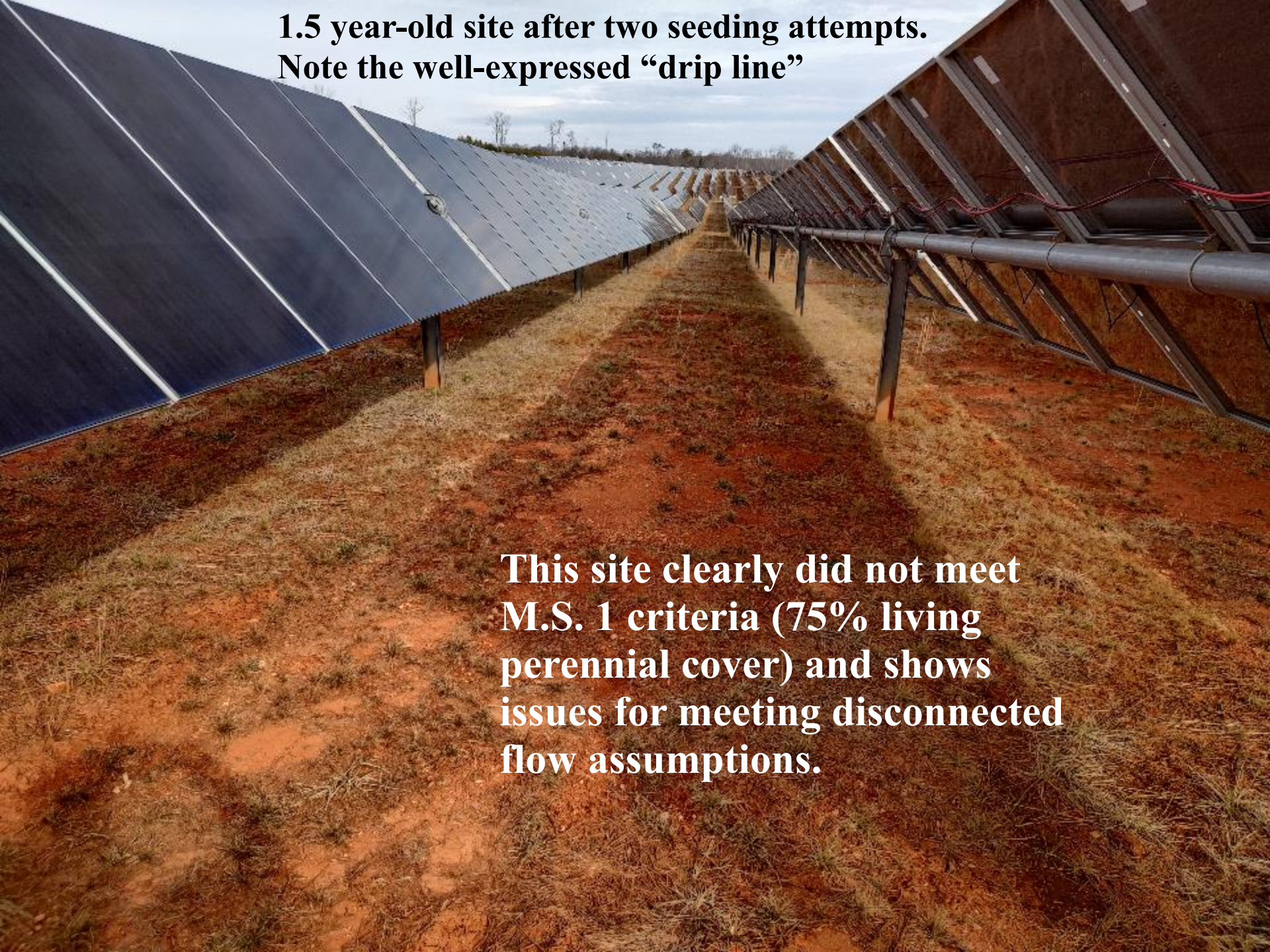
Common Name (Botanical Name)	Life Cycle	Season	pH Range	Germination Time (days)	Optimum Germination Temperature (° F)	Winter Hardiness	Drought Tolerance	Fertility	Soil Drainage Tolerance	Seeding Rate (lbs/acre) PLS*	Maintenance Requirements	Remarks	Suggested Varieties for Virginia
Flatpea (*Lathyrus silvestrus*)	P	C	5.0 - 7.0	14 - 28	65 - 75	G	G	L	PD	10-15	Needs lime and high phosphorus. Good shade tolerance.	Tolerates acidic and wetter soils better than other legumes.	Lathco
Birdsfoot trefoil (*Lotus corniculatus*)	P	C	6.0 - 6.5	7	65 - 70	G	F	M	SPD	15-25	Inoculation is essential. Grows in medium-fertile, slightly acid soils.	Grows better on poorly drained soils than most legumes. Moderate heat tolerance.	Audewey Empire Fergus Norcean
Annual Lespedezas (*Lespedeza striata, L. stipulacea*)	A	W	5.8 - 6.2	14	70 - 85	F	VG	L	MWD	20-30	Will grow on almost any well-drained soil.	Choose Kobe for southeastern VA; needs almost no nitrogen to survive.	Kobe, Korean
Red clover (*Trifolium pratense*)	P	C	6.0 - 6.5	7 - 14	70	G	F	M	SPD	15-20	Needs high levels of phosphorus and potassium.	Acts as a biennial. Can be added to low-maintenance mixes.	Kenstar, Kenland
White clover (*Trifolium repens*)	P	C	6.0 - 6.5	10	70	G	P	M	PD	10-15	Requires favorable moisture, fertile soils, high pH.	Spreads by soil surface stolons, white flowers.	Common, White Dutch
					F)								
Partridge Pea	A	Warm	5.5 - 7.0	10-14	70	G	G	L	MWD	10-15	Good for initial restoration; can reseed; tolerates sandy soils	Native; high pollinator value	Lark, Riley Comanche

Seed mix guidance emphasizes use of at least 3 to 5 perennial species to include two or more legumes with varying tolerance ranges. Use of both cool- and warm-season grass mixes is recommended for the eastern Piedmont and Coastal Plain. Improved varieties of tall fescue strongly preferred. Sericea lespedeza and other DCR listed invasives prohibited.





Typical two year-old site in central Piedmont on Mattaponi-Cecil and Tatum-Manteo complex map units. The majority of this site did not meet M.S. 1 at the time of this image; it does now following a new round of amendments & seeding.


1.5 year-old site after two seeding attempts.
Note the well-expressed “drip line”
This site clearly did not meet M.S. 1 criteria (75% living perennial cover) and shows issues for meeting disconnected flow assumptions.

Topsoiling – C – SSM -02

1.0 Definition

Topsoil is defined as the A and E horizons of the existing mineral soil profile. Well humified litter layer (O horizon) material may also be included but not fresh or partially decomposed litter. Topsoiling as a construction best management practice (BMP) entails preserving and using the surface layer of undisturbed soil, often enriched in organic matter, to obtain a more desirable planting and growth medium and enhance final site stabilization.

Source: Wetlands Inc. 2021

2.0 Purpose and Applicability of Best Management Practice

Topsoiling provides a suitable growth medium for final site-stabilizing vegetation.

The site should be evaluated in the field to determine if there is sufficient topsoil of good quality to justify stripping. Topsoil should be friable and Natural Resources Conservation Service (NRCS) texture class loam (loam, sandy loam, silt loam, sandy clay loam, clay loam). Heavy loads of debris, trash, stumps, rocks, roots, and noxious weeds should not be present, and the soil should demonstrate the ability to support healthy vegetation.

All topsoil should be tested by a qualified laboratory for the following criteria:

1. Organic matter as humus content should be not less than 1.5% by weight.
2. pH range should be from 6.0 to 7.5. If pH is less than 6.0, lime should be added in accordance with soil test results or in accordance with the recommendations of the vegetative establishment practice being used.
3. Soluble salts concentrations should not exceed 500 parts per million (ppm).

If additional off-site or manufactured topsoil is needed, or if the topsoil is modified, it should meet these standards.

Bioretention - P-FIL-05 (SW)

Wide range of types/applications. New 2024 criteria allow for using entire underlying soil "ponded footprint" for an infiltration media if Ksat is between 0.5 and 10 inches per hour and field confirmed. Most designed in compliance with new VRRM (I will not cover that here!) for P removal credit and/or for stormwater peak flow (Q) reduction.

Bioretention - P-FIL-05

Table F-1 Filter Media Criteria and Testing for Bioretention

Filter Media Criterion	Description	Standard(s)	Testing Method
General Composition	Filter media must have the proper proportions sand, fines, and organic matter to promote plant growth, drain at the proper rate over time, and filter pollutants, particularly P.	80%–90% sand; 10%–20% soil fines (silt+clay); maximum clay content:10% 3%–5% organic matter content by weight	Particle size analysis via Soil Survey Staff (2014) on mineral blend only or following organic matter removal; Grind sample to < 2.0 mm for organic matter via Loss on Ignition (LOI) or Walkley-Black. Nelson & Sommers (1982). Also in Sparks et al. 2020.
Sand Component	Medium to coarse aggregate natural mineral source or quartz substitute. Do not use ground concrete, aggregate, bottom ash, or other similar materials.	(< 2.0 to 0.05 mm); Mica < 5%.	Standard dry sieve analysis
Topsoil	Loamy sand, Sandy Loam, or Loam Based on U.S. Department of Agriculture (USDA) Textural Triangle	NRCS texture class based on < 2mm. For whole sample, no more than 20% total > 2.0 mm; all must pass 9.5 mm.	PSA via Soil Survey Staff (2014)
Organic Amendment	Stable, well-aged, clean compost from leaf litter, humus, peat moss or other suitable organic source(s)	See P-FIL-08 Soil Compost Amendment for criteria for suitable organic materials.	See the following for methods: Compost Research & Education Foundation: https://www.compostfoundation.org/Portals/2/Images/Bioretention.pdf

Bioretention - P-FIL-05

Filter Media Criterion	Description	Standard(s)	Testing Method
Cation Exchange Capacity (CEC)	CEC measures soil reactivity and ability to retain ions against leaching. CEC generally increases with OM and clay content and pH.	CEC: > 5.0 milliequivalents per 100 grams (or cmolc per kg) via pH 7 NH_4OAc method.	Soil Survey Staff 2014. Based on Sumner & Miller (1996) or other similar unbuffered salt methods. Also in Sparks et al. (2020).
Permeability (Ksat)	Refers to the hydraulic conductance (Ksat) of the filter media.	Ksat = 1 to 2 inches/hour. Rates will most likely be higher. Initial rates ≤ 10 inches/hour acceptable	Virginia Department of Transportation (VDOT) × Virginia Department of Environmental Quality (VDEQ) 2021 VTM-134, or procedures in Appendix C Infiltration Practices. https://www.virginiadot.org/business/resources/Materials/bu-mat-VTMs.pdf
Extractable P	Filter media with high P levels will export P through the media and potentially to downstream conveyances or receiving waters.	Mehlich I 5–15 mg/kg or Mehlich III 18–40 mg/kg	Mehlich I or Mehlich III extraction of < 2mm ground whole media sample.
pH	Soil pH influences plant nutrient availability, microbial populations and net soil charge/reactivity.	Between 5.5 and 7.5	1:1, 1:2 soil:water or saturated paste soil extract. Soil Survey Staff (2014)
Soluble Salts	Filter media with high levels of soluble salts can injure or kill plants and can clog the filter media	Less than 4.0 mmhos/cm	Saturated paste soil extract. Soil Survey Staff (2014)

Chapter 6 – Stormwater & BMPs

- **6.3.1.5.2 – Solar sites must meet M.S. 1, % living cover criteria, adjust runoff CN's for disturbance and treat panels as impervious surfaces (with some exceptions)**

- **6.3.1.5.3 – Solar site CN's are presumed to based on bare soil conditions during construction and modified by increasing the HSG assigned class by 1 letter (e.g. B to C) for post-disturbance conditions. CN's adjusted upward again if % panel coverage is > 30% of the catchment associated with a given basin or discharge point.**

- **6.3.1.5.4 – Imperviousness requirements waived if rain sensors are employed to turn tracking panels vertical for when design storm (Ia) rainfall received.**

- **6.3.1.5.5 – Soils must be "decompacted" to meet B.D. criteria (e.g. 1.85 g/cm3 for sands; 1.45 for massive clays). Minimum separation distances to ensure "disconnected flow", use diverse sun/shade tolerant mixes with legumes and or native/pollinators, etc.**

HSG CN Allocations via VRRM

E. Unadjusted and adjusted post-development CNs for the specified land cover categories within the Virginia Runoff Reduction Method should be as follows:

Land Cover	HSG A	HSG B	HSG C	HSG D
Forest Cover	30	55	70	77
Forest Cover (adjusted)	55	70	77	77
Open Space	34	59	72	79
Open Space (adjusted)	59	72	79	79
Managed Turf	39	61	74	80
Managed Turf (adjusted)	61	74	80	80
Impervious Cover	98	98	98	98

5.303 BARE EARTH CURVE NUMBER SELECTION

Bare earth CNs for the purposes of performing runoff computations for erosion and sediment controls (temporary sediment traps, temporary sediment basins, etc.) should be as follows:

Land Cover	HSG A	HSG B	HSG C	HSG D
Bare Earth	77	86	91	94

House Bill 206 – 9 VAC - Small Renewable Energy Projects (Solar) Permit by Rule (PBR)

- **"Small" in this context applies to projects between 5 and 150 MW or ~ 50 to 1500 acres of total site size.**
- **Impacts to prime farmland (as defined by NRCS) > 10 acres or contiguous forest lands > 50 acres require "mitigation"**
- **Default prime farmland acreage will be estimated from WSS**
- **Developers may choose site-specific soil mapping by a Virginia LPSS as an alternative with review by DEQ (methods TBD)**
- **All areas that are cleared & grubbed or topsoil salvage/return will be considered "significantly disturbed"**

House Bill 206 Implications

- **Impacts to prime farmland (as defined by NRCS) > 10 acres or contiguous forest lands > 50 acres require "mitigation"**
- **Default prime farmland acreage will be estimated from WSS**
- **Developers may choose site-specific soil mapping by a Virginia LPSS as an alternative with review by DEQ (methods TBD)**
- **All areas that are cleared & grubbed or topsoil salvage/return will be considered "significantly disturbed"**

Final proposed prime farmland USS mitigation options for "onsite practices". If no onsite mitigation is planned, mitigation ratio is 1:1 for offsite conservation easements within a local region/HUC.

ON-SITE Mitigation Actions Taken**	Rationale	Acreage of OFF-SITE Conservation Required *For 1 Acre of Prime Ag Soil Disturbed*	100-Acre Site EXAMPLE
OPTION 1*: No Change in Grade Areas with no change in grade or topsoil removal, no trenching, decompaction of topsoil (A horizon) following installation, maintenance of ≥ 75% living vegetative cover, and decompaction to ≥ 6" & soil amendment after decommissioning	These actions should maintain prime farmland productivity, but some losses will occur due to loss of contiguous manageable acreage due to unavoidable disturbances (access roads, conveyances, etc.)	0.10	**100 * 0.10 =** **10 acres**
OPTION 2*: Preservation of Topsoil Areas with changes in grade due to cut/fill with removal/return of topsoil, decompaction of topsoil and subsoil following installation, maintenance of ≥ 75% living vegetative cover for project lifetime, and decompaction to ≥ 24" & surface soil amendment after decommissioning.	Prime farmland productivity will be permanently reduced by extensive cut/fill disturbance, even with topsoil salvage and replacement.	0.25	**100 * 0.25 =** **25 acres**
OPTION 3*: Decompaction of Surface Soil on Cut/Fill Areas Areas with changes in grade due to cut/fill without topsoil salvage/return, decompaction of surface soil following installation, maintenance of ≥ 75% living vegetative cover for project lifetime, and surface soil decompaction & soil amendment to ≥ 6" after decommissioning.	Failure to salvage and return topsoil and overall net soil profile alteration will result in a permanent reduction in prime farmland productivity.	0.50	**100* 0.50 =** **50 acres**

*Access roads, trenches, foundations, stormwater ponds and excavated conveyances considered permanent disturbance and will be mitigated OFF-SITE at 1:1.

**All options presume compliance with all applicable DEQ and/or local government stormwater (SW) management and erosion & sediment control (ESC) regulations and mandates.

House Bill 206 Implications

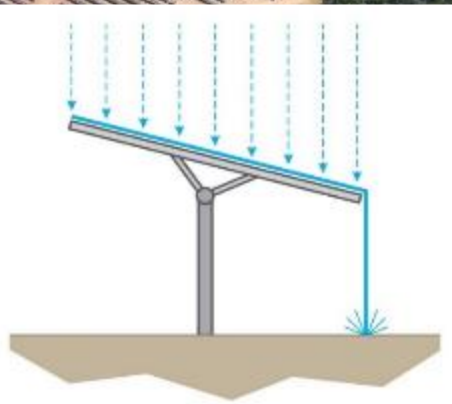
- **Onsite areas that are managed for grazing or crops or "pollinator friendly" will receive another 25% reduction in offsite mitigation.**

- **Forest impact mitigation alternatives vary by "eco core categorization". Impacts to Core 1 & 2 (exceptional value forests) are proposed at 7:1!**

- **So, if you have 100 acres of prime farmland and disturb 20% of it via cut/fill and don't follow any of the three mitigation offsets (shown in previous table) you will mitigate for 20 acres of impacts via conservation easements or in lieu fees.**


This site was mapped Cecil/Pacolet. Non-eroded Cecil on a & b slopes here would be prime farmland and require mitigation under HB 206.


Permanent SW basin immediately downhill from previous image. All BMPs installed to date were constructed during the period when panels were not considered to be “impervious” for peak flow designs.



From presentation by M. Rolband, VA DEQ, 4/6/23, CBF x STAC Workshop

Compliance Snapshot

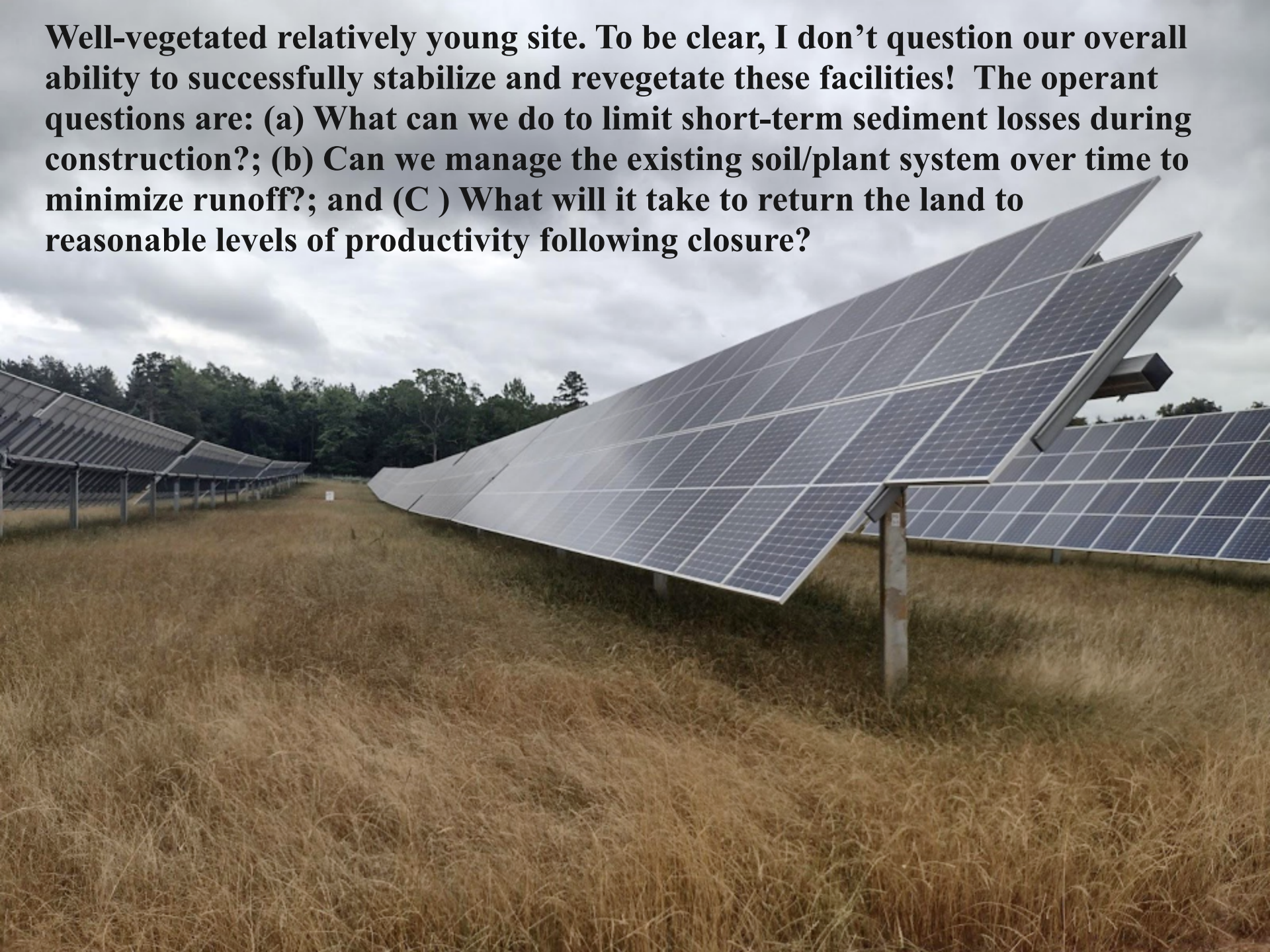
Similar survey was conducted in mid-2024; over 50% of sites out of compliance with MS 1.

Permitted USS	124	
DEQ is VSMP	77	
Final Consent Orders	12	16%
Pending Consent Order	11	14%
March Inspections:		
• Notices of Violation	1	3%
• Warning Letters	8	20%
• Corrective Action Needed	21	54%
• No Issues	9	23%
• **Total Sites**	**39**	**100%**

$\frac{53}{77}$ = **At least 69% have "Issues"**

Note: *This March 2023 review only looked at sites with a DEQ PBR permit. Larger SCC or sites with locality VSMP authority* ***were not evaluated.***

DEQ


Well-vegetated relatively young site. To be clear, I don't question our overall ability to successfully stabilize and revegetate these facilities! The operant questions are: (a) What can we do to limit short-term sediment losses during construction?; (b) Can we manage the existing soil/plant system over time to minimize runoff?; and (C) What will it take to return the land to reasonable levels of productivity following closure?

Chapter 6 – Stormwater & BMPs

- **6.2.2.7.1 – Acid Sulfate Soils (ASS) & Sulfidic Materials recognized as a special geologic condition (like Karst) screening criteria and remediation plans recommended. Still up to local enforcement, M.S. 1 requirements and discharge SW pH must be between 6 and 9 for monitored points (or violations).**

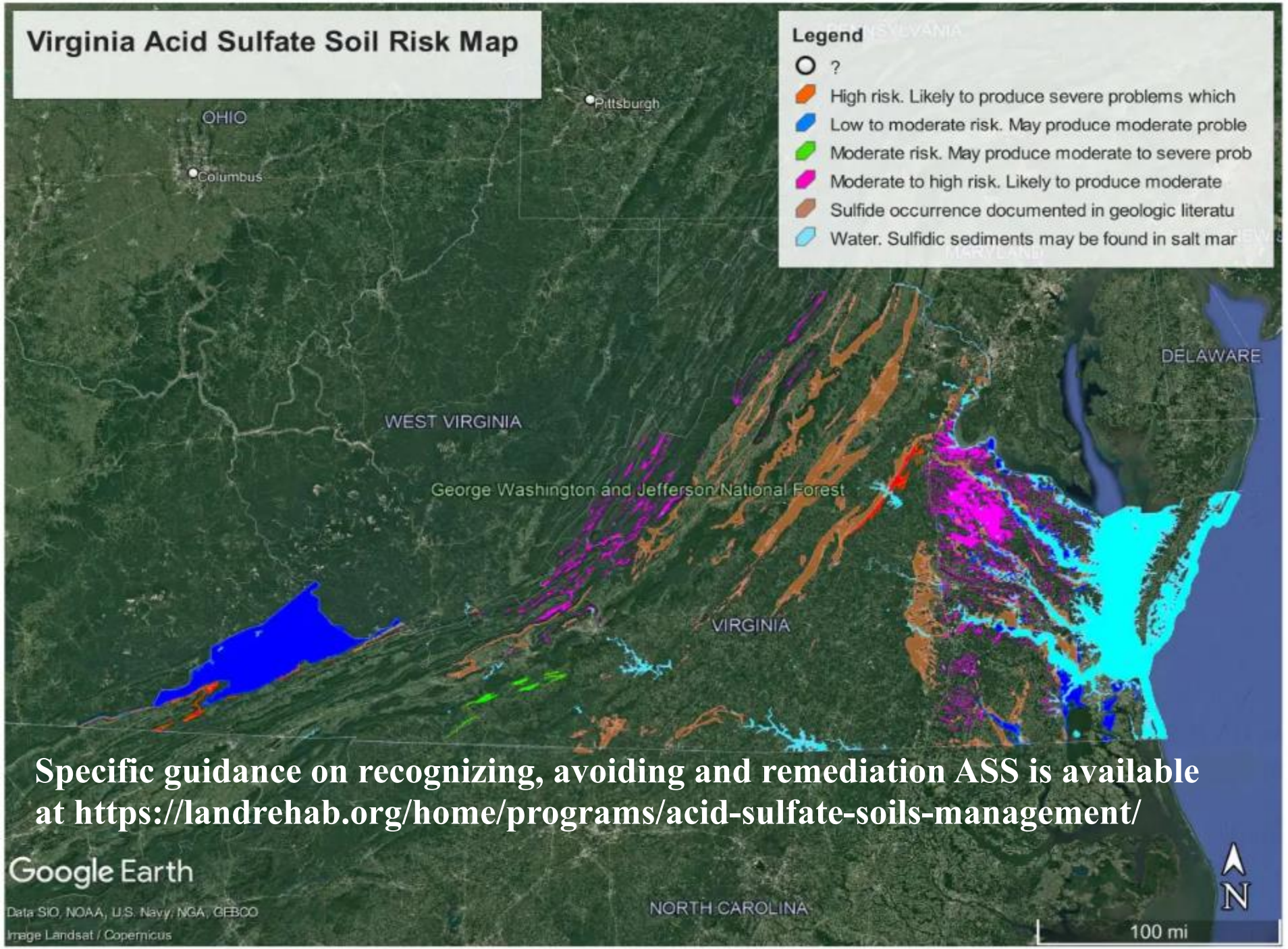
- **Other components of 6.2.2 – Site Scale Mapping include:**
  1. **Wetlands**
  2. **Topo/Drainage**
  3. **Bedrock & Groundwater**
  4. **Built Features**
  5. **Karst**
  6. **Soils & Geotech**

Acid sulfate soil impacts to soil quality in a subdivision in Fredericksburg and immediately adjacent (behind house) surface water impacts.

Naturally occurring S containing sediments and rocks are frequently exposed by construction activity and then quickly oxidize to for sulfuric acid soil conditions.

Sulfidic materials underlie much of the Coastal Plain at variable depths (usually > 5 to 10 feet). They also are common in certain regions of the Piedmont.

On solar sites, most likely encountered in lower landscapes in stormwater ponds



Specific guidance on recognizing, avoiding and remediation ASS is available at https://landrehab.org/home/programs/acid-sulfate-soils-management/

Other Important BMPs & Appendices in the 7/1/24 Combined Manual

- **Soil Compost Amendment – P-FIL-08**
- **Tree Planting – P–Fil – 09**
- **Mulching – C – SSM - 11**
- **Appendix A – Hydrologic and Hydraulic Methods and Computations. Most calculations, CN's, TR-55, required storage volumes, models, etc.**
- **Appendix B – Virginia Runoff Reduction Method (VRRM)**
- **Appendix C – Soil Characterization Infiltration Testing**

Appendix C – Soil & Infiltration Characterization

APPENDIX C SOIL CHARACTERIZATION AND INFILTRATION TESTING

Contents:

Appendix C – Soil & Infiltration Characterization

C.2.1 Hydrologic Soil Group

A soil's HSG is typically determined through information available in the Natural Resources Conservation Service (NRCS) Web Soil Survey (websoilsurvey.nrcs.usda.gov). Based on compiled and published U.S. Cooperative Soil Survey field mapping, the NRCS soil survey generally separates soils into four discrete HSG designations. Soils are grouped into Hydrologic Soils Groups A, B, C, or D based on similarities in soil characteristics such as:

- Soil texture and structure;
- Depth to a restrictive layer;
- Depth to water table;
- Hydraulic conductivity or transmission rate of water; and
- Degree of swelling when soils are saturated.

To my knowledge, the text section below is the first time that the fundamental differences between infiltration, permeability and Ksat have been defined in statewide guidance.

In order to help designers work through the elements of soil science related to soils, the following paragraphs provide basic definitions of some of the more common terms used.

- Soil infiltration: the rate at which stormwater enters the surface of the soil. Infiltration is influenced by soil texture, structure, organic matter, compaction, moisture content, and other physical characteristics. The design infiltration rate is usually expressed as a constant value, such as inches per hour, but the actual infiltration rate will be proportional to the hydraulic head or gradient and will change depending on hydrology.
- Soil permeability: the rate at which stormwater flows through the soil. Infiltration and permeability are often used interchangeably in many reference manuals. Used correctly, "permeability" refers to the rate of water moving through a given depth of soil after it has already infiltrated into that layer.
- Saturated Hydraulic Conductivity: the hydraulic conductivity (K) of a soil is related to its infiltration and permeability. Under optimal conditions, infiltration starts very fast, then declines, and eventually approaches a more constant rate of entry. This constant rate of infiltration is sometimes called the soil's permeability but is technically defined as the saturated hydraulic conductivity (K_{sat}). In almost all cases, reference to an infiltration rate implies this long-term constant rate (permeability or K_{sat}) (Jarrett 2008). K_{sat} often determines the soil's HSG (U.S. Department of Agriculture [USDA] NRCS 2007).

Appendix C – Soil & Infiltration Characterization

The lead investigator should evaluate the available soil survey information and compare it with site visit observations to determine if soil exploration is needed to identify and locate the HSGs on the site more accurately.

C.3 Soil Evaluation

Where infiltration of runoff into the existing soil strata is part of the selected BMP runoff reduction strategy, the designer should determine the actual soil conditions through field tests. The failure of stormwater infiltration devices is often attributed to an inaccurate estimation of the design infiltration rate and/or depth to the seasonal high water table or other limiting conditions for the underlying soils such as bedrock. The purpose of this guidance is to provide clear recommendations for the numbers and types of soil tests required to determine if infiltration practices are appropriate for a specific site location or BMP type.

C.3.1 Number, Location, and Depth of Soil Test during BMP Design

Soil testing during design should include soil profile test pits or soil borings and infiltration tests. At a minimum, any stormwater practice that requires confirmation of soil conditions should include one soil profile and two infiltration tests with increased testing recommendations shown in Table C-1.

Table C-1 Number of Soil Profiles and Infiltration Tests per BMP

BMP Footprint	# of Soil Profile Explorations	# of Infiltration Tests
Up to 2,500 ft^2	1	1 *
2,500 ft^2 to 10,000 ft^2	2	2

For footprints greater than 10,000 ft2, add one soil profile and one infiltration test for each additional 10,000 ft2 of practice.

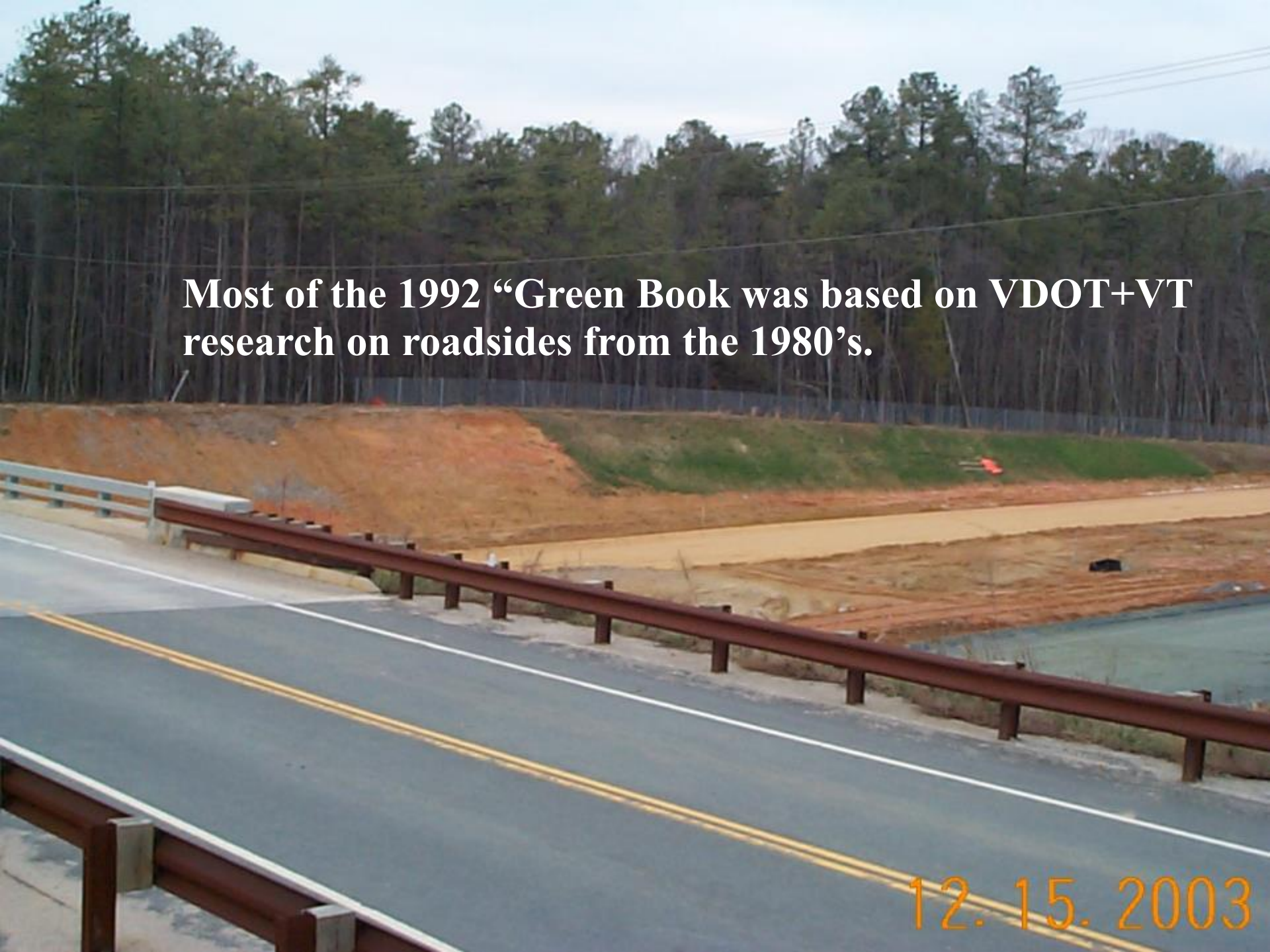
* Linear practices should add one additional soil profile and infiltration test for each 100 linear feet of practice.

Appendix C – Soil & Infiltration Characterization

C.3.2 Soil Profiles (Test Pits and Soil Borings)

The documentation of soil profiles (including test pits or soil borings) should include a soil log prepared for each soil profile in general accordance with ASTM D 1452 Standard Practice for Soil Investigation and Sampling by Auger Borings and should include a description of all soil horizons encountered according to the Unified Soil Classification System (USCS) per ASTM D-2488 Standard Practice for Description and Identification of Soils Visual- Manual Procedures with the USDA textural classification. In addition, results from dynamic cone penetrometer (DCP) Testing [ASTM D6951] or standard penetration testing (SPT) [ASTM D1586-99] should be provided. The soil profile log should include the following:

a. Elevation of the existing ground surface and elevations of infiltration test locations;
b. Depth and thickness of each soil horizon and the depth to the substratum;
c. Dominant matrix or background and mottle colors, abundance, size, and contrast using the Munsell system of classification for hue, value, and chroma;
d. Appropriate textural class as shown on the USDA textural classification;
e. Volume percentage of coarse fragments larger than 2 millimeters in diameter;
f. Soil structure, particle sizes, and shape;
g. Soil moisture condition using standard USDA classification terminology;
h. Depth and occurrence of soil restrictions such as fragipans and bedrock;
i. Depth to the seasonally high ground water level (either perched or regional);
j. Any observed seepage or saturation; and
k. Elevation of the seasonally high water table (SHWT) based on soil redoximorphic features such as Fe-concentrations and depletions (drainage mottles).


Most of the 1992 “Green Book was based on VDOT+VT research on roadsides from the 1980’s.
12. 15. 2003

VDOT Topsoil Definitions - 2016

(b) **Topsoil:**

1. **Class A topsoil:** Class A topsoil shall be stockpiled topsoil that has been salvaged in accordance with the requirements of Section 303.04(a). It shall be the original layer of the soil profile formed under natural conditions, technically defined as the "A" horizon or as defined by the United States Department of Agriculture–Natural Resources Conservation Service (USDA–NRCS) Soil Survey Division. It shall be free from refuse and any other materials toxic to plant growth and subsoil, stumps, viable noxious weeds, roots, brush, rocks, clay lumps, or similar objects larger than 3 inches in any dimension.

2. **Class B topsoil:** Class B topsoil shall be topsoil furnished from sources outside the project limits and shall be the original top layer of a soil profile formed under natural conditions, technically defined as the "A" horizon or as defined by USDA–NRCS Soil Survey Division. It shall consist of natural, friable, loamy soil without admixtures of subsoil or other foreign materials and shall be free of viable noxious weed seed, plant propagules, brush, rocks or other litter, and rocks greater than 3 inches in any dimension. It shall have demonstrated by evidence of healthy vegetation growing or having grown on it prior to stripping that it is well drained and does not contain substances toxic to plants. The Contractor shall submit a source of materials for topsoil on the project prior to use. The Department reserves the right to reject any topsoil material not complying with the requirements of this specification.

VDOT Topsoil Definitions - 2016

The allowable pH range for Class B topsoil for use in establishing sod or turf shall be 5.5 to 7.0.

Class B topsoil shall be a "sandy loam," "loamy sand," or "sandy clay loam" soil as defined by the USDA Soil Textural Classification System with an organic matter content between 1 and 8 percent or as approved in writing by the Engineer.

3. **Testing and documentation:** The Contractor shall submit the following test reports to the Engineer for Class B topsoil prior to use. Testing shall be completed by an independent commercial soils testing laboratory:

   a) **Soil analysis** of topsoil including pH factor, mechanical analysis (composition), salinity, percentage of organic content, and soil classification based thereon.

   b) **Recommendations** on type and quantity of additives required to establish a satisfactory pH and bring the supply of nutrients to a level satisfactory for sustaining turf and/or for use as a soil mix for planting if applicable.

VDOT Topsoil Definitions – 2025?

SECTION 602—TOPSOIL
602.01—Description

This work shall consist of applying topsoil in accordance with these specifications and in conformity with the depths and limits shown on the plans or as established by the Engineer. In the case of Class B topsoil this work shall also involve furnishing topsoil to the project site.

602.02—Materials

(a) **Class A topsoil** shall conform to Section 244.02(b)1.
(b) **Class B topsoil** shall conform to Section 244.02(b)2.

(b) **Topsoil:** Topsoil may be naturally occurring or may be manufactured and shall be free of foreign objects such as refuse, woody vegetation, stumps, roots, brush, stone larger than 3/4 inches, viable noxious weeds or weed seed, plant propagules, and any other material toxic or deleterious to plant growth. Maximum size of other foreign objects shall be 2 inches. The total of stones (> 2mm and < ¾ inches) + foreign objects shall be less than 50% by volume. Topsoil shall conform to the following:

Property	**Physical Requirement**
pH	5.5 to 7.5
USDA Soil Textural Classification (< 2mm fraction)	Sandy Loam, Loamy Sand, Sandy Clay Loam, Loam, Silt Loam
Rock fragments and stones (> 2mm and < ¾")	≤50% by volume
Organic Matter Content	2 to 10 percent
Available Phosphorus (P)	Minimum P Fertility of "Medium (M)" by Mehlich I or III
Soluble Salts	< 1280 ppm (or 2 mmhos/cm)

VDOT Topsoil Definitions – 2025?

1. **Class A topsoil:** shall be stockpiled topsoil that has been salvaged from within the project limits in accordance with Section 303.04(a). It shall be the original layer of the soil profile formed under natural conditions, and its physical, chemical, and biological characteristics shall be consistent with the "A+E" soil horizons as defined by the United States Department of Agriculture–Natural Resources Conservation Service (USDA–NRCS) Soil Survey Division.

2. **Class B topsoil:** shall be topsoil furnished from sources outside the project limits and shall be either the original A+E horizons of a soil profile formed under natural conditions, or manufactured topsoil made from naturally occurring soil, geologic and organic materials. Regardless of the source, all topsoil shall have the physical, chemical, and biological characteristics consistent with the "A+E" horizons of the soil profile as defined by USDA–NRCS Soil Survey Division. If the topsoil is not manufactured topsoil, then it shall consist of natural, friable, loamy soil without admixtures of subsoil or foreign materials. The Contractor shall provide to the Engineer a source of materials for topsoil planned for use on the project prior to use.

3. **Testing and documentation:** The Contractor shall submit the following test reports to the Engineer for Class A and Class B topsoil prior to use. Testing shall be completed by a DCR approved soils testing laboratory.

a. **Soil analysis** of the topsoil, including soil:water pH, mechanical analysis (USDA texture; and % > 2mm and < ¾"), salinity (soluble salts), percent organic matter, and plant available Ca, Mg, K and P..

b. **Recommendations** on the types and quantities of additives (lime, NPK fertilizer, organic matter or others) required to establish a satisfactory pH and bring the supply of nutrients to a level satisfactory for establishing and sustaining turf and/or for use as a soil mix for planting, if applicable.

Opportunities for Soil Scientists

- For solar, pre-development confirmation of prime farmland via site specific mapping and/or insight into how WSS "works" with respect both prime farmland definitions and mapping unit concepts. What's really out there?

- Determination of erosion phases and/or disturbance history on prime farmland map units will become important for solar permits.

- On-site determination of cut/fill and extent of "significant disturbance" on all development sites to determine mitigation ratios (solar) & CNs for all disturbed sites.

- Soil sampling, amendment and revegetation prescriptions. Apply some basic Agronomy! Is that a grass or a legume?

Opportunities for Soil Scientists

- ***Apriori*** **recognition of acid sulfate materials and/or development of remediation protocols**

- **Development of protocols for development of short & long-term management practices for "pollinator friendly" systems that are compatible with both short-term ESC mandates and longer-term objectives. Everybody wants to see these, very few know how to do it and still meet M.S. 1.**

- **Field inspection of biofiltration BMPs & recommendations for renovation. Failures are common and replacement timelines unknown.**

Opportunities for Soil Scientists

- **Importantly: Interact with local government officials and citizens groups in the oversight and development of local ordinances that clearly recognize the importance of soil science, simple agronomic principles, etc.**

- **Advocate for transparency on estimating net soil impacts in the planning and permit approval process.**

- **Emphasize the critical need for local ESC enforcement to treat all "active construction sites" with similar oversight including permanent seeding within 7 days following final grading, 14 says if dormant, etc.**

- **Work with VT Extension, local citizens and officials to promote applications of sound BMPs for all three phases of site development, management and decommissioning (solar).**

2024 DEQ Stormwater and ESC Guidance; What Soil Scientists Need to Know

W. Lee Daniels & Ryan Stewart

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School of Plant & Environmental Sciences

http://www.landrehab.org