Stormwater Management Swale Design Templates
Talbot County, MD

Purpose:
This template plan set is intended to provide a framework for implementing three (3) commonly used ditch retrofits. One of these practices can generally installed in most ditches - see appropriate circumstance for each individual type of retrofit.

General implementation notes for each option should be reviewed.

TABLE OF CONTENTS

DESIGN VARIABLES
L = LENGTH OF PRACTICE
B = WIDTH OF SWALE BOTTOM
D=WIDTH OF DISTURBED AREA
S = WIDTH OF STABILIZED SLOPE
H = HEIGHT OF SWALE
P = LENGTH OF PIPE TO OUTFALL (DRY SWALE ONLY)
d = DIAMETER OF UNDERDRAIN AND PIPE (DRY SWALE ONLY)
B2 = WIDTH OF 2ND STAGE (2-STAGE ONLY)
H1= HEIGHT OF LOWER SWALE (2-STAGE ONLY)
H2 = HEIGHT OF UPPER SWALE (2-STAGE ONLY)
R = FLOODED WIDTH / BANKFULL WIDTH (2-STAGE ONLY)
E = BANKFULL WIDTH (2-STAGE ONLY)
F = FLOODED WIDTH (2-STAGE ONLY)
m = NUMBER OF WOODCHIP SECTIONS (BIOREACTOR ONLY)
n = NUMBER OF GRAVEL COLUMNS (BIOREACTOR ONLY)
Dg = DEPTH OF GRAVEL (BIOREACTOR ONLY)
Lgs = LENGTH OF GRAVEL SECTION (BIOREACTOR ONLY)
Dw = DEPTH OF WOODCHIP (BIOREACTOR ONLY)
C = LENGTH OF WOODCHIP SECTION (BIOREACTOR ONLY)

Material Specifications

a. Rock shall be provided in accordance with "Maryland State Highway Administration, Standard specifications for Construction and Materials, dated July 2008" Section 901.05. All rock material shall be limestone.
b. Filter cloth shall be provided in accordance with "Maryland State Highway Administration, Standard specifications for Construction and Materials, dated July 2008" Section 921.09.01 and shall be non-woven type SE.
c. Wood chips shall be provided in accordance with AADPW specification 02860.02 and be between 0.5" and 3.0" along their greatest dimension. No pressure treated wood, redwood or cedar will be accepted as wood chip material for this project.
d. Fill material under in-ditch weirs shall be compacted "common borrow". Material gained on site may be used following approval by the County Engineer or designee.
e. Supplied top soil shall conform to the "Maryland State Highway Administration, Standard specifications for Construction and Materials, dated July 2008" Section 920.
f. Supplied "Select Borrow" shall conform to the "Maryland State Highway Administration, Standard specifications for Construction and Materials, dated July 2008" Section 916.
g. Supplied biochar material shall be wood derived-Hardwood preferred, softwood acceptable. Material must have a production temperature between 500 and 600 °C and a pyrolysis time of at least 3 hours. Particle size shall be between 0.5 mm and 3.0 mm or material must pass through a number 6 standard mesh sieve and across a number 35 standard mesh screen.
h. Engineered soil shall be classified as sand or loamy sand, and have a composition of at least 80% sand, no more than 2% organic matter, and no more than 1% clay.
i. Pea Gravel shall meet ASTM-D-448, #6.
j. Gravel shall be clean, washed, #57 stone. Conforming to the following sieve analysis and requirements:

% Passing	Sieve Size
100	3/4" – 1"
85	3/8"
60	#4
30	#40
< 3	#200

k. Underdrain shall be 4"-6" rigid schedule 40 PVC or SDR35. 3/8" perf. @ 6" on center, 4 holes per row
l. Pipes and cleanouts shall be rigid Schedule 40 PVC, where shown in the plans.
m. Sand shall meet AASHTO-M-6 or ASTM-C-33. Sand substitutions such as Diabase and Graystone #10 are not acceptable. No calcium carbonated or dolomitic sand substitutions are acceptable. No "rock dust" can be used for sand.
n. Plants: Types of plantings to supply are shown on the Project Plans and must be good quality and free of disease and nematodes, and not damaged in storage or transit. All plant materials shall comply with the type and size required by the approved drawings and shall be alive and free of obvious signs of disease.
o. Grass Material: See temporary seeding summary and permanent seeding summary as shown on the Project Plans.

MATERIAL QUANTITY	
Dry Swale	
Engineered Soil	**(24"-36") x L x W**
Pea Gravel	**3" x L x W**
PVC Perforated	**L**
PVC Solid	**P**
#57 Stone	**(12"-24") x L x W- (3.1415/4 x (d^2) x L)**
Clean Out	**L/50**
Denitrification Ditch	
Woodchip	**C x Dw x B x m**
#57 Stone	**Lgs x Dg x B x n**
Topsoil	**8" x C x B x m**
Two Stage Ditch	
none	

*See Accompanying Quantities Spreadsheet
**WHEN ORDERING MATERIAL, ORDER 5% EXTRA

SWALE GENERAL MAINTENANCE SCHEDULE

Task	Frequency
Side slope grasses shall not exceed 18" and shall be hand mowed to 6"	At least 2 times per year
Spot weeding, erosion repair, trash removal	2 times per year
Add reinforcement planting to maintain desired vegetation density	As needed
Remove invasive plants	As needed
Remove sediment	Once every 2 years

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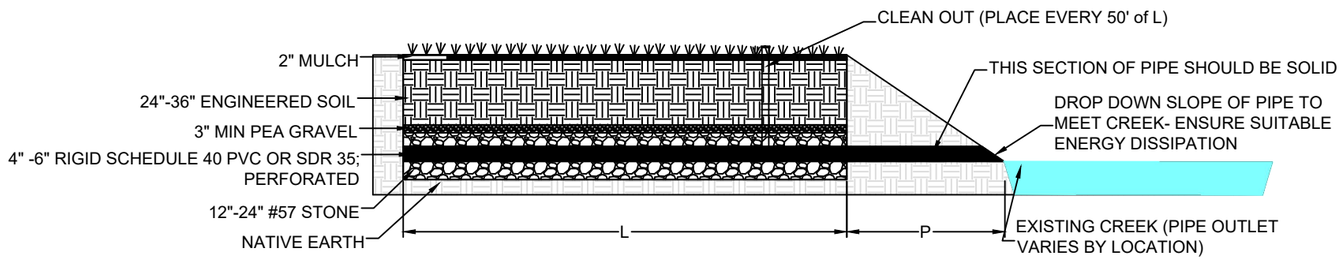
THE GREAT SEAL OF TALBOT COUNTY MARYLAND

Swale Template	DATE
TALBOT COUNTY, MD	NO SCALE
	SHEET 1 OF X

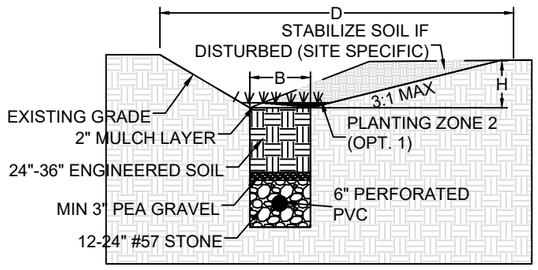
DRY SWALE

Practice Selection: Dry swales should be placed in ditches that provide enough depth to allow for the underdrain to reach an outfall (pipe, stream, etc.). The bottom of the gravel section should not intercept groundwater. Ditches in Talbot County tend to be flat, therefore the use of check dams is not necessary. Retrofits should be limited to ditches with slopes at 1% or less.

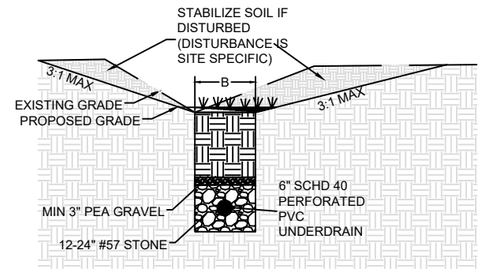
PROFILE VIEW



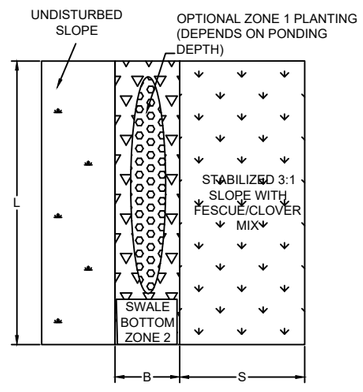
TYPICAL CROSS SECTION



ALTERNATIVE CROSS SECTION (optional grading on both sides)



TYPICAL PLANTING PLAN



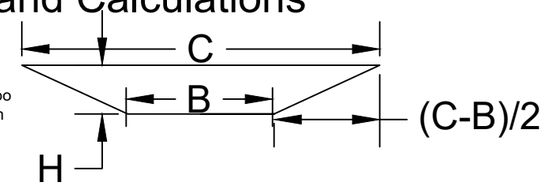
Zone 1- Companion Species for Saturated and Wet soils					
Species	**Common Name**	**WIS**	**Height**	**Light Requirements**	**Notes**
Juncus effusus	common sedge	FACW+	2-5'	Part Shade to Full Sun	salt tolerant, deer resistant
Solidago sempervirens	seaside goldenrod	FACW	3-5'	Part Shade to Full Sun	salt tolerant
Pycnanthemum muticum	clustered mountainmint	FACW	2-3'	Full Shade to Full Sun	rhizomatous, deer resistant
Tripsacum dactyloides	eastern gamagrass	FACW	4-5'	Full Sun	warm season grass
Deschampsia cespitosa	tufted hairgrass	FACW	2-4'	Part Shade to Full Sun	salt tolerant
Lobelia cardinalis	cardinal flower	FACW+	2-5'	Part Shade to Full Sun	
Asclepias incarnata	swamp milkweed	OBL	3-5'	Part Shade to Full Sun	
Chelone glabra	white turtlehead	OBL	2-4'	Full Sun to Full Shade	
Iris versicolor	blue flag iris	OBL	2-3'	Full Sun to Full Shade	
Zone 2- Companion Species for Moist Soils					
Deschampsia cespitosa	tufted hairgrass	FACW	2-4'	Part Shade to Full Sun	salt tolerant
Elymus virginicum	Virginia wild rye	FACW-	2-3'	Part Shade to Full Sun	deer resistant
Aster novae-angliae	New England aster	FACW-	3-6'	Full Sun to Full Shade	self-sowing
Juncus tenuis	poverty rush	FAC-	1-2'	Part Shade to Full Sun	salt tolerant, deer resistant
Penstemon digitalis	foxglove beardtongue	FAC	3-4'	Part Shade to Full Sun	rhizomatous, salt tolerant
Carex amphibola	eastern narrowleaf sedge	FAC	3-4'	Full Sun to Full Shade	
Panicum virgatum	switchgrass	FAC	3-5'	Part Shade to Full Sun	warm season, salt tolerant, deer resistant
Solidago rugosa	wrinkle leaf goldenrond	FAC	3-5'	Part Shade to Full Sun	rhizomatous

Stock	Application	Spacing (o.c.)	Notes
Plugs	Standard	12"	Normal application
	High	8"	Where rapid and complete cover is desired in first year
Quart	Standard	18"	Normal application
	High	12"	Where rapid and complete cover is desired in first year

Design Criteria and Calculations

Depth of engineered soil and #57 stone depends on elevation of outlet point.

Check dams may be needed if longitudial slope is too large to pond water. =>Design to meet MDE Erosion and Sediment Control, Spec Detail D-2.



Minimum Swale Height Calculations:
The height of the swale, H, depends on the peak flow rate (Q), velocity of the inflow (v) and the bottom width of the swale (B) (see schematic for variables).
Where,

Equation 1: Area of swale (A)= Q/v
Equation 2: A=H*(C+B)/2

Since the side slopes are 3:1,
Equation 3: 3H=(C-B)/2

Combining (2) and (3)
Equation 4: $A=3H^2+BH$

Combining (1) and (4)
Equation 5: $Q/v=3H^2+BH$

Q and v can be found using TR-55, which is County approved
v depends on the drainage area flow
Q is calculated with v and and watershed hydrology data

Example Scenario
Inputs into TR-55
Dimensionless Unit Hydrograph= delmarva
Storm Data= Talbot NOAA_C County, MD (NRCS)
CN=85 (Fallow, Crop residue, B soils, poor condition)
Drainage Area (DA)= 1 acre
Time of Concentration Information: flow into swale
30 ft sheet flow with n=.17, S=.005
208ft Channel flow, S=.005, n=.24, A=6ft², WP=10ft
On this screen will be the velocity of the flow, v=.22ft/s
=>Run TR-55, 2-yr, obtain Q peak. Q=1.4cfs

DA (acres)	flow length (ft)	v (ft/s)	Q (cfs)	H (ft)
1	209	0.22	1.4	1.04
3	361	0.25	3.3	1.66
6	511	0.26	5.5	2.19
10	660	0.27	7.9	2.64
20	933	0.28	12.6	3.39
100	2087	0.30	357.7	19.5

Plug information into Equation 5 and solve for H, given that B=3ft, H=1.04ft. For the design H, multiply by at least 1.5.

The table to the right is a chart of the various heights that would be needed based on the change in drainage area for a swale with B=3ft and all the parameters same as above. This is a hypothetical example. For your scenario, this value can be estimated based on space.

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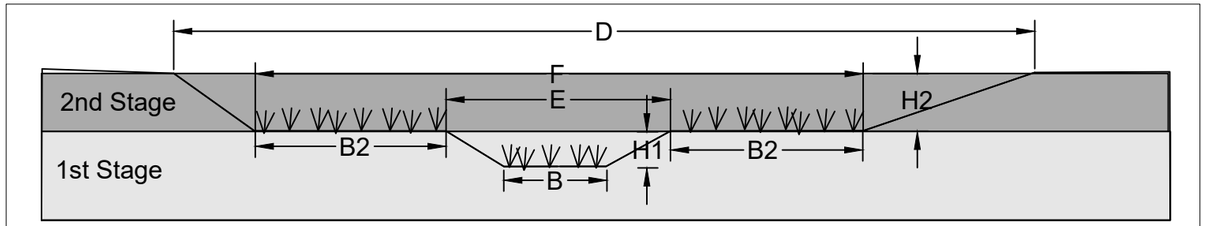
THE GREAT SEAL OF TALBOT COUNTY MARYLAND

Swale Template	DATE
TALBOT COUNTY, MD	NO SCALE
PROFILE SHEET	SHEET 2 OF X

TWO-STAGE DITCH

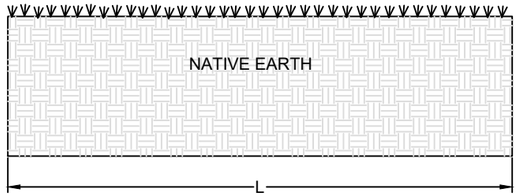
Practice Selection: A two-stage ditch should be used of there is enough width perpendicular to the road. Ditches in Talbot County tend to be flat, therefore the use of check dams is not necessary. Retrofits should be limited to ditches with slopes at 1% or less.

Design Criteria and Calculations

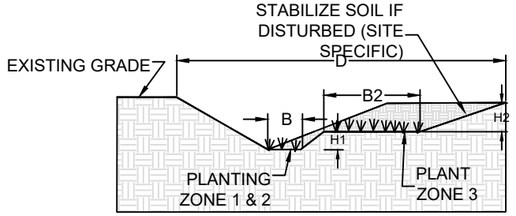


- bench stability important
- look for ditches that show signs of natural bench
- in cohesive soils, slope from first stage to second stage are typically steeper than 1.5:1
- side slope on 2nd stage should be 2:1 or flatter
- best suited for da 1-10 sq. mi., bed slope less than 0.5%p- if developing a 2 stage ditch without constraints, benches should be used on both sides

PROFILE VIEW

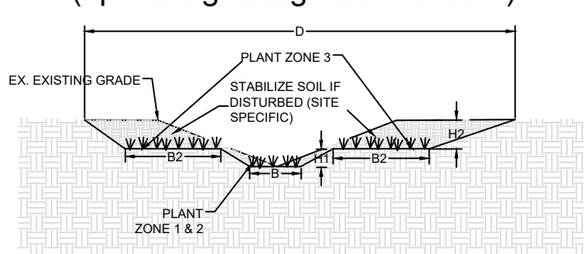


TYPICAL CROSS SECTION



SIDE SLOPES NO MORE THAN 3:1

ALTERNATIVE CROSS SECTION (optional grading on both sides)



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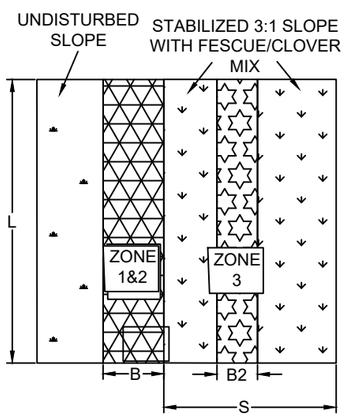

Zone 1- Companion Species for Saturated and Wet soils					
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Solidago rugosa	wrinkle leaf goldenrond	FAC	3-5'	Part Shade to Full Sun	rhizomatous
Zone 3- Companion Species for Dry Soils					
Chasmanthium latifolium	Indian woodoats	FACU	3-5'	Full Sun to Full Shade	warm season
Dennstaedtia punctilobula	eastern hayscented fern	FACU-	15-24"	Part Shade to Full Shade	rhizomatous, deer resistant
Andropogon virginicus	broomsedge bluestem	FACU	2-3'	Part Shade to Full Sun	warm season, salt tolerant, deer resistant
Schizachyrrium scoparium	little bluestem	FACU-	3-4'	Part Shade to Full Sun	warm season, deer resistant
Panicum amarum	bitter panicgrass	FACU-	3-4'	Part Shade to Full Sun	warm season, salt tolerant, deer resistant
Bouteloua curtipendula	sideoats grama		18-30"	Full Sun	rhizomatous, warm season, salt tolerant, deer resistant

Stock	Application	Spacing (o.c.)	Notes
Plugs	Standard	12"	Normal application
	High	8"	Where rapid and complete cover is desired in first year
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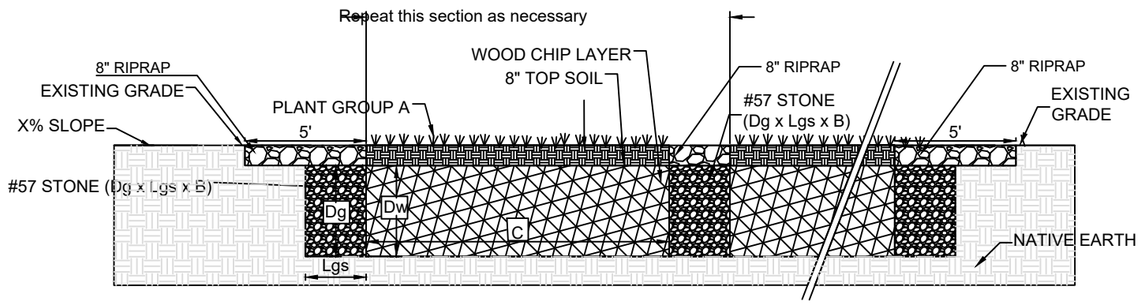
THE GREAT SEAL OF TALBOT COUNTY MARYLAND

Swale Template	DATE
TALBOT COUNTY, MD	NO SCALE
PROFILE SHEET	SHEET 3 OF X

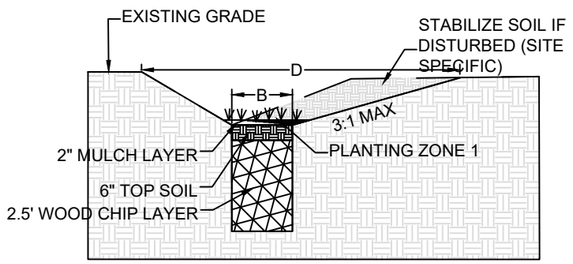
DITCH BIOREACTOR

Practice Selection: Dinitrifcation ditches should be placed in areas where the bottom of the woodchips will intercept groundwater.

PROFILE VIEW



TYPICAL CROSS SECTION



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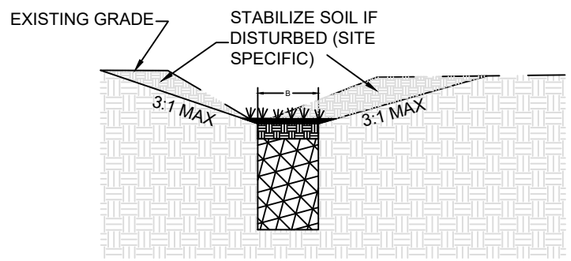
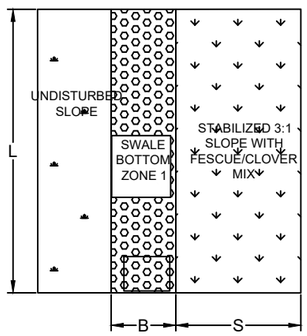


TYPICAL PLANTING PLAN



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Design Criteria and Calculations

Width of swale (B) and length of swale (Ls) is dependent on site constraints
Depth of bioreactor (Dw) is dependent on water table - woodchips should intercept groundwater to encourage anaerobic conditions. Dw shall be between 3'-5'.
There should be 1 gravel column for every 100 feet of woodchip section.

How to calculate woodchip length (lw) and gravel length (Lg)
(time it takes to fill up gravel volume cannot be more than the time it takes the water to exit into the bioreactor)

Volume of water in woodchip section (V1)= pore space (E) * Volume of woodchip section (Vw)
V1 / 24 hours = volume of water per hour to fillup bioreactor in 24 hours
V1 / 24 hours = cross sectional area of gravel where water enters reactor (Area of gravel, Ag) x hydraulic conductivity of gravel (ks) / safety factor (SF)

Relationship derivation:
E=.4
ks = 70 in/hr
SF=10
(eq. 1) Volume of bioreactor (Vw)=420Area of gravel (Ag)
(eq. 2) Area of Gravel (Ag)= Length of Gravel (Lg) xWidth of Gravel (Wg)
(eq. 3) Volume of bioreactor (Vw)= Length (Lw) x Width (Ww) x Depth (Dw)
(eq. 4) Width of bioreactor (Ww)=Width of gravel (Wg)=Base of Swale (B)
Therefore with (1) and (3):
Vw=420Ag=Lw*Ww*Dw, substituting (2)
420 (Lg/Wg)=Lw*Ww*Dw
420(Lg/Wg)/(Lw*Ww)=Dw, subsituting (4) and canceling out Wg
420Lg/Lw=Dw
Lg=Dw*Lw/420, where 3'≤Dw≤5'

Example:
Depth of practice = 3ft (constrained by site)
Allowable length of practice=Lw=300 ft (constrained by site)
Lg=3ft * 300ft /420ft = 2.14ft
This is the total length of gravel and bioreactor (not broken into repeated sections)

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THE GREAT SEAL OF TALBOT COUNTY MARYLAND

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PROFILE SHEET	SHEET 4 OF X

EROSION AND SEDIMENT CONTROL STANDARDS AND SPECIFICATIONS FOR VEGETATIVE STABILIZATION

1.) CONTRACTOR SHALL INSTALL SOIL EROSION AND SEDIMENT CONTROL DEVICES PRIOR TO ANY GRADING. FOLLOWING INITIAL DISTURBANCE OR RE-DISTURBANCE, PERMANENT OR TEMPORARY STABILIZATION SHALL BE COMPLETED WITHIN THREE (3) CALENDAR DAYS AS TO THE SURFACE OF ALL PERIMETER CONTROLS, DIKES, SWALES, DITCHES, PERIMETER SLOPES GREATER THAN THREE (3) HORIZONTAL TO ONE (1) VERTICAL (3:1) AND SEVEN (7) DAYS AS TO ALL OTHER DISTURBED OR GRADED AREAS ON THE PROJECT SITE NOT UNDER ACTIVE GRADING.
2.) ALL TEMPORARY EROSION AND SEDIMENT CONTROL DEVICES ARE TO BE PROVIDED AS INDICATED ON THIS PLAN, WITH LOCATION ADJUSTMENTS TO BE MADE IN THE FIELD AS NECESSARY, AND TO BE MAINTAINED AT THE END OF EACH WORKING DAY UNTIL PROJECT COMPLETION. THE MINIMUM AREA PRACTICAL SHALL BE DISTURBED FOR THE MINIMAL AMOUNT OF TIME POSSIBLE.
3.) CLEARING AND GRUBBING SHALL INCLUDE ALL TREES, BRUSH, DEBRIS, ROOT MAT AND ORGANIC MATERIALS TO BE REMOVED.
4.) TEMPORARY SEEDING SHALL BE ACCOMPLISHED BETWEEN FEBRUARY 15TH THROUGH APRIL 30TH, OR AUGUST 15TH THROUGH NOVEMBER 30TH. DURING OTHER TIMES, TEMPORARY MULCHING SHALL BE PROVIDED.
5.) TEMPORARY SEEDING SHALL CONFORM TO THE FOLLOWING APPLICATIONS: 436 LBS. PER ACRE OF 10-20-20; 4,000 LBS. PER ACRE OF GROUND LIMESTONE, TO BE INCORPORATED INTO THE SOIL BY DISKING OR OTHER SUITABLE MEANS ANNUAL RYEGRASS SHALL BE APPLIED AT A RATE OF 50 LBS. PER ACRE USING SUITABLE EQUIPMENT. MULCHING SHALL BE ACCOMPLISHED IMMEDIATELY AFTER SEEDING.

Temporary Seeding Summary

Hardiness Zone (from Figure B.3): ____7a_____

No.	Species	Application Rate (lb/ac)	Seeding Dates	Seeding Depths	Fertilizer Rate (10-20-20)	Lime Rate
	Annual Ryegrass	50	2/15 - 4/30 8/15 - 11/30	1/2 in	436 lb/ac (10 lb/1000 sf)	2 tons/ac (90 lb/1000 sf)
	Barley	96	2/15 - 4/30 8/15 - 11/30	1 in		
	Oats	72		1 in		
	Wheat	120		1 in		
	Cereal Rye	112	2/15 - 4/30 8/15 - 12/15	1 in		
	Foxtail Millet	30	5/1-8/14	1/2 in		
	Pearl Millet	20	5/1-8/14	1/2 in		

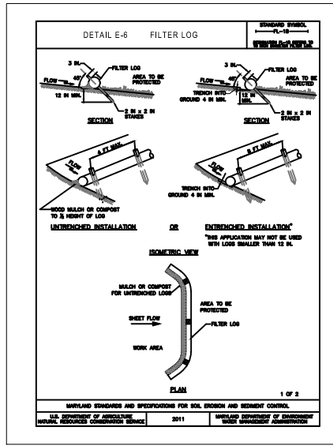
6.) MULCHING SHALL BE UNCHOPPED, UNROTTED, SMALL GRAIN STRAW APPLIED AT A RATE OF 2-21/2 TONS PER ACRE. ANCHOR MULCH WITH A MULCH ANCHORING TOOL ON THE CONTOUR. WOOD CELLULOSE FIBER MAY BE USED FOR ANCHORING STRAW AT A RATE OF 750 LBS. PER ACRE MIXED WITH WATER AT A MAXIMUM OF 50 LBS. OF WOOD CELLULOSE FIBER PER 100 GALS. OF WATER, OR WITH A SYNTHETIC LIQUID BINDER ACCORDING TO MANUFACTURER RECOMMENDATIONS. WOOD CELLULOSE FIBER USED AS MULCH MUST BE APPLIED AT A NET DRY WEIGHT OF 1,500 LBS. PER ACRE. MIX WOOD CELLULOSE FIBER WITH WATER TO ATTAIN A MIXTURE WITH A MAXIMUM OF 50 LBS. OF WOOD CELLULOSE FIBER PER 100 GALS. OF WATER.
7.) PERMANENT SEEDING SHALL BE ACCOMPLISHED BETWEEN MARCH 1ST THROUGH MAY 15TH, OR AUGUST 15TH THROUGH OCTOBER 15TH. PERMANENT SEEDING AT OTHER THAN SPECIFIED TIMES WILL BE ALLOWED ONLY UPON WRITTEN APPROVAL. PERMANENT SEEDING SHALL CONFORM TO THE FOLLOWING APPLICATIONS: PERMANENT SEEDING FOR SITES HAVING DISTURBED OVER FIVE (5) ACRES SHALL USE FERTILIZER RATES RECOMMENDED BY A SOIL TESTING AGENCY AND THE RECOMMENDATIONS PROVIDED IN THE PERMANENT SEEDING SUMMARY TABLE. PERMANENT SEEDING FOR CONDITIONS OTHER THAN LISTED ABOVE SHALL BE PERFORMED AT THE RATES AND DATES AS PROVIDED IN THE PERMANENT SEEDING SUMMARY TABLE BELOW. FERTILIZER AND LIME AMENDMENTS SHALL BE INCORPORATED INTO THE TOP 3"-5" OF THE SOIL BY DISKING OR OTHER SUITABLE MEANS. MULCHING SHALL BE ACCOMPLISHED AS DISCUSSED IN ITEM #6 OF THESE SPECIFICATIONS.\
8.) ANY SPOIL OR BORROW WILL BE PLACED AT A SITE APPROVED BY THE SOIL CONSERVATION DISTRICT.
9.) ALL AREAS REMAINING OR INTENDED TO REMAIN DISTURBED FOR LONGER THAN SEVEN (7) DAYS SHALL BE STABILIZED IN ACCORDANCE WITH THE USDA, NATURAL RESOURCES CONSERVATION SERVICE STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL IN DEVELOPING AREAS FOR CRITICAL AREA STABILIZATION.
10.) IT WILL BE THE RESPONSIBILITY OF THE CONTRACTOR OR SUBCONTRACTOR TO NOTIFY THE ENGINEER OF ANY DEVIATION FROM THIS PLAN. ANY CHANGE MADE IN THIS PLAN WITHOUT WRITTEN AUTHORIZATION FROM THE ENGINEER WILL PLACE RESPONSIBILITY OF SAID CHANGE ON THE CONTRACTOR OR SUBCONTRACTOR.

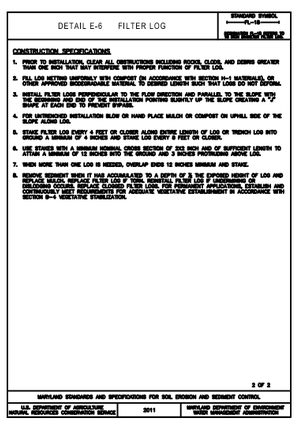
Permanent Seeding Summary

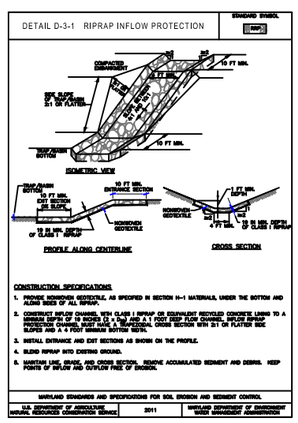
Hardiness Zone (from Figure B.3): ___7a_____

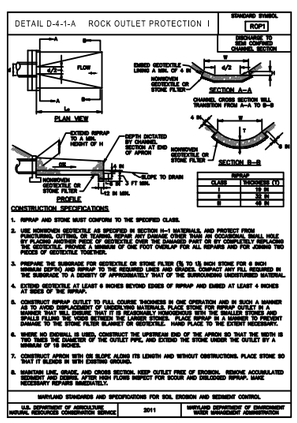
No.	Species	Application Rate (lb/ac)	Seeding Dates	Seeding Depths	Fertilizer N	Fertilizer P_2O_5	Fertilizer K_2O	Lime Rate
	Creeping Red Fescue	60	3/1- 5/15 8/15-10/15	1/4 - 1/2 in	45 lb/ac (1 lb/1000 sf)	90 lb/ac (2 lb/1000 sf)	90 lb/ac (2 lb/1000 sf)	2 tons/ac (90 lb/1000 sf)
	Kentucky Bluegrass	15						
	Tall Fescue	100	3/1- 5/15 8/15-10/15	1/4 - 1/2 in				
	Tall Fescue	60	3/1- 5/15 8/15-10/15	1/4 - 1/2 in				
	Kentucky Bluegrass	40						
	Perrenial Ryegrass	20						

Spoil material will be hauled off site.
The project is located in soil type XXX (XX%), and XX (XX%).









Plan View of Whole Project with ESC

CENTER FOR WATERSHED PROTECTION

Swale Template	DATE
TALBOT COUNTY, MD	NO SCALE
SEDIMENT CONTROL	SHEET 5 OF X

PLAN VIEW

Provide plan view of project projected on an aerial map. Include direction of flow and N arrow. Include details if necessary.

Swale Template	DATE
TALBOT COUNTY, MD	NO SCALE
PLAN VIEW	SHEET 6 OF X

Dry Swale Maintenance

1. Maintenance shall include one (1) mowing each year.
2. Inspection for rill or gully erosion.This should be followed by smoothing, and following permanent seeding instructions on page 5.
3. Remove excess sediment along bottom and at inlet every three (3) to five (5) years.

Two-Stage Ditch Maintenance

1. Maintenance shall include one (1) mowing each year.
2. Inspection for rill or gully erosion.This should be followed by smoothing, and following permanent seeding instructions on page 5.
3. Remove excess sediment along bottom and at inlet every three (3) to five (5) years.

Denitrification Maintenance

1. Maintenance shall include one (1) mowing each year.
2. Inspection for rill or gully erosion.This should be followed by smoothing, and following permanent seeding instructions on page 5.
3. Stone pillars should be kept free of debris like leaves, branches, and sediment. Annual cleaning is required and vacuum removal of sediment when observed is suggested.
4. Woodchip media should be evaluated ten (10) years after installation and every five (5) years thereafter. Woodchips should still be recognizeable at the bottom of the facility. If unrecognizeable, woodchips have likely lost carbon supplying capability.
5. Remove excess sediment along bottom and at inlet every three (3) to five (5) years.

Material

Mulch: Acceptable mulch shall be shredded hardwood only. It shall consist of bark from hardwood trees which have been milled and screened to a maximum of 4 inches particle size and provide a uniform texture free from sawdust, toxic substances, and foreign materials including plant material. Mulch must be aged 6 months, minimum. Pine mulch and wood chips will float and move to the perimeter of the bioretention area during a storm event and are not acceptable. Mulch must be 3 inches in depth.

Top Soil: See soil preparation, topsoiling, and soil amendments. On site topsoil may be used if it is S, SL, or L.

Wood Chip: Wood chip layer shall be comprised primarily of aged wood chips from yard debris with median diameter (D50) of 1.75”. No cedar, redwood, or treated wood shall be used in wood chip layer.

Swale Plants (bottom of swale): See planting plan, or county approved native vegetation.

Stabilization Seed and Mulch (disturbed side slopes of swale): Fescue/clover mix, or county approved native mix. See Permanent seeding specification.

#57 Stone: Stone shall be ½ - 1 ½ inch in diameter (Double washed, AASHTO #57 stone).

Engineered soil media: Soil mixture shall be 80-85% sand; 1% leaf compost or organic matter; and 14% - 19% topsoil (loam). The soil shall be uniform mix, free of stones, stumps, roots, weeds, or other similar objects larger than two inches. The planting soil shall be free of Bermuda Grass, Quackgrass, Johnson Grass, Mugwort, Nutsedge, Poison Ivy, Canadian Thistle, Tearthumb, or other noxious weeds as specified under COMAR 15.08.01.05. The soil should also be free of allelopathic species (such as Juglans spp., Plantanus occidentalis, etc). Provide clean sand, free of deleterious materials. Sand shall meet AASHTO M-6 or ASTM C-33 with grain size of 0.02- 0.04 inch. The filter media should be tested for phosphorous content and the P-index of the media should not exceed 30 (22.5 mg P per kg soil).
The filter media shall have a minimum of one test. Each test shall consist of both the standard soil test for pH, phosphorus, and potassium, and additional tests of organic matter, and soluble salts. A textural analysis is required from the site stockpiled topsoil. If topsoil is imported then a texture analysis shall be performed for each location where the topsoil was excavated. Since different labs calibrate their testing equipment differently, all testing results shall come from the same testing facility. Should the pH fall out of the acceptable range, it may be modified (higher) with lime or (lower) with iron sulfate plus sulfur.

Perforated 4”-6” Underdrain: Rigid Schedule 40 or SDR 35 PVC 4”-6” diameter pipe either drilled or bought in a commonly available perforated style (e.g. ¼ or ½ inch perforations, 6 inch center to center, along four longitudinal rows).

Solid 4”-6” Underdrain: Rigid Schedule 40 or SDR 35 PVC 4”-6” diameter.

Pea Gravel or choker stone: Clean, washed #8 or #89 stone.

Biochar:

Criterion	Description	Standard(s)		
		Sieve	Size	% Passing
Biochar	Woody derived material	No. 6	3 mm	100%
		No. 36	0.5 mm	0%
		Production temperatures between 500 and 600 °C		
		Pyrolysis time at least 3 hours		

CENTER FOR WATERSHED PROTECTION

Swale Template	DATE
TALBOT COUNTY, MD	NO SCALE
MAINTENANCE AND MATERIALS	SHEET 7 OF X