NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

FILTER STRIP

(Ac.)

CODE 393

DEFINITION

A strip or area of herbaceous vegetation that removes contaminants from overland flow.

PURPOSE

- Reduce suspended solids and associated contaminants in runoff.
- Reduce dissolved contaminant loadings in runoff.
- Reduce suspended solids and associated contaminants in irrigation tailwater.

CONDITIONS WHERE PRACTICE APPLIES

Filter strips are established where environmentally-sensitive areas need to be protected from sediment, other suspended solids, and dissolved contaminants in runoff.

CRITERIA

General Criteria Applicable to All Purposes

Overland flow entering the filter strip shall be uniform sheet flow. Concentrated flows shall be dispersed before entering the filter strip. When necessary, grading and shaping will be used to obtain uniform sheet flow.

For the larger concentrated flow channels that can not be easily dispersed and controlled, the channel will be treated to conform to the GRASSED WATERWAY (412) practice standard and specification through the flow length of the vegetative filter strip.

The maximum gradient along the leading edge (along the field edge) of the filter strip shall not

exceed one-half of the up-and-down hill slope percent, immediately upslope from the filter strip, up to a maximum of 5 percent.

Select species that are adapted to the local area and provide the desired benefits for removing suspended solids or dissolved contaminants. State-listed noxious plants will not be allowed to establish in the filter strip.

Filter strips shall not be used as a travel lane for equipment or livestock or used as a parking or storage area for vehicles and equipment. Agricultural products such as hay bales and cotton modules shall not be placed or stored on a filter strip.

Additional Criteria to Reduce Suspended Solids and Associated Contaminants in Runoff

The vegetated filter strip flow width will be designed according to Appendix A: Vegetative Filter Strip Design Process. The filter strip will be designed to have a minimum 10-year life span based on the calculations completed using Appendix A and associated Excel worksheets.

The minimum flow length through the filter strip shall be 20 feet.

The filter strip shall be located immediately downslope from the source area of contaminants.

The drainage area above the filter strip shall have a slope of 1 percent or greater.

The filter strip shall be established to permanent herbaceous vegetation using the criteria in the CRITICAL AREA PLANTING (342) practice standard and the VEGETATION ESTABLISHMENT, HERBACEOUS SEEDING (723) specification.

Species selected shall:

- be able to withstand partial burial from sediment deposition;

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resource Conservation Service or download the standard from the electronic Field Office Technical Guide for Missouri.

- tolerate herbicides used on the area that contributes runoff to the filter strip;
- have stiff stems and a high stem density near the ground surface;
- be suited to current site conditions and intended uses; and
- have the capacity to achieve adequate density and vigor within an appropriate period to stabilize the site sufficiently to permit suited uses with ordinary management activities.

Species, rates of seeding or planting, minimum quality of planting stock such as pure live seed (PLS) or stem caliper, and method of establishment shall be specified before application. Only viable, high quality seed or planting stock will be used.

Site preparation and seeding or planting shall be done at a time and in a manner that best ensures survival and growth of the selected species. Specify what constitutes successful establishment, e.g. minimum percent ground/canopy cover, percent survival, stand density, etc. prior to application.

Planting dates shall be scheduled during periods when soil moisture is adequate for germination and/or establishment.

The vegetative filter strip will be managed to maintain a healthy and vigorous stand that creates an effective barrier to runoff.

Additional Criteria to Reduce Dissolved Contaminants in Runoff

The vegetated filter strip flow width will be designed according to Appendix A: Vegetative Filter Strip Design Process. The filter strip will be designed to have a minimum 10-year life span based on the calculations completed using Appendix A and associated Excel worksheets.

The minimum flow length for this purpose shall be 30 feet.

The filter strip shall be located immediately downslope from the source area of contaminants.

The drainage area above the filter strip shall have a slope of 1 percent or greater.

The filter strip shall be established to permanent herbaceous vegetation using the criteria in the CRITICAL AREA PLANTING (342) practice standard and the VEGETATION ESTABLISHMENT, HERBACEOUS SEEDING (723) specification.

Species selected shall:

- be able to withstand partial burial from sediment deposition;
- tolerate herbicides used on the area that contributes runoff to the filter strip;
- have stiff stems and a high stem density near the ground surface;
- be suited to current site conditions and intended uses; and
- have the capacity to achieve adequate density and vigor within an appropriate period to stabilize the site sufficiently to permit suited uses with ordinary management activities.

Species, rates of seeding or planting, minimum quality of planting stock such as pure live seed (PLS) or stem caliper, and method of establishment shall be specified before application. Only viable, high quality seed or planting stock will be used.

Site preparation and seeding or planting shall be done at a time and in a manner that best ensures survival and growth of the selected species. Specify what constitutes successful establishment, e.g. minimum percent ground/canopy cover, percent survival, stand density, etc. prior to application.

Planting dates shall be scheduled during periods when soil moisture is adequate for germination and/or establishment.

The vegetative filter strip will be managed to maintain a healthy and vigorous stand that creates an effective barrier to runoff.

The Windows version of the Pesticide Screening Tool (Win-PST) and the Missouri Phosphorus Index will be used to determine the fields that require conservation treatments for this purpose.

Filter strips may be used to mitigate losses of pesticides or nutrients. Win-PST risk

assessments of intermediate, high, or extra high qualifies for mitigation. A Missouri Phosphorus Index rating of high or very high qualifies for mitigation.

The field areas drained by concentrated flow channels through the vegetated filter strip have not been mitigated for water quality purposes and are potentially not adequately treated with a filter strip practice.

Additional Criteria to Reduce Suspended Solids and Associated Contaminants in Irrigation Tailwater

Filter strip vegetation shall be a small grain or other suitable annual or perennial plant stand.

The minimum flow length for this purpose shall be 20 feet.

The seeding rate shall be sufficient to ensure that the plant spacing does not exceed 4 inches. Seed will be applied by one of the following methods:

- broadcast and rolled;
- drilled twice in a crosshatch pattern; or
- drilled twice in a split row pattern.

Acceptable seeding rates with a drill (increase seed by 50 percent if broadcasting) for annual small grain crops are:

- Winter rye – 90 pounds/acre
- Winter Wheat – 100 pounds/acre
- Barley – 110 pounds/acre
- Oats – 120 pounds/acre

Perennial grasses will be established according to criteria in the CRITICAL AREA PLANTING (342) practice standard and the VEGETATION ESTABLISHMENT, HERBACEOUS SEEDING (723) specification.

Filter strips shall be established early enough prior to the irrigation season so that the vegetation is mature enough to filter sediment from the first irrigation. Select species and seeding dates to achieve the necessary growth.

CONSIDERATIONS

Filters strips with the leading edge on the contour will function better than those with a gradient along the leading edge.

Seeding rates that establish a higher stem density will be more effective in trapping and treating contaminants.

Increasing the width of the filter strip beyond the minimum required will increase the potential for capturing contaminants in runoff.

Filter strips are often the only break in the monotony of intensively-cropped areas. The wildlife benefits of this herbaceous cover can be enhanced by:

- increasing the width beyond the minimum required, and planting this additional area to species that can provide food and cover for wildlife. This additional width should be added on the downslope side of the filter strip.
- adding herbaceous plant species to the filter strip seeding mix that are beneficial to wildlife and compatible for one of the listed purposes. Changing the seeding mix should not detract from the purpose for which the filter strip was established.

Vegetative filter strips can:

- enhance connectivity of corridors and non-cultivated patches of vegetation within the watershed.
- enhance the aesthetics of a watershed.
- be strategically located to reduce runoff, and increase infiltration and ground water recharge throughout the watershed.

Increasing the width of a filter strip beyond the minimum required will increase the potential for carbon sequestration.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared for each field site where a filter strip will be installed. This includes information about the location, construction sequence, vegetation establishment, and management and maintenance requirements.

As a minimum, the specifications shall include:

a) RUSLE2 data for vegetative filter strip design;

b) Length, width (flow path through the filter strip), slope of the leading edge, and slope of the filter strip to accomplish the planned purpose;

c) Construction details for planned treatment of concentrated flow channels to stabilize the channel or control sections to achieve uniform sheet flow;

d) Justification of the planned life span and anticipated sediment accumulation (vegetative filter strip design calculations);

e) Species selection and seeding or sprigging rates to accomplish the planned purpose;

f) Planting dates, care and handling of the seed to ensure that planted materials have an acceptable rate of survival;

g) A statement that only viable, high quality and regionally adapted seed will be used; and

h) Site preparation sufficient to establish and grow selected species.

OPERATION AND MAINTENANCE

For the purposes of filtering contaminants, permanent filter strip vegetative plantings shall be harvested and managed as appropriate to encourage dense growth, maintain an upright growth habit and remove nutrients and other contaminants that are contained in the plant tissue.

Control undesired weed species, especially state-listed noxious weeds and locally important weedy species.

If prescribed burning is used to manage and maintain the filter strip, an approved burn plan must be developed by the appropriate personnel.

Inspect the filter strip after storm events and repair any gullies that have formed or flow paths that have been damaged, remove unevenly deposited sediment accumulation that will disrupt sheet flow, reseed disturbed areas, and take other measures to prevent concentrated flow through the filter strip or along the leading edge.

Apply supplemental nutrients as needed to maintain the desired species composition and stand density of the filter strip. Monitor nutrient accumulation with regular soil tests.

Periodically re-grade and re-establish the filter strip area when sediment deposition at the filter strip-field interface jeopardizes its function. Re-establish the filter strip vegetation in these regraded areas.

REFERENCES

Widman, Norm. “Using RUSLE2 for the Design and Predicted Effectiveness of Vegetative Filter Strips (VFS) for Sediment”, USDA-NRCS Agronomy Technical Note No. 2, June 2007

Dillaha, T.A., J.H. Sherrard, and D. Lee. 1986. Long-Term Effectiveness and Maintenance of Vegetative Filter Strips. VPI-VWRRC Bulletin 153.

Dillaha, T.A., and J.C. Hayes. 1991. A Procedure for the Design of Vegetative Filter Strips: Final Report Prepared for U.S. Soil Conservation Service.

Foster, G.R. Revised Universal Soil Loss Equation, Version 2 (RUSLE2) Science Documentation (In Draft). USDA-ARS, Washington, DC. 2005.

Renard, K.G., G.R. Foster, G.A. Weesies, D.K. McCool, and D.C. Yoder, coordinators. 1997. Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE). U.S. Department of Agriculture. Agriculture Handbook 703.

Appendix A: Vegetative Filter Strip Design Process

The vegetative filter strip (VFS) design process is summarized in this appendix. The design process is divided into four distinct sections:

- Design Procedure,
- RUSLE2 Data for VFS Design,
- VFS Design Calculations, and
- Terms and Definitions.

DESIGN PROCEDURE

1) Each vegetative filter strip (VFS) section and contributing area will be considered and planned independently based on the site characteristics. Sections will be determined by the location in the field and the specific drainage area to the filter strip. VFS sections may be located between concentrated flow channels, along separate and distinct reaches of a stream or drainage system, and around sinkholes or ponds.

2) Identify locations for planned filter strips on a plan map. Determine the actual area of each section based on the flow length for one of the purposes and location of the leading edge of the VFS.

3) Determine the contributing area (area above the VFS that contributes sheet flow to the filter). Outline each area on the map. Make sure to include any and all areas that contribute sheet flow runoff even if these areas are outside of the field boundary. Do NOT include field areas that reach the VFS as concentrated flow or have pipelines or underground outlets to remove runoff from a field beyond or below the VFS.

4) Visit the field and determine a unique water flow path termed the Overland Flow Slope Length for each VFS section (top of the slope to the sensitive water feature). Mark this flow path on the plan map. Start at the top of the slope or terrace ridge and record the distance and information for each separate and distinct break in crops, management, slope, and soil as you move down slope to the environmentally-sensitive area requiring protection:

- slope length segments
- slope steepness for each separate segment
- soil type and any changes
- current crop rotation
- cover condition or tillage treatment
- change in crop or surface cover
- row grade
- residue burial
- rock cover
- patterned drainage system
- documented yield or average yield for the area
- structural and vegetative practices affecting runoff flow
- location of leading edge of VFS, and
- any other factor(s) for a soil loss prediction on an overland flow slope length.

Record the required information for each separate VFS and contributing area on the attached "RUSLE2 Data for VFS Design" (one worksheet per VFS section). Each section will need to be justified on its own specific site conditions and criteria. Use the 'Notes' portion of the worksheet to record any special concerns or resource data.

5) Using a current plan map, identify those areas where shaping and grading will be used to disperse concentrated flows above the VFS. Identify the specific location of structural practices (diversions, terraces, tile lines, grade control structures, and underground pipelines and outlets) that affect runoff volume and surface flow patterns. Make sure that the true contributing area for each VFS segment is identified for design purposes.

6) Divide the acres of contributing area by the acres of VFS actually treating that area. This determines the **ratio** of contributing area to VFS area.

7) Open the RUSLE2 model and select a profile template in the “Advanced”, “Summary”, or “Science” modes. These templates provide the necessary options to enter specific changes in “management”, “topography”, and “soils” along the slope.

8) Enter the field collected RUSLE2 data to describe each separate Overland Flow Slope Length. Identify each and every change in crop cover, management, soil and topography from the top of the slope to the environmentally sensitive area. Include the proposed VFS area in the Overland Flow Slope Length. Complete the RUSLE2 calculation to show soil loss (eroded portion) and sediment delivery from the slope length for the crop rotation for the field or fields. Save each distinct profile and print the data to show the changes along the Overland Flow Slope Length. The “soil loss eroded portion” and “sediment delivery” values will be used in the VFS design procedure.

9) Use the formulas in the Excel file at {~~“T:\NRCS\FTS_Section\Agronomy\VFS design.xls”~~} to calculate:

a) Ratio of Contributing Area to VFS Area
b) VFS Trapping Efficiency
c) Sediment Delivery in cubic feet per acre per year
d) Sediment Trapped in Vegetative Filter Strip in cubic feet per acre per year
e) Accumulated Sediment Depth in inches per year
f) Years to Accumulate 6 Inches of Sediment

10) A vegetative filter strip must have a minimum 10-year projected life span. Each VFS section must meet the 10-year criteria prior to installation to meet the Filter Strip (393) practice criteria.

11) Keep all design data on each separate section of VFS (VFS Design Worksheet for RUSLE2, plan map, and RUSLE2 printout) in the case file for documentation purposes.

{File is now located on the Missouri Sharepoint Site under Technical Resources›Technical Links›Vegetative Filter Strip Design.}

RUSLE2 Data for VFS Design

The following section is an example worksheet of the RUSLE2 data needed to make a soil loss prediction for the filter strip design process. This Excel file is located at: ~~{"T:\NRCS\FTS_Section\Agronomy\RUSLE2 data for VFS design.xls"}.~~ Distance is measured from the top of the slope to any change in cover, management, slope, or soil.

VFS Section _____

Planner _____

Date _____

COVER MANAGEMENT

Rotation	Crop/Forage	Tillage/Grazing Operations	^Distance	Row Grade	Yield Level
Crop or Year 1					
Crop or Year 2					
Crop or Year 3					
Crop or Year 4					
Filter Strip	Cover Type:		Density:		

FIELD MANAGEMENT

Rotation Year	Structural Practices	Residue Burial	Drainage	Buffers
Crop or Year 1				
Crop or Year 2				
Crop or Year 3				
Crop or Year 4				
Filter Strip	Management:			

{File is now located on the Missouri Sharepoint Site under Technical Resources›Technical Links›Vegetative Filter Strip Design.}

TOPOGRAPHY (top of slope to bottom)

	^Distance	% Slope
Segment 1		
Segment 2		
Segment 3		
Segment 4		
Segment 5		
Segment 6		
Segment 7		
Segment 8		
Segment 9		
Segment 10		

VFS Flow Length (width) _____ft.

VFS Length _____ft.

Contributing Area _____ac.

SOILS (top of slope to bottom)

	Map Unit/Soil Name	^Distance	Rock Cover (%)
Soil 1			
Soil 2			
Soil 3			
Soil 4			

NOTES:

VFS DESIGN CALCULATIONS
The following table is an example calculation only. Use a copy of this Excel file located at:
~~{"T:\NRCS\FTS_Section\Agronony\VFS calculations.xls"}~~ to make actual VFS design calculations.
Cells contain formulas to complete calculations in the Excel file.

Date: _____

Vegetative Filter Strip (VFS) Design Procedure

(See NRCS Agronomy Technical Note No. 2 dated June 2007)

Step 1		Step 2	Step 3	Step 4
VFS Flow Length (Width) (ft.)	VFS Length (ft)	Contributing Area (ac.)	RUSLE2 Soil Loss Eroded Portion (t/ac/yr)	RUSLE2 Sediment Delivery (t/ac/yr)
45.00	2500.00	7.80	26.00	3.40

VFS Area (ac.)	Trapping Efficiency (%)	Sediment Accumulation in VFS (cu ft/yr)	Sediment Depth in VFS (inches)	Years to Accumulate 0.5 feet of Sediment	Meets 10 year VFS Life Span
2.58	86.9%	1483.9	0.41	14.7	Yes

INSTRUCTIONS (yellow cells require entries)
Step 1: Enter average Filter Strip Dimensions (Width and Length). **Step 2:** Enter the Measured "Contributing Area" for the VFS. **Step 3:** Enter the "Soil Loss Eroded Portion" (Overland Flow Slope Length calculated in RUSLE2). **Step 4:** Enter the "Sediment Delivery" (Overland Flow Slope Length calculated in RUSLE2).

{File is now located on the Missouri Sharepoint Site under Technical Resources›Technical Links›Vegetative Filter Strip Design.}

TERMS AND DEFINITIONS

The Overland Flow Slope Length used in these calculations is defined as the slope length from the point of origin of runoff flow to the point where the slope enters concentrated flow or the upper edge of a vegetative filter strip. This slope length differs from the slope length used in conservation planning (the length from the origin of flow to either concentrated flow or deposition). The slope lengths used for conservation planning purposes are usually shorter than the slope lengths used to plan a vegetative filter strip.

VFS SECTION – identify the specific area of the field or vegetative filter strip segment that is being planned. All data collected will represent this area for design purposes.

PLANNER – record the name of the NRCS, SWCD, or TSP planner

DATE – record the date data was collected for planning purposes.

CROP/FORAGE – identify the crops and/or forages being produced in the rotation. Enter up to four separate and distinct crops in the rotation to be included in the Overland Flow Slope Length calculations. Add as many crops or forages as are found on the slope length; use the notes section if the crops in rotation exceed four.

TILLAGE/GRAZING OPERATIONS – identify the specific tillage, planting, and harvesting operations for the crop year. On grassland identify the grazing patterns and use including haying operations and dates that will occur throughout the year. On cropland identify the grazing period and intensity of use. Use the Notes Section to explain any abbreviations used.

DISTANCE – measure horizontal distance in feet from the top of the slope progressing down slope in segments of management, topography, and soils differences. Note that separate and distinct distances may be required in the tables of the RUSLE2 Data for VFS Design worksheet.

ROW GRADE – measure the field row grade for each different crop on the RUSLE2 slope.

YIELD LEVEL - record the average yield for the crop or pasture/hay.

STRUCTURAL PRACTICES – identify the location of any structural practices and how these practices will affect the flow of runoff water.

RESIDUE BURIAL – identify the level of residue burial anticipated on this tillage system and producer's management style. Select "normal", "heavier", or "lighter" burial.

DRAINAGE – identify those fields that have a patterned drainage system of underground drainage tile or perforated pipe. This is a YES or NO answer for the field segment.

BARRIERS – identify the location of all vegetative barriers down the slope including the leading edge and the tailing edge of the proposed filter strip.

VFS – provide specific data (cover type, distance, density, and management) on the cover of the proposed or existing vegetative filter strip.

SEGMENT 1 to 10 – Enter the slope length and slope steepness for each and every slope break from the top of the slope to the environmentally sensitive area including the VFS. Record data on all breaks that are significant to the RUSLE2 calculations.

SLOPE STEEPNESS (%) – measure slope with an inclinometer or other acceptable survey instrument and record the slope for each separate and distinct slope break.

SOILS 1 to 4 – Record the information on each and every separate soil type encountered down the slope. Record additional data in the Notes section if more than four soils occur in the overland flow slope length.

MAP UNIT/SOIL NAME – identify the specific soil type for each portion of the overland flow slope length.

ROCK COVER (%) – use the line transect method to determine the percentage surface cover of rocks for the soil type.

VFS FLOW LENGTH (WIDTH) – record the minimum width in feet for the Filter Strip (393) conservation practice planned on this segment. Include all vegetation that already exists on the site and providing protection for the sensitive area.

VFS LENGTH – record the planned length in feet for the Filter Strip (393) practice on this segment.

CONTRIBUTING AREA – determine the area of the field or watershed in acres that is contributing runoff to the current section of the planned Filter Strip (393) practice. Do not count those areas where runoff leaves the field as concentrated flows.