NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

GRASSED WATERWAY

(Ac.)

CODE 412

DEFINITION

A shaped or graded channel that is established with suitable vegetation to convey surface water at a non-erosive velocity using a broad and shallow cross section to a stable outlet.

PURPOSE

- To convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding.
- To reduce gully erosion.
- To protect/improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This practice is applied in areas where added water conveyance capacity and vegetative protection are needed to prevent erosion and improve runoff water quality resulting from concentrated surface flow.

This practice is not applicable where its construction would destroy important woody wildlife cover or wetlands, and the present watercourse is not seriously eroding.

Ephemeral gullies may be treated according to the conservation practice standard Critical Area Planting (342) in many cases. Larger gullies indicate the need for more extensive design considerations. Ephemeral gullies meeting the following criteria can be treated with the Critical Area Planting (342) standard:

1. The drainage area at the outlet is ≤ 7 acres.
2. The area to be vegetated begins within 250 feet of the top of the watershed area and extends for no more than 500 feet downslope.
3. The area to be vegetated is parabolic in shape, a minimum of 20 feet in width, and 0.75 feet in depth.
4. The bottom grade is between 3 and 10 percent, except when drainage area is ≤ 4 acres the bottom grade may exceed 10 percent.
5. The outlet for the area is stable (i.e. level or gently sloping area, joins the flowline of a waterway or other structural measure, etc.)
6. The area does not serve as an outlet for a diversion or terrace.

CRITERIA

General Criteria Applicable to All Purposes

Plan, design, and construct grassed waterways to comply with all Federal, State, and local laws and regulations.

Capacity. Design the waterway to convey the peak runoff expected from the 10-year frequency, 24-hour duration storm. Increase capacity as needed to account for potential volume of sediment expected to accumulate in the waterway between planned maintenance activities. When the waterway slope is less than 1 percent, out-of-bank flow may be permitted if such flow will not cause excessive erosion. Ensure that the design capacity, at a minimum, will remove the water before crops are damaged.

Use “B” retardance when determining capacity; or where a “good maintenance program” can be reasonably expected. “C” retardance may be used to determine capacity. The “good

maintenance program" shall include mowing grass at least twice per year and fertilizing to maintain vigorous growth. In urban areas, it may be appropriate to use "D" retardance to evaluate capacity if frequent mowing and provisions for fertilization and waterway drainage are assured.

When allowing out-of-bank flow in agricultural areas, the minimum waterway capacity shall be from the applicable drainage curve for drainage flow. See the Minnesota supplement in the NRCS Engineering Field Handbook, Chapter 7 (EFH7), Grassed Waterways.

In urban areas, out-of-bank flow is normally not recommended. Care should be exercised to evaluate the flooding effects of urban out-of-bank flow. The minimum in such cases shall be the capacity required to convey the peak runoff from a 2-year frequency, 24-hour storm.

Stability. Determine the minimum depth and width requirements for stability of the grassed waterway using the procedures in the EFH7, Grassed Waterways; Agricultural Research Service (ARS) Agriculture Handbook 667, Stability Design of Grass-Lined Open Channels; or other equivalent method.

Ensure that the vegetation species selected are suited to the current site conditions and intended uses. Select species that have the capacity to achieve adequate density, height, and vigor within an appropriate time frame to stabilize the waterway.

For sites with ML, OL, and SM soils with a plasticity index of 12 or less, the tractive stress procedure in EFH7 (December 2007) or in the Engineering Field Tools software should be considered.

Velocity. When using the allowable velocity method, the design velocity shall be determined using a retardance at least one curve lower than that used to determine capacity. For example, if "B" retardance is used for capacity, then "C" retardance or less, must be used to determine maximum velocity. The velocity shall not exceed the values given in Table 1. Velocities for waterways on slopes of less than 1% shall not exceed these allowable velocities when calculated for the Q_{10} discharge.

Where stone centers, perforated grid pavers, turf reinforcement mats or other erosion-resistant materials are used to supplement the vegetative lining, the maximum allowable velocity may be based on manufacturer recommendations.

A minimum velocity of 1.5 fps should be achieved to prevent significant sediment deposition. If this velocity cannot be achieved, the potential deposition problem and associated maintenance requirements shall be addressed in the Operation and Maintenance Plan.

Cross Section Shape. Triangular V-shaped sections shall not be used in MN.

Width. Keep the bottom width of trapezoidal waterways less than 100 feet unless multiple or divided waterways or other means are provided to control meandering of low flows. A minimum bottom width of eight (8) feet shall be used where vehicular traffic or machinery will cross the waterway. For bottom widths over twenty (20) feet, the modified trapezoidal section shown in the Engineering Field Tools software shall be used, either the v-dip or parabolic cross-section.

Side Slopes. Keep the side slopes flatter than a ratio of two horizontal to one vertical. Reduce the side slopes as needed to accommodate the equipment anticipated to be used for maintenance and tillage/harvesting equipment so that damage to the waterway is minimized. Where vehicular traffic or equipment must cross the waterway, the side slopes should be 8:1 or flatter. Where it is not necessary to cross the waterway, a 4:1 side slope is commonly used.

Depth. The capacity of the waterway must be large enough so that the water surface of the waterway is below the water surface of the tributary channel, terrace, or diversion that flows into the waterway at design flow.

Provide 0.5 foot freeboard above the designed depth when flow must be contained to prevent damage. Provide freeboard above the designed depth when the vegetation has the maximum expected retardance.

Drainage. When needed to help or keep vegetation established on sites having prolonged flows, high water tables, or seepage problems, include Subsurface Drain (606), Underground Outlet (620), stone center waterways or other suitable measures in waterway designs.

Where drainage practices are not practicable or sufficient to solve these seepage problems, use conservation practice Lined Waterway or Outlet (468) in place of Grassed Waterway (412).

Outlets. Provide a stable outlet with adequate capacity. The outlet can be another vegetated channel, an earthen ditch, a grade-stabilization structure, filter strip or other suitable outlet.

Vegetative Establishment. Establish vegetation as soon as possible using the criteria listed under "Establishment of Vegetation" in the conservation practice standard Critical Area Planting (342) and/or the state planting guide.

Establish vegetation as soon as conditions permit. Use mulch anchoring, nurse crop, rock, straw or hay bale dikes, fabric checks, filter fences, or runoff diversion to protect the vegetation until it is established. Planting of a close growing crop, e.g. small grains or millet, on the contributing watershed prior to construction of the grassed waterway can also significantly reduce the flow through the waterway during establishment.

Provide livestock and vehicular crossings as necessary to prevent damage to the waterway and its vegetation.

Consider using erosion control blankets on sites with erosive soils or in situations where vegetation will be difficult to establish.

Fabric Barriers. When deemed necessary, fabric barriers used as gully checks during vegetative establishment shall be spaced 50 to 100 feet apart. The fabric must be 36 inches wide with 18 inches buried and 18 inches lying on the ground. Barriers shall extend across the waterway bottom and up the side slopes to a minimum depth of (0.7) x (design depth) or 0.5 ft, whichever is greater.

CONSIDERATIONS

The most critical time in successfully installing grassed waterways is during establishment of vegetation. Supplemental irrigation may also be warranted. The vegetation should be well established before large flows are permitted in the channel when possible.

Where environmentally-sensitive areas need to be protected from dissolved contaminants, pathogens, or sediment in runoff, consider establishment of an increased width of vegetation on the waterway above the flow area. Increasing the width of the waterway above the flow area will increase filtering of sediment and pathogens as well as increase infiltration of runoff and increase nutrient removal. Where sediment control is the primary concern, consider using vegetation in the waterway which can withstand partial burial and adding sediment control measures above the waterway such as residue management. Consider increasing the channel depth and/or designing areas of increased width or decreased slope to trap and store sediment to reduce the amount of sediment that leaves a field. Be sure to provide for regular cleaning out of the waterway when trapping sediment in this manner.

Tillage and crop planting often takes place parallel to the waterway, resulting in preferential flow – and resulting erosion – along the edges of the waterway. Consider installation of measures that ensure that runoff from adjacent areas will enter the waterway. Measures such as directing spoil placement or small swales can direct this preferential flow into the grassed waterway.

Avoid areas where unsuitable plant growth limiting subsoil and/or substratum material such as salts, acidity, root restrictions, etc. may be exposed during implementation of the practice. Where areas cannot be avoided, seek recommendations from a soil scientist for improving the condition or, if not feasible consider over-cutting the waterway and add topsoil over the cut area to facilitate vegetative establishment.

Avoid or protect, if possible, important wildlife habitat, such as woody cover or wetlands when determining the location of the grassed waterway. If trees and shrubs are incorporated, they should be retained or planted in the periphery of grassed waterways so they do not interfere with hydraulic functions. Medium or tall bunch grasses and perennial forbs may also be planted along waterway margins to improve wildlife habitat. Waterways with these wildlife features are more beneficial when connecting other habitat types; e.g., riparian areas, wooded tracts and wetlands. When possible, select species of vegetation that can serve multiple purposes, such as benefiting wildlife, while still meeting

the basic criteria needed for providing a stable conveyance for runoff.

Water-tolerant vegetation may be an alternative to subsurface drains or stone center waterways on some wet sites.

Use irrigation in dry regions or supplemental irrigation as necessary to promote germination and vegetation establishment.

Wildlife habitat benefits can be provided by adding width of appropriate vegetation to the sides of the waterway. Care should be taken to avoid creating small isolated planting zones that could become population sinks where wildlife attracted to an area experience reproductive loss due to predation.

Consider including diverse legumes, forbs, and flowering plants such as milkweeds that provide pollen and nectar for native bees and other pollinators. In dry regions, these sites may be able to support flowering forbs with higher water requirements and thus provide bloom later in the summer.

The construction of a grassed waterway can disturb large areas and potentially affect cultural resources. Be sure to follow state cultural resource protection policies before construction begins.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for grassed waterways that describe the requirements for applying the practice according to this standard. As a minimum include:

- A plan view of the layout of the grassed waterway.
- Typical cross sections of the grassed waterway(s).
- Profile(s) of the grassed waterway(s).
- Disposal requirements for excess soil material.
- Site specific construction specifications that describe in writing the installation of the grassed waterway. Include specification for control of concentrated flow during construction and vegetative establishment.
- Vegetative establishment requirements.

All trees, stumps, brush, and similar material are to be removed from the site and disposed of in a manner consistent with environmental concerns and proper functioning of the waterway.

Topsoil shall be stockpiled and respread where necessary to provide a seedbed for the grass.

OPERATION AND MAINTENANCE

Provide an operation and maintenance plan to review with the landowner. Include the following items and others as appropriate in the plan.

- Establish a maintenance program to maintain waterway capacity, vegetative cover, and outlet stability. Vegetation damaged by machinery, herbicides, or erosion must be repaired promptly.
- Protect waterway from concentrated flow by using diversion of runoff or mechanical means of stabilization such as silt fences, mulching, hay bale barriers and etc. to stabilize grade during vegetation establishment.
- Minimize damage to vegetation by excluding livestock whenever possible, especially during wet periods. Permit grazing in the waterway only when a controlled grazing system is being implemented.
- Inspect grassed waterways regularly, especially following heavy rains. Fill, compact, and reseed damaged areas immediately. Remove sediment deposits to maintain capacity of grassed waterway.
- Avoid use of herbicides that would be harmful to the vegetation in and adjacent to the waterway area.
- Avoid using waterways as turn-rows during tillage and cultivation operations.
- Mow or periodically graze vegetation to maintain capacity and reduce sediment deposition. Mowing may be appropriate to enhance wildlife values, but must be conducted to avoid peak nesting seasons and reduced winter cover.

- Apply supplemental nutrients as needed to maintain the desired species composition and stand density of the waterway.
- Control noxious weeds.
- Do not use waterways as a field road. Avoid crossing with heavy equipment when wet.
- Lift tillage equipment off the waterway when crossing and turn off chemical application equipment.

REFERENCES

USDA, ARS. 1987. Stability design of grass-lined open channels. Agriculture Handbook 667.

USDA, NRCS. 2007. National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 7, Grassed waterways.

Table 1. Maximum Permissible Velocities for Vegetated Waterways

		Channel Vegetation Condition		
Soil Texture	**Retardance**	**Poor ft/sec**	**Fair ft/sec**	**Good ft/sec**
Sand, silt, sandy loam, silty loam	B	2.0	3.0	4.0
	C	1.5	2.5	3.5
	D	1.5	2.0	3.0
Silty clay loam and sandy clay loam	B	3.0	4.0	5.0
	C	2.5	3.5	5.0
	D	2.0	3.0	4.0
Clay	B	3.5	5.0	6.0
	C	3.0	4.5	5.5
	D	2.5	4.0	5.0

The choice of retardance B, C or D will depend on the vegetation and maintenance planned for the waterway channel. Refer to Table 7-4 on page 7-13 in Chapter 7, Grassed Waterways, in the Engineering Field Handbook to select vegetal retardance.

Table 2. Permissible Velocities for Out of Bank Flow

Material on Channel Bottom and Sides			
Descriptive Term or Name	Soil Classification		Permissible Velocity, fps
	USDA	Unified	
Fine Sand (noncolloidal)	s, fs,vfs, lvfs, vfsl	ML(PI≤5), SM(PI≤10) SP, SW, SP-SM	1.5 Easily Erodible
Sandy Loam (noncolloidal)	fsl, sl, ls, lfs, si	SM(PI≥10), ML(PI=5-10), ML-CL, SM-SC, SC(PI<10)	
Silt Loam (noncolloidal), Alluvial silts when noncolloidal	sil, scl, GR-s	ML(PI=10-12), OL, Coarse clean sand (D50>#10 sieve)	
Ordinary Firm Loam Fine Gravel	l, scl, GR	CL, ML(PI>12), MH(PI<20), Clean gravels (D50>#4 sieve)	2.0 Average
Stiff Clay (very colloidal) Graded, loam to cobbles, when noncolloidal Alluvial Silts when colloidal	cl, sicl, c, sc, GR-1	CL(PI>20), CH, MH(PI>20), SC(PI>10), GC(PI<10), GM(PI>10)	2.5 Erosion Resistant
Graded, silt to cobbles, when colloidable Coarse Gravel (noncolloidal)	Coarse GR, GR-c	GC(PI>10), Clean gravel (D50>¾")	