United States Department of Agriculture

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

GRASSED WATERWAY

CODE 412

(ac)

DEFINITION

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

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding
- Prevent gully formation
- 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.

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. *Waterways which are components of waste management systems shall have a minimum capacity to convey the peak runoff from the 25-year frequency, 24-hour 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.

Peak discharge for all storms will be determined by the method outlined in NRCS National Engineering Handbook (NEH), Part 650 - Engineering Field Handbook (EFH), Chapter 2.

The vegetative retardance used shall consider the types of grasses to be seeded and the type of management anticipated. The retardance used shall be in accordance with the EFH, Chapter 7, Figure 7- 11.

Capacity of waterways shall be based on vegetative retardance A, B, or C.

Stability

Determine the minimum depth and width requirements for stability of the grassed waterway using the procedures in the NRCS National Engineering Handbook (Title 210), Part 650, Chapter 7, "Grassed Waterways," or Agricultural Research Service Agriculture Handbook 667, "Stability Design of Grass-Lined Open Channels." Base stability computations on the peak runoff expected from a 10 *or 25*-year, 24-hour duration storm *for the capacity storm chosen*.

Ensure that the vegetative species selected are suited to the 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.

Stability of waterways shall be based on vegetative retardance C, D, or E.

Stability of waterways shall convey the peak discharge expected from the design storm without exceeding the allowable effective stress or permissible velocity.

Design velocities shall not exceed the values shown in Table 1.

Evaluate the potential effect of waterways with velocities exceeding the critical velocity (supercritical).

Table 1 Permissible Velocity [1]

Waterway Slope Range (%)	***Erosion Resistant Soils [2] (ft./sec.)***	***Easily Eroded Soils [3] (ft./sec.)***
0 - 5	*7*	*5*
5.1 - 10	*6*	*4*
Over 10	*5*	*3*

1 Use velocities exceeding 5 ft./sec only where good cover and proper maintenance can be obtained.

2 Cohesive (clayey) fine-grain soils and coarse-grain soils with cohesive fines with a plasticity index of 10 to 40 (CL, CH, SC, and GC).

3 Soils that do not meet the requirements for erosion-resistant soils

Alignment

Except for short transition sections, flow in the range of 0.7 to 1.3 of the critical slope must be avoided unless the waterway is straight.

Velocities exceeding the critical velocity shall be restricted to straight

reaches. Use transition sections of at least 50 feet long to change

channel dimensions.

Width
Keep the bottom width of a trapezoidal waterway less than 100 feet unless multiple or divided waterways or other means are provided to prevent meandering of low flows.

Side slopes
Keep the side slopes flatter than a ratio of 2 horizontal to 1 vertical (2:1). Flatten the side slopes as needed to accommodate the equipment used for maintenance, tillage, and harvesting so that damage to the waterway is minimized.

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 feet of freeboard above the designed depth when flow must be contained to prevent damage. Provide freeboard above the designed depth based on capacity conditions when the vegetation has the maximum expected retardance. To achieve the freeboard, extend side slopes at a slope equal to or flatter than the side slope of the design cross section.

Drainage
When needed to establish or maintain vegetation on sites having prolonged flows, high water tables, or seepage problems, use Wisconsin NRCS Conservation Practice Standards (WI NRCS CPSs) Subsurface Drain (Code 606), Underground Outlet (Code 620), or other suitable measures in waterway designs.

Where drainage practices are not practicable or adequate to solve these seepage problems, use WI NRCS CPS Lined Waterway or Outlet (Code 468) in place of WI NRCS CPS Grassed Waterway (Code 412).

All grassed waterways shall have stable inlet areas. The area downstream of bridges, culverts, or other structures shall be stabilized with durable lining materials if vegetation cannot be established.

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

Grassed waterways that serve as terrace outlets shall be established with adequate vegetation prior to the terrace construction.

Vegetative establishment
Establish vegetation as soon as possible using the criteria listed under “Establishment of Vegetation” in WI NRCS CPS Critical Area Planting (Code 342) . Use mulch; nurse crop; rock, straw, or hay bale dikes; fabric or rock checks; filter fences; or runoff diversion to protect the vegetation until it is established.
Planting a close-growing crop (e.g., small grains or grasses) 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.

CONSIDERATIONS

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 established vegetation above the flow area will increase filtering of sediment and pathogens, and it will increase infiltration of runoff and nutrient removal.

Where sediment control is the primary concern, consider using vegetation in the waterway that 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. Provide for regular cleaning out of the waterway when trapping sediment in this manner.

Implement best management practices and use a system of additional conservation practices or a soil health management system in conjunction with the grassed waterway to minimize upstream runoff and concentrated flow.

Tillage and crop planting often takes place parallel to the waterway, resulting in preferential flow paths and erosion along the edges of the waterway. Consider installation of measures that ensure the 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.

Livestock and vehicle crossings should occur perpendicular to the waterway. Consider locating crossings to minimize potential damage to the waterway. Crossing design must not interfere with design-flow capacity.

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. Avoid placing trees and shrubs in or near the grassed waterway so they do not interfere with hydraulic functions or send roots into associated subsurface drainage. 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 plant species 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 for wildlife. These can become population sinks where wildlife attracted to an area experience reproductive loss due to predation. Mowing may be appropriate to enhance wildlife values, but should be conducted to avoid peak nesting seasons and reduced winter cover whenever possible.

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

For all organic or transitioning-to-organic operations, follow all National Organic Program rules.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for a grassed waterway 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.
- Dimensions of the waterway, including length, grade, top width, bottom width, depth, and side slopes as applicable.
- 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.

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 the waterway from concentrated flow by using diversion of runoff or mechanical means of stabilization, such as silt fences, mulching, hay bale barriers, etc., to stabilize grade during vegetation establishment as necessary.
- After vegetation is established, remove any temporary measures, such as diversions or silt fences, that were installed so as to not interfere with design flow.
- 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 the grassed waterway.
- Avoid use of herbicides or pesticides that would be harmful to the vegetation or

pollinating insects 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, reduce sediment deposition, and maintain suitable plant composition and vigor.
- 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 and turn off chemical application equipment when crossing the waterway.

REFERENCES

USDA Agricultural Research Service. 1987. Stability Design of Grass-Lined Open Channels. Agriculture Handbook Number 667. Washington, D.C. https://naldc-legacy.nal.usda.gov/catalog/CAT87216054

USDA NRCS. 2007. National Engineering Handbook (Title 210), Part 650, Chapter 7, Grassed Waterways. Washington, D.C. https://directives.sc.egov.usda.gov/