NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

GRADE STABILIZATION STRUCTURE

(No.)

CODE 410

DEFINITION

A structure used to control the grade and head cutting in natural or artificial channels.

PURPOSE

To stabilize the grade and control erosion in natural or artificial channels, to prevent the formation or advance of gullies, and to enhance environmental quality and reduce pollution hazards.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to areas where the concentration and flow velocity of water require structures to stabilize the grade in channels or to control gully erosion. The practice applies to all types of structures, including a combination of earth embankments and principal spillways and full-flow or detention-type structures. This practice also applies to channel side-inlet structures installed to lower the water from a field elevation, a surface drain, or a waterway to a deeper outlet channel.

Structures include drop inlets, hood and canopy inlets, chutes, and drop spillways and toewalls.

CRITERIA

General Criteria Applicable to All Purposes

The structure must be designed for stability after installation. The crest of the inlet must be set at an elevation that stabilizes upstream head cutting.

Laws, rules, and regulations. This practice shall conform to all federal, state, and local laws, rules, and regulations. Laws, rules, and regulations of particular concern include those involving water rights, land use, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species. Refer to Kansas statutes, rules, and regulations of the Kansas Department of Agriculture, Division of Water Resources (DWR).

The owner is responsible for securing necessary permits, complying with all laws and regulations, and meeting legal requirements applicable to the installation and operation and maintenance of this practice.

Embankment dams. Class (a) dams that have a product of storage times the effective height of the dam of 3,000 or more, those more than 35 feet in effective height, and all class (b) and class (c) dams shall meet or exceed the requirements specified in Technical Release 60, Earth Dams and Reservoirs.

Class (a) dams that have a product of storage times the effective height of the dam of less than 3,000 and an effective height of 35 feet or less shall meet or exceed the requirements for Conservation Practice Standard 378, Pond.

The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway (earth spillway) crest and the lowest point in the cross section along the centerline of the dam. If there is no auxiliary spillway, the top of the dam is the upper limit.

If spillways are required, the minimum capacity of the principal spillway shall be that required to pass the peak flow expected from a 24-hour duration design storm of the frequency shown in Table 1, less any reduction because of detention storage. Except for DWR-approved dams, floodrouting through the principal spillway conduit may be used when the conduit diameter is 10 inches or larger.

Table 1 - Minimum storm controlled without auxiliary spillway flow

Drainage Area (acres)	Effective Height of Dam (feet)	Total Storage (acre-feet)	Minimum Design Storm	
			Frequency (years)	Duration (hours)
100 or less	35 or less	Less than 50	2	24
100 to 200	20 or less	Less than 50	2	24
100 to 200	20.1 to 35	Less than 50	5	24
200 to 400	20 or less	Less than 50	5	24
All Others	35 or less		10	24

Sediment storage will be provided whenever detention storage is used to size the principal spillway conduit. Sediment storage will be based upon the estimated life of the structure and will be allocated to a sediment pool or partially to the detention pool. The stage-storage curve used for routing will reflect the anticipated accumulation of sediment above the inlet crest.

The minimum difference in elevation between the crest of the auxiliary spillway and the settled top of dam may be 2 feet for dams under the following conditions:

1. The location of the dam is on flat land without well-defined abutments.
2. The top of the dam is the highest point in the adjoining topography.
3. The maximum flow depth in the auxiliary spillway is 1 foot.

The dam must be designed so that it is stable after installation. The crest of the inlet must be set at an elevation that stabilizes upstream head cutting and at the elevation of the sediment storage based upon the estimated life of the structure.

Grade stabilization structures with a settled fill height of less than 15 feet and a 10-year frequency, 24-hour storm runoff less than 10 acre-feet shall be designed to control the 10-year frequency storm without overtopping. The principal spillway (regardless of size) may be considered in design, and an auxiliary spillway is not required if the combination of storage and principal spillway discharge will safely discharge the design storm. The embankment can be designed to meet the requirements for Conservation Practice Standard 638, Water and Sediment Control Basin, rather than the requirements for Conservation Practice Standard 378, Pond.

Full-flow open structures. Drop, chute, and box inlet drop spillways shall be designed according to the principles set forth in National Engineering Handbook Part 650, *Engineering Field Handbook*; National Engineering Handbook Section 11, *Drop Spillways*; National Engineering Handbook Section 14, *Chute Spillways*; and other applicable Natural Resources Conservation Service (NRCS) publications and reports. The minimum capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2, less any reduction because of detention storage. Structures must not create unstable conditions upstream or downstream. Provisions must be made to ensure safe re-entry of bypassed storm flows.

Toewall drop structures can be used if the vertical drop is 4 feet or less, flows are intermittent, downstream grades are stable, and tailwater depth at design flow is equal to or greater than 1/3 of the height of the overfall.

Drop boxes to road culverts shall be as required by the responsible road authority or as specified in Table 2 (less any reduction because of detention storage), whichever is greater. The drop box capacity (attached to a new or existing culvert) must equal or exceed the culvert capacity at design flow.

Table 2 - Minimum capacity for drop spillways, chute spillways, box inlet spillways, toewall drop structures, and drop boxes to culverts

Drainage Area (acres)	Vertical Drop (feet)	Minimum Design Storm		
		Principal Spillway Capacity Frequency (years)	Total [1/] Capacity Frequency (years)	Duration (hours)
450 or less	5 or less	5	10	24
900 or less	10 or less	10	25	24
All others		25	100	24

[1/] Principal spillway may carry total capacity without detention storage.

Structures used in surface drainage systems to lower water from constructed ditches or laterals into deeper open channels may have the principal spillway capacity based on the design drainage curve in lieu of the frequency shown in Table 2. The total capacity need not be greater than a 50-year frequency for structures in the "all other" category.

The structure design shall include freeboard in the amount suggested in the NRCS references or 0.25 foot. Freeboard is the additional height of the headwall extension or sidewall above the head of the design storm flowing over the crest of the inlet.

When earth spillways are used, the principal spillway plus the earth spillway must be designed to handle the total capacity indicated in Table 2. The flow depth in the earth spillway shall not exceed 1 foot, and a minimum freeboard of 1 foot shall be provided between the maximum water surface and the top of the embankment.

Embankment shall extend a minimum of 1 foot over the top of the headwall extension or sidewall and have side slopes no steeper than 3:1 and a minimum top width of 6 feet.

Excavations must be stable for all anticipated conditions. Side slopes shall be no steeper than 2:1.

VEGETATION

The exposed surfaces of the embankment, earth spillway, outlet channel, borrow area, spoil, and other areas disturbed during construction shall be seeded. Seedbed preparation, seeding, fertilizing, and mulching shall comply with Conservation Practice Standard 342, Critical Area Planting.

CONSIDERATIONS

If the area is used for livestock, the structures, earthfill, vegetated spillways, and other areas should be fenced as necessary to protect the structure. Near urban areas, fencing may be necessary to control access and exclude traffic that may damage the structure or to prevent serious injury or death to trespassers.

In highly visible public areas and those associated with recreation, careful considerations should be given to landscape resources.

Landforms, structural materials, water elements, and plant materials should visually and functionally complement their surroundings. Excavated material and cut slopes should be shaped to blend with the natural topography. Shorelines can be shaped and islands created to add visual interest and valuable wildlife habitat.

Exposed concrete surfaces may be formed to add texture or finished to reduce reflection and to alter color contrast. Site selection can be used to reduce adverse impacts or create desirable focal points.

Special consideration should be given to maintaining or improving habitat for fish and wildlife where applicable.

The earth embankment structures are potentially hazardous, and precautions must be taken to prevent serious injury or loss of life. Consider adding protective guardrails, warning signs, fences, or lifesaving equipment as needed.

PLANS AND SPECIFICATIONS

Plans and specifications for installing grade stabilization structures shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed and reviewed with the landowner or individual responsible for operation and maintenance. A comprehensive maintenance plan will enhance the useful life of the grade stabilization structure. The plan shall detail items such as timing of maintenance inspections and methods of performing maintenance.