NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

Grade Stabilization Structure

(Number)

Code 410

DEFINITION

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

PURPOSE

- Stabilize the grade and control erosion in natural or artificial channels
- Prevent the formation or advance of gullies
- Enhance environmental quality and reduce pollution hazards.

CONDITIONS WHERE PRACTICE APPLIES

In areas where the concentration and flow velocity of water require structures to stabilize the channel grade or to control gully erosion. Special attention shall be given to maintaining or improving habitat for fish and wildlife where applicable. This practice does not apply to structural inlets to sink holes.

CRITERIA

General Criteria Applicable to All Purposes. All planned work shall comply with all federal, state and local laws, rules, and regulations.

Soil borings will be conducted to determine the feasibility and type of structure needed to stabilize the channel grade or to control gully erosion.

The structure shall be designed for stability after installation. The crest of the inlet shall be set at an elevation that stabilizes the upstream head cutting. The outlet of the structure shall be such that there is minimum erosion at the outlet.

Earth embankments and emergency spillways of structures for which criteria are not provided under Indiana (IN) Natural Resources Conservation Service (NRCS) Electronic Field Office Technical Guide (eFOTG) Standard (378) Pond must be stable for all anticipated conditions. If earth spillways are used, they must be designed to handle the total capacity flow indicated in Tables 1 or 2 without overtopping the embankment. The foundation preparation, compaction, top width, and side slopes must ensure a stable embankment for anticipated flow conditions. Discharge from the structure shall be controlled to minimize crop damage resulting from flow detention.

Sediment storage capacity shall equal the expected life of the structure, unless a provision is made for a periodic cleanout.

The structures, earthfill, vegetated spillways, and other areas shall be fenced as necessary to protect the structure. Precautions shall be taken to prevent serious injury or loss of life. Protective guardrails, warning signs, fences, or lifesaving equipment shall be added as needed.

The exposed surfaces of the embankment, earth spillway, borrow area, and other areas disturbed during construction shall be seeded, or sodded or otherwise protected as necessary to prevent erosion.

Table1. Design criteria for establishing minimum capacity of full-flow open structures.

Maximum drainage area (acres)	Vertical drop (feet)	Frequency of minimum design, 24-hour duration storm peak flow	
		Principal spillway capacity[2/] (year)	Total capacity[3/] (year)
320	5 or less	5 [1/]	10
640	10 or less	10	25
All others		25	100

1/ Rock chutes, grouted rock chutes, block chutes, concrete chutes and reinforced vegetated chutes shall be designed to carry a 10-year storm as a minimum unless it can be shown that allowable design velocities will not be exceeded should the head water reach the maximum freeboard level. If the minimum design capacity exceeds the downstream channel, then the capacity may be reduced to be equal with the downstream channel.

2/ To below emergency spillway crest.

3/ Before overtopping the lowest part of earth embankment portion of structure. Total Capacity = Principal Spillway Capacity + Emergency Spillway Capacity.

Table 2. Design Criteria for Establishing Minimum Capacity of Side Inlet Drainage Structures [1]/

Limiting Factors			Minimum Design Storm 24-Hour Duration Peak Flow	
Maximum Drainage Area, Acres	Vertical Drop, [5/] Feet	Receiving Channel Depth, [6/] Feet	Principal Spillway [2/] Capacity [3/]	Total Capacity [4/]
320	0-5	0-10	2	5
320	5-10	10-20	5	10
640	0-10	0-20	10	25
All Others	All	All	25	50

1/ For structures outletting into a drainage channel whose drainage area is at least two times the structure drainage area and the channel frequently runs bank full. This table does not apply to rock chutes, grouted rock chutes, block chutes, concrete chutes and reinforced vegetated chutes.

2/ To auxiliary or emergency spillway.

3/ B drainage curve capacity may be used if average watershed slope for side inlet structure is less than 1.0%.

4/ Before overtopping earth embankment portion of structure. Total Capacity = Principal Spillway Capacity + Emergency Spillway Capacity.

5/ Controlled drop in grade.

6/ From low bank to channel grade.

Freeboard. Freeboard of one foot shall be provided on structures where no emergency spillway is provided. Where an emergency spillway is provided, one half foot of freeboard is required, with a minimum total difference of one foot between the crest of the emergency spillway and the top of the fill. If temporary storage is used, the freeboard starts at the temporary storage elevation.

Embankment dams. Class (a) dams having a product of storage times the effective height of the dam of less than 3,000 ac-ft^2 and an effective height of 35 ft. or less shall meet or exceed the requirements specified for IN NRCS eFOTG Standard (378) Pond. Principal and emergency spillway capacity requirements shall meet or exceed Table 3.

Class (a) dams having a product of storage times the effective height of the dam of 3,000 ac-ft^2 or more, those more than 35 ft. in effective height, and all class (b) and class (c) dams shall meet or exceed the hydrologic, hydraulic, and embankment requirements specified in NRCS Technical Release No. 60, Earth Dams and Reservoirs (TR-60), Revised July 2005.

Pond size dams. If principal 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 3, less any reduction attributed to detention storage. Detention storage is the volume between the normal pool elevation and the crest of the emergency spillway.

If (1) the effective height of the dam is less than 20 feet and (2) the emergency spillway has a stable grade throughout its length, with no overfalls, and good vegetation along its reentry into the downstream channel, then the principal spillway capacity may be reduced. However, the principal spillway capacity can be no less than 80 percent of the 2-year frequency, 24-hour duration storm as indicated by footnote 3 in Table 3.

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

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

Table 3. Design Criteria for Dams with Temporary Storage Capacity

Limiting Factors			Frequency of Minimum Design Design Storm, years 24-Hour Duration Peak Flow	
Maximum Drainage Area (Acres)	Maximum Effective Height of Dam[5/] (Feet)	Storage Capacity[6/] (Ac-Ft)	Principal Spillway Capacity[1/]	Total Capacity[2/]
100	<20	Less than 50	2[3/]	10
320	<20	Less than 50	5	25
<640	<20	50 or greater	10	50
All others[7\]			50% PMP[4/]	

1/ To below emergency spillway crest.

2/ Before overtopping the lowest part of earth embankment portion of structure. Total Capacity = Principal Spillway Capacity + Emergency Spillway Capacity.

3/ Can be reduced to 80% of a 2-year frequency if emergency spillway has stable, well vegetated outlet with no overfalls.

4/ Based on a 6-hour Probable Maximum Precipitation (PMP) storm as required by IDNR.

5/ The effective height of the dam is the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no emergency spillway, the top of the dam is the upper limit.

6/ Storage is the total volume of storage available below the emergency crest elevation or top of fill elevation if there is no emergency spillway.

7/ Requires an IDNR Permit and Approval from the State Conservation Engineer.

Full-flow open structures. Full-flow open structures shall pass the design storm through the principal and emergency spillways with no reduction for storage.

Drop, chute, and box inlet drop spillways shall be designed according to the principles set forth in the Engineering Field Manual for Conservation Practices, the National Engineering Handbook, and other applicable 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 1. Structures must not create unstable conditions upstream or downstream. Provisions must be made to insure reentry of bypassed storm flows.

Toe wall drop structures can be used if the vertical drop is 5 ft. or less, flows are intermittent, downstream grades are stable, and tail water depth at design flow is equal to or greater than one-third of the height of the overfall.

The ratio of the capacity of drop boxes to new or existing road culverts shall be as required by the responsible road authority or as specified in Tables 2, 3 or 4, whichever is greater.

Island-type structures. If the principal spillway is designed as an island-type structure, its minimum capacity shall equal the capacity of the downstream channel. An island-type structure has an emergency spillway on both sides. The principal spillway shall carry at least the 2-year, 24-hour storm or the design drainage curve runoff. The minimum emergency spillway capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 1 for total capacity without overtopping the earth fill. Provisions must be made for safe reentry of bypassed flow in excess of the design capacity as necessary.

Side-inlet drainage structures. The design criteria for minimum capacity of open-weir or pipe structures used to lower surface water from field elevations or lateral channels into deeper open channels are shown in Table 2.

Side inlet conduits are to meet the principal spillway thickness and fill height over the pipe conduit requirements of the IN NRCS eFOTG Standard (378) Pond. Protection against seepage shall be provided. This may be provided by the use of an anti-seep diaphragm, anti-seep collar or toe plate extension on flared inlets. Site conditions may limit anti-seep diaphragms to the bottom half only.

Vegetation establishment. A protective cover of vegetation shall be established on all exposed surfaces of the embankment, spillway, borrow area and disturbed areas if soil and climatic conditions permit. Temporary vegetation may be used until permanent vegetation can be established.

If needed, apply lime to raise the pH to the level desired for the species of vegetation being seeded.

Fertilize, at the time of seeding, according to soil tests or at a rate of 500 lbs. of 12-12-12 fertilizer, or its equivalent, per acre.

Use seeding mixes from IN NRCS eFOTG Standard (412) Grassed Waterway around the structure site when built in association with the grassed waterway; otherwise, use IN NRCS eFOTG Standard (342) Critical Area Planting.

Establish vegetation as soon as conditions permit. Use straw mulch, filter fences, or nurse crop to protect the vegetation until it is established.

Table 4. Minimum Capacity for Drop Boxes to Culverts

Box Inlet or Riser to Existing Road Culvert	
Condition	Design Capacity
Culvert capacity less than Q_{50}	1.25 culvert capacity
Culvert capacity greater than Q_{50}	Culvert capacity not to exceed 1.5 Q_{50}

CONSIDERATIONS

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.

Consideration should be given to the effect a structure will have on the aquatic habitat of a channel. If the channel supports fish, the effect of a structure on the passage of fish should be considered.

Structures installed in natural channels should be compatible with the fluvial geomorphic conditions at the site to ensure the stability of the structure.

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. Minimum requirements in the plans are:

- Plan view of structure layout.
- Topographic map (where applicable).
- Profiles and cross sections (where applicable), with soil boring.
- Soil boring locations.
- Hydraulic design data.
- Profile, location and dimensions of principal and emergency spillways.
- Details of principal spillway appurtenances.
- Stationing along centerline of fill. Show stations of intersections of principal and emergency spillway centerlines.
- Fill cross section showing side slopes, top width, elevations of top of fill, berms, ground line, core trench, etc.
- Erosion and sediment control measures.
- Seeding, fertilizing and fencing requirements.
- Quantities and bill of materials.
- Specifications w/earth fill compaction requirements and sealing treatment if applicable.

OPERATION AND MAINTENANCE

A maintenance program shall be established by the landowner/user to maintain capacity and vegetative cover.

1. Protect area of the grade stabilization structure from overgrazing.
2. Fertilize to maintain a vigorous vegetative cover in protected area. Caution shall be used with fertilization to maintain water quality.
3. Mow, spray or chop out undesirable vegetation periodically to prevent growth of large woody-stemmed weeds, water plants such as cattails or trees (such as willows) from embankment and spillway areas.
4. Promptly repair eroded areas.
5. Promptly remove any burrowing rodents that may invade area of embankment.
6. Re-establish vegetative cover immediately where scour erosion has removed established seeding.
7. Keep all spillways open and remove trash that may accumulate around entrance.
8. Periodically inspect area for any new maintenance needs. If any are observed take immediate action to protect from further damage or deterioration.

REFERENCES

National Engineering Field Handbook, Part 650

NRCS, Technical Release No. 55, Urban Hydrology for Small Watersheds June 1986

NRCS, Technical Release No. 60, Earth Dams and Reservoirs Revised July 2005.