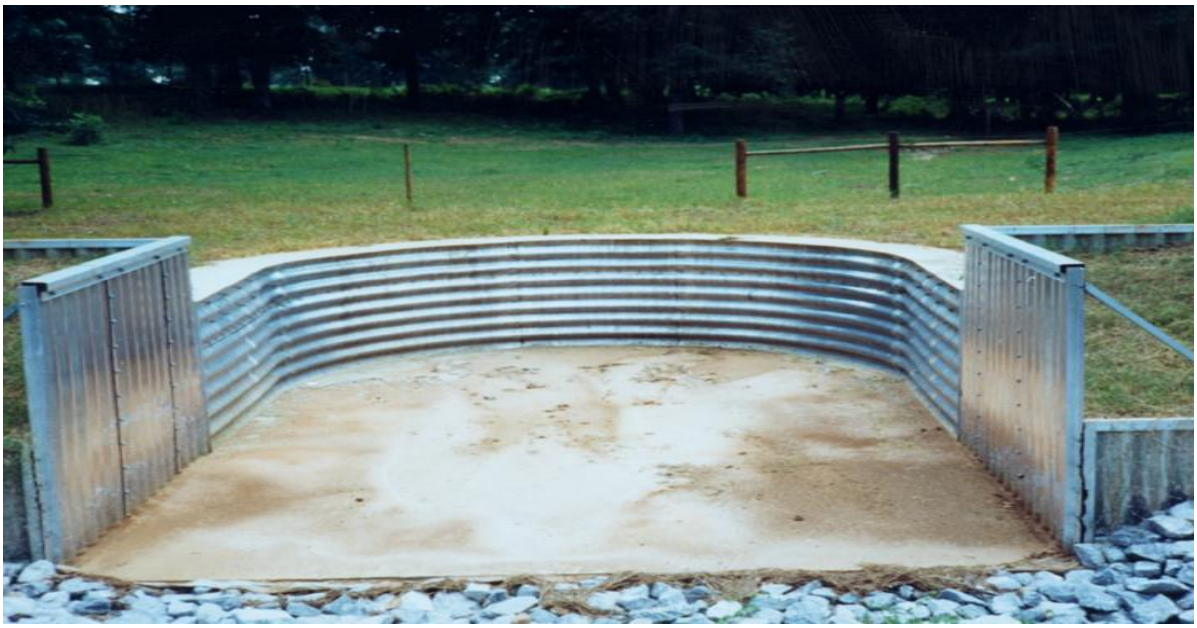
NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

GRADE STABILIZATION STRUCTURE

(No.)
Code 410



DEFINITION

A grade stabilization structure is a structure used to control the grade in natural or constructed channels.

PURPOSE

The purpose of a grade stabilization structure is to stabilize grade, reduce erosion, or improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where channels require a structure to stabilize the grade or to control gully erosion.

CRITERIA APPLICABLE TO ALL PURPOSES

General Criteria. Plan, design, and construct this practice to comply with all federal, state, and local laws, rules, and regulations. Grade stabilization structures may need to be approved or permitted by the appropriate water management district (WMD) or the Florida Department of Environmental Protection (FDEP). Refer to Chapter 373 Florida Statutes (F.S.) and WMD Chapter 40-4 Florida Administrative Code (F.A.C.) for permitting requirements.

Impact to cultural resources, wetlands and Federal and state protected species shall be evaluated and avoided or minimized to the extent practicable during planning, design and implementation of this conservation practice in accordance with established National and Florida policy, General Manual (GM) Title 420-Part 401; Title 450-Part 401, Title 190-Parts 410.22 and 410.26, National Planning Procedures Handbook (NPPH) Florida Supplements to Parts 600.1 and 600.6, National Cultural Resources Procedures Handbook (NCRPH), National Food Security Act Manual (NFSAM), and the National Environmental Compliance Handbook (NECH).

Give special attention to maintaining or improving habitat for fish and wildlife where applicable.

Set the crest of the inlet at an elevation that stabilizes or prevents any upstream head cutting. If erosion at the outlet of the grade stabilization structure is anticipated to be a problem, design appropriate outlet protection measures that will provide protection for the life of the structure.

Design earthen embankments and auxiliary spillways to handle the total capacity flow indicated in Tables 1, 2, or 3 without overtopping any embankment. The foundation preparation, compaction, top width, and side slopes must ensure a stable earthen embankment for anticipated flow conditions.

Provide a minimum sediment storage capacity equal to the expected life of the structure, or provide for periodic cleanout.

Provide measures necessary to prevent serious injury or loss of life such as protective guardrails, warning signs, fences, or lifesaving equipment.

Geological investigations. Geologic investigations shall be in accordance with National Engineering Manual (NEM) Part 531, Geology, Subpart A – Geological Investigations. Pits, trenches, borings, review of existing data or other suitable means of investigation shall be conducted to characterize materials within the embankment foundation, auxiliary spillway and borrow areas. Classify soil materials using the Unified Soil Classification System (USCS).

Maintain a permanent record of all soil borings and test pits with the design documentation.

Embankment dams. Low hazard dams that have a product of storage times the effective height of the dam of 3,000 ac-ft^2 or more, those more than 35 feet in effective height, and all significant and high hazard dams must meet or exceed the criteria specified in Engineering Technical Release (TR) No. 60, Earth Dams and Reservoirs.

Low hazard dams that have 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 feet or less must meet or exceed the requirements specified in Florida NRCS conservation practice standard (CPS) Pond, Code 378.

The effective height of the dam is the difference in elevation, in feet, between the auxiliary 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.

Storage is the capacity of the reservoir in acre-feet below the elevation of the crest of the lowest auxiliary spillway or the elevation of the top of the dam if there is no open channel auxiliary spillway.

For dams that have a storage capacity of less than 50 ac-ft, the minimum capacity of the principal spillway must convey the peak flow expected from a 24-hour duration design storm of the frequency shown in Table 1, less any reduction from detention storage.

For dams with a storage capacity more than 50 ac-ft or criteria values exceeding those shown in Table 1, use the 10-year frequency, 24-hour duration storm as the minimum principal spillway design storm.

For dams with an effective height of less than 15 feet and 10-year frequency, 24-hour storm runoff volume less than 10 ac-ft, the designer may use the requirements of Florida NRCS CPS Water and Sediment Control Basin, Code 638. Design the grade stabilization structure to control the peak flow from the 10-year frequency, 24-hour duration storm without overtopping. If the combination of storage and mechanical spillway discharge will handle the design storm, an auxiliary spillway is not required.

The combined side slopes of the settled embankment shall be not less than 5 horizontal to 1 vertical (5:1), and neither slope shall be steeper than 2 horizontal to 1 vertical (2:1). Design all slopes to be stable. Where embankments are to be mowed; 3 horizontal to 1 vertical (3:1) or flatter slopes are recommended.

Compaction of the embankment fill material shall be in accordance with the specified design requirements for compaction and moisture content. Maximum thickness of earthfill layers will be 9 inches. If for any reason the designer is of the opinion that more stringent compaction requirements are necessary, percent of standard proctor and moisture limits may be specified. The design height of the embankment shall be increased by the amount needed to ensure that after settlement has taken place, the constructed height

of embankment will equal or exceed the design height. This settlement shall not be less than 3 percent for rubber tired pans and scrapers and 5 percent for track type equipment such as bulldozers, except where detailed soil testing and laboratory analysis shows a lesser amount is adequate or field observations indicate a greater amount is needed to obtain the required level of compaction.

Full-flow open structures. Design drop, chute, and box inlet drop spillways to the requirements in the National Engineering Handbook, Part 650, and other applicable NRCS publications and reports. Provide a minimum capacity to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2, less any reduction from detention storage. If site conditions exceed those shown in Table 2, design the minimum principal spillway capacity for the 25-year frequency, 24-hour duration storm and design the minimum total capacity for the 100-year frequency, 24-hour duration storm. Structures must not create unstable conditions upstream or downstream. Install provisions for reentry of bypassed storm flows.

The ratio of the capacity of drop boxes to road culverts must meet the requirements of the responsible road authority or as specified in Table 2 or 3, as applicable, less any reduction from 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.

Structures with flashboard risers shall be designed to handle the design discharge with the water surface below the crest of auxiliary spillway with all the flashboards in place.

Island-type structures. Design the minimum capacity equal to the capacity of the downstream channel. Design the minimum auxiliary spillway capacity equal to that required to pass the peak flow expected from a 24-hour duration storm of the frequency shown in Table 2 for total capacity without overtopping the headwall extensions of the mechanical spillway. For channels with drainage areas of 40 acres or less, the mechanical spillway shall have the minimum capacity of removing the runoff from a 2-year, 24-hour storm in 24 hours or the design drainage curve runoff. Make provision for safe reentry of bypassed flow.

Provisions must be made to prevent damage from overtopping the structure and to divert excess flows away from the structure.

Side-inlet, open weir, or pipe-drop drainage structures. Table 3 provides 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. Design the minimum principal spillway capacity equal to the design drainage curve runoff for all conditions. If site condition values exceed those shown in Table 3, use the 50-year frequency, 24-hour duration storm for minimum design of total capacity.

On structures with drainage areas of 3 acres or less, overtopping of the structure is permitted only if damage will be minor and island type construction will interfere with normal farming operations.

Design side-inlet structures with flashboard risers to handle the design discharge with the water surface below the crest of the auxiliary spillway with all the flashboards in place.

Earth embankment side slopes may be as steep as 1.5 horizontal to 1 vertical (1.5:1) on pipe island-type or side-inlet drainage structures where the effective height is less than 10 feet and the vertical drop is less than 10 feet from natural ground to channel bottom or normal downstream water level.

Freeboard. For all structures, provide a minimum of 0.5 feet additional height of embankment above the design height to account for freeboard.

Seepage control. Include seepage control if (1) seepage will create unstable conditions downstream, (2) it is needed to ensure a stable embankment or (3) special circumstances require drainage for a stable structure. Seepage may be controlled by foundation, abutment or embankment drains.

Seepage along pipes extending through the embankment may be controlled by use of a filter and drainage diaphragm, unless it is determined that anti-seep collars will adequately serve the purpose. Anti-seep collars shall meet the requirements of Florida NRCS CPS Pond, Code 378. Filter diaphragms shall be designed according to National Engineering Handbook, Part 628 Dams, Chapter 45, Filter Diaphragms.

Table 1 - Design criteria for establishing minimum capacity of the principal spillway for dams with storage capacity of less than 50 acre-feet. [1/]

Maximum drainage area for indicated rainfall in a 5-year frequency, 24-hour duration storm			Effective height of dam	Frequency of minimum principal spillway design, 24-hour duration storm	Frequency of minimum auxiliary spillway design, 24-hour duration storm
0-3 inches	3 - 5 inches	5+ inches			
----------acres----------			*feet*	*year*	*year*
200	100	50	0 - 35	2	25
400	200	100	0 - 20	2	25
400	200	100	20 - 35	5	25
600	400	200	0 - 20	5	25

[1/] For dams with a storage capacity greater than 50 ac-ft and those with values exceeding this table, the minimum principal spillway design storm is the 10 year – 24 hour storm event and the minimum auxiliary spillway design storm is the 25 year – 24 hour storm event.

Table 2 - Design criteria for establishing minimum capacity of full-flow open structures. [1/]

Maximum drainage area for indicated rainfall in a 5-year frequency, 24-hour duration storm				Frequency of minimum design, 24-hour duration storm	
0 - 3 inches	3 - 5 inches	5+ inches	Vertical drop	Principal spillway capacity	Total capacity
----------acres----------			*feet*	*year*	*year*
1,200	450	250	0 - 5	5	10
2,200	900	500	0 - 10	10	25

[1/] For site conditions exceeding those shown, the minimum principal spillway capacity is the 25-year frequency, 24-hour duration storm and design the minimum total capacity is the 100-year frequency, 24-hour duration storm

Table 3 - Design criteria for establishing minimum capacity of side-inlet, open weir, or pipe-drop drainage structure. [1/]

Maximum drainage area for indicated rainfall in a 5-year frequency, 24-hour duration storm				Frequency of minimum design, 24-hour duration storm	
0 - 3 inches	3 - 5 inches	5+ inches	Vertical drop	Receiving channel depth	Total capacity
----------acres----------			*feet*	*feet*	*year*
1,200	450	250	0 - 5	0 - 10	5
1,200	450	250	5 - 10	10 - 20	10
2,200	900	500	0 - 10	0 - 20	25

[1/] For site conditions exceeding those shown, the minimum total capacity is the 50-year frequency, 24-hour duration storm.

Trash guards. Where needed to prevent clogging of the conduit, install an approved type of trash rack on the riser of drop inlets. Openings for trash racks shall be no larger than one-half of the barrel conduit diameter, but in no case less than 6 inches. The total cross sectional area of the trash rack openings shall be equal to or greater than the area of the box or riser being protected.

Antivortex device. Drop inlet pipe spillways shall be installed with an antivortex device where needed to prevent the formation of vortices. Design antivortex devices in accordance with ARS-NC-33, Hydraulics of Closed Conduit Spillways, Part XIV.

Materials. Structures installed under this standard shall be constructed of durable material with a life expectancy equal to the planned life of the structure. Pipe conduits used in grade stabilization structures shall meet the requirements as stated in Florida NRCS CPS Pond, Code 378.

Polyethylene, Type III, Class C, Category 4 or 5 conforming to ASTM D1248 and D3350 and AASHTO M252 or M294, Type S may be used for grade stabilization structures with a hydraulic head of 10 feet or less. Pipe connections must be watertight.

Design concrete appurtenances for the anticipated loading and to meet the requirements of National Engineering Handbook, Part 642 Construction Specification 32, Structure Concrete.

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

Safety. Earth embankment dam structures are potentially hazardous and precautions must be taken to prevent serious injury or loss of life. Protective guardrails, warning signs, fences, or lifesaving equipment shall be added as needed.

Protection. Seed or sod the exposed surfaces of earthen embankments, earth spillways, borrow areas, and other areas disturbed during construction in accordance with Florida NRCS CPS Critical Area Planting, Code 342. If climatic conditions preclude the use of seed or sod, use Florida NRCS CPS Mulching, Code 484 to install inorganic cover material such as gravel.

CONSIDERATIONS

Structures located in areas used for livestock or in urban areas should be fenced as necessary to control access and exclude traffic to prevent damage to the structure from vandalism, as well as preventing serious injury to trespassers.

Where conditions preclude or make it difficult to establish vegetative cover, consider using non-vegetative coverings such as rock, geocell, gabions, interlocking blocks or other type of protection.

Grade stabilization structures with detention storage may affect the volume and rates of runoff, evaporation, deep percolation and ground water recharge.

Grade stabilization structures may trap sediment and sediment attached substances carried by runoff. Consideration should be given to the amount of sediment that will be deposited and allowances made for removal.

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.

Consider the susceptibility of downstream stream banks and streambeds to erosion in selecting the type of outlet and in determining the final grade of the outlet channel.

Provide sufficient discharge to minimize crop damaging water detention

Consider the effect of the grade control structure on aquatic habitat. For channels supporting fish, consider the effect of the structure on fish passage.

In natural channels, consider the effect of the grade control structure on fluvial geomorphic conditions.

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.

Plans and specifications shall include, but not limited to, the following items:

- Location and plan view of grade stabilization structure.
- Profile and cross-section(s) of the embankment.
- Special requirements for foundation preparation and treatment.
- Location of the principal and auxiliary spillway.
- Profile and cross sections of the principal and auxiliary spillway.
- Structural drawings, as needed.
- Safety features.
- Requirements for diverting water, dewatering the site, or spoil disposal.
- Borrow source.
- Vegetative requirements.

OPERATION AND MAINTENANCE

Operation and maintenance shall be provided to and reviewed with the landowner. The plan shall include the following items and others as appropriate.

- Inspect the grade stabilization structure periodically to ensure that the structure functions as planned.
- Inspect vegetation on all earthfills. Mow when vegetative growth becomes excessive. Repair and/or fertilize damaged vegetation in accordance with Florida NRCS CPS Critical Area Planting, Code 342.
- Inspect structures for deterioration and capacity. Remove any blockage of trash and debris that could affect flows through the structure. Repair or replace materials that have deteriorated, including rock riprap used for outlet protection.
- Inspect for safety of people or animals using the area near the structure.
- Periodically remove sediment if storage is less than the expected accumulation during the design life.

REFERENCES

AASHTO M252, M294

ARS-NC-33

ASTM D1248, D3350

Chapter 40-4 F.A.C

Chapter 373 F.S.

Florida NRCS CPS:
Critical Area Planting, Code 342
Mulching, Code 484
Pond, Code 378
Water and Sediment Control Basin, Code 638

General Manual
Title 420-Part 401
Title 450-Part 401
Title 190-Parts 410.22 and 410.26

National Cultural Resources Handbook

National Engineering Handbook, Part 628,Dams, Chapter 45, Filter Diaphrams

National Engineering Handbook, Part 642
Construction Specification 32, Structure Concrete

National Engineering Handbook, Part 650, Engineering Field Handbook

National Engineering Manual, Part 531, Geology, Subpart A – Geological Investigations

National Environmental Compliance Handbook

National Food Security Act Manual

National Planning Procedures Handbook
Florida Supplements to Parts 600.1 and 600.6

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