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.

SCOPE

This standard applies to all types of grade stabilization structures, including a combination of earth embankments and mechanical spillways and full-flow or detention-type structures. This standard 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. It does not apply to structures designed to control the rate of flow or to regulate the water level in channels (587).

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

In areas where the concentration and flow velocity of water require structures to stabilize the grade in channels or to control gully erosion. Special attention shall be given to maintaining or improving habitat for fish and wildlife where applicable.

DESIGN CRITERIA

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.

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 ft in effective height, and all class (b) and class (c) dams shall meet or exceed the requirements specified in Technical Release No. 60 (TR-60).

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 ft or less shall meet or exceed the requirements specified for Pond (378).

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.

Pond size dams. If mechanical 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.

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

Maximum drainage area for indicated rainfall*			Effective height of dam	Frequency of minimum design, 24-hour duration storm
0-3 in.	3 - 5 in.	5+ in.		
--------*acres*---------			*ft*	*Yr.*
200	100	50	35 or less	2
400	200	100	20 or less	2
400	200	100	20 - 35	5
600	400	200	20 or less	5

* In a 5-year frequency, 24-hour duration storm

If the effective height of the dam is less than 20 ft and the emergency spillway has a stable grade throughout its length with no overfall and has good vegetation along its reentry into the downstream channel, the principal spillway capacity may be reduced but can be no less than 80 percent of the 2-year frequency, 24-hour duration storm.

If criteria values exceed those shown in table 1 or the storage capacity is more than 50 acre-ft, the 10-year frequency, 24-hour duration storm must be used as the minimum design storm.

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

Seepage Control

Seepage control will be provided for pipes over 30 inches in diameter. Seepage along pipes shall be controlled by use of a filter and drainage diaphragm, unless it is determined that antiseep collars will adequately serve the purpose. Seepage control shall be designed in accordance with the requirements for Pond (378).

Anti-vortex Baffles

An anti-vortex baffle should be used if the maximum depth of flow over the lip of the riser is expected to exceed one-half the diameter of the riser pipe.

Outlet Treatment

Where structures, without detention storage, discharge onto non-cohesive soils, pipe outlets may require protection to prevent undermining of the structure. Refer to Ponds (378).

Embankment

Embankment for structure for water control shall be designed to fit existing site conditions, shall meet the requirements of Ponds (378), and shall meet the following requirements.

1. For pipe overfall structures, the combined upstream and downstream side slopes of the settled embankments shall not be less than 5 horizontal to 1 vertical. The top width of the fill shall be at least 6 feet and shall be increased in proportion to the fill height so

that at least two-thirds of the pipe is covered with fill material.

2. For pipe drop inlets used to control a vertical drop into a drainage channel or waterway, the combined upstream and downstream side slopes of the settled embankments shall not be less than 5 horizontal to 1 vertical, and neither slope shall be steeper than 2 horizontal to 1 vertical. The top width of the fill shall be in accordance with Pond 378.

Emergency Spillway

All structures shall have an emergency spillway to prevent overtopping of the support fill; except in flat land areas where adequate temporary storage is provided to prevent overtopping. The spillway shall be designed to carry the difference between the runoff expected from the design storm and the capacity of the structures.

The design storm shall be at least a 10-yr. frequency storm for structures designed to carry a runoff 25 percent greater than the design capacity of the channel in which it is placed. The design storm of other structures shall be at least a 25-yr. frequency storm.

Full-flow open structures. 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 2, less any reduction because of detention storage. If site conditions exceed those shown in table 2, the minimum design 24-hour storm frequency is 25 years for the principal spillway and 100 years for the total capacity. 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 4 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 over-fall.

The ratio of the capacity of drop boxes to road culverts shall be as required by the responsible road authority or as specified in table 2 or 3, as applicable, 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. - Design criteria for establishing minimum capacity of full-flow open structures.

Maximum drainage area for indicated rainfall*				Frequency of minimum design, 24-hour duration storm	
0 - 3 in.	3 - 5 in.	5+ in.	Vertical drop	Principal spillway capacity	Total capacity
----------*acres*----------			*ft*	*yr.*	*yr.*
1,200	450	250	5 or less	5	10
2,200	900	500	10 or less	10	25

*In a 5-year frequency, 24-hour duration storm.

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

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

*In a 5-year frequency, 24-hour duration storm.

Island-type structures. If the mechanical spillway is designed as an island-type structure, its minimum capacity shall equal the capacity of the downstream channel. For channels with very small drainage areas, the mechanical spillway should 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 2 for total capacity without overtopping the headwall extensions of the mechanical spillway. Provision must be made for safe reentry of bypassed flow 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 3. The minimum principal spillway capacity shall equal the design drainage curve runoff for all conditions. If site condition values exceed those shown in table 3, the 50-year frequency storm shall be used for minimum design of total capacity.

Landscape resources. 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.

General criteria. Earth embankment and emergency spillways of structures for which criteria are not provided under the standard for Pond (378) or in TR-60 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 2 or 3 without overtopping the dam. The foundation preparation, compaction, top width, and side slopes must ensure a stable dam for anticipated flow conditions. Discharge from the structure shall be sufficient that no crop damage results from flow detention.

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

The earth embankment pond 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.

If the area is used for livestock, the structures, earth-fill, 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.

Protection. The exposed surfaces of the embankment, earth spillway, borrow area, and other areas disturbed during construction shall be seeded or vegetated as necessary to prevent erosion. If climatic conditions preclude the use of vegetation, nonvegetative coverings such as gravel or other mulches may be used.

PLANNING CONSIDERATIONS

Food Security Act, Swampbuster, and Section 404 of the Clean Water Act provisions must be considered prior to providing assistance.

Quantity

1. Effects on volumes and rates of runoff, evaporation, deep percolation and ground water recharge.
2. Effects of the structure on soil water and resulting changes in plant growth and transpiration.

Quality

1. Ability of structure to trap sediment and sediment-attached substances carried by runoff.
2. Effect of structure on the susceptibility of downstream stream banks and streambeds to erosion.
3. Effects of the proposed structure on the movement of dissolved substances to ground water.
4. Effects on visual quality of downstream water resources.

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.

Specifications for grade stabilization structures within the scope of the standard for ponds (378) shall, as a minimum, be commensurate with those for ponds. Grade stabilization structures within the scope of TR-60 shall be constructed according to the guide specifications in the National Engineering Handbook, Section 20.

Installation of all pipe structures shall be in accordance with Pipe Specifications for ponds, Code 378.

MATERIALS

The plans shall specify the size, kind, length, gate, finish or coating, type of grade of pipe to be used. Specified materials shall be of a quality capable of providing the stability and durability required to achieve the planned objective with appropriate factors of safety.

Standard corrugated metal pipe with standard band couplers may be used for pipe overfall structures. When corrugated metal pipe is used for pipe drop inlet structure, it shall be of lock seam, or close riveted construction with watertight couplers if the pipe will be under significant pressure.

INSTALLATION
GENERAL

The installation of the pipe, risers, couplings, and diaphragms shall be in accordance with manufacturer's recommendations and as shown on the plans.

All corrugated metal pipe shall be laid with the outside circumferential joints pointing upstream and with the longitudinal laps at the sides at above the vertical mid-height of the pipe.

PIPE OVER-FALL STRUCTURE

The pipe shall be installed in a structure trench, excavated in undisturbed material. The trench shall not be less than 12-inches nor more than 24-inches wider than the diameter of the pipe. Backfill shall be accomplished as outlined under "Back-filling" in this specification.

PIPE DROP INLET-STRUCTURE

The pipe shall be installed in a structure trench, excavated in undisturbed or semi-compacted

material. The trench shall not be less than 12-inches nor more than 24-inches wider than the diameter of the pipe. Where the ground line is such that the trench cannot be excavated in undisturbed material, the area shall be filled with semi-compacted fill to an elevation of at least two feet above the planned elevation of the crown of the barrel prior to excavating the structure trench. The pipe shall then be installed and back fill accomplished as hereinafter specified.

REPAIR OF COATINGS

The pipe, fittings, and appurtenances will be transported and handled in such a manner as to prevent brushing, scaling, or breaking of galvanized or coatings. After the pipe and fittings have been completely installed and while still exposed, any damaged areas where the coating has been broken sufficiently to expose the base metal shall be remedied by re-coating with a material similar and equal to the original coating.

BEDDING

The bottom of the trench or excavation shall be molded to fit the outer circumference of the pipe in such a manner that the depth of the molded bed shall be a minimum of one-tenth times the outside diameter of the pipe below the level of the original bottom of the trench. The pipe shall be bedded on approximately 1-½ inches of moist, loose, well-pulverized soil material for the entire length of the molded bed. The trench bottom shall be free of sod, stumps, roots, boulders or rock, and frozen earth.

BACK-FILLING

The materials for back filling shall be obtained from required excavation or material available at the site and shall be similar to the material of the trench bottom. The back-fill material shall be free of sod, roots, hard lumps or clods, rocks larger than three inches in diameter, frozen material or earth containing a high percentage of organic material.

Back-fill under the haunches and around the pipe shall be accomplished by placing and thoroughly tamping layers of maximum 6-inches thickness or alternate sides so as to keep the same elevation on both sides of the pipe at all times. Care must be exercised during back-fill to assure that the pipe is not displaced. The tamping may be accomplished with hand or mechanical equipment. Heavy equipment or loads shall not be allowed to pass over the pipe until at least 2 feet of fill has been placed and tamped over the top of the pipe.

CONCRETE

The concrete required at the base of the risers or at the other locations as shown on the drawings shall be composed of Type I, Portland Cement, sand, course aggregate, and water. The cement content of the concrete shall not be less than five sacks per cubic yard. The aggregate composed of sand and gravel, shall consist of tough, hard, durable particles, free of organic matter or other objectionable material, having a maximum size of 1 ½ inches and not more than 5 percent passing a No. 200 sieve. The weight of fine aggregate shall not be less than 250 pounds and combined aggregate shall not be more than 660 pounds per sack of cement. Allowable slump shall be 2 to 4 inches.

EARTHWORK

The earth-fill and emergency spillway will be constructed to the elevations, slopes, and dimensions shown on the plans. Vegetative treatment shall be carried out as shown on the plans.

CHECKING FOR COMPLETION

Structures for Water Control shall be checked

for completion in accordance with procedures given in TR-62, Note-keeping Instruction for Engineer Practices.

OPERATION AND MAINTENANCE

This grade stabilization structure was designed and installed to stabilize an eroding area and to safely convey runoff from the drainage area. The estimated life span of this installation is at least 10 years. The life of he structure can be assured and usually increased by developing and carrying out a good operation and maintenance program.

This practice will require periodic maintenance and may also require operational items to maintain satisfactory performance.

Avoid operating farm equipment too close to the structure.

Maintain vigorous growth of desirable vegetative coverings. This includes reseeding, fertilization and controlled application of herbicides when necessary. Periodic mowing may also be needed to control height.

Repair any rills that develop in the emergency spillway.

Control livestock access to the structure.

Remove all debris that may accumulate at the structure, principal spillway trash rack, and immediately upstream or downstream from the structure.

Make sure all structure drains are functional and soil is not being transported through the drainage system, repair if not functioning. The screens and/or rodent shall also be kept in place.

Eradicate or otherwise remove all rodents or burrowing animals. Immediately repair any damage caused by their activity.

Remove woody vegetation from embankments.

Determine and eliminate causes of settlement or cracks in the earthen sections and repair damage.

Repair or replace rusted or damaged metal and paint.

Replace weathered or displaced rock riprap to constructed grade.