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 stabilize 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 ponds (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	Frequency of minimum design, 24-hour
0-3 in.	3 - 5 in.	5+ in.	of dam	duration storm
----------*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 overfalls 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 ponds (378).

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 SCS 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 overfall.

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*			Vertical drop	Frequency of minimum design, 24-hour duration storm	
0 - 3 in.	3 - 5 in.	5+ in.		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*			Vertical drop	Frequency of minimum design, 24-hour duration storm	
0 - 3 in.	3 - 5 in.	5+ in.		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 ponds (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 cleanout.

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, 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.

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

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.

GENERAL

PIPE OVERFALL

Pipe overfall structures are adapted for control of low overfalls and where relatively small quantities of water are involved. The installation shall be of the "Island Type" construction as shown on drawings in the Engineering Field Manual for Conservation Practices.

PIPE DROP INLET

Pipe drop inlet structures are adapted for control of larger overfalls and where relatively large quantities of water are involved. The installation shall be of the type construction shown on the drawings in the Engineering Field Manual for Conservation Practices.

DESIGN CRITERIA

PIPE OVERFALL AND PIPE DROP INLET

The minimum conduit capacity shall equal the design dtrainage curve runoff. The combined capacity of the conduit and emergency spillway shall meet the total capacity requirements shown in Table 3 of the National Standard.

When the purpose of the structure is to control an overfall at the end of a drainage channel, the conduit shall be designed to carry a discharge 50 percent greater than the design capacity of the channel in which it is placed. The combined capacity of the conduit and emergency spillway shall meet the total capacity requirements shown in Table 3 of the National Standard.

The island method of construction is usually sufficient to provide the required emergency spillway capacity for structures installed on flat lands (drainage ditches).

Exit discharge velocity shall not exceed five (5) feet per second except where special outlet protection measures are to be implemented.

The invert of the outlet end of the conduit shall not be more than two (2) feet above the bottom of the outlet channel where the outlet channel is less than six (6) feet deep. For outlet channels greater than six (6) feet deep the outlet invert of the conduit may be four (4) feet above the bottom of the outlet channel. One (1) foot is recommended. The end of the conduit shall be recessed out of channel flow.

SEEPAGE CONTROL

Seepage control is only required when structures are placed in pervious soil. Antiseep collars or Drainage Diaphrams (sand collars) may be used. The latter is recommended. For additional information on seepage control refer to page 3 of National Standard for Pond – 378.

ANTIVORTEX BAFFLES

An antivortex baffle should be used if the maximum depth of flow over the lip of the riser exceeds one-half of the diameter of the riser pipe.

TRASH GUARD

Pipe drop inlet structures, with 18 inch or greater risers, shall have a trash guard installed over the riser to prevent clogging of the conduit. The size of the openings in the guard shall not be greater than one-half the diameter of the barrel. An antivortex baffle may be used as a trash guard.

OUTLET TREATMENT

Where structures, have no detention storage or discharge onto erosive soils, outlets may require protection to prevent undermining of the structure. Riprap, sacked concrete, headwalls, or equivalent protective measures shall be planned. Where detention storage is incorporated in the plan for such structures, pipe outlets shall be provided with a supporting bent 6 to 8 feet from the end to form a cantilever outlet. Treated timber piling with cross members of treated timber will provide a satisfactory support. Point support using a single cross member shall be avoided. The length of pipe actually in contact with the

support shall not be less than one-third of the pipe diameter.

Plunge basins normally develop below cantilever outlets. In highly erodible soils such basins shall be excavated during installation of the structure and lined, bottom sides, with rock riprap.

For detailed design of plunge basins refer to Engineering Design Note No. 6 “Riprap Lined Plunge Pool for Cantilever Outlet”.

VEGETATIVE COVER

All areas disturbed during structure installation shall be protected from erosion by use of suitable vegetation and/or mulch material until natural vegetation is adequate.

GENERAL

There are many types of Grade Stabilization Structures, Guidance on the design and installation of approved structures can be found in the Engineering Field Manual for Conservation Practices, Chapter 6, “Structures”. For structures not illustrated in the Manual, contact the State Design Section for assistance in design, if needed, and for approval.

REPAIR OF COATINGS

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

TRENCH

The trench shall be constructed to the lines and grades as shown on the plans of as staked in the field. The side slopes of the trench will be 1:1 or flatter depending upon soil conditions, depth of cut, and method of installation.

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-fifth times the outside diameter of the pipe below the level of the original bottom of the trench. The pipe shall be bedded on approximately 1½ inches of moist, loose, well-pulverized soil or clean sand for the entire length of the molded bed. The trench bottom shall be free of sod, stumps, roots, boulders or rock, and frozen earth.

BACKFILLING

The material for backfilling shall be obtained from required excavation or material available at the site and shall be similar to the material of the trench bottom. The backfill 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.

Backfill under the haunches and around the pipe shall be accomplished by placing and thoroughly tamping layers a maximum of 6 inches thick on alternate sides so as to keep the same elevation on both sides of the pipe at all times. Care must be exercised during backfill 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 enough fill has been placed and tamped above the top of the pipe to prevent damage.

An alternate procedure, used for low head structure, is to use soft mud. After the conduit is set to design grade the driest suitable soil available is placed over each end of the conduit to form retaining dikes. Soft, soupy material is then placed in the void between the two dikes until the conduit is covered approximately one foot. This material is then allowed to settle around the conduit and dry sufficiently to support the balance of the fill necessary to complete the job.

EARTHWORK

The earthfill and emergency spillway shall be constructed to the elevation, slopes and

dimensions shown on the plans or staked in the field.

INSTALLATION – OTHER STRUCTURES

GENERAL

The installation of all component parts of a structure shall be in accordance with manufacturer's recommendations and as shown on the plans.

EXCAVATION

Structure of trench excavation shall be completed to the specified elevations and to sufficient length and width to include allowance for forms, bracing and supports. This will be accomplished before any concrete or earthfill is placed, or any piles are driven within the limits of the excavation.

All excavated surfaces shall be sloped or adequately braced or shored.

BACKFILLING

The material for backfilling shall be obtained from required excavation or from a site approved by the engineer. It shall be free of sod, roots, hard lumps or clods, rocks larger than three inches in diameter, frozen materials, or earth containing a high percentage of organic material.

EARTHWORK

The earthfill and emergency spillway shall be constructed to the elevation, slopes and dimensions shown on the plans or staked in the field.

CHECKING FOR COMPLETION

Grade Stabilization Structures shall be checked for completion in accordance with the procedures given in "Notekeeping", Grade Stabilization Structure.

Specifications

Specified materials shall provide stability, durability, and safety characteristics required to achieve the planned objective.

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.

SPECIFICATION

DESIGN

All designs and plans will be in accordance with the National Engineering Standard for Grade Stabilization Structures, Code 410. All structures will be designed to provide a minimum service life of 10 years.

MATERIALS

The plans shall specify the size, kind, length, gauge, finish or coating, and type or 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.

PIPE STRUCTURES

Standard corrugated metal pipe with standard band couplers may be used for low head conditions. When corrugated metal pipe is used under significant pressure, lock seam, or close riveted construction with watertight couplers will be used.

For minimum wall thickness refer to the Engineering Field Manual, Louisiana Supplement, Chapter 6 "Structures".

Tank rods for aluminum pipe shall be galvanized steel. All other hardware shall be aluminum or aluminized steel. Nuts, bolts and other hardware on all other pipe shall be galvanized steel.

CONCRETE STRUCTURES

The concrete required a shown on the drawings shall be composed of Type I. Portland cement, sand, coarse aggregate and water. The cement 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, f ree of organic matter or other objectional material, having a maximum size of 1½ inches and with not more than 5 percent passing No. 200 sieve. The weight of fine aggregate shall be more than 660 pounds per sack of cement. Maximum water shall be 6.5 gal./sack of cement. Allowable slump shall be two to four inches.

WOODEN STRUCTURES

Wooden structures shall be constructed from treated materials meeting the requirements of the following table.

Exposure	Minimum Preservative Treatment (lb. per. cu. ft.)		
	Creosote	Pentachlorophenol (Penta, etc.)	Water-Borne Preservative (Wolmanized etc.)
Contact with sea water	12	Not Recommended	0.6
Contact with Ground or fresh Water	10	0.5	0.4

All nuts, bolts, washers and other hardware shall be galvanized.

ALL STRUCTURES

In some instances, the designed life of the structure will not be possible with the use of the above materials alone. Additional material thickness, coatings, inhibitors, cathodic protection, or selected backfill may be required. Condition of existing structures installed in similar type soil is a good indication if a special design is needed.

MATERIAL CERTIFICATION

When a material certification and/or a bill of materials will be required before a final acceptance it shall be noted on the plans.

NOTEKEEPING

DESIGN SURVEY AND DESIGN

Record all data related to hydraulic design. Check and record information such as drainage areas, grades, overfall dimensions and site conditions.

INSTALLATION – PIPE STRUCTURES

GENERAL

The installation of the pipe, risers, couplings, and etc., 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 about the vertical midheight of the pipe.

Prepare drawing or sketch of the proposed structure. Number and identify with respect to its location on the farm. If applicable, standard drawings or forms may be used to indicate this information.

CONSTRUCTION LAYOUT

Set enough well marked stakes to guide farmer or contractor in installing and structure to the designed depth and grade.

CONSTRUCTION CHECK

Check the job at least once during installation to determine adequacy of the work. Simple structures need not be observed individually during installation after the farmer and/or contractor has demonstrated ability to install them.

Check and record survey data for the completed structure to assure planned dimensions, elevations, and quantities were obtained in construction.

Check all materials used in construction to verify they are as specified for in the plans. Check material certification and/or bill of materials if they were called for in the plans.

RECORDING DATA

Record survey data on field notebook paper or other appropriate prepared forms.

Record practice name, agreement number, ACP referral number, photo number, and sketch of field and location of surveys.

Check notes carefully to determine that all specifications have been met. Date and sign the statement, “This practice meets specifications.” Note any exceptions.

RECORDING COMPLETED PRACTICE

Show completed structure in red on the field office copy of the conservation plan map, or, if not available, on aerial photograph or overlay. See Standard Conservation Symbols. Number permanent structures. A.C.P. cost shared structures shall have the year completed behind structure number (i.e. 1-88, 2-88, etc.); non-costsharing practices will not. No two structures shall be numbered alike.

FILING NOTES AND RECORDS

See General Manual 120, Administrative Services, Part 408, Records; Subpart D, Exhibits; 210-11, Conservation Practices.

PLANNING CONSIDERATIONS FOR WATER QUANTITY AND QUALITY

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 stream beds 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.