Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

GRADE STABILIZATION STRUCTURE

CODE 410

(no)

DEFINITION

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

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Reduce erosion
- 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

General Criteria Applicable to All Purposes

Plan, design, and construct this practice to comply with all Federal, State, and local regulations.

Set the crest of the inlet at an elevation that will stabilize the channel and prevent upstream head cutting.

Design earthen embankments and auxiliary spillways to handle the total capacity flow indicated in tables 1 or 2 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.

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

Use existing stream crossings for equipment access during practice installation.

Minimize soil and vegetation disturbance during practice installation; avoid total removal of vegetation to allow regrowth by only removing targeted species and leaving the native herbaceous layer as undisturbed as possible.

Ensure equipment does not have oil or fuel leaks, and maintenance is done well away from water.

Immediately clean grease, oil, or other contaminant spills and remove from the site.

Plant or seed native species adapted to local conditions on disturbed ground to reduce opportunities of invasive weed establishment. In listed habitat, NRCS will consult on any non-native plant species used in the planting plan.

Minimize upland soil compaction during practice construction by selecting the location and timing of the practice to minimize compaction (i.e. avoid periods when soil is wet, especially high clay soils).

Use existing roads, limit cross-country travel or initiation of new roads.

Conduct a pre-installation, pedestrian survey for wildlife that may be trapped within a temporarily fenced construction area. Trapped wildlife will be allowed to escape prior to construction.

Table 1. Design Criteria for Establishing Minimum Capacity of Full-flow Open Structures

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

Table 2. Design Criteria for Establishing Minimum Capacity of Side-inlet, Open-weir, or Pipe-drop Drainage Structure

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

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 NRCS Engineering Technical Release (Title 210), 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 NRCS 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.

Pond-sized dams
If mechanical spillways are required, 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 3, less any reduction from detention storage. For dams with effective height less than 20 feet, a stable auxiliary spillway with no overfalls, and good auxiliary spillway vegetation along its reentry into the downstream channel, the designer may reduce the principal spillway capacity to no less than 80 percent of the 2-year frequency, 24-hour duration storm. For dams with a storage capacity more than 50 acre-feet or criteria values exceeding those shown in table 3, use the 10-year frequency, 24-hour duration storm as the minimum design storm.

Table 3. 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 in a 5-year frequency, 24-hour duration storm			Effective height of dam	Frequency of minimum design, 24-hour duration storm
0–3 inches	3–5 inches	5+ inches		
acres			feet	year
200	100	50	0–35	2
400	200	100	0–20	2
400	200	100	20–30	5
600	400	200	0–20	5

Small pond-sized dams
For dams with an effective height of less than 15 feet and 10-year frequency, 24-hour storm runoff volume less than 10 acre-feet, the designer may use the requirements of NRCS CPS Water and Sediment Control Basin (Code 638). Design the grade control 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.

Full-flow open structures
Design drop, chute, and box inlet drop spillways to the guidance in the NRCS National Engineering Handbook (Title 210), Part 650, “Engineering Field Handbook” 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 1, less any reduction from detention storage. If site conditions exceed those shown in table 1, 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 1 or 2, 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.

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 1 for total capacity without overtopping the headwall extensions of the mechanical spillway. Make provision for safe reentry of bypassed flow as necessary.

Rock and Brush Structures (Arizona 410A) for watersheds less than 200 acres

The structure shall be designed in accordance with:

1. *Accepted standard designs*
2. *Engineering Field Manual, Chapter 10 "Gully Treatment"*
3. *Forest Service Research Paper RM-169, Revised 1979*
4. *National Engineering Handbook (NEH) Part 654 Technical Supplement 14P Gullies and Their Control*

Minimum requirements:

1. *Weir crest height above channel shall not exceed 4 feet;*
2. *Weir length (upstream to downstream) shall be equal to or exceed the weir crest height;*
3. *Weir crest width shall correspond to the approximate width of the channel;*
4. *Weir shall be configured to direct flows away from channel banks;*
5. *Structure shall be capable of safely passing a minimum flow depth of 1 foot through the weir without overtopping and a minimum capacity specified in Table 2;*
6. *Slopes (H:V) for structure shall be no steeper than as shown in the table below.*

Rock Shape	*Upstream*	*Downstream*
Rectangular Slab or Flagstone, Hand Placed	*1:2*	*1.5:1*
Angular	*1:1*	*1.5:1*
Round	*1:1*	*2:1*

Side-inlet, open weir, or pipe-drop drainage structures
Table 2 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 2, use the 50-year frequency, 24-hour duration storm for minimum design of total capacity.

Additional Criteria for Treatments in Listed Species Habitats

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- Where clearing of vegetation is determined to be necessary during planned construction or maintenance, the corridor cleared, otherwise prepared, or maintained will not exceed 25 Feet in width.
- Flag or otherwise protect individuals of a listed plant species in construction areas.
- A Pre-construction survey will be completed to ensure that vegetation or habitat structural materials to be removed are not used as primary cover for a listed species. Cover or nest materials will remain with a 250' undisturbed buffer.
- Installing outside covered species' critical time periods (Table 2), Referenced in practice standard as Field Office Technical Guide, Section II, Technical note.
- Use existing travel routes through listed species habitat.
- Alignments for planned construction will be routed to avoid specific areas known to be occupied by the covered species and known habitat features of the covered species such as burrows and nests.
- Screen inlets and outlets to prevent non-native fish and amphibians from spreading into other habitats.
- Time practice implementation to reduce spread of non-native plants by implementing the practice during the dormant season (e.g. avoid ground disturbance in riparian areas in the summer to reduce salt cedar spread).
- Clean equipment used in practice implementation (vehicles, farm equipment, and tools) before entering and leaving project site to prevent the spread of non-native plant/animals or disease.

CONSIDERATIONS

Provide sufficient discharge to minimize crop-damaging water detention.

In highly visible public areas and those associated with recreation, give careful consideration to landscape resources. Landforms, structural materials, water elements, and plant materials should complement their surroundings visually and functionally. Consider using a diverse mix of native vegetation that is adapted to the site to provide enhanced ecological, habitat, and pollinator benefits. Shape excavated material and cut slopes to blend with the natural topography. Shape shorelines and create islands to add visual interest and wildlife habitat. Form and finish exposed concrete surfaces to add texture, reduce reflection, and to alter color contrast. Select sites to reduce adverse impacts or create desirable focal points.

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.

Provide fences to protect structures, earth embankments, and vegetated spillways from livestock. Near urban areas, provide fencing as appropriate to control access and exclude traffic.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for installing grade stabilization structures that describe the requirements for applying the practice according to this standard. As a minimum, include—

- A plan view of the layout of the grade stabilization structure and appurtenant features.
- Typical profiles and cross sections of the grade stabilization structure and appurtenant features as needed.
- Structural drawings, as needed.
- Seeding requirements, as needed.
- Safety features.
- Site-specific construction requirements.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator. As a minimum, include—

- Periodic inspections of all structures, earthen embankments, spillways, and other significant appurtenances.
- Prompt repair or replacement of damaged components.
- Prompt removal of sediment when it reaches predetermined storage elevations.
- Periodic removal of trees, brush, and invasive species.
- Periodic inspection of safety components and immediate repair if necessary.

Require maintenance of vegetative protection and immediate seeding of bare areas as needed.

REFERENCES

USDA NRCS. 2019. Engineering Technical Release (Title 210), 60, Earth Dams and Reservoirs. Washington, D.C. https://directives.sc.egov.usda.gov

USDA NRCS. 2008. National Engineering Handbook (Title 210), Part 628, Dams. Washington, D.C. https://directives.sc.egov.usda.gov

USDA NRCS. 2012. National Engineering Handbook (Title 210), Part 650, Engineering Field Handbook. Washington, D.C. https://directives.sc.egov.usda.gov