Drop Structure (DS)

Practice Description

A drop structure is an erosion-control structure created by constructing a barrier across a drainageway or installing a permanent manufactured product down a slope. The purpose of a drop structure is to convey concentrated flow storm runoff from the top to the bottom of a slope or to lower water from a grassed swale into an open channel such as an intermittent or perennial stream. This practice applies where other erosion-control measures are insufficient to prevent excessive erosion and off-site sedimentation.

Planning Considerations

This practice applies to the following sites: 1) where earth and vegetation cannot safely handle water at permissible velocities; 2) where excessive grades or over-fall conditions are encountered; and/or 3) where water is to be structurally lowered from one elevation to another. These structures should be planned and installed as a part of an overall surface-water disposal system. This practice does not apply to storm sewers, concrete over-fall structures, in-channel grade-control structures, or road culverts.

Design Criteria and Construction

Design and specifications shall be prepared for each structure on an individual job basis depending on its purpose and site conditions.

Capacity

The minimum design capacity for pipe structures shall be as required to pass the peak runoff expected from a 2-year frequency, 24-hour duration storm. Peak rates of runoff values used to determine the capacity requirements should be calculated using accepted engineering methods. Some accepted methods are:

- Natural Resources Conservation Service, National Engineering Handbook Series, Part 650, Engineering Field Handbook, Chapter 2, Estimating Runoff.

- Natural Resources Conservation Service (formerly Soil Conservation Service), Technical Release 55, Urban Hydrology for Small Watersheds.

- Other comparable methods – See *Appendix A: Erosion and Stormwater Runoff Calculations* found in the Appendices Volume.

Runoff computation will be based upon the most severe soil and cover conditions that will exist in the area draining into the pipe structures during the planned life of the structure.

All pipe structures should be designed as island type with an emergency spillway to safely pass storm runoff greater than the structure design storm. The minimum total capacity of the principal and emergency spillways shall be that required to handle the 25-year 24-hour duration storm, or the peak rate of flow from the contributing structure, whichever is greater.

General

The planning and design of antivortex devices, trash racks, and anti-seep collars should be in accordance with the requirements for principal spillway pipe design in the *Sediment Basin Practice*. Outlet protection should be designed according to the *Outlet Protection Practice.*

The crest elevation for the emergency spillway shall be set at the minimum level necessary to ensure full pipe flow of the principal spillway. The top of the settled embankment shall be based on 1 foot of freeboard above the design flow depth in the emergency spillway.

Straight pipe structures should be built in accordance with Figure DS-l.

Pipe drop structures should be built in accordance with Figure DS-2.

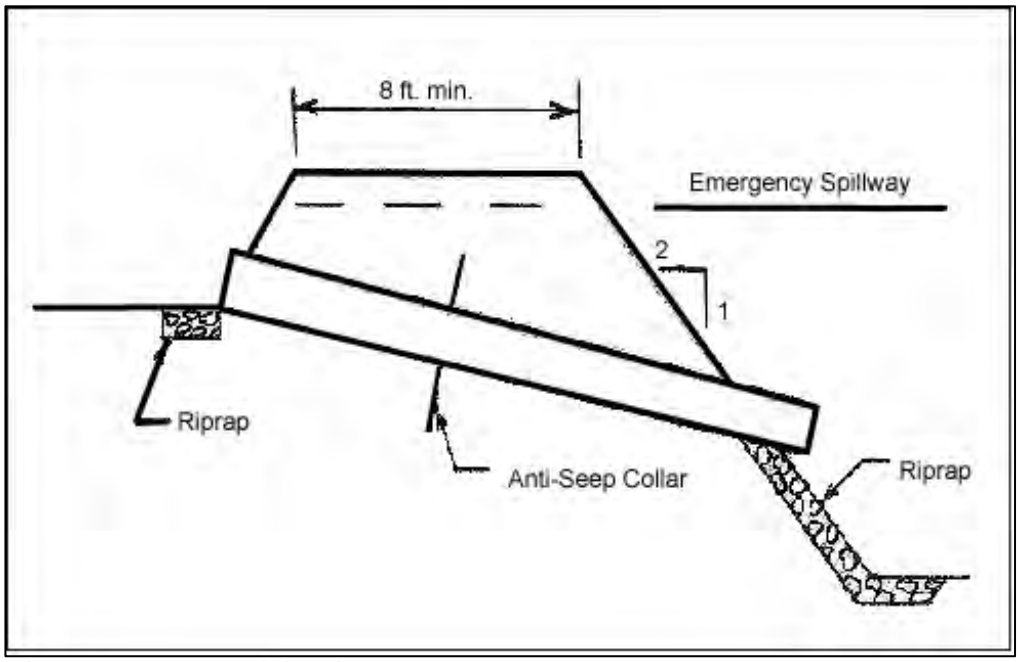

Figure DS-1 Straight Pipe Structure

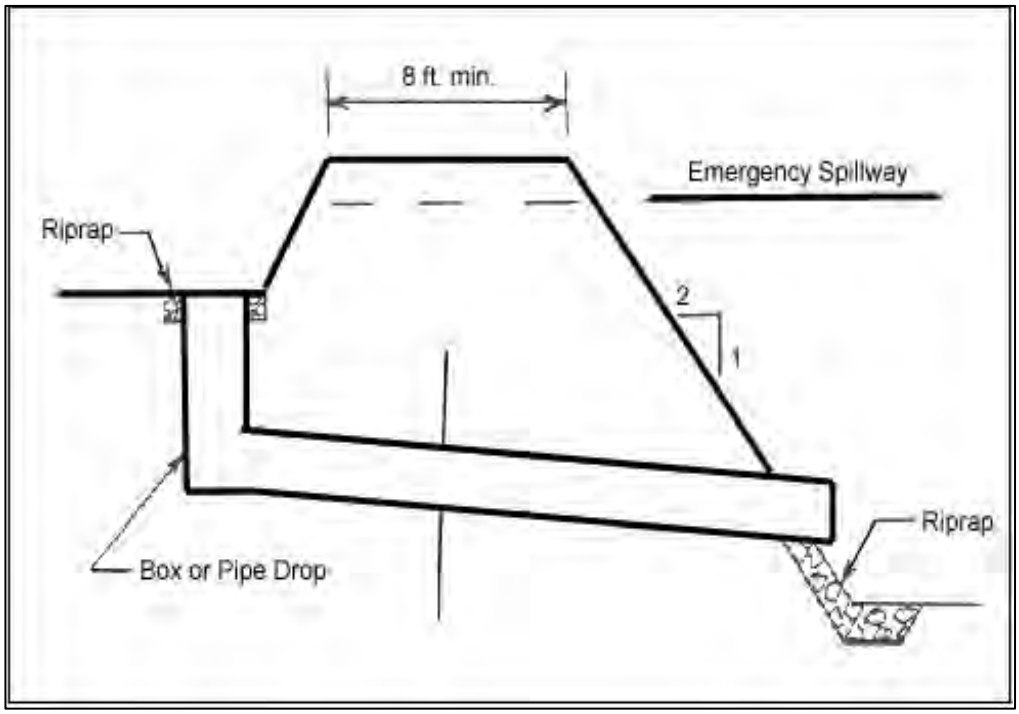

Figure DS-2 Pipe Drop Structure

Construction

Prior to the start of construction, drop structures should be designed by a qualified design professional.

Plans and specifications should be referred to by field personnel throughout the construction process. The drop structure should be built according to planned grades and dimensions.

Note: Construction of an embankment with spillways is the only type of drop structure covered in this edition of the manual.

Consider the following guidance as construction proceeds:

Site Preparation

Locate all utilities at the site to ensure avoidance (See Appendix C: MS One-Call and 811 Color Coding).

Clear, grub, and strip the dam foundation and emergency spillway area, removing all woody vegetation, rocks and other objectionable material. Dispose of trees, limbs, logs, and other debris in designated disposal areas.

Stockpile surface soil for use later during topsoiling.

Clear the sediment pool to facilitate sediment clean-out and dispose of trees, limbs, logs, and other debris in designated disposal areas.

Principal Spillway

Prepare the pipe bedding and situate the spillway barrel (pipe) on a firm, even foundation.

Install anti-seep collars according to the design plan.

Place around the barrel 4″ layers of moist, clayey, workable soil (not pervious material such as sand, gravel or silt), and compact with hand tampers to at least the density of the foundation soil. (Do not raise the pipe from the foundation when compacting under the pipe haunches.)

At the pipe inlet, install *Inlet Protection* according to the design plan.

At the pipe outlet, install *Outlet Protection* according to the design plan (if not specific, use a riprap apron at least 5 feet wide to a stable grade).

Embankment

Scarify the foundation of the dam before placing fill. Use fill from predetermined borrow areas. It should be clean, stable soil free of roots, woody vegetation, rocks and other debris, and must be wet enough to form a ball without crumbling, yet not so wet that water can be squeezed out.

Place the most permeable soil in the downstream toe and the least permeable in the center portion of the dam.

Protect the spillway barrel with 2 feet of fill that has been compacted with hand tampers before traversing over the pipe with equipment.

Compact the fill material in 6″ to 8″ continuous layers over the length of the embankment. One way is by routing construction equipment so that each layer is traversed by at least one wheel of the equipment.

Construct and compact the embankment to an elevation 10% above the design height to allow for settling. The embankment should have a minimum 8-foot top width and 3:1 (Horizontal: Vertical) side slopes, but the design may specify additional width and gentler side slopes.

Emergency Spillway

Construct the spillway at the site located by the qualified design professional according to the plan design (in undisturbed soil around one end of the embankment, and so that any flow will return to the receiving channel without damaging the embankment).

Erosion Control

Minimize the size of all disturbed areas.

Use temporary diversions to prevent surface water from running onto disturbed areas.

Vegetate and stabilize the embankment, the emergency spillway and all disturbed areas immediately after construction.

Construction Verification

Check the finished grades and configuration for all earthwork. Check elevations and dimensions of all pipes and structures.

Common Problems

Consult with a qualified design professional if any of the following occur:

Variations in topography on site indicate drop structure will not function as intended.

Seepage is encountered during construction; it may be necessary to install drains.

Design specifications for fill, pipe, seed variety or seeding dates cannot be met; substitutions may be required. Unapproved substitutions could lead to failure.

Maintenance

Inspect the drop structure after each storm event until it is completely stabilized with vegetation.

Periodically check the embankment, emergency spillway and outlet for erosion damage, piping, settling, seepage or slumping along the toe or around the barrel and repair immediately.

References

BMPs from Volume 1

Chapter 4