NRCS
Natural Resources Conservation Service

Rock Outlet Protection

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What is rock outlet protection?

A pad or apron of heavy rock placed at the outlet end of culverts or chutes.

When is rock outlet protection used?

Rock outlet protection is installed where the energy at the outlets of culverts or chutes are sufficient to erode the receiving channel or area. This fact sheet does not apply to continuous rock linings of channels or streams. Pipes that dump water at the top of a slope, or down slopes steeper than 10 percent, or flow at rates greater than 10 feet per second require a site specific design that is beyond the scope of this fact sheet.

How is rock outlet protection installed?

Apron length: Apron length ***(La)*** shall be determined from Table 1.

Apron width: The apron width is based on the diameter of the discharge pipe, ***(D)***. The apron width will be ***3D*** at the upstream end ***(Wu),*** and the downstream width ***(Wd)*** will be equal to ***(D + La)***. The apron shall extend across the channel bottom and up side slopes for a minimum height equal to the diameter of the pipe, ***(D)***.

Alignment: The apron shall be located so that there are no bends in the horizontal alignment. The apron should be level over its length, and the elevation of the downstream end of the apron must be the same as the elevation of the receiving channel or adjacent ground.

Thickness: The required apron thickness is shown in Table 1.

Gabions: When a gabion mattress is used it shall be made of double twisted galvanized steel wire. Gabions shall be fabricated in such a manner that the sides, ends, and lid can be assembled at the construction site into mats a minimum of 12 inches thick.

Materials: Outlet protection may be done using rock riprap or gabion mattresses to construct the apron. The rock shall consist of field stone or rough unhewn quarry stone. The stone shall be hard and angular and of a quality that will not disintegrate on exposure to water or weathering. Broken concrete may be used provided it does not have any exposed steel or reinforcing bars, and that it is broken into blocky pieces such that the largest dimension of each piece is no more than 3 times the smallest dimension. The required rock size is shown in Tables 1 and 2. In all cases a geotextile (filter fabric) shall be placed between the apron and the underlying soil to prevent soil movement into and through the riprap.

When type of maintenance is required?

Inspect rock outlet structures after heavy rains to see if any erosion around or below the riprap has taken place or if stones have been dislodged. Immediately make all needed repairs to prevent further damage. Remove any debris that has collected on the outlet pad.

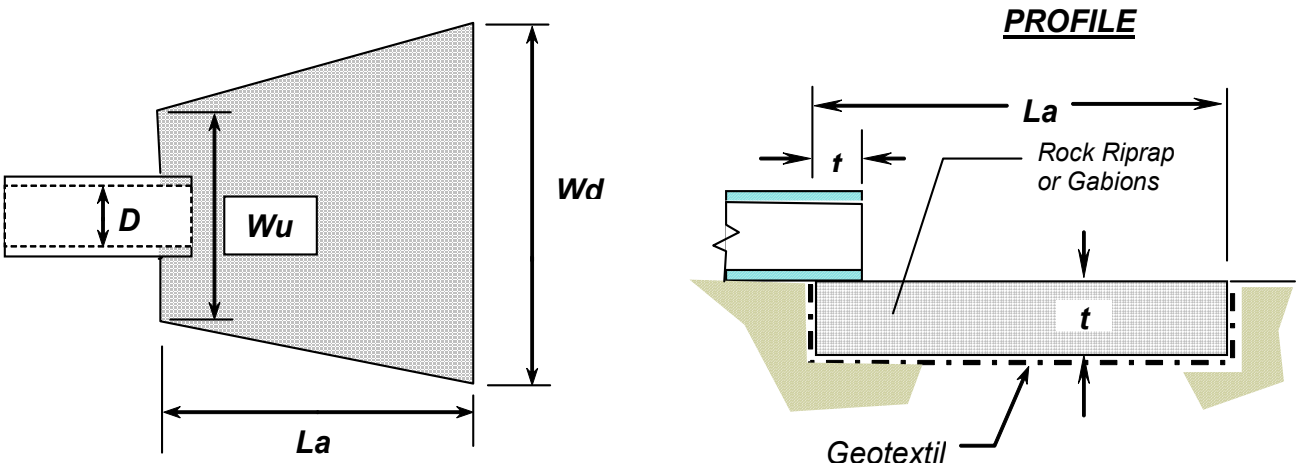

Figure 1 - Typical detail for rock outlet protection below a culvert

Culvert Size D, (inches)	Rock Size d_{50} (inches)	Apron Legnth La, (feet)	Upstream Width Wu, (feet)	Downstream Width Wd, (feet)	Thickness *t*, (inches)	Quantity (tons)
12	6	12	3	13	18	15
18	9	16	4.5	18	24	20
21	9	18	5	20	24	35
24	9	20	6	22	24	60
30	9	22	7.5	24	24	75
36	12	24	9	27	30	120
42	18	26	10.5	30	36	180
48	18	28	12	32	36	215

TABLE 1 - Rock outlet protection apron dimensions

Smallest Dimension in Inches					% of rocks small than size shown
Gadion Rock	6"d_{50}	9"d_{50}	12"d_{50}	18"d_{50}	
8	12	15	21	30	100
6	9	12	18	24	50-70
4	6	9	12	18	35-50
3	2	3	4	6	2-10

TABLE 2 - Required rock gradation

NOTE: After a fire many trees are weakened from burning around the base of the trunk. The trees can fall over or blow down without warning. Shallow rooted trees can also fall. Therefore be extremely alert when around burned trees.