## 2.3 RIP RAP AND APRONS

### 2.31 Rock Rip Rap

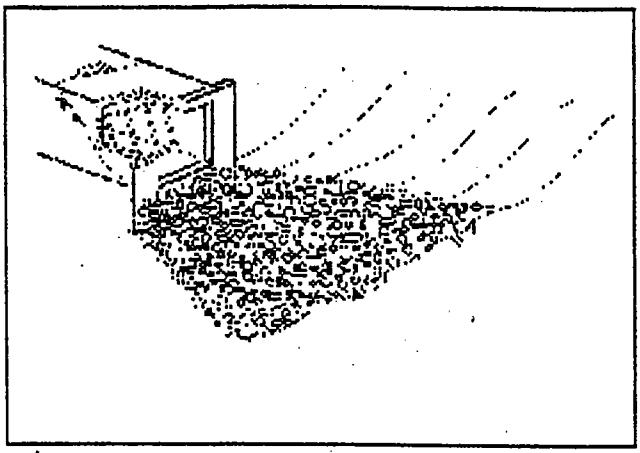


Figure 2.31a

In situations where velocities discharging from a drain are moderate (<15 fps), rock rip rap may be the most economical type of dissipator to construct. Aesthetically, the rock may blend into the natural environment. However, in some areas, it may be more of an eyesore than a formed structure that can be effectively screened with landscaping.

There are two possible approaches. One is a horizontal apron with sufficient length and width to allow the flows to disperse. The other alternative would be a preformed scour hole, lined with rock.

Preformed scour holes can effectively dissipate flow energy and reduce downstream erosion. However, uncontrolled scour holes can undermine the drain and result in subsequent structural failure. A scour hole is objectionable in most areas because it collects debris and presents a safety hazard. The ponded water also breeds insects without proper maintenance.

The criteria presented in this report will be for horizontal rock rip rap aprons, and it is recommended that they be used instead of a preformed scour hole. Energy dissipation may not be as effective, but there will not be the hazards discussed above.

*Sample Problem:*

*Given:*

*Storm drain discharging into a retention basin.*
*$D_o$= 36" RCP*
*Q = 60 cfs*
*$V_o$ = 8.5 fps*
*Design a rock rip-rap apron to reduce scour*

*Solution:*

*Using the empirical equation*

$$\frac{L_{sp}}{D_0} = 1.7 \times \frac{Q}{D_0^{5/2}} + 8$$

*Yields*

$$\frac{L_{sp}}{D_0} = 1.7 \times \frac{Q}{D_0^{5/2}} + 8 = 14.56$$

*Solving for apron length,*
*$L_{sp}$ = (3')(14.56) = 43.69'*

*Use $L_{SP}$ = **44'**, with a flare of **1:2***
*(transverse:long.)*

*Use an upstream width = $3D_0$ = **9'***

*Therefore, downstream width =*
*$\frac{1}{2}L_{SP} + 3D_0$ = **31'***

*Find stone sizing per Chart Q-10 in the Sedimentation Manual*
***$D_{50}$ = 11"***

## 2.32 Flared Apron with Sill

For drains with moderate flow rates and moderate velocities ( < 15 fps), a flared apron with an end sill can provide a simple and effective dissipator. The apron can be constructed of concrete or rock rip rap. The apron should have a width of at least 3 pipe diameters. The divergence angle should be at least 1:1.75 if an end sill is employed (See Fig. 2.32a), and at least 1:3 without. A small channel should be cut in the sill to accommodate low flows,

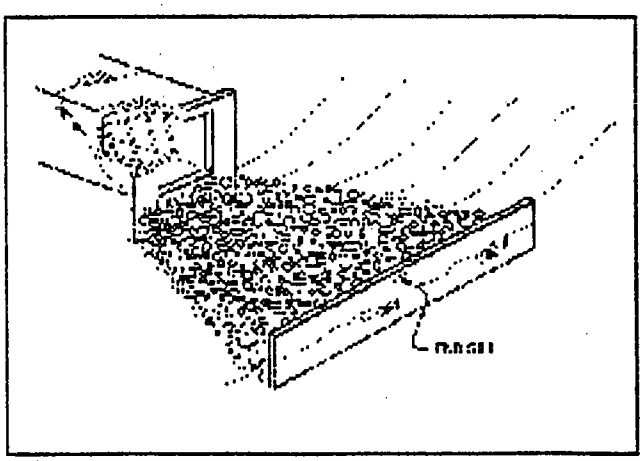
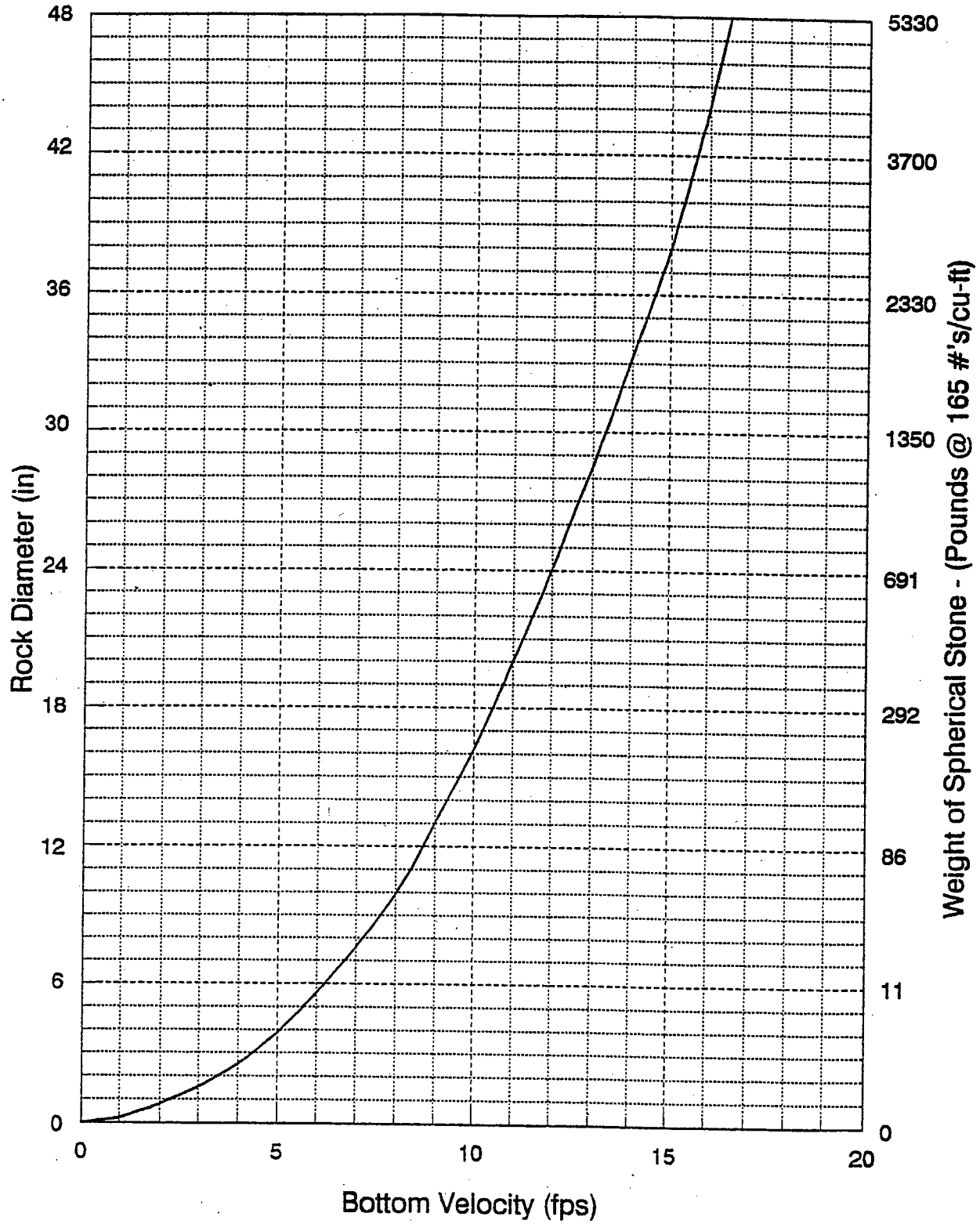


Figure 2.32a

# RIPRAP ROCK SIZE




For rock with specific gravity = 2.65

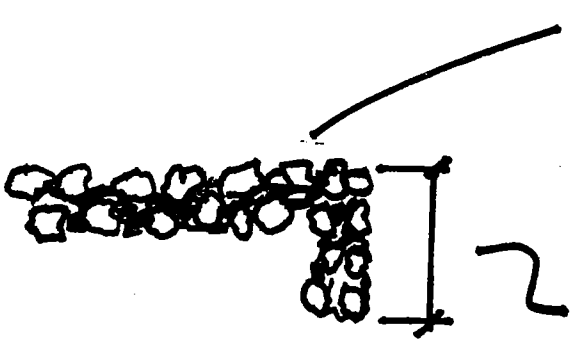
Source: Bureau of Reclamation

EXAMPLE OF THE WAY RIP-RAP SIZES SHOULD BE SHOWN ON P.D. PLANS:

| USE D50 50# RIP-RAP | |
|---|---|
| % LARGER THAN | SIZE |
| 0-5 | 100 # |
| 50-100 | 50 # |
| 95-100 | 25 # |

ROCK SIZE BASED ON OUTLET VELOCITY. (Pg. F-32 HYDRAULICS MANUAL)

Required gradations for D-50 classification can be found on page F-33 of L.A.C.F.C.D. Hydraulics Manual.



RIP RAP PAD THICKNESS (1½-2 TIMES AVG. ROCK SIZE)

CUT-OFF DEPTH (4'-15')* END OF RIP-RAP.

(SURFACE ROCKS TO BE EXPOSED ½ TO ⅓ THIER AVERAGE SIZE)

* REQUIRED CUT-OFF DEPTHS DEPENDS ON OUTLET VELOCITIES, SOIL TYPE, VEGETATION, FLOW RATE, CHANNEL TYPE & SLOPE.

— A GOOD ESTIMATE FOR CUT-OFF DEPTH IN ABSCENSE OF SOILS REPORT IS ± ½ DEPTH SHOWN FOR CURVED REACH ON PAGE F-31 HYDRAULICS MANUAL.

# LEVEE CRITERIA

## Cut-Off Depths

| Velocities | Straight Reaches | *Curved Reach |
|---|---|---|
| 0 - 6 f.p.s. | 6-ft. | 9-ft. |
| 6 - 10 f.p.s. | 8-ft. | 12-ft. |
| 10 - 15 f.p.s. | 10-ft. | 15-ft. |
| 15 - 18 f.p.s. | 12.5 ft. | 18-ft. |
| 18 - 20 f.p.s. | 14 ft. | 21-ft. |

*Check the cut off depth for curved reach on Chart F-06 on Page F-38 Use that depth if greater than given hereon.

## Material and Structural Requirements

Concrete Levees (1 1/2:1 max. side slope)

| Velocities | Levee Thickness - T | | Reinforcing |
|---|---|---|---|
| | Straight Reach | Curved Reach | |
| 0 - 10 f.p.s. | 6-inch | 8-inch | #4 @ 18" Bothways |
| 10 - 20 f.p.s. | 8-inch | 10-inch | #4 @ 18" Bothways |

Gunite Levees (1 1/2:1 max. side slopes)

| Velocities | Levee Thickness - T | | Reinforcing |
|---|---|---|---|
| | Straight Reach | Curved Reach | |
| 0 - 10 f.p.s. | 8-inch | 10-inch | #4 @ 18" Bothways |
| Gunite levees not permitted where velocities exceed 10 f.p.s. | | | |

Material and Structural Requirements

Rip-Rap Levees (2:1 max. side slopes)

(Ungrouted)

| Velocities | Rock Size (D50 Size) | Levee Thickness - T | | Filter Thickness |
|---|---|---|---|---|
| | | Straight Reach | Curved Reach | |
| 0 - 7 f.p.s. | 50 lb. (10") | 15-inch | 20-inch | 6-inch |
| 7 - 9 f.p.s. | 100 lb. (12") | 18-inch | 24-inch | 6-inch |
| 10 f.p.s. | 150 lb. (15") | 23-inch | 30-inch | 9-inch |
| 11 f.p.s. | 300 lb. (18") | 27-inch | 36-inch | 9-inch |
| 12 f.p.s. | 1/4-ton (21") | 32-inch | 42-inch | 9-inch |
| 13 f.p.s. | 1/2-ton (27") | 41-inch | 54-inch | 12-inch |
| 13 - 15 f.p.s. | 1-ton (34") | 51-inch | 68-inch | 12-inch |
| 16 - $17^5$ f.p.s. | 2-ton (43") | 65-inch | 86-inch | 12-inch |
| 18 - 20 f.p.s. | 4-ton (54") | 81-inch | 108-inch | 12-inch |
| (Grouted) Can be used only with special District approval | | | | |
| 16 - 20 f.p.s. | 1-ton (34") | 51-inch | 68-inch | 12-inch |

Gabion Levees (2:1 side slopes)

| Velocities | Levee Thickness (Straight or Curved Reach) | Rockfill | Wire Gage of Baskets | Apron Length |
|---|---|---|---|---|
| 0 - 7 f.p.s. | 12-inch Baskets | 4" - 8" | 12 ga. | 12 feet |
| 8 - 10 f.p.s. | 18-inch Baskets | 4" - 8" | 11 ga. | 18 feet |
| 11 - 15 f.p.s. | 18-inch Baskets | 4" - 8" | 11 ga. | 21 feet |

Gabion levees not permitted where velocities exceed 15 f.p.s.

# RIPRAP NOTES

1. ROCKS FOR GROUTED RIPRAP SHALL BE GOOD QUALITY BROKEN CONCRETE AND/OR RIVER RUN ROCK. THE SMALLEST DIMENSIONS SHALL EXCEED 6 INCHES AND THE LARGEST DIMENSION SHALL NOT EXCEED 24 INCHES. THE LARGEST DIMENSION SHALL NOT EXCEED 4 TIMES THE SMALLEST DIMENSION.
2. THERE SHALL BE A GROUT BED OF AT LEAST 2 INCHES BENEATH THE FIRST LAYER OF ROCK. ALL THE VOIDS BETWEEN THE ROCKS SHALL BE FILLED WITH GROUT. MAXIMUM SPACING BETWEEN ROCKS SHALL BE 2 INCHES.
3. SURFACE ROCKS SHALL BE IMBEDDED FROM 1/2 TO 2/3 OF THEIR MAXIMUM DIMENSION

**NOTE: CONCRETE MAY BE SUBSTITUTED FOR THE GROUT.**