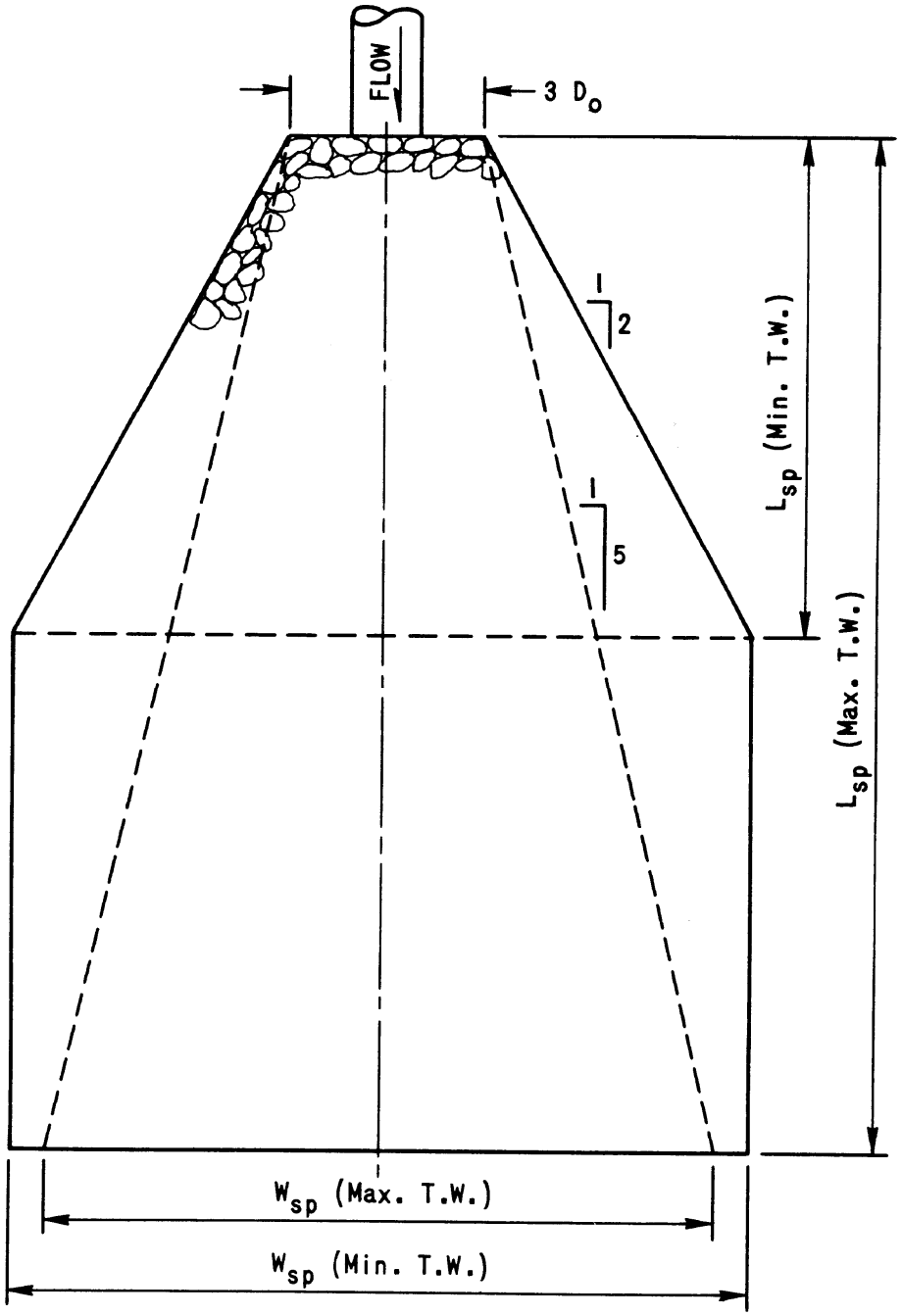
DISSIPATOR LIMITATIONS

Dissipator Type	Froude Number Fr	Allowable Debris			Tailwater TW	Special Consideration
		Silt Sand	Boulders	Floating		
Free Hydraulic Jump	>1	H	H	H	Required	--
CSU Rigid Boundary	<3	M	L	M	--	--
Tumbling Flow	>1	M	L	L	--	$4 < S_o < 25$
Increased Resistance	--	M	L	L	--	Check Outlet Control HW
USBR Type II	4 to 14	M	L	M	Required	--
USBR Type III	4.5 to 17	M	L	M	Required	--
USBR Type IV	2.5 to 4.5	M	L	M	Required	--
SAF	1.7 to 17	M	L	M	Required	--
Contra Costa	<3	H	M	M	<0.5D	--
Hook	1.8 to 3	H	M	M	--	--
USBR Type VI	--	M	L	L	Desirable	Q <400 cfs V <50 fps
Forest Service	--	M	L	L	Desirable	D <36 inches
Drop Structure	<1	H	L	M	Required	Drop <15 ft.
Manifold	--	M	N	N	Desirable	--
Corps Stilling Well	--	M	L	N	Desirable	--
Riprap	<3	H	H	H	--	--

NOTE: N = None
L = Low
M = Moderate
H = Heavy

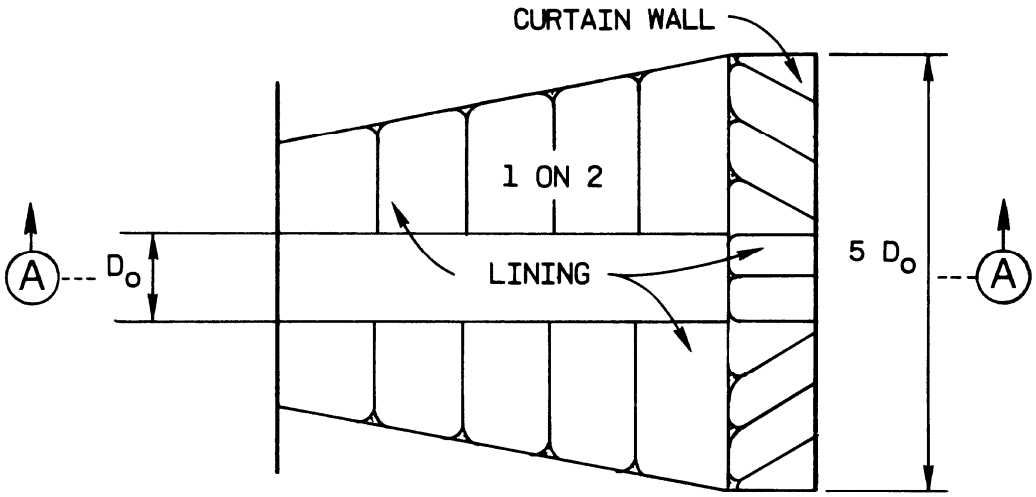
Source HEC No. 14, "Hydraulic Design of Energy Dissipators," FHWA, November, 1975.



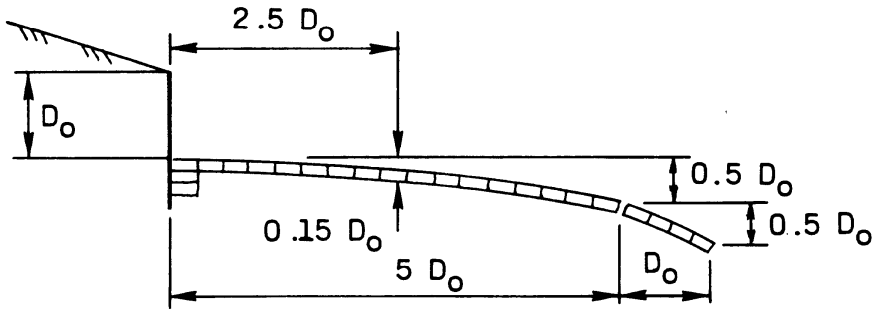
RECOMMENDED CONFIGURATION OF RIPRAP BLANKET SUBJECT TO MAXIMUM AND MINIMUM TAILWATERS

Source: Miscellaneous paper H-72-5, "Practical Guidance for Estimating and Controlling Erosion at Culvert Outlets", U.S. Army Engineer Waterways Experiment Station, May, 1972.

CULVERT OUTLET EROSION PROTECTION. LINED CHANNEL EXPANSIONS



PLAN

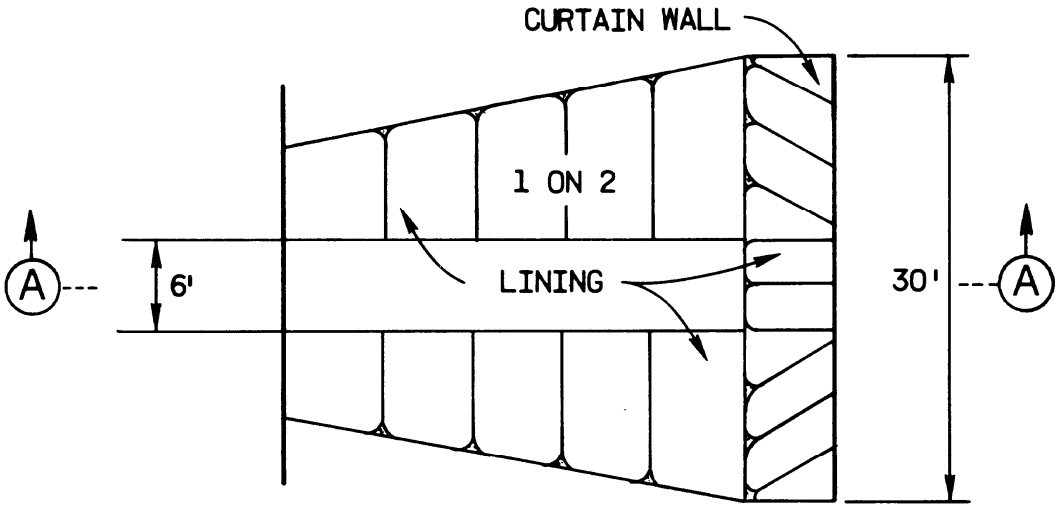


SECTION A-A

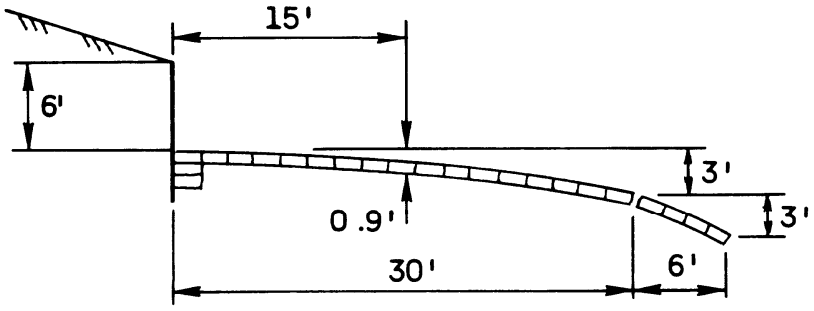
Source: Miscellaneous paper H-72-5, U.S. Army Engineer Waterways Experiment Station, May, 1972.

EXAMPLE PROBLEM

FINAL DESIGN DIMENSIONS FOR THE LINED CHANNEL EXPANSION

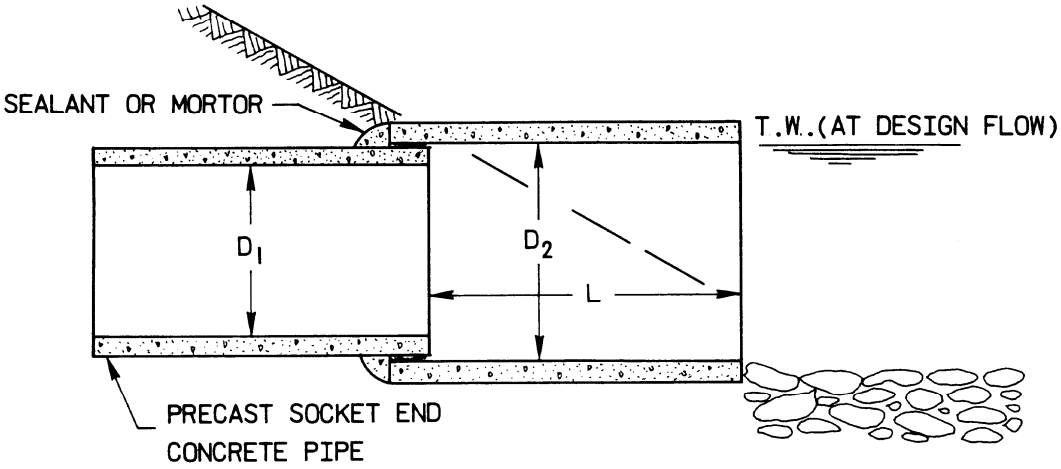


PLAN



SECTION A-A

OUTLET EXPANSION



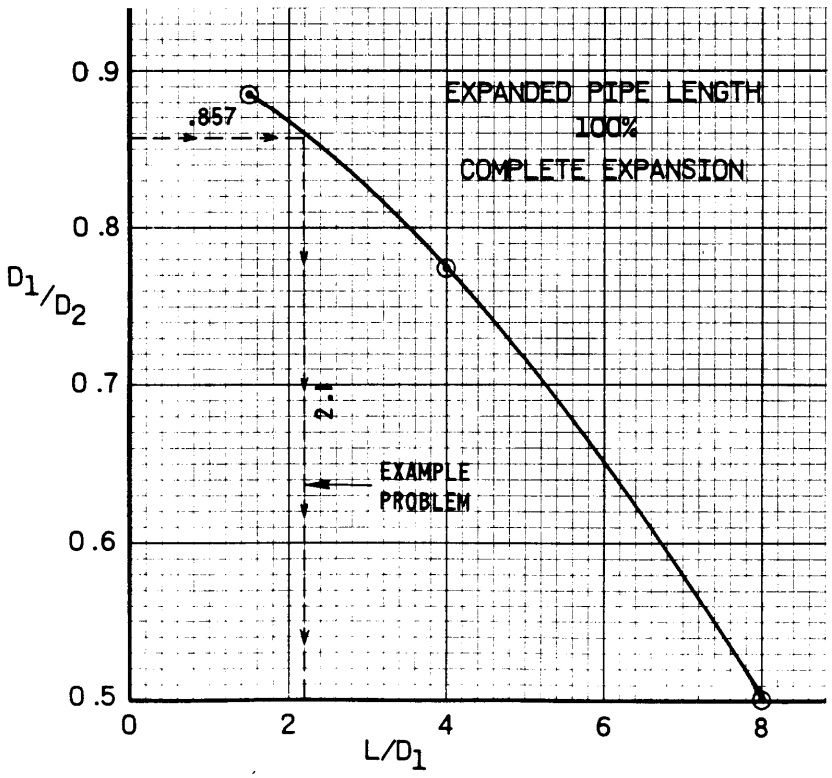
EXPANDED PIPE LENGTH

	100% Complete Expansion	90% Complete Expansion
D_1/D_2	L/D_1	L/D_1
.883	1.5	1.0
.775	4.0	--*
.500	8.0	--*

* NOT REPORTED.

Source: American Concrete Pipe Association, "Culvert Velocity Reduction With an Outlet Expansion," Concrete Pipe News.

DETAIL A



DETAIL B