Reference: Federal Highway Administration, Hydraulic Engineering Circular No. 14, Third Edition (HEC-14), Hydraulic Design for Culverts and Channels, Publication No. FHWA-NHI-06-086, July 2006

															Provided		
Outlet	**Pipe Diameter (D, in)**	**Pipe Diameter (D, ft)**	**Design 100-YR discharge (Q, cfs)**	**Tailwater depth (TW)(=0.4D)**	**Aceeleration due to gravity (g, ft/s^2)**	**Yn**	**D'**	**D_{50} (MIN) (ft)**	**D_{50} (MIN) (in)**	**D_{50} (SELECTED) (in)**	**Class**	**Apron Length (ft)**	**Apron Depth (ft)**	**Apron Width (ft)**	**Apron Length (ft)**	**Apron Depth (ft)**	**Apron Width (ft)**
FES-1	12	1	4.8	0.4	32.2	0.920	0.960	0.42	6	6	2	4.0	1.7	5.4	4.0	1.5	5.5
FES-2	12	1.00	0.4	0.40	32.2	0.266	0.633	0.03	1	5	2	4.0	0.3	5.4	4.0	1.5	5.5
FES-3	12	1	2	0.4	32.2	0.594	0.797	0.17	3	5	2	4.0	0.9	5.4	4.0	1.5	5.5

CLASS		D_{50} (in)	Apron Length	Apron Depth
1		5	4D	3.5D50
2		6	4D	3.3D50
3		10	5D	2.4D50
4		14	6D	2.2D50

Equations: $D_{50} = 0.2D(\frac{Q}{D^{2.5}\sqrt{g}})^{\frac{4}{3}}$(D/TW)

$Supercritical\ Flow\ D' = (D + yn)/2$

y_n= 0.42 [(Q^1/2)/(D^1/4)]