Table 3-3
Comparative Flow Rates for Concrete Box Culvert lined with Snap-Tite®
Based on Manning's equation n=0.00914 for Snap-Tite®, s=0.001ft/ft

Existing Concrete Box Size	Manning's "n" Factor	Snap-Tite® Liner Size	Box full-flow cfs	Snap-Tite® Flow cfs	% of Flow
3 ft. x 3 ft.	0.012	36"	29	25	86%
	0.015	36"	23	25	108%
4 ft. x 4 ft.	0.012	48"	63	54	86%
	0.015	48"	50	54	107%
5 ft. x 5 ft.	0.012	54"	114	74	65%
	0.015	54"	91	74	81%
6 ft. x 6 ft.	0.012	63"	186	111	60%
	0.015	63"	149	111	75%

**Many culverts operate under Inlet Control where full flow Manning's equation comparisons are not accurate since they fail to account for inlet and outlet losses, which may not be minor losses, especially when the barrel is short.*

High velocity in a liner can cause separation on the liner joints when the liner is not grouted in place. Grouting of the liner into the host culvert eliminates separation concerns.

It should be noted that one of the anomalies associated with circular pipes is that a partially full pipe will have higher discharge flow rates than a full pipe can carry, due to the increased friction along the wetted perimeter (Figure3-1). Flow rates above 80% full will be higher than a pipe than full pipe flow with a peak at 93%. Velocities above 50% will be higher than full pipe velocities with a peak at approximately 80% full mark.

Figure 3-1

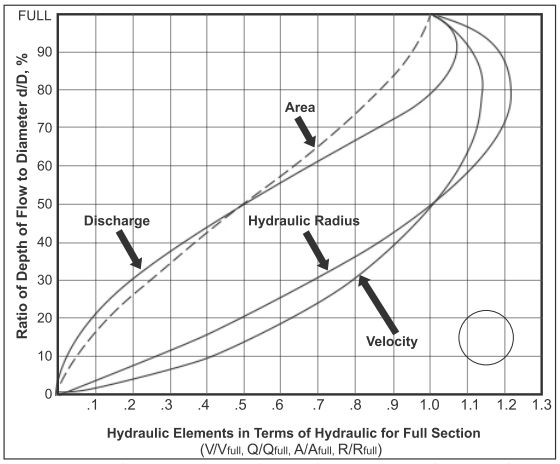

Chart courtesy of Introduction to Highway Culverts.

3-5 Pressure Considerations

Snap-Tite® is made using low-pressure HDPE pipe. The Snap-Tite® joint is designed for use in gravity flow applications and to meet the requirements for AASHTO M 326 . Pressure from headwater or tailwater conditions should not harm the liner or the joint. Snap-Tite® is not designed for long-term pressure applications.

3-6 Types of Flow Control

Once a pipe exceeds the point of full open channel flow, culvert operation is ruled at all times by one of two conditions: inlet control or outlet control. When lining culverts, both inlet and outlet control must be considered. The hydraulic capacity of a culvert depends upon a combination of factors that influence each type of control, identified in Table 3-4. The slope of a culvert, that is barrel slope, is the primary factor influencing whether or not a culvert will be in inlet or outlet control.

Outlet control occurs when flow through the culvert barrel or tailwater can not accept as high a flow as the inlet opening will accept. Full barrel flow with no hydraulic jump is considered to operate under outlet control. Tailwater is the water surface elevation on the downstream side of a culvert as measured from the invert at the culvert exit. High tailwater alone can make a culvert operate under inlet control, but long culverts with rough interiors or slightly sloping culverts are other factors with outlet control.