

The standard precast concrete box section produced under Standards C789 and C850 is shown in Figure 1, and the standard sizes and wall thicknesses in Tables I and II. Generally, box culverts are designed with wingwalls and a wing wall flare of 30-75 degrees as shown in Figure 2 encompass a majority of installations. The precast concrete box sections commonly have a tongue and groove joint configuration similar to precast concrete pipe. The entrance loss coefficient, K_e , is 0.2 for concrete pipe with the groove end projecting. The box section groove also provides basically a rounded crown edge and therefore, an entrance loss coefficient of 0.2 should apply.

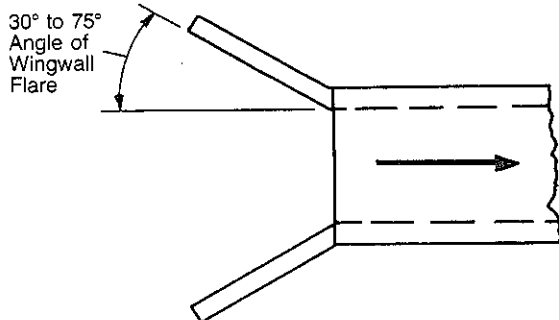
Performance curves for the hydraulic design of the standard precast concrete box culvert are presented in Figures 3 through 22. These curves correlate discharge-headwater depth and are based on nomographs included in Hydraulic Engineering Circular Number 5, Federal Highway Administration, with a recommended roughness coefficient of 0.012. The headwater depths for inlet-controlled flow are read directly from the performance curves. For outlet-controlled flow it is necessary to subtract the product of the culvert length and slope from the headwater depth.

A complete discussion of the hydraulics of culverts is presented in Design Data 8, Hydraulics of Culverts; 12-inch through 21-inch Diameter Pipe and specifics on the hydraulic properties of precast concrete box sections in Design Data 26, Hydraulic Capacity of Precast Concrete Boxes.

TABLE II: Standard Thicknesses

Span, Feet	T_T , inches		T_B , inches		T_S , inches	
	C789	C850	C789	C850	C789	C850
3	4	7	4	6	4	4
4	5	7½	5	6	5	5
5	6	8	6	7	6	6
6	7	8	7	7	7	7
7	8	8	8	8	8	8
8	8	8	8	8	8	8
9	9	9	9	9	9	9
10	10	10	10	10	10	10
11	11	11	11	11	11	11
12	12	12	12	12	12	12

FIGURE 2: Wingwall Flare



EXAMPLE

Given: An 800-foot long box culvert is to be installed on a 0.5 percent slope. Due to minimum cover requirements, the maximum rise is limited to 8 feet. It is required to carry a maximum flow of 1,000 cubic feet per second with an allowable headwater depth of 15 feet.

Find: Size of precast concrete box section required and type of control.

Solution: Investigate three concrete box culvert sections, 8 × 8-foot, 9 × 7-foot and 10 × 6-foot, which meet the maximum rise limit of 8 feet.

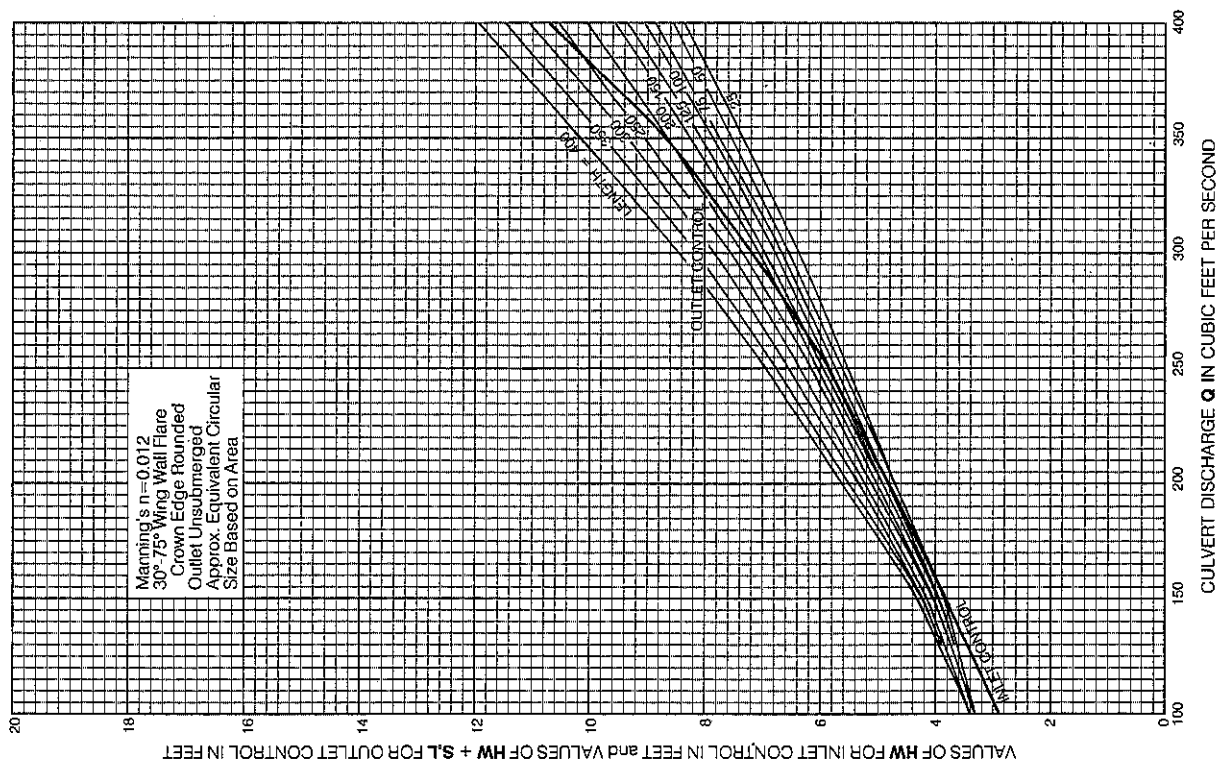
Enter Figure 11: 8 × 8-foot concrete box section, and project a vertical line from $Q = 1,000$ to the inlet control curve and the outlet control curve for $L = 800$ feet. Project horizontally to the vertical scale and read a headwater depth of 14.8 feet for inlet control and a value of 17.5 feet for outlet control. To obtain outlet control headwater depth, subtract the value ($S_0 \times L$) from the outlet control value: $17.5 - (0.005 \times 800) = 13.5$ feet for the outlet control headwater depth. Therefore inlet control governs.

Entering Figure 14: 9 × 7-foot concrete box section and proceeding in a similar manner, read a headwater depth of 14.7 feet for inlet control and obtain 13.1 feet for the outlet control headwater depth with inlet control governing.

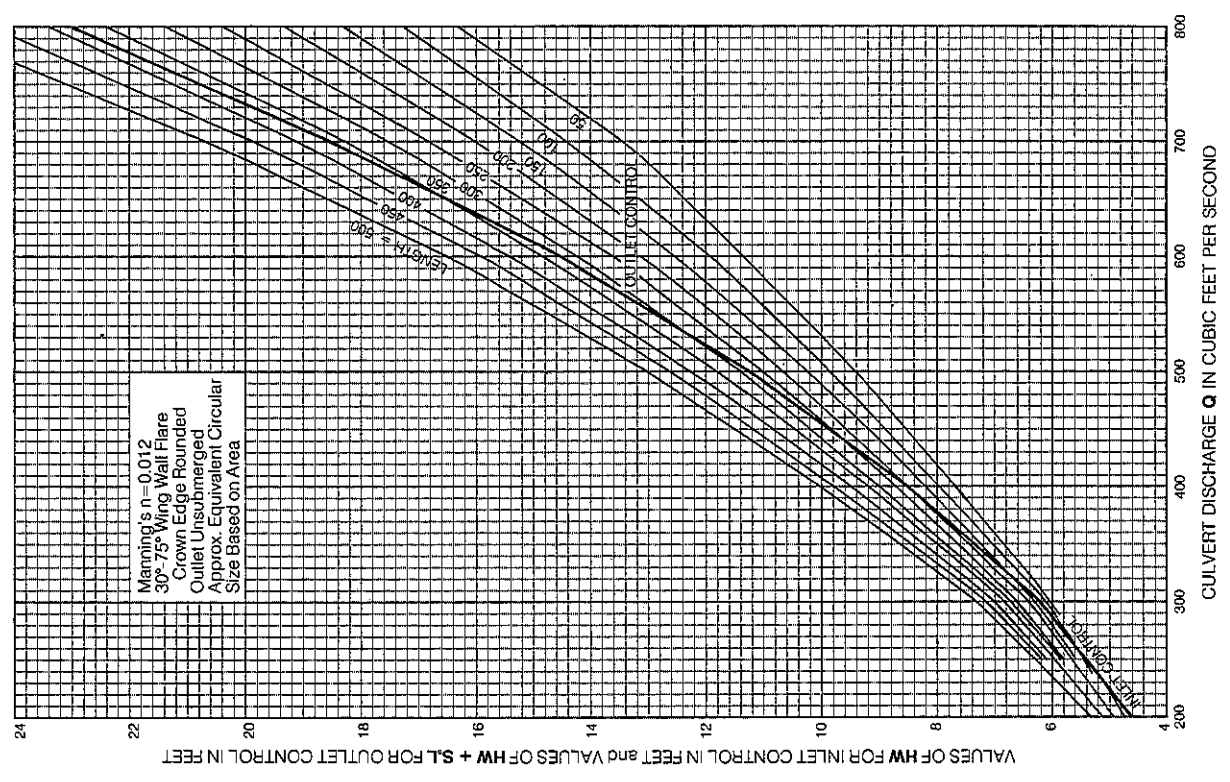
Entering Figure 18: 10 × 6-foot concrete box section and again proceeding in a similar manner, read a headwater depth of 14.4 feet for inlet control and obtain 13.5 feet for the outlet control headwater depth with inlet control governing.

Answer: Therefore, each of the concrete box culvert sections, 8 × 8-foot, 9 × 7-foot and 10 × 6-foot, will carry the design discharge within the allowable headwater depth of 15 feet and is under inlet control.

**FIGURE 3: Culvert Capacity—7 x 4-foot Precast Box Section
Equivalent 71-inch Circular**

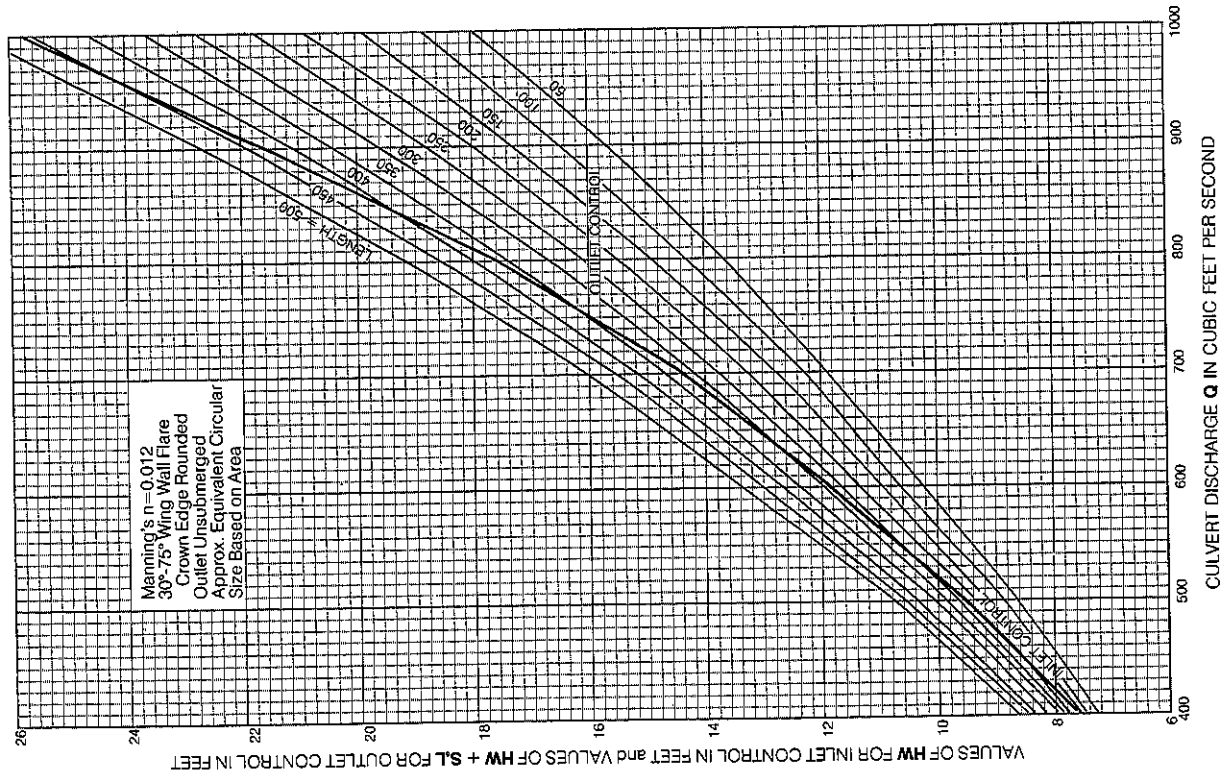


**FIGURE 4: Culvert Capacity—7 x 5-foot Precast Box Section
Equivalent 79-inch Circular**

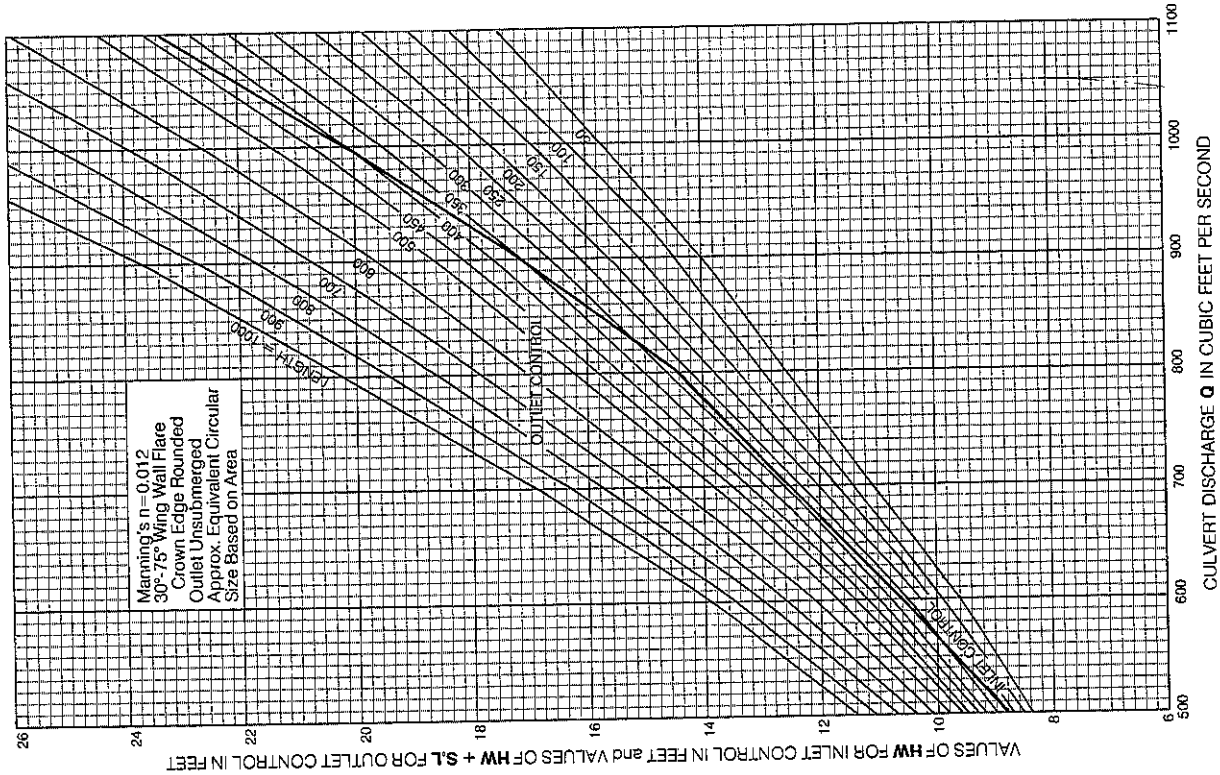


Interpolate for intermediate culvert lengths

**FIGURE 5: Culvert Capacity—7 x 6-foot Precast Box Section
Equivalent 87-inch Circular**

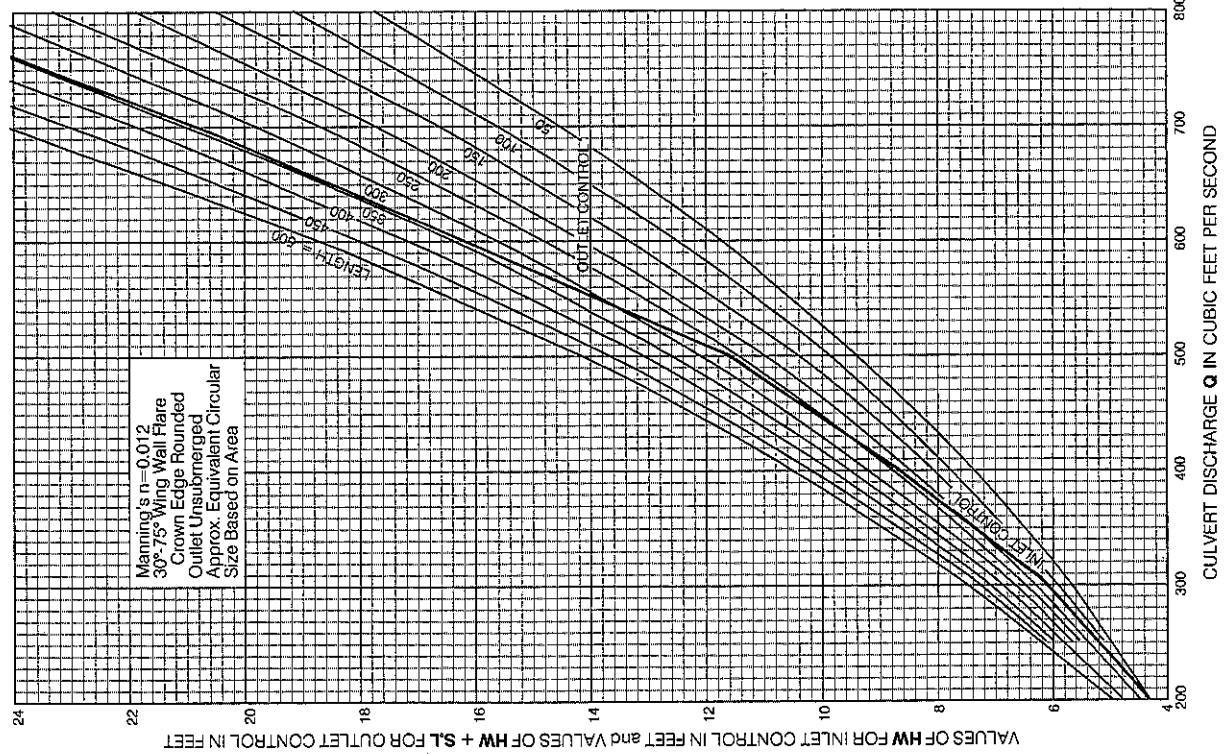


**FIGURE 6: Culvert Capacity—7 x 7-foot Precast Box Section
Equivalent 94-inch Circular**

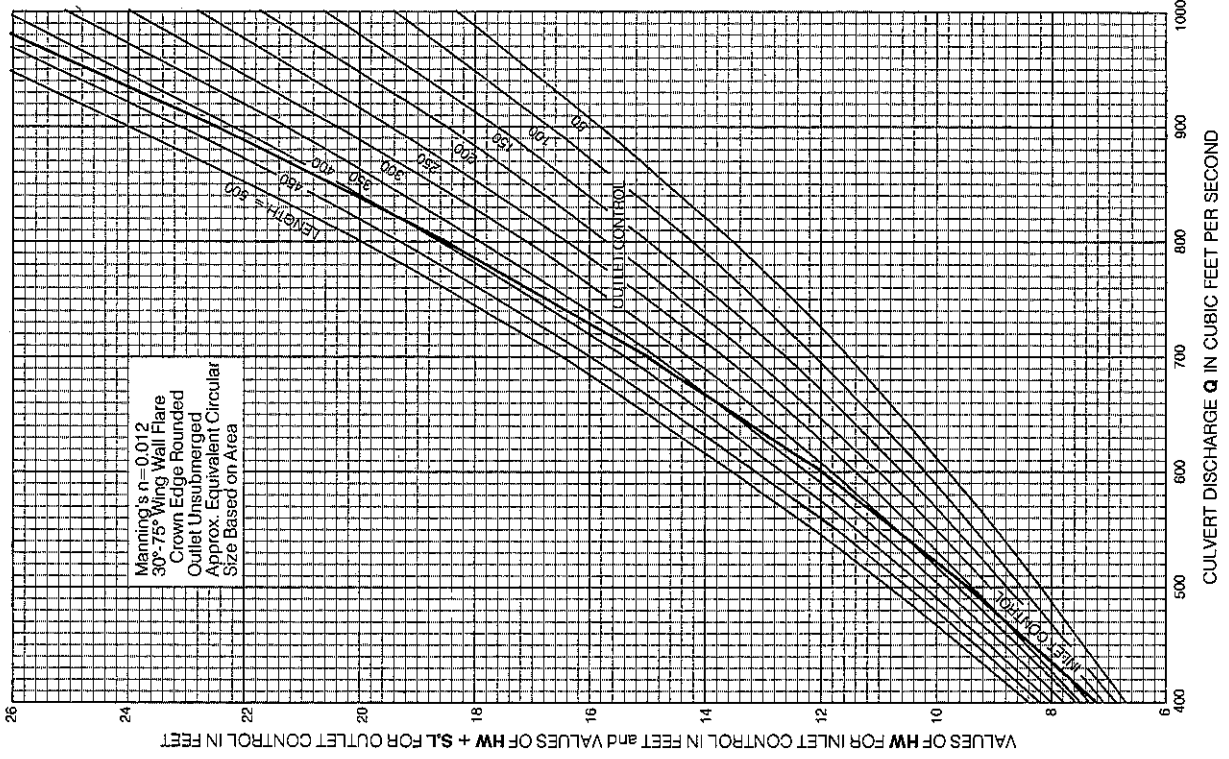


Interpolate for intermediate culvert lengths

**FIGURE 7: Culvert Capacity—8 x 4-foot Precast Box Section
Equivalent 76-inch Circular**

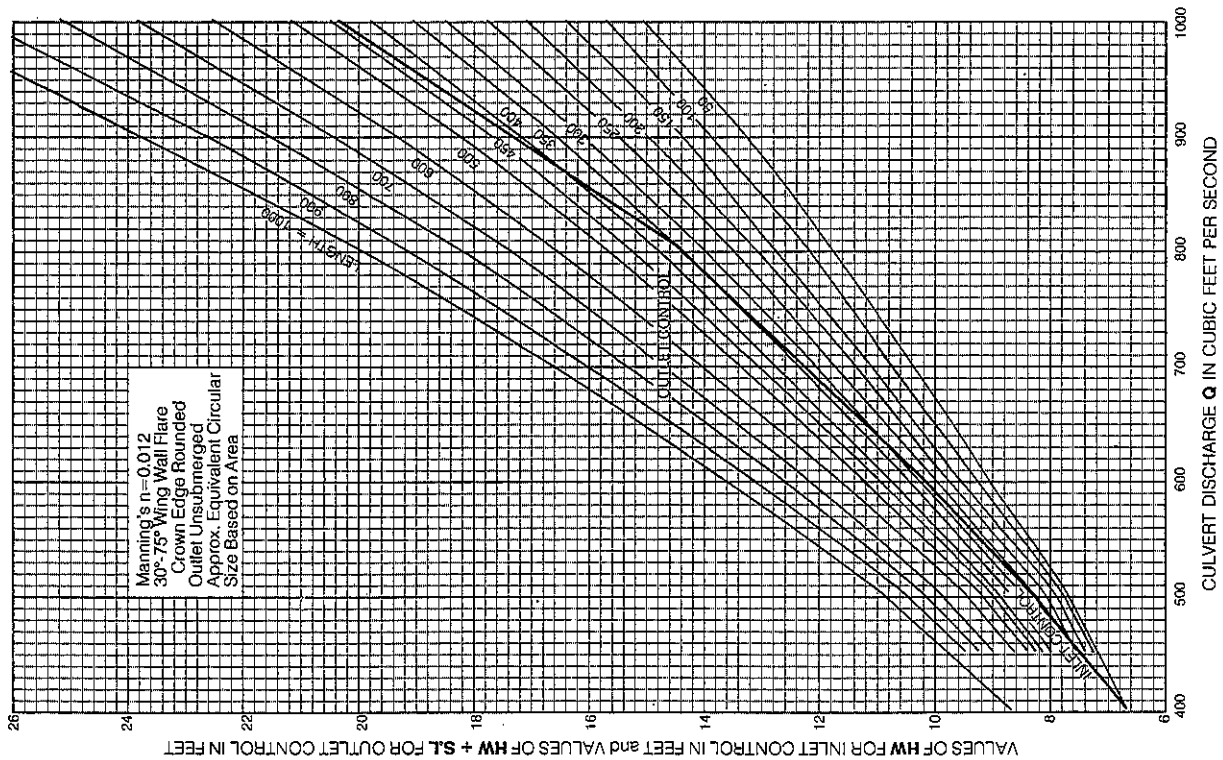


**FIGURE 8: Culvert Capacity—8 x 5-foot Precast Box Section
Equivalent 85-inch Circular**

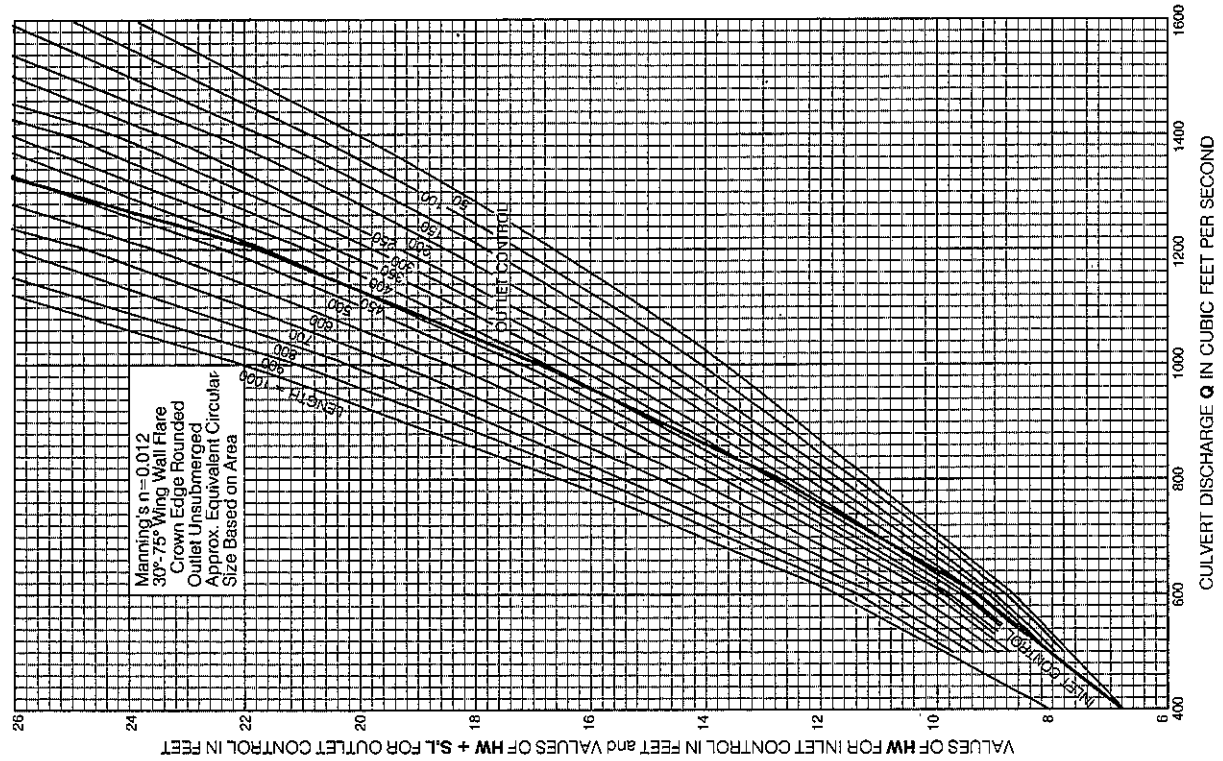


Interpolate for intermediate culvert lengths

**FIGURE 9: Culvert Capacity—8 x 6-foot Precast Box Section
Equivalent 93-inch Circular**

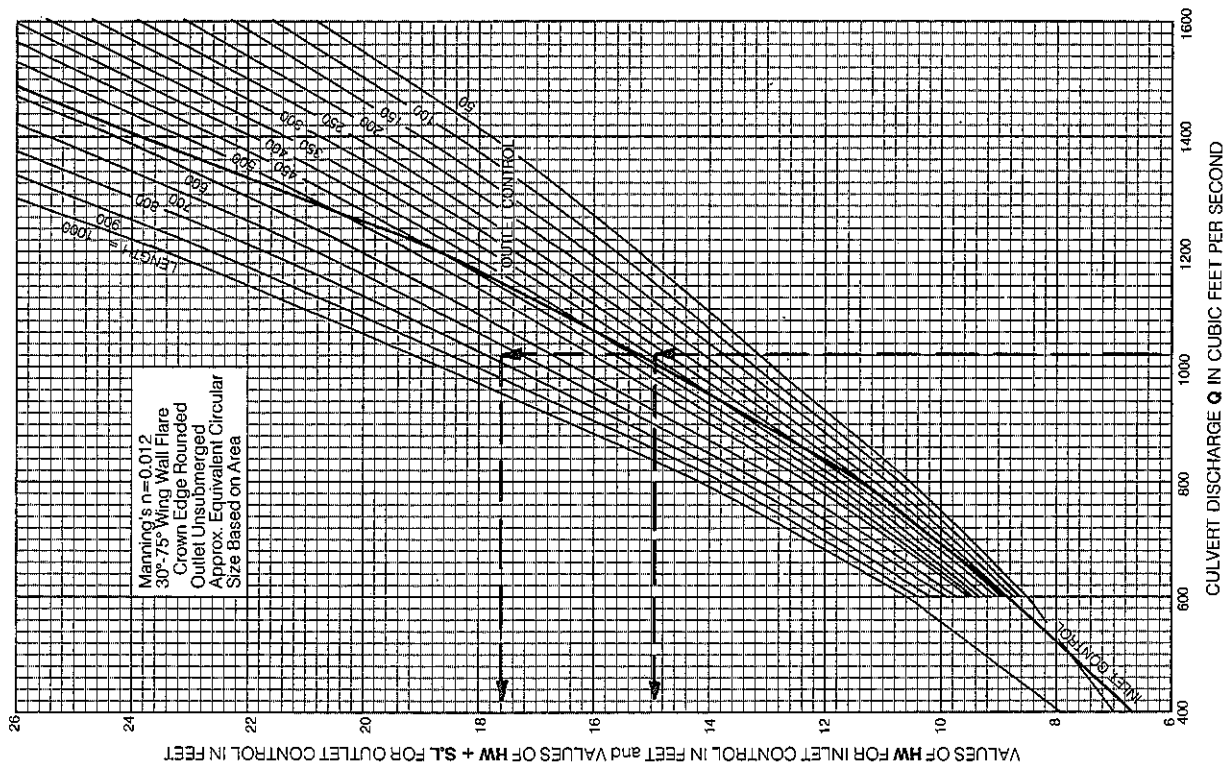


**FIGURE 10: Culvert Capacity—8 x 7-foot Precast Box Section
Equivalent 101-inch Circular**

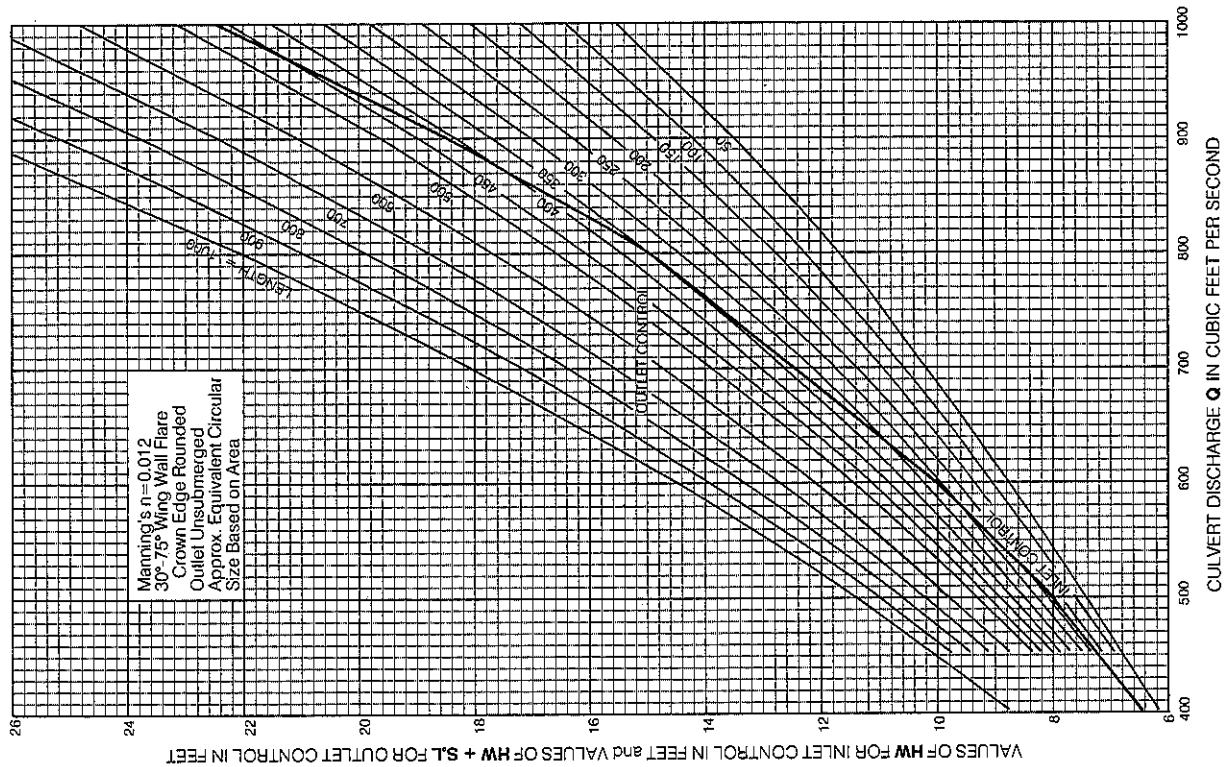


Interpolate for intermediate culvert lengths

**FIGURE 11: Culvert Capacity—8 x 8-foot Precast Box Section
Equivalent 108-inch Circular**

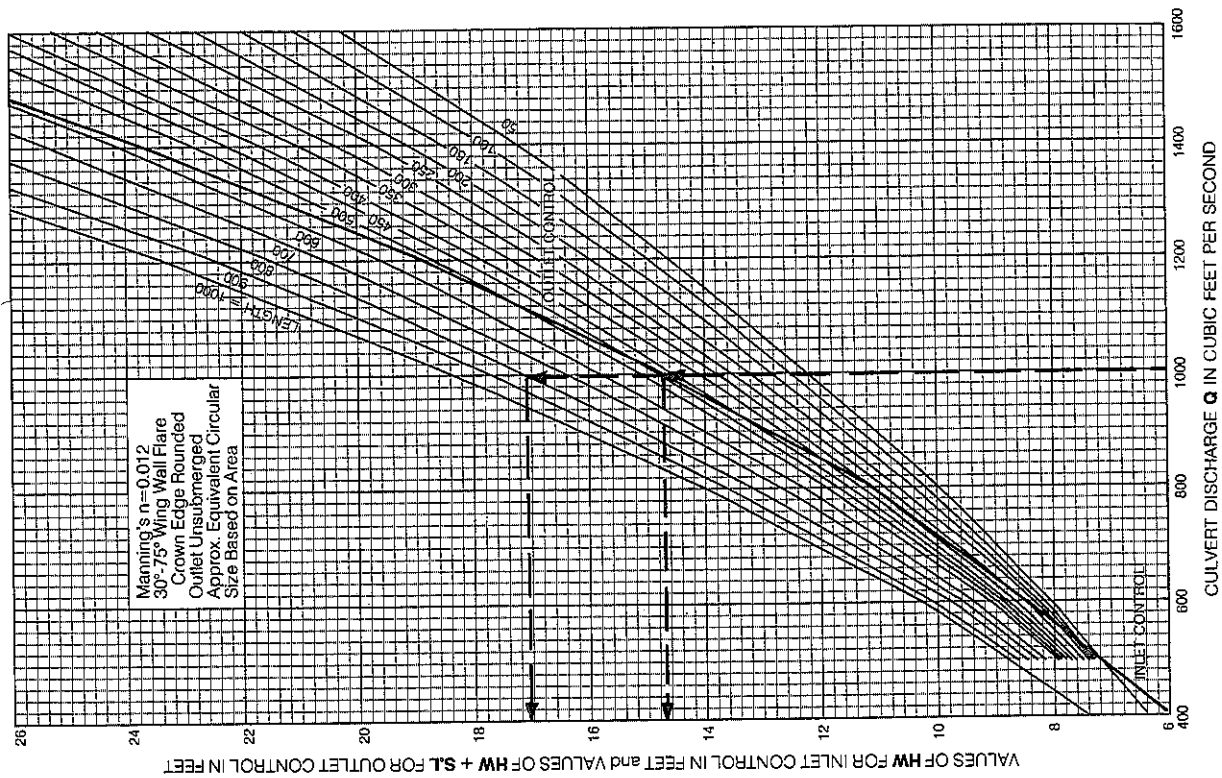


**FIGURE 12: Culvert Capacity—9 x 5-foot Precast Box Section
Equivalent 90-inch Circular**

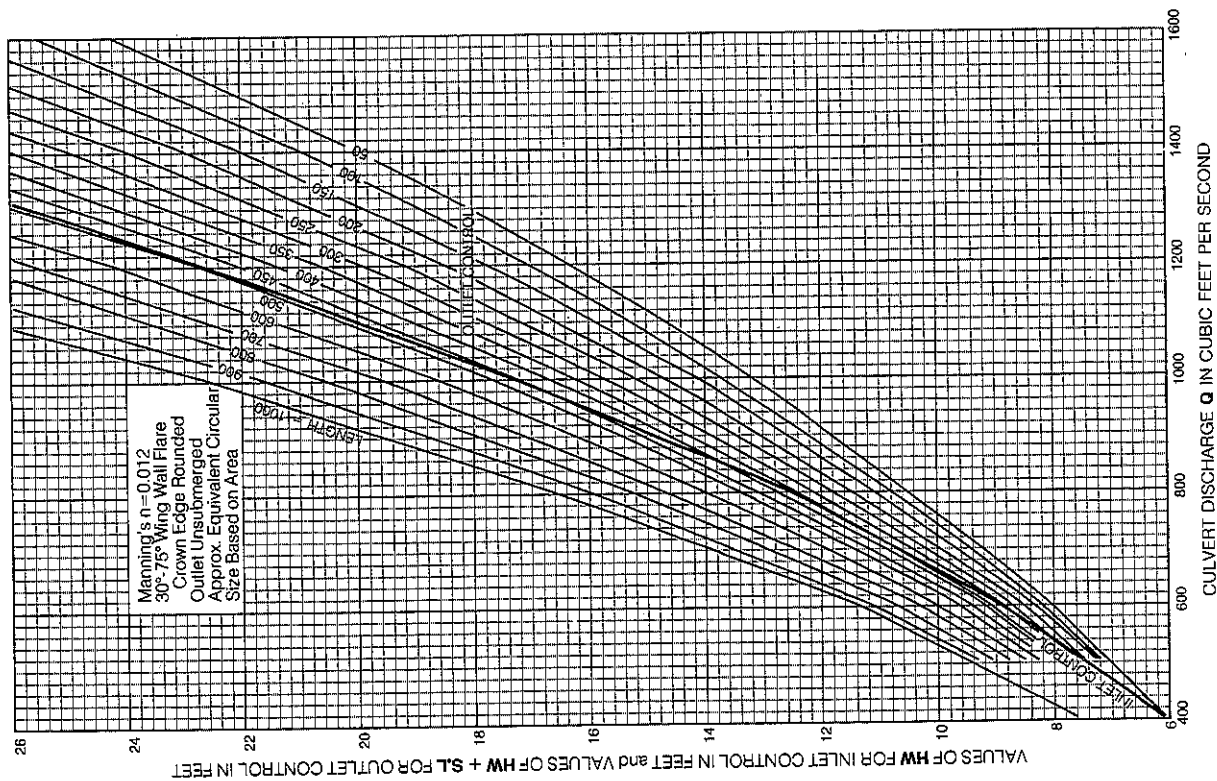


Interpolate for intermediate culvert lengths

**FIGURE 14: Culvert Capacity—9 x 7-foot Precast Box Section
Equivalent 107-inch Circular**

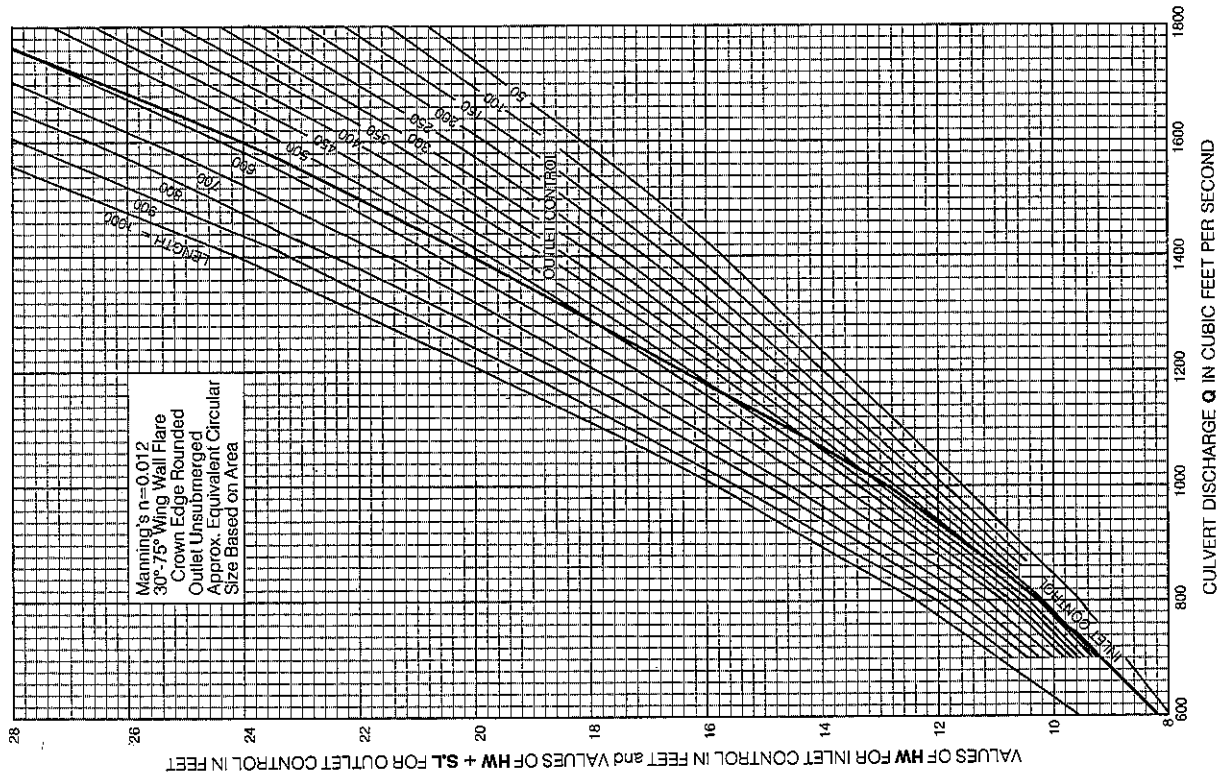


**FIGURE 13: Culvert Capacity—9 x 6-foot Precast Box Section
Equivalent 99-inch Circular**



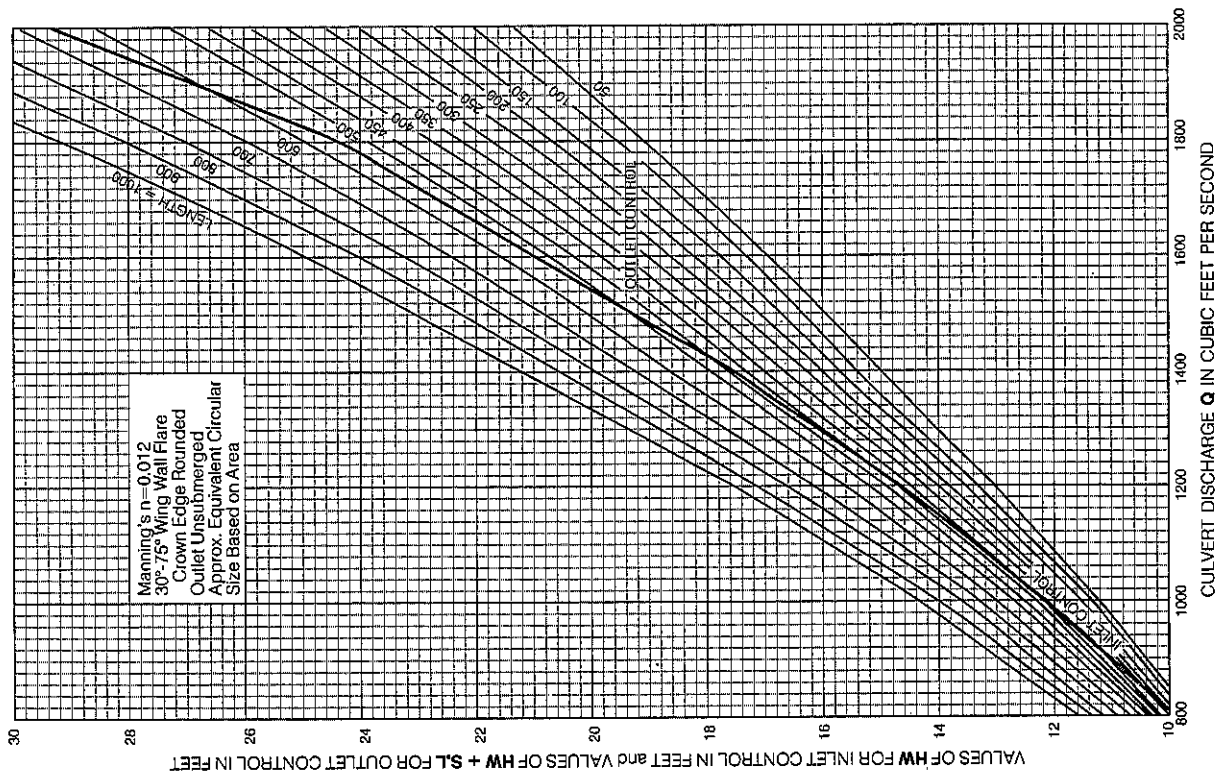
Interpolate for intermediate culvert lengths

**FIGURE 15: Culvert Capacity—9 x 8-foot Precast Box Section
Equivalent 114-inch Circular**

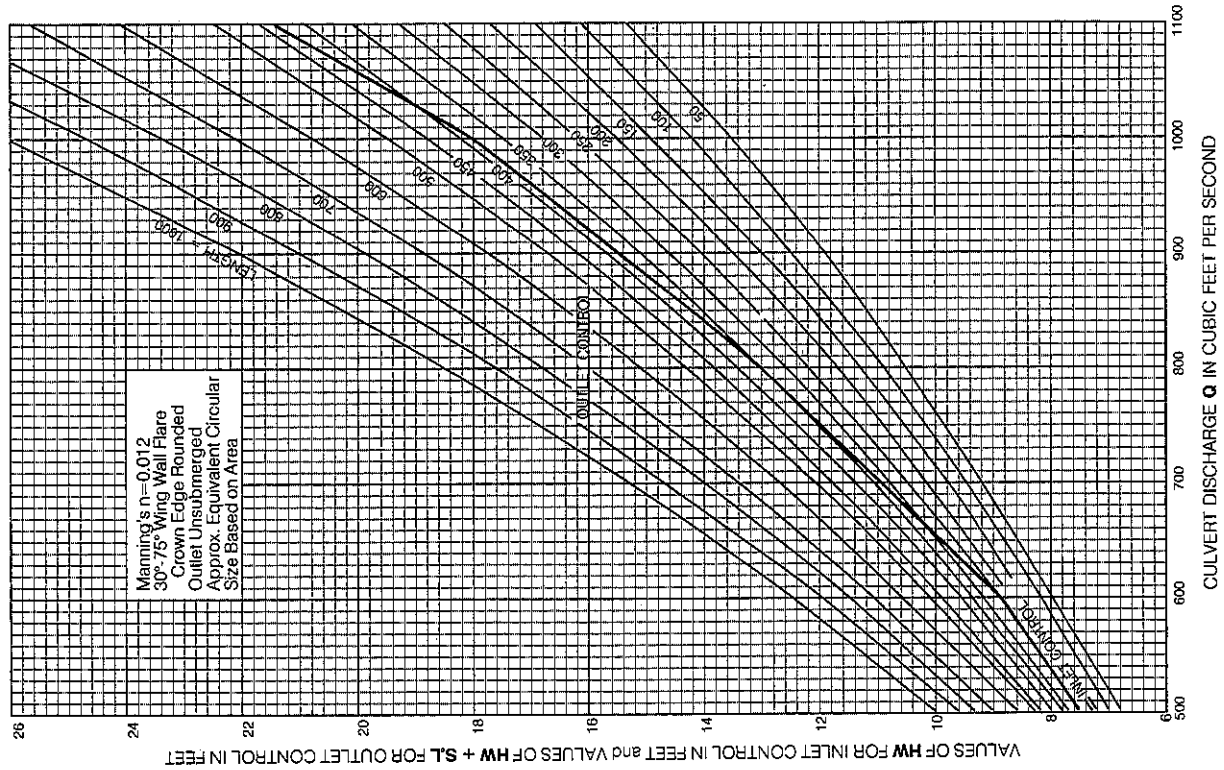


Interpolate for intermediate culvert lengths

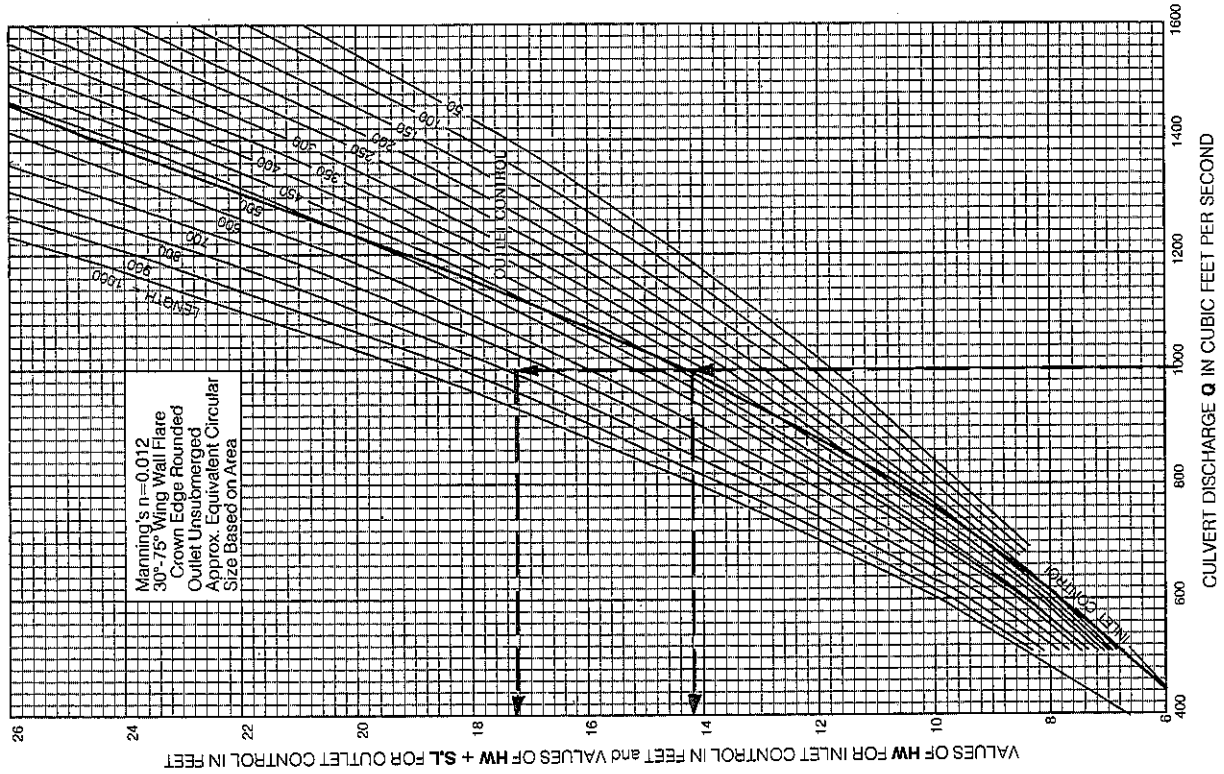
**FIGURE 16: Culvert Capacity—9 x 9-foot Precast Box Section
Equivalent 121-inch Circular**



**FIGURE 17: Culvert Capacity—10 x 5-foot Precast Box Section
Equivalent 94-inch Circular**



**FIGURE 18: Culvert Capacity—10 x 6-foot Precast Box Section
Equivalent 104-inch Circular**



Interpolate for intermediate culvert lengths

FIGURE 19: Culvert Capacity—10 x 7-foot Precast Box Section Equivalent 112-inch Circular

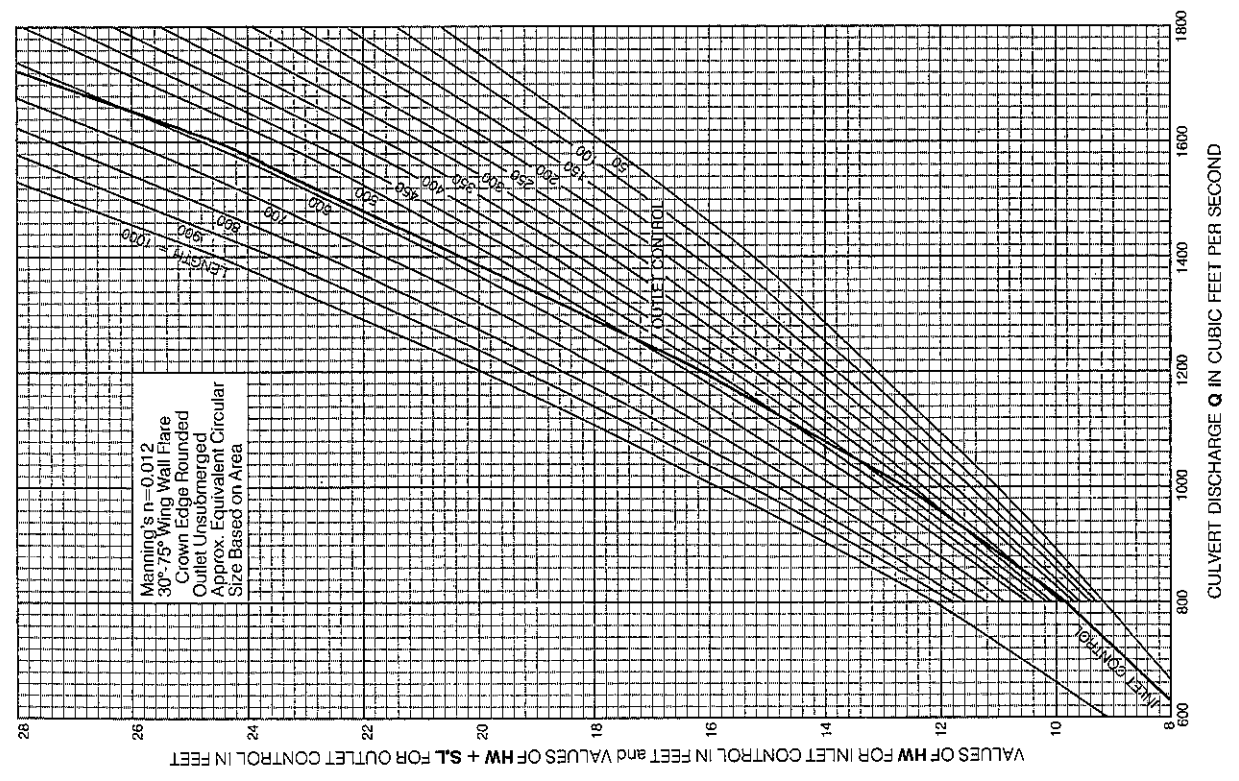
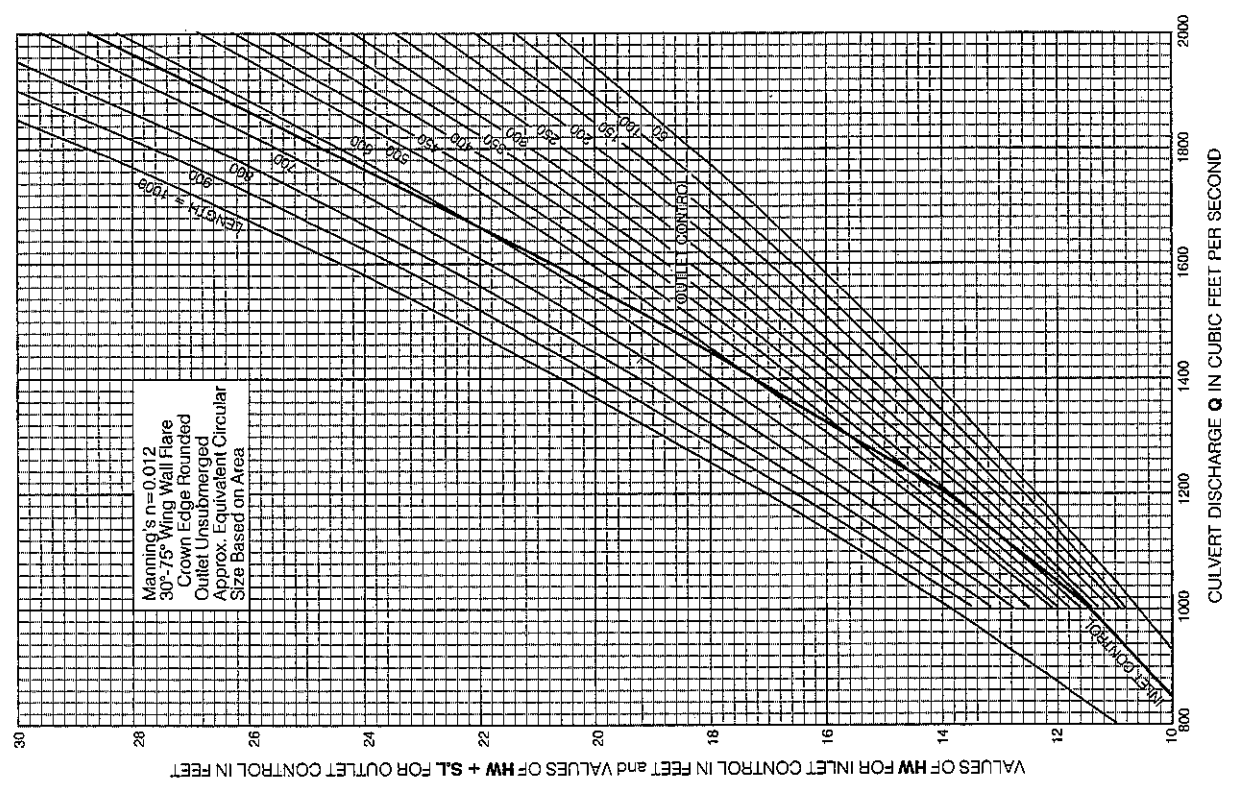
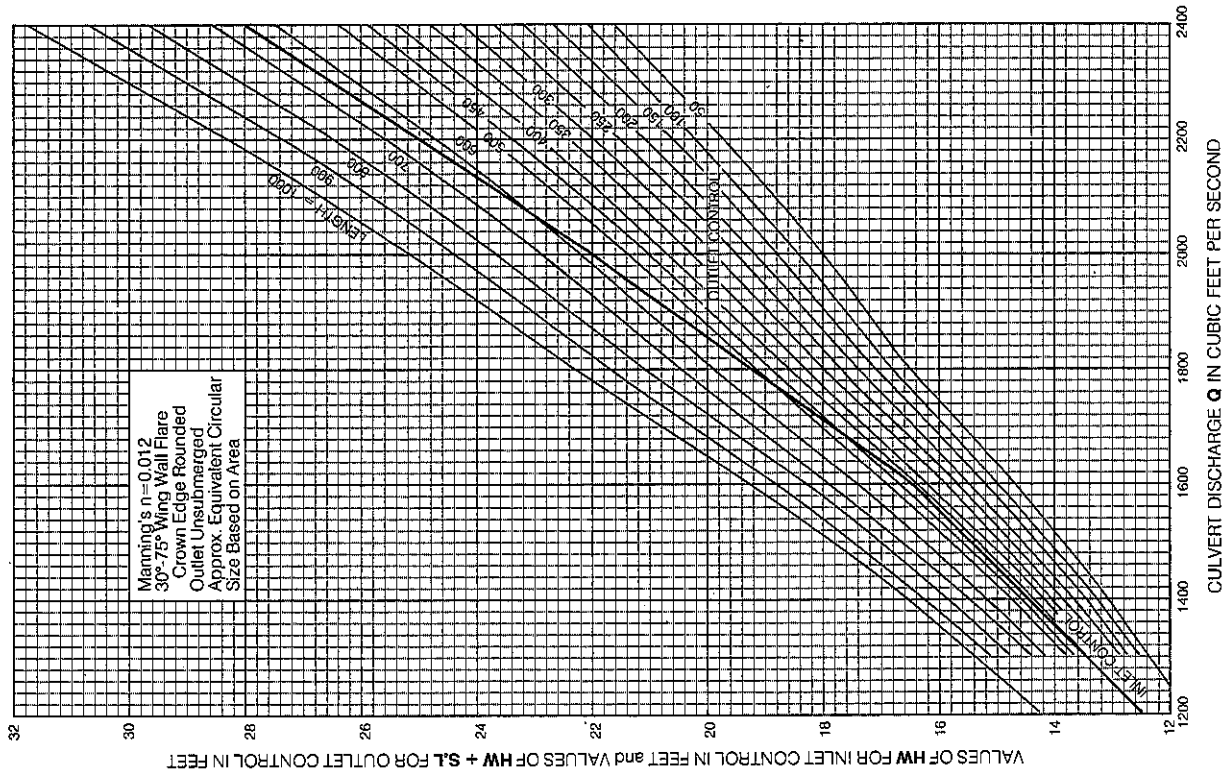


FIGURE 20: Culvert Capacity—10 x 8-foot Precast Box Section Equivalent 120-inch Circular

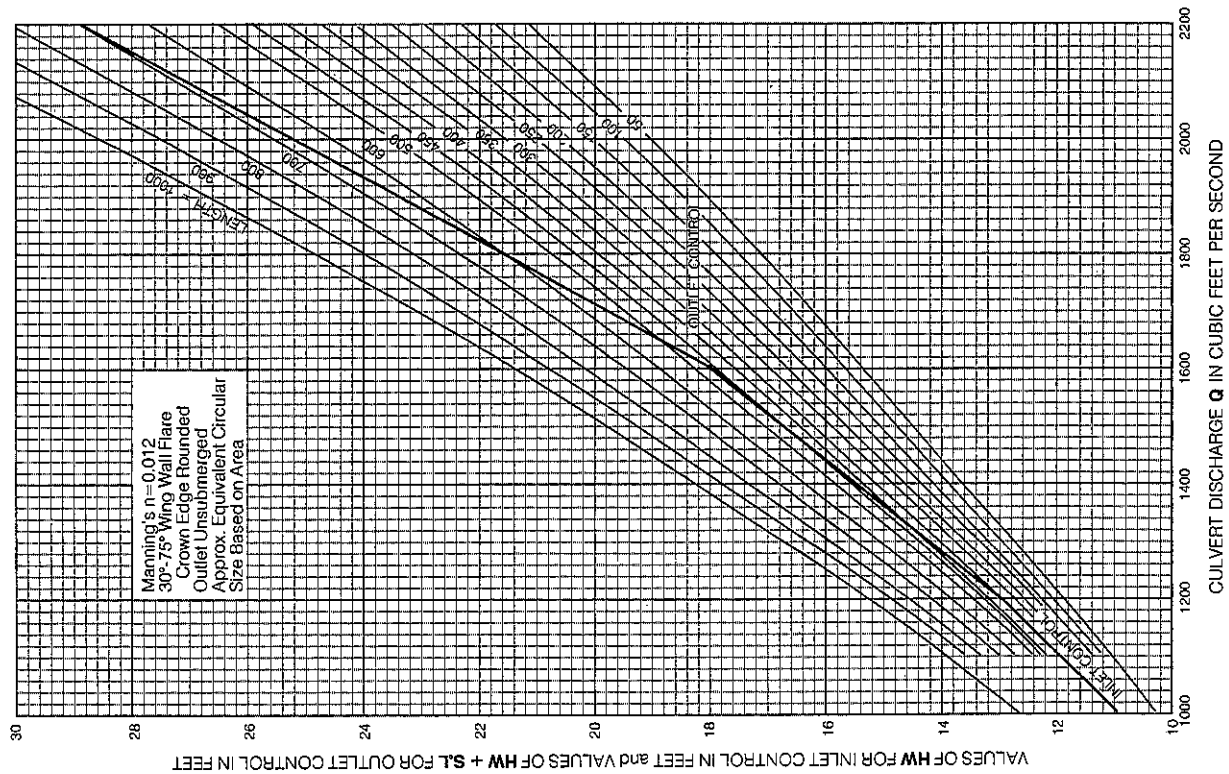


Interpolate for intermediate culvert lengths

**FIGURE 22: Culvert Capacity—10 x 10-foot Precast Box Section
Equivalent 135-inch Circular**



**FIGURE 21: Culvert Capacity—10 x 9-foot Precast Box Section
Equivalent 128-inch Circular**



Interpolate for intermediate culvert lengths