APPENDIX B - HYDRAULIC PROPERTIES OF CONDUITS

This appendix lists hydraulic properties for various conduits, as follows:

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TABLE -1
HYDRAULIC PROPERTIES OF
CIRCULAR PIPE

(Size, Waterway Area, Hydraulic Radius)

Diameter (inches)	Waterway Area (square feet)	Hydraulic Radius (feet)	Diameter (inches)	Waterway Area (square feet)	Hydraulic Radius (feet)
12	0.79	0.25	156	132.7	3.25
15	1.23	0.31	135	143.1	3.38
18	1.77	0.38	168	153.9	3.50
21	2.41	0.44	174	165.1	3.63
24	3.14	0.50	180	176.7	3.75
30	4.91	0.63	186	188.7	3.88
36	7.07	0.75	192	201.1	4.00
42	9.62	0.88	198	213.8	4.13
48	12.57	1.00	204	227.0	4.25
54	15.90	1.13	210	240.5	4.38
60	19.64	1.25	216	254.5	4.50
66	23.76	1.38	222	268.8	4.63
72	28.27	1.50	228	283.5	4.75
78	33.18	1.63	234	298.6	4.88
84	38.49	1.75	240	314.2	5.00
90	44.18	1.88	246	330.1	5.13
96	50.27	2.00	252	346.4	5.25
108	63.62	2.25	258	363.1	5.38
114	70.88	2.38	264	380.1	5.50
120	78.54	2.50	270	397.6	5.63
126	86.59	2.63	276	415.5	5.75
132	95.03	2.75	282	433.7	5.88
138	103.87	2.88	288	452.4	6.00
144	113.10	3.00	294	471.4	6.13
150	122.70	3.13	300	490.9	6.25

TABLE -2
HYDRAULIC PROPERTIES OF
CORRUGATED STEEL PIPE-ARCHES

(Size, Waterway Area, Hydraulic Radius, Equivalent Diameter)

2 2/3 x 1/2 inch Corrugations				3 x 1 inch Corrugations			
Span x Rise (inches) x (inches)	Waterway Area (square feet)	Hydraulic Radius (feet)	Equivalent Diameter (inches)	Span x Rise (inches) x (inches)	Waterway Area (square feet)	Hydraulic Radius (feet)	Equivalent Diameter (inches)
17 x 13	1.1	.28	15	60 x 46	15.6	1.10	54
21 x 15	1.6	.34	18	66 x 51	19.3	1.23	60
24 x 18	2.2	.40	21	73 x 55	23.2	1.34	66
28 x 20	2.9	.46	24	81 x 59	27.4	1.45	72
35 x 24	4.5	.57	30	87 x 63	32.1	1.57	78
42 x 29	6.5	.69	36	95 x 67	37.0	1.68	84
49 x 33	8.9	.81	42	103 x 71	42.4	1.80	90
57 x 38	11.6	.92	48	112 x 75	48.0	1.91	96
64 x 43	14.7	1.04	54	117 x 79	54.2	2.03	102
71 x 47	18.1	1.15	60	128 x 83	60.5	2.14	108
77 x 52	21.9	1.27	66	137 x 87	67.4	2.26	114
83 x 57	26.0	1.38	72	142 x 91	74.5	2.37	120

TABLE -3
HYDRAULIC PROPERTIES OF
STRUCTURAL PLATE STEEL PIPE-ARCHES

(Size, Waterway Area, Hydraulic Radius, Equivalent Diameter)

6 x 2 inch Corrugations 18-inch Corner Radius				6 x 2 inch Corrugations 31-inch Corner Radius			
Span x Rise (feet - inches) x (feet -inches)	Waterway Area (square feet)	Hydraulic Radius (feet)	Equivalent Diameter (inches)	Span x Rise (feet - inches) x (feet -inches)	Waterway Area (square feet)	Hydraulic Radius (feet)	Equivalent Diameter (inches)
6-1 x 4-7	22	1.29	66	13-3 x 9-4	97	2.68	138
6-4 x 4-9	24	1.35	69	13-6 x 9-6	102	2.74	141
6-9 x 4-11	26	1.39	72	14-0 x 9-8	105	2.78	144
7-0 x 5-1	28	1.45	75	14-2 x 9-10	109	2.83	147
7-3 x 5-3	30	1.51	78	14-5 x 10-0	114	2.90	150
7-8 x 5-5	33	1.55	81	14-11 x 10-2	118	2.94	153
7-11 x 5-7	35	1.61	84	15-4 x 10-4	123	2.98	156
8-2 x 5-9	38	1.67	87	15-7 x 10-6	127	3.04	159
8-7 x 5-11	40	1.71	90	15-10 x 10-8	132	3.10	162
8-10 x 6-1	43	1.77	93	16-3 x 10-10	137	3.14	165
9-4 x 6-3	45	1.81	96	16-6 x 11-0	142	3.20	168
9-6 x 6-5	48	1.87	99	17-0 x 11-2	146	3.24	171
9-9 x 6-7	51	1.93	102	17-2 x 11-4	151	3.30	174
10-3 x 6-9	54	1.97	105	17-5 x 11-6	157	3.36	177
10-8 x 6-11	57	2.01	109	17-11 x 11-8	161	3.40	180
10-11 x 7-1	60	2.07	111	18-1 x 11-10	167	3.45	183
11-5 x 7-3	63	2.11	114	18-7 x 12-0	172	3.50	186
11-7 x 7-5	66	2.17	117	18-9 x 12-2	177	3.56	189
11-10 x 7-7	70	2.23	120	19-3 x 12-4	182	3.59	192
12-4 x 7-9	73	2.26	123	19-6 x 12-6	188	3.65	195
12-6 x 7-11	77	2.32	126	19-8 x 12-8	194	3.71	198
12-8 x 8-1	81	2.38	129	19-11 x 12-10	200	3.77	201
12-10 x 8-4	85	2.44	132	20-5 x 13-0	205	3.81	204
13-5 x 8-5	88	2.48	135	20-7 x 13-2	211	3.87	207
13-11 x 8-7	91	2.52	138				
14-1 x 8-9	95	2.57	141				
14-3 x 8-11	100	2.63	144				
14-10 x 9-1	103	2.67	147				
15-4 x 9-3	107	2.71	150				
15-6 x 9-5	111	2.77	153				
15-8 x 9-7	116	2.83	156				
15-10 x 9-10	121	2.89	159				
16-5 x 9-11	125	2.92	162				
16-7 x 10-1	130	2.98	165				

TABLE -4
HYDRAULIC PROPERTIES OF
STRUCTURAL PLATE STEEL ARCHES

(Size, Waterway Area, Hydraulic Radius, Rise/Span, Radius)
6 x 2 inch Corrugations

Span (feet)	Rise (feet-inches)	Waterway Area (square feet)	Hydraulic Radius (feet)	Rise/ Span	Radius (inches)
6.0	1-9½	7½	.58	0.30	41
	2-3½	10	.72	0.38	37½
	3-2	15	.97	0.53	36
7.0	2-4	12	.77	0.34	45
	2-10	15	.91	0.40	43
	3-8	20	1.11	0.52	42
8.0	2-11	17	.93	0.37	51
	3-4	20	1.05	0.42	48½
	4-2	26	1.26	0.52	48
9.0	2-11	18½	.93	0.32	59
	3-10½	26½	1.23	0.43	55
	4-8½	33	1.43	0.52	54
10.0	3-5½	25	1.11	0.35	64
	4-5	34	1.41	0.44	60½
	5-3	41	1.60	0.52	60
11.0	3-6	27½	1.22	0.32	73
	4-5½	37	1.43	0.41	67½
	5-9	50	1.77	0.52	66
12.0	4-0½	35	1.30	0.34	77½
	5-0	45	1.58	0.42	73
	6-3	59	1.91	0.52	72
13.0	4-1	38	1.32	0.32	86½
	5-1	49	1.62	0.39	80½
	6-9	70	2.10	0.52	78
14.0	4-7½	47	1.50	0.33	91
	5-7	58	1.77	0.40	86
	7-3	80	2.22	0.52	84
15.0	4-7½	50	1.51	0.31	101
	5-8	62	1.79	0.38	93
	6-7	75	2.07	0.44	91
	7-9	92	2.39	0.52	90

TABLE -4 CONTD.
HYDRAULIC PROPERTIES OF
STRUCTURAL PLATE STEEL ARCHES

(Size, Waterway Area, Hydraulic Radius, Rise/Span, Radius)
6 x 2 inch Corrugations (cont)

Span (feet)	Rise (feet-inches)	Waterway Area (square feet)	Hydraulic Radius (feet)	Rise/ Span	Radius (inches)
16.0	5-2	60	1.68	0.32	105
	7-1	86	2.22	0.45	97
	8-3	105	2.55	0.52	96
17.0	5-2½	63	1.68	0.31	115
	7-2	92	2.18	0.42	103
	8-10	119	2.72	0.52	102
18.0	5-9	75	1.88	0.32	119
	7-8	104	2.41	0.43	109
	8-11	126	2.77	0.50	108
19.0	6-4	87	2.05	0.33	123
	8-2	118	2.58	0.43	115
	9-5½	140	2.91	0.50	114
20.0	6-4	91	2.05	0.32	133
	8-3½	124	2.61	0.42	122
	10-0	157	3.10	0.50	120
21.0	6-11	104	2.22	0.33	137
	8-10	140	2.80	0.42	128
	10-6	172	3.23	0.50	126
22.0	6-11	109	2.24	0.31	146
	8-11	146	2.82	0.40	135
	11-0	190	3.41	0.50	132
23.0	8-0	134	2.58	0.35	147
	9-10	171	3.10	0.43	140
	11-6	208	3.57	0.50	138
24.0	8-6	150	2.75	0.35	152
	10-4	188	3.26	0.43	146
	12-0	226	3.71	0.50	144
25.0	8-6½	155	2.75	0.34	160
	10-10½	207	3.43	0.43	152
	12-6	247	3.89	0.50	150

CHART 1
HYDRAULIC ELEMENTS OF
CIRCULAR PIPE

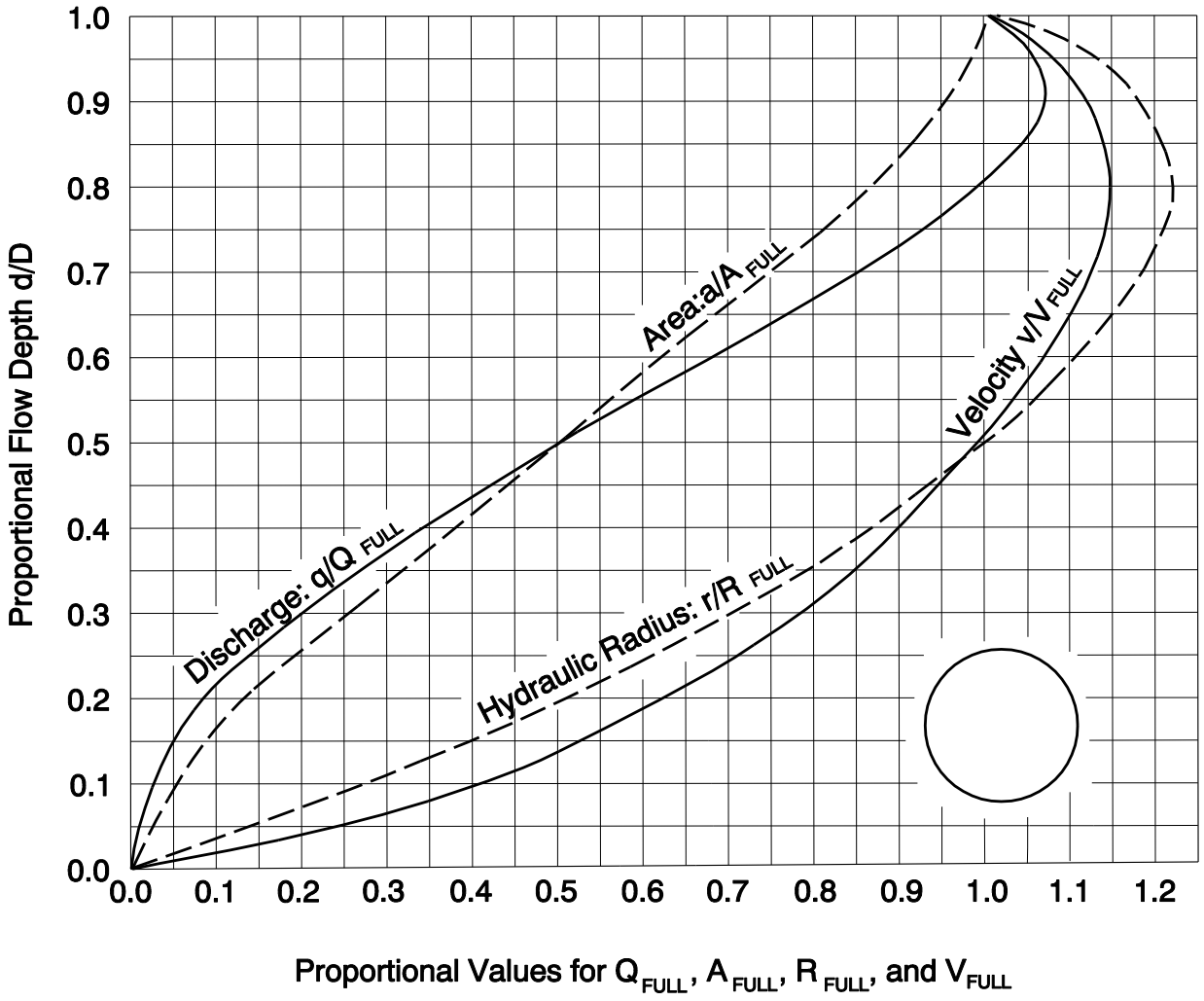


CHART 2
HYDRAULIC ELEMENTS OF
PIPE-ARCHES

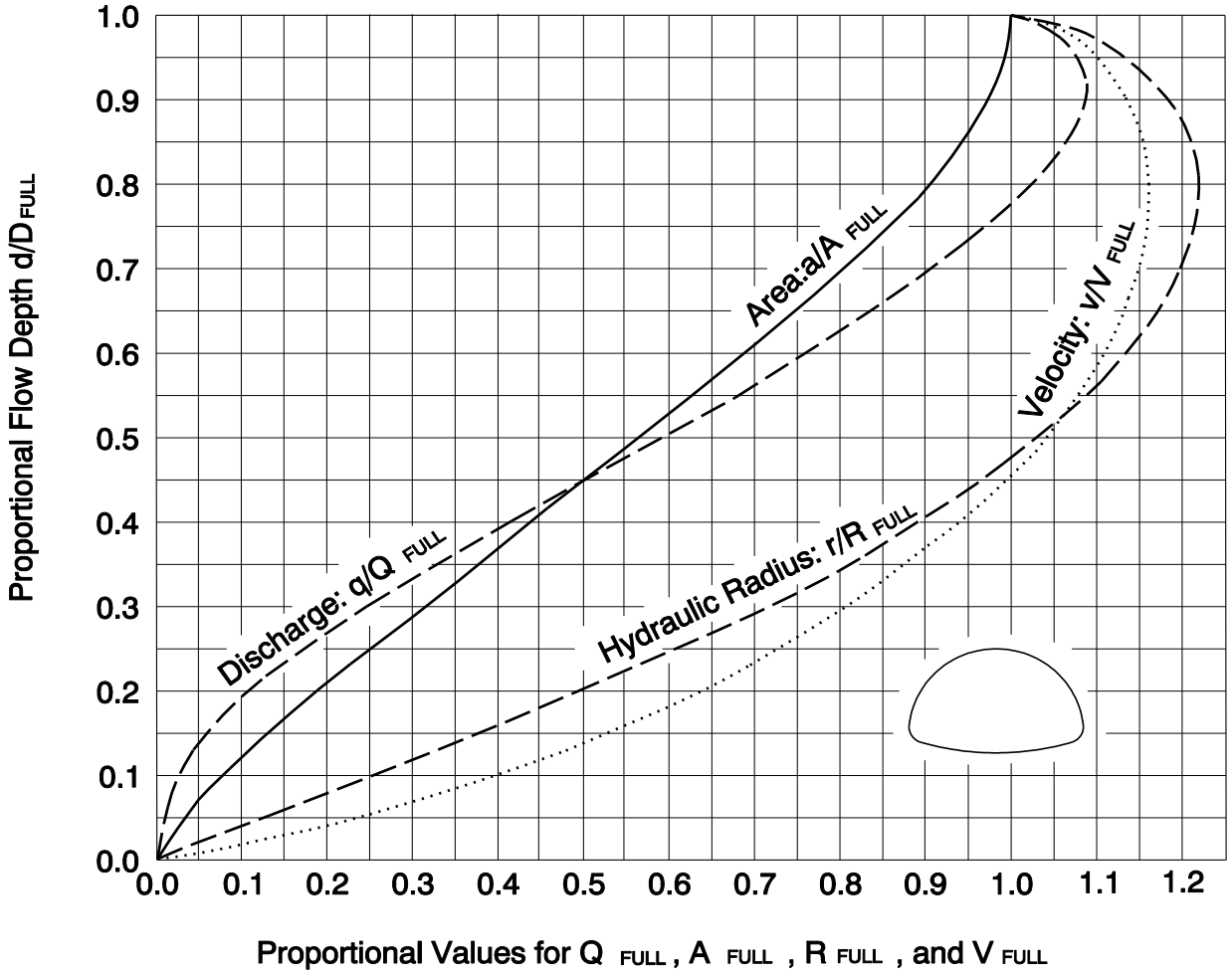


CHART 3
HYDRAULIC ELEMENTS OF
SEMICIRCULAR ARCHES

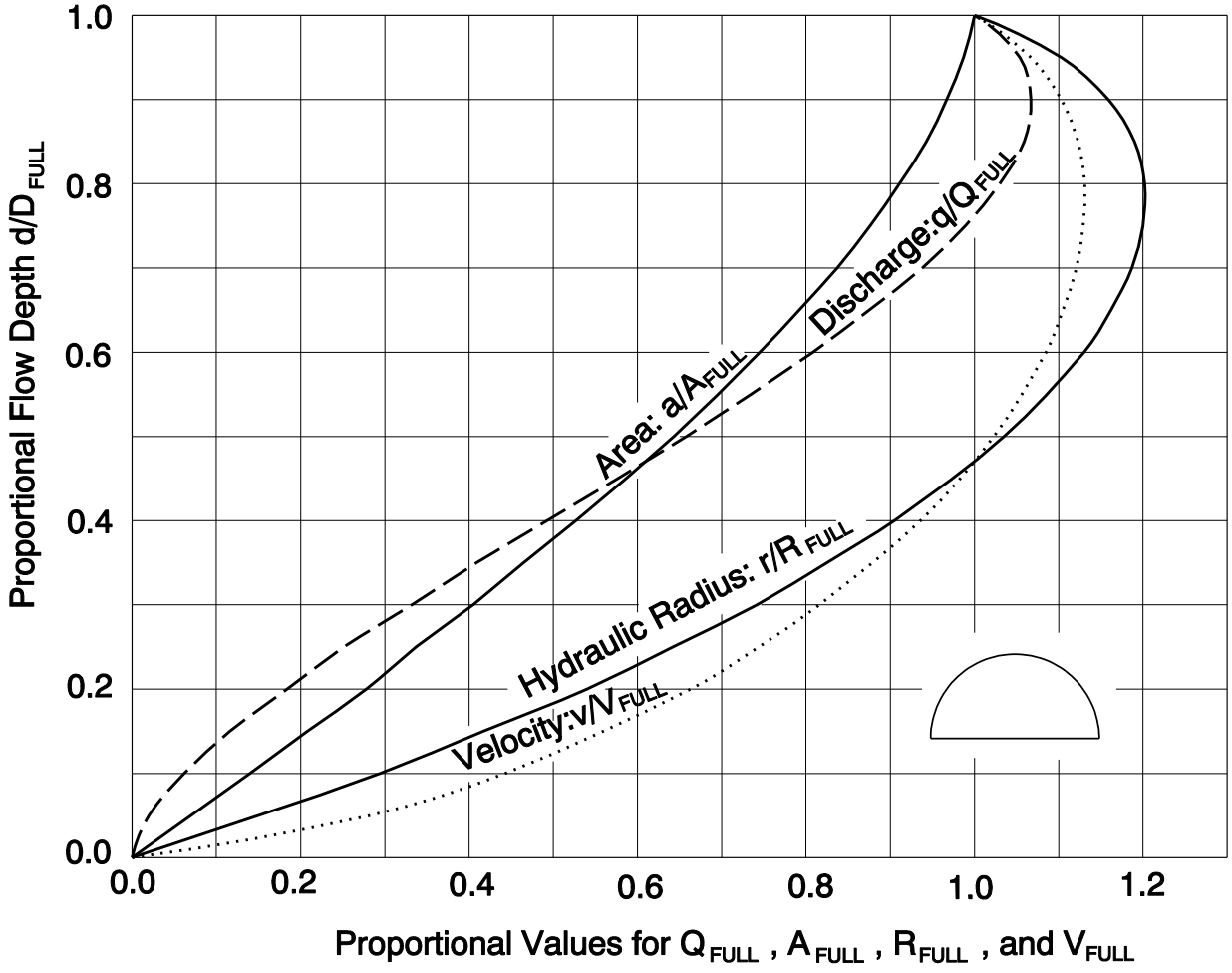
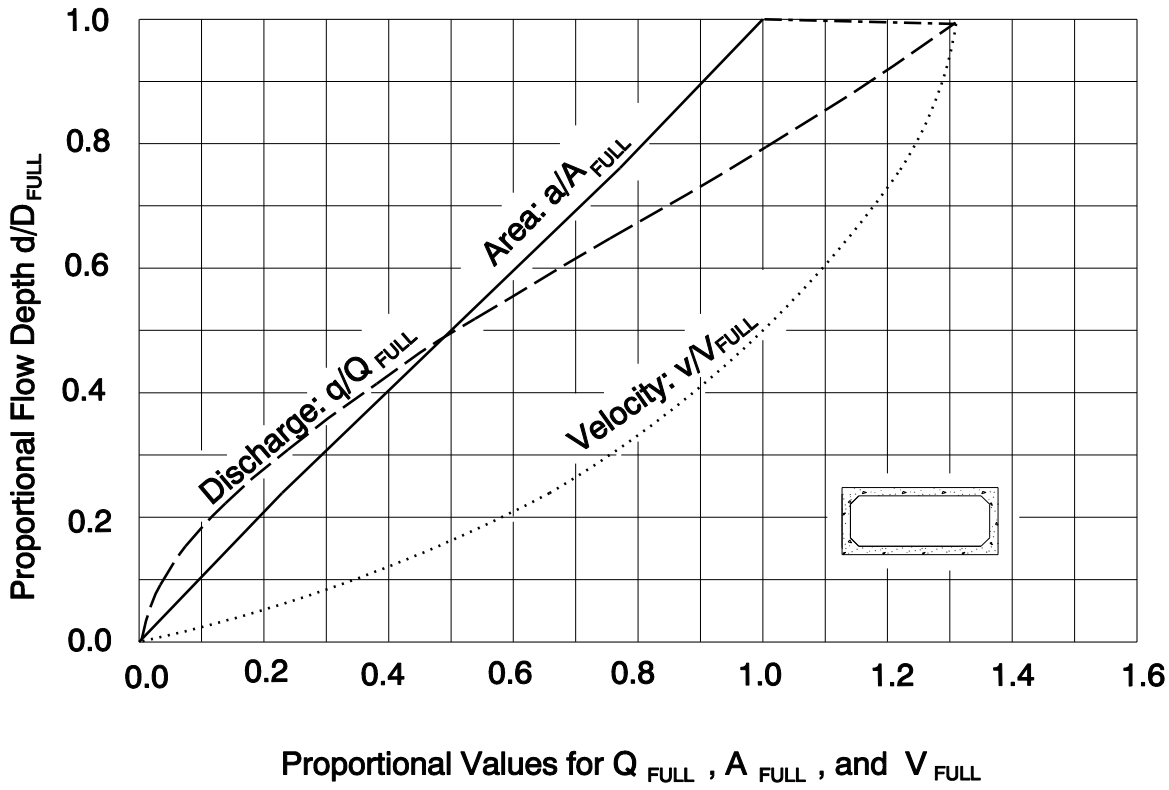
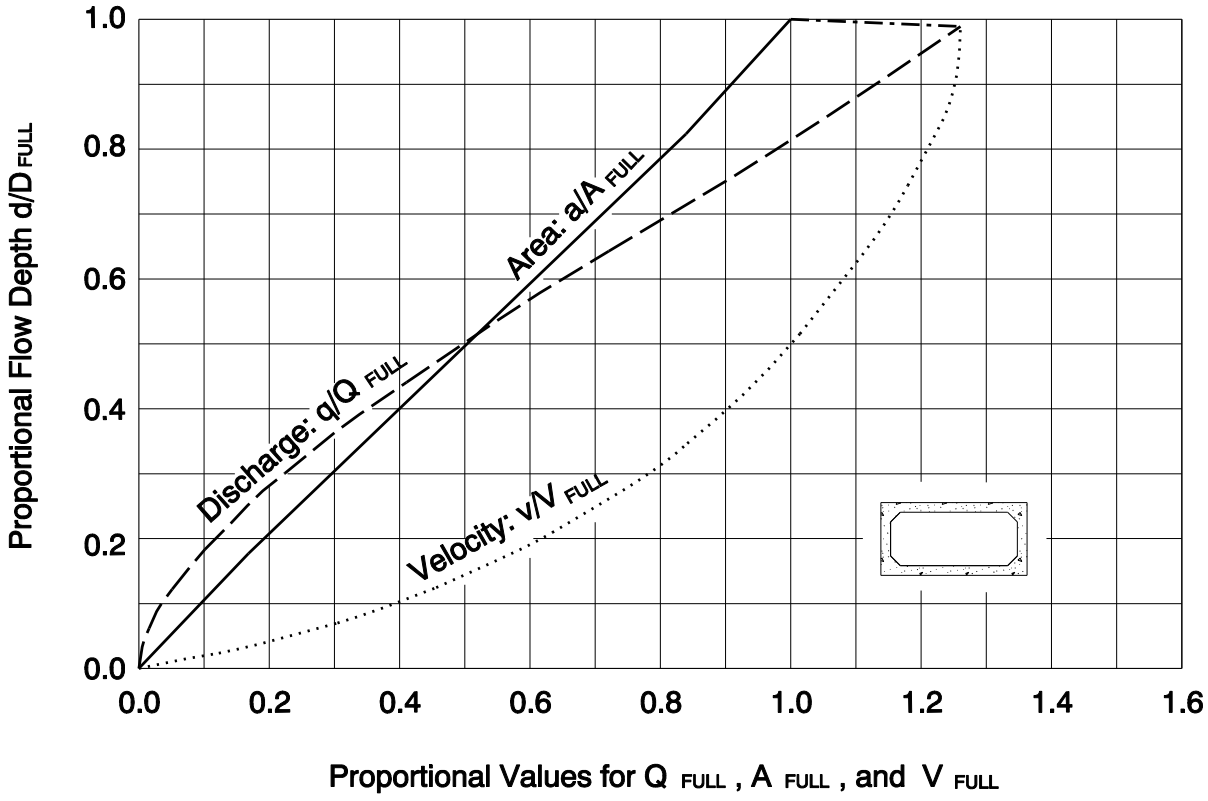


CHART 4
HYDRAULIC ELEMENTS OF RCBC 0.33 ≤ RISE / SPAN ≤ 0.36



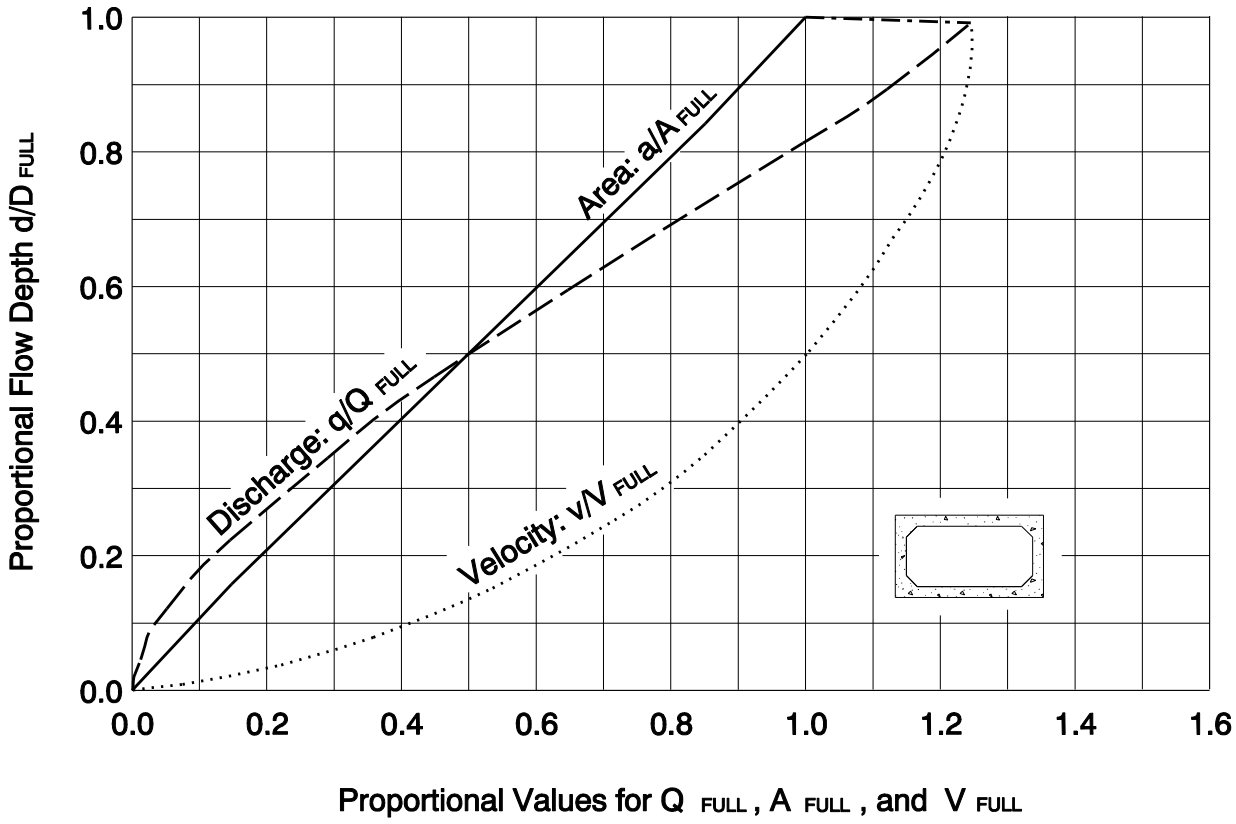
Applicable for 11-foot x 4-foot
and 12-foot x 4-foot sections

CHART 5
HYDRAULIC ELEMENTS OF RCBC RISE / SPAN = 0.50



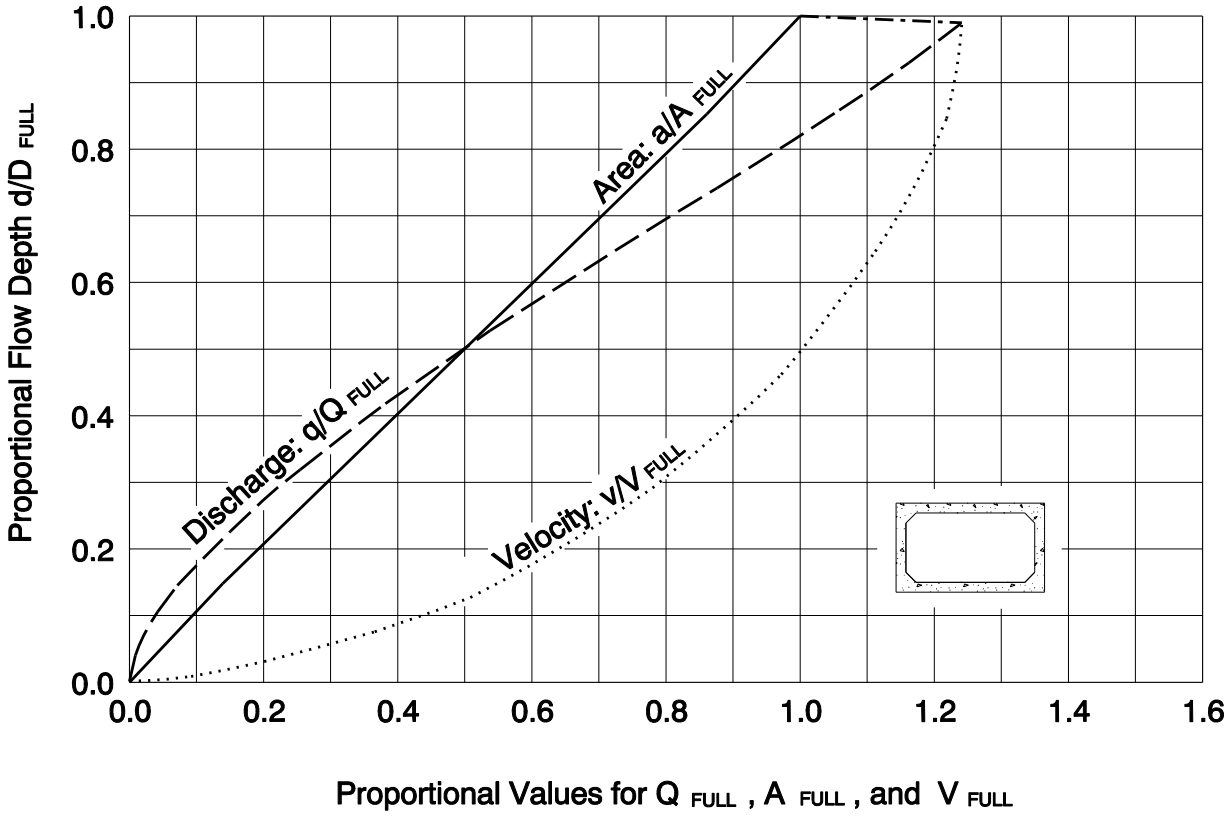
Applicable for 4-foot x 2-foot, 6-foot x 3-foot,
8-foot x 4-foot, 10-foot x 5-foot, 12-foot x 6-foot sections

CHART 6
HYDRAULIC ELEMENTS OF RCBC 0.55 ≤ RISE / SPAN ≤ 0.57



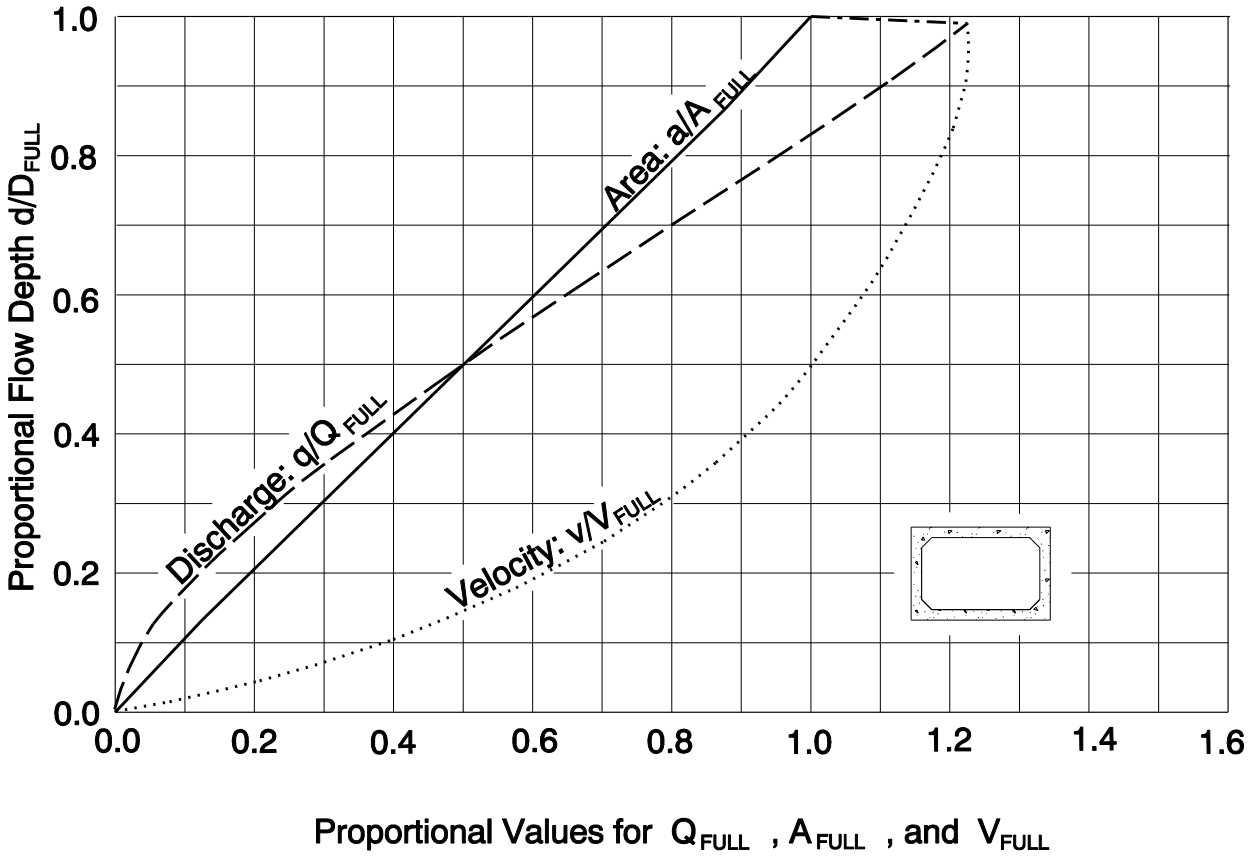
Applicable for 7-foot x 4-foot,
9-foot x 5-foot, and 11-foot x 6-foot sections

CHART 7
HYDRAULIC ELEMENTS OF RCBC 0.60 ≤ RISE / SPAN ≤ 0.63



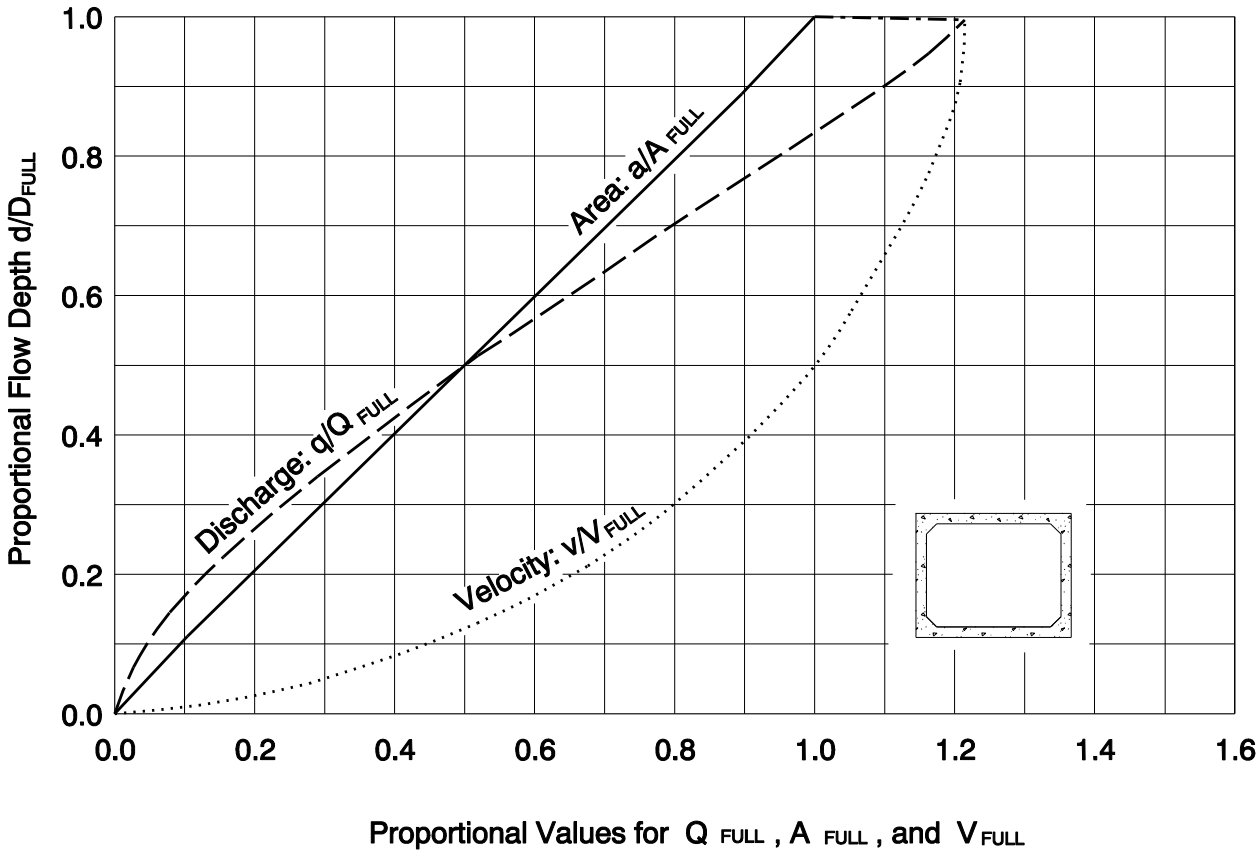
Applicable for 5-foot x 3-foot, 8-foot x 5-foot,
and 10-foot x 6-foot sections

CHART 8
HYDRAULIC ELEMENTS OF RCBC RISE / SPAN = 0.67



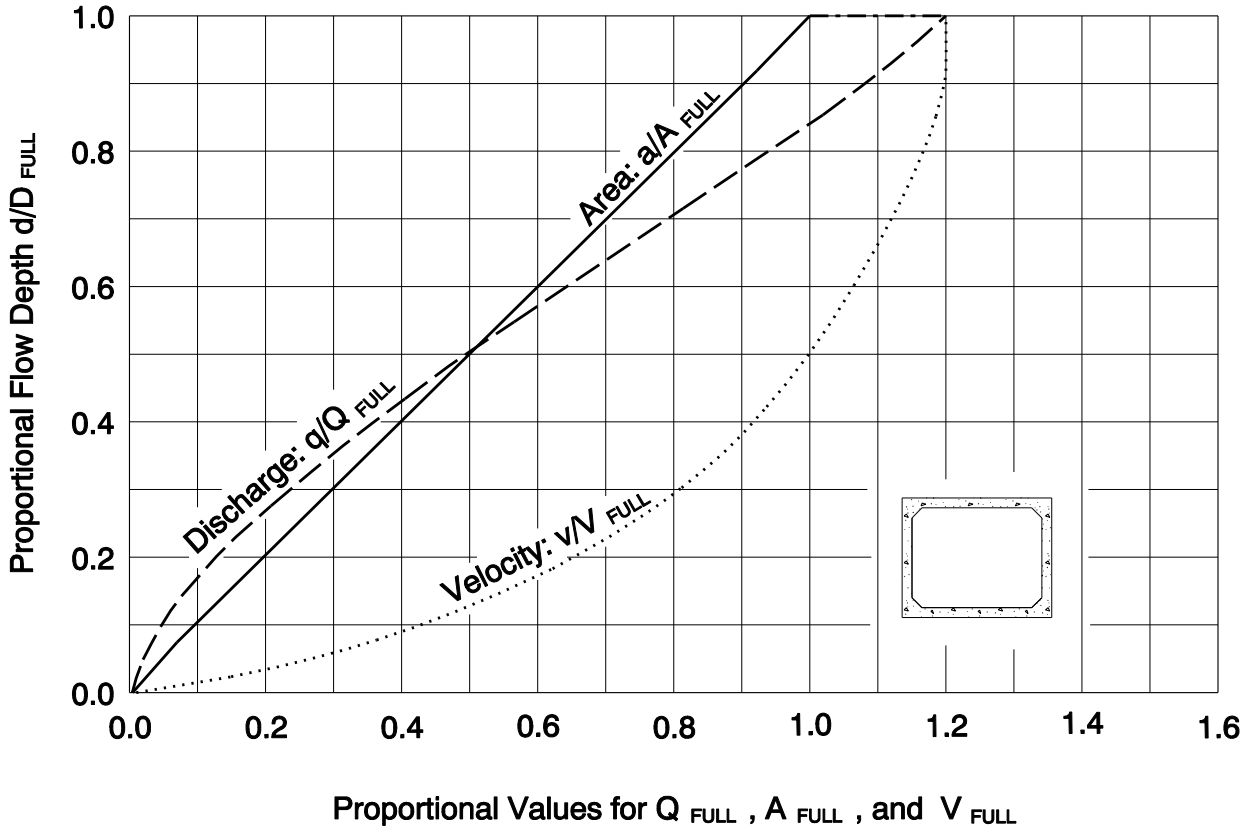
Applicable for 3-foot x 2-foot, 6-foot x 4-foot,
9-foot x 6-foot, and 12-foot x 8-foot sections

CHART 9
HYDRAULIC ELEMENTS OF RCBC 0.70 ≤ RISE / SPAN ≤ 0.75



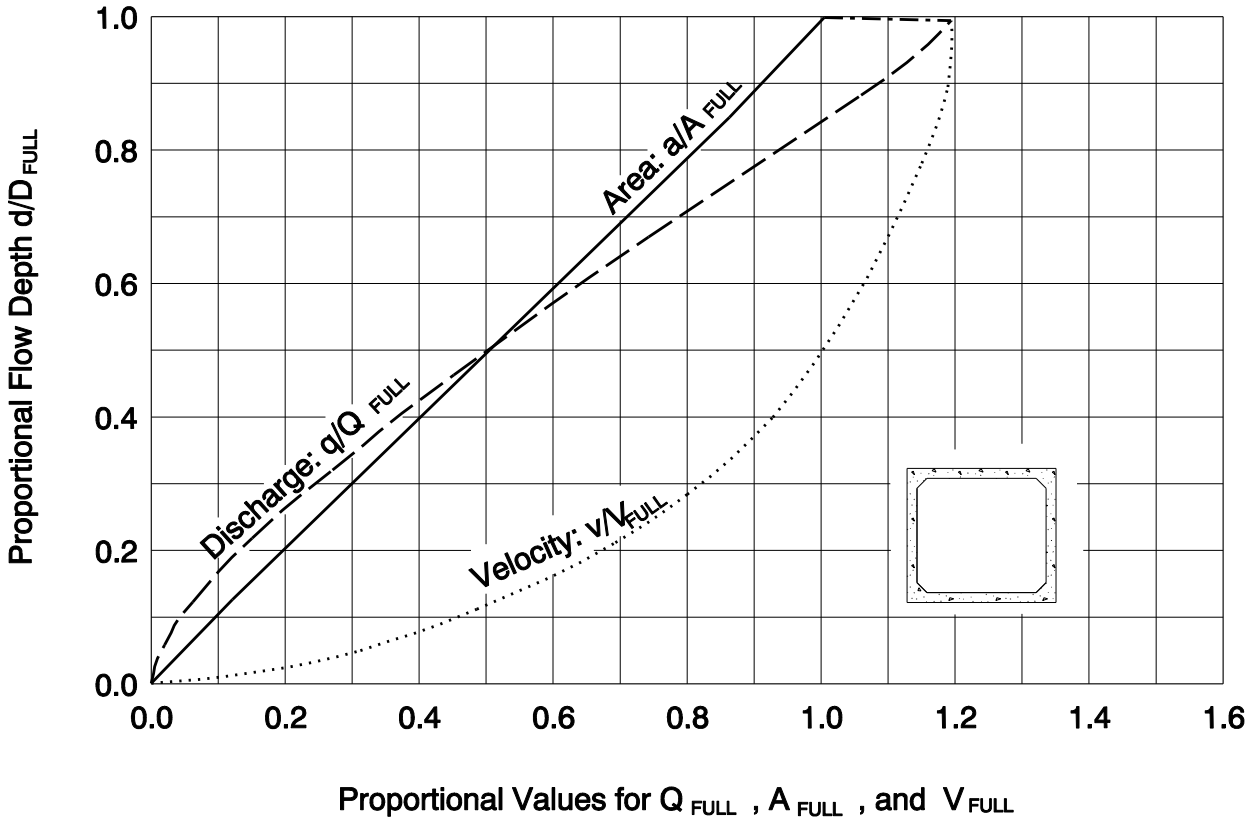
Applicable for 4-foot x 3-foot, 7-foot x 5-foot, 8-foot x 6-foot, 10-foot x 7-foot, and 11-foot x 8-foot sections

CHART 10
HYDRAULIC ELEMENTS OF RCBC 0.77 ≤ RISE / SPAN ≤ 0.83



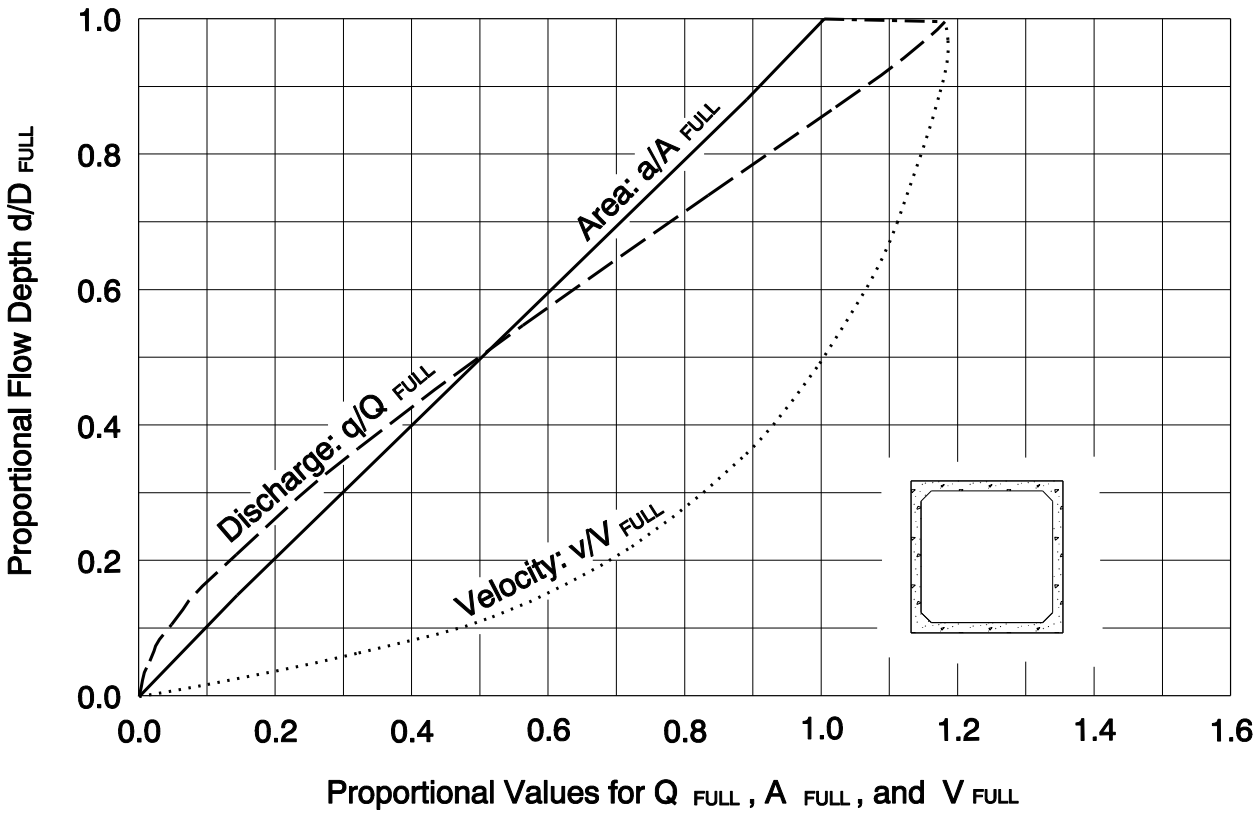
Applicable for 5-foot x 4-foot, 6-foot x 5-foot, 9-foot x 7-foot, 10-foot x 8-foot, 11-foot x 10-foot, and 12-foot x 10-foot sections

CHART 11
HYDRAULIC ELEMENTS OF RCBC 0.85 ≤ RISE / SPAN ≤ 0.91



Applicable for 7-foot x 6-foot, 8-foot x 7-foot,
9-foot x 8-foot, and 10-foot x 9-foot sections

CHART 12
HYDRAULIC ELEMENTS OF RCBC RISE / SPAN = 1.0



Applicable for 3-foot x 3-foot, 4-foot x 4-foot, 5-foot x 5-foot, 6-foot x 6-foot, 7-foot x 7-foot, 8-foot x 8-foot, 9-foot x 9-foot 10-foot x 10-foot, 11-foot x 11-foot, and 12-foot x 12-foot sections

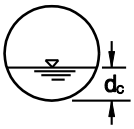
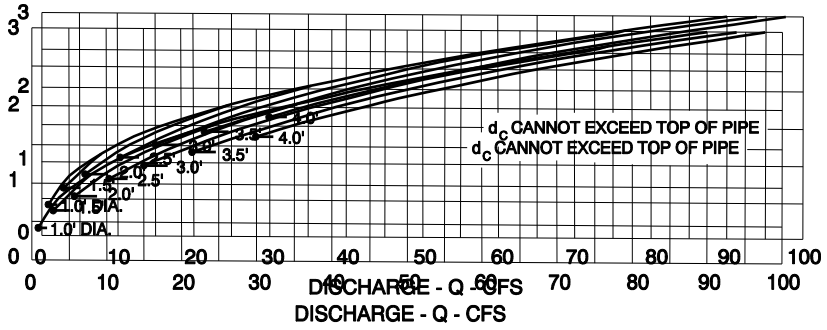
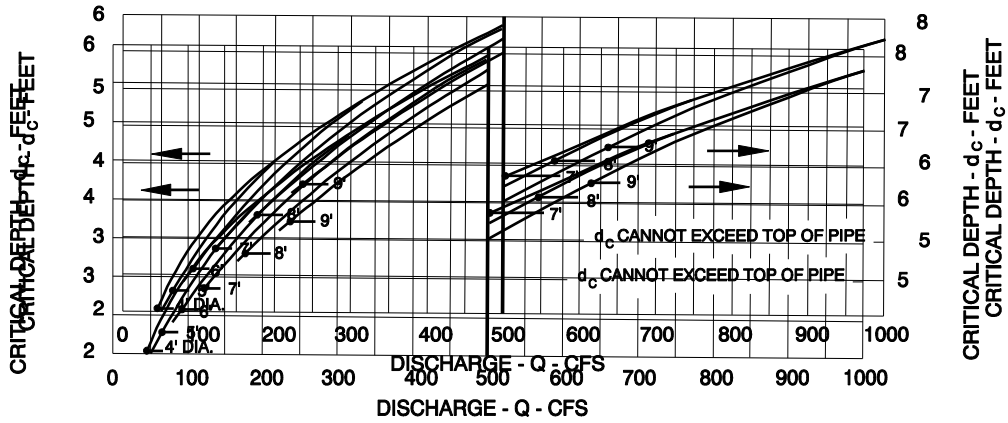


CHART 13
CRITICAL DEPTH IN CIRCULAR PIPES





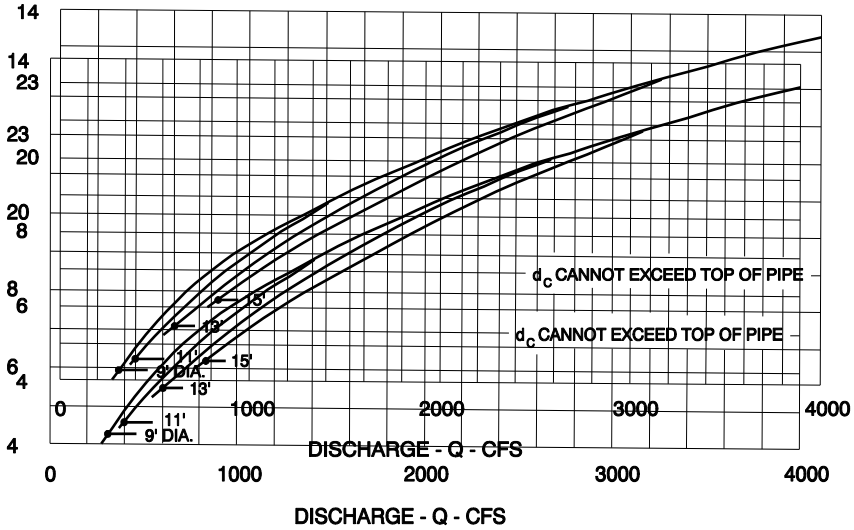
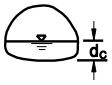
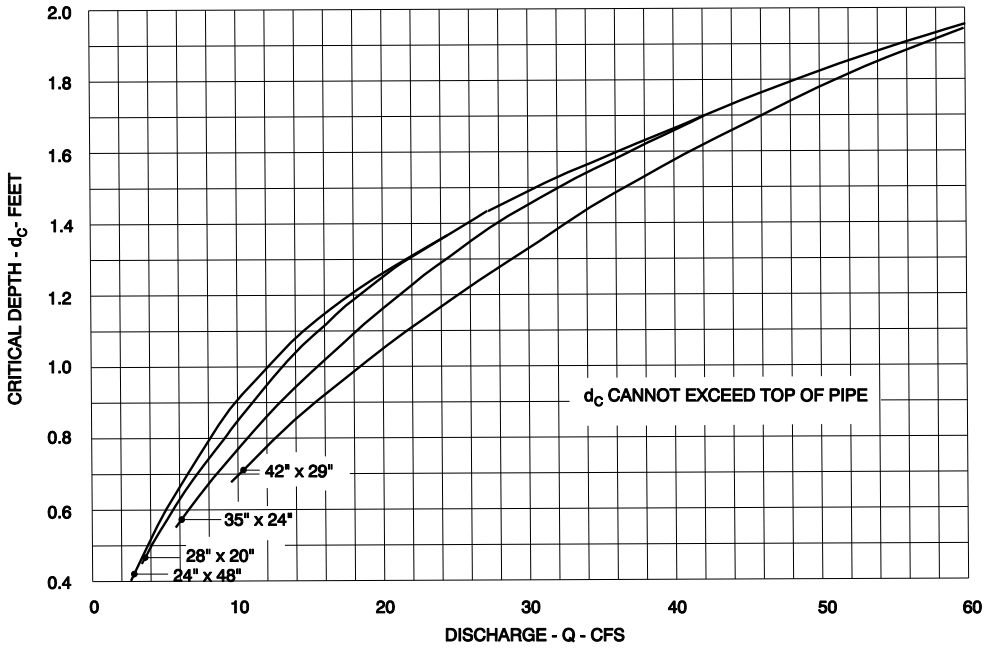


CHART 14
CRITICAL DEPTH IN CORRUGATED
PIPE ARCHES





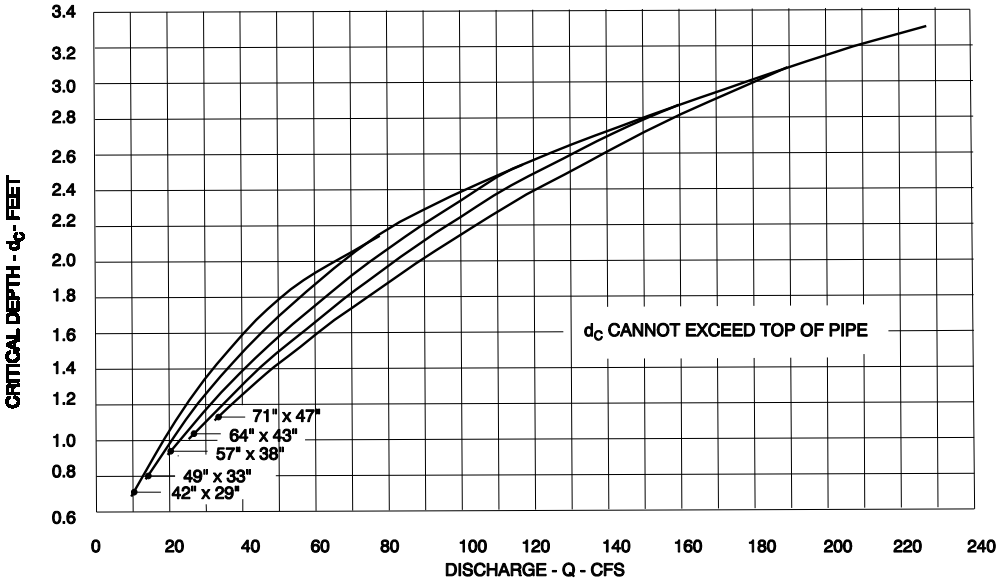
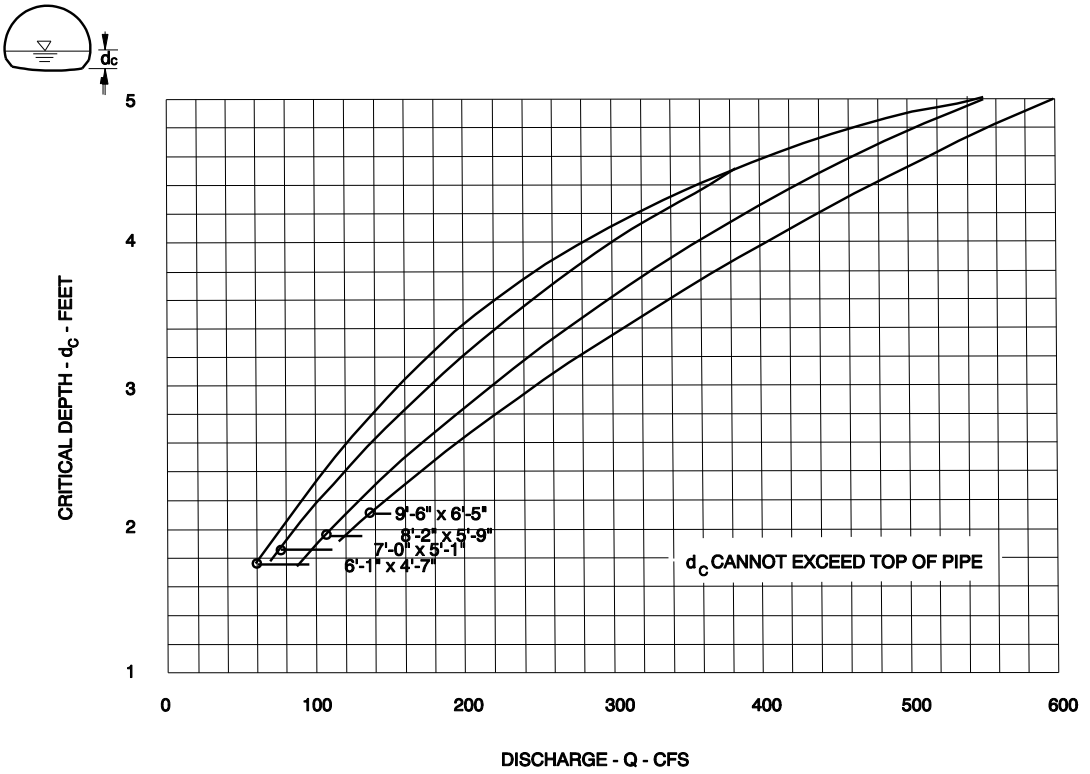


CHART 15
CRITICAL DEPTH IN STRUCTURAL PLATE PIPE ARCHES



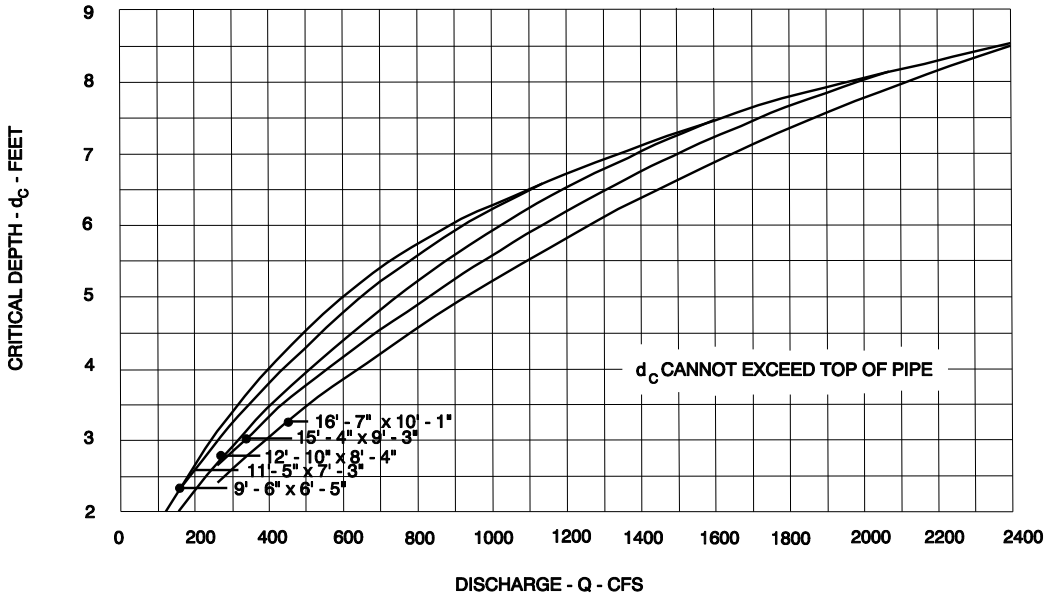
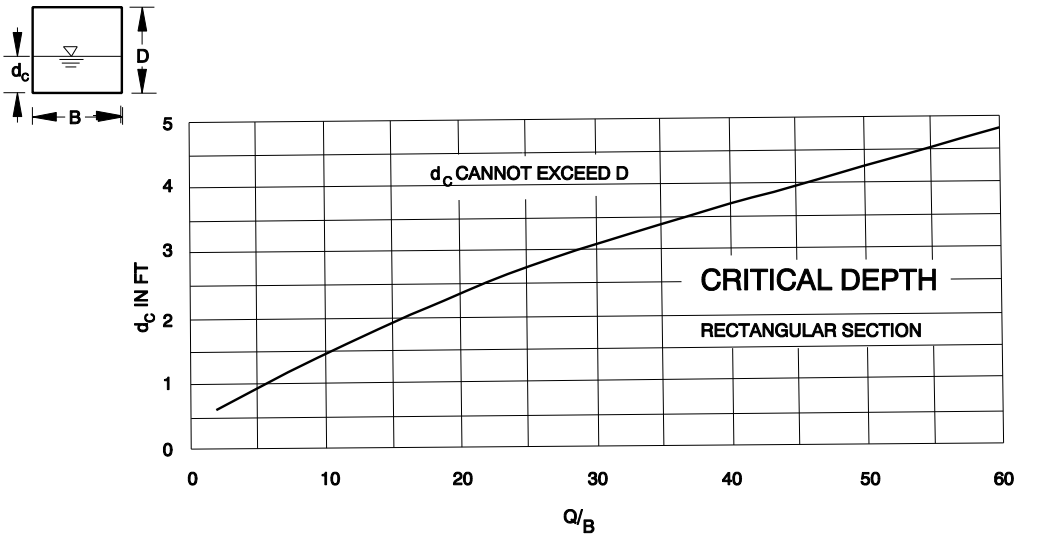


CHART 16
CRITICAL DEPTH IN BOXES



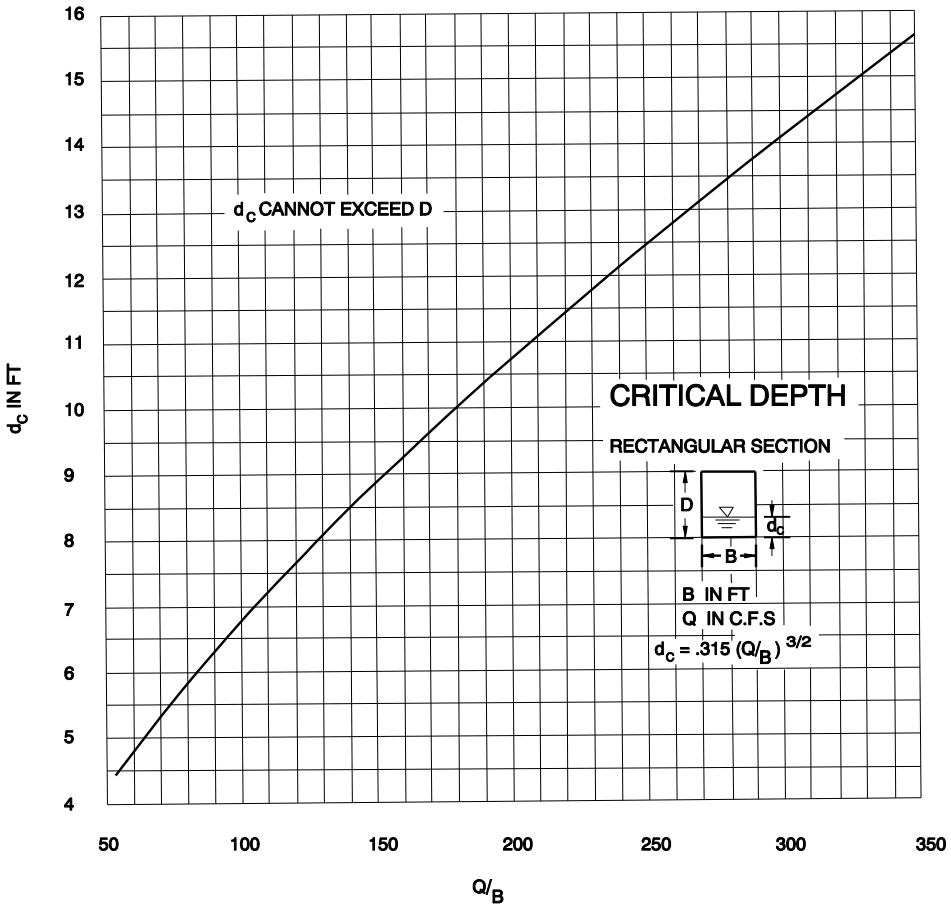
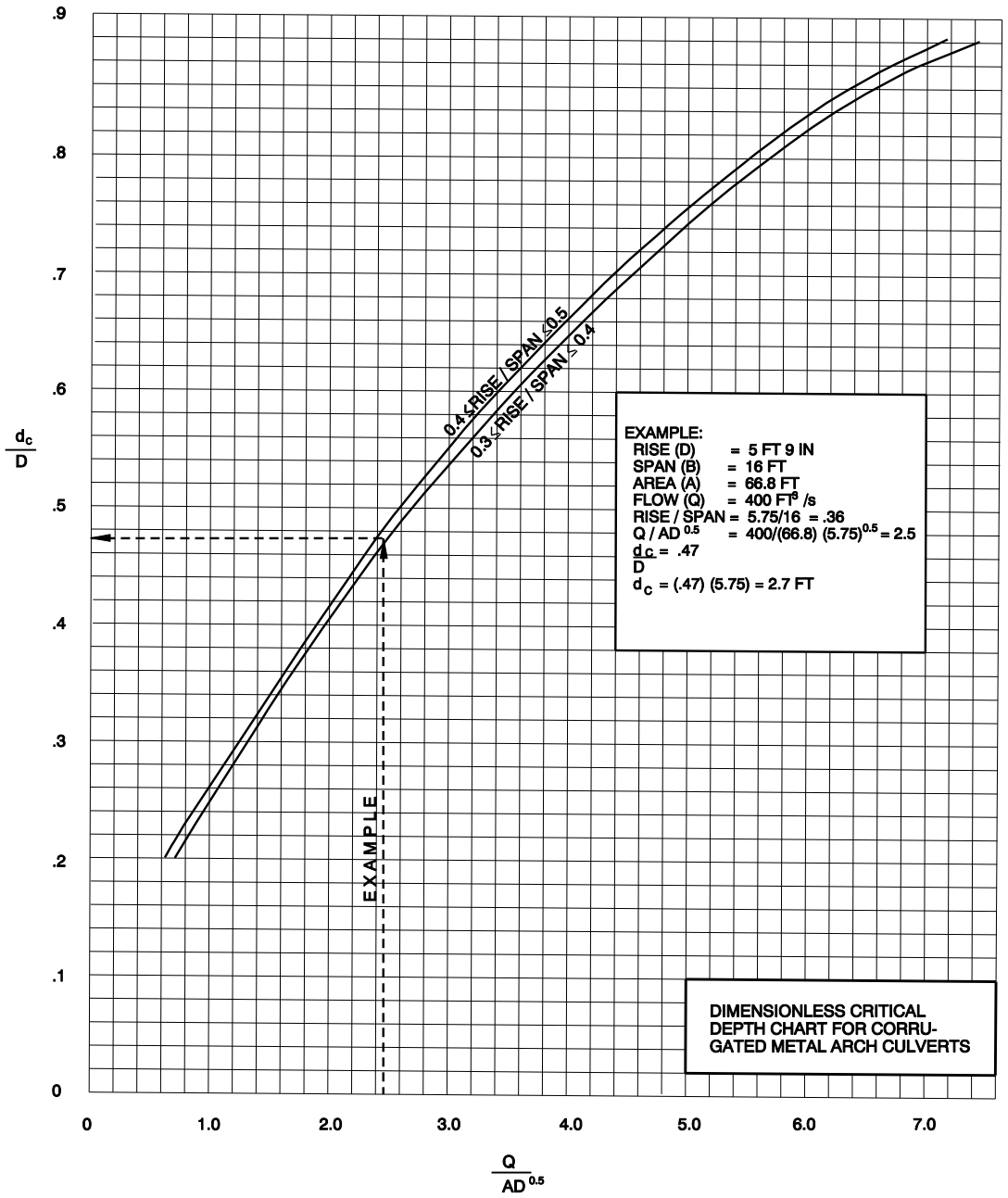



CHART 17
CRITICAL DEPTH IN ARCHES