



Friction of Water New Steel Pipe (Continued)
(Based on Darcy's Formula)

1 Inch

Flow U S gal per min	Standard wt steel—sch 40				Extra strong steel—sch 80				Schedule 160 steel			
	1.049" inside dia				.957" inside dia				.815" inside dia			
	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft
2	0.74	.009	.365	.89	.01	.599	1.23	.023	1.26	1.23	.023	1.26
3	1.11	.019	.787	1.34	.03	1.19	1.85	.053	1.85	1.85	.053	1.85
4	1.48	.034	1.270	1.79	.05	1.99	2.46	.075	2.46	2.46	.075	2.46
5	1.86	.054	1.90	2.23	.06	2.99	3.08	.100	3.08	3.08	.100	3.08
6	2.23	.077	2.65	2.68	.11	4.17	3.69	.140	3.69	3.69	.140	3.69
8	2.97	.137	4.50	3.57	.20	7.11	4.92	.230	4.92	4.92	.230	4.92
10	3.71	.214	6.81	4.46	.31	10.8	6.15	.350	6.15	6.15	.350	6.15
12	4.45	.308	9.58	5.36	.45	15.2	7.38	.490	7.38	7.38	.490	7.38
14	5.20	.420	12.8	6.25	.61	20.4	8.61	.640	8.61	8.61	.640	8.61
16	5.94	.548	16.5	7.14	.79	26.3	9.84	.820	9.84	9.84	.820	9.84
18	6.68	.694	20.6	8.03	1.00	32.9	11.07	1.00	11.07	11.07	1.00	11.07
20	7.42	.857	25.2	8.92	1.24	40.3	12.30	1.24	12.30	12.30	1.24	12.30
22	8.17	1.036	30.3	9.82	1.50	48.4	13.53	1.50	13.53	13.53	1.50	13.53
24	8.91	1.23	35.8	10.7	1.8	57.2	14.76	1.8	14.76	14.76	1.8	14.76
26	9.65	1.45	41.7	11.6	2.1	66.8	15.99	2.1	15.99	15.99	2.1	15.99
28	10.39	1.68	48.1	12.5	2.4	77.1	17.22	2.4	17.22	17.22	2.4	17.22
30	11.1	1.93	55.0	13.4	2.8	88.2	18.45	2.8	18.45	18.45	2.8	18.45
35	13.0	2.62	74.1	15.6	3.8	119	21.9	3.8	21.9	21.9	3.8	21.9
40	14.8	3.43	96.1	17.9	5.0	154	25.4	5.0	25.4	25.4	5.0	25.4
45	16.7	4.33	121	20.1	6.3	194	28.9	6.3	28.9	28.9	6.3	28.9

1 1/4 Inch

Flow U S gal per min	Standard wt steel—sch 40				Extra strong steel—sch 80				Schedule 160—steel			
	1.380" inside dia				1.278" inside dia				1.160" inside dia			
	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft
4	.858	.011	.35	1.00	.015	.51	1.21	.023	1.21	1.21	.023	1.21
5	1.073	.018	.52	1.25	.024	.75	1.52	.036	1.52	1.52	.036	1.52
6	1.29	.026	.72	1.50	.034	1.04	1.82	.051	1.82	1.82	.051	1.82
7	1.50	.035	.95	1.75	.048	1.33	2.13	.070	2.13	2.13	.070	2.13
8	1.72	.046	1.20	2.00	.062	1.69	2.43	.092	2.43	2.43	.092	2.43
10	2.15	.072	1.74	2.50	.097	2.55	3.04	.143	3.04	3.04	.143	3.04
12	2.57	.103	2.45	3.00	.140	3.57	3.64	.206	3.64	3.64	.206	3.64
14	3.00	.140	3.24	3.50	.190	4.75	4.25	.280	4.25	4.25	.280	4.25
16	3.43	.183	4.15	4.00	.249	6.10	4.86	.366	4.86	4.86	.366	4.86
18	3.86	.232	5.17	4.50	.315	7.61	5.46	.463	5.46	5.46	.463	5.46
20	4.29	.286	6.31	5.00	.388	9.28	6.07	.572	6.07	6.07	.572	6.07
25	5.36	.431	9.61	6.25	.607	14.2	7.59	.894	7.59	7.59	.894	7.59
30	6.44	.644	13.6	7.50	.874	20.1	9.11	1.29	9.11	9.11	1.29	9.11
35	7.51	.876	18.2	8.75	1.19	27.0	10.63	1.75	10.63	10.63	1.75	10.63
40	8.58	1.14	23.5	10.0	1.55	34.9	12.14	2.29	12.14	12.14	2.29	12.14
50	10.7	1.79	36.2	12.5	2.43	53.7	15.18	3.58	15.18	15.18	3.58	15.18
60	12.9	2.57	51.5	15.0	3.50	76.5	18.22	5.15	18.22	18.22	5.15	18.22
70	15.0	3.50	69.5	17.5	4.76	103	21.25	7.01	21.25	21.25	7.01	21.25
80	17.2	4.53	90.2	20.0	6.21	134	24.29	9.16	24.29	24.29	9.16	24.29
90	19.3	5.79	114	22.5	7.86	168	27.32	11.59	27.32	27.32	11.59	27.32

Note: No allowance has been made for age, difference in diameter, or any abnormal condition of interior surface. Any factor of safety must be estimated from the local conditions and the requirements of each particular installation. It is recommended that for most commercial design purposes a safety factor of 15 to 20% be added to the values in the tables—see page 3-5.

Friction of Water New Steel Pipe (Continued)
(Based on Darcy's Formula)

1 1/2 Inch

Flow U S gal per min	Standard wt steel—sch 40				Extra strong steel—sch 80				Schedule 160—steel			
	1.610" inside dia				1.500" inside dia				1.338" inside dia			
	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft
4	.63	.006	.166	.73	.01	.233	1.14	.013	.166	.73	.013	.166
5	.79	.010	.246	.91	.01	.346	1.14	.020	.246	.91	.020	.246
6	1.09	.019	.340	1.09	.02	.478	1.37	.029	.340	1.09	.029	.340
7	1.10	.019	.457	1.27	.03	.630	1.60	.040	.457	1.27	.040	.457
8	1.26	.025	.567	1.45	.03	.800	1.83	.052	.567	1.45	.052	.567
9	1.42	.031	.701	1.63	.04	.990	2.05	.065	.701	1.63	.065	.701
10	1.58	.039	.848	1.82	.05	1.20	2.28	.081	.848	1.82	.081	.848
12	1.89	.056	1.18	2.18	.07	1.61	2.74	.116	1.18	2.18	.116	1.18
14	2.21	.078	1.51	2.54	.10	2.14	3.20	.158	1.51	2.54	.158	1.51
16	2.52	.099	1.83	2.90	.13	2.74	3.65	.207	1.83	2.90	.207	1.83
18	2.84	.125	2.40	3.27	.17	3.41	4.11	.262	2.40	3.27	.262	2.40
20	3.15	.154	2.92	3.63	.20	4.15	4.56	.323	2.92	3.63	.323	2.92
22	3.47	.187	3.48	3.99	.25	4.96	5.02	.391	3.48	3.99	.391	3.48
24	3.76	.222	4.10	4.36	.30	5.84	5.48	.465	4.10	4.36	.465	4.10
26	4.10	.261	4.76	4.72	.35	6.80	5.93	.546	4.76	4.72	.546	4.76
28	4.41	.303	5.47	5.08	.40	7.82	6.39	.634	5.47	5.08	.634	5.47
30	4.73	.347	6.23	5.45	.46	8.91	6.85	.727	6.23	5.45	.727	6.23
32	5.04	.395	7.04	5.81	.52	10.1	7.30	.828	7.04	5.81	.828	7.04
34	5.36	.446	7.90	6.17	.59	11.3	7.76	.934	7.90	6.17	.934	7.90
36	5.67	.500	8.80	6.54	.66	12.6	8.22	1.05	8.80	6.54	1.05	8.80
38	5.99	.557	9.76	6.90	.74	14.0	8.67	1.17	9.76	6.90	1.17	9.76
40	6.30	.618	10.8	7.26	.82	15.4	9.13	1.29	10.8	7.26	1.29	10.8
42	6.62	.681	11.8	7.63	.90	16.9	9.58	1.43	11.8	7.63	1.43	11.8
44	6.93	.747	12.9	7.99	.99	18.5	10.04	1.57	12.9	7.99	1.57	12.9
46	7.25	.817	14.0	8.35	1.08	20.1	10.50	1.71	14.0	8.35	1.71	14.0
48	7.56	.889	15.2	8.72	1.18	21.8	10.95	1.86	15.2	8.72	1.86	15.2
50	7.88	.965	16.5	9.08	1.28	23.6	11.41	2.02	16.5	9.08	2.02	16.5
55	8.67	1.17	19.8	9.99	1.55	28.4	12.55	2.45	19.8	9.99	2.45	19.8
60	9.46	1.39	23.4	10.9	1.8	33.6	13.69	2.91	23.4	10.9	2.91	23.4
65	10.24	1.63	27.3	11.8	2.2	39.2	14.83	3.41	27.3	11.8	3.41	27.3
70	11.03	1.89	31.5	12.7	2.5	45.3	15.97	3.96	31.5	12.7	3.96	31.5
75	11.8	2.17	36.0	13.6	2.9	51.8	17.11	4.55	36.0	13.6	4.55	36.0
80	12.6	2.47	40.8	14.5	3.3	58.7	18.25	5.17	40.8	14.5	5.17	40.8
85	13.4	2.79	45.9	15.4	3.7	66.0	19.40	5.84	45.9	15.4	5.84	45.9
90	14.2	3.13	51.3	16.3	4.1	73.8	20.54	6.55	51.3	16.3	6.55	51.3
95	15.0	3.48	57.0	17.2	4.6	82.0	21.68	7.29	57.0	17.2	7.29	57.0
100	15.8	3.86	63.0	18.2	5.1	90.7	22.82	8.08	63.0	18.2	8.08	63.0
110	17.3	4.67	75.8	20.0	6.2	109.3	25.10	9.78	75.8	20.0	9.78	75.8
120	18.9	5.56	89.9	21.8	7.4	128.8	27.38	11.6	89.9	21.8	11.6	89.9
130	20.5	6.52	105	23.6	8.7	151.6	29.66	13.7	105	23.6	13.7	105
140	22.1	7.56	122	25.4	10.0	175	31.94	15.9	122	25.4	15.9	122
150	23.6	8.68	139	27.2	11.5	201	34.22	18.2	139	27.2	18.2	139
160	25.2	9.88	158	29.0	13.1	228	36.50	20.5	158	29.0	20.5	158
170	26.8	11.15	178	30.9	14.8	257	38.78	22.8	178	30.9	22.8	178
180	28.4	12.50	199	32.7	16.6	288	41.06	25.1	199	32.7	25.1	199

Note: No allowance has been made for age, difference in diameter, or any abnormal condition of interior surface. Any factor of safety must be estimated from the local conditions and the requirements of each particular installation. It is recommended that for most commercial design purposes a safety factor of 15 to 20% be added to the values in the tables—see page 3-5.

Friction of Water New Steel Pipe
(Based on Darcy's Formula)

1/4 Inch

Flow U S gal per min	Standard wt steel—sch 40			Extra strong steel—sch 80		
	0.364" inside dia			0.302" inside dia		
	Velocity head-ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head-ft	Head loss ft per 100 ft	Velocity ft per sec
0.4	1.23	0.024	1.79	0.05	0.05	9.18
0.6	1.85	0.053	2.69	0.11	0.11	19.0
0.8	2.47	0.095	3.59	0.20	0.20	32.3
1.0	3.08	0.148	4.48	0.31	0.31	48.8
1.2	3.70	0.213	5.38	0.45	0.45	68.6
1.4	4.32	0.290	6.27	0.61	0.61	91.7
1.6	4.93	0.378	7.17	0.80	0.80	118.1
1.8	5.55	0.479	8.07	1.01	1.01	147.7
2.0	6.17	0.591	8.96	1.25	1.25	180.7
2.4	7.40	0.850	10.75	1.79	1.79	256
2.8	8.63	1.157	12.54	2.44	2.44	345

Friction of Water New Steel Pipe (Continued)
(Based on Darcy's Formula)

1/2 Inch

Flow U S gal per min	Standard wt steel—sch 40			Extra strong steel—sch 80			Schedule 160		
	.622" inside dia			.546" inside dia			.464" inside dia		
	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft
0.7	0.739	.008	0.74	.96	.01	1.39	1.90	.056	1.66
1.0	1.056	.017	1.86	1.37	.03	2.58	2.85	.126	5.73
1.5	1.58	.039	2.82	2.06	.07	5.34	3.80	.224	12.0
2.0	2.11	.069	4.73	2.74	.12	9.02	4.74	.349	20.3
2.5	2.64	.108	7.10	3.43	.18	13.6	5.69	.503	30.8
3.0	3.17	.156	9.94	4.11	.26	19.1	6.64	.684	43.5
3.5	3.70	.212	13.2	4.80	.36	25.5	7.59	.894	58.2
4.0	4.22	.277	17.0	5.48	.47	32.7	8.54	1.13	75.0
4.5	4.75	.351	21.1	6.17	.59	40.9	9.49	1.40	94.0
5.0	5.28	.433	25.8	6.86	.73	50.0	10.44	1.69	115
5.5	5.81	.524	30.9	7.54	.88	59.9	11.38	2.01	138
6.0	6.34	.624	36.4	8.23	1.05	70.7	12.33	2.36	163
6.5	6.86	.732	42.4	8.91	1.23	82.4	13.28	2.74	190
7.0	7.39	.849	48.8	9.60	1.43	95.0	14.23	3.14	220
7.5	7.92	.975	55.6	10.3	1.6	109			
8.0	8.45	1.109	63.0	11.0	1.9	123			
8.5	8.98	1.25	70.7	11.6	2.1	138			
9.0	9.50	1.40	78.9	12.3	2.4	154			
9.5	10.03	1.56	87.8	13.0	2.6	171			
10	10.56	1.73	96.6	13.7	2.9	189			

3/4 Inch

Flow U S gal per min	Standard wt steel—sch 40			Extra strong steel—sch 80			Steel—schedule 160		
	.824" inside dia			.742" inside dia			.612" inside dia		
	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft
1.5	0.90	.013	0.72	1.11	.02	1.19	1.64	.042	3.05
2.0	1.20	.023	1.19	1.48	.03	1.99	2.18	.074	5.12
2.5	1.50	.035	1.78	1.86	.05	2.97	2.73	.115	7.70
3.0	1.81	.051	2.47	2.23	.08	4.14	3.27	.166	10.8
3.5	2.11	.069	3.26	2.60	.11	5.48	3.82	.226	14.3
4.0	2.41	.090	4.16	2.97	.14	7.01	4.36	.295	18.4
4.5	2.71	.114	5.17	3.34	.17	8.72	4.91	.374	22.9
5.0	3.01	.141	6.28	3.71	.21	10.6	5.45	.462	28.0
6	3.61	.203	8.80	4.45	.31	14.9	6.54	.665	39.5
7	4.21	.276	11.7	5.20	.42	19.8	7.64	.905	53.0
8	4.81	.360	15.1	5.94	.55	25.6	8.73	1.18	68.4
9	5.42	.456	18.8	6.68	.69	32.1	9.82	1.50	85.8
10	6.02	.563	23.0	7.42	.86	39.2	10.91	1.85	105
11	6.62	.681	27.8	8.17	1.04	47.0	12.00	2.23	126
12	7.22	.822	32.5	8.91	1.23	55.5	13.09	2.66	149
13	7.82	.961	37.9	9.63	1.44	64.8	14.18	3.13	175
14	8.42	1.103	43.7	10.4	1.7	74.7	15.27	3.62	202
16	9.63	1.44	56.4	11.9	2.2	96.7	17.45	4.73	261
18	10.8	1.82	70.8	13.4	2.8	121			
20	12.0	2.25	86.8	14.8	3.4	149			

Note: No allowance has been made for age, difference in diameter, or any abnormal condition of interior surface. Any factor of safety must be estimated from the local conditions and the requirements of each particular installation. It is recommended that for most commercial design purposes a safety factor of 15 to 20% be added to the values in the tables—see page 3-5.

Friction of Water New Steel Pipe
(Based on Darcy's Formula)

1/4 Inch

Flow U S gal per min	Standard wt steel—sch 40			Extra strong steel—sch 80		
	0.493" inside dia			0.423" inside dia		
	Velocity ft per sec	Velocity head-ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head-ft	Head loss ft per 100 ft
0.5	0.84	0.011	1.26	1.14	0.02	2.63
1.0	1.68	0.044	4.26	2.28	0.08	9.05
1.5	2.52	0.099	8.85	3.43	0.18	19.0
2.0	3.36	0.176	15.0	4.57	0.32	32.4
2.5	4.20	0.274	22.7	5.71	0.51	49.3
3.0	5.04	0.395	32.0	6.85	0.73	69.6
3.5	5.88	0.538	42.7	8.00	0.99	93.3
4.0	6.72	0.702	55.0	9.14	1.30	120
5.0	8.40	1.097	84.2	11.4	2.0	185
6.0	10.08	1.58	119	13.7	2.9	263

3/4 Inch

Flow U S gal per min	Standard wt steel—sch 40			Extra strong steel—sch 80		
	0.493" inside dia			0.423" inside dia		
	Velocity ft per sec	Velocity head-ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head-ft	Head loss ft per 100 ft
0.5	0.84	0.011	1.26	1.14	0.02	2.63
1.0	1.68	0.044	4.26	2.28	0.08	9.05
1.5	2.52	0.099	8.85	3.43	0.18	19.0
2.0	3.36	0.176	15.0	4.57	0.32	32.4
2.5	4.20	0.274	22.7	5.71	0.51	49.3
3.0	5.04	0.395	32.0	6.85	0.73	69.6
3.5	5.88	0.538	42.7	8.00	0.99	93.3
4.0	6.72	0.702	55.0	9.14	1.30	120
5.0	8.40	1.097	84.2	11.4	2.0	185
6.0	10.08	1.58	119	13.7	2.9	263

Calculations on pages 3-12 to 3-34 are by Ingersoll-Rand Co.

Note: No allowance has been made for age, difference in diameter, or any abnormal condition of interior surface. Any factor of safety must be estimated from the local conditions and the requirements of each particular installation. It is recommended that for most commercial design purposes a safety factor of 15 to 20% be added to the values in the tables—see page 3-5.



Friction of Water New Steel Pipe (Continued)

(Based on Darcy's Formula)

2 Inch

Flow U S gal per min	Standard wt steel—sch 40				Extra strong steel—sch 80				Schedule 160—steel			
	2.087" inside dia				1.939" inside dia				1.687" inside dia			
	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Head loss ft per 100 ft
5	.478	.004	.074	.101	.54	.00	.101	.139	.718	.008	.197	.271
6	.574	.005	.102	.139	.65	.01	.139	.189	.861	.012	.271	.371
7	.669	.007	.134	.176	.76	.01	.176	.231	.991	.016	.357	.488
8	.765	.009	.167	.219	.87	.01	.219	.285	1.15	.020	.452	.614
9	.860	.012	.200	.266	.98	.01	.266	.343	1.29	.026	.559	.761
10	.956	.014	.232	.299	1.09	.02	.299	.413	1.44	.032	.675	.914
12	1.15	.021	.349	.461	1.30	.03	.461	.629	1.72	.046	.938	1.267
14	1.34	.028	.461	.629	1.52	.04	.629	.881	2.01	.063	1.20	1.634
16	1.53	.036	.566	.800	1.74	.05	.800	1.133	2.30	.082	1.53	2.044
18	1.72	.046	.672	.991	1.96	.06	.991	1.400	2.58	.104	1.90	2.511
20	1.91	.057	.787	1.18	2.17	.07	1.18	1.683	2.87	.128	2.31	3.044
22	2.10	.069	.905	1.38	2.39	.09	1.38	1.983	3.16	.155	2.76	3.644
24	2.29	.082	1.025	1.58	2.61	.11	1.58	2.299	3.45	.184	3.25	4.311
26	2.49	.096	1.147	1.78	2.83	.12	1.78	2.633	3.73	.216	3.77	5.044
28	2.68	.111	1.272	1.98	3.04	.14	1.98	2.983	4.02	.251	4.33	5.844
30	2.87	.128	1.400	2.18	3.26	.17	2.18	3.349	4.31	.288	4.93	6.711
35	3.35	.174	1.822	2.88	3.80	.22	2.88	4.211	5.02	.392	6.59	8.944
40	3.82	.227	2.306	3.66	4.35	.29	3.66	5.122	5.74	.512	8.49	11.444
45	4.30	.288	2.822	4.59	4.89	.37	4.59	6.083	6.46	.648	10.6	14.244
50	4.78	.355	3.342	5.53	5.43	.46	5.53	7.099	7.18	.799	13.0	17.344
55	5.26	.430	3.862	6.37	5.98	.56	6.37	8.166	7.89	.967	15.6	20.744
60	5.74	.511	4.387	7.31	6.52	.66	7.31	9.283	8.61	1.15	18.4	24.344
65	6.21	.600	4.917	8.34	7.06	.77	8.34	10.450	9.33	1.35	21.5	28.144
70	6.69	.696	5.452	9.47	7.61	.90	9.47	11.667	10.05	1.57	24.8	32.144
75	7.17	.799	6.000	10.70	8.15	1.03	10.70	12.923	10.77	1.80	28.3	36.344
80	7.65	.909	6.552	12.04	8.69	1.17	12.04	14.219	11.48	2.05	32.1	40.744
85	8.13	1.03	7.109	13.47	9.03	1.27	13.47	15.555	12.20	2.31	36.1	45.344
90	8.60	1.15	7.672	14.98	9.78	1.49	14.98	16.931	12.92	2.59	40.3	50.144
95	9.08	1.28	8.241	16.57	10.3	1.6	16.57	18.347	13.64	2.89	44.8	55.144
100	9.56	1.42	8.806	18.24	10.9	1.8	18.24	19.803	14.35	3.20	49.5	60.344
110	10.52	1.72	9.944	20.99	12.0	2.2	20.99	22.709	15.79	3.87	59.6	71.444
120	11.5	2.05	11.111	23.82	13.0	2.6	23.82	25.665	17.22	4.61	70.6	82.644
130	12.4	2.40	12.389	26.72	14.1	3.1	26.72	28.671	18.66	5.40	82.8	94.044
140	13.4	2.76	13.722	29.69	15.2	3.6	29.69	31.727	20.10	6.27	95.5	105.644
150	14.3	3.20	15.111	32.72	16.3	4.1	32.72	34.833	21.53	7.20	109	117.444
160	15.3	3.64	16.556	35.81	17.4	4.7	35.81	37.989	22.97	8.19	124	129.444
170	16.3	4.11	18.056	38.96	18.5	5.3	38.96	41.195	24.40	9.24	140	141.644
180	17.2	4.60	19.611	42.16	19.6	6.0	42.16	44.451	25.84	10.36	156	154.044
190	18.2	5.13	21.222	45.41	20.6	6.6	45.41	47.757	27.27	11.54	174	166.644
200	19.1	5.68	22.889	48.71	21.7	7.3	48.71	51.113	28.71	12.79	192	179.444
220	21.0	6.88	27.722	58.11	23.9	8.9	58.11	60.51	32.15	15.14	222	204.444
240	22.9	8.18	32.611	67.56	26.2	10.6	67.56	69.91	35.60	17.69	254	230.444
260	24.9	9.60	37.556	77.06	28.3	12.4	77.06	79.31	39.05	20.34	288	257.444
280	26.8	11.14	42.556	86.61	30.4	14.4	86.61	88.71	42.50	23.19	324	285.444
300	28.7	12.8	47.611	96.16	32.6	16.5	96.16	98.11	45.95	26.14	362	314.444

Note: No allowance has been made for age, difference in diameter, or any abnormal condition of interior surface. Any factor of safety must be estimated from the local conditions and the requirements of each particular installation. It is recommended that for most commercial design purposes a safety factor of 15 to 20% be added to the values in the tables—see page 3-5.

Friction of Water New Steel Pipe (Continued)

(Based on Darcy's Formula)

2 1/2 Inch

Flow U S gal per min	Standard wt steel—sch 40				Extra strong steel—sch 80				Schedule 160—steel			
	2.469" inside dia				2.323" inside dia				2.125" inside dia			
	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Head loss ft per 100 ft	Velocity ft per sec	Velocity head ft	Head loss ft per 100 ft	Head loss ft per 100 ft
8	.536	.005	.072	.101	.61	.01	.101	.144	.724	.008	.149	.204
10	.632	.007	.107	.144	.76	.01	.144	.199	.905	.013	.221	.299
12	.728	.010	.148	.191	.91	.01	.191	.266	1.09	.018	.305	.414
14	.824	.014	.195	.241	1.06	.02	.241	.333	1.27	.025	.403	.538
16	.920	.018	.247	.291	1.21	.02	.291	.400	1.45	.033	.512	.684
18	1.016	.023	.305	.343	1.36	.03	.343	.467	1.63	.041	.634	.844
20	1.112	.028	.369	.393	1.51	.04	.393	.534	1.81	.051	.767	.1.011
22	1.208	.034	.438	.443	1.67	.04	.443	.601	1.99	.061	.912	.1.188
24	1.304	.040	.513	.493	1.82	.05	.493	.668	2.17	.073	1.03	.1.365
26	1.400	.047	.583	.543	1.97	.06	.543	.735	2.35	.086	1.20	.1.542
28	1.496	.055	.659	.593	2.12	.07	.593	.802	2.53	.100	1.37	.1.719
30	1.592	.063	.739	.643	2.27	.08	.643	.869	2.71	.114	1.56	.1.896
35	1.888	.086	.966	.866	2.85	.11	.866	1.133	3.17	.156	2.08	.2.365
40	2.184	.112	1.200	1.080	3.03	.14	1.200	1.397	3.62	.203	2.66	.2.834
45	2.480	.141	1.57	1.397	3.41	.18	1.57	1.711	4.07	.257	3.32	.3.303
50	2.776	.174	1.91	1.711	3.79	.22	1.91	2.025	4.52	.318	4.05	.3.772
55	3.072	.211	2.28	2.025	4.16	.27	2.28	2.339	4.97	.384	4.85	.4.241
60	3.368	.251	2.69	2.339	4.54	.32	2.69	2.653	5.43	.457	5.72	.4.710
65	3.664	.295	3.13	2.653	4.92	.38	3.13	2.967	5.88	.537	6.66	.5.179
70	3.960	.342	3.60	2.967	5.30	.44	3.60	3.281	6.33	.622	7.67	.5.648
75	4.256	.393	4.10	3.281	5.68	.50	4.10	3.595	6.79	.714	8.75	.6.117
80	4.552	.447	4.64	3.595	6.05	.57	4.64	3.909	7.24	.813	9.90	.6.586
85	4.848	.504	5.20	3.909	6.43	.64	5.20	4.223	7.69	.916	11.1	.7.055
90	5.144	.565	5.80	4.223	6.81	.72	5.80	4.537	8.14	1.03	12.4	.7.524
95	5.440	.630	6.43	4.537	7.19	.80	6.43	4.851	8.59	1.15	13.8	.7.993
100	5.736	.698	7.09	4.851	7.57	.89	7.09	5.165	9.05	1.27	15.2	.8.462
110	6.328	.844	8.51	5.165	8.33	1.08	8.51	5.781	9.95	1.54	18.3	.9.341
120	6.920	1.00	10.1	5.481	9.08	1.28	9.08	6.397	10.86	1.83	21.8	.10.220
130	7.512	1.18	11.7	5.801	9.84	1.50	11.7	7.013	11.76	2.15	25.2	.11.099
140	8.104	1.37	13.5	6.121	10.6	1.7	13.5	7.629	12.67	2.49	29.1	.11.978
150	8.696	1.57	15.5	6.441	11.3	2.0	15.5	8.245	13.57	2.86	33.3	.12.857
160	9.288	1.79	17.5	6.761	12.1	2.3	17.5	8.861	14.47	3.25	37.8	.13.736
170	9.880	2.02	19.7	7.081	12.9	2.6	19.7	9.477	15.38	3.67	42.5	.14.615
180	10.472	2.26	22.0	7.401	13.6	2.9	22.0	10.093	16.28	4.12	47.5	.15.494
190	11.064	2.52	24.4	7.721	14.4	3.2	24.4	10.709	17.19	4.59	52.8	.16.373
200	11.656	2.79	27.0	8.041	15.1	3.5	27.0	11.325	18.09	5.08	58.4	.17.252
220	12.848	3.38	32.5	8.661	16.7	4.3	32.5	12.541	19.90	6.15	70.3	.18.731
240	14.040	4.02	38.5	9.281	18.2	5.1	38.5	13.757	21.71	7.32	83.4	.19.950
260	15.232	4.72	45.0	9.901	19.7	6.0	45.0	14.973	23.52	8.59	97.6	.21.169
280	16.424	5.47	52.3	10.521	21.2	7.0	52.3	16.189	25.33	9.96	113	.22.388
300	17.616	6.28	59.6	11.141	22.7	8.0	59.6	17.405	27.14	11.43	129	.23.607
350	20.5	8.55	80.6	12.361	26.5	10.9	80.6	20.221	31.66	15.66	175	.26.826
400	23.4	11.2	105	13.581	30.3	14.3	105	23.037	36.19	20.32	228	.29.845
450	26.3	14.1	132	14.801	34.1	18.1	132	25.853	40.71	25.72	286	.32.864
500	29.2	17.4	163	16.021	37.9	22.3	163	28.669	45.23	31.75	354	.35.883

Note: No allowance has been made for age, difference in diameter, or any abnormal condition of interior surface. Any factor of safety must be estimated from the local conditions and the requirements of each particular installation. It is recommended that for most commercial design purposes a safety factor of 15 to 20% be added to the values in the tables—see page 3-5.



Friction of Water Asphalt-dipped Cast Iron and New Steel Pipe (Continued)
(Based on Darcy's Formula)

3 inch

Flow U S gal per min	Asphalt-dipped cast iron			Std wt steel sch 40			Extra strong steel sch 80			Schedule 160—steel		
	3.0" inside dia	3.068" inside dia	2.900" inside dia	2.624" inside dia	3.068" inside dia	2.900" inside dia	2.624" inside dia	3.068" inside dia	2.900" inside dia	2.624" inside dia	3.068" inside dia	2.900" inside dia
	Velocity ft per sec	Head loss ft per 100 ft	Velocity head ft	Velocity ft per sec	Head loss ft per 100 ft	Velocity head ft	Velocity ft per sec	Head loss ft per 100 ft	Velocity head ft	Velocity ft per sec	Head loss ft per 100 ft	Velocity head ft
10	454	.042	.004	.434	.003	.038	.49	.001	.050	.593	.005	.080
15	681	.01	.008	.651	.007	.077	.73	.01	.101	.890	.012	.184
20	908	.01	.014	.878	.012	.129	.97	.02	.169	1.19	.022	.275
25	1135	.02	.021	1.105	.018	.192	1.21	.02	.253	1.48	.034	.411
30	1362	.03	.031	1.332	.026	.267	1.45	.03	.351	1.78	.049	.572
35	1589	.04	.041	1.559	.036	.353	1.70	.04	.464	2.08	.067	.757
40	1816	.05	.051	1.786	.047	.449	1.94	.06	.592	2.37	.087	.933
45	2043	.06	.061	2.013	.059	.557	2.18	.07	.734	2.67	.111	1.118
50	2270	.08	.081	2.240	.073	.676	2.43	.09	.860	2.97	.137	1.411
55	2497	.10	.101	2.467	.089	.778	2.67	.11	1.03	3.26	.165	1.688
60	2724	.12	.121	2.694	.105	.912	2.91	.13	1.21	3.56	.197	1.999
65	2951	.14	.141	2.921	.124	1.06	3.16	.15	1.40	3.86	.231	2.311
70	3178	.16	.161	3.148	.143	1.22	3.40	.18	1.61	4.15	.268	2.655
75	3405	.18	.181	3.375	.165	1.38	3.64	.21	1.83	4.45	.307	3.022
80	3632	.21	.203	3.602	.187	1.56	3.88	.23	2.07	4.75	.350	3.411
85	3859	.23	.228	3.829	.211	1.75	4.12	.26	2.31	5.04	.395	3.833
90	4086	.26	.255	4.056	.234	1.95	4.37	.29	2.56	5.34	.443	4.277
95	4313	.29	.283	4.283	.261	2.16	4.61	.32	2.86	5.63	.493	4.733
100	4540	.32	.312	4.510	.283	2.37	4.85	.36	3.15	5.93	.546	5.211
110	4999	.39	.375	4.777	.354	2.84	5.33	.44	3.77	6.53	.661	6.255
120	5458	.46	.445	5.044	.421	3.35	5.81	.52	4.45	7.12	.787	7.388
130	5917	.54	.519	5.311	.495	3.90	6.30	.62	5.19	7.71	.923	8.611
140	6376	.63	.600	5.578	.574	4.50	6.79	.71	5.98	8.31	1.07	9.833
150	6835	.72	.687	5.845	.659	5.13	7.28	.82	6.82	8.90	1.23	11.055
160	7294	.82	.779	6.112	.749	5.80	7.76	.93	7.72	9.49	1.40	12.277
180	8117	1.04	.991	6.639	.948	7.27	8.72	1.01	9.68	10.68	1.77	16.111
200	8940	1.28	1.21	7.166	1.17	8.90	9.70	1.46	11.86	11.87	2.19	19.833
220	9763	1.55	1.45	7.693	1.42	10.7	10.7	1.78	14.26	13.05	2.64	23.833
240	10586	1.84	1.73	8.220	1.69	12.7	11.6	2.07	16.88	14.24	3.15	28.233
260	11409	2.16	2.02	8.747	1.98	14.8	12.6	2.46	19.71	15.43	3.69	32.933
280	12232	2.51	2.34	9.274	2.29	17.1	13.6	2.88	22.77	16.61	4.28	38.033
300	13055	2.88	2.68	9.801	2.63	19.5	14.5	3.26	26.04	17.80	4.92	43.533
320	13878	3.28	3.04	10.328	3.00	22.1	15.5	3.77	29.53	18.99	5.59	49.433
340	14701	3.70	3.43	10.855	3.38	24.9	16.5	4.22	33.24	20.17	6.32	55.833
360	15524	4.15	38.4	11.382	3.79	27.8	17.5	4.73	37.16	21.36	7.08	62.233
380	16347	4.62	42.7	11.909	4.23	30.9	18.4	5.27	41.31	22.55	7.89	68.633
400	17170	5.12	47.3	12.436	4.68	34.2	19.4	5.81	45.73	23.73	8.74	75.033
420	17993	5.65	52.1	12.963	5.16	37.6	20.4	6.43	50.25	24.92	9.64	81.433
440	18816	6.20	57.1	13.490	5.67	41.2	21.4	7.13	55.05	26.11	10.58	87.833
460	19639	6.77	62.4	14.017	6.19	44.9	22.3	7.75	60.06	27.29	11.58	94.233
480	20462	7.38	67.9	14.544	6.74	48.8	23.3	8.37	65.30	28.48	12.59	100.633
500	21285	8.00	73.6	15.071	7.32	52.9	24.2	9.15	70.75	29.66	13.66	107.033
550	23170	9.88	88.9	16.204	8.95	63.8	26.7	11.1	85.33	32.63	16.53	143.033
600	25055	11.5	106	17.337	10.5	75.7	29.1	13.1	101	35.60	19.67	170.033
650	26940	13.5	124	18.470	12.4	88.6	31.6	15.5	119	38.56	23.08	199.033

Note: No allowance has been made for age, difference in diameter, or any abnormal condition of interior surface. Any factor of safety must be estimated from the local conditions and the requirements of each particular installation. It is recommended that for most commercial design purposes a safety factor of 1.5 to 2.0% be added to the values in the tables—see page 3-5.

Friction of Water Asphalt-dipped Cast Iron and New Steel Pipe (Continued)
(Based on Darcy's Formula)

3 1/2 inch

Flow U S gal per min	Asphalt-dipped cast iron			Std wt steel sch 40			Extra strong steel sch 80		
	3.5" inside dia	3.548" inside dia	3.364" inside dia	3.5" inside dia	3.548" inside dia	3.364" inside dia	3.5" inside dia	3.548" inside dia	3.364" inside dia
	Velocity ft per sec	Head loss ft per 100 ft	Velocity head ft	Velocity ft per sec	Head loss ft per 100 ft	Velocity head ft	Velocity ft per sec	Head loss ft per 100 ft	Velocity head ft
15	500	.043	.004	.487	.038	.050	.54	.001	.050
20	667	.072	.007	.649	.064	.083	.72	.01	.083
25	834	.101	.010	.811	.095	.105	.90	.01	.105
30	1000	.146	.016	.974	.132	.146	1.08	.02	.146
35	1167	.195	.021	1.14	.174	.195	1.26	.02	.195
40	1334	.250	.028	1.30	.221	.250	1.44	.03	.250
45	1501	.311	.035	1.46	.274	.311	1.63	.04	.311
50	1667	.379	.043	1.62	.332	.379	1.80	.05	.379
60	2001	.535	.059	1.95	.463	.535	2.17	.07	.535
70	2334	.717	.085	2.27	.614	.717	2.53	.10	.717
80	267	.924	.110	2.60	.757	.924	2.89	.13	.924
90	300	1.160	.133	2.92	.943	1.160	3.25	.16	1.160
100	334	1.42	.153	3.25	1.15	1.42	3.61	.20	1.42
110	367	1.70	.170	3.57	1.37	1.70	3.97	.24	1.70
120	400	2.01	.188	3.89	1.62	2.01	4.33	.29	2.01
130	434	2.35	.202	4.22	1.88	2.35	4.69	.34	2.35
140	467	2.71	.216	4.54	2.16	2.71	5.05	.40	2.71
150	500	3.10	.228	4.87	2.47	3.10	5.41	.45	3.10
160	534	3.52	.239	5.19	2.79	3.52	5.78	.52	3.52
170	567	3.96	.249	5.52	3.13	3.96	6.14	.59	3.96
180	600	4.42	.256	5.84	3.49	4.42	6.50	.66	4.42
190	634	4.92	.262	6.17	3.86	4.92	6.85	.73	4.92
200	667	5.43	.267	6.49	4.26	5.43	7.22	.81	5.43
220	734	6.55	.284	7.14	5.12	6.55	7.94	.98	6.55
240	800	7.76	.299	7.79	6.04	7.76	8.66	1.17	7.76
260	867	9.08	.311	8.44	7.05	8.67	9.38	1.37	8.67
280	934	10.5	.321	9.09	8.13	9.34	10.1	1.6	9.34
300	1000	12.0	.328	9.74	9.29	10.0	10.8	1.8	10.0
320	1067	13.7	.332	10.4	10.5	10.67	11.5	2.1	10.67
340	1134	15.4	.334	11.0	11.8	11.34	12.3	2.4	11.34
360	1200	17.2	.334	11.7	13.2	12.0	13.0	2.6	12.0
380	1267	19.2	.334	12.3	14.7	12.67	13.7	2.9	12.67
400	1334	21.2	.334	13.0	16.2	13.34	14.4	3.2	13.34
420	1400	23.3	.334	13.6	17.8	14.0	15.2	3.6	14.0
440	1467	25.6	.334	14.3	19.5	14.67	15.9	3.9	14.67
460	1534	27.9	.334	14.9	21.3	15.34	16.6	4.3	15.34
480	1600	30.4	.334	15.6	23.1	16.0	17.3	4.7	16.0
500	1667	32.9	.334	16.2	25.1	16.67	18.1	5.1	16.67
550	1834	39.8	.334	17.8	30.2	18.34	19.9	6.2	18.34
600	2000	47.2	.334	19.5	35.8	20.0	21.7	7.3	20.0
650	2167	55.4	.334	21.1	41.9	21.67	23.5	8.6	21.67
700	2334	64.1	.334	22.7	48.4	23.34	25.3	9.4	23.34
750	2500	73.5	.334	24.3	55.4	25.0	27.1	11.4	25.0
800	2667	83.6	.334	26.0	62.9	26.67	28.9	13.0	26.67
850	2834	94.2	.334	27.6	70.9	28.34	30.7	14.6	28.34

Note: No allowance has been made for age, difference in diameter, or any abnormal condition of interior surface. Any factor of safety must be estimated from the local conditions and the requirements of each particular installation. It is recommended that for most commercial design purposes a safety factor of 1.5 to 2.0% be added to the values in the tables—see page 3-5.



Friction of Water Asphalt-dipped Cast Iron and New Steel Pipe
(Based on Darcy's Formula) **4 Inch** (Continued)

Flow U.S. gal per min	Asphalt-dipped cast iron				Std wt steel sch 40				Extra strong steel sch 80				Schedule 160—steel			
	4.0" inside dia				4.026" inside dia				3.826" inside dia				3.438" inside dia			
	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft
20	.511	.038	.004	.035	.56	.045	.061	.691	.007	.074	.691	.007	.074	.691	.007	.074
30	.766	.076	.009	.072	.84	.072	.104	.104	.017	.154	.104	.017	.154	.104	.017	.154
40	1.02	.118	.016	.112	1.12	.153	.030	.258	.300	.300	.300	.300	.300	.300	.300	.300
50	1.28	.162	.025	.179	1.40	.203	.046	.387	.466	.466	.466	.466	.466	.466	.466	.466
60	1.53	.207	.036	.250	1.67	.260	.067	.540	.667	.667	.667	.667	.667	.667	.667	.667
70	1.79	.255	.050	.330	1.95	.330	.091	.691	.861	.861	.861	.861	.861	.861	.861	.861
80	2.04	.304	.065	.422	2.23	.422	.119	.985	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23
90	2.30	.354	.082	.528	2.51	.528	.150	1.10	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41
100	2.55	.404	.101	.643	2.79	.643	.185	1.34	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71
110	2.81	.456	.123	.782	3.07	.823	.224	1.61	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03
120	3.06	.509	.146	.941	3.35	.941	.267	1.89	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39
130	3.32	.563	.171	1.111	3.63	1.111	.313	2.20	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79
140	3.57	.618	.199	1.311	3.91	1.311	.363	2.53	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21
150	3.83	.674	.228	1.531	4.19	1.531	.417	2.89	3.63	3.63	3.63	3.63	3.63	3.63	3.63	3.63
160	4.08	.731	.259	1.771	4.47	1.771	.475	3.26	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.08
170	4.34	.789	.293	2.021	4.75	2.021	.536	3.66	4.53	4.53	4.53	4.53	4.53	4.53	4.53	4.53
180	4.60	.848	.328	2.281	5.02	2.281	.600	4.09	4.99	4.99	4.99	4.99	4.99	4.99	4.99	4.99
190	4.85	.908	.368	2.551	5.29	2.551	.669	4.53	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43
200	5.11	.969	.408	2.831	5.56	2.831	.742	5.00	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.91
220	5.62	1.08	.490	3.29	6.14	3.29	.897	6.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
240	6.13	1.20	.583	3.90	6.70	3.90	1.07	7.09	8.19	8.19	8.19	8.19	8.19	8.19	8.19	8.19
260	6.64	1.33	.685	4.55	7.26	4.55	1.25	8.27	9.47	9.47	9.47	9.47	9.47	9.47	9.47	9.47
280	7.15	1.46	.794	5.26	7.82	5.26	1.45	9.55	10.85	10.85	10.85	10.85	10.85	10.85	10.85	10.85
300	7.66	1.60	.912	6.02	8.38	6.02	1.67	10.9	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3
320	8.17	1.74	1.04	6.84	8.94	6.84	1.90	12.4	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9
340	8.68	1.88	1.17	7.70	9.50	7.70	2.14	13.9	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5
360	9.19	2.03	1.31	8.61	10.0	8.61	2.40	15.5	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3
380	9.70	2.18	1.46	9.58	10.6	9.58	2.68	17.3	19.1	19.1	19.1	19.1	19.1	19.1	19.1	19.1
400	10.2	2.33	1.62	10.5	11.2	10.5	2.97	19.1	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0
420	10.7	2.48	1.79	11.5	11.7	11.5	3.27	21.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
440	11.2	2.63	1.96	12.5	12.3	12.5	3.59	22.9	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
460	11.7	2.79	2.14	13.9	12.8	13.9	3.92	25.0	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2
480	12.3	2.93	2.33	15.2	13.4	15.2	4.27	27.2	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
500	12.8	3.08	2.53	16.4	14.0	16.4	4.64	29.5	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9
550	14.0	3.06	3.06	19.8	15.3	19.8	5.61	35.5	39.5	39.5	39.5	39.5	39.5	39.5	39.5	39.5
600	15.3	3.65	3.65	23.6	16.7	23.6	6.67	42.1	47.1	47.1	47.1	47.1	47.1	47.1	47.1	47.1
650	16.6	4.28	4.28	27.6	18.1	27.6	7.83	49.2	55.2	55.2	55.2	55.2	55.2	55.2	55.2	55.2
700	17.9	4.96	4.96	32.0	19.5	32.0	9.08	57.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0
750	19.1	5.70	5.70	36.8	20.9	36.8	10.4	65.2	73.0	73.0	73.0	73.0	73.0	73.0	73.0	73.0
800	20.4	6.48	6.48	41.6	22.3	41.6	11.7	74.1	83.0	83.0	83.0	83.0	83.0	83.0	83.0	83.0
850	21.7	7.32	7.32	46.9	23.7	46.9	13.4	83.4	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0
900	23.0	8.20	8.20	52.6	25.1	52.6	15.0	93.4	104.0	104.0	104.0	104.0	104.0	104.0	104.0	104.0
950	24.3	9.14	9.14	58.5	26.5	58.5	16.7	104	116.0	116.0	116.0	116.0	116.0	116.0	116.0	116.0
1000	25.5	10.1	10.1	64.8	27.9	64.8	18.5	115	129.0	129.0	129.0	129.0	129.0	129.0	129.0	129.0
1100	28.1	12.3	12.3	78.3	30.7	78.3	22.4	139	155.0	155.0	155.0	155.0	155.0	155.0	155.0	155.0

Note: No allowance has been made for age, difference in diameter, or any abnormal condition of interior surface. Any factor of safety must be estimated from the local conditions and the requirements of each particular installation. It is recommended that for most commercial design purposes a safety factor of 15 to 20% be added to the values in the tables—see page 3-5.

Friction of Water * New Steel Pipe (Continued)
(Based on Darcy's Formula) **5 Inch**

Flow U.S. gal per min	Standard wt steel—sch 40				Extra strong steel—sch 80				Schedule 160—steel			
	5.047" inside dia				4.813" inside dia				4.313" inside dia			
	Velocity ft per sec	Head loss ft per 100 ft	Velocity ft per sec	Head loss ft per 100 ft	Velocity ft per sec	Head loss ft per 100 ft	Velocity ft per sec	Head loss ft per 100 ft	Velocity ft per sec	Head loss ft per 100 ft	Velocity ft per sec	Head loss ft per 100 ft
30	.481	.004	.004	.024	.53	.01	.030	.659	.007	.051	.085	.085
40	.641	.006	.006	.032	.71	.01	.040	.878	.012	.085	.128	.128
50	.802	.010	.010	.040	.88	.01	.045	1.10	.019	.105	.178	.178
60	.962	.014	.014	.058	1.06	.02	.060	1.32	.027	.138	.236	.236
70	1.12	.018	.018	.078	1.23	.02	.078	1.54	.037	.176	.301	.301
80	1.28	.022	.022	.100	1.41	.03	.100	1.76	.048	.218	.373	.373
90	1.44	.026	.026	.125	1.59	.04	.125	1.98	.061	.265	.453	.453
100	1.60	.030	.030	.150	1.76	.05	.150	2.20	.075	.315	.531	.531
120	1.92	.038	.038	.187	2.11	.07	.187	2.64	.108	.370	.616	.616
140	2.25	.046	.046	.228	2.47	.09	.228	3.07	.147	.431	.716	.716
160	2.57	.054	.054	.272	2.82	.12	.272	3.51	.192	.491	.816	.816
180	2.89	.062	.062	.319	3.17	.16	.319	3.95	.243	.551	1.05	1.05
200	3.21	.070	.070	.368	3.52	.19	.368	4.39	.298	.607	1.31	1.31
220	3.53	.078	.078	.419	3.88	.23	.419	4.83	.356	.663	1.60	1.60
240	3.85	.086	.086	.472	4.23	.28	.472	5.27	.414	.719	1.91	1.91
260	4.17	.094	.094	.528	4.58	.33	.528	5.71	.474	.776	2.25	2.25
280	4.49	.102	.102	.586	4.94	.38	.586	6.15	.534	.833	2.63	2.63
300	4.81	.110	.110	.646	5.29	.43	.646	6.59	.594	.891	3.02	3.02
320	5.13	.118	.118	.708	5.64	.49	.708	7.03	.654	.949	3.45	3.45
340	5.45	.126	.126	.772	5.99	.56	.772	7.47	.714	1.007	3.91	3.91
360	5.77	.134	.134	.838	6.35	.63	.838	7.91	.774	1.065	4.39	4.39
380	6.09	.142	.142	.904	6.70	.70	.904	8.35	.834	1.123	4.90	4.90
400	6.41	.150	.150	.972	7.05	.77	.972	8.79	.894	1.181	5.43	5.43
420	6.74	.158	.158	1.042	7.40	.85	1.042	9.22	.954	1.239	6.00	6.00
440	7.06	.166	.166	1.114	7.76	.94	1.114	9.66	1.014	1.297	6.59	6.59
460	7.38	.174	.174	1.188	8.11	1.02	1.188	10.10	1.074	1.355	7.21	7.21
480	7.70	.182	.182	1.264	8.46	1.11	1.264	10.54	1.134	1.413	7.85	7.85
500	8.02	.190	.190	1.342	8.82	1.21	1.342	10.98	1.194	1.471	8.53	8.53
550	8.82	.214	.214	1.54	9.70	1.46	1.54	12.08	1.46	1.631	9.23	9.23
600	9.62	.238	.238	1.76	10.6	1.7	1.76	13.18	1.7	1.791	11.1	11.1
650	10.4	.262	.262	2.00	11.5	2.1	2.00	14.27	2.1	1.851	13.1	13.1
700	11.2	.286	.286	2.26	12.3	2.4	2.26	15.37	2.4	1.911	15.4	15.4
750	12.0	.310	.310	2.54	13.2	2.7	2.54	16.47	2.7	1.971	17.8	17.8
800	12.8	.334	.334	2.84	14.1	3.1	2.84	17.57	3.1	2.031	20.3	20.3
850	13.6	.358	.358	3.16	15.0	3.5	3.16	18.67	3.5	2.091	23.0	23.0
900	14.4	.3										



Friction of Water Asphalt-dipped Cast Iron and New Steel Pipe
(Based on Darcy's Formula) **6 Inch**

Flow U S gal per min	Asphalt-dipped cast iron				Std wt steel sch 40				Extra strong steel sch 80				Schedule 160—steel			
	6.0" inside dia				6.065" inside dia				5.761" inside dia				5.187" inside dia			
	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft
50	.57	.005	.027	.094	.56	.005	.027	.094	.62	.01	.032	.110	.152	.036	.184	
60	.66	.007	.038	.132	.67	.007	.034	.132	.74	.01	.044	.154	.206	.043	.256	
70	.79	.010	.048	.176	.86	.010	.058	.184	.86	.01	.058	.166	.228	.048	.300	
80	.91	.013	.062	.231	.98	.013	.074	.242	1.02	.01	.074	.184	.256	.052	.340	
90	1.02	.016	.077	.283	1.11	.016	.086	.291	1.11	.01	.086	.206	.283	.056	.380	
100	1.13	.020	.094	.346	1.23	.020	.104	.354	1.23	.02	.110	.228	.346	.060	.440	
120	1.36	.029	.132	.486	1.48	.029	.144	.494	1.48	.03	.154	.283	.486	.074	.600	
140	1.59	.039	.176	.654	1.72	.039	.194	.662	1.72	.05	.206	.346	.654	.088	.800	
160	1.82	.051	.226	.861	1.97	.051	.251	.869	1.97	.06	.260	.428	.861	.102	.980	
180	2.04	.065	.283	1.11	2.22	.065	.323	1.11	2.22	.08	.323	.514	1.11	.116	1.320	
200	2.27	.080	.346	1.40	2.46	.080	.392	1.40	2.46	.09	.392	.606	1.40	.143	1.680	
220	2.50	.097	.415	1.72	2.71	.097	.464	1.72	2.71	.11	.464	.744	1.72	.173	2.060	
240	2.72	.115	.490	2.06	2.96	.115	.536	2.06	2.96	.14	.536	.861	2.06	.206	2.440	
260	2.95	.135	.571	2.42	3.20	.135	.618	2.42	3.20	.16	.618	.980	2.42	.242	2.820	
280	3.18	.157	.658	2.81	3.45	.157	.708	2.81	3.45	.19	.708	1.10	2.81	.281	3.200	
300	3.40	.180	.752	3.24	3.69	.180	.807	3.24	3.69	.21	.807	1.22	3.24	.322	3.580	
320	3.63	.205	.851	3.69	3.94	.205	.911	3.69	3.94	.24	.911	1.34	3.69	.366	3.960	
340	3.86	.231	.957	4.14	4.19	.231	1.02	4.14	4.19	.27	1.02	1.46	4.14	.414	4.340	
360	4.08	.259	1.07	4.60	4.43	.259	1.14	4.60	4.43	.31	1.14	1.58	4.43	.464	4.720	
380	4.31	.289	1.19	5.06	4.68	.289	1.26	5.06	4.68	.34	1.26	1.70	4.68	.514	5.100	
400	4.54	.320	1.31	5.51	4.93	.320	1.39	5.51	4.93	.38	1.39	1.82	5.51	.572	5.480	
450	5.10	.403	1.65	6.86	5.50	.403	1.74	6.86	5.50	.48	1.74	2.14	6.86	.725	6.540	
500	5.67	.500	2.02	8.21	6.16	.500	2.13	8.21	6.16	.59	2.13	2.46	8.21	.884	7.600	
550	6.24	.605	2.44	9.56	6.77	.605	2.55	9.56	6.77	.71	2.55	2.78	9.56	1.08	8.660	
600	6.81	.720	2.89	10.91	7.39	.720	3.02	10.91	7.39	.85	3.02	3.10	10.91	1.29	9.720	
650	7.37	.845	3.38	12.26	8.00	.845	3.52	12.26	8.00	.99	3.52	3.42	12.26	1.51	10.780	
700	7.94	.980	3.90	13.61	8.63	.980	4.06	13.61	8.63	1.16	4.06	3.74	13.61	1.75	11.840	
750	8.51	1.12	4.47	14.96	9.24	1.12	4.64	14.96	9.24	1.33	4.64	4.06	14.96	2.01	12.900	
800	9.08	1.28	5.07	16.31	9.85	1.28	5.25	16.31	9.85	1.51	5.25	4.38	16.31	2.29	13.960	
850	9.64	1.44	5.72	17.66	10.46	1.44	5.90	17.66	10.46	1.7	5.90	4.70	17.66	2.59	15.020	
900	10.2	1.62	6.40	19.01	11.1	1.62	6.60	19.01	11.1	1.9	6.60	5.02	19.01	2.90	16.080	
950	10.8	1.80	7.11	20.36	11.7	1.80	7.33	20.36	11.7	2.1	7.33	5.34	20.36	3.22	17.140	
1000	11.3	2.00	7.87	21.71	12.3	2.00	8.09	21.71	12.3	2.4	8.09	5.66	21.71	3.58	18.200	
1100	12.5	2.42	9.50	24.4	13.5	2.42	9.74	24.4	13.5	2.8	9.74	6.31	24.4	4.33	20.320	
1200	13.6	2.88	11.3	27.1	14.8	2.88	11.5	27.1	14.8	3.4	11.5	7.06	27.1	5.15	22.440	
1300	14.7	3.38	13.2	29.8	16.0	3.38	13.5	29.8	16.0	4.0	13.5	7.80	29.8	6.05	24.560	
1400	15.9	3.92	15.3	32.5	17.2	3.92	15.6	32.5	17.2	4.6	15.6	8.54	32.5	7.01	26.680	
1500	17.0	4.50	17.5	35.2	18.5	4.50	17.8	35.2	18.5	5.3	17.8	9.28	35.2	8.05	28.800	
1600	18.2	5.12	19.9	37.9	19.7	5.12	20.3	37.9	19.7	6.0	20.3	10.02	37.9	9.16	30.920	
1700	19.3	5.78	22.4	40.6	20.9	5.78	22.8	40.6	20.9	6.8	22.8	10.76	40.6	10.34	33.040	
1800	20.4	6.48	25.1	43.3	22.2	6.48	25.5	43.3	22.2	7.7	25.5	11.50	43.3	11.59	35.160	
1900	21.5	7.22	28.0	46.0	23.4	7.22	28.4	46.0	23.4	8.4	28.4	12.24	46.0	12.92	37.280	
2000	22.7	8.00	31.0	48.7	24.6	8.00	30.7	48.7	24.6	9.4	30.7	13.00	48.7	14.31	39.400	
2200	25.0	9.68	37.4	54.0	27.1	9.68	37.9	54.0	27.1	11.4	37.9	15.02	54.0	17.32	43.600	
2400	27.2	11.5	44.5	59.3	29.6	11.5	44.9	59.3	29.6	13.6	44.9	17.14	59.3	20.61	47.800	

Note: No allowance has been made for age, difference in diameter, or any abnormal condition of interior surface. Any factor of safety must be estimated from the local conditions and the requirements of each particular installation. It is recommended that for most commercial design purposes a safety factor of 15 to 20% be added to the values in the tables—see page 3-5.

Friction of Water Asphalt-dipped Cast Iron and New Steel Pipe
(Based on Darcy's Formula) **8 Inch**

Flow U S gal per min	Asphalt-dipped cast iron				Std wt steel sch 40				Extra strong steel sch 80				Schedule 160—steel			
	8.0" inside dia				7.981" inside dia				7.625" inside dia				6.813" inside dia			
	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft
130	.83	.011	.037	.114	.83	.011	.036	.114	.91	.01	.046	.126	.02	.158	.039	
140	.89	.012	.042	.126	.89	.012	.042	.126	.96	.01	.052	.138	.03	.167	.043	
150	.96	.014	.048	.138	.96	.014	.047	.138	1.05	.02	.059	.150	.04	.176	.048	
160	1.02	.016	.054	.150	1.02	.016	.053	.150	1.12	.02	.066	.162	.05	.194	.058	
170	1.08	.018	.060	.162	1.08	.018	.059	.162	1.19	.02	.074	.174	.06	.211	.069	
180	1.15	.021	.067	.174	1.15	.021	.066	.174	1.26	.02	.082	.186	.07	.229	.081	
190	1.21	.023	.074	.186	1.21	.023	.073	.186	1.33	.03	.091	.198	.08	.246	.094	
200	1.28	.025	.082	.198	1.28	.025	.080	.198	1.41	.03	.099	.210	.09	.264	.108	
220	1.40	.031	.098	.222	1.40	.031	.095	.222	1.55	.04	.118	.234	.11	.278	.122	
240	1.53	.037	.115	.246	1.53	.037	.111	.246	1.69	.04	.139	.258	.12	.303	.146	
260	1.66	.043	.134	.270	1.66	.043	.128	.270	1.83	.05	.161	.272	.13	.327	.160	
280	1.79	.050	.154	.294	1.79	.050	.147	.294	1.97	.06	.184	.294	.14	.351	.184	
300	1.91	.057	.175	.318	1.91	.057	.175	.318	2.11	.07	.209	.318	.15	.375	.209	
350	2.23	.077	.235	.390	2.23	.077	.235	.390	2.46	.09	.278	.390	.18	.444	.278	
400	2.55	.101	.303	.462	2.55	.101	.303	.462	2.81	.12	.343	.462	.22	.513	.343	
450	2.87	.128	.380	.534	2.87	.128	.380	.534	3.16	.15	.428	.534	.26	.582	.428	
500	3.19	.158	.465	.606	3.19	.158	.465	.606	3.51	.19	.522	.606	.30	.650	.522	
550	3.51	.191	.559	.678	3.51	.191	.559	.678	3.86	.23	.625	.678	.34	.718	.625	
600	3.83	.228	.661	.750	3.83	.228	.661	.750	4.22	.28	.736	.750	.38	.786	.736	
650	4.15	.267	.772	.822	4.15	.267	.772	.822	4.57	.32	.817	.822	.42	.836	.817	
700	4.47	.310	.881	.894	4.47	.310	.881	.894	4.92	.38	.896	.894	.46	.886	.896	
750	4.79	.356	1.02	.966	4.79	.356	1.02	.966	5.27	.43	1.13	.966	.50	.966	.966	
800	5.11	.405	1.16	1.038	5.11	.405	1.16	1.038	5.62	.49	1.27	1.038	.54	1.038	1.038	
850	5.42	.457	1.30	1.110	5.42	.457	1.30	1.110	5.97	.55	1.43	1.110	.59	1.110	1.110	
900	5.74	.513	1.45	1.182	5.74	.513	1.45	1.182	6.32	.62	1.59	1.182	.66	1.182	1.182	
950	6.06	.571	1.61	1.254	6.06	.571	1.61	1.254	6.67	.69	1.77	1.254	.70	1.254	1.254	
1000	6.38	.633	1.78	1.326	6.38	.633	1.78	1.326	7.03	.77	1.95	1.326	.74	1.326	1.326	
1100	7.02	.766	2.15	1.498	7.02	.766	2.15	1.498	7.83	.95	2.34	1.498	.91	1.498	1.498	
1200	7.66	.911	2.55	1.670	7.66	.911	2.55	1.670	8.43	1.10	2.77	1.670	1.05	1.670	1.670	
1300	8.30	1.07	2.98	1.842	8.30	1.07	2.98	1.842	9.13	1.30	3.23	1.842	1.20	1.842	1.842	
1400	8.93	1.24	3.45	2.014	8.93	1.24	3.45	2.014	9.83	1.5	3.73	2.014	1.36	2.014	2.014	
1500	9.57	1.42	3.95	2.186	9.57	1.42	3.95	2.								

Friction of Water Asphalt-dipped Cast Iron and New Steel Pipe
(Based on Darcy's Formula)

Friction of Water Asphalt-dipped Cast Iron and New Steel Pipe
(Based on Darcy's Formula)

10 Inch

12 Inch

Flow U S gal per min	Asphalt-dipped cast iron			Std wt steel sch 40			Schedule 80 steel			Schedule 160—steel		
	10.0" inside dia			10.020" inside dia			9.562" inside dia			8.500" inside dia		
	Ve-locity ft per sec	Head loss 100 ft	Ve-locity ft per sec	Head loss 100 ft	Ve-locity ft per sec	Head loss 100 ft	Ve-locity ft per sec	Head loss 100 ft	Ve-locity ft per sec	Head loss 100 ft	Ve-locity ft per sec	Head loss 100 ft
180	.74	.008	.023	.008	.022	.010	.027	.010	.027	.016	.048	
200	.82	.010	.026	.010	.026	.011	.027	.011	.027	.016	.059	
220	.90	.013	.032	.013	.031	.012	.033	.012	.033	.020	.069	
240	.98	.015	.038	.015	.037	.015	.039	.015	.039	.024	.070	
260	1.06	.018	.044	.017	.042	.017	.045	.018	.046	.029	.082	
280	1.14	.020	.051	.019	.049	.019	.053	.019	.053	.034	.094	
300	1.23	.023	.057	.021	.055	.021	.058	.021	.061	.039	.108	
350	1.43	.032	.077	.030	.085	.034	.089	.038	.099	.049	.123	
400	1.63	.042	.099	.041	.093	.041	.100	.045	.110	.061	.159	
450	1.84	.053	.123	.052	.116	.052	.123	.056	.131	.079	.208	
500	2.04	.065	.150	.064	.140	.064	.152	.068	.163	.100	.259	
550	2.25	.079	.180	.078	.177	.078	.191	.083	.204	.124	.304	
600	2.45	.093	.213	.092	.206	.092	.220	.097	.233	.150	.364	
650	2.66	.110	.248	.109	.242	.109	.257	.114	.271	.179	.428	
700	2.86	.127	.286	.126	.283	.126	.300	.131	.315	.210	.498	
800	3.27	.166	.370	.165	.365	.165	.384	.172	.399	.243	.573	
900	3.68	.210	.464	.208	.458	.208	.479	.216	.494	.278	.658	
1000	4.09	.259	.569	.257	.562	.257	.584	.265	.606	.313	.753	
1100	4.49	.314	.685	.311	.676	.311	.700	.319	.724	.350	.858	
1200	4.90	.373	.811	.370	.801	.370	.826	.378	.851	.386	.973	
1300	5.31	.438	.947	.435	.935	.435	.961	.444	.986	.424	1.098	
1400	5.72	.508	1.094	.504	.998	.504	1.024	.513	1.050	.462	1.233	
1500	6.13	.584	1.251	.579	1.167	.579	1.193	.588	1.220	.500	1.378	
1600	6.54	.664	1.421	.659	1.411	.659	1.438	.668	1.465	.538	1.533	
1700	6.94	.749	1.601	.743	1.586	.743	1.613	.752	1.640	.576	1.698	
1800	7.35	.840	1.791	.834	1.772	.834	1.800	.809	1.828	.614	1.873	
1900	7.76	.936	1.991	.929	1.968	.929	2.006	.852	2.034	.652	2.058	
2000	8.17	1.04	2.201	1.03	2.174	1.03	2.212	.890	2.240	.690	2.253	
2200	8.99	1.26	2.65	1.25	2.62	1.25	2.66	.988	2.716	.776	2.538	
2400	9.80	1.49	3.15	1.48	3.11	1.48	3.16	1.086	3.232	.862	2.833	
2600	10.6	1.75	3.68	1.74	3.63	1.74	3.68	1.184	3.748	.948	3.138	
2800	11.4	2.03	4.26	2.02	4.19	2.02	4.24	1.282	4.364	1.034	3.453	
3000	12.3	2.33	4.88	2.32	4.80	2.32	4.85	1.380	4.980	1.120	3.778	
3200	13.1	2.66	5.54	2.63	5.45	2.63	5.50	1.478	5.606	1.206	4.113	
3400	13.9	3.00	6.25	2.97	6.14	2.97	6.19	1.576	6.232	1.292	4.458	
3600	14.7	3.36	6.99	3.33	6.87	3.33	6.92	1.674	6.858	1.378	4.813	
3800	15.5	3.74	7.79	3.71	7.66	3.71	7.71	1.772	7.484	1.464	5.178	
4000	16.3	4.15	8.62	4.12	8.48	4.12	8.53	1.870	8.110	1.550	5.553	
4500	18.4	5.25	10.9	5.21	10.7	5.21	10.7	2.066	10.636	1.736	6.328	
5000	20.4	6.48	13.4	6.43	13.1	6.43	13.1	2.262	12.862	1.922	7.113	
5500	22.5	7.85	16.2	7.78	15.8	7.78	15.8	2.458	15.288	2.108	7.908	
6000	24.5	9.34	19.2	9.26	18.5	9.26	18.5	2.654	17.714	2.294	8.723	
6500	26.6	11.0	22.6	10.9	21.6	10.9	21.6	2.850	20.140	2.480	9.558	
7000	28.6	12.7	26.1	12.6	24.5	12.6	24.5	3.046	22.566	2.666	10.413	
7500	30.6	14.6	30.0	14.5	28.5	14.5	28.5	3.242	25.002	2.852	11.288	

Note: No allowance has been made for age, difference in diameter, or any abnormal condition of interior surface. Any factor of safety must be estimated from the local conditions and the requirements of each particular installation. It is recommended that for most commercial design purposes a safety factor of 15 to 20% be added to the values in the tables—see page 3-5.

Flow U S gal per min	Asphalt-dipped cast iron			Std wt steel sch 40			Schedule 80 steel			Schedule 160 steel		
	12.0" inside dia			11.938" inside dia			11.374" inside dia			10.126" inside dia		
	Ve-locity ft per sec	Head loss 100 ft	Ve-locity ft per sec	Head loss 100 ft	Ve-locity ft per sec	Head loss 100 ft	Ve-locity ft per sec	Head loss 100 ft	Ve-locity ft per sec	Head loss 100 ft	Ve-locity ft per sec	Head loss 100 ft
200	.57	.005	.011	.005	.011	.006	.014	.006	.014	.010	.025	
250	.75	.008	.017	.008	.017	.008	.019	.008	.019	.015	.036	
300	.85	.011	.024	.011	.024	.011	.026	.011	.026	.020	.052	
350	.99	.015	.031	.015	.031	.015	.033	.015	.033	.025	.069	
400	1.13	.020	.040	.020	.040	.020	.042	.020	.042	.030	.088	
450	1.28	.025	.049	.025	.049	.025	.051	.025	.051	.035	.110	
500	1.42	.031	.060	.031	.060	.031	.062	.031	.062	.040	.133	
550	1.56	.038	.072	.038	.072	.038	.074	.038	.074	.045	.159	
600	1.70	.045	.085	.045	.085	.045	.087	.045	.087	.050	.187	
700	1.99	.061	.114	.061	.114	.061	.116	.061	.116	.065	.240	
800	2.27	.080	.147	.080	.147	.080	.150	.080	.150	.080	.308	
900	2.55	.101	.184	.101	.184	.101	.187	.101	.187	.095	.384	
1000	2.84	.125	.225	.125	.225	.125	.228	.125	.228	.105	.469	
1100	3.12	.151	.271	.151	.271	.151	.274	.151	.274	.115	.562	
1200	3.40	.180	.320	.180	.320	.180	.323	.180	.323	.125	.663	
1300	3.69	.211	.374	.211	.374	.211	.377	.211	.377	.135	.772	
1400	3.97	.245	.431	.245	.431	.245	.434	.245	.434	.145	.889	
1500	4.26	.281	.493	.281	.493	.281	.496	.281	.496	.155	1.015	
1600	4.54	.320	.558	.320	.558	.320	.561	.320	.561	.165	1.151	
1800	5.11	.405	.702	.405	.702	.405	.705	.405	.705	.185	1.44	
2000	5.67	.500	.862	.500	.862	.500	.865	.500	.865	.205	1.76	
2200	6.24	.605	1.04	.605	1.04	.605	1.04	.605	1.04	.225	2.12	
2400	6.81	.720	1.23	.720	1.23	.720	1.23	.720	1.23	.245	2.51	
2600	7.38	.845	1.44	.845	1.44	.845	1.44	.845	1.44	.265	2.93	
2800	7.94	.980	1.67	.980	1.67	.980	1.67	.980	1.67	.285	3.38	
3000	8.51	1.13	1.91	1.13	1.91	1.13	1.91	1.13	1.91	.305	3.86	
3500	9.93	1.53	2.58	1.53	2.58	1.53	2.61	1.53	2.61	.345	5.22	
4000	11.3	2.00	3.36	1.55	2.04	1.55	3.39	1.55	3.39	.385	6.77	
4500	12.8	2.53	4.24	2.04	2.92	2.04	4.27	2.04	4.27	.425	8.52	
5000	14.2	3.13	5.21	2.59	3.68	2.59	5.24	2.59	5.24	.465	10.5	
5500	15.6	3.78	6.30	3.19	4.52	3.19	6.29	3.19	6.29	.505	12.6	
6000	17.0	4.50	7.48	3.86	5.44	3.86	7.37	3.86	7.37	.545	15.0	
6500	18.4	5.28	8.76	4.60	6.45	4.60	8.65	4.60	8.65	.585	17.5	
7000	19.9	6.13	10.1	5.39	7.54	5.39	9.98	5.39	9.98	.625	20.3	
7500	21.3	7.03	11.6	6.26	8.72	6.26	11.5	6.26	11.5	.665	23.3	
8000	22.7	8.04	13.2	7.18	9.98	7.18	13.1	7.18	13.1	.705	26.4	
8500	24.1	9.04	14.9	8.17	11.3	8.17	14.5	8.17	14.5	.745	29.8	
9000	25.5	10.1	16.7	9.22	12.8	9.22	16.3	9.22	16.3	.785	33.3	
9500	26.9	11.3	18.6	10.3	14.3	10.3	18.0	10.3	18.0	.825	37.1	
10,000	28.4	12.5	20.6	11.5	15.9	11.5	20.4	11.5	20.4	.865	41.0	
11,000	31.2	15.1	24.9	12.8	17.6	12.8	22.6	12.8	22.6	.905	46.6	
12,000	34.0	18.0	29.6	15.4	21.2	15.4	25.1	15.4	25.1	.945	52.7	
13,000	36.9	21.1	34.7	16.3	23.2	16.3	27.6	16.3	27.6	.985	59.0	
14,000	39.7	24.5	40.1	18.3	26.7	18.3	30.1	18.3	30.1	1.025	65.9	
15,000	42.6	28.1	46.2	20.7	30.2	20.7	32.6	20.7	32.6	1.065	73.9	

Note: No allowance has been made for age, difference in diameter, or any abnormal condition of interior surface. Any factor of safety must be estimated from the local conditions and the requirements of each particular installation. It is recommended that for most commercial design purposes a safety factor of 15 to 20% be added to the values in the tables—see page 3-5.



Friction of Water (Continued)
(Based on Darcy's Formula)

Asphalt-dipped cast iron and new steel pipe

14 Inch **16 Inch**

Flow U S gal per min	Asphalt-dipped cast iron			New steel schedule 40			Asphalt-dipped cast iron			New steel schedule 40		
	14.0" inside dia			13.124" inside dia			16.0" inside dia			15.000" inside dia		
	Ve- locity ft per sec	Head loss ft per 100 ft	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Head loss ft per 100 ft
300	.625	.046	.011	.712	.008	.015	.908	.013	.020	.008	.011	.015
400	.834	.011	.019	.949	.014	.025	1.000	.019	.027	.011	.015	.020
500	1.04	.017	.028	1.19	.022	.036	1.19	.027	.036	.016	.020	.026
600	1.25	.024	.039	1.42	.031	.052	1.42	.035	.046	.020	.026	.032
700	1.46	.033	.053	1.66	.043	.070	1.66	.043	.058	.025	.032	.039
800	1.67	.043	.068	1.90	.056	.089	1.90	.053	.070	.032	.039	.046
900	1.88	.055	.085	2.14	.071	.111	2.14	.061	.085	.041	.048	.055
1000	2.08	.067	.103	2.37	.087	.134	2.37	.077	.100	.048	.055	.062
1100	2.29	.082	.124	2.61	.106	.160	2.61	.091	.121	.055	.062	.069
1200	2.50	.097	.147	2.85	.126	.182	2.85	.101	.131	.062	.069	.076
1300	2.71	.114	.171	3.08	.148	.212	3.08	.119	.151	.070	.076	.083
1400	2.92	.132	.197	3.32	.171	.243	3.32	.142	.182	.083	.089	.096
1500	3.13	.152	.225	3.56	.196	.277	3.56	.168	.212	.096	.103	.110
1600	3.34	.173	.253	3.80	.223	.313	3.80	.194	.243	.110	.116	.123
1700	3.54	.195	.286	4.03	.252	.351	4.03	.223	.277	.123	.130	.137
1800	3.75	.218	.320	4.27	.283	.391	4.27	.253	.313	.137	.144	.151
1900	3.96	.243	.355	4.51	.315	.434	4.51	.283	.343	.151	.158	.165
2000	4.17	.270	.392	4.74	.349	.478	4.74	.315	.374	.165	.172	.179
2500	5.21	.421	.605	5.93	.546	.732	5.93	.421	.546	.212	.219	.226
3000	6.25	.607	.864	7.12	.766	1.04	7.12	.546	.712	.269	.276	.283
3500	7.30	.826	1.17	8.30	1.07	1.40	8.30	.712	.830	.326	.333	.340
4000	8.34	1.08	1.52	9.49	1.40	1.81	9.49	.949	1.08	.383	.390	.397
4500	9.38	1.37	1.91	10.67	1.77	2.27	10.67	1.17	1.37	.440	.447	.454
5000	10.42	1.69	2.35	11.86	2.18	2.79	11.86	1.40	1.69	.497	.504	.511
6000	12.51	2.43	3.37	14.23	3.14	3.98	14.23	1.99	2.43	.607	.614	.621
7000	14.6	3.30	4.49	16.60	4.28	5.37	16.60	2.71	3.30	.712	.719	.726
8000	16.7	4.32	5.86	18.97	5.59	6.98	18.97	3.63	4.32	.819	.826	.833
9000	18.8	5.47	7.39	21.35	7.07	8.79	21.35	4.63	5.47	.926	.933	.940
10,000	20.8	6.75	9.11	23.72	8.73	10.8	23.72	5.74	6.75	1.033	1.040	1.047
11,000	22.9	8.17	11.0	26.09	10.56	13.0	26.09	6.98	8.17	1.140	1.147	1.154
12,000	25.0	9.71	13.3	28.46	12.57	15.5	28.46	8.34	9.71	1.247	1.254	1.261
13,000	27.1	11.4	15.3	30.83	14.75	18.1	30.83	9.81	11.4	1.354	1.361	1.368
14,000	29.2	13.2	17.7	33.20	17.11	21.0	33.20	11.38	13.2	1.461	1.468	1.475
15,000	31.3	15.2	20.3	35.58	19.64	24.0	35.58	13.06	15.2	1.568	1.575	1.582
16,000	33.3	17.3	23.1	37.95	22.35	27.3	37.95	14.84	17.3	1.675	1.682	1.689
17,000	35.4	19.5	26.1	40.32	25.23	30.8	40.32	16.71	19.5	1.782	1.789	1.796
18,000	37.5	21.8	29.7	42.69	28.27	34.6	42.69	18.68	21.8	1.889	1.896	1.903
20,000	41.7	27.0	36.0	47.43	34.92	42.9	47.43	22.11	27.0	2.103	2.110	2.117
22,000	45.9	32.7	43.5	52.18	42.26	51.3	52.18	25.54	32.7	2.317	2.324	2.331
24,000	50.0	38.8	52.7	56.92	50.29	61.0	56.92	29.07	38.8	2.531	2.538	2.545

Note: No allowance has been made for age, difference in diameter, or any abnormal condition of interior surface. Any factor of safety must be estimated from the local conditions and the requirements of each particular installation. It is recommended that for most commercial design purposes a safety factor of 15 to 20% be added to the values in the tables—see page 3-5.

Friction of Water (Continued)
(Based on Darcy's Formula)

Asphalt-dipped cast iron and new steel pipe

18 Inch **20 Inch**

Flow U S gal per min	Asphalt-dipped cast iron			New steel schedule 40			Asphalt-dipped cast iron			New steel schedule 40		
	18.0" inside dia			16.876" inside dia			20.0" inside dia			18.812" inside dia		
	Ve- locity ft per sec	Head loss ft per 100 ft	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Head loss ft per 100 ft	Ve- locity ft per sec	Head loss ft per 100 ft	Head loss ft per 100 ft
500	.630	.006	.008	.717	.008	.011	.800	.010	.012	.013	.015	.018
600	.756	.009	.012	.861	.011	.015	1.000	.012	.016	.015	.020	.023
700	.883	.012	.016	1.000	.016	.020	1.200	.015	.023	.016	.023	.028
800	1.010	.016	.020	1.150	.020	.026	1.400	.016	.026	.016	.026	.031
900	1.140	.020	.024	1.290	.026	.032	1.600	.016	.032	.016	.032	.037
1000	1.260	.025	.029	1.430	.032	.039	1.800	.016	.039	.016	.039	.044
1200	1.510	.036	.041	1.720	.046	.055	2.000	.016	.055	.016	.055	.060
1400	1.770	.048	.056	2.080	.063	.073	2.400	.016	.073	.016	.073	.078
1600	2.020	.063	.072	2.390	.082	.093	2.800	.016	.093	.016	.093	.098
1800	2.270	.080	.090	2.580	.103	.116	3.200	.016	.116	.016	.116	.121
2000	2.520	.099	.110	2.870	.128	.137	3.600	.016	.137	.016	.137	.142
2500	3.150	.154	.168	3.590	.200	.208	4.000	.016	.208	.016	.208	.213
3000	3.780	.222	.239	4.300	.287	.294	4.800	.016	.294	.016	.294	.299
3500	4.410	.302	.323	5.020	.391	.400	5.600	.016	.400	.016	.400	.405
4000	5.040	.395	.418	5.740	.511	.520	6.400	.016	.520	.016	.520	.525
4500	5.670	.500	.528	6.460	.646	.657	7.200	.016	.657	.016	.657	.662
5000	6.300	.617	.647	7.170	.798	.810	8.000	.016	.810	.016	.810	.815
6000	7.570	.888	.924	8.610	1.110	1.120	9.600	.016	1.120	.016	1.120	1.125
7000	8.830	1.210	1.250	10.050	1.490	1.500	11.200	.016	1.500	.016	1.500	1.505
8000	10.100	1.560	1.630	11.500	2.040	2.050	13.000	.016	2.050	.016	2.050	2.055
9000	11.300	2.000	2.050	12.900	2.590	2.600	15.000	.016	2.600	.016	2.600	2.605
10,000	12.600	2.470	2.520	14.300	3.190	3.200	16,000	.016	3.200	.016	3.200	3.205
12,000	15.100	3.550	3.620	17.200	4.600	4.620	18,000	.016	4.620	.016	4.620	4.625
14,000	17.700	4.840	4.910	20.100	6.260	6.270	20,000	.016	6.270	.016	6.270	6.275
16,000	20.200	6.320	6.400	22.900	8.180	8.190	22,000	.016	8.190	.016	8.190	8.195
18,000	22.700	7.990	8.080	25.800	10.300	10.310	24,000	.016	10.310	.016	10.310	10.315
20,000	25.200	9.870	9.960	28.700	12.800	12.810	26,000	.016	12.810	.016	12.810	12.815
22,000	27.700	11.900	12.000	31.600	15.500	15.510	28,000	.016	15.510	.016	15.510	15.515
24,000	30.300	14.200	14.300	34.400	18.400	18.410	30,000	.016	18.410	.016	18.410	18.415
26,000	32.800	16.700	16.800	37.300	21.600	21.610	32,000	.016	21.610	.016	21.610	21.615
28,000	35.300	19.300	19.400	40.200	25.000	25.010	34,000	.016	25.010	.016	25.010	25.015
30,000	37.800	22.200	22.300	43.000	28.700	28.710	36,000	.016	28.710	.016	28.710	28.715
32,000	40.300	25.300	25.300	45.900	32.700	32.710	38,000	.016	32.710	.016	32.710	32.715
34,000	42.900	28.500	28.500	48.800	36.900	36.910	40,000	.016	36.910	.016	36.910	36.915
36,000	45.400	32.000	32.000	51.600	41.400	41.410	42,000	.016	41.410	.016	41.410	41.415
38,000	47.900	35.600	35.600	54.500	46.100	46.110	44,000	.016	46.110	.016	46.110	46.115
40,000	50.400	39.500	39.500	57.400	51.100	51.110	46,000	.016	51.110	.016	51.110	51.115
42,000	53.000	43.500	43.500	60.200	56.300	56.310	48,000	.016	56.310	.016	56.310	56.315
44,000	55.500	47.800	47.800	63.100	61.800	61.810	50,000	.016	61.810	.016	61.810	61.815
46,000	58.000	52.200	52.200	66.000	67.600	67.610	52,000	.016	67.610	.016	67.610	67.615

Note: No allowance has been made for age, difference in diameter, or any abnormal condition of interior surface. Any factor of safety must be estimated from the local conditions and the requirements of each particular installation. It is recommended that for most commercial design purposes a safety factor of 15 to 20% be added to the values in the tables—see page 3-5.