



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
2	0.74	.009	.385	.89	.01	.598	1.23	.023	1.26
3	1.11	.019	.787	1.34	.03	1.19	1.85	.053	2.26
4	1.48	.034	1.270	1.79	.05	1.99	2.46	.083	4.40
5	1.86	.054	1.90	2.23	.06	2.99	3.08	.147	6.63
6	2.23	.077	2.65	2.68	.11	4.17	3.69	.211	9.30
8	2.97	.137	4.50	3.57	.20	7.11	4.92	.376	15.9
10	3.71	.214	6.81	4.46	.31	10.8	6.15	.587	24.3
12	4.45	.308	9.58	5.36	.45	15.2	7.38	.845	34.4
14	5.20	.420	12.8	6.25	.61	20.4	8.61	1.15	46.2
16	5.94	.548	16.5	7.14	.79	26.3	9.84	1.50	59.7
18	6.68	.694	20.6	8.03	1.00	32.9	11.07	1.90	74.9
20	7.42	.857	25.2	8.92	1.24	40.3	12.30	2.35	91.8
22	8.17	1.036	30.3	9.82	1.50	48.4	13.53	2.84	110
24	8.91	1.23	35.8	10.7	1.8	57.2	14.76	3.38	131
26	9.65	1.45	41.7	11.6	2.1	66.8	15.99	3.97	153
28	10.39	1.68	48.1	12.5	2.4	77.1			
30	11.1	1.93	55.0	13.4	2.8	88.2			
35	13.0	2.62	74.1	15.6	3.8	119			
40	14.8	3.43	96.1	17.9	5.0	154			
45	16.7	4.33	121	20.1	6.3	194			

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
4	.858	.011	.35	1.00	.015	.51	1.21	.023	.806
5	1.073	.018	.52	1.25	.024	.75	1.52	.036	1.20
6	1.29	.026	.72	1.50	.034	1.04	1.82	.051	1.61
7	1.50	.035	.95	1.75	.048	1.33	2.13	.070	2.14
8	1.72	.046	1.20	2.00	.062	1.69	2.43	.092	2.73
10	2.15	.072	1.74	2.50	.097	2.55	3.04	.143	4.12
12	2.57	.103	2.45	3.00	.140	3.57	3.64	.206	5.78
14	3.00	.140	3.24	3.50	.190	4.75	4.25	.280	7.72
16	3.43	.183	4.15	4.00	.249	6.10	4.86	.366	9.92
18	3.86	.232	5.17	4.50	.315	7.61	5.46	.463	12.4
20	4.29	.286	6.31	5.00	.388	9.28	6.07	.572	15.1
25	5.36	.431	9.61	6.25	.607	14.2	7.59	.894	23.2
30	6.44	.644	13.6	7.50	.874	20.1	9.11	1.29	32.9
35	7.51	.876	18.2	8.75	1.19	27.0	10.63	1.75	44.2
40	8.58	1.14	23.5	10.0	1.55	34.9	12.14	2.29	57.3
50	10.7	1.79	36.2	12.5	2.43	53.7	15.18	3.58	88.3
60	12.9	2.57	51.5	15.0	3.50	76.5	18.22	5.15	126
70	15.0	3.50	69.5	17.5	4.76	103	21.25	7.01	170
80	17.2	4.53	90.2	20.0	6.21	134	24.29	9.16	221
90	19.3	5.79	114	22.5	7.86	168	27.32	11.59	279

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
4	.63	.006	.166	.73	.01	.233	.913	.013	.404
5	.79	.010	.246	.91	.01	.346	1.14	.020	.601
6	1.09	.014	.340	1.09	.02	.478	1.37	.029	.832
7	1.10	.019	.457	1.27	.03	.630	1.60	.040	1.10
8	1.26	.025	.567	1.45	.03	.800	1.83	.052	1.35
9	1.42	.031	.701	1.63	.04	.990	2.05	.065	1.67
10	1.58	.039	.848	1.82	.05	1.20	2.28	.081	2.03
12	1.89	.056	1.18	2.18	.07	1.61	2.74	.116	2.84
14	2.21	.078	1.51	2.54	.10	2.14	3.20	.158	3.78
16	2.52	.098	1.83	2.90	.13	2.74	3.65	.207	4.85
18	2.84	.125	2.40	3.27	.17	3.41	4.11	.262	6.04
20	3.15	.154	2.92	3.63	.20	4.15	4.56	.323	7.36
22	3.47	.187	3.48	3.99	.25	4.96	5.02	.391	8.81
24	3.76	.222	4.10	4.36	.30	5.84	5.48	.465	10.4
26	4.10	.261	4.76	4.72	.35	6.80	5.93	.546	12.1
28	4.41	.303	5.47	5.08	.40	7.82	6.39	.634	13.9
30	4.73	.347	6.23	5.45	.46	8.91	6.85	.727	15.9
32	5.04	.395	7.04	5.81	.52	10.1	7.30	.828	18.0
34	5.36	.446	7.90	6.17	.59	11.3	7.76	.934	20.2
36	5.67	.500	8.80	6.54	.66	12.6	8.22	1.05	22.5
38	5.99	.577	9.76	6.90	.74	14.0	8.67	1.17	25.0
40	6.30	.618	10.8	7.26	.82	15.4	9.13	1.29	27.8
42	6.62	.681	11.8	7.63	.90	16.9	9.58	1.43	30.3
44	6.93	.747	12.9	7.99	.99	18.5	10.04	1.57	33.1
46	7.25	.817	14.0	8.35	1.08	20.1	10.50	1.71	36.1
48	7.56	.889	15.2	8.72	1.18	21.8	10.95	1.86	39.2
50	7.88	.965	16.5	9.08	1.28	23.6	11.41	2.02	42.4
55	8.67	1.17	19.8	9.99	1.55	28.4	12.55	2.45	51.0
60	9.46	1.39	23.4	10.9	1.8	33.6	13.69	2.91	60.4
65	10.24	1.63	27.3	11.8	2.2	39.2	14.83	3.41	70.6
70	11.03	1.89	31.5	12.7	2.5	45.3	15.97	3.96	81.5
75	11.8	2.17	36.0	13.6	2.9	51.8	17.11	4.55	93.2
80	12.6	2.47	40.8	14.5	3.3	58.7	18.25	5.17	106
85	13.4	2.79	45.9	15.4	3.7	66.0	19.40	5.84	119
90	14.2	3.13	51.3	16.3	4.1	73.8	20.54	6.55	133
95	15.0	3.48	57.0	17.2	4.6	82.0	21.68	7.29	148
100	15.8	3.86	63.0	18.2	5.1	90.7	22.82	8.08	164
110	17.3	4.67	75.8	20.0	6.2	109.3	25.10	9.78	197
120	18.9	5.56	89.9	21.8	7.4	128.6	27.38	11.6	234
130	20.5	6.52	105	23.6	8.7	151.6	29.66	13.7	274
140	22.1	7.56	122	25.4	10.0	175			
150	23.6	8.68	139	27.2	11.5	201			
160	25.2	9.88	158	29.0	13.1	228			
170	26.6	11.15	178	30.9	14.8	257			
180	28.4	12.50	199	32.7	16.6	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.

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	3.80	.224	20.3
2.5	2.64	.108	7.10	3.43	.18	13.6	4.74	.349	30.8
3.0	3.17	.156	9.94	4.11	.26	19.1	5.69	.503	43.5
3.5	3.70	.212	13.2	4.80	.36	25.5	6.64	.684	58.2
4.0	4.22	.277	17.0	5.48	.47	32.7	7.59	.894	75.0
4.5	4.75	.351	21.1	6.17	.59	40.9	8.54	1.13	94.0
5.0	5.28	.433	25.8	6.86	.73	50.0	9.49	1.40	115
5.5	5.81	.524	30.9	7.54	.88	59.9	10.44	1.69	138
6.0	6.34	.624	36.4	8.23	1.05	70.7	11.38	2.01	163
6.5	6.86	.732	42.4	8.91	1.23	82.4	12.33	2.36	190
7.0	7.39	.849	48.8	9.60	1.43	95.0	13.28	2.74	220
7.5	7.92	.975	55.6	10.3	1.6	109	14.23	3.14	
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	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
5	.478	.004	.074	.54	.00	.101	.718	.008	.197
6	.574	.005	.102	.65	.01	.139	.851	.012	.271
7	.689	.007	.134	.76	.01	.182	.961	.016	.357
8	.821	.009	.170	.87	.01	.231	1.15	.020	.452
9	.966	.012	.209	.98	.01	.285	1.29	.026	.559
10	1.125	.014	.252	1.09	.02	.343	1.44	.032	.675
12	1.34	.021	.349	1.30	.03	.476	1.72	.046	.938
14	1.57	.028	.461	1.52	.04	.629	2.01	.063	1.20
16	1.81	.036	.596	1.74	.05	.800	2.30	.082	1.53
18	2.06	.046	.765	1.96	.06	.991	2.58	.104	1.90
20	2.32	.057	.978	2.17	.07	1.16	2.87	.128	2.31
22	2.59	.069	1.22	2.39	.09	1.38	3.16	.155	2.76
24	2.87	.082	1.49	2.61	.11	1.62	3.45	.184	3.25
26	3.15	.096	1.79	2.83	.12	1.88	3.73	.216	3.77
28	3.44	.111	2.12	3.04	.14	2.16	4.02	.251	4.33
30	3.73	.128	2.48	3.26	.17	2.48	4.31	.288	4.93
35	4.38	.174	3.38	3.80	.22	3.28	5.02	.392	6.59
40	5.03	.227	4.61	4.35	.29	4.21	5.74	.512	8.49
45	5.68	.288	6.26	4.89	.37	5.26	6.46	.648	10.6
50	6.33	.355	8.26	5.43	.46	6.42	7.18	.799	13.0
55	6.98	.430	10.6	5.98	.56	7.70	7.89	.967	15.6
60	7.63	.511	13.3	6.52	.66	9.09	8.61	1.15	18.4
65	8.28	.600	16.1	7.06	.77	10.59	9.33	1.35	21.5
70	8.93	.696	19.0	7.61	.90	12.2	10.05	1.57	24.8
75	9.58	.799	22.0	8.15	1.03	13.9	10.77	1.80	28.3
80	10.23	.909	25.1	8.69	1.17	15.8	11.48	2.05	32.1
85	10.88	1.03	28.2	9.03	1.27	17.7	12.20	2.31	36.1
90	11.53	1.15	31.4	9.78	1.49	19.8	12.92	2.59	40.3
95	12.18	1.28	34.7	10.3	1.6	22.0	13.64	2.89	44.8
100	12.83	1.42	38.1	10.9	1.8	24.3	14.35	3.20	49.5
110	14.12	1.72	44.8	12.0	2.2	29.2	15.79	3.87	59.6
120	15.41	2.05	51.6	13.0	2.6	34.5	17.22	4.61	70.6
130	16.70	2.40	58.5	14.1	3.1	40.3	18.66	5.40	82.5
140	18.00	2.76	65.5	15.2	3.6	46.6	20.10	6.27	95.5
150	19.29	3.20	72.6	16.3	4.1	53.3	21.53	7.20	109
160	20.58	3.64	80.0	17.4	4.7	60.5	22.97	8.19	124
170	21.87	4.11	87.5	18.5	5.3	68.1	24.40	9.24	140
180	23.16	4.60	95.2	19.6	6.0	76.1	25.84	10.36	156
190	24.45	5.13	103	20.6	6.6	84.6	27.27	11.54	174
200	25.74	5.68	111	21.7	7.3	93.6	28.71	12.79	192
220	28.74	6.88	129	23.9	8.9	113			
240	31.74	8.18	147	26.9	10.6	134			
260	34.74	9.60	165	29.3	12.4	157			
280	37.74	11.14	183	30.4	14.4	181			
300	40.74	12.8	201	32.6	16.5	206			

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	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
8	.536	.005	.072	.61	.01	.097	.724	.008	.149
10	.670	.007	.107	.76	.01	.144	.905	.013	.221
12	.804	.010	.148	.91	.01	.199	1.09	.018	.305
14	.938	.014	.195	1.06	.02	.251	1.27	.025	.403
16	1.07	.018	.247	1.21	.02	.332	1.45	.033	.512
18	1.21	.023	.305	1.36	.03	.411	1.63	.041	.634
20	1.34	.028	.369	1.51	.04	.497	1.81	.051	.767
22	1.47	.034	.438	1.67	.04	.590	1.99	.061	.912
24	1.61	.040	.513	1.82	.05	.691	2.17	.073	1.03
26	1.74	.047	.593	1.97	.06	.800	2.35	.086	1.20
28	1.88	.055	.679	2.12	.07	.915	2.53	.100	1.37
30	2.01	.063	.770	2.27	.08	1.00	2.71	.114	1.56
35	2.35	.086	1.06	2.65	.11	1.31	3.17	.156	2.08
40	2.68	.112	1.26	3.03	.14	1.71	3.62	.203	2.66
45	3.02	.141	1.57	3.41	.18	2.13	4.07	.257	3.32
50	3.35	.174	1.91	3.79	.22	2.59	4.52	.318	4.05
55	3.68	.211	2.28	4.16	.27	3.10	4.98	.384	4.85
60	4.02	.251	2.69	4.54	.32	3.65	5.43	.457	5.72
65	4.36	.295	3.13	4.92	.38	4.25	5.88	.537	6.66
70	4.69	.342	3.60	5.30	.44	4.89	6.33	.622	7.67
75	5.03	.393	4.10	5.68	.50	5.58	6.79	.714	8.75
80	5.36	.447	4.64	6.05	.57	6.31	7.24	.813	9.90
85	5.70	.504	5.20	6.43	.64	7.08	7.69	.916	11.1
90	6.03	.565	5.80	6.81	.72	7.89	8.14	1.03	12.4
95	6.37	.630	6.43	7.19	.80	8.76	8.59	1.15	13.8
100	6.70	.698	7.09	7.57	.89	9.68	9.05	1.27	15.2
110	7.37	.844	8.51	8.33	1.08	11.8	9.95	1.54	18.3
120	8.04	1.00	10.1	9.08	1.28	13.7	10.86	1.83	21.8
130	8.71	1.18	11.7	9.84	1.50	16.0	11.76	2.15	25.2
140	9.38	1.37	13.5	10.6	1.7	18.5	12.67	2.49	29.1
150	10.05	1.57	15.5	11.3	2.0	21.1	13.57	2.86	33.3
160	10.7	1.79	17.5	12.1	2.3	23.9	14.47	3.25	37.8
170	11.4	2.02	19.7	12.9	2.6	26.9	15.38	3.67	42.5
180	12.1	2.26	22.0	13.6	2.9	30.1	16.28	4.12	47.5
190	12.7	2.52	24.4	14.4	3.2	33.4	17.19	4.59	52.8
200	13.4	2.79	27.0	15.1	3.5	36.9	18.09	5.08	58.4
220	14.7	3.38	32.5	16.7	4.3	44.4	19.90	6.15	70.3
240	16.1	4.02	38.5	18.2	5.1	52.7	21.71	7.32	83.4
260	17.4	4.72	45.0	19.7	6.0	61.6	23.52	8.59	97.6
280	18.8	5.47	52.3	21.2	7.0	71.2	25.33	9.96	113
300	20.1	6.28	59.6	22.7	8.0	81.6	27.14	11.43	129
350	23.5	8.55	80.6	26.5	10.9	110	31.66	15.66	175
400	26.8	11.2	105	30.3	14.3	144	36.19	20.32	228
450	30.2	14.1	132	34.1	18.1	181	40.71	25.72	286
500	33.5	17.4	163	37.9	22.3	223	45.23	31.75	354

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) 6 Inch

Table with 12 columns: Flow (U S gal per min), Asphalt-dipped cast iron (6.0" inside dia), Std wt steel sch 40 (6.065" inside dia), Extra strong steel sch 80 (5.761" inside dia), Schedule 160-steel (5.187" inside dia). Rows include velocity (ft per sec), head loss (ft per 100 ft), and head loss (ft per 100 ft) for various flow rates from 50 to 2400.

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

Table with 12 columns: Flow (U S gal per min), Asphalt-dipped cast iron (8.0" inside dia), Std wt steel sch 40 (7.981" inside dia), Extra strong steel sch 80 (7.625" inside dia), Schedule 160-steel (6.813" inside dia). Rows include velocity (ft per sec), head loss (ft per 100 ft), and head loss (ft per 100 ft) for various flow rates from 130 to 5500.

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)

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

10 Inch (Continued)

12 Inch (Continued)

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 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
180	.74	.008	.023	.008	.022	.027	.804	.010	.027	.033	.016	.048
200	.82	.010	.026	.010	.026	.033	.894	.012	.033	.041	.020	.059
220	.90	.013	.032	.013	.031	.039	.983	.015	.039	.051	.024	.070
240	.98	.016	.038	.016	.037	.046	1.071	.018	.046	.063	.029	.082
260	1.06	.018	.044	.018	.042	.053	1.16	.021	.053	.074	.034	.094
280	1.14	.020	.051	.020	.049	.061	1.25	.024	.061	.081	.039	.108
300	1.23	.023	.057	.023	.055	.069	1.34	.028	.069	.095	.045	.123
350	1.43	.032	.073	.032	.073	.092	1.56	.038	.092	1.18	.061	.163
400	1.63	.042	.099	.041	.083	1.17	1.79	.050	1.17	1.42	.079	.208
450	1.84	.053	.123	.052	.116	1.45	2.01	.063	1.45	1.74	.100	.259
500	2.04	.065	.150	.064	.140	.177	2.34	.077	.177	2.19	.124	.304
550	2.25	.079	.180	.078	.167	.211	2.66	.094	.211	2.53	.150	.364
600	2.45	.093	.213	.092	.197	.239	3.09	.122	.239	3.09	.179	.428
650	2.66	.110	.248	.109	.228	.290	3.61	.152	.290	3.61	.210	.498
700	2.86	.127	.286	.126	.253	.313	4.14	.186	.313	3.96	.243	.573
800	3.27	.166	.370	.165	.325	.357	5.71	.244	.357	5.71	.318	.738
900	3.68	.210	.464	.208	.405	.402	6.24	.291	.402	6.24	.369	.923
1000	4.09	.259	.569	.257	.484	4.47	7.79	.352	4.47	7.79	.436	1.133
1100	4.49	.314	.685	4.48	.521	.582	8.32	.422	.582	8.32	.514	1.360
1200	4.90	.373	.811	.488	.619	.699	9.85	.506	.699	9.85	.601	1.600
1300	5.31	.438	.947	.529	.735	.814	11.38	.601	.814	11.38	.706	1.860
1400	5.72	.508	1.09	.604	.838	.926	12.91	.706	.926	12.91	.811	2.150
1500	6.13	.584	1.25	.679	1.07	1.17	14.44	.821	1.17	14.44	.926	2.460
1600	6.54	.664	1.42	.759	1.21	1.33	16.00	.946	1.33	16.00	1.041	2.780
1700	6.94	.749	1.60	.843	1.36	1.50	17.57	1.071	1.50	17.57	1.146	3.130
1800	7.35	.840	1.79	.932	1.52	1.66	19.14	1.206	1.66	19.14	1.241	3.490
1900	7.76	.936	1.99	1.027	1.68	1.81	20.71	1.351	1.81	20.71	1.336	3.880
2000	8.17	1.04	2.20	1.122	1.86	1.96	22.28	1.506	1.96	22.28	1.431	4.290
2200	8.99	1.26	2.65	1.257	2.24	2.25	25.44	1.811	2.25	25.44	1.626	5.160
2400	9.80	1.49	3.15	1.48	2.64	2.64	29.10	2.166	2.64	29.10	1.821	6.110
2600	10.6	1.75	3.68	1.74	3.09	3.09	33.26	2.521	3.09	33.26	2.016	7.140
2800	11.4	2.03	4.26	1.97	3.57	3.57	37.91	2.876	3.57	37.91	2.211	8.250
3000	12.3	2.33	4.88	2.22	4.08	4.08	43.06	3.231	4.08	43.06	2.406	9.440
3200	13.1	2.66	5.54	2.47	4.62	4.62	48.71	3.586	4.62	48.71	2.601	10.700
3400	13.9	3.00	6.25	2.72	5.20	5.20	54.86	3.941	5.20	54.86	2.796	12.100
3600	14.7	3.36	6.99	2.97	5.81	5.81	61.51	4.296	5.81	61.51	2.991	13.500
3800	15.5	3.74	7.79	3.21	6.46	6.46	68.66	4.651	6.46	68.66	3.186	15.000
4000	16.3	4.15	8.62	3.46	7.14	7.14	76.31	5.006	7.14	76.31	3.381	16.600
4500	18.4	5.25	10.9	4.25	8.99	8.99	90.46	5.711	8.99	90.46	3.976	20.900
5000	20.4	6.48	13.4	5.04	11.1	11.1	106.61	6.416	11.1	106.61	4.571	25.700
5500	22.5	7.85	16.2	5.83	13.3	13.3	124.76	7.121	13.3	124.76	5.166	31.100
6000	24.5	9.34	19.2	6.62	15.5	15.5	144.91	7.826	15.5	144.91	5.761	36.900
6500	26.6	11.0	22.6	7.41	18.5	18.5	167.06	8.531	18.5	167.06	6.356	43.200
7000	28.6	12.7	26.1	8.20	21.4	21.4	191.21	9.236	21.4	191.21	6.951	50.000
7500	30.6	14.6	30.0	9.00	24.5	24.5	217.36	9.941	24.5	217.36	7.546	57.300

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
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			
	14.0" inside dia				16.0" inside dia				18.0" inside dia				20.0" inside dia			
	Ve-locity		Head loss		Ve-locity		Head loss		Ve-locity		Head loss		Ve-locity		Head loss	
	ft per sec	ft per 100 ft	ft per sec	ft per 100 ft	ft per sec	ft per 100 ft	ft per sec	ft per 100 ft	ft per sec	ft per 100 ft	ft per sec	ft per 100 ft	ft per sec	ft per 100 ft	ft per sec	ft per 100 ft
300	.625	.011	.068	.798	.010	.015	.008	.011	1.000	.006	.008	.012	.016	.013	.020	.015
400	.834	.011	.091	.949	.014	.020	.018	.025	1.300	.009	.012	.016	.021	.015	.023	.018
500	1.04	.017	.128	1.19	.022	.036	.027	.036	1.700	.012	.019	.027	.036	.020	.030	.023
600	1.25	.024	.169	1.42	.031	.052	.042	.058	2.100	.016	.024	.033	.046	.026	.038	.030
700	1.46	.033	.222	1.66	.043	.070	.051	.082	2.500	.020	.029	.040	.056	.032	.047	.036
800	1.67	.043	.285	1.90	.056	.099	.063	.110	3.000	.025	.035	.048	.067	.040	.057	.043
900	1.88	.055	.358	2.14	.071	.131	.082	.147	3.500	.030	.041	.056	.077	.045	.064	.050
1000	2.08	.067	.440	2.37	.087	.174	.100	.190	4.000	.035	.048	.064	.089	.050	.070	.056
1100	2.29	.082	.530	2.61	.106	.220	.116	.230	4.500	.040	.054	.072	.100	.055	.076	.062
1200	2.50	.097	.625	2.85	.126	.268	.130	.270	5.000	.045	.061	.080	.111	.060	.083	.068
1300	2.71	.114	.728	3.08	.148	.321	.148	.330	5.500	.050	.067	.088	.125	.065	.089	.073
1400	2.92	.132	.838	3.32	.171	.379	.168	.370	6.000	.055	.074	.098	.143	.070	.095	.078
1500	3.13	.152	.955	3.56	.196	.437	.189	.420	6.500	.060	.081	.109	.162	.075	.101	.083
1600	3.34	.173	1.078	3.80	.223	.502	.211	.480	7.000	.065	.088	.119	.183	.080	.107	.086
1700	3.54	.195	1.206	4.03	.252	.571	.230	.530	7.500	.070	.095	.129	.205	.085	.113	.090
1800	3.75	.218	1.340	4.27	.283	.644	.249	.590	8.000	.075	.102	.140	.228	.090	.121	.094
1900	3.96	.243	1.478	4.51	.315	.721	.269	.650	8.500	.080	.109	.150	.252	.095	.131	.098
2000	4.17	.270	1.620	4.74	.349	.802	.288	.710	9.000	.085	.116	.160	.277	.100	.141	.102
2500	5.21	.421	2.640	6.05	.523	1.300	.406	1.100	11.000	.120	.170	.220	.340	.130	.190	.130
3000	6.25	.607	3.800	7.12	.766	1.900	.562	1.500	13.000	.160	.230	.300	.450	.170	.250	.170
3500	7.30	.826	5.100	8.30	1.07	2.600	.780	2.000	15.000	.200	.280	.360	.530	.210	.300	.210
4000	8.34	1.08	6.500	9.49	1.40	3.400	1.050	2.600	17.000	.240	.330	.420	.610	.250	.350	.250
4500	9.38	1.37	8.000	10.67	1.77	4.300	1.340	3.200	19.000	.280	.390	.490	.710	.290	.400	.290
5000	10.42	1.69	9.500	11.86	2.18	5.200	1.630	3.800	21.000	.320	.450	.560	.790	.330	.450	.330
6000	12.51	2.43	13.000	14.23	3.14	7.400	2.300	5.200	27.000	.430	.600	.750	1.050	.440	.580	.440
7000	14.6	3.30	16.600	16.60	4.28	9.800	3.100	7.000	33.000	.540	.740	.920	1.250	.550	.710	.550
8000	16.7	4.32	19.800	18.97	5.59	12.600	4.000	8.900	40.000	.650	.890	1.100	1.550	.660	.830	.660
9000	18.8	5.47	22.800	21.35	7.07	15.800	5.000	11.000	48.000	.760	1.050	1.290	1.850	.770	.950	.770
10,000	20.8	6.75	25.500	23.72	8.73	19.400	6.100	13.200	57.000	.870	1.190	1.460	2.100	.880	1.080	.880
11,000	22.9	8.17	27.800	26.09	10.56	23.300	7.300	15.600	67.000	.980	1.340	1.670	2.350	.990	1.200	.990
12,000	25.0	9.71	30.000	28.46	12.57	27.400	8.700	18.100	78.000	1.090	1.500	1.890	2.600	1.100	1.330	1.100
13,000	27.1	11.4	32.000	30.83	14.75	31.700	10.100	20.700	90.000	1.200	1.670	2.130	2.850	1.210	1.470	1.210
14,000	29.2	13.2	33.500	33.20	17.11	36.200	11.600	23.400	103.000	1.310	1.850	2.380	3.100	1.320	1.630	1.320
15,000	31.3	15.2	35.000	35.58	19.64	41.000	13.100	26.200	117.000	1.420	2.040	2.640	3.350	1.430	1.830	1.430
16,000	33.3	17.3	36.500	37.95	22.35	46.000	14.700	29.100	132.000	1.530	2.240	2.910	3.600	1.540	2.030	1.540
17,000	35.4	19.5	38.000	40.32	25.23	51.100	16.400	32.100	148.000	1.640	2.450	3.190	3.850	1.650	2.230	1.650
18,000	37.5	21.8	39.500	42.69	28.27	56.300	18.200	35.200	165.000	1.750	2.670	3.480	4.100	1.760	2.430	1.760
20,000	41.7	27.0	43.000	47.43	34.92	63.000	21.400	39.500	195.000	1.970	3.000	3.810	4.550	1.980	2.750	1.980
22,000	45.9	32.7	46.500	52.18	42.26	70.000	24.700	44.000	227.000	2.190	3.350	4.160	4.900	2.200	3.000	2.200
24,000	50.0	38.8	50.000	56.92	50.29	77.000	28.100	48.500	260.000	2.410	3.710	4.520	5.250	2.420	3.250	2.420

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.