Piping Friction Loss and Velocity Tables

Tables on the following pages give friction losses per 100 feet and water velocities for various commonly used pipe sizes and flow rates. Friction loss calculations are based on the Hazen-Williams equation:

$$Hf = \frac{10.472}{C^{1.852}} \times \frac{Q^{1.852}}{D^{4.871}} \times L$$

Where Hf = Friction Head Loss (ft)
C = Roughness Coefficient*
Q = Flow Rate (gpm)
L = Pipe Length (ft)
D = Pipe Inner Diameter (inches)

*for fresh water at 60 degrees Fahrenheit.

Roughness Coefficient C Values for Hazen-Williams Equation

Type of Pipe	*Range*	*New Pipe*	*Design C*
PVC	160 - 145	150	150
Polyethylene	150 - 130	140	140
Asbestos-cement	160 - 140	150	140
Cement-lined steel	160 - 140	150	140
Welded steel	150 - 80	140	100
Riveted steel	140 - 90	110	100
Concrete	150 - 85	120	100
Wrought or cast iron	150 - 80	130	100
Copper, brass	150 - 120	140	130
Wood stave	145 - 110	120	110
Vitrified clay		110	100
Corrugated steel		60	60

Velocity figures in the tables are based on the flow equation Q = AV, or

$$\textit{Velocity (ft/sec)} = \frac{Q\ (\textit{cu ft/sec})}{\textit{Pipe cross-sectional area (sq ft)}}$$

REFERENCE TABLE
VELOCITY AND FRICTION LOSS IN PSI PER 100 FEET
FOR IPS PVC -- SDR 32.5
PRESSURE RATING = 125 PSI

PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)	PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)	PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)
1	4	1.11	.22	2	20	1.64	.22	4	75	1.72	.11
	6	1.67	.46		30	2.46	.46		100	2.29	.19
	8	2.23	.78		40	3.28	.79		125	2.86	.29
	10	2.78	1.18		50	4.11	1.19		150	3.43	.41
	12	3.34	1.66		60	4.93	1.67		175	4.00	.54
	14	3.89	2.21		70	5.75	2.23		200	4.57	.69
	16	4.45	2.83		80	6.57	2.85		225	5.15	.86
	18	5.01	3.52		90	7.39	3.55		250	5.72	1.05
	20	5.56	4.27		100	8.21	4.31		275	6.29	1.25
	22	6.12	5.10		110	9.03	5.14		300	6.86	1.47
	24	6.68	5.99		120	9.85	6.04		325	7.43	1.70
	26	7.23	6.95		130	10.68	7.01		350	8.00	1.95
	28	7.79	7.97		140	11.50	8.04		375	8.58	2.22
1 1/4	8	1.38	.24	2 1/2	30	1.68	.18	6	200	2.11	.11
	12	2.06	.51		40	2.24	.31		250	2.64	.16
	16	2.75	.88		50	2.80	.47		300	3.17	.22
	20	3.44	1.33		60	3.36	.66		350	3.69	.30
	24	4.13	1.86		70	3.92	.88		400	4.22	.38
	28	4.82	2.47		80	4.48	1.12		450	4.75	.47
	32	5.51	3.17		90	5.04	1.40		500	5.28	.57
	36	6.19	3.94		100	5.60	1.70		550	5.81	.69
	40	6.88	4.79		110	6.16	2.03		600	6.33	.81
	44	7.57	5.71		120	6.72	2.38		650	6.86	.93
	48	8.26	6.71		130	7.28	2.76		700	7.39	1.07
	52	8.95	7.78		140	7.84	3.17		750	7.92	1.22
	56	9.63	8.92		150	8.40	3.60		800	8.44	1.37
1 1/2	15	1.93	.38	3	20	.76	.03	8	100	.62	.01
	20	2.58	.65		40	1.51	.12		200	1.25	.03
	25	3.22	.99		60	2.27	.25		300	1.87	.06
	30	3.86	1.39		80	3.03	.43		400	2.49	.11
	35	4.51	1.85		100	3.78	.65		500	3.11	.16
	40	5.15	2.36		120	4.54	.92		600	3.74	.22
	45	5.79	2.94		140	5.30	1.22		700	4.36	.30
	50	6.44	3.57		160	6.05	1.56		800	4.98	.38
	55	7.08	4.26		180	6.81	1.94		900	5.60	.47
	60	7.73	5.01		200	7.57	2.36		1000	6.23	.57
	65	8.37	5.81		220	8.32	2.81		1100	6.85	.68
	70	9.01	6.66		240	9.08	3.30		1200	7.47	.80
	75	9.66	7.57		260	9.84	3.83		1300	8.09	.93

REFERENCE TABLE
VELOCITY AND FRICTION LOSS IN PSI PER 100 FEET
FOR IPS PVC -- SDR 26
PRESSURE RATING = 160 PSI

PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)	PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)	PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)
1	4	1.14	.23	2	20	1.70	.24	4	75	1.77	.12
	6	1.71	.49		30	2.55	.50		100	2.36	.21
	8	2.29	.84		40	3.39	.86		125	2.96	.31
	10	2.86	1.26		50	4.24	1.29		150	3.55	.44
	12	3.43	1.77		60	5.09	1.81		175	4.14	.59
	14	4.00	2.36		70	5.94	2.41		200	4.73	.75
	16	4.57	3.02		80	6.79	3.09		225	5.32	.93
	18	5.14	3.75		90	7.64	3.84		250	5.91	1.13
	20	5.71	4.56		100	8.48	4.67		275	6.50	1.35
	22	6.29	5.44		110	9.33	5.57		300	7.09	1.59
	24	6.86	6.39		120	10.18	6.54		325	7.68	1.84
	26	7.43	7.41		130	11.03	7.59		350	8.28	2.12
	28	8.00	8.50		140	11.88	8.70		375	8.87	2.40
1 1/4	8	1.39	.25	2 1/2	30	1.74	.20	6	200	2.18	.11
	12	2.09	.53		40	2.32	.34		250	2.73	.17
	16	2.78	.90		50	2.89	.51		300	3.27	.24
	20	3.48	1.36		60	3.47	.71		350	3.82	.32
	24	4.17	1.91		70	4.05	.95		400	4.36	.41
	28	4.87	2.54		80	4.63	1.22		450	4.91	.51
	32	5.56	3.25		90	5.21	1.51		500	5.46	.62
	36	6.26	4.04		100	5.79	1.84		550	6.00	.74
	40	6.95	4.91		110	6.37	2.19		600	6.55	.87
	44	7.65	5.86		120	6.95	2.58		650	7.09	1.01
	48	8.34	6.88		130	7.52	2.99		700	7.64	1.16
	52	9.04	7.98		140	8.10	3.43		750	8.18	1.32
	56	9.73	9.15		150	8.68	3.90		800	8.73	1.49
1 1/2	15	1.99	.41	3	20	.78	.04	8	100	.64	.01
	20	2.65	.70		40	1.56	.13		200	1.29	.03
	25	3.32	1.06		60	2.35	.27		300	1.93	.07
	30	3.98	1.49		80	3.13	.47		400	2.58	.11
	35	4.64	1.98		100	3.91	.71		500	3.22	.17
	40	5.30	2.54		120	4.69	.99		600	3.86	.24
	45	5.97	3.16		140	5.47	1.32		700	4.51	.32
	50	6.63	3.84		160	6.26	1.69		800	5.15	.41
	55	7.29	4.58		180	7.04	2.10		900	5.79	.51
	60	7.96	5.38		200	7.82	2.56		1000	6.44	.62
	65	8.62	6.24		220	8.60	3.05		1100	7.08	.74
	70	9.28	7.16		240	9.39	3.58		1200	7.73	.87
	75	9.95	8.13		260	10.17	4.15		1300	8.37	1.01

REFERENCE TABLE
VELOCITY AND FRICTION LOSS IN PSI PER 100 FEET
FOR IPS PVC -- SDR 21
PRESSURE RATING = 200 PSI

PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)	PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)	PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)
1/2	.5	.40	.06	1 1/4	10	1.81	.41	2 1/2	40	2.41	.37
	1	.80	.22		12	2.17	.58		50	3.02	.56
	1.5	1.19	.46		14	2.53	.77		60	3.62	.79
	2	1.59	.78		16	2.89	.99		70	4.22	1.05
	2.5	1.99	1.17		18	3.26	1.23		80	4.82	1.34
	3	2.39	1.65		20	3.62	1.50		90	5.43	1.67
	3.5	2.79	2.19		22	3.98	1.79		100	6.03	2.03
	4	3.18	2.81		24	4.34	2.10		110	6.63	2.43
	4.5	3.58	3.49		28	5.06	2.79		120	7.24	2.85
	5	3.98	4.24		32	5.79	3.57		130	7.84	3.30
	6	4.78	5.94		36	6.51	4.45		140	8.44	3.79
	7	5.57	7.91		40	7.23	5.40		150	9.05	4.31
	8	6.37	10.13		44	7.96	6.45		160	9.65	4.85
3/4	3	1.42	.46	1 1/2	5	.69	.06	3	20	.81	.04
	4	1.89	.78		10	1.38	.21		40	1.63	.14
	5	2.36	1.19		15	2.07	.45		60	2.44	.30
	6	2.83	1.66		20	2.76	.77		80	3.26	.52
	7	3.30	2.21		25	3.45	1.17		100	4.07	.78
	8	3.77	2.83		30	4.14	1.64		110	4.48	.93
	9	4.25	3.52		35	4.83	2.18		130	5.29	1.27
	10	4.72	4.28		40	5.52	2.79		140	5.70	1.46
	11	5.19	5.11		45	6.21	3.47		160	6.51	1.86
	12	5.66	6.00		50	6.90	4.22		180	7.33	2.32
	14	6.60	7.99		55	7.59	5.04		200	8.14	2.82
	16	7.55	10.23		60	8.27	5.92		220	8.95	3.36
	18	8.49	12.72		65	8.96	6.86		240	9.77	3.95
1	6	1.73	.50	2	10	.88	.07	4	75	1.85	.13
	7	2.02	.67		20	1.77	.26		100	2.46	.23
	8	2.31	.86		30	2.65	.55		125	3.08	.35
	10	2.89	1.29		40	3.53	.94		150	3.69	.49
	12	3.46	1.81		50	4.42	1.43		175	4.31	.65
	14	4.04	2.41		55	4.86	1.70		200	4.92	.83
	16	4.62	3.09		60	5.30	2.00		225	5.54	1.03
	18	5.19	3.84		65	5.74	2.32		250	6.15	1.25
	20	5.77	4.67		70	6.18	2.66		275	6.77	1.49
	22	6.35	5.58		80	7.07	3.41		300	7.38	1.75
	24	6.93	6.55		90	7.95	4.24		325	8.00	2.03
	26	7.50	7.60		100	8.83	5.15		350	8.61	2.33
	28	8.08	8.71		110	9.72	6.15		375	9.23	2.65

REFERENCE TABLE
VELOCITY AND FRICTION LOSS IN PSI PER 100 FEET
FOR IPS PVC -- SDR 13.5
PRESSURE RATING = 315 PSI

PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)	PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)	PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)
1/2	.5	.40	.06	1 1/4	10	2.04	.56	2 1/2	40	2.72	.50
	1	.80	.22		12	2.45	.78		50	3.40	.76
	1.5	1.19	.46		14	2.86	1.04		60	4.08	1.06
	2	1.59	.78		16	3.26	1.33		70	4.76	1.41
	2.5	1.99	1.17		18	3.67	1.65		80	5.44	1.80
	3	2.39	1.65		20	4.08	2.01		90	6.12	2.24
	3.5	2.79	2.19		22	4.49	2.40		100	6.80	2.73
	4	3.18	2.81		24	4.90	2.82		110	7.48	3.25
	4.5	3.58	3.49		28	5.71	3.75		120	8.16	3.82
	5	3.98	4.24		32	6.53	4.80		130	8.84	4.43
	6	4.78	5.94		36	7.35	5.97		140	9.52	5.08
	7	5.57	7.91		40	8.16	7.25		150	10.20	5.78
	8	6.37	10.13		44	8.98	8.65		160	10.88	6.51
3/4	3	1.53	.56	1 1/2	5	.78	.08	3	20	.92	.05
	4	2.04	.95		10	1.56	.29		40	1.84	.19
	5	2.55	1.44		15	2.34	.61		60	2.75	.41
	6	3.06	2.02		20	3.12	1.04		80	3.67	.69
	7	3.57	2.68		25	3.90	1.58		100	4.59	1.04
	8	4.08	3.43		30	4.68	2.21		110	5.05	1.25
	9	4.59	4.27		35	5.45	2.94		130	5.96	1.70
	10	5.10	5.19		40	6.23	3.76		140	6.42	1.95
	11	5.62	6.19		45	7.01	4.68		160	7.34	2.49
	12	6.13	7.28		50	7.79	5.69		180	8.26	3.10
	14	7.15	9.68		55	8.57	6.78		200	9.18	3.77
	16	8.17	12.40		60	9.35	7.97		220	10.09	4.50
	18	9.19	15.42		65	10.13	9.24		240	11.01	5.29
1	6	1.95	.67	2	10	1.00	.10	4	75	2.08	.18
	7	2.27	.89		20	1.99	.35		100	2.78	.31
	8	2.60	1.14		30	2.99	.74		125	3.47	.46
	10	3.25	1.72		40	3.99	1.27		150	4.16	.65
	12	3.90	2.42		50	4.98	1.92		175	4.86	.87
	14	4.55	3.22		55	5.48	2.29		200	5.55	1.11
	16	5.19	4.12		60	5.98	2.68		225	6.25	1.38
	18	5.84	5.12		65	6.48	3.11		250	6.94	1.68
	20	6.49	6.23		70	6.98	3.57		275	7.63	2.00
	22	7.14	7.43		80	7.98	4.57		300	8.33	2.35
	24	7.79	8.73		90	8.97	5.69		325	9.02	2.72
	26	8.44	10.12		100	9.97	6.91		350	9.71	3.13
	28	9.09	11.61		110	10.97	8.25		375	10.41	3.55

REFERENCE TABLE
VELOCITY AND FRICTION LOSS IN PSI PER 100 FEET
FOR SCHEDULE 40 IPS PVC PIPE

PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)	PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)	PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)
1/2	.5	.53	.12	1 1/4	10	2.14	.63	2 1/2	40	2.68	.48
	1	1.05	.43		12	2.57	.88		50	3.35	.73
	1.5	1.58	.91		14	3.00	1.17		60	4.02	1.02
	2	2.11	1.54		16	3.43	1.50		70	4.69	1.35
	2.5	2.64	2.33		18	3.86	1.86		80	5.35	1.73
	3	3.16	3.27		20	4.28	2.26		90	6.02	2.16
	3.5	3.69	4.35		22	4.71	2.70		100	6.69	2.62
	4	4.22	5.57		24	5.14	3.17		110	7.36	3.13
	4.5	4.75	6.93		28	6.00	4.22		120	8.03	3.67
	5	5.27	8.42		32	6.86	5.40		130	8.70	4.26
	6	6.33	11.80		36	7.71	6.72		140	9.37	4.89
	7	7.38	15.70		40	8.57	8.17		150	10.04	5.55
	8	8.44	20.10		44	9.43	9.74		160	10.71	6.26
3/4	3	1.80	.83	1 1/2	5	.79	.08	3	20	.87	.05
	4	2.40	1.42		10	1.57	.30		40	1.73	.17
	5	3.00	2.14		15	2.36	.63		60	2.60	.35
	6	3.61	3.00		20	3.15	1.07		80	3.47	.60
	7	4.21	3.99		25	3.94	1.61		100	4.33	.91
	8	4.81	5.11		30	4.72	2.26		110	4.77	1.09
	9	5.41	6.35		35	5.51	3.01		130	5.63	1.48
	10	6.01	7.72		40	6.30	3.85		140	6.07	1.70
	11	6.61	9.21		45	7.08	4.79		160	6.94	2.17
	12	7.21	10.83		50	7.87	5.83		180	7.80	2.70
	14	8.41	14.40		55	8.66	6.95		200	8.67	3.28
	16	9.61	18.44		60	9.44	8.17		220	9.54	3.92
	18	10.82	22.94		65	10.23	9.47		240	10.40	4.60
1	6	2.22	.93	2	10	.95	.09	4	75	1.89	.14
	7	2.60	1.23		20	1.91	.32		100	2.52	.24
	8	2.97	1.58		30	2.86	.67		125	3.15	.37
	10	3.71	2.38		40	3.82	1.14		150	3.78	.51
	12	4.45	3.34		50	4.77	1.72		175	4.41	.68
	14	5.19	4.44		55	5.25	2.06		200	5.03	.87
	16	5.93	5.69		60	5.73	2.42		225	5.66	1.09
	18	6.67	7.08		65	6.21	2.80		250	6.29	1.32
	20	7.42	8.60		70	6.68	3.22		275	6.92	1.58
	22	8.16	10.26		80	7.64	4.12		300	7.55	1.85
	24	8.90	12.06		90	8.59	5.12		325	8.18	2.15
	26	9.64	13.98		100	9.55	6.23		350	8.81	2.46
	28	10.38	16.04		110	10.50	7.43		375	9.44	2.80

REFERENCE TABLE
VELOCITY AND FRICTION LOSS IN PSI PER 100 FEET
FOR SCHEDULE 80 IPS PVC PIPE

PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)	PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)	PIPE SIZE (INCHES)	FLOW (GPM)	VELOCITY (FT/SEC)	FRICTION LOSS (PSI/100 FT)
1/2	.5	.68	.22	1 1/4	10	2.50	.91	2 1/2	40	3.02	.65
	1	1.37	.81		12	3.00	1.28		50	3.78	.98
	1.5	2.05	1.71		14	3.50	1.70		60	4.54	1.37
	2	2.74	2.91		16	4.00	2.17		70	5.29	1.82
	2.5	3.42	4.40		18	4.50	2.70		80	6.05	2.33
	3	4.11	6.17		20	5.00	3.29		90	6.80	2.90
	3.5	4.79	8.20		22	5.50	3.92		100	7.56	3.53
	4	5.47	10.51		24	6.00	4.61		110	8.32	4.21
	4.5	6.16	13.07		28	6.99	6.13		120	9.07	4.94
	5	6.84	15.88		32	7.99	7.85		130	9.83	5.73
	6	8.21	22.26		36	8.99	9.76		140	10.58	6.58
	7	9.58	29.62		40	9.99	11.87		150	11.34	7.47
	8	10.95	37.93		44	10.99	14.16		160	12.10	8.42
3/4	3	2.22	1.38	1 1/2	5	.91	.12	3	20	.97	.06
	4	2.96	2.36		10	1.81	.42		40	1.94	.22
	5	3.71	3.56		15	2.72	.88		60	2.91	.46
	6	4.45	5.00		20	3.63	1.51		80	3.88	.79
	7	5.19	6.65		25	4.53	2.28		100	4.85	1.20
	8	5.93	8.51		30	5.44	3.19		110	5.34	1.43
	9	6.67	10.59		35	6.35	4.25		130	6.31	1.95
	10	7.41	12.87		40	7.25	5.44		140	6.79	2.23
	11	8.15	15.35		45	8.16	6.77		160	7.76	2.86
	12	8.89	18.04		50	9.07	8.22		180	8.73	3.55
	14	10.37	24.00		55	9.97	9.81		200	9.70	4.32
	16	11.86	30.73		60	10.88	11.53		220	10.67	5.15
	18	13.34	38.22		65	11.79	13.37		240	11.64	6.05
1	6	2.67	1.45	2	10	1.09	.12	4	75	2.09	.18
	7	3.12	1.92		20	2.17	.43		100	2.79	.31
	8	3.56	2.46		30	3.26	.91		125	3.48	.47
	10	4.45	3.73		40	4.34	1.56		150	4.18	.66
	12	5.35	5.22		50	5.43	2.36		175	4.88	.87
	14	6.24	6.95		55	5.97	2.81		200	5.57	1.12
	16	7.13	8.90		60	6.51	3.30		225	6.27	1.39
	18	8.02	11.07		65	7.05	3.83		250	6.97	1.69
	20	8.91	13.45		70	7.60	4.39		275	7.66	2.02
	22	9.80	16.05		80	8.68	5.62		300	8.36	2.37
	24	10.69	18.85		90	9.77	6.99		325	9.06	2.75
	26	11.58	21.87		100	10.85	8.50		350	9.76	3.16
	28	12.47	25.08		110	11.94	10.14		375	10.45	3.59