PERCENTAGE OF WHEEL LOADS TRANSMITTED TO UNDERGROUND PIPES*

FOR UNPAVED ROADWAY OR BERM AREAS

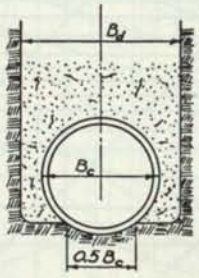
Tabulated figures show percentage of wheel load applied to one lineal foot of pipe.

Depth of Backfill over Top of Pipe in Feet	TRENCH WIDTH AT TOP OF PIPE IN FEET						
	1	2	3	4	5	6	7
1	17.0	26.0	28.6	29.7	29.9	30.2	30.3
2	8.3	14.2	18.3	20.7	21.8	22.7	23.0
3	4.3	8.3	11.3	13.5	14.8	15.8	16.7
4	2.5	5.2	7.2	9.0	10.3	11.5	12.3
5	1.7	3.3	5.0	6.3	7.3	8.3	9.0
6	1.0	2.3	3.7	4.7	5.5	6.2	7.0

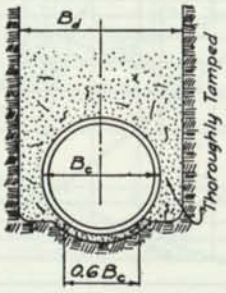
Live Loads Transmitted Are Practically Negligible below 6 Feet.

★These percentages include both live load and impact transmitted to the pipe.

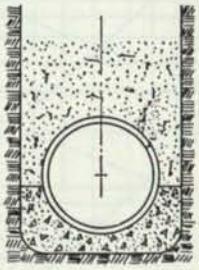
IMPERMISSIBLE BEDDING
Not to be used



ORDINARY BEDDING
Load Factor = 1.5



FIRST CLASS BEDDING
Load Factor = 1.9



CONCRETE CRADLE BEDDING
Load Factor = 2.25-3.4

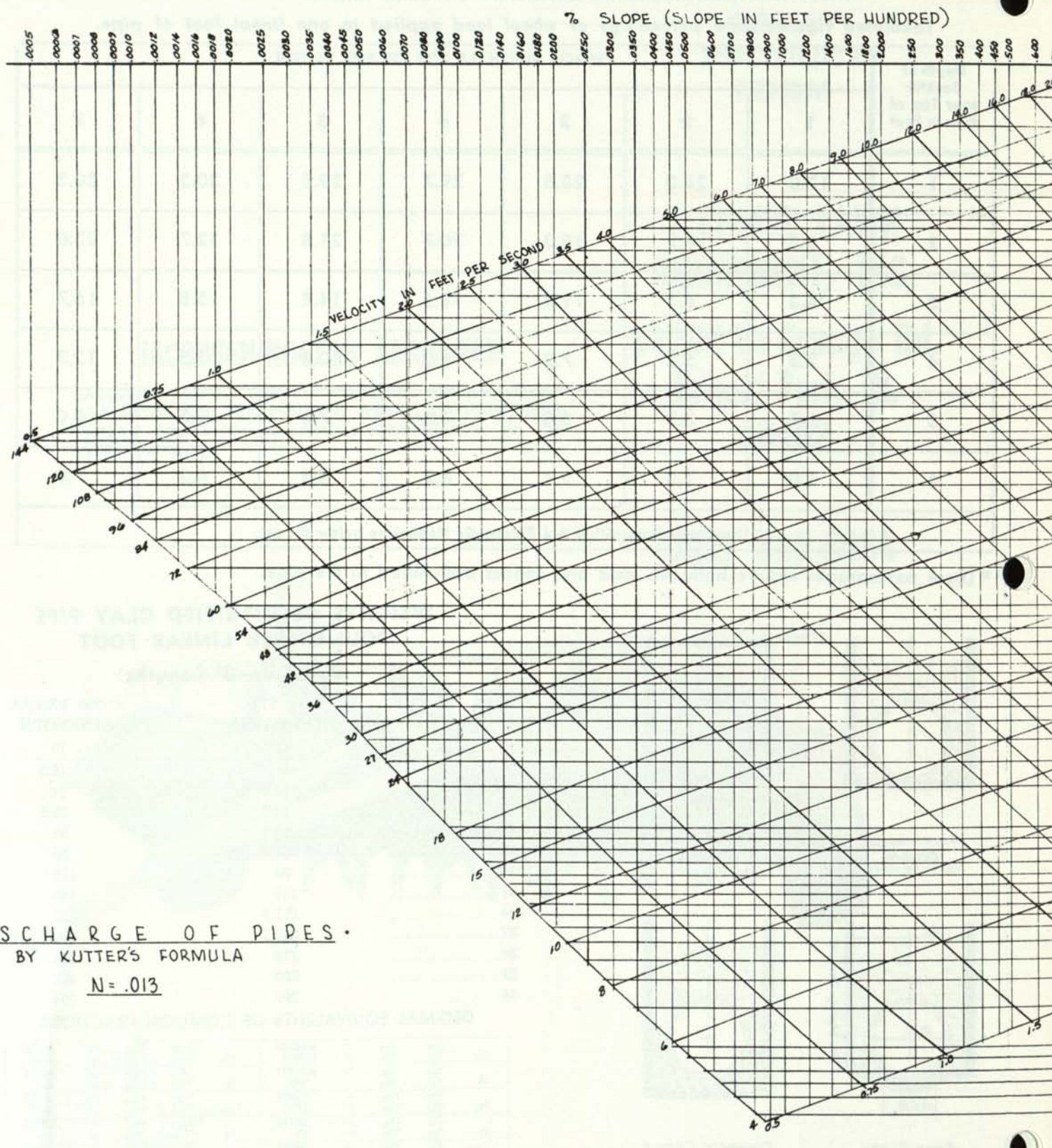
WEIGHTS OF VITRIFIED CLAY PIPE POUNDS PER LINEAR FOOT

(Based on 3' Lengths)

	C-13 STD. STRENGTHS	C-200 EXTRA STRENGTH
4	8	10
6	14	15.5
8	21.5	24
10	31.5	36.5
12	43.5	55
15	67.5	90
18	96	116
21	137	180
24	171.5	218
27	225.5	256
30	270	334
33	330	424
36	390	504

DECIMAL EQUIVALENTS OF COMMON FRACTIONS

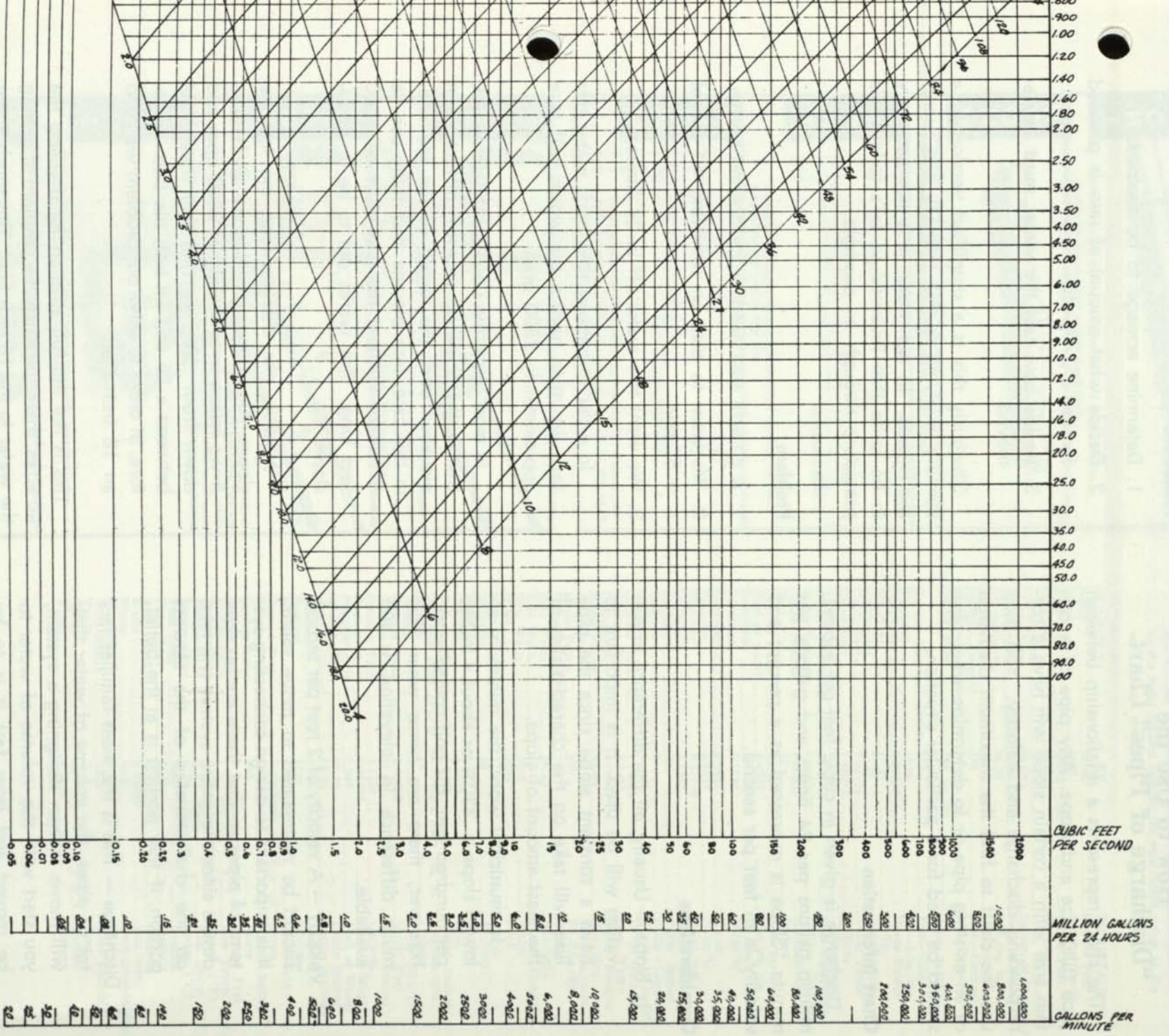
	1/32	3/64	=	0.03125		17/32	34/64	= .53125
1/16	2/32	4/64	=	0.0625	9/16	18/32	36/64	= .5625
	3/32	6/64	=	0.09375		19/32	38/64	= .59375
1/8	4/32	8/64	=	.125	5/8	20/32	40/64	= .625
	5/32	10/64	=	.15625		21/32	42/64	= .65625
3/16	6/32	12/64	=	.1875	11/16	22/32	44/64	= .6875
	7/32	14/64	=	.21875		23/32	46/64	= .71875
1/4	8/32	16/64	=	.25	3/4	24/32	48/64	= .75
	9/32	18/64	=	.28125		25/32	50/64	= .78125
5/16	10/32	20/64	=	.3125	13/16	26/32	52/64	= .8125
	11/32	22/64	=	.34375		27/32	54/64	= .84375
3/8	12/32	24/64	=	.375	7/8	28/32	56/64	= .875
	13/32	26/64	=	.40625		29/32	58/64	= .90625
7/16	14/32	28/64	=	.4375	15/16	30/32	60/64	= .9375
	15/32	30/64	=	.46875		31/32	62/64	= .96785
1/2	16/32	32/64	=	.50	1	—	—	= 1.00



DISCHARGE OF PIPES.

BY KUTTER'S FORMULA

N = .013


CUBIC FEET PER SECOND
MILLION GALLONS PER 24 HOURS
GALLONS PER MINUTE

·DISCHARGE·

How to Use the "Discharge of Pipes" Chart

The chart represents a relationship between pipe (tile) size and slope. Any pipe of a certain size with a certain slope will have a corresponding discharge and velocity. You may use the chart to find the maximum discharge of an existing pipe or to determine what pipe should be used for a particular situation.

Chart Information

Discharge is given in cubic feet per second, million gallons per 24 hours and gallons per minute. Slope is expressed as a percent and velocity is in feet per second.

Considerations

1. Slope — Usually, all the difference in elevation will be used. It is important to have a constant slope since the pipe line will take on the characteristics of the least amount of slope.

   In municipal work, the minimum allowed slope is .330% or about 4 inches per hundred feet. For golf course work, however, there are times when that much difference in elevation is not available.

2. Velocity — A velocity of 2 feet per second should be maintained to move solids. It is important to design connecting systems of pipes so that there are no slow downs since the entire system will take on the characteristics of the slowest portion, if that portion is at the outlet.

3. Discharge — This is the most familiar factor of pipes, the volume of water they will move. When designing a system, you start with the volume of water to be moved and how fast it is to be moved. On the chart it is expressed in three ways but most often used on golf courses is gpm.

Procedure

1. Determine acreage to be drained.
2. Decide what amount of rain is planned for i.e. 3", 4", etc.
3. Decide how fast the water must be removed.

Obviously this is a simplified version of a formula involving rainfall intensity and runoff coefficients. In our work, it is not necessary to be quite that involved so let's follow this procedure through an example.

Problem

1. A 40 acre area needs to be drained by tile.
2. We want to plan on removing 4" out of a 5" rain.
3. We want this water off in 24 hours.

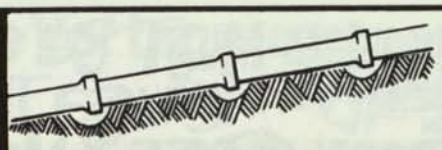
   In order to remove this much water this fast, we must have a tile which will take approximately 2800 gpm.

   In most cases, the slope is predetermined, that is, there will be a certain difference in elevation over the length of the tile line. In this case, let's assume that there can be 5 feet of fall and the line must be 1000 feet long. This works out to be a .500% slope.

   Now to the chart. Along the top are slopes. Along the right side are discharges. It we follow in to the left at 2800 gpm and down from .500, we find that they meet between a 15 and 18 inch tile line. Therefore, in order to solve our problem we need an 18 inch tile.

This is not the full solution for draining the 40 acres, there still exists the problem of getting the water to the 18 inch line. This much water would probably have to be collected and overflowed into the tile by means of a pond or sump.

RIGHT

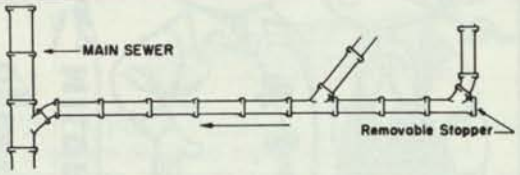


Proper grades insure unrestricted flow and good bedding permits the line to safely support trench loads.

WRONG

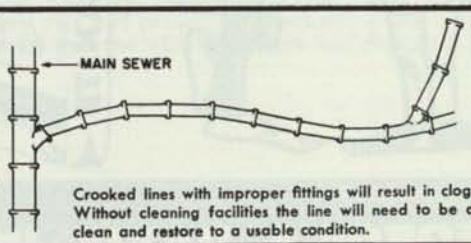
Poor grades and bedding will result in sluggish flow, clogging, and inability to withstand trench loads which good bedding would permit.

RIGHT



Straight lines, proper fittings, and provisions for cleaning, insure proper flow and trouble free use.

WRONG



Crooked lines with improper fittings will result in clogged flow. Without cleaning facilities the line will need to be dug up to clean and restore to a usable condition.

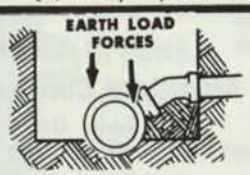
RIGHT

Prepare proper trough for pipe so that the entire barrel is continuously supported. Excavate bell holes.

WRONG

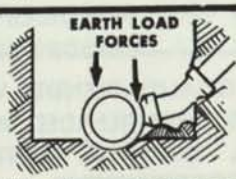
Pipe poorly bedded without trough and bell holes. Pipe will be easily misaligned, and will safely carry only two-thirds of possible trench load.

RIGHT



Spurs on Wye and Tee fittings must be thoroughly underbedded to resist the shearing action of backfill soil.

WRONG



When spur is bedded in loosely refilled soil which settles away, the unsupported spur can easily be sheared off.

CONVERSION FACTORS

If the unit in the left hand column is multiplied by the number in the middle column, the resultant quantity in the right column will be the equivalent value in the unit therein shown.

MULTIPLY	BY	TO OBTAIN
Acres	43560	Square Feet
Acres	4840	Square Yards
Acre Feet	43560	Cubic Feet
Acre Feet	325851	Gallons
Atmospheres	76.0	Cms. of Mercury
Atmospheres	29.92	Inches of Mercury
Atmospheres	33.90	Feet of Water
Atmospheres	14.70	Lbs./sq. in.
Barrels—Oil	42	Gallons—oil
Barrels—Cement	376	Lbs.—Cement
Bags/sacks cement	94	Lbs. Cement
Board Feet	144 sq. in. x1 in.	Cubic Inches
British Thermal Units	777.5	Foot—Lbs.
Btu./min.	12.96	Ft.—Lbs./sec.
Btu./min.	0.02356	Horse Power
Btu./min.	17.57	Watts
Cubic Feet	1728	Cubic Inches
Cubic Feet	0.03704	Cubic Yards
Cubic Feet	7.48052	Gallons
Cubic Feet/min.	0.1247	Gallons/sec.
Cubic Feet/min.	62.43	Lbs. water/min.
Cubic Feet/sec	0.646317	Million Gals./Day
Cubic Feet/sec	448.831	Gallons/min.
Feet	12	Inches
Feet of water	62.43	Lbs./sq. in.
Feet of water	0.4335	Lbs./sq. in.
Feet/min.	0.1667	Ft./sec.
Feet/min.	0.1136	Miles/hr.
Feet/sec.	0.5921	Knots
Feet/sec.	0.6818	Miles/hr.
Feet/sec.	0.01136	Miles/min.
Gallons	0.1337	Cubic Feet
Gallons	231	Cubic Inches
Gallons	8	Pints (Liquid)
Gallons	4	Quarts (Liquid)
Gallons Imperial	1.20095	U. S. Gallons
Gallons Water	8.3453	Lbs. Water
Gallons/min.	8.0208	Cubic Feet/hr.
Horse Power	42.44	Btu./Min.
Horse Power	33,000	Foot-lbs./min.
Horse Power	550	Ft.-Lbs./Sec.
Horse Power	745.7	Watts
Kilo Watts	56.92	Btu./min.
Kilo Watts	1.341	Horse Power
Kilo Watts	1000	Watts
Miles	5280	Feet
Miles	1760	Yards
Miles/hr.	88	Ft./min.
Miles	1.467	Ft./sec.
Ounces	0.0625	Lbs.
Ounces (Fluid)	1.805	Cubic Inches
Overflow Rate (Ft./hr.)	0.12468 x area (sq. ft.)	Gallons/min.
Pounds	16	Ounces
Pounds	0.0005	Tons (Short)
Pounds Water	0.01602	Cubic Feet
Pounds Water	27.68	Cubic Inches
Pounds Water	0.1198	Gallons
Pounds/sq. ft.	0.01602	Feet of Water
Pounds/sq. in.	2.307	Feet of Water
Quarts (Dry)	67.20	Cubic Inches
Quarts (Liquid)	57.75	Cubic Inches
Radians	57.30	Degrees
Radians	3438	Minutes
Radians	0.637	Quadrants
Square Feet	0.00002296 (2.296×10^{-5})	Acres
Square Feet	144	Square inches
Square miles	640	Acres
Square yards	9	Square Feet
Temperature	(°C) 273 × 1	Abs. Temp. (°C)
Temperature	(°C) +17.78 × 1.8	Temp. (°F)
Temperature	(°F) +460 × 1	Abs. Temp. (°F)
Temperature	(°F) —32 × 5/9	Temp. (°C)
Tons Long	2240	Pounds
Tons Short	2000	Pounds
Tons Short	32000	Ounces
Watts	0.05692	Btu./min.
Watts	44.26	Foot-pounds/min.
Watt-Hours	3.415	Btu.
Watt-Hours	2655	Foot-pounds
Yards	3	Feet
Yards	36	Inches
Yards	0.9144	Meters