Pump Sizing and Selection
For Submersible Pumps
Basic Information

1

VERTICAL LIFT/ ELEVATION
The vertical distance between the well head and the level at the point of use. It must be added to the TOTAL DYNAMIC HEAD if the inlet is lower than the outlet and subtracted if the inlet is higher. As a rule of good installation practice, however, pipes should slope continuously upward from the inlet to the outlet to prevent entrapment of air.

2

SERVICE PRESSURE
The range of pressure in the pressure tank during the pumping cycle.

3

PUMPING LEVEL
The lowest water level reached during pumping operation. (Static level – drawdown)

STATIC OR STANDING WATER LEVEL
The undisturbed level of water in the well before pumping. Not as important as pumping level.

DRAWDOWN
The distance that the water level in the well is lowered by pumping. It is the difference between the STATIC WATER LEVEL and the PUMPING LEVEL.

4

FRICTION LOSS
The loss of pressure or head due to the resistance to flow in the pipe and fittings. Friction loss is influenced by pipe size and fluid velocity, and is usually expressed in feet of head.

HORIZONTAL RUN
The horizontal distance between the point where fluid enters a pipe and the point at which it leaves.

5

TOTAL DYNAMIC HEAD or TDH
TDH and capacity required determines pump size. The total pressure or head the pump must develop is the sum of the VERTICAL LIFT/ELEVATION, THE SERVICE PRESSURE, PUMPING LEVEL, and THE FRICTION LOSS. All of these measurements must be expressed in the same units, usually feet of head or pressure (PSI), before adding them together.

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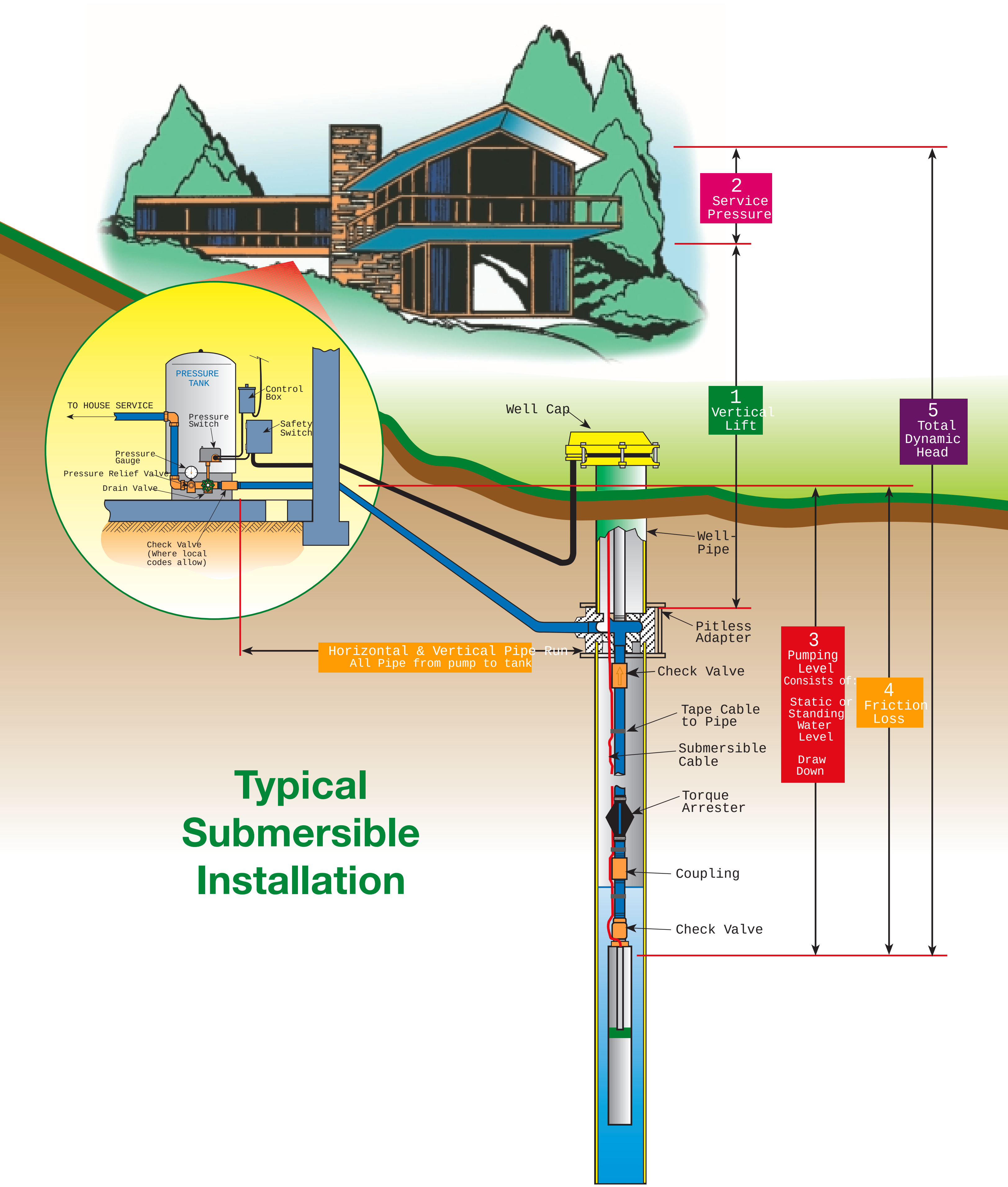

Typical Submersible Installation

Pump Sizing and Selection
For Submersible Pumps

Well Size (inside diameter in inches) _________

Determining Total Dynamic Head

HEAD

1 **Vertical Lift / Elevation**
The vertical distance in feet from the pitless adapter to the top of the pressure tank

+

2 **Service Pressure**
The average (pump shut-off) pressure switch setting x 2.31'. Example for a 30/50 switch: 40 x 2.31' = 92.4 feet

ConvertPSI to feet (X 2.31)

+

3 **Pumping Level**
The vertical distance in feet from the pitless adapter or well seal to the water drawdown level in the well that yelds the flow rate required by the pump

+

4 **Friction Loss**
Water flowing through piping will lose head depending on the size, type and length of piping, number of fittings, and flow rate. Example: Pumping 20 GPM through 500 ft. of 1 1/4" plastic pipe with three elbows will cause a friction loss equal to:

$$\frac{500 \text{ ft.} + 21 \text{ ft. (elbow loss)}}{100 \text{ ft.}} \text{ X } 6.00 \text{ ft (loss per 100')} = 31.26 \text{ ft.}$$

=

Feet of Pipe ____________ **Diameter of Pipe** __________

Type of Pipe ____________

See Friction Loss Charts on Page 2-5

5 **Total Dynamic Head** Ft.

After determining TDH, match this number with capacity required on pump curves of specific pumps in this catalog to select the correct pump.

Gallons Per Minute (or Hour) Needed

Determining Flow Rate

Although methods will vary, in general, the Water Systems Council bases pump flow selection for a residential system on total gallon usage during a seven minute peak demand period. This can be supplemented by using a properly sized pressure tank.

Farms, irrigation and sprinkling demand more water.

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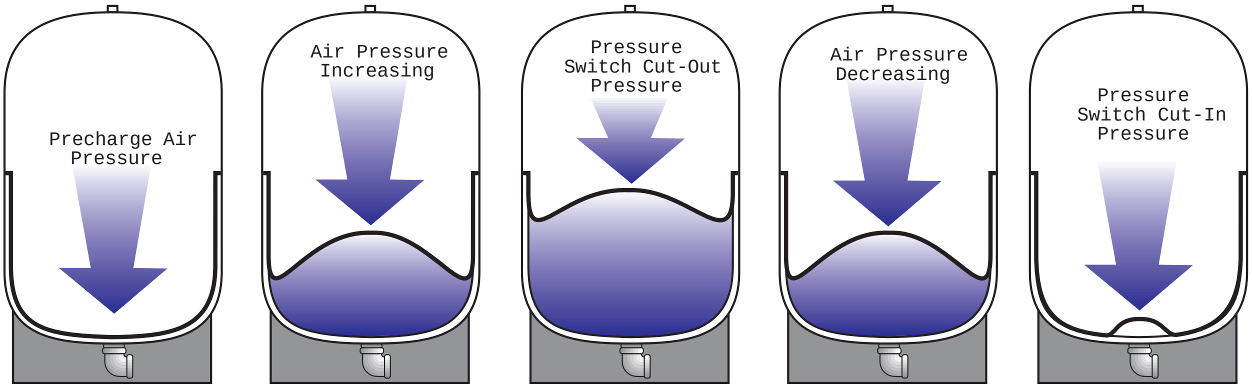
Pressure Tank Sizing

Tank Operation



1 Tank empty Pump comes on and cycle begins

2 Tank is filling

3 Tank is full Pump turns off

4 Water is being used

5 Tank is nearly empty and pump comes on to repeat cycle

Why do I need a tank?

There are four main reasons to include a tank in your system:

1. To protect and extend the life of the pump by reducing the number of cycles.
2. To provide storage of water under pressure for delivery between cycles.
3. To have reserve capacity for periods of peak demand.
4. To reduce system maintenance.

How do I choose a tank for my system?

Choosing the proper tank for your pumping system will greatly reduce the risk of premature pump failure. Most manufacturers recommend a **minimum** run time of one minute in order to protect the pump and the pump motor. The larger the tank the longer the running time and fewer pump cycles will result in longer pump life.
1 HP and larger pumps require longer run times.

To determine the proper size of tank, there are three factors to consider:
1. Pump flow rate in gallons per minute
2. Desired run time of the pump
3. Cut-in and cut-out psi of the pressure switch

From these factors you can determine the tank drawdown with the following equation:
Pump flow rate X run time = tank drawdown capacity required.

Tank drawdown capacity is the minimum amount of water stored and/or delivered by the pressure tank between pump shut-off and pump re-start. This should not be confused with "tank volume." For example, a pre-charged tank with a tank volume of 20 gallons has only 5 to 7 gallons drawdown capacity depending on the cut-in / cut-out (on/off) setting of the pressure switch.

Pumps with flow rates (capacities) up to 10 GPM should have a tank with a minimum of 1 gallon drawdown capacity for each GPM delivered by the pump. Example: 10 GPM pump = 10 gal. "drawdown"

Pump flow rates from 11 to 20 GPM should have tank drawdowns approximately 1.5 times the GPM rating. For example, 20 GPM X 1.5 = 30 gal. "drawdown"

Pump flow rates above 20 GPM should have tank drawdowns approximately 2 times the GPM rating and multiple tanks should be considered.

(Check your tank manufacturer's charts for tank drawdown rating.)

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Friction Loss Charts

Loss of head in feet, due to friction per 100 feet of pipe

3/4" Pipe

FLOW US GAL MIN	STEEL C-100 ID .824"	PLASTIC C-140 ID .824"
1.5	1.13	.61
2.0	1.93	1.04
2.5	2.91	1.57
3.0	4.08	2.21
3.5	5.42	2.93
4.0	6.94	3.74
4.5	8.63	4.66
5.0	10.50	5.66
6.0	–	7.95
7.0	–	10.60

1" Pipe

FLOW US GAL MIN	STEEL C-100 ID 1.049"	PLASTIC C-140 ID 1.049"
2	.595	.322
3	1.26	.680
4	2.14	1.15
5	3.42	1.75
6	4.54	2.45
8	7.73	4.16
10	11.7	6.31
12	–	8.85
14	–	11.8

1 1/4" Pipe

FLOW US GAL MIN	STEEL C-100 ID 1.380"	PLASTIC C-140 ID 1.380"
4	.564	.304
5	.853	.460
6	1.20	.649
7	1.59	.860
8	2.04	1.10
10	3.08	1.67
12	4.31	2.33
14	5.73	3.10
16	7.34	3.96
18	9.13	4.93
20	11.10	6.00
25	–	9.06

1 1/2" Pipe

FLOW US GAL MIN	STEEL C-100 ID 1.61"	PLASTIC C-140 ID 1.61"
4	.267	.144
6	.565	.305
8	.962	.520
10	1.45	.785
12	2.04	1.10
14	2.71	1.46
16	3.47	1.87
18	4.31	2.33
20	5.24	2.83
25	7.90	4.26
30	11.1	6.0
35	–	7.94
40	–	10.20

2" Pipe

FLOW US GAL MIN	STEEL C-100 ID 2.067"	PLASTIC C-140 ID 2.067"
10	.431	.233
15	.916	.495
20	1.55	.839
25	2.35	1.27
30	3.29	1.78
35	4.37	2.36
40	5.60	3.03
45	6.96	3.76
50	8.46	4.57
55	10.10	5.46
60	11.90	6.44
70	–	8.53
80	–	10.90

2 1/2" Pipe

FLOW US GAL MIN	STEEL C-100 ID 2.469"	PLASTIC C-140 ID 2.469"
20	.654	.353
30	1.39	.750
40	2.36	1.27
50	3.56	1.92
60	4.99	2.69
70	6.64	3.58
80	8.50	4.59
90	10.60	5.72
100	–	6.90
110	–	8.25
120	–	9.71
130	–	11.30

3" Pipe

FLOW US GAL MIN	STEEL C-100 ID 3.0"	PLASTIC C-140 ID 3.068"
20	.149	.129
30	.316	.267
40	.541	.449
50	.825	.676
60	1.17	.912
70	1.57	1.22
80	2.03	1.56
90	2.55	1.95
100	3.12	2.37
110	3.75	2.84
120	4.45	3.35
130	5.19	3.90
140	6.00	4.50

4" Pipe

FLOW US GAL MIN	STEEL C-100 ID 4.0"	PLASTIC C-140 ID 4.026"
20	.038	.035
30	.076	.072
40	.128	.120
50	.194	.179
60	.273	.250
70	.365	.330
80	.470	.422
90	.588	.523
100	.719	.613
110	.862	.732
120	1.02	.861
130	1.19	1.00
140	1.37	1.15

Example:
10 GPM with 1' plastic pipe has 6.31' of loss per 100 ft. - if your run is 50 ft., multiply by .5, if 250 ft. multiply by 2.5, etc.

Loss through fittings in terms of equivalent lengths of pipe

TYPE FITTING & APPLICATION	PIPE & FTG. MATERIAL. (Note 1)	EQUIVALENT LENGTH OF PIPE NOMINAL SIZE FITTING & PIPE						
		1/2	3/4	1	1¼	1½	2	2½
Insert coupling	Plastic	3	3	3	3	3	3	3
Threaded adapter Plastic or copper to thread	Copper Plastic	1 3	1 3	1 3	1 3	1 3	1 3	1 3
90° standard elbow	Steel Copper Plastic	2 2 4	3 3 5	3 3 6	4 4 7	4 4 8	5 5 9	6 6 10

TYPE FITTING & APPLICATION	PIPE & FTG. MATERIAL. (Note 1)	EQUIVALENT LENGTH OF PIPE NOMINAL SIZE FITTING & PIPE						
		1/2	3/4	1	1¼	1½	2	2½
Standard tee Flow through side	Steel Copper Plastic	4 4 7	5 5 8	6 6 9	8 8 12	9 9 13	11 11 17	14 14 20
Gate valve	Note 2	2	3	4	5	6	7	8
Swing check valve	Note 2	4	5	7	9	11	13	16

Note 1: Loss figures are based on equivalent lengths of indicated pipe material
Note 2: Loss figures are for screwed valves and are based on equivalent lengths of steel pipe
•Loss figures for copper lines are approximately 10% higher than shown for plastic

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Technical Data

Glossary

ACIDITY—A condition of water when the pH is below 7. See pH.

ALKALINITY—A condition of water when the pH is above 7. See pH.

AQUIFER—A water-saturated geologic unit or system that yields water to wells or springs at a sufficient rate that the wells or springs can serve as practical sources of water.

ARTESIAN WELL (flowing and non-flowing)—Well where the water rises above the surface of the water in the aquifer after drilling is completed. It is a flowing artesian well if the water rises above the surface of the earth.

CENTRIFUGAL—consists of a fan-shaped impeller rotating in a circular housing, pushing liquid towards a discharge opening. Simple design, only wearing parts are the shaft seal and bearings (if so equipped). Usually used where a flow of liquid at relatively low pressure is desired. Not self-priming unless provided with a priming reservoir or foot valve: works best with the liquid source higher than the pump (flooded suction/gravity feed). As the discharge pressure (head) increases, flow and driven power requirements decrease. Maximum flow and motor loading occur at minimum head.

CHECK VALVE—Allows liquid to flow in one direction only. Generally used in suction and discharge line to prevent reverse flow.

CISTERN–A non-pressurized tank (usually underground) for storing water.

COAGULATION—The chemically combining of small particles suspended in water.

CONTAMINATED WATER—Water that contains a disease causing or toxic substances.

DEEP WELL – Use a pump (submersible or deep well jet) to force water upward from a pumping element below the well water level. Not restricted by suction lift limitations.

DRAWDOWN—The vertical distance the water level drops in a well pumped at a given rate.

DYNAMIC HEAD – Vertical distances (in feet) when the pump is running/producing water.

FLOODED SUCTION—Liquid source is higher than pump and liquid flows to pump by gravity. (Preferable for centrifugal pump installations.)

FLOW—The measure of the liquid volume capacity of a pump. Given in Gallons Per Hour (GPH) or Gallons Per Minute (GPM), as well as Cubic Meters Per Hour (CMPH), and Liters Per Minute (LPM).

FOOT VALVE—A type of check valve with a built-in strainer. Used at point of liquid intake to retain liquid in the system, preventing loss of prime when liquid source is lower than pump.

FRICTION LOSS – The loss of pressure or head due to the resistance to flow in the pipe and fittings. Friction loss is influenced by pipe size and fluid velocity, and is usually expressed in feet of head.

GRAINS PER GALLON—The weight of a substance, in grains, in a gallon. Commonly, grains of minerals per gallon of water as a measure of water hardness. 1 gpg = 17.1 mgl.

GROUND WATER—Water that has filtered down to a saturated geologic formation beneath the earth's surface.

HARDNESS MINERALS—Minerals dissolved in water that increase the scaling properties and decrease cleansing action - usually calcium, iron and magnesium.

HEAD—Another measure of pressure, expressed in feet. Indicates the height of a column of water being lifted by the pump neglecting friction losses in piping.

INCRUSTATION—A mineral scale chemically or physically deposited on wetted surfaces, such as well screens, gravel packs, and in tea kettles.

INTERMEDIATE STORAGE—A holding tank included in a water system when the water source does not supply the peak use rate.

JET PUMP – A pump combining two pumping principles - centrifugal operation and ejection. Can be used in shallow or deep wells.

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MILLIGRAMS PER LITER (mg/l)—The weight of a substance, in milligrams in a liter. 1 mg/l = 1 oz. per 7500 gallons. It is equivalent to 1 ppm; see Parts per Million.

NEUTRALITY—A condition of water when the pH is at 7. See pH.

OXIDATION—A chemical reaction between a substance and oxygen.

PALATABLE WATER—Water of acceptable taste. May also include non-offensive appearance and odor.

PARTS PER MILLION, ppm—A measure of concentration; one unit of weight or volume of one material dispersed in one million units of another; e.g., chlorine in water, carbon monoxide in air. Equivalents to indicate small size of this unit: 1 ppm = 1 oz. per 7500 gallons; 1 kernel of corn in 13 bushels 1/4 sq. in. in an acre.

PEAK USE RATE—The flow rate necessary to meet the expected maximum water demand in the system.

pH—A measure of the acidity or alkalinity of water. Below 7 is acid, above 7 is alkaline.

POLLUTED WATER—Water containing a natural or man-made impurity.

POTABLE WATER—Water safe for drinking.

PRESSURE—The force exerted on the walls of a container (tank pipe, etc.) by the liquid. Measured in pounds per square inch (PSI).

PRIME—A charge of liquid required to begin pumping action of centrifugal pumps when liquid source is lower than pump. May be held in pump by a foot valve on the intake line or a valve or chamber within the pump .

RELIEF VALVE—Usually used at the discharge of a pump. An adjustable, spring-loaded valve opens, or relieves pressure when a pre-set pressure is reached. Used to prevent excessive pressure and pump or motor damage if discharge line is closed off.

SHALLOW WELL – Use a pump located above ground to lift water out of the ground through a suction pipe. Limit is a lift of 33.9 feet at sea level.

SOFTENING-The process of removing hardness caused by calcium and magnesium minerals.

SPRING—A place on the earth's surface where ground water emerges naturally.

STATIC HEAD—Vertical Distance (in Feet) from pump to point of discharge when the pump is not running.

STRAINERS—A device installed in the inlet of a pump to prevent foreign particles from damaging the internal parts.

SUBMERGENCE / SETTING - The vertical distance between PUMPING LEVEL and the bottom of the pump or jet assembly. Submergence must be sufficient to insure that the suction opening of the pump or jet assembly is always covered with water, while maintaining enough clearance from the bottom of the well to keep it out of sediment (at least 10 feet clearance is recommended). Could be useful when figuring friction loss.

SUBMERSIBLE—A pump which is designed to operate totally submersed in the fluid which is being pumped. With water-proof electrical connections, using a motor which is cooled by the liquid.

SUMP—A well or pit in which liquids collect below floor level.

SURGING—Forcing water back and forth rapidly and with more than normal force in a well or other part of the water system.

TOTAL HEAD—The sum of discharge head suction lift and friction losses.

VISCOSITY— The thickness of a liquid, or its ability to flow. Temperature must be stated when specifying viscosity, since most liquids flow more easily as they get warmer. The more viscous the liquid the slower the pump speed required.

WATER TABLE WELL—A well where the water level is at the surface of the aquifer.

WATER TREATMENT—A process to improve the quality of water.

WATER WELL—A man-made hole in the earth from which ground water is removed.

WELL DEVELOPMENT—A process to increase or maintain the yield of a well.

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Technical Data

Metric Conversion Tables

MEASUREMENT CONVERSION FACTORS (Approximate)

Metric x Conversion Factor = Customary

Metric		Conversion Factor	Customary	
LENGTH				
mm	millimeter	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
AREA				
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10.000 m2)	2.5	acres	
MASS (weight)				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes(1000kg)	1.1	shorttons	
VOLUME				
ml	milliliters	0.03	fluid ounces	n oz
1	liters	2.1	pints	pt
1	liters	1.06	quarts	qt
1	liters	0.26	gallons	gal
m^3	cubic meters	35.3	cubicteet	tt^3
m^3	cubic meters	1.3	cubic yards	yd^3
m^3	cubic meters	264.2	gallons	gal.
FORCE/AREA				
kPa	kilo paschals	.145	pound force/in^2	psi
bar	bar	14.5	pound force/in^2	psi

Customary x Conversion Factor = Metric

Customary		Conversion Factor	Metric	
LENGTH				
in	inches	2.54	centimeters	cm
tt	feet	30.5	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
AREA				
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square teet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
a	acres	0.4	hectares	ha
MASS (weight)				
oz	ounces	28	grams	9
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
VOLUME				
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
tl oz	tluid ounces	30	milliliters	ml
c	cups	0.24	liters	
pt	pints	0.47	liters	
qt	quarts	0.95	liters	
gal	gallons	3.8	liters	
ft^3	cubic teet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
gal	gallons	.0038	cubic meters	m^3
FORCE/AREA				
psi	pound force/in^2	6.89	kilo paschals	kPa
psi	pound force/in^2	.069	bar	bar

Average water requirements for general service around the home and farm

Each person, per day for all purposes	100 gal.
Each horse, dry cow or beef animal	12 gal.
Each milking cow	35 gal.
Each hog per day	4 gal.
Each sheep per day	2 gal.
Each 100 chickens per day	4 gal.

Average amount of water required by various home and yard fixtures

Drinking fountain	50-100 gal./day
Each shower	25-60 gal. @ 5 GPM
To fill bathtub	35 gal.
To flush toilet	3-7 gal.
To fill lavatory	1-2 gal.
To sprinkle 1/4" of water on each 1000 sq. ft. of lawn	160 gal.
Dishwasher	10-20 gal. @ 2 GPM
Washer	up to 50 gal. @ 4-6 GPM
Regeneration of water softener	up to 150 gal.

Average flow rate requirements by various fixtures
GPM = Gal. per minute • GPH = Gal. per hour

Shower	3-5 GPM
Bathtub	3-5 GPM
Toilet	4 GPM
Lavatory	4 GPM
Kitchen sink	5 GPM
1/2" hose & nozzle	3 GPM
3/4" Hose & nozzle	6 GPM
Lawn sprinkler	3-7 GPM

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Technical Data

Centrifugal Pumps • Formulas and Conversion Factors

Pipe velocity (ft. per second) $= \dfrac{.408 \times \text{GPM}}{(\text{pipe diameter})^2} = \dfrac{.321 \times \text{GPM}}{\text{pipe area}}$

Velocity head (feet) $= \dfrac{(\text{pipe velocity ft. per second})^2}{64.4}$

Water horsepower $= \dfrac{\text{GPM} \times \text{head in ft.} \times \text{specific gravity}}{3960}$

Brake horsepower (pump) $= \dfrac{\text{GPM} \times \text{head in ft.} \times \text{specific gravity}}{3960 \times \text{pump efficiency}}$

Efficiency (pump) $= \dfrac{\text{GPM} \times \text{head in ft.} \times \text{specific gravity}}{3960 \times \text{BHP}} = \dfrac{\text{WHP}}{\text{BHP}}$

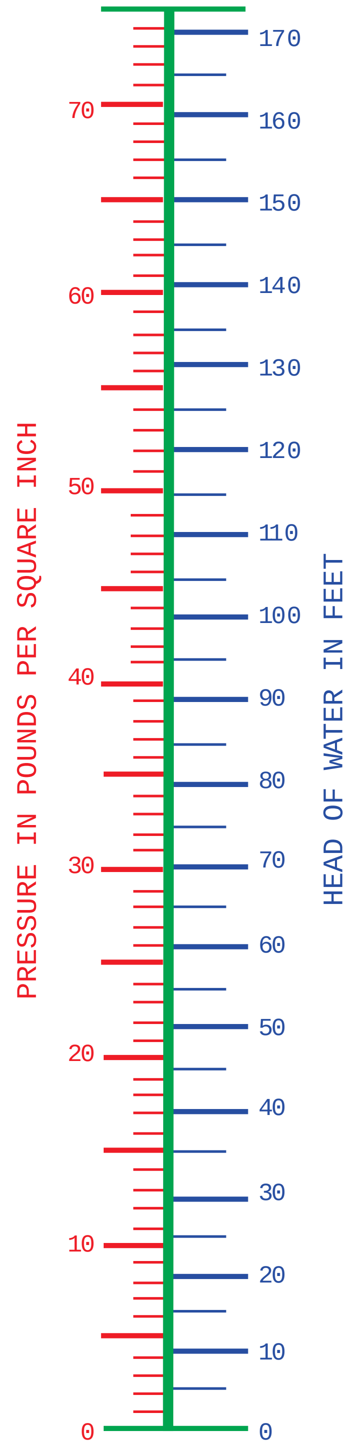
Brake horsepower (motor) $= \dfrac{\text{Watts input} \times \text{motor efficiency}}{746}$

Pressure (lbs. per sq. in.) $= \dfrac{\text{Head ft.} \times \text{specific gravity}}{2.31'} = \text{Head ft.} \times \text{specific gravity} \times .433$

Head feet $= \dfrac{\text{Lbs. per sq. in.} \times 2.31'}{\text{Specific gravity}}$

Lbs. per square in. = Head in ft. x .433

Head in ft. = lbs. per sq. in. x 2.31'



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Technical Data

Drop Cable Selction Chart

SINGLE-PHASE, TWO OR THREE WIRE CABLE, 60 HZ (SERVICE ENTRANCE TO MOTOR)

Motor Rating		Copper Wire Size									
Volts	HP	14	12	10	8	6	4	4	2	1	0
	1/3	130	210	340	540	840	1300	1610	1960	2390	2910
115	1/2	100	160	250	390	620	960	1190	1460	1780	2160
	1/3	550	880	1390	2190	3400	5250	6520	7960	9690	11770
	1/2	400	650	1020	1610	2510	3880	4810	5880	7170	8720
	3/4	300	480	760	1200	1870	2890	3580	4370	5330	6470
	1	250	400	630	990	1540	2380	2960	3610	4410	5360
230	1.5	190	310	480	770	1200	1870	2320	2850	3500	4280
	2	150	250	390	620	970	1530	1910	2360	2930	3620
	3	120	190	300	470	750	1190	1490	1850	2320	2890
	5	0	110*	180	280	450	710	890	1110	1390	1740
	7.5	0	0	120*	200	310	490	610	750	930	1140
	10	0	0	0	160*	250	390	490	600	750	930
	15	0	0	0	0	170*	270	340	430	530	660

1 foot - .3048 meter

THREE-PHASE, THREE WIRE CABLE, 60 HZ 200 AND 230 VOLTS (SERVICE ENTRANCE TO MOTOR)

Motor Rating		Copper Wire Size (1)												
Volts	HP	14	12	10	8	6	4	3	2	1	0	00	000	0000
	1/2	710	1 140	1800	2840	4420								
	3/4	510	810	1280	2030	3160								
	1	430	690	1080	1710	2670	4140	5140						
	1.5	310	500	790	1260	1960	3050	3780						
	2	240	390	610	970	1520	2360	2940	3610	4430	5420			
200V	3	180	290	470	740	1160	1810	2250	2760	3390	4130			
60 Hz	5	110*	170	280	440	690	1000	1350	1660	2040	2490	3050	3670	4440
Three Phase	7.5	0	0	200	310	490	770	960	1180	1450	1770	2170	2600	3150
Three Wire	10	0	0	150*	230	370	570	720	880	1090	1330	1640	1970	2390
	15	0	0	0	160	250	390	490	600	740	510	1110	1340	1630
	20	0	0	0	0	190'	300	380	460	s70	700	860	1050	1270
	25	0	0	0	0	0	240*	300	370	460	570	700	840	1030
	30	0	0	0	0	0	200*	250*	310	380	470	580	700	850
	1/2	810	1300	2040	3210	4990								
	3/4	590	940	1480	2330	3620								
	1	490	790	1240	1 960	3050	4720	5860						
	1.5	360	580	920	1450	2260	3510	4360						
230V	2	280	450	700	1110	1740	2710	3370	4130	5070	6200			
60 Hz	3	210	340	540	860	1340	2080	2580	3170	3830	4730			
Three-Phase	5	130*	200	320	510	800	1240	1550	1900	2330	2850	3490	4200	5080
Three Wire	7.5	0	140*	230	360	570	890	1100	1350	1660	2030	2480	2980	3600
	10	0	0	170*	270	420	660	820	1010	1240	1520	1870	2260	2740
	15	0	0	0	180*	290	450	560	690	850	1040	1280	1540	1860
	20	0	0	0	140*	220*	350	430	530	660	810	990	1200	1450
	25	0	0	0	0	180*	260	350	430	530	650	800	970	1170
	30	0	0	0	0	0	230*	290	350	440	540	660	800	970
	1/2	3770	6020	9460										
	3/4	2730	4350	6850										
	1	2300	3670	5770	9070									
	1.5	1700	2710	4270	6730									
	2	1300	2070	3270	5150	8050								
	3	1000	1600	2520	3970	6200								
460v	5	590	950	1500	2360	3700	5750							
60 Hz	7.5	420	680	1070	1690	2640	4100	5100	6260	7680				
Three Phase	10	310	500	790	1250	1960	3050	3800	4680	5750	7050			
ThreeWire	15	0	340*	540	850	1340	2090	2600	3200	3930	4810	5900	7110	
	20	0	0	410	650	1030	1610	2000	2470	3040	3730	4560	5530	
	25	0	0	330*	530	830	1300	1620	1990	2450	3010	3700	4470	5430
	30	0	0	270*	430	680	1070	1330	1640	2030	2490	3060	3700	4500
	40	0	0	0	320*	500*	790	980	1210	1490	1830	2250	2710	3290
	50	0	0	0	0	410*	640	800	980	1210	1480	1810	2190	2650
	60	0	0	0	0	0	540*	670*	830	1020	1250	1540	1850	2240
	75	0	0	0	0	0	440*	550*	680*	840	1030	1260	1520	1850
	100	0	0	0	0	0	0	0	500*	620*	760*	940	1130	1380
	125	0	0	0	0	0	0	0	0	0	600*	740*	890*	1000
	150	0	0	0	0	0	0	0	0	0	0	630*	760*	920*
	175	0	0	0	0	0	0	0	0	0	0	0	670*	810*
	200	0	0	0	0	0	0	0	0	0	0	0	590*	710*

Lengths marked * meet the U.S. National Electrical Code ampacity only for individual conductor 75°C. cable. Only the lengths without * meet the code for jacketed 75°C cable. Local code requirements may vary.

CAUTION!! Use of wire sizes smaller than determined above will void warranty, since low starting voltage and early failure of the unit will result. Larger wire sizes (smaller numbers) may always be used to improve economy of operation.

(1) If aluminum conductor is used, multiply above lengths by 0.61. Maximum allowable length of aluminum wire is considerably shorter than copper wire of same size.

Pump Sizing and Selection
For Aboveground Pumps
Basic Information

1

VERTICAL LIFT/ ELEVATION
The vertical distance between the well head and the level at the point of use. It must be added to the TOTAL DYNAMIC/TOTAL DISCHARGE HEAD if the inlet is lower than the outlet and subtracted if the inlet is higher. As a rule of good installation practice, however, pipes should slope continuously upward from the inlet to the outlet to prevent entrapment of air.

2

SERVICE PRESSURE
The range of pressure in the pressure tank during the pumping cycle.

3

FRICTION LOSS
The loss of pressure or head due to the resistance to flow in the pipe and fittings. Friction loss is influenced by pipe size and fluid velocity, and is usually expressed in feet of head.

HORIZONTAL RUN
The horizontal distance between the point where fluid enters a pipe and the point at which it leaves.

4

TOTAL DYNAMIC/TOTAL DISCHARGE HEAD or TDH
TDH and capacity required determines pump size. The total pressure or head the pump must develop is the sum of VERTICAL LIFT/ELEVATION, THE SERVICE PRESSURE, and THE FRICTION LOSS. All of these measurements must be expressed in the same units, usually feet of head or pressure (PSI), before adding them together. For aboveground pumps, distance to water in feet are shown in the respective charts.

5

PUMPING LEVEL
The lowest water level reached during pumping operation. (Static level minus drawdown)

STATIC OR STANDING WATER LEVEL
The undisturbed level of water in the well before pumping. Not as important as pumping level.

DRAWDOWN
The distance that the water level in the well is lowered by pumping. It is the difference between the STATIC WATER LEVEL and the PUMPING LEVEL.

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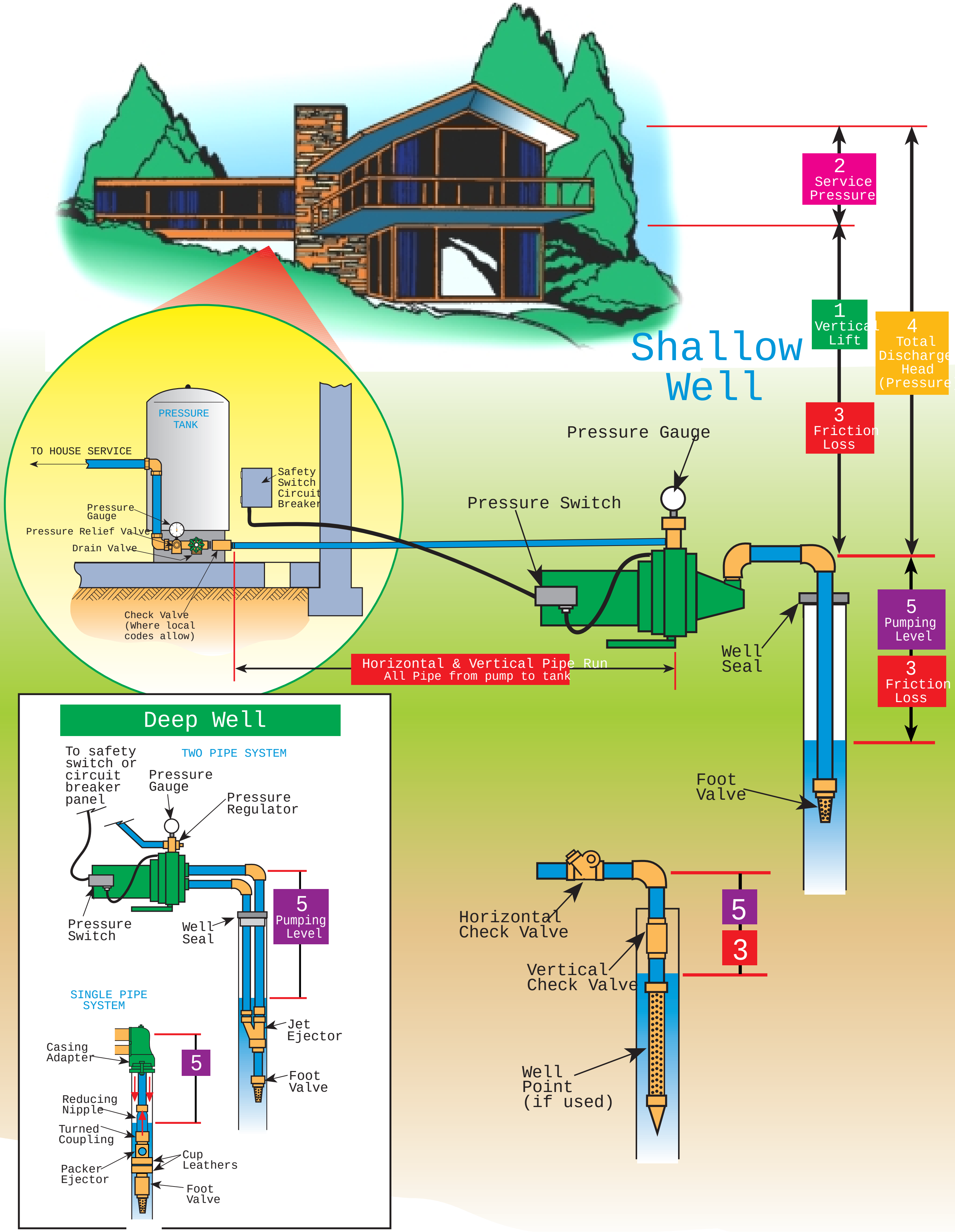
Typical Jet Pump Installations



Pump Sizing and Selection
For Aboveground Pumps

The difference between submersible pump and surface pump sizing is that surface pumps, including jet pumps, show performance in "charted" form versus "curves" for submersibles. Except for the "pumping level" (which is shown in feet in the charts) all other head/lift requirements should be converted to PSIG for surface pump sizing. (Feet X .433 = PSIG (Pounds per Square Inch Gage).

Well size (inside diameter in inches) _______________

1 Vertical Lift / Elevation

The vertical distance in feet from the location of the pump to the point of highest delivery (e.g. from a pump house near the well to the second floor of a two story house)

[ ] Feet X .433 [ ] PSIG

+

2 Service Pressure

The average pressure switch setting.
Example 20/40 switch (1/2 HP) = 30 PSIG average (3/4 HP and larger pumps have 30/50 switch settings) = 40 PSIG average

[ ] PSIG

+

3 Friction Loss

Water flowing through piping will lose head depending on the size, type and length of piping, number of fittings, and flow rate. Example: Pumping 10 GPM through 100 ft. of 1" plastic pipe with 3 elbows will cause a friction loss equal to:

[ ] Feet X .433 [ ] PSIG

$$\frac{100 \text{ ft.} + 18 \text{ ft. (elbow loss)}}{100 \text{ ft.}} \text{ X } 6.31 \text{ ft (loss per 100')} = 7.44' \text{ X } .433 = 3.2 \text{ PSIG}$$

=

Feet of Pipe ________ **Diameter of Pipe** ______ **Type of Pipe** __________

See Friction Loss Charts on Page 2-5

4 Total Dynamic/Discharge Head • 1 + 2 + 3 =

[ ] PSIG

5 Pumping Level/Depth to Water

The vertical distance in feet from the pump to the water level including draw down level - if any. In Shallow Well systems, referred to as suction lift/head and is limited to 20 or 25 feet at sea level (deduct 1' suction capability for each 1000' above sea level). Note: Friction losses (3) in the suction piping must be added to the pumping level for total suction lift.

No need to convert. Charts are in feet

[ ] Ft

If 25' or less, use shallow well charts

If more than 25' use deep well charts

Deep Well jet pump charts include the friction losses in the vertical piping only. See page 4-17 if long horizontal, offset piping cannot be avoided.

Determining Flow Rate

Although methods will vary, in general, the Water Systems Council bases pump flow selection for a residential system on total gallon usage during a seven minute peak demand period. This can be supplemented by using a properly sized pressure tank.

Farms, irrigation and sprinkling demand more water.

Gallons Per Minute (or hour) Needed

See Page 2-8 for water demands

[ ]

After determining TDH and flow requirements in GPM / GPH, match these numbers with surface pump charts in sections 4 and 5.

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