

WATER SYSTEM SIZING

Introduction

It is crucial that water supply systems are properly sized. Well owners are often concerned about whether or not there will be enough water for their needs. The area geology determines how successful a well drilling contractor may be in obtaining a suitable water supply from a well.

“Enough” water means a sufficient quantity *with sufficient pressure* to meet the following needs:

- ✓ Everyday use – drinking, cooking, and water for plumbing
- ✓ Seasonal use – lawn and garden watering, car washing, and swimming pool
- ✓ Other special uses – animal watering, crop irrigation, and water treatment devices that require backwashing

A day's use may be concentrated into a period of one to two hours, often in different areas of the house at the same time (laundry, bathroom, and lawn). The water supply system must be able to meet this type of peak demand.

In addition to providing for regular household use, wells sometimes supply water for heating and cooling purposes. Some energy-conscious homeowners install groundwater geothermal systems, which extract and concentrate heat energy from water and make it available for heating or cooling purposes.

According to the well construction code in Michigan, there is no minimum gallons per minute a well must produce. This is because a few areas of the state (e.g. “Thumb”, Upper Peninsula, and SE Michigan) have groundwater conditions that do not produce more than just 2-3 gallons per minute. However, the well code does have a provision that requires the well be “adequate in size, design, and development for the intended use.” That is why it is very important for a well owner to discuss their needs with the well drilling contractor prior to drilling the well.

In designing a water supply system the following factors should be considered:

- *Peak demand of the house or facility*
- *The capacity of the well*
- *The total dynamic head the pump must overcome*
- *Storage Tank capacity*

In cases where local groundwater conditions do not produce enough water for the needs of the owner, well drilling contractors should take the necessary steps (e.g. increase storage capacity or screen length) to provide the well owner with as much water as possible.

Residential Water System Sizing

A properly designed residential water supply system should deliver water at the desired quantity, quality, and pressure to any outlet on the system during periods of heaviest use. To accomplish this, the peak demand for the home is determined and the well and pump are sized to meet or exceed the demand. If local geological conditions prohibit the development of a water supply with quantity to meet the demand, additional storage facilities are necessary.

Determining the Pump Capacity

A simple method of determining pump capacity is based on the number of water using fixtures or outlets. The pump capacity (in gallons per minute or GPM) should equal the total number of fixtures in the home.

EXAMPLE:

The Smith residence has 2 bathrooms (each with a water closet, tub/shower, and lavatory), kitchen sink, garbage disposal, dishwasher, washing machine, laundry sink, and 3 outside hose bibs. A total of 14 fixtures are present. Therefore, the minimum pump capacity should be 14 gpm.

Peak demand periods occur when several fixtures are used at the same time. The average time of high water usage from fixtures such as showers, dishwashers, washing machines, etc., is seven (7) minutes. The seven minute peak demand and minimum pump size for modern residences may be obtained from Table 1.

No. of Bathrooms	7 Minute Peak Demand (GAL)*	Minimum Pump Size to Meet PD (GPM)**
1	45	7
1.5	70	10
2 to 2.5	98	14
3 to 4	122	17

* Includes water usage for kitchen sink, washing machine, and dishwasher. Additional demand for farm, irrigation, and sprinkling must be added to peak demand figures if usage will occur during peak demand periods.

** Minimum pump size to meet peak demands without supplemental storage.

Pump Capacity Meets or Exceeds Demand

If the actual pump capacity is equal to or exceeds the minimum pump size indicated in Table 1, supplemental storage is not required. The pressure tank should then be sized to provide a tank draw-off equal to the pump capacity for a one to two minute pump cycle. See *"Determining Storage Capacity" below*

EXAMPLE

The well for the Smith residence is capable of sustaining a 14 gpm pump. Table 1 indicates the 7 minute peak demand for the Smith's 2-bathroom home is 98 gpm. Since the 14 gpm pump will supply 98 gallons during the 7 minute peak period, supplemental storage is not necessary. A one minute pump cycle would produce 14 gallons of water. Therefore, the pressure tank selected should provide a minimum draw-off (available water volume) of 14 gallons. If a two minute pump cycle were desired, the pressure tank should be sized to provide 28 gallons of available water. Manufacturer's specifications should be consulted to determine which model pressure tank will supply the necessary volume at the desired operating pressure.

Pump Capacity Less Than Demand

If the actual pump capacity is less than the minimum pump size indicated in Table 1, supplemental storage is necessary to meet peak demands. The difference between the 7 minute peak demand and the amount of water provided by the pump during a 7 minute period is the volume that must be provided from storage. The pressure tank should then be sized to provide a tank draw-off equal to the difference between the 7 minute peak demand and the 7 minute pump capacity.

EXAMPLE

The well for the Jones residence is capable of sustaining a 10 gpm pump. The 7 minute peak demand for the Jones residence is 98 gpm. During the 7 minute period, the pump will produce 70 gallons of water. $98 - 70 = 28$ gallons. Twenty eight gallons must be supplied from storage during the 7 minute peak demand period. Therefore, the pressure tank selected should provide a minimum draw-off (available water volume) of 28 gallons.

The additional volume required can also be provided by precharging the pressure tank and adjusting the pressure switch settings. Precharging is the addition of air to the pressure tank. If the precharge pressure is about 5 psi below the pump cut-in pressure, supplemental supply is obtained from the tank. When the demand exceeds the pump capacity the pressure will drop, and the supplemental supply from the tank will be used to meet the demand.

EXAMPLE

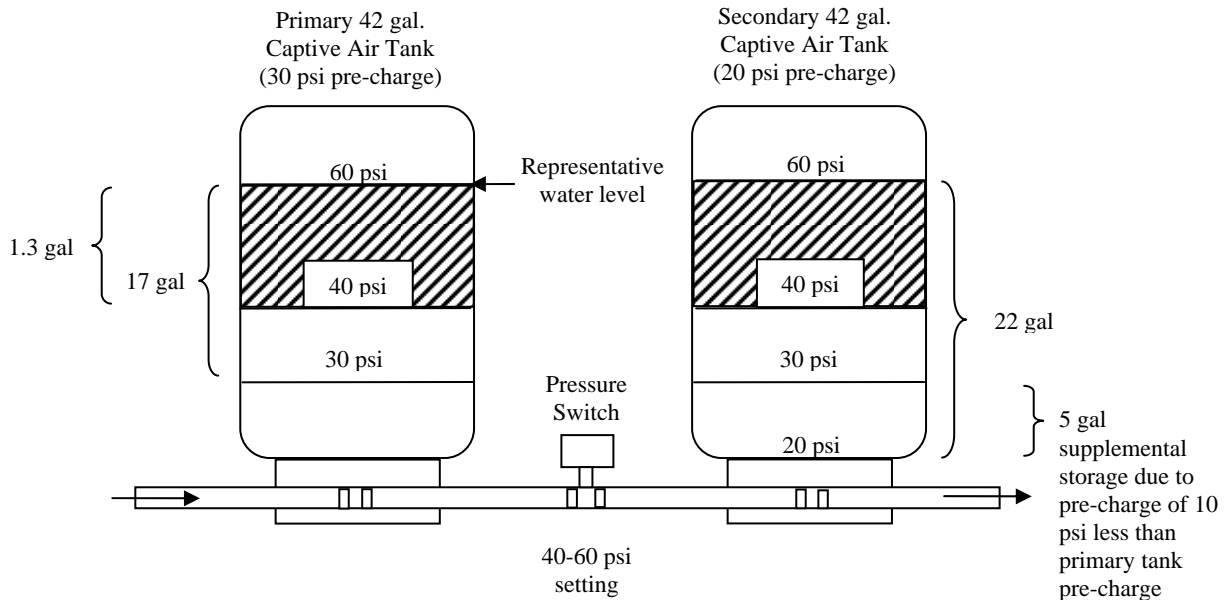
It was determined that the minimum tank draw-off for the Jones residence should be 28 gallons. If a 120 gallon plain steel tank (no diaphragm) were installed and operated at 30-50 psi without a precharge, about 10 percent of the total tank volume, or 12 gallons (from manufacturer's specifications) would be available from the tank. By lowering the operating pressure to 20-40 psi and precharging the tank to 15 psi the usable tank capacity will increase to 37.4 gallons or 31 percent. This volume would then meet the 7 minute peak demand.

If an additional pressure tank is installed for supplemental storage, the precharge of the second tank should be lower than that of the primary tank. The differential pressure switch range should also be set closer. This will increase the overall operating range of the system and provide additional water for peak demand.

EXAMPLE

The Black residence has a 7 minute peak demand of 70 gallons. The Blacks complain of running out of water and have requested that additional storage be added. The well produces 5 gpm and a 42 gallon diaphragm-type captive air tank is currently installed. The system is operating at 30-50 psi and the tank has a precharge of 30 psi. During the 7 minute peak demand, the pump will produce 35 gpm. $70 - 35 = 35$ gallons. Thirty five gallons must be produced from storage during the 7 minute peak demand period. Therefore, the present tank plus the additional tank must provide at least 35 gallons of water. The usable capacity of the existing tank is about 31 percent or 13 gallons. Therefore, the supplemental storage must provide 22 gallons of water. If an additional 42 gallon tank, precharged to 20 psi, is installed and the pressure switch adjusted to 40-60 psi, the usable capacity of the primary tank will increase to 17 gallons and the second tank will provide about 22 gallons. The pressure tanks will provide water over a 40 psi differential, from 20-60 psi, and the total volume of available water from the pressure tank has now increased to 39 gallons. When the pressure drops, to the pump cut-in pressure of 40 psi,

there will be about 5.7 gallons left in the primary tank and 10.7 gallons in the secondary tank. If the demand lowers the pressure to 30 psi, the first tank will essentially be out of water and 5 gallons will remain in the secondary tank. If the pressure continues to decrease to 20 psi, both tanks will be out of water and the only supply will be from the pump. The diagram below illustrates this installation.



Reference: Water Systems Handbook, 7th Edition, 1980.
Water Systems Council, 221 N. LaSalle St., Chicago, IL 60601

DETERMINING TOTAL DYNAMIC HEAD

The total dynamic head of a water system must be considered when determining the size of pumping equipment to be installed. It determines the various head losses that the pump must overcome. Total dynamic head = elevation head + friction head loss + pressure head.

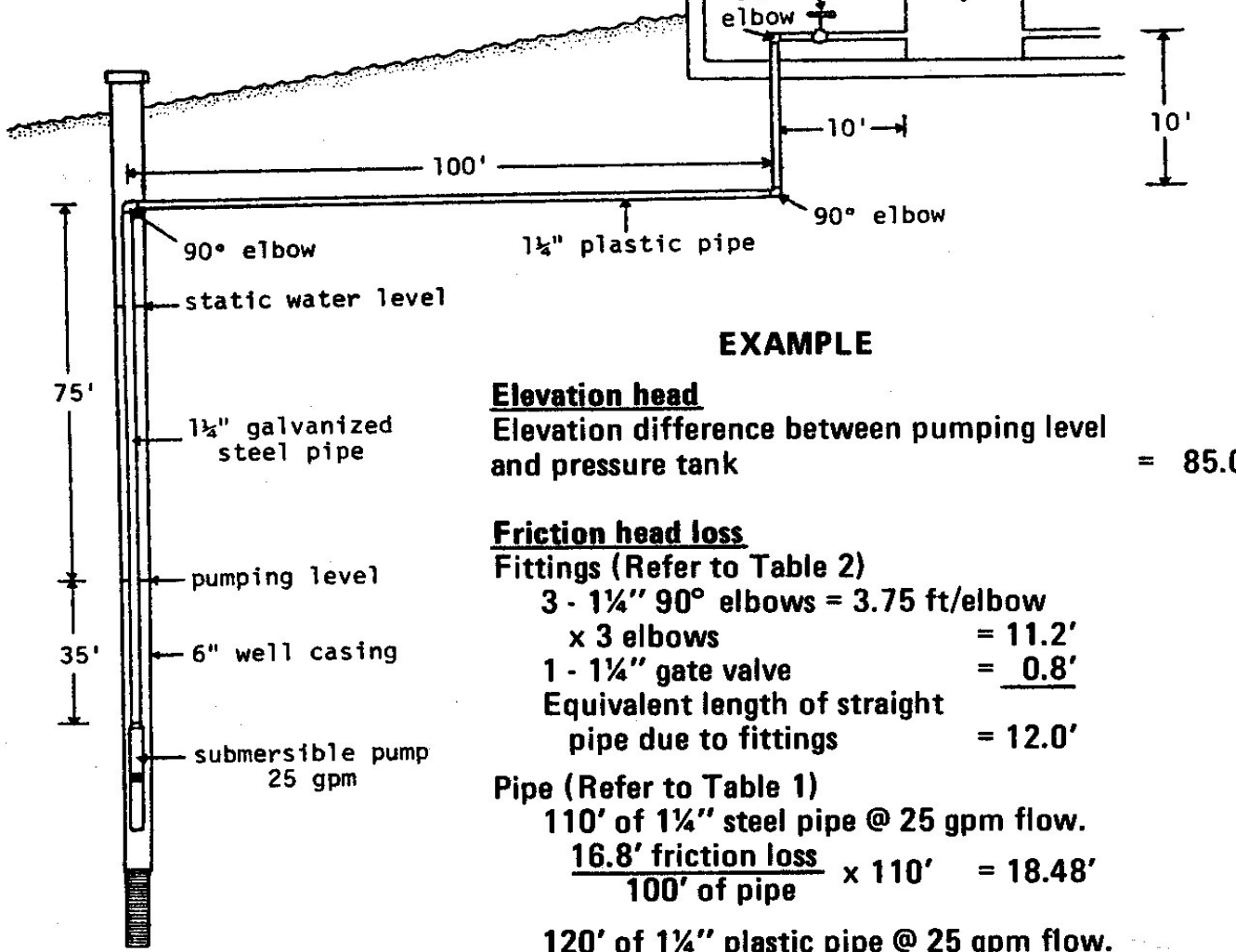
- A. Elevation head - is the vertical distance which the water must be pumped. It is the elevation difference in feet between the pumping level in the well and the pressure tank.
- B. Friction head loss is the loss of pressure due to the flow of water through pipe and fittings. Determine diameter, length, and type of pipe material through which the water flows from the well to the pressure tank. Using the pump flow rate as determined from the Residential Unit Method or Fixture Method, refer to Table I (Friction Loss Charts) and Table 2 (Resistance of Valves and Fittings to Flow of Fluids) to determine friction head loss due to pipe and fittings. Friction loss can be overcome by using a larger pipe size or changing piping materials. (Note: In small water systems with few fittings, the head loss due to the fittings may be disregarded.)
- C. Pressure head - is the maximum operating pressure of the water system converted from pressure (psi) to feet of head. If the pressure switch setting is 30-50 psi, then the maximum pressure is 50 psi. Convert psi to feet of head using the following conversion:

1psi = 2.31 feet of head. Therefore, pressure head equals maximum operating pressure x 2.31 feet.

D. Other head losses to be considered:

Water softener	10 psi x 2.31 = head in feet
Iron filter.....	20 psi x 2.31 = head in feet
Hot water heater	2 psi x 2.31 = head in feet

TOTAL DYNAMIC HEAD CALCULATION



TOTAL WELL DEPTH=125'

EXAMPLE

Elevation head
 Elevation difference between pumping level and pressure tank = 85.00'

Friction head loss
 Fittings (Refer to Table 2)
 3 - 1 1/2" 90° elbows = 3.75 ft/elbow
 x 3 elbows = 11.2'
 1 - 1 1/2" gate valve = 0.8'
 Equivalent length of straight pipe due to fittings = 12.0'

Pipe (Refer to Table 1)
 110' of 1 1/2" steel pipe @ 25 gpm flow.
 16.8' friction loss / 100' of pipe x 110' = 18.48'

120' of 1 1/2" plastic pipe @ 25 gpm flow.
 Equivalent length of pipe due to fittings must be added to the plastic pipe length. 120' + 12' = 132'

9.06' friction loss / 100' of pipe x 132' = 11.95'

Friction head loss: 18.48' + 11.95' = 30.43'

Pressure head
 30-50 psi pressure switch setting. Maximum discharge pressure = 50 psi.
 50 psi x 2.31 ft/psi = 115.50'

Total dynamic head
 85.00' + 30.43' + 115.50' = 231'

FRICTION LOSS CHART





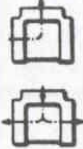




1 1/2 inch to 2 1/2 inch pipe and under 300 GPM

Loss of Head in Feet, Due to Friction Per 100 Feet of Pipe

1 1/2 INCH				2 INCH				2 1/2 INCH			
GP M	Steel	Copper	Plastic	GP M	Steel	Copper	Plastic	GP M	Steel	Copper	Plastic
	C=100	C=130	C=140		C=100	C=130	C=140		C=100	C=130	C=140
	ID=1.61"	ID=1.60"	ID=1.61"		ID=2.067"	ID=2.062"	ID=2.067		ID=2.469"	ID=2.50"	ID=2.469"
4	0.267	0.165	0.144	10	0.431	0.268	0.233	20	0.654	0.375	0.353
6	0.565	0.358	0.305	15	0.916	0.569	0.495	30	1.39	0.792	0.75
8	0.962	0.611	0.52	20	1.55	0.962	0.839	40	2.36	1.35	1.27
10	1.45	0.923	0.785	25	2.35	1.45	1.27	50	3.56	2.04	1.92
12	2.04	1.29	1.1	30	3.29	2.03	1.78	60	4.99	2.86	2.69
14	2.71	1.71	1.46	35	4.37	2.71	2.36	70	6.64	3.82	3.58
16	3.47	2.2	1.87	40	5.6	3.47	3.03	80	8.5	4.88	4.59
18	4.31	2.75	2.33	45	6.96	4.31	3.76	90	10.6	6.06	5.72
20	5.24	3.31	2.83	50	8.46	5.24	4.57	100	12.8	7.37	6.9
25	7.9	5	4.26	55	10.1	6.22	5.46	110	15.3	8.8	8.25
30	11.1	7	6	60	11.9	7.34	6.44	120	18	10.3	9.71
35	14.7	9.35	7.94	70	15.8	9.78	8.53	130	20.9	12	11.3
40	18.9	12	10.2	80	20.2	12.5	10.9	140	23.9	13.7	12.9
45	23.4	14.9	12.63	90	25.1	15.6	13.6	150	27.3	15.6	14.7
50	28.5	18.1	15.4	100	30.5	18.9	16.5	160	30.7	17.6	16.6
55	34	21.5	18.35	110	36.4	22.5	19.7	170	34.3	19.7	18.5
60	40	25.3	21.6	120	42.7	26.6	23.1	180	38.1	21.9	20.6
65	46.4	29	25.1	130	49.6	30.7	26.8	190	42.1	24.2	22.7
70	53.2	33.8	28.7	140	56.9	35.2	30.6	200	46.3	26.6	25
75	60.4	38	32.6	150	64.7	40.1	35	220	55.3	31.8	29.8
80	68.1	43.1	36.8	160	72.8	45.1	39.3	240	66.4	37.4	35.8
85	76.2	47.6	41.2	170	81.4	50.5	44	260	75.3	43.3	41.6
90	84.7	53.6	45.7	180	90.5	56.1	48.9	280	86.3	49.4	46.6
95	93.6	58.8	50.5	190	100	62	54	300	98.1	56.8	52.9
100	103	65.1	56.6	200	110	68	59.4				

Note: The area above the heavy line is recommended for normal operation based on a maximum flow velocity of 5 ft./sec.

FRICTION LOSSES THROUGH PIPE FITTINGS IN TERMS OF EQUIVALENT LENGTHS OF STANDARD PIPE

									
SIZE OF PIPE (SMALL DIA.)	STANDARD ELBOW	MEDIUM RADIUS ELBOW	LONG RADIUS ELBOW	45° ELBOW	TEE	RETURN BEND	GATE VALVE OPEN	GLOBE VALVE OPEN	ANGLE VALVE OPEN
LENGTH OF STRAIGHT PIPE GIVING EQUIVALENT RESISTANCE FLOW									
1/2"	1.5	1.4	1.1	.77	3.4	3.8	.35	16	8.4
3/4"	2.2	1.8	1.4	1.0	4.5	5.0	.47	22	12.
1"	2.7	2.3	1.7	1.3	5.8	6.1	.6	27	15.
1-1/4"	3.7	3.0	2.4	1.6	7.8	8.5	.8	37	18.
1-1/2"	4.3	3.6	2.8	2.0	9.0	10.	.95	44	22.
2"	5.5	4.6	3.5	2.5	11.	13.	1.2	57	28.
2-1/2"	6.5	5.4	4.2	3.0	14.	15.	1.4	66	33.
3"	8.1	6.8	5.1	3.8	17.	18.	1.7	85	42.
3-1/2"	9.5	8.0	6.0	4.4	19.	21.	2.	99	50.
4"	11.	9.1	7.0	5.0	22.	24.	2.3	110	58.
4-1/2"	12.	10.	7.9	5.6	24.	27.	2.6	130	61.
5"	14.	12.	8.9	6.1	27.	31.	2.9	140	70.
6"	16.	14.	11.	7.7	33.	37.	3.5	160	83.
8"	21.	18.	14.	10.	43.	49.	4.5	220	110.
10"	26.	22.	17.	13.	56.	61.	5.7	290	140.
12"	32.	26.	20.	15.	66.	73.	6.7	340	170.
14"	36.	31.	23.	17.	76.	85.	8.	390	190.
16"	42.	35.	27.	19.	87.	100.	9.	430	220.
18"	46.	40	30.	21.	100.	110.	10.2	500	250.
20"	52.	43.	34.	23.	110.	120.	12.	560	280.
22"	58.	50.	37.	25.	130.	140.	13.	610	310.
24"	63.	53.	40.	28.	140.	150.	14.	680	340.
30"	79.	68.	50.	35.	165.	190.	17.	860	420.
36"	94.	79.	60.	43.	200	220.	20.	1000	500.
42"	120.	95.	72.	50.	240	260.	23.	1200	600.
48"	135.	110.	82.	58.	275	300.	26.	1400	680.

From "Engineering Data On Flow Of Fluids In Pipes." - Crane Co.

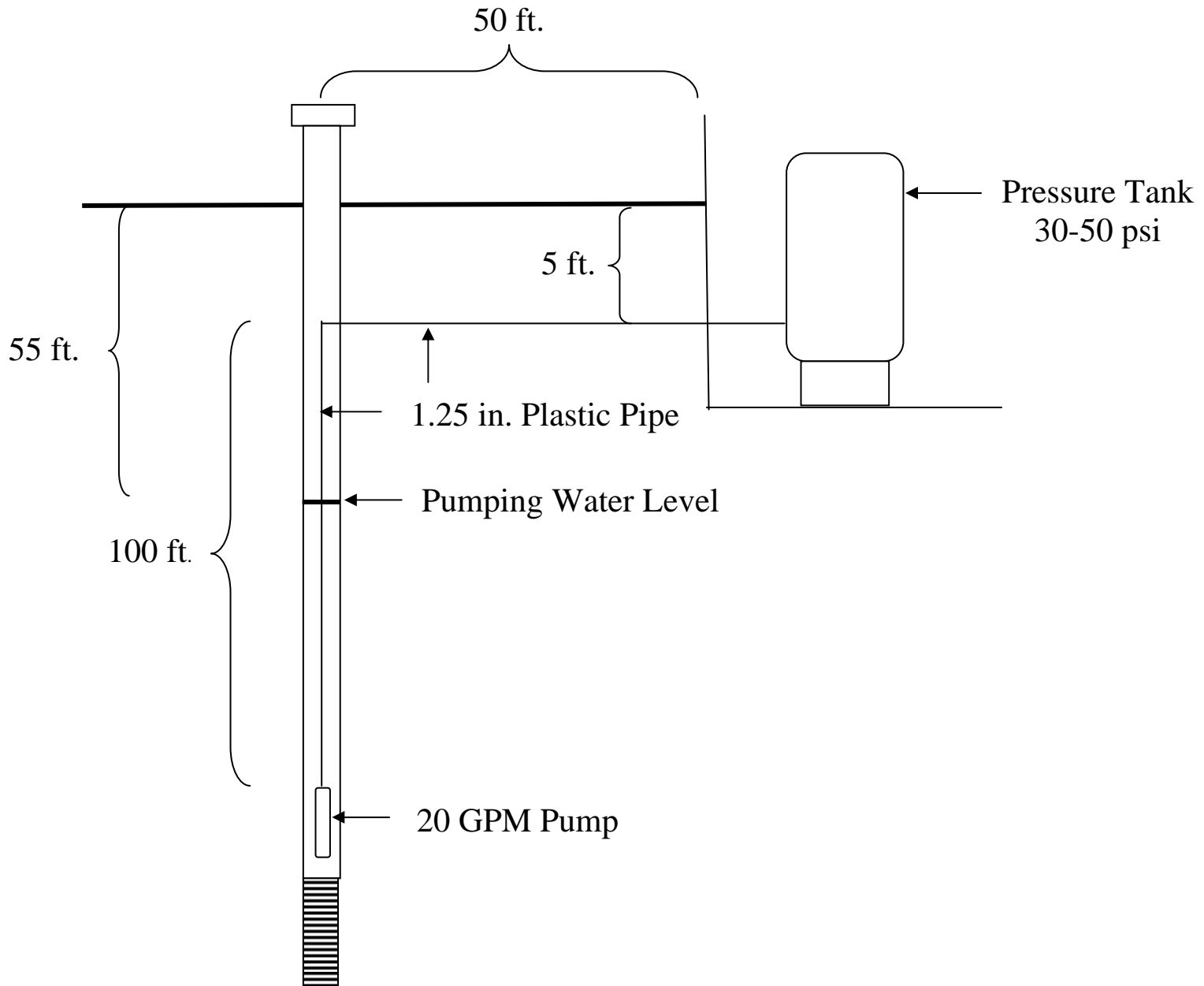
PUMP SELECTION USING A PUMP CURVE

In order to determine if the proposed well pump is properly sized, it is necessary to refer to the pump manufacturer's performance curve or chart, (Pump curves are available upon request from either the pump manufacturer or supplier.) The total dynamic head and desired pump capacity are applied to the pump curve to determine proper pump selection based on required electrical power input and optimum efficiency.

It is recommended that the sanitarian check the pump make and model number, horsepower, and pump capacity as listed on the Water Well and Pump Record to determine if adequately sized pumping equipment has been installed.

To determine proper pump size, locate the point on the pump curve where the pump capacity and total dynamic head intersect and select the pump which will provide the required capacity of water under the particular head conditions. If the point of intersection falls above the curve line, select the next highest pump size.

TOTAL DYNAMIC HEAD PROBLEM #1



TOTAL DYNAMIC HEAD WORKSHEET

Determine Total Elevation Head

1. How many vertical feet is it from the pumping water level to the pressure tank? _____ ft.

Determine Friction Head

2. What is the pump capacity flow rate through pipe? _____ gpm
3. What is the diameter and material type of the water service line from the well to the pressure tank? Diameter _____ in. Material _____
4. Apply the answers to questions 2 and 3 to a friction loss chart to find the friction head per 100 feet of water service line. _____ ft./100 ft.
5. What is the length of the water service line? _____ ft.
6. What is the friction head for the water service line (multiply the answers for questions 4 and 5). _____ ft.

Example: Friction loss chart shows that 1 inch diameter plastic pipe at 10 gpm flow rate has a friction head loss of 6.3 ft. per 100 ft. $\frac{6.3 \text{ ft.}}{100 \text{ ft.}} \times \text{pipe length} = \text{friction head}$

Water service line is 200 ft. in length.

$$\frac{6.3 \text{ ft.}}{100 \text{ ft.}} \times 200 \text{ ft.} = 12.6 \text{ ft. friction head}$$

7. What is the diameter and material type of the drop pipe from the pump to the pitless adapter? Diameter _____ in. Material _____
8. Apply the answers to questions 2 and 7 to a friction loss chart to find the friction head per 100 feet of pump drop pipe. _____ ft./100 ft.
9. What is the length of the pump drop pipe? _____ ft.
10. What is the friction head for the water service line? (multiply the answers for questions 8 and 9 – see example in #6 above). _____ ft.
11. What is the total friction head? _____ ft.

Determine Pressure Head

12. What is the pressure switch pump cut-out setting? _____ psi

Example: The pump cut-out setting is the pressure at which the pump will shut off at the end of the pump operating cycle. If the pressure switch setting is 30-50 psi, the pump cut-out setting is 50 psi.

13. Determine the pressure head by converting the answer from question 12 from pound per square inch to feet of head by multiplying it by 2.31 ft./psi. _____ ft.
Example: 50 psi x 2.31 ft./psi = 115.5 ft.

Determine Total Dynamic Head

14. Determine TDH by adding answers for questions 1, 11, and 13.

Total dynamic head = _____ ft

- ANSWER #1-
TOTAL DYNAMIC HEAD WORKSHEET

Determine Total Elevation Head

1. How many vertical feet is it from the pumping water level to the pressure tank? 50 ft.

Determine Friction Head

2. What is the pump capacity flow rate through pipe? 20 gpm
3. What is the diameter and material type of the water service line from the well to the pressure tank? Diameter 1.25 in. Material plastic
4. Apply the answers to questions 2 and 3 to a friction loss chart to find the friction head per 100 feet of water service line. 6 ft./100 ft.
5. What is the length of the water service line? 50 ft.
6. What is the friction head for the water service line (multiply the answers for questions 4 and 5). 3 ft.

Example: Friction loss chart shows that 1 inch diameter plastic pipe at 10 gpm flow rate has a friction head loss of 6.3 ft. per 100 ft. $\frac{6.3 \text{ ft.}}{100 \text{ ft.}} \times \text{pipe length} = \text{friction head}$

Water service line is 200 ft. in length.

$$\frac{6.3 \text{ ft.}}{100 \text{ ft.}} \times 200 \text{ ft.} = 12.6 \text{ ft. friction head}$$

7. What is the diameter and material type of the drop pipe from the pump to the pitless adapter? Diameter 1.25 in. Material plastic
8. Apply the answers to questions 2 and 7 to a friction loss chart to find the friction head per 100 feet of pump drop pipe. 6 ft./100 ft.
9. What is the length of the pump drop pipe? 100 ft.
10. What is the friction head for the water service line? (multiply the answers for questions 8 and 9 – see example in #6 above). 6 ft.
11. What is the total friction head? 9 ft.

Determine Pressure Head

12. What is the pressure switch pump cut-out setting? 50 psi

Example: The pump cut-out setting is the pressure at which the pump will shut off at the end of the pump operating cycle. If the pressure switch setting is 30-50 psi, the pump cut-out setting is 50 psi.

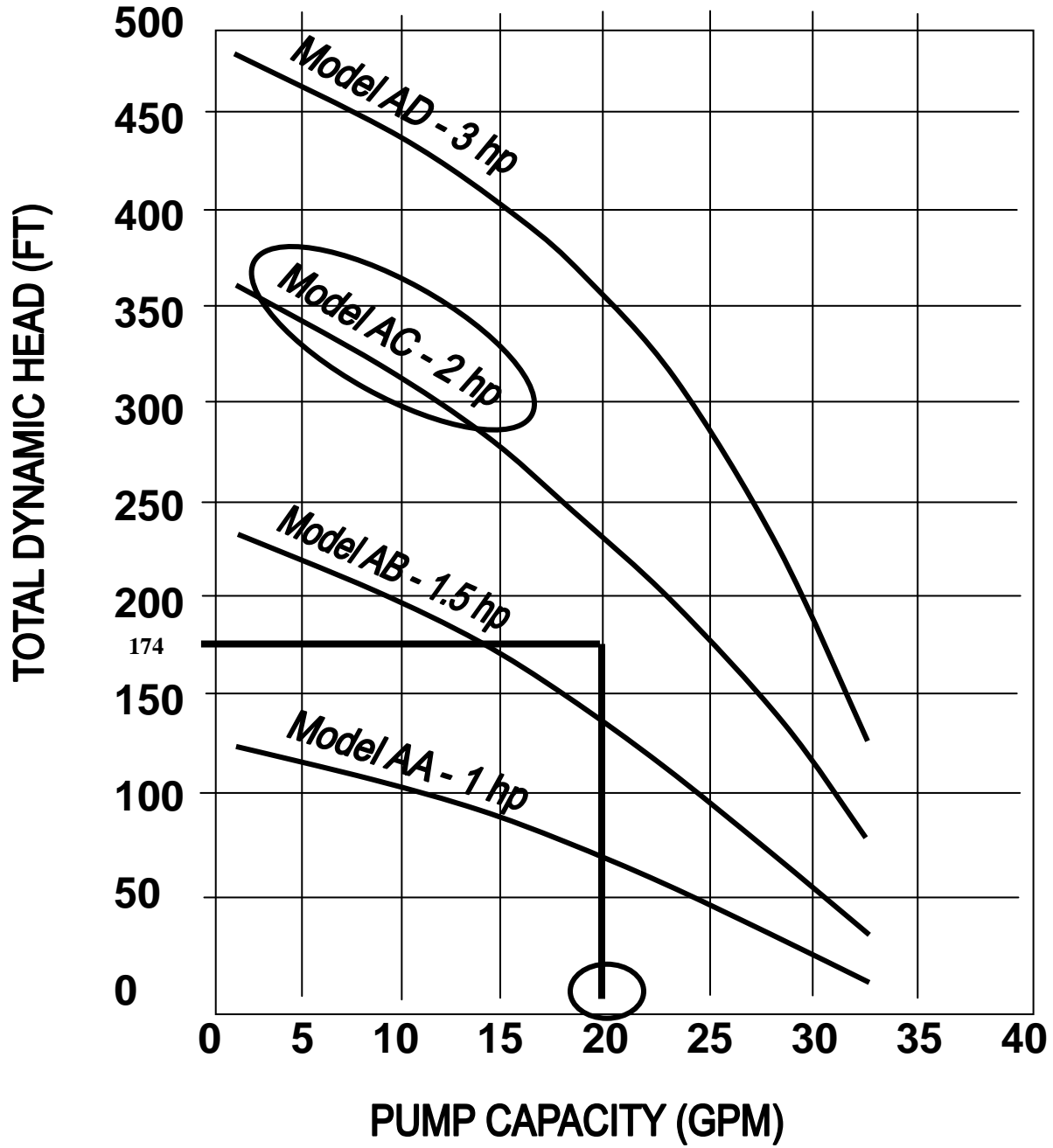
13. Determine the pressure head by converting the answer from question 12 from pound per square inch to feet of head by multiplying it by 2.31 ft./psi. 115 ft.
Example: $50 \text{ psi} \times 2.31 \text{ ft./psi} = 115.5 \text{ ft.}$

Determine Total Dynamic Head

14. Determine TDH by adding answers for questions 1, 11, and 13.

Total dynamic head = 174 ft.

PUMP CURVE #1



DETERMINING STORAGE CAPACITY

The basic functions of a storage tank are to minimize wear of electrical starting components, increase pump life by preventing rapid stopping and starting (short cycling), and provide water under pressure for delivery between pump cycles. Generally, there is more friction to overcome, and therefore, more electrical energy is required for starting larger pumps as opposed to smaller. As a result, larger pumps should be allowed to operate for longer periods of time than smaller domestic pumps. In a properly designed system, the storage tank should be sized to insure a minimum pump running time consistent with the cycling rate recommended by the manufacturer. Where no cycling rate is specified, Table 1 may be used as a guide:

TABLE 1

Gallons per Minute	Pump Running Time (Min.)
10 - 20	1
21 - 50	2
51 - 75	3
76 - 100	4
>100	Consult MDEQ

Bladder or Diaphragm Type Tank with Precharge

The available water capacity in gallons (drawdown) should equal or exceed the pump capacity times minimum pump running time. The available water in a precharge tank at a 30-50 psi setting is about 25 percent of the total tank volume. Figures on amounts of available water under various pressure settings can be obtained from the tank manufacturers' specifications.

EXAMPLE

$$\begin{aligned}
 &25 \text{ gpm} \times 2 \text{ min. running time} = 50 \text{ gallons of available water} \\
 &\text{Total volume (T)} \times 25\% = 50 \text{ gallons. Therefore} \\
 &T \times .25 = 50 \text{ gallons} \qquad T = \frac{50}{.25} \qquad T = 200 \text{ gallons}
 \end{aligned}$$

Total volume of bladder or diaphragm tank with precharge = 200 gallons

CONVENTIONAL STEEL TANK (no bladder or diaphragm) WITH PRECHARGE

Available draw-off *down* should equal or exceed the pump capacity times minimum pump running time. The available water in the steel tank with pre-charge with a 30-50 psi setting is about 20 percent of the total tank volume when the high water level is maintained at 55 percent of total capacity. (*Note: If the high water level becomes greater than 55 percent, less usable capacity is available; i.e., at 70 percent, usable capacity is 13 percent and then the tank is becoming water logged*).

EXAMPLE

$$\begin{aligned}
 &25 \text{ gpm} \times 2 \text{ min. running time} = 50 \text{ gallons of available water} \\
 &\text{Total volume (T)} \times 20\% = 50 \text{ gallons. Therefore .} \\
 &T \times .20 = 50 \text{ gallons} \qquad T = \frac{50}{.20} \qquad T = 250 \text{ gallons}
 \end{aligned}$$

Total volume of conventional steel tank with pre-charge = 250 gallons

Conventional Steel Tank with No Pre-Charge

Available drawdown should equal or exceed the pump capacity times minimum pump running time. The available water in the steel tank without precharge with a 30-50 psi setting is about 10 percent of the total tank volume.

EXAMPLE

$$25 \text{ gpm} \times 2 \text{ min. running time} = 50 \text{ gallons of available water}$$

$$\text{Total volume (T)} \times 10\% = 50 \text{ gallons. Therefore.}$$

$$T \times .10 = 50 \text{ gallons} \quad T = \frac{50}{.10} \quad T = 500 \text{ gallons}$$

Total volume of conventional steel tank without pre-charge = 500 gallons

The examples given use 30-50 psi as the assumed pressure switch setting, since 30-50 psi is now becoming more common to the water well industry than the 20-40 psi setting. Variations in system operating pressure and pre-charging of pressure tanks will alter the amount of available water (draw-off-down) from the pressure tank, Table 2 shows that precharging of the tank increases the draw-off, and increasing the operating pressure of the system decreases the tank draw-off. Operating pressure and tank precharge pressure must be taken into consideration when evaluating proposed storage facilities.

TABLE 2
Gallons Drawdown per Pump Cycle

		Total Tank Volume		
		42 gal	82 gal.	120 gal.
20-40 psi system pressure	no precharge	6.5	12.8	18.6
	10 psi precharge	10.8	21.3	31.0
	15 psi precharge	13.0	25.6	37.4
30-50 psi system pressure	no precharge	4.3	8.4	12.3
	15 psi precharge	8.6	16.8	24.6
	20 psi precharge	10.0	19.6	28.7
	25 psi precharge	11.5	22.4	32.8

For details on water storage facilities for flowing wells consult DNRE.

CONSTANT PRESSURE SYSTEMS

Constant pressure (CP) technology for water well systems is becoming increasingly popular. Pump manufacturers are marketing the new technology as the biggest advancement since the development of the submersible pump. Sanitarians should become familiar with CP systems and the differences between conventional pump/pressure tank system and CP system design and operation.

Two methods are used to control the water pressure in CP systems: variable frequency drives (VFDs), also known as variable speed pumps, and pressure control valves (PCVs). A system using a VFD provides constant pressure over a fairly broad range of flow rates by electronically changing the speed of the motor as the water demand changes. The second means of furnishing CP is by installing a pressure control valve (PCV). PCVs are installed upstream of the pressure tank, between the pump and the pressure switch. They respond to downstream pressure by automatically opening or closing a valve to maintain system pressure. PCVs are used with standard submersible pumps that do not have variable speed motors

VFDs and PCVs are designed to provide consistent pressure to the building occupants and eliminate pressure fluctuations that occur with a conventional system. CP system manufacturers advertise that they provide steady "city-like" water pressure, which does not fluctuate as in a conventional water well system. Space limitations are minimized with the VFD pumps because a large pressure tank is not necessary to make the system work correctly. A much smaller pressure tank can be used to control a VFD system. A VFD system may also save on electrical costs by minimizing the number of starts and stops. Another VFD benefit is the reduction of water hammer.

Conventional pressure tank sizing methodology is not applicable to VFD systems, because the need to achieve a minimum pump run time (as with conventional fixed speed pumps) is not a concern. Therefore, the traditional pressure tank sizing criteria found in MDEQ, Water Division and Noncommunity Manuals should not be applied to VFD systems. To determine appropriate pressure tank sizes for VFD systems follow the manufacturer's installation specifications.

More and more well drillers and facility owners are expected to request approval to install VFD systems. Sanitarians can approve the installation of these systems with the appropriate reduction in pressure tank sizing for VFD systems. Pressure tank sizes are not reduced for PCV installations unless there is continuous water usage; such as community and large industry process water usage or irrigation systems that are using water continually. Therefore, the pump must be sized to meet the requisite peak demand/well capacity requirements and the pressure tank is sized to meet the pump manufacturers sizing requirements.

Some PCVs have internal check valves that violate state well code provisions. Product specifications should be checked to ensure that the particular PCV proposed to be used does not have a check valve and will comply with state regulations.