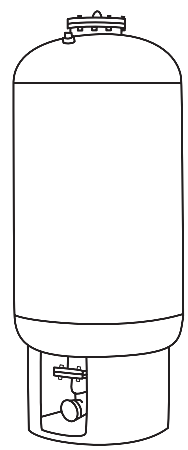
SIZING THE WELL-X-TROL®

AMTROL®

For Commercial Well System Applications

This handbook will discuss the basic sizing used for our larger, full acceptance bladder Well-X-Trol well tanks. This allows you to use the Well-X-Trol principle of separation of air and water on larger jobs that are beyond the typical residential range.

Larger Well-X-Trol well tanks are designed and built for maximum acceptance on each operating cycle. This allows you to replace a large galvanized tank with a more space efficient Well-X-Trol and improve system performance.



Series 420 and 447

Pressure Switch

Table 1

WX Model Non-Code (Non-ASME)	WX Model Code (ASME)	Total Volume (Gallons)	Maximum Acceptance Factor (MAF)	Maximum Acceptance Factor (MAF)
WX-401	WX-401C	18	11	.65
WX-402	WX-402C	25	11	.45
WX-403	WX-403C	34	11	.33
WX-404	WX-404C	68	34	.50
WX-405	WX-405C	90	34	.39
WX-406	WX-406C	110	34	.31
WX-407	WX-407C	132	46	.35
WX-421	not available	158	103	.65
WX-422	not available	211	137	.65
WX-423	not available	264	172	.65
WX-424	not available	317	206	.65
WX-426	not available	422	274	.65
WX-427	not available	528	343	.65
WX-447	WX-447C	53	34	.65
WX-448	WX-448C	80	52	.65
WX-449	WX-449C	106	69	.65
WX-450	WX-450C	132	86	.65
WX-451	WX-451C	158	102	.65
WX-452	WX-452C	211	136	.65
WX-453	WX-453C	264	170	.65
WX-454	WX-454C	317	205	.65
WX-455	WX-455C	370	239	.65
WX-456	WX-456C	422	273	.65
WX-457	WX-457C	528	341	.65

Based on 30 PSIG pre-charge (P_1).

For example, a 900 gallon galvanized tank is 48″ in diameter, 168″ long, and weighs approximately 10,000 pounds when filled with water. A WX-423, with a total volume of only 275 gallons, can be used instead and is only 36″ in diameter and 84″ high. When filled with water to the 65% maximum acceptance it only weighs 1,489 pounds. It can be easily handled, requires no support structures and occupies a fraction of the space of the galvanized tank.

Aside from initial cost, the cost of rigging and handling large galvanized tanks, providing adequate support and the cost of space required significantly adds to the overall installation cost.

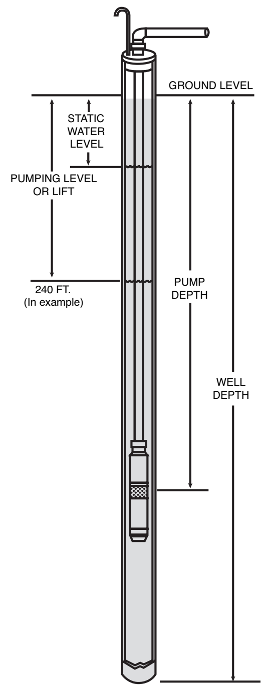
At higher pressures, the galvanized tank will waterlog at an accelerated rate, so some provision must be made to maintain the required air cushion. This means the cost of an air compressor or other means of recharging must be added to the installation.

Since the Well-X-Trol's air cushion is sealed-in, there is no need for external air compressors or control devices.

Using the maximum acceptance of the 420 and 450 Series Well-X-Trol, can service much larger jobs, with large pumps, without paying the penalty of higher installation and maintenance costs.

Step 1:

Determine the Best Operating Pressure Range – Pump Cut-In (P_2) to Pump Cut-Out (P_3) and Well Tank Pre-Charge (P_1):



The first thing we must do in sizing the bladder is to determine the best pressure range that will achieve maximum acceptance.

If we look at the pump curve for the pump which is to be installed, we can easily determine the pump cut-in pressure (P_2) and pump cut-out pressure (P_3) that will give us the widest pressure range.

The pump curve for the pump selected indicates the total pressure range of the pump or its dynamic head measured in feet of head.

The pump must have enough head, or pressure differential to:

- Bring water from the level of the well to the well head at the surface of the ground.
- Provide head capacity to pressurize the system piping to overcome elevation (static height) and friction (friction loss) and deliver the required pressure.

Example:

In a well with the water level 240 feet down, system pressurization will be shown on the pump curve at some point above the intersection of the line indicating 240 feet of head.

In other words, at 240 feet of head we can assume that the pump will have brought water from the pumping level of the well to the surface and pressure in the system piping will be 0 PSIG.

We now must select a pressure range (min. to max.) to establish pressurized delivery of water to the system that will overcome elevation (static height) and friction loss of the piping.

We'll do this by pre-charging the Well-X-Trol to a pressure (P_1) equal to the minimum pressure required at the Well-X-Trol location. In addition, we'll select a pump cut-in pressure (P_2) which is at the same pressure to start the pump whenever system pressure drops to this point.

We'll assume a minimum system pressure at the Well-X-Trol location of 30 PSIG. This pressure will be adequate to ensure system pressurization to overcome elevation and friction loss and provide adequate pressure at the fixture.

To find this pump cut-in point on the pump curve, we convert 30 PSIG to feet of head by multiplying PSIG by 2.31.

30 PSIG x 2.31 = 69.3 or 70 feet of head

Locate this point on the pump curve by adding:

Minimum System Pressure	70 Ft. of Head
Lift	+ 240 Ft. of Head
Pump cut-in point on curve	310 Ft. of Head

Now we will select the maximum pump cut-out point on the curve which will allow the widest possible pressure range without impairing pump performance and efficiency.

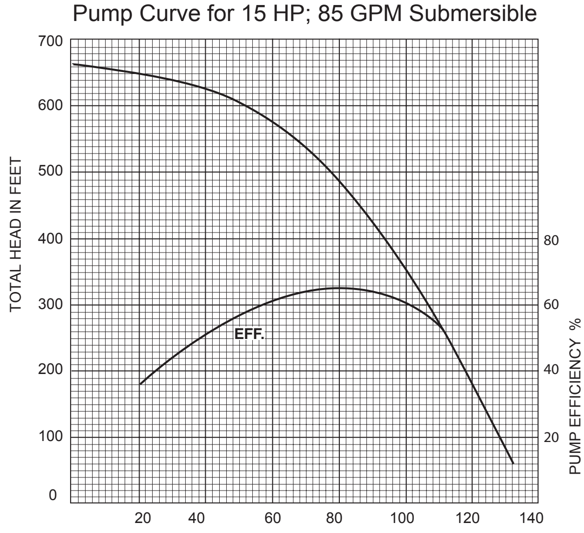
We will do this by moving up the curve to find a point that:

- Is just before the curve begins to "flatten" out
- And is still within the upper limits of the best efficiency range of the pump (approximately 85%)

In this example, that point would be at the intersection on the curve of the horizontal line indicating 420 feet of head.

This is the point on the curve which will be the maximum pump cut-out for this particular pump.

Pump Curve for 15 HP; 85 GPM Submersible



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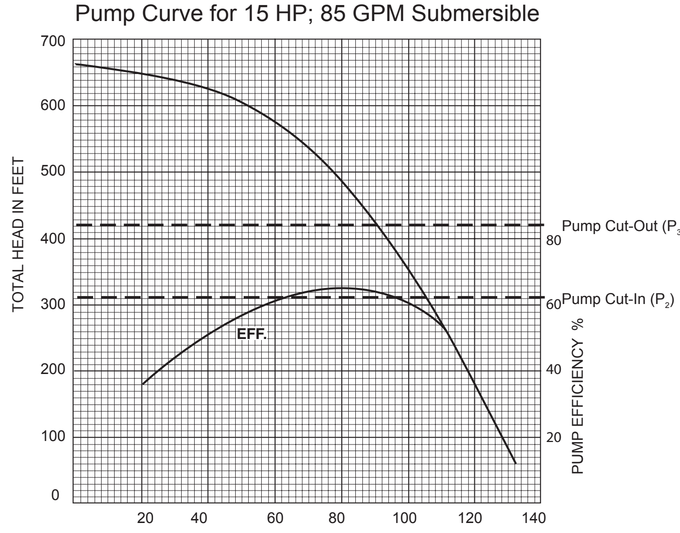


Subtracting the feet of head required for lift of 240′ we can convert this point to PSIG:

Maximum pump cut-out	= 420 feet
Lift	- 240 feet
Maximum pressure	180 feet

To convert feet of head to PSIG, we divide by 2.31

$$180 \div 2.31 = 77.9 \text{ or } 78 \text{ PSIG.}$$

Pump cut-out pressure (P_3) is 78 PSIG.

To Summarize:

We have used actual pump performance, as shown on the pump curve for the pump selected, to complete Step 1 in utilizing maximum capacity of the full acceptance Well-X-Trol®.

In this step we have determined:

- System minimum pressure of 30 PSIG. To establish the Well-X-Trol precharge pressure.
- Pump cut-in pressure (P_2) of 30 PSIG.
- Pump cut-out pressure (P_3) of 78 PSIG.

Step 2:

Determine Average Capacity in GPM:

With larger pumps, capacity, or flow of the pump will vary depending upon the pressure or feet of head at which it is operating.

Even though the pump may be rated as an 85 GPM pump (as in our example), the actual capacity in GPM will vary as the pump operates throughout its pressure range from pump cut-in (30 PSIG) and pump cut-out (78 PSIG).

So, we'll go back to our curve and determine what capacity in GPM the pump will deliver at its cut-in point, and what capacity in GPM it will deliver at its pump cut-out point. Then, we'll average these two capacities by adding them together and dividing by two.

Reading the curve, we can find the point that indicates pump cut-in. We already know that this is:

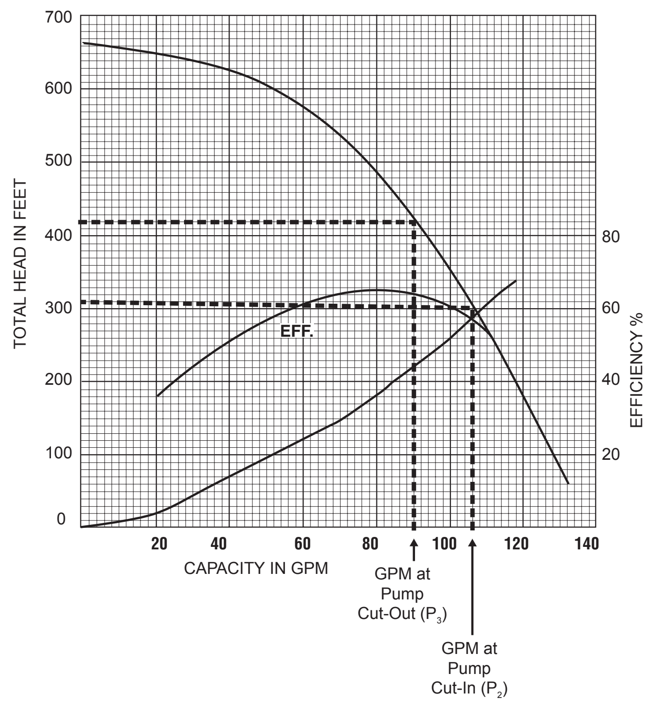
30 PSIG x 2.31	70 Ft. of Head
Lift	+ 240 Ft. of Head
Point on Curve	= 310 Ft. of Head

Reading down to capacity we can determine that at 310 feet of head, the pump will deliver 106 GPM.

We then read the curve to determine the capacity at pump cut-out:

78 PSIG x 2.31	180 Ft. of Head
Lift	+ 240 Ft. of Head
Point on Curve	= 420 Ft. of Head

Reading down to capacity, we can determine that at 420 feet of head, the pump will deliver 90 GPM.



Average Capacity

at P_2: 106

at P_3: +90

196 ÷ 2 = 98 GPM

Being a large pump, we will want to have a minimum run time at least 2 minutes on the pump:

Effective System Protection (ESP) Volume

98 GPM x 2 = 196 ESP Volume

Step 3:
Calculate Acceptance Factor (AF)

$$AF = 1 - \frac{P_2 + 14.7}{P_3 + 14.7}$$

$$AF = 1 - \frac{30 + 14.7}{78 + 14.7}$$

$$AF = .518$$

Step 4:
Verify Maximum Acceptance Factor

After calculating the acceptance factor (AF), compare the value to the maximum acceptance factors shown in Table 1. In the example, an AF of 0.518 is less than the maximum acceptance factor of all WX-420 and WX-450 series models. Therefore, either series can be used.

Step 5:
Calculate Minimum Total Volume (T_v)

$$T_V = \frac{\text{ESP Volume}}{AF}$$

$$T_V = \frac{196}{.518} = 378 \text{ gallons}$$

Step 6:
Select Well-X-Trol® Model Equal to or Greater Than T_v

If ASME construction is not required, select from 420 series, Table 1.

This example would be a WX-426.

To Recap:

We went through six steps to size a full acceptance Well-X-Trol to gain maximum acceptance:

Step 1: Determine pre-charge pressure (P_1); pump cut-in pressure (P_2) and pump cut-out pressure (P_3) from pump curve of pump selected for system.

Step 2: Determine Average Capacity in GPM from pump curve:

Step 3: Determine Acceptance Factor:

$$1 - \frac{P_2 + 14.7}{P_2 + 14.7}$$

Step 4: Verify the calculated AF is less than or equal to the maximum acceptance factor for the Well-X-Trol required.

$$AF = 1 - \frac{P_2 + 14.7}{P_3 + 14.7}$$

Step 5: Calculate total Well-X-Trol Volume:

$$T_V = \frac{\text{ESP Volume}}{AF}$$

Step 6: Select series 420 (Non-ASME) or 450 (ASME) Well-X-Trol Model

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1400 Division Road, West Warwick, RI 02893 USA
T: 800.426.8765 F: 800.293.1519
www.amtrol.com

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