PENTAIR

Pump Curves
Primer

Presented by

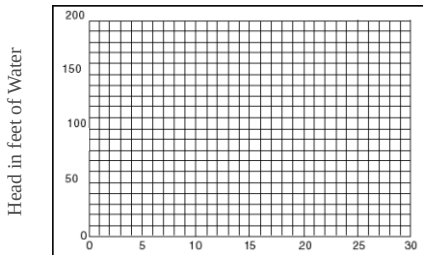
Pentair Training Institute

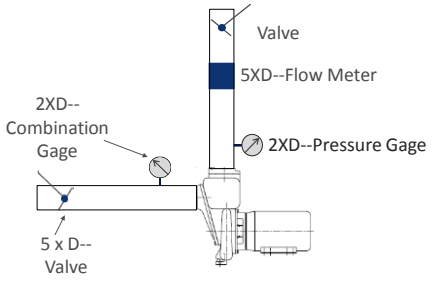
In this presentation you will understand:

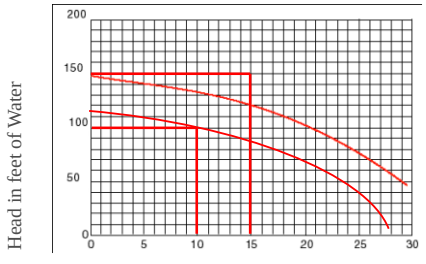
How a curve is created

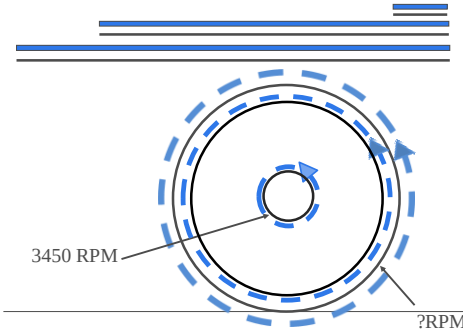
Basic information needed to size a pump

What the curve is telling you



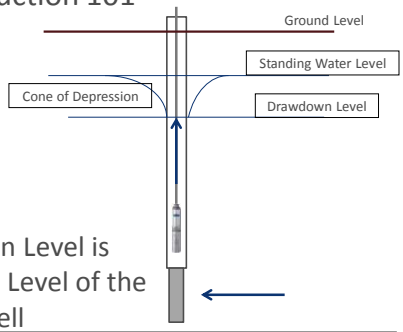






So a pump curve is based on GPM and TDH……

Well construction 101



Equilibrium

Drawdown Level is The Working Level of the Well

Where to Start…

GPM

For today we are assuming the well can support the demand of the system

What is the demand of the system?

Pentair has developed the following "Rule of Thumb" formula for sizing home water systems that will be applicable in many instances:

Simply count the fixtures and water outlets in the home. This method bases the approximate pumping capacity on use at the rate of a gallon per minute per fixture, and avoids the possibility of undersizing.

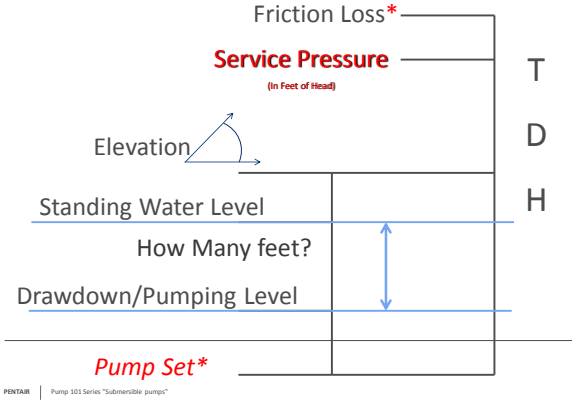
For instance, let us assume you count the following list of fixtures and water outlets in your home:

Kitchen:	Sink/Dishwasher (count as 1 fixture)	1
Bath:	Lavatory	1
	Tub	1
	Toilet	1
Powder Room:	Lavatory	1
	Toilet	1
Laundry and Utility Room:		
	Automatic washing machine (count as one fixture)	1
	Laundry tubs	1
	Shower	1
	Outdoor faucets	2
Total fixtures and outlets		**12**

Be sure that your pump installer provides a water system that will deliver 12 gallons per minute at the desired pressure.

Average Flow Rate Requirements by Various Fixtures
(GPM equals gallons per minute; GPH equals gallons per hour)

Shower	4 to 6 GPM
Bathtub	4 to 8 GPM
Toilet	4 to 5 GPM
Lavatory	1 to 3 GPM
Kitchen sink	2 to 3 GPM
1/2" hose and nozzle	200 GPH
3/4" hose and nozzle	300 GPH
Lawn sprinkler	120 GPH



Total means *TOTAL*

Friction loss (do not forget pump set and horizontal run)

Service pressure (in feet of head)

Pumping level (elevation, static water level, drawdown)

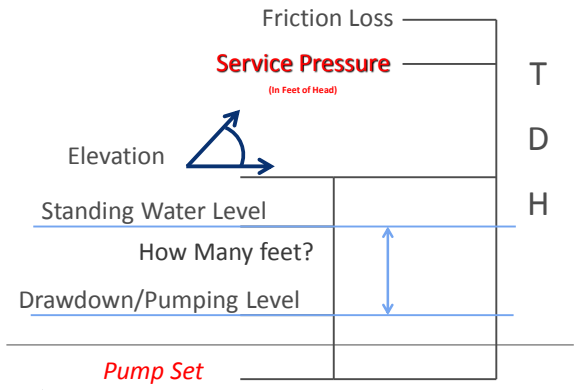
Therefore if:

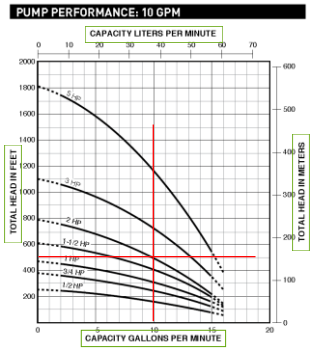
One PSI = 2.31 Feet of Head

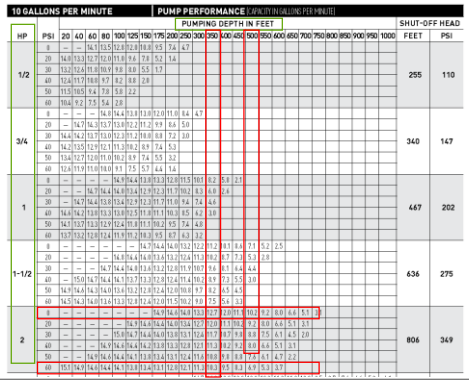
PSI x 2.31=FoH

Or

FoH ÷ 2.31= PSI

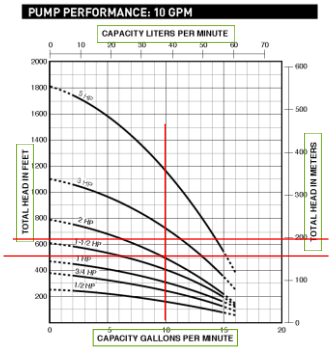




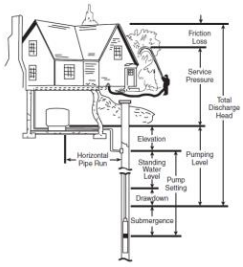


Total means *TOTAL*

Or the problem with: "and 60 PSI"

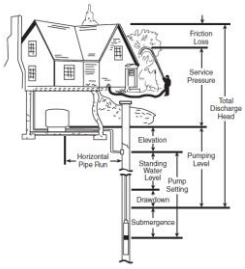


Example 1



Well Size	6”
Standing Water Level	42’
Drawdown	10’
Well Depth	82’
Pump Setting	67’
Horizontal Pipe Run (1” PVC pipe already installed)	70’

Example 1



Elevation	0’
System Pressure Desired	30-50
Fixture Count	10
Irrigation Use	None
Power Supply Available	230V/1 ph

LOSS OF HEAD IN FEET DUE TO FRICTION PER 100 FEET OF PIPE

1/2"					3/4"					1"					1-1/4"				
Flow U.S. Gal. Min.	Velocity Plastic ft/sec	Plastic C=140 ID .622"	Steel C=100 ID .622"	Copper C=130 ID .625"	Flow U.S. Gal. Min.	Velocity Plastic ft/sec	Plastic C=140 ID .824"	Steel C=100 ID .824"	Copper C=130 ID .822"	Flow U.S. Gal. Min.	Velocity Plastic ft/sec	Plastic C=140 ID 1.049"	Steel C=100 ID 1.049"	Copper C=130 ID 1.042"	Flow U.S. Gal. Min.	Velocity Plastic ft/sec	Plastic C=140 ID 1.380"	Steel C=100 ID 1.380"	Copper C=130 ID 1.360"
0.5	0.5	0.314	0.582	0.35	1.5	0.9	0.61	1.13	0.7	2	0.74	0.322	0.595	0.345	4	0.9	0.304	0.564	0.364
1	1.1	1.14	2.1	1.26	2	1.2	1.04	1.93	1.21	3	1.1	0.68	1.26	0.732	5	1.1	0.46	0.853	0.545
1.5	1.6	2.38	4.44	2.67	2.5	1.5	1.57	2.91	1.82	4	1.5	1.15	2.14	1.24	6	1.3	0.649	1.2	0.765
2	2.1	4.1	7.57	4.56	3	1.8	2.21	4.08	2.56	5	1.9	1.75	3.42	1.88	7	1.5	0.86	1.59	1.02
2.5	2.6	6.15	11.4	6.88	3.5	2.1	2.93	5.42	3.4	6	2.2	2.45	4.54	2.63	8	1.7	1.1	2.04	1.31
3	3.2	8.65	16	9.66	4	2.4	3.74	6.94	4.36	8	3.0	4.16	7.74	4.5	10	2.1	1.67	3.08	1.98
3.5	3.7	11.5	21.3	12.9	4.5	2.7	4.66	8.63	5.4	10	3.7	6.31	11.7	6.8	12	2.6	2.33	4.31	2.75
4	4.2	14.8	27.3	16.4	5	3.0	5.66	10.5	6.57	12	4.5	8.85	16.4	9.47	14	3.0	3.1	5.73	3.64
4.5	4.8	18.3	33.9	20.4	6	3.6	7.95	14.7	9.22	14	5.2	11.8	21.8	12.6	16	3.4	3.96	7.34	4.68
5	5.3	22.2	41.2	24.8	7	4.2	10.6	19.6	12.2	16	5.9	15.1	27.9	16.2	18	3.9	4.93	9.13	5.81
5.5	5.8	26.6	49.2	29.5	8	4.8	13.5	25	15.7	18	6.7	18.7	34.7	20.1	20	4.3	6	11.1	7.1
6	6.3	31.2	57.8	34.8	9	5.4	16.8	31.1	19.5	20	7.4	22.8	42.1	24.4	25	5.4	9.06	16.8	10.7
6.5	6.9	36.2	67	40.2	10	6.0	20.4	37.8	23.7	22	8.2	27.1	50.2	28.8	30	6.4	12.7	23.5	15
7	7.4	41.5	76.8	46.1	11	6.6	24.4	45.1	28.2	24	8.9	31.9	59	34	35	7.5	16.9	31.2	20
7.5	7.9	47.2	87.3	52.5	12	7.2	28.6	53	33.2	26	9.7	36.9	68.4	39.7	40	8.6	21.6	40	25.6
8	8.4	53	98.3	59.4	13	7.8	33.2	61.5	38.5	28	10.4	42.5	78.5	45.5	50	10.7	32.6	60.4	38.7
8.5	9.0	59.5	110	66	14	8.4	38	70.5	44.2	30	11.1	48.1	89.2	51.6	60	12.9	45.6	84.7	54.1
9	9.5	66	122	73.5	15	9.6	48.6	90.2	56.6	35	13.0	64.3	119	68.7	70	15.0	61.5	114	72.2
9.5	10.0	73	135	81	18	10.8	60.5	112	70.4	40	14.8	82	152	88	80	17.2	77.9	144	92.4
10	10.6	80.5	149	89.4	20	12.0	73.5	136	83.5	45	16.7	102	189	109	90	19.3	96.6	179	115

NOTE: Recommended velocity is 5 FPS (feet per second) with a maximum of 7 FPS

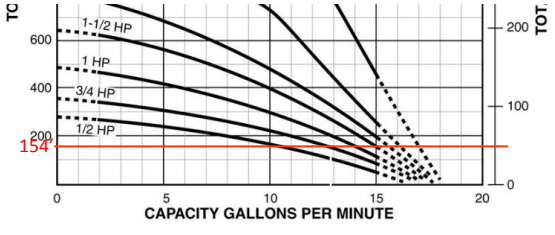
Example 1

Selecting Pipe Size:

System Design GPM:	10	(from example)
Select Pipe Size:	1”	
Friction Loss for Pipe:	6.31	(per 100’)
Pipe Totals:	67	(pump setting)
+	70	(Horizontal Pipe Run)
=	137	(Total length of pipe)

Example 1

Total Friction Loss:	1.37	(length/100)
x	6.31	(friction loss per 100’)
=	8.64	(total friction loss)
Round up	9	(to allow for fittings, etc.)
Total Dynamic Head:	52	Pumping level
	93	Service pressure (in feet)
	9	Friction loss
	154	Total Dynamic Head



Total means *TOTAL*

Or the problem with: "and 40 PSI"

4" Submersible Pumps

10 Gallons per Minute | **PUMP PERFORMANCE** *(Capacity in Gallons Per Minute)*

HP	PSI	Pumping Depth in Feet																												Shut-Off Head	
		20	40	60	80	100	125	150	175	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	Feet	PSI
1/2	0	—	—	14.1	13.5	12.8	12.0	10.8	9.5	7.4	4.7																	
	20	14.0	13.3	12.7	12.0	11.0	9.6	7.8	5.2	1.4																		
	30	13.2	12.6	11.8	10.9	9.8	8.0	5.5	1.7																			
	40	12.4	11.7	10.8	9.7	8.2	8.8	2.0																				
	50	11.5	10.5	9.4	7.8	5.8	2.2																					
	60	10.4	9.2	7.5	5.4	2.8																						
3/4	0	—	—	—	14.8	14.4	13.8	13.0	12.0	11.0	8.4	4.7																
	20	—	14.7	14.3	13.7	13.0	12.2	11.2	9.9	8.6	5.0																		
	30	14.4	14.2	13.7	13.0	12.3	11.2	10.0	8.8	7.2	3.0																	
	40	14.2	13.5	12.9	12.1	11.3	10.2	8.9	7.4	5.3																		
	50	13.4	12.7	12.0	11.0	10.2	8.9	7.4	5.5	3.2																		
	60	12.6	11.9	11.0	10.0	9.1	7.5	5.7	4.4	1.4																		
1	0	—	—	—	—	14.9	14.4	13.8	13.3	12.8	11.5	10.1	8.2	5.8	2.1													
	20	—	—	14.7	14.4	14.0	13.4	12.9	12.3	11.7	10.2	8.3	6.0	2.6														
	30	—	14.7	14.4	13.8	13.4	12.9	12.3	11.7	11.0	9.4	7.4	4.6															
	40	14.6	14.2	13.8	13.3	13.0	12.5	11.8	11.1	10.3	8.5	6.2	3.0															
	50	14.1	13.7	13.3	12.9	12.4	11.8	11.1	10.2	9.5	7.4	4.8																
	60	13.7	13.2	12.8	12.4	11.9	11.2	10.3	9.5	8.7	6.3	3.2																

		255	110
		340	147
		467	202

Total means *TOTAL*

Friction loss (do not forget pump set and horizontal run)

Service pressure (in feet of head)

Pumping level (elevation, static water level, drawdown)

Problem 2 – Submersible Well Pump

Well Size	6"	Elevation	25'
Standing Water Level	150'	System Pressure Desired	30-50
Drawdown	75'	Fixture Count	20
Well Depth	300'	Irrigation Use	None
Pump Setting	285'	Power Supply Available	230V/1 ph
Horizontal Pipe Run (1-1/2" PVC pipe already installed)	75'		

Pipe Friction Loss Charts

1-1/2"–2-1/2" I.D.

LOSS OF HEAD IN FEET DUE TO FRICTION PER 100 FEET OF PIPE

	1-1/2"					2"					2-1/2"				
Flow U.S. Gal. Min.	Velocity Plastic ft/sec	Plastic C=150 ID 1.61"	Steel C=100 ID 1.61"	Copper C=130 ID 1.69"	Flow U.S. Gal. Min.	Velocity Plastic ft/sec	Plastic C=140 ID 2.067"	Steel C=100 ID 2.067"	Copper C=130 ID 2.062"	Flow U.S. Gal. Min.	Velocity Plastic ft/sec	Plastic C=140 ID 2.469"	Steel C=100 ID 2.469"	Copper C=130 ID 2.38"
4	0.6	0.144	0.267	0.165	10	1.0	0.233	0.431	0.268	20	1.3	0.353	0.654	0.375
6	0.9	0.305	0.565	0.358	15	1.4	0.495	0.916	0.569	30	2.0	0.75	1.39	0.792
8	1.3	0.52	0.962	0.611	20	1.9	0.839	1.55	0.962	40	2.7	1.27	2.36	1.35
10	1.6	0.785	1.45	0.923	25	2.4	1.27	2.35	1.45	50	3.4	1.92	3.56	2.04
12	1.9	1.1	2.04	1.29	30	2.9	1.78	3.29	2.03	60	4.0	2.69	4.99	2.86
14	2.2	1.46	2.71	1.71	35	3.3	2.36	4.37	2.71	70	4.7	3.58	6.64	3.82
16	2.5	1.87	3.47	2.2	40	3.8	3.03	5.6	3.47	80	5.4	4.59	8.5	4.88
18	2.8	2.33	4.31	2.75	45	4.3	3.76	6.96	4.31	90	6.0	5.72	10.6	6.06
20	3.2	2.83	5.23	3.33	50	4.8	4.57	8.46	5.24	100	6.7	6.9	12.8	7.37
25	3.9	4.26	7.9	5	55	5.3	5.46	10.1	6.22	110	7.4	8.25	15.3	8.8
30	4.7	6	11.1	7	60	5.7	6.44	11.9	7.34	120	8.0	9.71	18	10.3
35	5.5	7.94	14.7	9.35	70	6.7	8.53	15.8	9.78	130	8.7	11.3	20.9	12
40	6.3	10.2	18.9	12	80	7.6	10.9	20.2	12.5	140	9.4	12.9	23.9	13.7
45	7.1	12.63	23.4	14.9	90	8.6	13.6	25.1	15.6	150	10.1	16.7	27.3	15.6
50	7.9	15.4	28.5	18.1	100	9.6	16.5	30.5	18.9	160	10.7	16.6	30.7	17.6
55	8.7	18.35	34	21.5	110	10.5	19.7	36.4	22.5	170	11.4	18.5	34.3	19.7
60	9.5	21.6	40	25.3	120	11.5	23.1	42.7	26.4	180	12.1	20.6	38.1	21.9
65	10.2	25.1	46.4	29	130	12.4	26.8	49.6	30.7	190	12.7	22.7	42.1	24.2
70	11.0	28.7	53.2	33.8	140	13.4	30.6	56.9	35.2	200	13.4	25	46.3	26.6
75	11.8	32.6	60.4	38	150	14.3	35	64.7	40.1	220	14.7	29.8	55.3	31.8
80	12.6	36.8	68.1	43.1	160	15.3	39.3	72.8	45.1	240	16.1	35.8	66.4	37.4
85	13.4	41.2	76.2	47.6	170	16.3	44	81.6	50.5	260	17.4	41.6	75.3	43.3
90	14.2	45.7	84.7	53.6	180	17.2	48.9	90.5	56.1	280	18.8	46.6	86.3	49.4
95	15.0	50.5	93.6	58.8	190	18.2	54	100	62	300	20.1	52.9	98.1	56.8
100	15.8	56.6	103	65.1	200	19.1	59.4	110	68					

Problem 2 – Submersible Well Pump

Selecting Pipe Size:

System Design GPM: **20** (from example)

Select Pipe Size: **1-1/2"**

Friction Loss for Pipe: **2.83** (per 100')

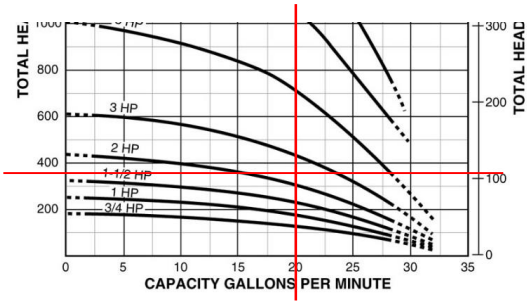
Pipe Totals: **285** (pump setting)

\+ **75** (Horizontal Pipe Run)

= **360** (Total length of pipe)

Problem 2B – Submersible Well Pump

Total Friction Loss:	**3.6**	(length/100)
x	**2.83**	(friction loss per 100')
=	**10.19**	
Round up	**11**	(to allow for fittings, etc.)
Total Dynamic Head:	**250**	(Pumping level) plus elevation
	93	Service pressure (in feet)
	11	Friction loss
	364	Total Dynamic Head



HP	PSI	PUMPING DEPTH IN FEET																													SHUT-OFF HEAD	
		20	40	60	80	100	125	150	175	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	FEET	PSI
2	0	–	–	–	–	–	–	–	27.3	26.0	23.2	20.3	16.2	9.5													450	194
	20	–	–	–	–	–	–	26.1	24.9	23.4	20.4	16.7	9.5															
	30	–	–	–	–	27.6	26.2	25.0	23.5	22.1	19.1	13.8	4.8															
	40	–	–	–	27.5	26.4	25.1	23.7	22.2	20.8	17.2	10.5																
	50	–	–	27.2	26.1	25.1	23.8	22.3	20.9	19.3	14.0	5.7																
	60	–	27.1	26.0	25.0	23.9	22.4	21.0	19.4	17.3	10.6																	
3	0	–	–	–	–	–	–	–	–	–	27.2	25.3	23.1	19.1	16.0	11.3	3.6										605	349
	20	–	–	–	–	–	–	–	–	27.3	25.4	23.2	20.4	17.3	14.1	12.0	5.0											
	30	–	–	–	–	–	–	–	27.4	26.6	24.8	22.5	20.6	18.1	14.5	9.0												
	40	–	–	–	–	–	–	27.5	26.7	25.5	23.8	21.7	19.4	16.8	17.5	5.3												
	50	–	–	–	–	–	27.6	26.7	25.8	24.9	22.8	20.8	18.3	15.0	9.5													
	60	–	–	–	–	27.7	26.8	25.7	24.9	23.9	21.8	19.7	16.4	12.7	5.6													
5	0	–	–	–	–	–	–	–	–	–	–	–	–	17.5	26.5	25.2	24.0	22.8	21.5	20.2	18.9	17.0	14.3	11.0	6.8		1005	476
	20	–	–	–	–	–	–	–	–	–	–	–	27.6	26.6	25.3	24.1	22.9	21.6	20.3	19.0	17.2	14.0	11.2	7.3				
	30	–	–	–	–	–	–	–	–	–	–	–	27.5	26.0	24.9	23.5	22.2	21.0	19.9	18.2	16.2	13.3	9.5	5.2				
	40	–	–	–	–	–	–	–	–	–	–	27.7	26.7	25.4	24.2	22.9	21.7	20.6	19.1	17.5	14.4	11.5	7.7	3.1				
	50	–	–	–	–	–	–	–	–	–	–	27.7	26.0	25.0	23.6	22.3	21.1	20.0	18.4	16.3	13.5	9.9	5.7					
	60	–	–	–	–	–	–	–	–	–	27.8	26.6	26.0	24.3	23.0	21.8	20.5	19.2	17.7	14.9	12.0	8.0	3.7