

## Basic Pumping Information

The sun is the natural source of energy for an independent water supply. Solar pumps operate anywhere that the sun shines, and the longer it shines, the more water they pump. When it's cloudy, they pump less water, but often you need less water when it is cloudy. Photovoltaic modules, the power source for solar pumping, have no moving parts, require no maintenance and last for decades. A properly designed solar pumping system will be efficient, simple and reliable.

Solar water pumping systems operate on direct current. The output of the solar power system varies throughout the day and with changes in weather conditions. The nature of variable electricity in the form of direct current (DC) is quite different from conventional, steady alternating (AC) current from the utility grid or a generator. To use solar energy economically, the pumping system must utilize the long solar day, drawing a minimum of power. This means pumping slower than conventional pumps. Pumping at rates of less than 6 GPM requires different mechanisms from the conventional (centrifugal) pumps.

Small solar pumps are unique, both electrically and mechanically. The most efficient pumps are "positive displacement pumps"; that pump a certain amount of water with each rotation. If it is cloudy or early morning, the pump will receive less energy and run slower. A "positive displacement" pump will pump approximately  $\frac{1}{2}$  as much water with  $\frac{1}{2}$  as much energy.

Conventional AC pumps are usually centrifugal pumps that turn at high speed to pump as many gallons per minute as possible. They also consume a large amount of power. If you run a centrifugal pump at  $\frac{1}{2}$  speed, it pumps  $\frac{1}{4}$  the water. Their efficiency is very low at low speeds and when pumping against high pressure.

If your water sources are remote from power lines, add up your long-term costs of fuel and repairs on generators, or the cost of utility line extensions. Now consider the savings with a solar pump that needs attention only once every 2 to 20 years.

Solar powered pumps can provide an equal volume of water per day without the high and inefficient energy demands of a large capacity AC pump. Instead of pumping a large volume of water in a short time and turning off, the solar pump works slowly and efficiently all day. Often a solar pump will work fine in a well with a recovery rate too slow for a conventional AC pump.

## Solar Submersible Pumps

If you are pumping from a well, we have solar pumps that can deliver from 1 gallon per minute (GPM) to over 50 GPM.

The smallest pump, the low power diaphragm pump from Shurflo, operates from two 50 to 75 watt solar modules, depending on the head (vertical distance) they are pumping. It can pump 500 to 1000 gallons per day and lift water 200 feet. This pump requires service every 2 to 4 years.

If you have a higher lift, need more water or want a

pump that does not require service for 15 to 20 years, the Grundfos SQFlex pump is a good choice. The SQFlex can lift water 525 feet and can pump over 20,000 gallons per day at lower lifts.

For greater water needs or deeper wells, the Grundfos SQ-series AC submersible pump can easily be powered by an inverter or generator.

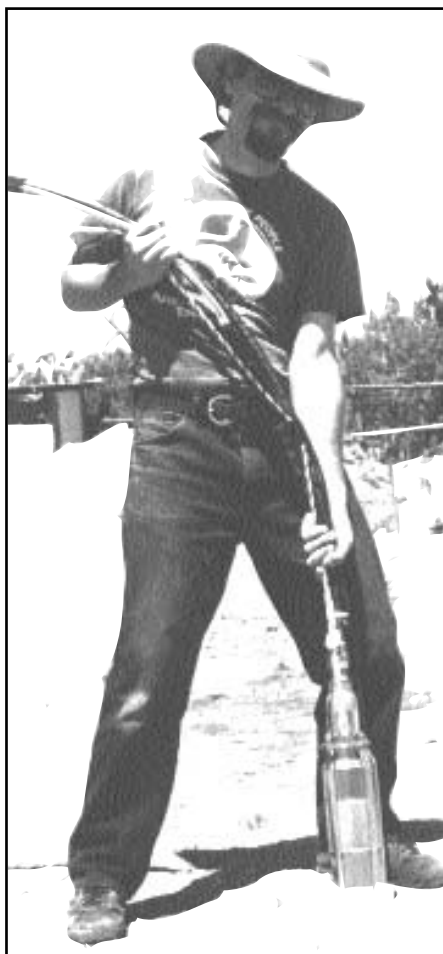
Larger conventional single and three phase AC pumps, up to 5 HP, can be solar powered with the Aerovironment AC Pump Controller and a large PV array.

## Surface Pumping

Surface pumps are less expensive than DC submersibles, where applicable. A surface pump is not submersible. It can draw

water from a dug well, spring, pond, river or tank, and push it far uphill and through a long pipeline to fill a storage tank or to pressurize it for home use or for irrigation, livestock, etc. The pump may be placed at ground level, or suspended in a well in some cases.

All pumps are better at pushing than pulling. Surface pumps must be placed no higher than 10 or 20 feet higher than the surface of the water source at sea level (subtract one foot per 1000 ft. Elevation). Suction piping must be oversized a bit and not allow air entrapment (much like a drain line) and should be as short as possible. Pumps can push very long distances. The vertical lift and flow rates are the primary factors that determine power requirements.



## Pressurization

Many conventional AC powered water systems pump from a well or other water source, into a pressure tank that stores water and stabilizes the pressure for household use. When you turn on water in the house, an air-filled bladder in the tank forces the water into the pipes. When the pressure drops, a pressure switch turns on the pump, refilling and repressurizing the tank. This works fine because of the ability of the AC pump to deliver a volume of water larger than the household uses. This can work in systems with an inverter large enough to run a standard AC pump. However, this will not work with pumps operating directly from PV modules. First, the sun may not be shining when you need pressure. Second, many solar pumps deliver water too slowly to keep up with household use.

There are two ways to solve this problem. A non-pressurized water tank can be located high enough above the house for gravity to supply the water pressure. This can be on a hill or a tower. Water pressure in PSI = Head in feet times 0.433. For reasonable pressure the tank needs to be at least 40 feet above the house. If this is not possible, a battery operated pressure booster pump can fill a pressure tank as needed from a storage tank that is filled by a solar pump during the day. The Flowlight Booster pump, as well as the Shurflo 2088 pumps can be used for this purpose. You must use a pump that can deliver the maximum GPM required by the house, or have a pressure tank that is large enough to make up the difference between what the pressure pump can deliver and what is required, for the amount of time it is required. This is called the "drawdown volume" of the tank. Air filled pressure tanks can be obtained locally from a pump dealer.

## Calculation of Solar Power Needs

With all solar powered pumps, the necessary solar array can be determined by looking at the watts required for the head and flow in your situation. Solar array watts should be at least 20% higher than the power required by the pump in your situation. If you use a larger array or a tracking array, the pump will operate at it's maximum output for more hours of the day, delivering more gallons per day.

If the pump runs on 24 volts, you can use pairs of 12V solar modules wired in series or 24V modules. Two solar modules with total wattage equivalent to or exceeding the wattage required by the pump must be used. If the pump uses 48 volts, you can use groups of four 12V solar modules wired in series or group of two 24V modules whose total wattage exceeds the pump's power requirement.

## Submersible Pump Cable

10/2

without ground

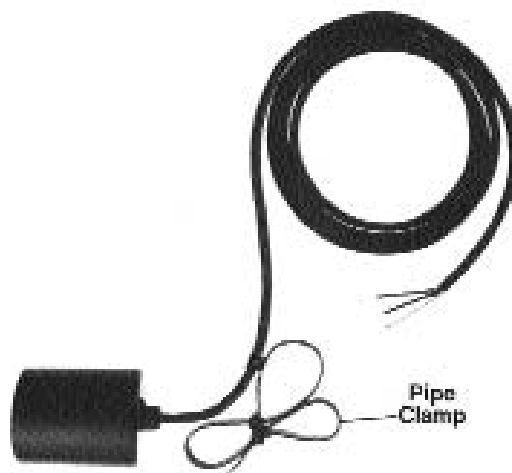
pump cable is for the Shurflo 9300 submersible pump. 2 conductor with ground pump cable is required for Grundfos SQFlex and SQ AC pumps.

### Sensor Wire

This 3-conductor, 22-gauge direct-burial wire can be used between water level sensors and pump controls in pumping applications where you must sense water level in a remote tank or in a well.

Description	Item Code	Price
10/2 without Ground	50.1637	\$0.75
12/2 w/Ground	50.1635	\$0.58
10/2 w/Ground	50.1638	\$0.88
8/2 w/Ground	50.1643	\$1.96
Sensor wire 22/3	50.1273	\$0.24

## Float Switch



This SPDT float switch can be used to control a pump in tank filling or tank emptying operation. Contacts located in the float will switch at 12 degrees above and below horizontal. A pipe clamp secures the cable to a pipe or weight in tank. The length of cable from clamp to float determines the difference between turn-on level and turn-off level. Maximum current is 5 amps. For larger pumps, use float switch to turn a relay on and off and let relay contacts control pump. Safe for domestic water systems. 2 year warranty.

75.5270 SPDT Float Switch

\$42

## Grundfos SQFlex Submersible Pumps

This is the ultimate submersible pump for water lifts of up to 525 feet. They can be directly powered by solar or wind or can be run on an inverter, a generator, a battery or the utility grid, or any combination of these sources. Virtually any source of power,

30-300 VDC and 90-240 VAC can be used to run the pump, and with the name Grundfos on it, you know it is built to last and is maintenance-free. The SQFlex will fit into a 3" or larger well.

Seven pump models can deliver from 4 GPM at 525 feet to 50 GPM at 20 feet of head with 1 kilowatt solar array or less. Helical rotor pumps for high head applications and centrifugal pumps for low head applications assure a pump that is efficient for any application. The SQFlex has

built-in protection from dry-running, overload and overheating.

The SQFlex pump can run on a solar arrays starting at 129 watts. The array must have an operating voltage over 30 volts. The array can be made with the Grundfos GF50 high voltage modules in parallel or any combination of 3 or more 12 volt nominal modules in series.

Grundfos also has a specially designed Whisper H80 wind generator for applications using wind power. Please contact us for information.

### Optional Controls

The **CU200** interface box communicates with the pump and monitors operating conditions. Built-in diagnostics indicate faults and dry-running, display operating status, power consumption and level switch input.

The **Level Switch** interfaces with the CU200 control to turn off the pump when a tank is full.

The **IO100** is a simple control box with cable terminations and a manual on/off switch. It is a great interface between a solar array and the pump to allow you to turn off the high voltage array when working on the pump.

The **IO101** is an interface for using AC backup on a solar pump. An automatic transfer switch disconnects the solar array when AC power from a generator, utility connection or inverter is present. When AC power stops, it automatically reconnects the array to let the sun continue pumping.

The **IO102** interface unit is used for systems powered exclusively by a wind turbine or by a combination of wind and PV.

You can use several controls if you need more features than one control can provide.

Use the table on next page to choose a pump. Left Column shows total head in feet and meters. The top row shows array wattage/number and suggested type of modules. Boxes show seasonal pump performance and maximum flow as shown in the sample box below.

See the **Heads above 390 ft** section below for heads over 390 feet.

40 SQF-3	Pump Model #
10,030	Daily Summer Volume (GPD)
5,846	Daily Winter Volume (GPD)
31	Peak Flow Rate (GPM)

Select the row with the head (total lift) that most closely matches your application. Move across the row to the column that contains the desired daily volume or peak flow rate. Note the pump model in that block and wattage of the PV array in that column.

### Heads above 390 ft.

For heads greater than 390 ft and up to 525 feet, the 3SQF-2 pump may be used. Use the sizing chart at right for this pump at 390 ft and use the table

below to determine the array wattage required for the head that will be pumped. Flow will be the same as that listed

Head (ft)	Wattage Multiplier
420	1.15
450	1.3
475	1.45
500	1.6
525	1.8

on the chart for 390 feet.

**\*\*Note:** Daily volume and flow calculations are based on 36° North latitude location, winter fixed array tilt of 36° and 4.1 kWh/m<sup>2</sup> (POA), summer fixed array tilt of 36° and 6.0 kWh/m<sup>2</sup> solar insolation. Up to 40% more water can be pumped in the summer if the array is on a tracking mount.

Pumps and Accessories	Item Code	List
SQFlex 3 SQF-2 Pump	75.1012	\$1,455
SQFlex 6 SQF-2 Pump	75.1015	\$1,455
SQFlex 11 SQF-2 Pump	75.1018	\$1,455
SQFlex 25 SQF-3 Pump	75.1021	\$1,455
SQFlex 25 SQF-6 Pump	75.1024	\$1,455
SQFlex 40 SQF-3 Pump	75.1027	\$1,455
SQFlex 75 SQF-3 Pump	75.1030	\$1,455
IO100 Interface Box	75.1039	\$109
IO101 Interface Box (115V)	75.1036	\$311
CU200 Interface for multiple sources	75.1033	\$245
Level Switch (Use with CU200 only)	75.1042	\$19
H80 Wind Turbine	75.1199	\$1,933
IO102 Wind Turbine Breaker Box	75.1040	\$200
Wind Turbine Tower Kit 30 foot	16.1089	\$385
Wind Turbine Tower Kit 50 Foot	16.1095	\$480
Auger/Anchor (set of 4)	16.1119	\$70

# Estimated Water Production from SQFlex Pumps

## Summer and Winter Volumes and Peak Flow Rates Based on Solar Array Wattage

Array Watts		165 W	225 W	275W	300 W	375 W	450 W	600 W	750 W	900 W	
# of Modules		3	3	5	4	5	6	8	10	12	
Module Type		SM55	SP75	SM55	SP75	SP75	SP75	SP75	SP75	SP75	
<b>Depth To Pumping Water Level (Lift) Feet</b>	20 ft. 6 M	11 SQF-2	25 SQF-3	40 SQF-3	40 SQF-3	40 SQF-3	40 SQF-3	75 SQF-3	75 SQF-3	75 SQF-3	
		2,891	4,381	6,258	6,599	9,585	10,670	13,880	17,100	20,060	
		1,374	2,414	3,030	3,609	5,377	6,623	8,549	10,890	12,890	
		11	14	20	22	27	30	39	45	49	
	35 ft. 10 M	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	25 SQF-3	25 SQF-3	40 SQF-3	40 SQF-3
		2,249	2,970	3,807	3,894	5,122	5,814	7,957	10,030	12,260	
		1,327	1,822	2,333	2,511	3,276	3,273	4,919	5,846	7,473	
		6.9	8.2	9.5	10	12	19	21	31	36	
	50 ft. 15 M	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	25 SQF-6	25 SQF-6	25 SQF-6
		1,901	2,568	3,368	3,458	4,638	4,929	5,899	7,677	9,320	
		1,097	1,542	2,005	2,180	2,894	3,284	3,321	4,628	5,754	
		6.2	7.5	8.7	9.3	10.5	11	19	23	26	
	65 ft. 20 M	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	25 SQF-6
		1,550	2,148	2,898	2,993	4,093	4,435	5,283	5,751	7,347	
		858	1,266	1,664	1,833	2,488	2,879	3,696	4,229	4,343	
		5.4	6.7	7.8	8.5	10.4	10	10	10	23	
	80 ft. 25 M	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2
		1,153	1,689	2,343	2,439	3,457	3,825	4,816	5,373	5,727	
		582	951	1,297	1,442	2,007	2,404	3,202	3,833	4,216	
		4.3	5.8	6.8	7.5	9.3	10	10	10	10	
	100 ft. 30 M	6 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2
		663	1,122	1,699	1,791	2,660	3,064	4,137	4,845	5,273	
		318	543	848	986	1,453	1,815	2,584	3,270	3,751	
		2.5	4.5	5.6	6.3	8	9.2	9.9	9.9	9.9	
	130 ft. 40 M	3 SQF-2	6 SQF-2	6 SQF-2	6 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2
		564	818	1,176	1,227	1,882	2,245	3,212	4,095	4,639	
		323	420	626	711	921	1,265	1,902	2,523	3,101	
		1.8	3	3.6	4	6.3	7.6	9.5	9.6	9.6	
	160 ft. 50 M	3 SQF-2	3 SQF-2	6 SQF-2	6 SQF-2	6 SQF-2	6 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2
		510	697	983	1,036	1,520	1,722	2,552	3,344	4,052	
282		415	481	569	842	1,043	1,445	2,000	2,494		
1.7		2.2	3.2	3.5	4.5	4.8	8.4	9.3	9.3		
200 ft. 60 M	3 SQF-2	3 SQF-2	3 SQF-2	3 SQF-2	6 SQF-2	6 SQF-2	6 SQF-2	11 SQF-2	11 SQF-2	11 SQF-2	
	440	623	840	870	1,241	1,445	1,994	2,533	3,202		
	233	361	481	528	642	845	1,215	1,403	1,873		
	1.5	2	2.3	2.3	3.9	4.6	4.7	8.5	8.8		
230 ft. 70 M	3 SQF-2	3 SQF-2	3 SQF-2	3 SQF-2	3 SQF-2	6 SQF-2	6 SQF-2	6 SQF-2	11 SQF-2	11 SQF-2	
	376	554	758	784	1,097	1,236	1,765	2,132	2,539		
	184	312	425	473	644	689	1,051	1,382	1,371		
	1.4	1.9	2.2	2.3	2.3	4.3	4.6	4.6	8.4		
260 ft. 80 M	3 SQF-2	3 SQF-2	3 SQF-2	3 SQF-2	3 SQF-2	3 SQF-2	6 SQF-2	6 SQF-2	6 SQF-2	6 SQF-2	
	320	492	689	717	1,021	1,091	1,553	1,960	2,201		
	151	267	378	424	591	703	898	1,218	1,493		
	1.3	1.7	2.1	2.2	2.3	2.3	4.5	4.5	4.5		
300 ft. 90 M	3 SQF-2	3 SQF-2	3 SQF-2	3 SQF-2	3 SQF-2	3 SQF-2	6 SQF-2	6 SQF-2	6 SQF-2	6 SQF-2	
	251	410	600	629	907	1,006	1,279	1,714	1,968		
	103	205	312	360	515	626	692	1,001	1,281		
	1.1	1.5	1.9	2.1	2.3	2.3	4.3	4.3	4.3		
330 ft. 100M	3 SQF-2	3 SQF-2	3 SQF-2	3 SQF-2	3 SQF-2	3 SQF-2	3 SQF-2	6 SQF-2	6 SQF-2	6 SQF-2	
	203	346	534	564	834	938	1,133	1,530	1,825		
	67	169	262	311	458	571	777	861	1,133		
	1	1.4	1.8	2	2.2	2.2	2.3	4.2	4.2		
390 ft. 120M		3 SQF-2	3 SQF-2	3 SQF-2	3 SQF-2	3 SQF-2	3 SQF-2	6 SQF-2	6 SQF-2	6 SQF-2	
		220	375	409	653	761	999	1,157	1,530		
		80	159	197	327	444	639	592	848		
		1.1	1.5	1.6	1.9	2.2	2.2	4.1	4.1		



### Shurflo 9300 Submersible Pump

Use this lightweight submersible pump for livestock, irrigation or remote home application with low water requirements. The 9300 is a positive displacement diaphragm type pump with very high efficiency, but a much shorter life than centrifugal or helical rotor pumps.

#### Array Direct Performance (24V Array)

Vertical Lift	Minimum Solar Array Size	Flow Rate (GPM)	Amps @ 30V
20	2 x 32 Watts	1.95	1.5
40	2 x 32 Watts	1.90	1.7
60	2 x 50 Watts	1.81	2.1
80	2 x 50 Watts	1.76	2.4
100	2 x 50 Watts	1.71	2.6
120	2 x 50 Watts	1.68	2.8
140	2 x 75 Watts	1.65	3.1
160	2 x 75 Watts	1.63	3.3
180	2 x 75 Watts	1.55	3.6
200	2 x 75 Watts	1.52	3.8
230	2 x 90 Watts	1.36	4.1

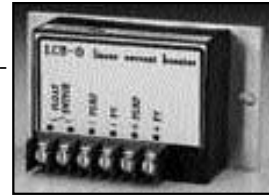
Diaphragm should be replaced every two to four years, depending on pumping volume.

The Shurflo 9300 can be operated on a 12 or 24-volts battery or, with the use of one of the Shurflo Pump Controls, directly on a PV array. The pump can lift 1.3 GPM to 230 ft. and can pump nearly 2 GPM from very shallow wells. It measures only 3.75" diameter x 12" long.

The 902-200 controller comes in an outdoor enclosure with water level sensors and sensor wire. It can be operated from a 12V or 24V array. The 902-100 control must be mounted in a dry location and used with a 24V array

Performance on a 12-volt battery will be less than 1/2 the flow on the chart at right.

1 year warranty.



Description	Voltage / Wattage	Wt. (lbs.)	Item Code	List
Shurflo 9300 Submersible Pump	24 VDC, 100 W	6	75.5817	\$689
Shurflo 902-100 Pump Controller	24 VDC, 150 W max.	6	75.5823	\$122
Shurflo 902-200 Pump Controller	12-24 VDC, 150 W max	6	75.5820	\$273

### LVM Submersible Pumps

LVM pumps are constructed of polyacetal plastic, enabling them to pump almost any liquids. They are small enough to enter the opening in a five gallon container or a 2" well casing. The outlet is a 1/2" hose barb. The intake has a removable strainer with another hose barb for inline use. These pumps can be used for most general intermittent pumping applications, like hosing down cars, vans, boats, pumping into and from containers, emptying bilges, etc. LVM 105 comes with battery clips. These pumps are designed for 12 volt operation and will be damaged by array direct operation if voltage goes above 15 volts. Made in England.



Model Number	Current (amps)	Flow Rate (GPM)	Pressure (Max PSI)	Maximum Head (Feet)	Dimensions (in.)	Weight (lb)	Cable Length	Item Code	Price
LVM105	7	4.75	14.22	32	1.5 x 6.54	2.5	12 ft	75.8052	\$63
LVM107	2	2.38	5.69	11.5	1.5 x 5.67	1.5	3 ft	75.8054	\$48

### Aquasolar 700 Fountain Pumps

This is the smallest solar-direct submersible water pump we sell. Ideal for fountains, solar displays and remote, very small pumping needs, it is designed to be powered by a 10 watt PV module or a 12 volt battery. Unlike other 12 volt fountain pumps it can operate continuously on the 16 to 20 volt open circuit output of 12 volt PV modules. It is made in Germany and is a very high quality pump. It pumps over 2 gallons per minute at 18 volts when powered by a 10 watt module in full sun. The pump housing acts as an intake screen. The built-in outlet adapter can receive 1/2" or 3/4" pipe thread. Maximum lift is 4' at 18VDC and 6' at 24VDC. Maximum voltage is 24VDC. Dimensions: 6.0" x 4.5" diameter. Cord length is 15 feet. 3 year warranty.

Model Number	Dimensions (in.)	Weight (lb)	Cable Length	Item Code	Price
700	6 x 4.5	2.1	15 ft	75.8134	\$150



### Dankoff Slowpump



The Slowpump can push water as high as 450 vertical feet. It runs on very little power, with or without batteries, to supply between 200 and 2600 gallons of water per day. The positive displacement vane pump mechanism is housed in forged

brass, and lasts for years of all-day running. 5 micron filtration is required to protect the pump. For PV-direct (no batteries in system) array, watts must exceed pump watts by 20% or more, and a linear current booster controller is required. The sizing chart shows the gallon per minute (GPM) output from the pump and power (Watts) consumed by the pump for various vertical lifts. (This is the lift from the water level to the top of the tank that the water is pumped to). The performance in the chart is measured at array direct voltage. The peak power voltage of typical solar modules is 17 Volts. A battery powered system will have 15% lower flow and wattage. To estimate gallons per day delivery, multiply GPM figure by 60 and then by the peak sun hours per day in your location. Using a tracker with your solar modules will give you approximately 40%-55% more water in the summer. Slowpumps are available with 1/2 HP motors for greater lift. NOTE: Pumps listed 12 or 24 Volts may be used with batteries or array direct. The 36PV/48B pumps can be run PV direct with a 36V array or from a 48V battery bank.

For 120VAC operation order the desired pump and the Slowpump AC Option.

Warranty is one year.

Description	Item Code	Price
Slow pump 1304-12	75.4155	\$475
Slow pump 1304-24	75.4157	\$475
Slow pump 1308-12	75.4159	\$475
Slow pump 1308-24	75.4161	\$475
Slow pump 1310-12	75.4163	\$475
Slow pump 1310-24	75.4165	\$475
Slow pump 1322-12	75.4167	\$475
Slow pump 1322-24	75.4169	\$475
Slow pump 1303-12	75.4171	\$475
Slow pump 1303-24	75.4173	\$475
Slow pump 2503-12	75.4175	\$475
Slow pump 2503-24	75.4177	\$475
Slow pump 2507-12	75.4179	\$475
Slow pump 2507-24	75.4181	\$475
Slow pump 1408-24B	75.4185	\$695
Slow pump 1408-36PV/48B	75.4187	\$695
Slow pump 1404-24B	75.4189	\$695
Slow pump 1404-36PV/48B	75.4191	\$695
Slow pump 1403-24B	75.4193	\$695
Slow pump 1403-36PV/48B	75.4195	\$695
Slow pump 2605-24B	75.4197	\$695
Slow pump 2605-36PV/48B	75.4199	\$695
Slow pump 2607-24B	75.4201	\$695
Slow pump 2607-36PV/48B	75.4203	\$695
Slow pump AC Option	75.4183	\$145

Slowpump Accessories	Item Code	Price
Inline Filter Housing	78.1125	\$35
Filter Cartridge 12"	78.1130	\$4
Dry Run Switch 1300/1400	75.4213	\$50
Dry Run Switch 2500/2600	75.4215	\$50
Intake Strainer/ Foot Valve	75.4211	\$73
Filter Foot Valve 30"	75.4207	\$70
Filter Cartridge 30" 3-pack	75.4209	\$44

Vert. Lift	1322		1310		1308		1304		1303		2503		2505		2507		1403		2605		2607		
	GPM	Watts	GPM	Watts	GPM	Watts	GPM	Watts	GPM	Watts	GPM	Watts	GPM	Watts	GPM	Watts	GPM	Watts	GPM	Watts	GPM	Watts	
20	0.51	27	0.92	29	1.25	30	1.75	37	2.5	48	2.5	48	3.25	52	4	57							
40	0.51	32	0.92	41	1.25	48	0	53	2.5	60	2.5	60	3.23	69	3.05	78							
60	0.51	36	0.89	46	1.2	54	1.68	64	2.4	78	2.4	78	3.15	90	3.9	102							
80	0.49	40	0.88	51	1.2	60	1.64	73	2.3	93	2.3	93	3.1	106	3.9	120							
100	0.49	45	0.88	57	1.2	66	0	82	2.3	105	2.3	105	3.08	124	3.85	144							
120	0.48	50	0.88	61	1.2	66	1.62	90	2.25	121	2.25	121	3.02	142	3.8	165							
140	0.48	56	0.88	66	1.2	75	1.6	100	2.2	138	2.2	138	2.92	166	3.65	195							
160	0.47	62	0.87	74	1.2	84	0	112	2.2	153	2.2	153	2.85	187							4.30	283	
180	0.47	68	0.86	82	1.18	93	1.57	122	2.15	165	2.15	165	2.75	205						3.35	280	4.25	305
200	0.47	74	0.85	89	1.16	99	1.56	133	2.15	180	2.15	180		1408		1404				3.33	296	4.20	338
240	0.45	90	0.83	105	1.14	117	1.54	152	2.15	204	2.15	204		GPM	Watts	GPM	Watts	2.55	266	3.30	331	4.05	396
280	0.44	102	0.81	120	1.1	135	1.51	175										2.50	302	3.25	373	4.00	444
320	0.41	120	0.79	138	1.1	153	1.48	196										1.66	255	2.50	338	3.20	410
360	0.41	134	0.76	154	1.05	171												1.62	280	2.50	374	3.16	450
400	0.4	150	0.73	176	1	198												1.64	312	2.50	406		
440	0.39	168	0.7	202	1.1	269							1.1	269	1.66	342	2.50	451					

## Solar Force Piston Pump

The Solar Force utilizes solar electricity or battery power to draw surface water from a shallow well, spring, pond, river or tank. It can push water uphill and over long distances. It is also used for domestic or irrigation pressurizing. As with all surface pumps, suction capacity is 20 feet (subtract 1 foot for every 1000 feet elevation above sea level). It is dirt tolerant, very long-lasting, reliable and easily rebuildable using common hand tools. This pump uses less energy per gallon of water delivered than any pump we sell. The pump head is cast iron with a brass cylinder also available with 120VAC motor. Pump is shipped in 2-3 parcels. Use of a surge tank is recommended in systems with long delivery piping. 2 year warranty.



Vertical Lift (feet)	Pressure (PSI)	Model 3010			Model 3020			Model 3040		
		Battery Only			PV or Battery			PV or Battery		
		GPM	LPM	Watts	GPM	LPM	Watts*	GPM	LPM	Watts*
20	8.7	5.9	22.3	77	5.2	19.7	110	9.3	35.2	168
40	17.4	5.6	21.3	104	5.2	19.7	132	9.3	35.2	207
60	26.0	5.3	20.2	123	5.1	19.2	154	9.2	34.9	252
80	35.0	5.2	19.7	152	5.1	19.2	182	9.2	34.9	286
100	43.0	5.1	19.2	171	5	18.9	202	9.1	34.5	322
120	52.0	4.9	18.7	200	5	18.9	224	9.1	34.5	364
140	61.0	4.9	18.7	226	5	18.9	252	9.1	34.5	403
160	70.0				4.9	18.6	269			
180	78.0				4.9	18.6	280			
200	86.0				4.8	18.2	308			
220	95.0				4.7	17.8	314			

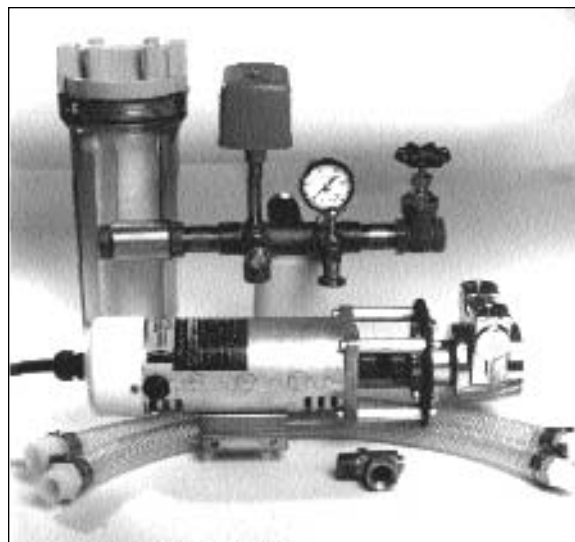
\* Watts listed is pump power used. For array direct operation array must be at least 20% larger

Solar Force Pump Description	Nominal Voltage	Power Source	Weight (lbs.)	Item Code	Price
Solar Force Piston Pump 3010-12-B	12	Battery	55	75.4265	\$1,085
Solar Force Piston Pump 3010-24-B	24	Battery	55	75.4267	\$1,085
Solar Force Piston Pump 3020-12-PV	12	PV	70	75.4273	\$1,525
Solar Force Piston Pump 3020-24-PV	24	PV	70	75.4277	\$1,510
Solar Force Piston Pump 3020-48-PV	48	PV	70	75.4281	\$1,525
Solar Force Piston Pump 3040-12-PV	12	PV	70	75.4287	\$1,595
Solar Force Piston Pump 3040-24-PV	24	PV	70	75.4291	\$1,585
Solar Force Piston Pump 3040-48-PV	48	PV	70	75.4295	\$1,595
Solar Force Piston Pump 3020-12-B	12	Battery	70	75.4271	\$1,340
Solar Force Piston Pump 3020-24-B	24	Battery	70	75.4275	\$1,340
Solar Force Piston Pump 3020-48-B	48	Battery	70	75.4279	\$1,350
Solar Force Piston Pump 3040-12-B	12	Battery	70	75.4285	\$1,425
Solar Force Piston Pump 3040-24-B	24	Battery	70	75.4289	\$1,415
Solar Force Piston Pump 3040-48-B	48	Battery	70	75.4293	\$1,395
Solar Force Piston Pump 3020-120VAC	120	120 VAC	70	75.4269	\$1,350
Solar Force Piston Pump 3040-120VAC	120	120 VAC	70	75.4283	\$1,340
Solar Force Pump Accessories					
Heavy Duty Pressure Switch	75.4297	\$75	EZ Install Kit for Solar Force	75.4248	\$135
1-1/4" Foot Valve (use if pump is higher than	75.4212	\$25	Surge Tank	75.4250	\$90
Seal & Belt Kit for 3020PV	75.4230	\$75	PK-3010B Parts Kit	75.4236	\$160
Seal & Belt Kit for 3040PV	75.4231	\$75	PK-3020B Parts Kit	75.4237	\$160
Seal & Belt Kit for 3020B	75.4232	\$46	PK-3040B Parts Kit	75.4238	\$160
Seal & Belt Kit for 3040B	75.4233	\$46	PK-3020PV Parts Kit	75.4241	\$210
Instruction Manual	75.4253	\$5	PK-3040PV Parts Kit	75.4242	\$210



### Flowlight Booster Pump

The Flowlight Booster Pumps provide “town pressure” for home water supplies where 12, 24 or 48 volt power is available. They have a longer life and greater flow rate than Flojet and Shurflo booster pumps and they use less than 1/2 the energy consumed by an AC jet pump running on an inverter. The Flowlight Booster pump will be damaged if it runs dry or is used for pumping rusty or dirty water, so order a filter and dry run switch. To make installation and service easy, flexible hose connectors with 3/4” threaded adapters are included. A minimum 40 gallon pressure tank is required for all Flowlight booster pump installations (available locally from a pump supplier). The standard Flowlight model has the highest flow. Use only where suction lift is less than 10 feet. The low flow model has a higher pressure capacity and should be used where suction lift is greater than 10 feet or where suction pipe is less than 1” inside diameter. Maximum suction lift is 20 feet at sea level for low flow model. Use the 115 VAC pump where DC wiring is not feasible, like long wire runs. It has similar high efficiency and low starting surge. It can run on less than a 500 watt inverter. Dimensions: 16.5” in length. 1-year warranty.



The photo above shows a Flowlight Booster Pump with the easy installation kit listed below.

Description	Voltage	MAX. (GPM)	Pressure (PSI)	Amps	Weight (lbs)	Item Code	Price
Standard 12V	12VDC	4.5	30	13.0	15	75.4125	\$540
			40	15.0			
			50	16.0			
Standard 24V	24VDC	4.5	30	6.5	15	75.4127	\$540
			40	7.5			
			50	8.0			
Standard 48V	12VDC	4.5	30	3.5	15	75.4129	\$695
			40	4.0			
			50	4.5			
Standard 120VAC	120VAC	4.5	30	1.7	15	75.4131	\$630
			40	2.0			
			50	2.1			
Low Flow 12V	12VDC	3.4	30	10.0	15	75.4121	\$520
			40	11.0			
			50	12.0			
Low Flow 24V	24VDC	3.4	30	5.0	15	75.4123	\$520
			40	7.5			
			50	8.0			

Description	Weight	Item Code	Price
EZ Installation Kit for Booster Pump - includes accessory t-fitting, adjustable pressure switch, pressure gauge, check valve, drain valve, shut-off valves and pipe nipples		75.4205	\$98
Inline Filter with 3/4" female pipe fittings		78.1125	\$35
Filter cartridge - 5 Micron		78.1130	\$4
Pressure Switch - off at 40 PSI and on at 20 PSI		71.4135	\$25

## Shurflo 2088 Pressure Pumps

These positive displacement diaphragm pumps make excellent household pressure pumps if you need less flow than the booster pumps on the previous page deliver. The Shurflo 2088 pumps up to 3.6 gallons per minute, are designed for **continuous duty\*** operation and they can be run dry without harm. They have a built-in pressure switch and 1/2" male pipe thread ports for easy connection to common plumbing fittings. Home pressurization installation requires a precharged water tank. For general water pumping, this pump can self prime to 10 feet and lift water up 100 feet. The 120 volt AC version can run on a 200 watt inverter and can be 1000 feet from the inverter using 12 gauge wire. Dimensions: 4.45" x 12.4" x 5".

\* with addition of optional heat sink



Shurflo Part Number	Description	Voltage	MAX. (GPM)	Pressure (PSI)	Flow (GPM)	Amps	Item Code	Price
2088-443-144	Standard Pump - 3.5 GPM open flow, 45 PSI Demand Switch, 1/2" MSPT ports	12VDC	3.5	10	2.83	5.80	75.5625	\$98
				30	2.31	8.00		
				40	2.02	9.10		
2088-514-145	Premium Pump with Fin Cooled Motor 3.6 GPM open flow, 45 PSI Demand Switch, 1/2" MSPT ports	12VDC	3.5	10	2.9	5.60	75.5613	\$155
				30	2.3	8.40		
				40	2.07	9.00		
2088-514-144	High Flow Pump - 3.8 GPM open Flow, 45 PSI Demand Switch, 1/2" MSPT ports	12VDC	3.8	10	3.3	7.90	75.5615	\$160
				30	2.5	10.00		
				40	2.2	10.50		
2088-414-534	Premium Pump with Splash-Proof Motor 3.6 GPM open flow, 45 PSI Demand Switch, 1/2" MSPT ports	12VDC	3.6	10	2.9	5.60	75.5616	\$186
				30	2.3	8.40		
				40	2.07	9.00		
2088-474-144	Standard Pump - 3.0 GPM open flow, 45 PSI Demand Switch, 1/2" MSPT ports	24VDC	3	10	2.8	2.41	75.5628	\$102
				30	1.75	2.73		
				40	1.25	2.71		
2088-574-534	Premium Pump with Splash-Proof Motor 3.6 GPM open flow, 45 PSI Demand Switch, 1/2" MSPT ports	24VDC	3.6	10	3.17	3.10	75.5619	\$186
				30	2.63	4.10		
				40	2.34	4.50		
2088-594-154	Standard Pump - 3.3 GPM open flow, 45 PSI Demand Switch, 1/2" MSPT ports	120VAC	3.3	10	2.6	0.58	75.5622	\$144
				30	2.08	0.76		
				40	1.85	0.94		

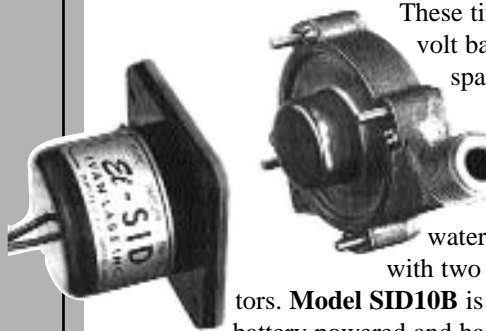
## Shurflo Pump Accessories

Use the 2 Gallon Pre-charged pressure tank to extend the life of your Shurflo pump. The tank helps provide a smooth flow in your pumped water system and reduces motor heating and pressure switch wear by decreasing the number of on/off cycles. Internal bladder is precharged to 20 PSI.

Adapters fit the Straight Pipe Thread on the 2088 pumps and allow connection of tapered pipe thread fitting. Right angle fittings have wingnut fitting that can be tightened by hand. Straight fitting has a hex nut cast into it.

Shurflo Part Number	Description	Item Code	Price
3400-002	Vertical 2 Gallon Pre-Charged Pressure Tank - Stainless steel with 3/4" male NPT port	75.5730	\$130
170-061-20	Twist-on Water Strainer - 50 mesh screen 1/2" FPST inlet	75.5784	\$10
8-035	Adapter w/Wingnut - Right Angle 1/2" FSPT to 1/2" NPT for 2088 Pumps	75.5760	\$2
8-155-01	Adapter w/Wingnut - Right Angle 1/2" FSPT to 5/8" Barb for 2088 Pumps	75.5763	\$2
8-205-00	Adapter - Straight 1/2" FSPT to 1/2" NPT Male for 2088 Pumps	75.5735	\$2
34-006	5" Heat Sink for continuous duty	75.5766	\$24

### EL-SID Brushless Water Circulators



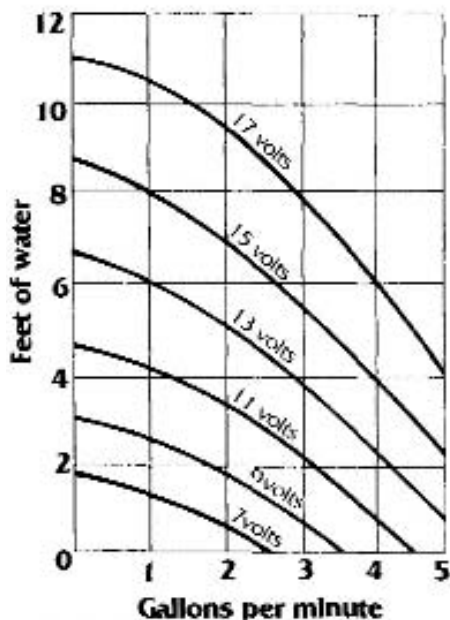
These tiny brushless, magnetic drive circulators can be driven by PV modules or 12 volt batteries for closed-loop circulation in solar water heating systems, individual space heat zones and individual loop radiant floor loops. Use of several small pumps in a radiant floor system allows each loop to be controlled by a different thermostat. **Model SID10** is designed to be powered by a 10 watt PV module and can pump 2.5 gallons per minute at no head and 1/2 GPM at 2.5 feet of head at 17 volts input. It can circulate water in a well designed solar

water heating system with two 4 x 10 collectors. **Model SID10B** is designed to be battery powered and has the same specifications at 12 volts. Dimensions: 4" x 4" x 5".

Model Number	Maximum Voltage	Weight (lb)	Dimensions (in)	Item Code	Price
EL-SID 10	18	2	4 x 4 x 5	75.7218	\$248
EL-SID 10B	15	2	4 x 4 x 5	75.7219	\$248

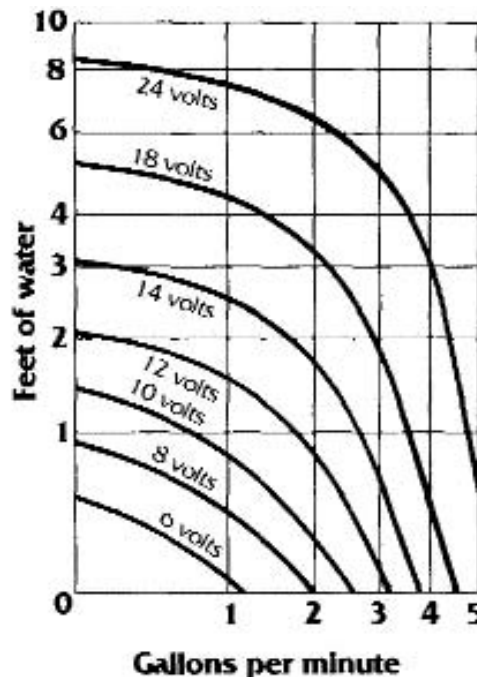
### Hartel MD10HEH Circulator

This pump has an electronically commutated, high efficiency brushless motor with a 30,000 hour life expectancy. It may be operated from an 18 to 22 watt solar module or directly from a 12 volt battery system. They work great for closed loop solar water heating systems and radiant floor heating. The graph shows this pumps performance at various heads and flows, at different input voltages.



### Hartel MD3DCL Circulator

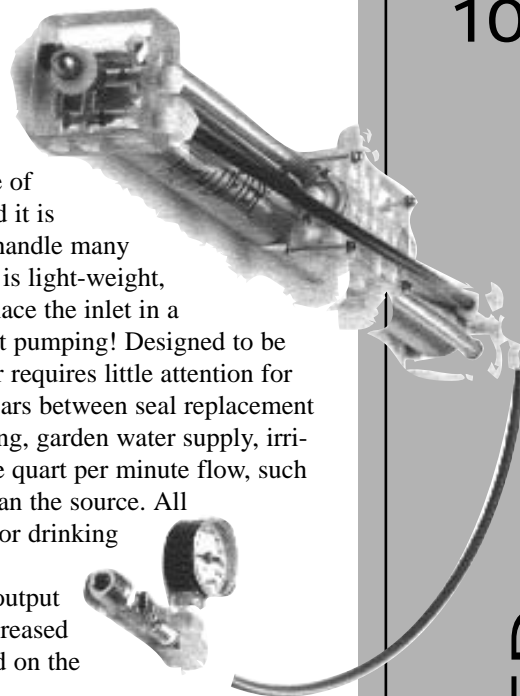
This pump has an economical brush-type motor that may be used with a 12 or 24 volt battery system, or directly from an 18 watt 12 volt PV module. It has a 7,000 hour life expectancy. It works well as a circulating pump between a tank and solar collector in a domestic hot water system. It also functions well as a circulating pump in a radiant floor heating system that requires less than 5 GPM of circulation. Brushes last for 3-5 years and are easily replaced without removing pump from plumbing.



Model Number	Operating Voltage	Pipe Connections	Dimensions (in)	Item Code	Price
MD-10-HEH	6-16 VDC	1/2" MNPT	5.25 x 9	75.7237	\$380
MD-3-DCL	2-24 VDC	1/2" MNPT	5.25 x 7.75	75.7241	\$199

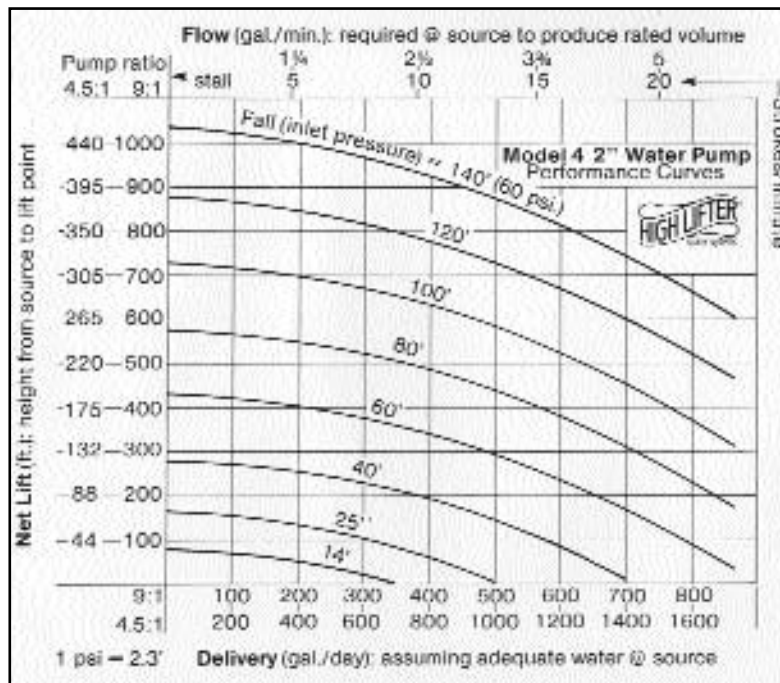
## HighLifter Water Powered Water Pumps

The HighLifter is a powerful water pump designed to move water uphill without using gasoline or electricity. By harnessing the energy from the head of water, the HighLifter pump drives a portion of this water uphill. Pistons provide the pumping action and water is the only lubricant used. It can pump 750-1500 gallons of water per day and it can also work on as little as one quart per minute of source water. It is self-starting and requires no lubrication, priming or tuning and it is extremely quiet. The HighLifter is an efficient, economical and reliable way to handle many water pumping requirements. Ideally suited for hilly and mountainous terrain, it is light-weight, quiet, easy to install and capable of extreme lifts with low inlet flows. Simply place the inlet in a stream or other water source, run a pipe downhill to get appropriate fall and start pumping! Designed to be installed and maintained by the user (with basic household tools), the HighLifter requires little attention for years of hard working service. A HighLifter can operate continuously for 1-3 years between seal replacement service. The HighLifter pump can be effectively used for domestic water pumping, garden water supply, irrigation, range cattle, etc. All that is required is a source of water with at least one quart per minute flow, such as a spring, creek or pond and a place to locate the pump at a lower elevation than the source. All HighLifter parts are made of stainless steel, Teflon and acrylic so they are safe for drinking water. Pump is 26" long. 1 year warranty on materials and workmanship.

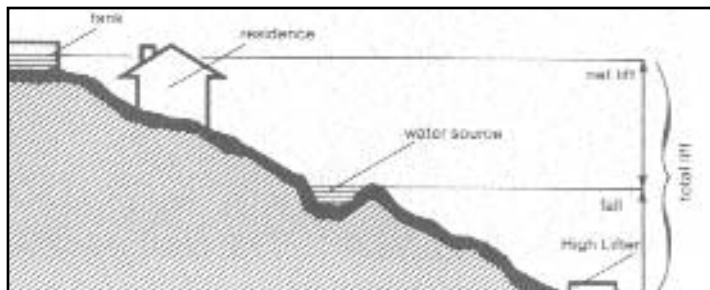


As illustrated in the graph below, the HighLifter responds to both inlet and output pressure. Because the HighLifter utilizes inlet water pressure to pump water, increased inlet pressure yields greater delivery. Reducing the output pressure puts less load on the pump, allowing more water to be pumped.

To determine how much water will be pumped, find the net lift for the ratio of the pump to be used on the left side of the graph. Move across the graph horizontally to the right until you cross the curve for the fall (inlet pressure). From the point where lift and fall cross, move vertically down to the bottom of the graph and read the Delivery (gal/day) for the ratio of the pump being used. To get this delivery amount, the input flow to the pump must be equal to or greater than the Flow (gal/min) at the top of the chart in line with the point where the lift and fall lines cross. If the input flow is less than this number, the output will be correspondingly lower.



The picture at right shows a typical setup using the HighLifter to fill a tank. This picture shows the definition of net lift and fall.



Model #	Pump Ratio	Maximum Output/Day	Maximum Net Lift	Maximum Total Lift	Item Code	Price
H44	4.5:1	1500 gal	440 ft.	580 ft.	76.9002	\$895
H49	9.1:1	750 gal	1000 ft.	1140 ft.	76.9005	\$895

### Hydraulic Ram Pump Info and Formula

As little as 3 feet fall from the water source to the pump at a flow rate of 1 to 3 gpm can provide up to 10 feet of vertical lift per foot of fall. For example, if you need to pump water 30 feet uphill, then you will require a minimum fall of 3 feet (a 10 to 1 ratio). However, in order to achieve a greater output of water at this lift, it is better to keep the fall-lift ratio as small as practical. You can achieve a 5 to 1 ratio by increasing the fall of the water to 6 feet ( $6 \times 5 = 30$ ). The actual output of a ram can be calculated with this formula:  $V \times F \times 0.5 / E = D$ .  $V$  is the available water flow in GPM,  $F$  is the vertical fall from the water source to the ram,  $E$  is the vertical lift from the ram to the top of the delivery pipe and  $D$  is the water delivered in GPM.

**Note:** The drive pipe must be 3 to 5 times as long as the vertical inlet fall for proper operation. On Folk rams, steel pipe must be used for the drop pipe. The delivery height can be no more than 15 times the intake fall height.

### Folk Heavy Duty Hydraulic Rams

These rams are made from cast aluminum alloy and stainless steel and are very heavy-duty. They can pump a maximum of 500 feet and operate from a fall of 50 feet or less. There are six models to choose from. The amount of water each size can pump is determined by the inlet flow, inlet fall and delivery height. Each size ram has a range of inlet flow it can operate from. If you have more flow, there is no problem, but if you have less flow, the ram will not operate.

Multiple ram pumps can be used if you need to pump more water than one pump can deliver.



Intake Flow Range (GPM)	Intake Pipe Size	Discharge Pipe Size	Item Code	Price
2 - 4	1"	1"	75.8601	\$1,045
2 - 7	1-1/4"	1"	75.8603	\$1,045
3 - 15	1-1/2"	1"	75.8605	\$1,045
6 - 30	2"	1-1/4"	75.8607	\$1,595
8 - 45	2-1/2"	1-1/4"	75.8609	\$1,595
15 - 75	3"	1-1/4"	75.8611	\$1,595

### Thermostats

These thermostats can switch up to 22 amps at 120 VAC and they work fine for up to 10 amps at 12 or 24 VDC. Use them with DC fans to turn the fans on or off as temperature changes. They mount in a standard 2" x 4" electrical box. The Attic Fan Thermostat has single pole contacts that close (turn fan on) as temperature rises. Its adjustment range is 90°F to 130°F. When the thermostat reaches the turn-on temperature, it must fall by 15°F before it will turn off. The Heat/Cool Thermostat has double throw contacts, so it can be used to turn a fan on as the temperature rises or as it falls, depending on how it is wired. Its range is 50°F to 90°F and its differential is 2°F.



Description	Item Code	Price
Attic Fan Thermostat 90 to 130 F	85.8036	\$35
Heating and Cooling Thermostat 50 to 90 F	85.8032	\$30