

GAIAM REAL GOODS

TWELFTH EDITION

# SOLAR LIVING SOURCE BOOK

Your Complete Guide to  
Renewable Energy Technologies  
and Sustainable Living

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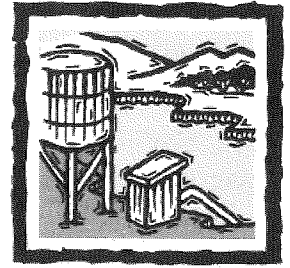
A REAL GOODS SOLAR LIVING BOOK

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# Water Development



*You don't miss your water  
till the well runs dry.*

—Folk saying

WATER IS THE SINGLE MOST IMPORTANT INGREDIENT in any homestead. Without a dependable water source, you can't call any place home for very long. An age-old saying goes, "You buy the water and the land comes for free." Gaiam Real Goods offers a wide variety of water development solutions for remote, and not so remote, homes. We specialize in products that are made specifically for solar-, battery-, wind-, or water-powered pumping. These pumps are designed for long hours of dependable duty in out-of-the-way places where the utility lines don't reach. For instance, ranchers are finding that small solar-powered submersible pumps are far cheaper and more dependable than the old wind pumps we're used to seeing dotting the Great Plains. Many state and national parks use our renewable-energy powered pumps for their backcountry campgrounds. The great majority of pumps we sell are solar- or battery-powered electric models, so we'll cover them first.

The initial cost of solar-generated electricity is high. Because of this high initial cost, most solar pumping equipment is scaled toward modest residential needs, rather than larger commercial or industrial needs. By wringing every watt of energy for all it's worth, we keep the start-up costs reasonable. Solar-powered pumps tend to be far more efficient than their conventional AC-powered cousins.

## The Three Components of Every Water System

Every rural water system has three easily identified basic components.

**A Source.** This can be a well, a spring, a pond, a creek, collected rainwater, or the big expensive tanker truck that hauls in a load every month.

**A Storage Area.** This is sometimes the same as the source, and sometimes it is an elevated or pressurized storage tank.

**A Delivery System.** This used to be as simple as the bucket at the end of a rope. But given a choice, most of us would prefer to have our water arrive under pressure from a faucet. Hauling water, because it's so heavy, and because we use such surprising amounts of it, gets old fast.

The first two components, source and storage, you need to produce locally; however, we can offer a few pointers based on experience and some of the better, and worse, stories we've heard.

## Sources

### WELLS

The single most common domestic water source is the well, which can be hand dug, driven, or drilled. Wells are less prone than springs, streams, or ponds to pick up surface contamination from animals, pesticides and herbicides, and the like. Hand-dug wells are usually about 3 feet or larger in diameter and rarely more than 40 feet deep. These are dangerous to build, they need regular cleaning, and it is dangerous to have them lying around unused on your property. Drilled or driven wells are standard practice now. The most common sizes for residential driven or drilled wells are 4 inches or 6 inches. Beware of the "do-it-yourself" well-drilling rigs, which rarely can insert pipe larger than 2 inches. This restricts your pump choices

Ranchers are finding that small solar-powered submersible pumps are far cheaper and more dependable than the old wind pumps we're used to seeing dotting the Great Plains.

Prior to developing a spring, you may want to give some consideration to any ecosystems it supports.

Ponds are one of the least expensive and most delightfully pleasing methods of supplying water, not only for your own needs, but also for the wildlife population that your pond will soon support.

## APPROXIMATE DAILY WATER USE FOR HOME AND FARM

USAGE	GALLONS PER DAY
<b>Home</b>	
National average residential use	60–70 per person
As above, without flush toilet	25–40 per person
Drinking and cooking water only	5–10 per person
<b>Lawn – Garden – Pool</b>	
Lawn sprinkler, per 1,000 sq. ft., per sprinkling	600 (approx. 1 inch)
Garden sprinkler, per 1,000 sq. ft., per sprinkling	600 (approx. 1 inch)
Swimming pool maintenance, per 100 sq. ft. surface area	30 per day
<b>Farm (maximum needs)</b>	
Dairy cows	20 per head
Dry cows or heifers	15 per head
Calves	7 per head
Beef cattle, yearlings (90°F)	20 per head
Beef, brood cows	12 per head
Sheep or goats	2 per head
Horses or mules	12 per head
Swine, finishing	4 per head
Swine, nursing	6 per head
Chickens, laying hens (90°F)	9 per 100 birds
Chickens, broilers (90°F)	6 per 100 birds
Turkeys, broilers (90°F)	25 per 100 birds
Ducks	22 per 100 birds
Dairy sanitation – milk room and milking parlor	500 per day
Flushing barn floors	10 per 100 sq. ft.
Sanitary hog wallow	100 per day

to only the least-efficient jet-type pumps. A 4-inch casing is the smallest you want, that's the minimum for a submersible pump.

### SPRINGS

Many folks with country property are lucky enough to have surface springs that can be developed. At the very least, springs need to be securely fenced to keep out wildlife. More commonly, springs are developed with either a backhoe and 2- or 3-foot concrete pipe sections sunk into the ground, or drilled and cased with one of the newer, lightweight horizontal drilling rigs. This helps to ensure that the water supply won't be contaminated by surface runoff or animals. To be respectful to your land and the critters that lived there before you came, prior to developing a spring you may want to give some consideration to any ecosystems it supports. If there are

no other springs nearby, try to ensure that some runoff will still continue after development.

### PONDS, STREAMS, AND OTHER SURFACE WATER

Some water systems are as simple as tossing the pump intake into the existing lake or stream. Surface water usually is used only for livestock or agricultural needs—although for many homesteads with gardens and orchards, this can be 90% of your total water use. If you don't have a surface water source on your property, consider putting in a pond. Ponds are one of the least expensive and most delightfully pleasing methods of supplying water, not only for your own needs, but also for the wildlife population that your pond will soon support. They often are used to hold winter and spring runoff for summertime use. Don't drink or cook with surface

water unless it has been treated or purified first (see chapter 8 for more help on this topic).

## Storage

You might need to provide some means of water storage for any number of reasons. The most common are: To get through long dry periods, to provide pressure through elevated storage or pressurized air, to keep drinking water clean and uncontaminated, or to prevent freezing.

### SURFACE STORAGE

Those with ponds, lakes, streams, or springs may not need any additional storage. Let the livestock find their own way to the water, or pump straight to whatever needs irrigation. However, many systems will need to pump water to an elevated storage site, or a large pressure tank, in order to develop pressure. You may need seasonal freeze protection, which means protected or underground storage.

### POND LINERS

Custom-made polyvinyl liners are available for ponds or leaking tanks. Liners have revolutionized pond construction. They are designed for installation during pond construction and are then buried with 6 inches of dirt around the edges, practically guaranteeing a leak-free pond even when working with gravel, sand, or other problem soils. When buried, the life expectancy

of these liners is 50 years-plus. They make reliable pond construction possible in locations that normally could not accommodate such inexpensive water storage methods.

### TANKS

Covered tanks of one sort or another are the most common and longest-lasting storage solutions. The cover must be screened and tight enough to keep critters such as lizards, mice, and squirrels from drowning in your drinking water (always an exciting discovery). The most common tank materials are polypropylene, fiberglass, and concrete or ferro-cement.

**Plastic Tanks.** Both fiberglass and polypropylene tanks are commonly available. Your local farm supply store is usually a good source. All plastic tanks will suffer slightly from UV degradation in sunlight. Simply painting the outside of the tank will stop the UV degradation and will probably make the tank more aesthetically pleasing. If this tank is for your drinking water, make sure it's internally coated with an FDA-approved material for drinking water. Most farm supply stores will offer both "drinking water grade" and "utility grade" tanks. Utility grade tanks often use recycled plastic materials and probably will leach some polymers into the water, particularly when new. Some plastic tanks can be partially or completely buried for freeze protection. Ask before you buy if this is a consideration for you.

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## A Mercifully Brief Glossary of Pump Jargon

**Flow:** The measure of a pump's capacity to move liquid volume. Given in gallons per hour (gph), gallons per minute (gpm), or for you worldly types who have escaped the shackles of archaic measurement, liters per minute (lpm).

**Foot Valve:** A check valve (one-way valve) with a strainer. Installed at the end of the pump intake line, it prevents loss of prime, and keeps large debris from entering the pump.

**Friction Loss:** The loss in pressure due to friction of the water moving through a pipe. As flow rate increases and pipe diameter

decreases, friction loss can result in significant flow and head loss.

**Head:** Two common uses. 1) The pressure or effective height a pump is capable of raising water. 2) The height a pump is actually raising the water in a particular installation.

**Lift:** Same as Head. Contrary to the way this term sounds, pumps do not suck water, they push it.

**Prime:** A charge of water that fills the pump and the intake line, allowing pumping action to start. Centrifugal pumps will not self-prime. Positive displacement pumps will usually self-prime if they have a free discharge—no pressure on the output.

**Suction Lift:** The difference between the source water level and the pump. Theoretical limit is 33

feet; practical limit is 10 to 15 feet. Suction lift capability of a pump decreases 1 foot for every 1,000 feet above sea level.

**Submersible Pump:** A pump with a sealed motor assembly designed to be installed below the water surface. Most commonly used when the water level is more than 15 feet below the surface, or when the pump must be protected from freezing.

**Surface Pump:** Designed for pumping from surface water supplies such as springs, ponds, tanks, or shallow wells. The pump is mounted in a dry, weatherproof location less than 10 to 15 feet above of the water surface. Surface pumps cannot be submerged and be expected to survive.

Pressure tanks are one of the few things in life where bigger really is better.

**Concrete Tanks.** These are one of the best and longest-lasting storage solutions, but they are expensive and/or labor intensive initially. All but the smallest concrete tanks are built on site. They can be concrete block, ferro-cement, or monolithic block pours. Although monolithic pours require hiring a contractor with specialized forming equipment, these tanks are usually the most trouble free in the long run. Any concrete tank will need to be coated internally with a special sealer to be watertight. Concrete tanks can be buried for freeze protection, and to keep the water cool in hot climates. They can cost \$0.40 to \$0.60 per gallon, but in the long run they're well worth it.

**Pressure Tanks.** These are used in pumped systems to store pressurized water so that the pump doesn't have to start for every glass of water. They work by squeezing a captive volume of air, since water doesn't compress. The newer, better types use a diaphragm—sort of a big heavy-duty balloon—so that the water can't



John Schaeffer's pond in Hopland, California.

absorb the air charge. This was a problem with the older-style pressure tanks. Pressure tanks are rated by their total volume. Draw-down volume, the amount of water that actually can be loaded into and withdrawn from the tank under ideal conditions, is typically about 40% of total volume. So a "20-gallon" pressure tank can really only deliver about 8 gallons before starting the

pump to refill. Pressure tanks are one of the few things in life where bigger really is better. With a larger pressure tank, your pump doesn't have to start as often, it will use less power and live longer, your water pressure will be more stable, and if power fails you'll have more pressurized water in storage to tide you over. Forty-gallon capacity is the minimum for residential use, and more is better.

## Delivery Systems

A few lucky folks are able to collect and store their water high enough above the level of intended use (you need 45 vertical feet for 20 psi) so that the delivery system will simply be a pipe, and the weight of the water will supply the pressure free of charge. Most of us are going to need a pump, or two, to get the water up from underground, and/or to provide pressure. We'll cover electrically-driven solar and battery-powered pumping first, then water-powered and wind-powered pumps.

The standard rural utility-powered water delivery system consists of a submersible pump in the well delivering water into a pressure tank in some location that's safe from freezing. A pressure tank extends the time between pumping cycles by saving up some pressurized water for delivery later. This system usually solves any freezing problems by placing the pump deep inside the well, and the pressure tank indoors. The downside is that the pump must produce enough volume to keep up with any potential demand, or the pressure tank will be depleted and the pressure will drop dramatically. This requires a 1/3-hp pump minimally, and usually 1/2 hp or larger. Well drillers often will sell a much larger than necessary pump because it increases their profit and guarantees that no matter how many sprinklers you add in the future, you'll have sufficient water-delivery capacity. (And they don't have to pay your electric bill!) This is fine when you have large amounts of utility power available to meet heavy surge loads, but it's very costly to power with a renewable energy system because of the large equipment requirements. We try to work smarter, smaller, and use less-expensive resources to get the job done.

# Solar-Powered Pumping

## Where Efficiency is Everything

PV modules are expensive, and water is surprisingly heavy. These two facts dominate the solar-pumping industry. At 8.3 pounds per gallon, a lot of energy is needed to move water uphill. Anything we can do to wring a little more work out of every last watt of energy is going to make the system less expensive initially. Because of these economic realities, the solar-pumping industry tends to use the most efficient pumps available. For many applications that means a positive-displacement type of pump. This class of pumps prevents the possibility of the water slipping from high-pressure areas to lower-pressure areas inside the pump. Positive-displacement pumps also ensure that even when running very slowly—such as when powered by a PV module under partial light conditions—water still will be pumped. As a general rule, positive-displacement pumps manage four to five times the efficiency of centrifugal pumps, particularly when lifts over about 60 feet are involved. Several varieties of positive-displacement pumps are commonly available. Diaphragm pumps, rotary-vane pumps, piston pumps, and the newest darling, helical-rotor pumps, will all be found in our product pages.

Positive-displacement pumps have some disadvantages. They tend to be noisier, as the water is expelled in lots of little spurts. They usually pump smaller volumes of water, they must start under full load, most require periodic maintenance, and most won't tolerate running dry. These are reasons why this class of pumps isn't used more extensively in the AC-powered pumping industry.

Most AC-powered pumps are centrifugal types. This type of pump is preferred because of easy starting, low noise, smooth output, and minimal maintenance requirements. Centrifugal pumps are good for moving large volumes of water at relatively low pressure. As pressure rises, however, the water inside the centrifugal pump "slips" increasingly, until finally a pressure is reached at which no water is actually leaving the pump. This is 0% efficiency. Single-stage centrifugal pumps suffer at lifts over 60 feet. To manage higher lifts, as in a submersible well pump, multiple stages of centrifugal pump impellers are stacked up.

In the solar industry, centrifugal pumps are used for pool pumping, and for some circulation duties in hot-water systems. But in all applications where pressure exceeds 20 psi, you'll find us recommending the slightly noisier, occasional-maintenance-requiring, but vastly more efficient positive-displacement-type pumps. For instance, an AC submersible pump running at 7 to 10% efficiency is considered "good." The helical-rotor submersible pumps we promote run at close to 50% efficiency.

## For Highest Efficiency, Run PV-Direct

We often design solar pumping systems to run PV-direct. That is, the pump is connected directly to the photovoltaic (PV) modules with no batteries involved in the system. The electrical-to-chemical conversion in a battery isn't 100% efficient. When we avoid batteries and deliver the energy directly to the pump, 20 to 25% more water gets pumped. This kind of system is ideal when the water is being pumped into a large storage tank, or is being used immediately for irrigation. It also saves the initial cost of the batteries, the maintenance and periodic replacement they require, plus the charge controllers and the fusing/safety equipment that batteries demand. PV-direct pumping systems, which are designed to run all day long, make the most of your PV investment, and help us get around the lower gallon-per-minute output of most positive-displacement pumps.

However (every silver lining has its cloud), we like to use one piece of modern technology on PV-direct systems that isn't often found on battery-powered systems. A linear current booster, or LCB for short, is a solid-state marvel that will help get a PV-direct pump running earlier in the morning, keep it running later in the evening, and sometimes make running at all a possibility on hazy or cloudy days. An LCB will convert excess PV voltage into extra amperage when the modules aren't producing quite enough current for the pump. The pump will run more slowly than if it had full power, but if a positive-displacement pump runs at all, it delivers water. LCBs will boost water delivery in most PV-direct systems by 20% or more, and we usually recommend a properly sized one with every system.

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DC motors have the great advantage of accepting variable voltage input without distress. Common AC motors will overheat if supplied with low voltage. DC motors simply run slower when the voltage drops.

## Direct Current (DC) Motors for Variable Power

Pumps that are designed for solar use DC electric motors. PV modules produce DC electricity, and all battery types store DC power. DC motors have the great advantage of accepting variable voltage input without distress. Common AC motors will overheat if supplied with low voltage. DC motors simply run slower when the voltage drops. This makes them ideal partners for PV modules. Day and night, clouds and shadows; these all affect the PV output, and a DC motor simply "goes with the flow"!

## Which Solar-Powered Pump Do You Want?

That depends on what you're doing with it, and what your climate is. We'll start with the most common and easiest choices, and work our way through to the less common.

### PUMPING FROM A WELL

Do you have a well that's cased with a 4-inch or larger pipe, and a static water level that is no more than 750 feet below the surface? Perfect. We carry several brands of proven DC-powered submersible pumps with a range of prices, lift, and volume capabilities. The SHURflo Solar Sub is the lowest-cost system with lift up to 230 feet, and sufficient volume for most residential homesteads. The bigger helical-rotor type sub pumps like the Grundfos and ETA pumps are available in over a dozen models, with lifts up to 750 feet, or volume over 25 gpm, depending on the model. Performance, prices, and PV requirements are listed in the products section. The SHURflo Solar Sub is a diaphragm-type pump, and unlike almost any other submersible pump, it can tolerate running dry. The manufacturer says just don't let it run dry for more than a month or two! This feature makes this pump ideal for many low-output wells.

Complete submersible pumping systems—PV modules, mounting structure, LCB, and pump—range from \$1,500 to \$11,000 depending on lift and volume required. Options such as float switches that will automatically turn the pump on and off to keep a distant storage tank full are inexpensive and easy to add when using an LCB with remote control, as we recommend.

Because many solar pumps are designed to work all day at a slow but steady output, they won't keep up directly with average household

fixtures, like your typical AC sub pump. This often requires some adjustment in how your water supply system is put together. For household use, we usually recommend, in order of cost and desirability:

**Option 1.** Pumping into a storage tank at least 50 feet higher than the house, if terrain and climate allow.

**Option 2.** Pumping into a house-level storage tank if climate allows, and using a booster pump to supply household pressure.

**Option 3.** Pumping into a storage tank built into the basement for hard-freeze climates, and using a booster pump to supply household pressure.

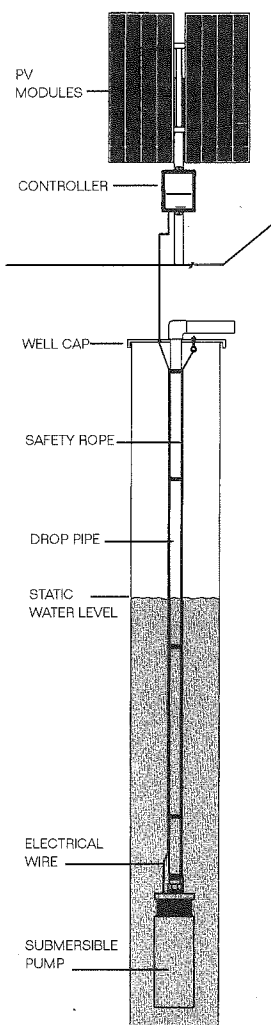
**Option 4.** Using battery power from your household renewable energy system to run the submersible pump, and using a big pressure tank (80 gallons minimum).

**Option 5.** Using a conventional AC-powered submersible pump, large pressure tank(s), and your household renewable energy system with large inverter. There is some loss of efficiency in this set-up, but it's the standard way to get the job done in freezing climates, and your plumber won't have any problems understanding the system. We strongly recommend one of the helical-rotor-type Grundfos SQ Flex pumps for this option. Start-up surge will be kind to your inverter, output is 5 to 9 gpm, and power use is a quarter of conventional AC pumps.

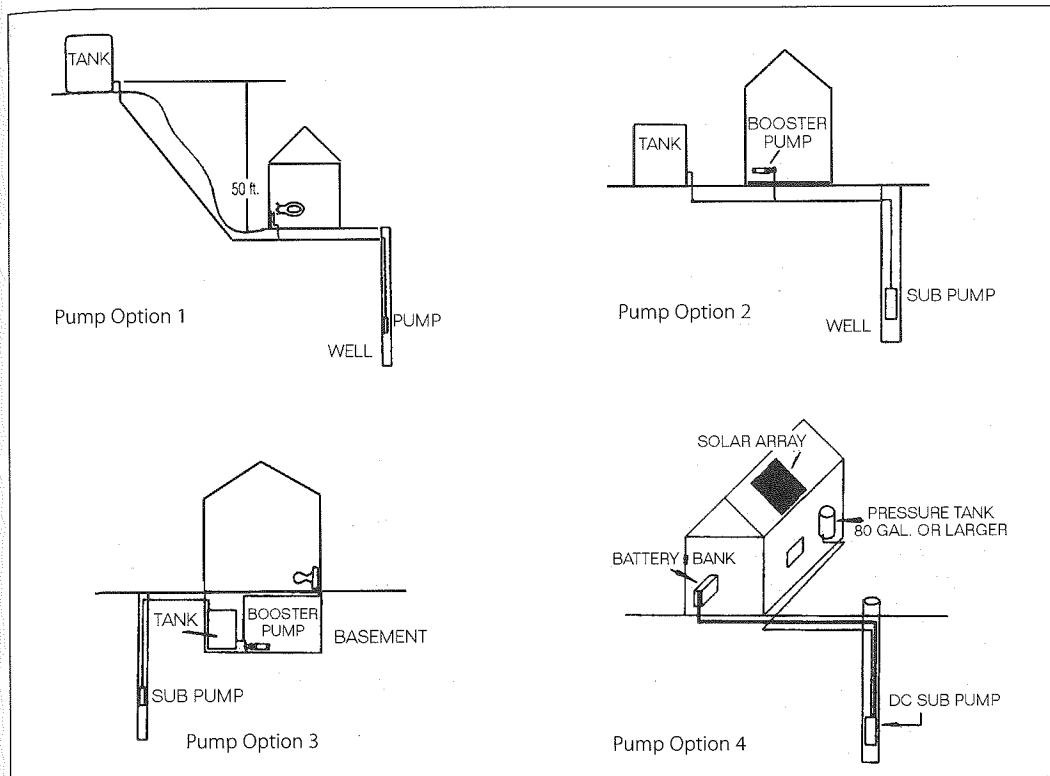
Many folks, for a variety of reasons, already have an AC-powered submersible pump in their well when they come to us, but are real tired of having to run the generator to get water. For wells with 6-inch and larger casings, it's usually possible to install both the existing AC pump and a submersible DC pump. If your AC pump is 4 inches in diameter, the DC pump can be installed underneath it. The cabling, safety rope, and ½-inch poly delivery pipe from the DC submersible will slip around the side of the AC pump sitting above it. Just slide both pumps down the hole together. It's often comforting to have emergency back-up for those times when you need it, like when it's been cloudy for three weeks straight, or the fire is coming up the hill, and you want a lot of water fast!

### PUMPING FROM A SPRING, POND, OR OTHER SURFACE SOURCE

Your choices for pumping from ground level are a bit more varied, depending on how high you need to lift the water, and how many gallons per minute you want. Surface-mounted pumps are not freeze tolerant. If you live in a freezing



A simple PV-direct solar pumping system



climate, make sure that your installation can be (and is!) completely drained before freezing weather sets in. If you need to pump through the hard-freeze season, we recommend a submersible pump as described above.

### Pumps Don't Suck! (They Push)

Pumps don't like to pull water up from a source. Or, put simply, Dr. Doug's #1 Principle of Pumping: Pumps don't suck, pumps push. In order to operate reliably, your surface-mounted pump must be installed as close to the source as practical. In no case should the pump be more than 10 feet above the water level. With some

positive-displacement pumps, higher suction lifts are possible, but not recommended. You are simply begging for trouble. If you can get the pump closer to the source, and still keep it dry and safe, do it! You'll be rewarded with more dependable service, longer pump life, more water delivery, and less power consumption.

### Low-Cost Solutions

For modest lifts up to 50 or 60 feet and volumes of 1.5 to 3.0 gpm, we have found the SHURflo diaphragm-type pumps to be moderately priced and tolerant of abuses that would kill other pumps. They can tolerate silty water and sand without distress. They'll run dry for hours and hours without damage. But you get what you pay for. Life expectancy is usually two to five years depending on how hard, and how much, the pump is working. Repairs in the field are easy, and disassembly is obvious. We carry a full stock of repair parts, but replacement motors don't cost much less than a new pump. Diaphragm pumps will tolerate sand, algae, and debris without damage, but these may stick in the internal check valves and reduce or stop output, necessitating disassembly to clean out the debris. Who needs the hassle? Filter your intake!

### Longer-Life Solutions

For higher lifts, or more volume, we often go to a pump type called a rotary-vane. Examples

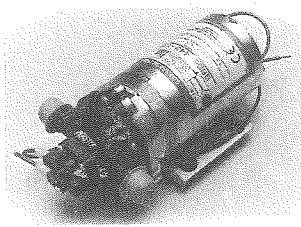
Because many solar pumps are designed to work all day at a slow but steady output, they won't keep up directly with average household fixtures, like your typical AC sub pump.

## Need Pump Help?

If you would like the help of our technical staff in selecting an appropriate pump, controller, power source, etc., we have a Solar Water Supply Questionnaire at the end of this chapter. It will give our staff the information we need in order to thoroughly and accurately recommend a water supply system for you. You can mail or fax your completed form. Please give us a daytime phone number if at all possible! Call us at 1-800-919-2400.



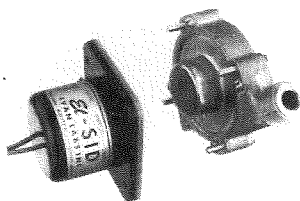
Any household pressure system requires a pressure tank. A 20-gallon tank is the minimum size we recommend for a small cabin; full-size houses usually have 40-gallon or larger tanks.



Diaphragm-type pump.

The smarter solar hot-water systems simply use a small PV panel wired directly to a DC pump.

Hot water circulation pump.



include the Slowpump and Flowlight Booster pumps. Rotary-vane pumps are capable of lifts up to 440 feet, and volumes up to 4.5 gpm, depending on the model. Of all the positive-displacement pumps, they are the quietest and smoothest. But they will not tolerate running dry, or abrasives of any kind in the water. It's very important to filter the input of these pumps with a 10-micron or finer filter in all applications. Rotary-vane pumps are very long-lived, but will eventually require a pump head replacement or a rebuild.

### HOUSEHOLD WATER PRESSURIZATION

We promote two pumps that are commonly used to pressurize household water: The Chevy and Mercedes models, if you will.

**The Chevy model.** SHURflo's Medium-Flow pump is our best-selling pressure pump. It comes with a built-in 20 to 40 psi pressure switch. With a 2.5 to 3.0 gpm flow rate it will keep up with most household fixtures, garden hoses excluded. The diaphragm pump is reliable, easy to repair, but somewhat noisy, and has a limited life expectancy. We recommend 24-inch flexible plumbing connectors in a loop on both sides of this pump, and a pressure tank plumbed in as close as possible to absorb most of the buzz.

**The Mercedes model.** Flowlight's rotary-vane pump is our smoothest, quietest, largest-volume pressure pump. It delivers 3 to 4.5 gpm at full pressure, and is very long-lived, but quite expensive initially. This pump will keep up easily with garden hoses, sprinklers, and any other normal household use. Brushes are externally replaceable, and will last five to ten years. Pump life expectancy is fifteen to twenty years.

Any household pressure system requires a pressure tank. A 20-gallon tank is the minimum size we recommend for a small cabin; full-size houses usually have 40-gallon or larger tanks. Pressure tanks are big, bulky, and expensive to ship. Get one at your local hardware or building supply store.

### SOLAR HOT-WATER CIRCULATION

Most of the older solar hot-water systems installed during the tax-credit heydays of the early 1980s used AC pumps with complex controllers and multiple temperature sensors at the collector, tank, plumbing, ambient air, etc. This kind of complexity allows too many opportunities for Murphy's Law.

The smarter solar hot-water systems simply use a small PV panel wired directly to a DC pump. When the sun shines a little bit, producing a small amount of heat, the pump runs slowly. When the sun shines bright and hot, producing lots of heat, the pump runs fast. Very simple, but absolutely perfect. System control is achieved with an absolute minimum of "stuff." We carry several hot-water circulation pumps for various-size systems. The best choice for most residential systems is the El-Sid pump. This is a solid-state, brushless DC circulation pump that was designed from scratch for PV-direct applications. The El-Sid pump comes in small, medium, and large sizes now, with open-discharge flow rates of 2, 3.3, and 6 gallons per minute. El-Sid pumps require a 5- to 30-watt PV module for drive, and life expectancy is three to four times longer than any other DC circulation pump. Volume and lift are sharply limited, however. These are circulation pumps, not lift pumps. They're meant to stir the fluid round and round in a closed system.

For solar hot-water systems with long, convoluted collection loops creating a lot of pipe friction, we can use multiple El-Sid pumps. If some amount of lift is involved, we have to look at more robust pumps like the Hartell or the SunCentric series, which will require substantially more PV power.

### SWIMMING POOL CIRCULATION

Yes, it's possible to live off-the-grid and still enjoy luxuries like a swimming pool. In fact, pool systems dovetail nicely with household systems in many climates. Houses generally require a minimum of PV energy during the summer because of the long daylight hours, yet the maximum of energy is available. By switching a number of PV modules to pool pumping in the summer, then back to battery charging in the winter, you get better utilization of resources.

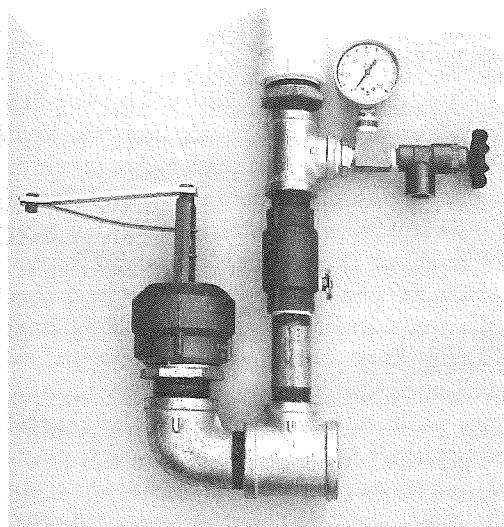
We offer several DC pool pumps. DC pumps run somewhat more efficiently than AC pumps, so a slightly smaller DC pump can do the same amount of work as a larger AC pump. We also strongly recommend using a low-back-pressure cartridge-type pool filter. Diatomaceous-earth filters are trouble. They have high back pressure, and will greatly slow circulation, or increase power use. See the product section for specs and prices. Please consult with our technical staff regarding pool filters, PV array sizing, and switching equipment.

## Water-Powered Pumps

A few lucky folks have an excess supply of falling water available. This falling-water energy can be used to pump water. Both the High Lifter and ram-type water pumps use the energy of falling water to force a portion of that water up the hill to a storage tank.

### RAM PUMPS

Ram pumps have been around for many decades, providing reliable water pumping at almost no cost. They are more commonly used in the eastern United States where modest falls and large flow rates are the norm, but they will work happily almost anywhere their minimum flow rate can be satisfied. Rams will work with a minimum of 1.5 feet to a maximum of about 20



Ram pump.

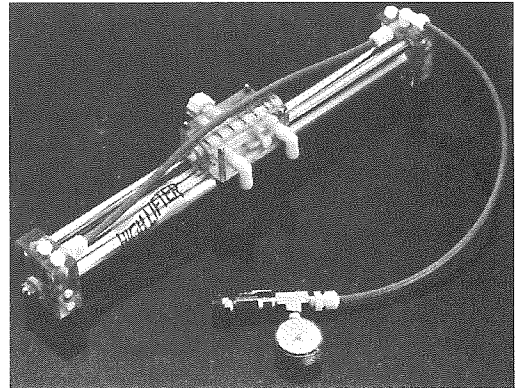
feet of fall feeding the pump. Minimum flow rates depend on the pump size; see the product section for specs.

Here's how ram pumps work: A flow is started down the drive pipe and then shut off suddenly. The momentum of moving water slams to a stop, creating a pressure surge that sends a little squirt of water up the hill. How much of a squirt depends on the pump size, the amount of fall, and the amount of lift. Output charts accompany the pumps in the product section. Each ram needs to be tuned carefully for its particular site. Ram pumps are not self-starting. If they run short of water, they will stop pumping and simply dump incoming water, so don't buy too big. Rams make some noise. A lot less than a gasoline-powered pump, but the constant twenty-four-hours-a-day chunk-chunk-chunk is a consideration for some sites. Ram

pumps deliver less than 5% of the water that passes through them, and the discharge must be into an unpressurized storage tank or pond. But they work for free and have life expectancies measured in decades.

### THE HIGH LIFTER PUMP

This pump is unique. It works by simple mechanical advantage. A large piston at low water pressure pushes a smaller piston at higher water pressure. High Lifters recover a much greater percentage of the available water than ram pumps do, but they generally require greater fall into the pump. This makes them better suited for more mountainous territory. They are available in two ratios, 4.5 to 1 and 9 to 1. Fall-to-lift ratios and waste-water-to-pumped-water ratios are also either 4.5 to 1 or 9 to 1. Note, however, that as the lift ratio gets closer to theoretical maximum, the pump is going to slow down and deliver fewer gallons per day. High Lifters are self-starting. If they run out of water, they will simply stop and wait, or slow down to match what water is available. This is a very handy trait for unattended or difficult to attend sites. The only serious disadvantage of the High Lifter is wear caused by abrasives. O-rings are used to seal the pistons against the cylinder walls. Any abrasives in the water wear out the O-rings quickly, so filtering of the intake is strongly encouraged. High Lifter pumps can be overhauled fairly easily in the field, but the O-ring kit costs a lot more than filter cartridges. Output charts for this pump are included in the product section.



High Lifter pump.

High Lifters recover a much greater percentage of the available water than ram pumps do, but they generally require greater fall into the pump.

## Wind-Powered Water Pumps

If you've been reading this far because you want to buy a nostalgic old-time jack-pump windmill, we're going to disappoint you. They are still made, but are very expensive, typically \$7,500 and up. We don't sell them, and don't recommend them. They are quite a big deal to set up and install into the well, and require routine yearly service at the top of the tower. This is technology that largely has seen its day. Submersible pumps powered by PV panels are a much better choice for remote locations now.

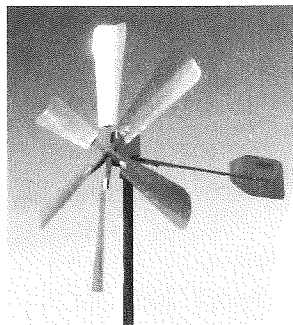
There are a couple of ways to run a pump with wind power that have seen good success.

The air is piped down the well and runs through a carefully engineered air injector. As it rises back up the supply tube, it carries slugs of water in between the bubbles.

### COMPRESSED-AIR WATER PUMPS

Airlift pumps use compressed air. Three models are available depending on lift and volume needs. They all use a simple pole-mounted turbine that direct-drives an air compressor with a wind turbine. The air is piped down the well and runs through a carefully engineered air injector. As it rises back up the supply tube, it carries slugs of water in between the bubbles. The lift/submergence ratio of this pump is fairly critical. Lift is the vertical rise between the standing water level in the well and your tank. Approximately 30% of the lift is the recommended distance for the air injector to be submerged below the standing level. As lifts edge over 200 feet, the submergence ratio rises to a maximum of 50%. Too little submergence and the air will separate from the water; too much and the air will not lift the water, though considerable latitude exists between these performance extremes. This pump isn't bothered by running dry. Output depends on wind speed, naturally, but the largest model is capable of over 20 gpm at lower lifts, or can lift a maximum of 315 feet. The air compressor requires an oil change once a year. See the product section for more details and output specs.

Wind-powered pump.



### WIND GENERATORS RUNNING SUBMERSIBLE PUMPS

The larger wind generator manufacturers, Bergey and Whisper, both offer options that allow the three-phase wind turbine output to power a three-phase submersible pump directly. These aren't residential-scale systems and are mostly used for large agricultural projects, or village pumping systems in less industrialized countries. They are moderately expensive initially. Contact our technical staff for more information on these options.

## Freeze Protection

In most areas of the country, freezing is a major consideration when installing plumbing and water storage systems. For outside pipe runs, the general rule is to bury the plumbing below frost level. For large storage tanks burial may not be feasible, unless you go with concrete. In moderate climatic zones, simply burying the bottom of the tank a foot or two along with the input/output piping is sufficient. In some locations, due to climate or lack of soil depth, outdoor storage tanks simply aren't feasible. In these situations, you can use a smaller storage tank built into a corner of the basement with a separate pressure-

boosting pump, or you can pump directly into a large pressure-tank system.

## Other Considerations and Common Questions

We hope that by this point you've zeroed in on a pump or pumps that seem to be applicable to your situation. If not, our technical staff will be happy to discuss your needs and recommend an appropriate pumping system—which may or may not be renewable-energy powered. Filling out the Solar Water Supply Questionnaire that follows will supply all the answers we're likely to need when we talk with you. At this point, another crop of questions usually appears, such as . . .

### HOW FAR CAN I PUT THE MODULES FROM THE PUMP?

Often the best water source will be deep in a heavily wooded ravine. It's important that your PV modules have clear, shadow-free access to the sun for as many hours as practical. Even a fist-sized shadow will effectively turn off most PV modules. The hours of 10 A.M. to 2 P.M. are usually the minimum your modules want clear solar access, and if you can capture full sun from 9 A.M. to 3 P.M., that's more power for you. If the pump is small, running off one or two modules, then distances up to 200 feet can be handled economically. Longer distances are always possible, but consult with our tech staff or check out the wire-sizing formula on page 200 first, because longer distances require large (expensive!) wire. Many pumps routinely come as 24- or 48-volt units now, as the higher voltage makes long-distance transmission much easier. The Grundfos sub pump accepts DC input up to 300 volts. If you need to run more than 300 feet for sunshine, this may be just the ticket.

### WHAT SIZE WIRE DO I NEED?

This depends on the distance, and the amount of power you are trying to move. See the Wire Sizing Chart on page 200 and formula that can properly size wire for any distance, at any voltage, AC or DC. Or, just give our tech staff a call, we do this kind of consultation all the time. Going down a well, 10-gauge copper submersible pump wire is the usual, although some of the larger sub pumps we're using now require 8-gauge, or even 6-gauge for very deep wells. If you need anything other than common 10-gauge wire, we'll let you know.

### WHAT SIZE PIPE DO I NEED?

Many of the pumps we offer have modest flow rates of 4 gpm or less. At this rate, it's okay to use smaller pipe sizes such as 3/4-inch or 1-inch for pumping delivery without increasing friction loss. However, that's for pumping delivery only. There's no reason you can't use the same pipe to take the water up the hill to the storage tank and also bring it back down to the house or garden. Pipes don't care which way the water is flowing through them. But if you do this, you'll want a larger pipe to avoid friction loss and pressure drop when the higher flow rate of the household or garden fixtures comes into play. We usually recommend at least 1 1/4-inch pipe for household and garden use, and 2-inch for fire hose lines. See the pipe friction loss charts on page 315 to be sure

### WHAT SIZE PV MODULES DO I NEED?

A number of the pumps listed in the product section have accompanying performance and wattage tables. For instance, the rotary-vane Solar Slowpump model 2503 lifting 40 feet will deliver 2.5 gpm and requires 60 watts. Hey, what's to figure here? All PV modules are rated by how many watts they put out, right? So you just need a 60-watt module. Wrong. PV modules are rated under ideal laboratory conditions, not real life. If you want your pump to work on hot or humid days, then you'd better add 30% to the pump wattage. Heat reduces PV output, water vapor cuts available sunlight. So in our example we actually need 78 watts. Looking at available PV modules, we don't find exactly 78-watt modules, which means we buy a 75-watt module if this is a relatively temperate climate, or an 80- to 85-watt module if this is a hot (over 80°F) climate. The usual rule for sizing PV-direct arrays is to add about 20% to the pump wattage in a mild climate, or add 30% in a hot climate. And, of course, an LCB (linear current booster) of sufficient amperage capacity is practically standard equipment with any PV-direct system.

### CAN I AUTOMATE THE SYSTEM?

Absolutely! Life's little drudgeries should be automated at every opportunity. The LCBs that we so strongly recommend with all PV-direct systems help us in this task. These units are all supplied with wiring for a remote control option. This allows you to install a float switch at the holding tank and a pair of tiny 18-gauge wires can be run as far as 5,000 feet back to the pump/controller/PV modules area. Float switches can be used either to pump up or pump

down a holding tank, and will automatically turn the system off when satisfied. The LCBs, float switches, and other pumping accessories are presented in the product section. LCBs can also be used on battery-powered systems when remote sensing and control would be handy.

### Where Do We Go from Here?

If you haven't found all the answers to your remote water pumping needs yet, please give our experienced technical staff a call. They'll be happy to work with you selecting the most appropriate pump, power source, and accessories for your needs. We run into situations occasionally where renewable energy sources and pumps simply may not be the best choice, and we'll let you know if that's the case. For 95% of the remote pumping scenarios, there is a simple, cost-effective, long-lived renewable energy-powered solution, and we can help you develop it.

The usual rule for sizing PV-direct arrays is to add about 20% to the pump wattage in a mild climate, or add 30% in a hot climate.

## Water Pumping Truths and Tips

1. Pumps prefer to **push** water, not **pull** it. In fact, most pumps are limited to 10 or 15 feet of lift on the suction side. Mother Nature has a theoretical suction lift of 33.9 feet at sea level, but only if the pump could produce a perfect vacuum. Suction lift drops 1 foot with every 1,000 feet rise in elevation. To put it simply, **Pumps Don't Suck, They Push.**
2. Water is heavy, 8.33 pounds per gallon. It can require tremendous amounts of energy to lift and move.
3. DC electric motors are generally more efficient than AC motors. If you have a choice, use a DC motor to pump your water. Not only can they be powered directly by solar modules, but your precious wattage will go further.
4. Positive-displacement pumps are far more efficient than centrifugal pumps. Most of our pumps are positive-displacement types. AC powered submersibles, jet pumps, and booster pumps are centrifugal types.
5. As much as possible, we try to avoid batteries in pumping systems. When energy is run into and out of a battery, 25% is lost. It's more efficient to take energy directly from your PV modules and feed it right into the pump. At the end of the day, you'll end up with 25% more water in the tank.
6. One pound per square inch (psi) of water pressure equals 2.31 feet of lift, a handy equation.

# Solar Water Supply Questionnaire

To thoroughly and accurately recommend a water supply system, we need to know the following information about your system. Please fill out the form as completely as possible. Please give us a daytime phone number, too.

Name: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_  
 email: \_\_\_\_\_ Phone: \_\_\_\_\_

**DESCRIBE YOUR WATER SOURCE:**

Depth of well: \_\_\_\_\_  
 Depth to standing water surface: \_\_\_\_\_  
 If level varies, how much? \_\_\_\_\_  
 Estimated yield of well (gallons per minute): \_\_\_\_\_  
 Well casing size (inside diameter): \_\_\_\_\_  
 Any problems? (silt, sand, corrosives, etc.) \_\_\_\_\_

**WATER REQUIREMENTS:**

Is this a year-round home? \_\_\_\_\_ How many people full time? \_\_\_\_\_  
 Is house already plumbed? \_\_\_\_\_ Conventional flush toilets? \_\_\_\_\_  
 Residential gallons/day estimated: \_\_\_\_\_  
 Is gravity pressurization acceptable? \_\_\_\_\_  
 Hard freezing climate? \_\_\_\_\_  
 Irrigation gallons/day estimated: \_\_\_\_\_ Which months? \_\_\_\_\_  
 If you have a general budget in mind, how much? \_\_\_\_\_  
 Do you have a deadline for completion? \_\_\_\_\_

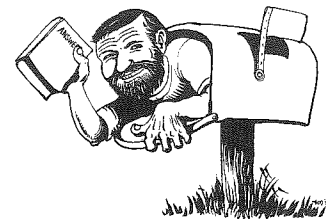
**DESCRIBE YOUR SITE:**

Elevation: \_\_\_\_\_  
 Distance from well to point of use: \_\_\_\_\_  
 Vertical rise or drop from top of well to point of use: \_\_\_\_\_  
 Can you install a storage tank higher than point of use? \_\_\_\_\_  
     How much higher? \_\_\_\_\_ How far away? \_\_\_\_\_  
 Complex terrain or multiple usage? \_\_\_\_\_ (Please enclose map)  
 Do you have utility power available? \_\_\_\_\_ How far away? \_\_\_\_\_  
 Can well pump be connected to nearby home power system? \_\_\_\_\_  
     How far? \_\_\_\_\_ Home power system power battery voltage: \_\_\_\_\_

Mail your completed questionnaire to:  
 Tech Staff/Water Supply, Real Goods, 13771 South Hwy. 101, Hopland, CA 95449.  
 Or fax to: 707-744-8771. Questions? Call us at 800-919-2400.

# Dr. Doug's Homestead Plumbing Recommendations

(Learn from Dr. Doug's mistakes, so you can make your own creative new mistakes.)



## TYPES OF PIPE

### Metals

**Black iron and galvanized iron**—used for gas (propane or natural gas) plumbing, but little else. It is slow and difficult to cut and thread, and requires special, expensive tools. (Consider renting tools if needed.) A special plastic-coated iron pipe is used for buried gas lines. The insides of galvanized pipe corrode when used for water supply and eventually restrict water flow. Older houses often suffer from this affliction, which causes ultra-sensitivity of shower temperature and other exciting problems.

**Cast iron**—used to be the material of choice for waste plumbing, but ABS plastic thankfully has replaced it. Simple conversion adapters to go from cast iron to ABS are available if you find yourself having to repair an existing older system.

**Copper**—the most common material for water supply plumbing in new home construction. Most plumbing codes require copper for indoor work. Type M, the most common grade for interior work, comes in 20-foot rigid lengths. Houses typically use 3/4-inch lines for feeders and 1/2-inch lines for fixtures. If gravity-fed water pressure will be lower than the 20- to 40-psi city standard, consider increasing your supply pipes one size. This cures many low-pressure woes by eliminating pressure loss within the house (and provides a shower that's nearly immune to temperature fluctuations). The thicker-walled flexible tubing L and K grades can be used legally in some localities, but they generally cost considerably more. Copper does not tolerate freezing at all! Copper is relatively quick and easy to work with, and you need only simple, inexpensive tools. Joints must be "sweat soldered," which takes about ten minutes to learn and is kinda fun afterward. Be sure to use the newer lead-free solders for water supply piping! Some states allow the use of flexible copper tubing for gas supply lines, in which case special compression-type fittings are used.

**Bronze/Brass**—beautiful stuff, but too expensive for common use. Pre-cut, pre-threaded nipples are used occasionally for dielectric water tank protection (5 inches of brass qualifies as protection under code). Use

brass only where plumbing will be exposed and you want it to look nice.

### Plastics

**Poly (polyethylene)**—this black, flexible pipe is used widely for drip and irrigation systems. Available in utility or domestic grades. Never use utility grade for drinking water! It's made with recycled plastics, and you don't know what will leach out. Poly is almost totally freezeproof. It's easy to work with (when warm) and requires common hand tools. It's sold in 100-foot or occasionally longer rolls. Barbed fittings and hose clamp fittings *will* leak (why do you suppose it's used in *drip* systems?). Do not use this cheap plumbing for any permanently pressurized installations, unless you can afford to throw water away. Poly also degrades fairly rapidly in sunlight. Two to three years is the usual unprotected lifespan. One good use for poly is with submersible well pumps where the flexibility makes for easy installations. Poly pipe is the usual choice for sub pumps unless they're pumping hundreds of feet of lift at very high pressure. Special 100- and 160-psi high-pressure versions of poly pipe are used for sub pumps.

**PVC (polyvinyl chloride)**—one of the wonders of chemistry that makes homesteading easy. This is the white plastic pipe that should be used for almost everything outside the house itself. It's easy to work with, and requires only common hand tools. (Although if you're doing a lot of it, a PVC cutter is a real time saver over the hacksaw.) PVC usually can survive mild freezing. Hard freezes will break joints, however, so use protection. It comes in 20-foot lengths. Sizes 1 inch and up generally are available with bell ends, saving you the expense and extra gluing of couplings. Use primer (the purple stuff), then glue (clear stuff) when assembling. PVC must be buried or protected. If exposed to sunlight, it will degrade slowly from the UV, but it will also grow algae inside the pipe! (Ask how I know...)

**PVC grades:** Schedule 40 is the standard PVC that is recommended for most uses. Some lighter-duty agricultural types are available. Class 125, class 160, and class 200 are graded by the psi rating of the pipe. Don't use these cheaper thin-wall classes if you're burying the

pipe! Leaks from stones pushing through thinner walls are too hard to find and fix.

**CPVC** (chlorinated polyvinyl chloride)—a PVC formulation specifically made for hot water. The fittings and the pipe are a light tan color so you can tell the difference from ordinary PVC. Some counties and states allow the use of CPVC, most don't. It works just like PVC.

**ABS** (acrylonitrile butadiene styrene)—a black rigid pipe universally used for unpressurized waste and vent plumbing. It's easy to work with, requires common hand tools, and glues up quickly just like PVC. Make sure that the glue you use is rated for ABS. Some glues are universal and will do both PVC and ABS, others are specific. Buy a big can of ABS glue—these larger pipes use a lot more glue. Also, the bigger cans come with bigger swabs, which you'll need on larger pipe.

**PB** (polybutylene)—a flexible plastic pipe that is used occasionally for home plumbing, but mostly for radiant-floor heating systems. It requires special compression rings and tools for fittings. PB will survive considerable abuse during construction without springing leaks. It makes no reaction with concrete floors. PB is the best choice for radiant floors and has nearly infinite life expectancy when buried in concrete.

## OTHER TIPS

**Don't go small on supply piping.** Long pipe runs from a supply tank up on the hill can produce substantial pressure drop. The typical garden needs 1¼-inch supply piping for watering and sprinklers. We recommend *at least* 1½-inch supply for most houses, and a 2-inch or larger line for a fire hose is often a very good idea.

**Keep plumbing runs as short as possible.** Try to arrange your house plan so that bathrooms, laundry room, and kitchen all fit back to back and can share a common plumbing wall. This saves thousands of dollars in materials costs, lots of time during construction, hours of time waiting for the hot water, and many gallons of expensive hot water.

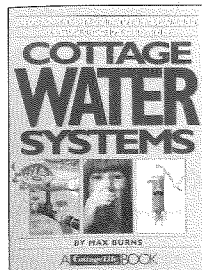
**Insulate *all* hot water pipes,** even those inside interior walls before the walls are covered up. The savings and comfort over the life of the house quickly make up for the initial costs.

**Store your glue cans upside down.** This sounds wacky, but it works. I learned it from an old pro. Tighten the cap first, obviously. The glue seals any tiny air leaks, and keeps all the glue inside and on the cap threads from drying solid. Don't store your primer upside down, though; it can't seal the tiny leaks and will disappear.

# WATER PUMPING PRODUCTS

## BOOKS

### Cottage Water Systems

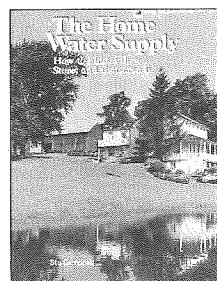


By Max Burns. An out-of-the-city guide to water sources, pumps, plumbing, water purification, and wastewater disposal, this lavishly illustrated book covers just about everything concerning water in the country. Each of the 12 chapters tackles a specific subject such as sources, pumps, plumbing

how-to, water quality, treatment devices, septic systems, outhouses, alternative toilets, graywater, freeze protection, and a good bibliography for more info. This is the best illustrated, easiest to read, most complete guide to waterworks we've seen yet. 150 pages, softcover. USA.

**80098 Cottage Water Systems \$24.95**

### The Home Water Supply



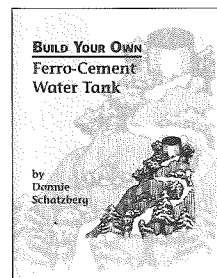
By Stu Campbell. Explains completely and in depth how to find, filter, store, and conserve one of our most precious commodities. A bit of history; finding the source; the mysteries of ponds, wells, and pumps; filtration and purification; and a good short discussion of the arcana of plumbing. After

reading this book, you may still need professional help with pipes and pumps, but you will know what you're talking about. 236 pages, softcover. USA.

**80205 The Home Water Supply \$19**

### Build Your Own Water Tank

By Donnie Schatzberg. An informative booklet by one of our original customers that has been updated and greatly expanded with more text, drawings, and illustrations.



It gives you all the details you need to build your own ferro-cement (iron-reinforced cement) water storage tank. No special tools or skills are required. The information given in this book is accurate and easy to follow, with no loose ends. The author has considerable experience building these

tanks, and has gotten all the "bugs" out. 58 pages, softcover. USA.

**80204 Build Your Own Water Tank \$14**

### Rainwater Collection for the Mechanically-Challenged

By Suzy Banks with Richard Heinichen.

Laugh your way to a home-built rainwater collection and storage system.

This delightful paperback is not only the best book on the subject of rainwater collection we've ever found, it's funny enough for recreational reading, and comprehensive enough to lead a rank amateur painlessly through the process. Technical information is presented in layman's terms, and accompanied with plenty of illustrations and witty cartoons. Topics include types of storage tanks, siting, how to collect and filter water, water purification, plumbing, sizing system components, freeze-proofing, and wiring. Substantially revised and expanded in 2003. Includes a resources list and a small catalog. 108 pages, softcover. USA.

**80704 Rainwater Collection for the Mechanically-Challenged \$20**

### Rainwater for the Mechanically-Challenged Video

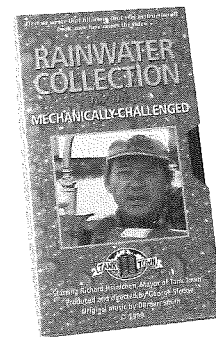
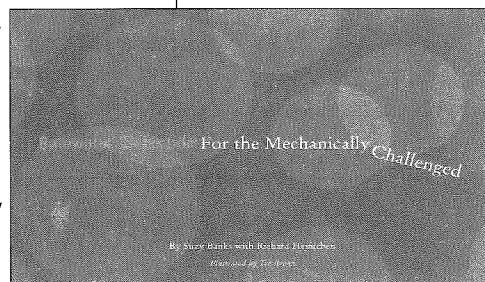
You say you're *really* mechanically challenged and want more than a few pictures? Here's your salvation. From the same irreverent, fun-loving crew that wrote the book. See how all the pieces actually go together as they assemble a typical rainwater collection system, and discuss your options. This is as close as you can get to having someone else put your system together. 37 minutes and lots of laughs. USA.

**82568 Rainwater Challenged Video \$19.95**

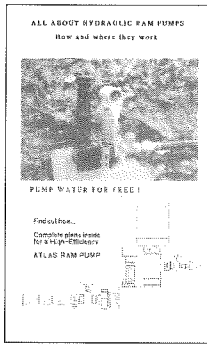
### A Great Water Pumping Video

Part of the Renewable Energy with the Experts series, this 59-minute video features solar-pumping pioneer Windy Dankoff, who has more than fifteen years experience in the field. Windy demonstrates practical answers to all the most common questions asked by folks facing the need for a solar-powered pump, and offers a number of tips to avoid common pitfalls. This is far and away the best video in this series, and offers some of the best advice and knowledge available for off-the-grid water pumping. This grizzled old technician/copyeditor even learned a few new tricks about submersible pump installations. Highly recommended! USA

**80368 RE Experts Water Pumping Video \$39**







### Build Your Own Ram Pump

Utilizing the simple physical laws of inertia, the hydraulic ram can pump water to a higher point using just the energy of falling water. The operation sequence is detailed with easy-to-understand drawings. Drive pipe calculations, use of a supply cistern, multiple supply pipes, and much more are explained in a clear, concise manner. The second half of the booklet is devoted to detailed plans and drawings for building your own 1- or 2-inch ram pump. Constructed out of commonly available cast iron and brass plumbing fittings, the finished ram pump will provide years of low-maintenance water pumping for a total cost of \$50 to \$75. No tapping, drilling, welding, special tools, or materials are needed. This pump design requires a minimum flow of 3 to 4 gallons per minute, and 3 to 5 feet of fall. It is capable of lifting as much as 200 feet with sufficient volume and fall into the pump. The final section of the booklet contains a setup and operation manual for the ram pump. Paperback, 25 pages. USA.

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**80501 All About Hydraulic Ram Pumps \$10.95**

## WATER-CONSERVATION PRODUCTS

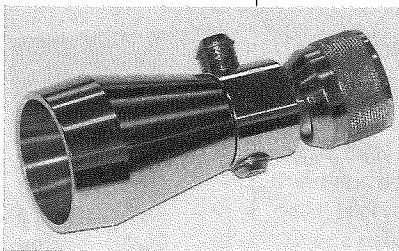
### Water-Saving Showerheads

*Showers typically account for 32% of home water use.*

A standard showerhead uses about 3 to 5 gallons of water per minute, so even a five-minute shower can consume 25 gallons. According to the U.S. Department of Energy, heating water is the second largest residential energy user. With a low-flow showerhead, energy use and costs for heating water for showers may drop as much as 50%. Add one of our instantaneous water heaters for even greater savings. Our low-flow showerheads easily can cut shower water usage by 50%. A recent study showed that changing to a low-flow showerhead saved 27¢ worth of water and 51¢ of electricity per day for a family of four. So, besides being good for the Earth, a low-flow showerhead will pay for itself in about two months!

### The Best Low-Flow Showerhead Ever

This is our longtime best-seller. Made in the USA of solid brass with a chrome-plate finish. Delivers a vigorous, well-controlled water spray pattern for a truly satisfying



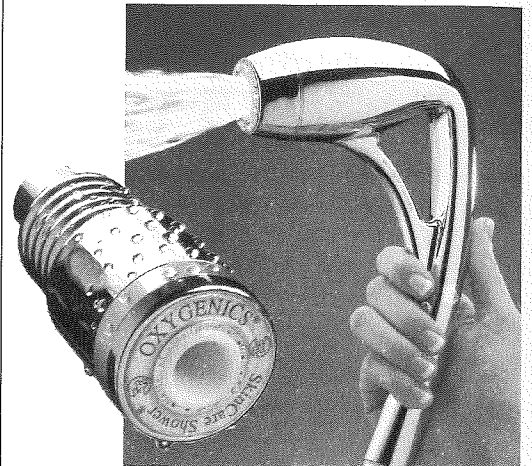
shower. Our favorite feature of this showerhead is that it's o-ringed and threaded together for easy cleaning of the stainless steel diffuser when the spray pattern gets erratic. This is a no-tools fix you can perform in the middle of a shower. Built-in soap-up valve.

Maximum flow is 2.25 gpm at 80 psi (1.2 to 1.4 gpm is about average for

most folks). This head cuts water use by 50 to 70% and can save a family of four up to \$250 a year. Standard 1/2" pipe thread. Ten-year manufacturer's guarantee.

**46104 Best Low-Flow Showerhead \$12**  
**2 or more \$9.50 each**

### Low-Flow Ultra Oxygenics Showerhead

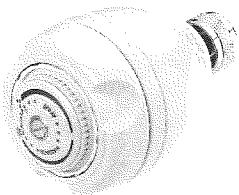


Ideal for homes with low water pressure or high energy or water costs, the patented technology inside our Ultra Oxygenics Showerhead pressurizes water to create a forcefully satisfying flow that belies the fact that up to 70% less water is being used—just 1.5 gallons per minute. To make your shower even better, internal mechanisms enrich shower water with up to 60% more oxygen to deep-clean skin, help fight free radicals, and improve circulation. Now available in a useful 2 gpm hand-held design that's great for cleaning the shower/tub and those hard-to-wash places. Not recommended for use with shower filters. USA.

**02-0201 Ultra \$30**  
**01-0452 Hand-held \$55**

## Earth Massage Showerhead

Enjoy a deluxe shower while only using 1.75 gallons per minute. Adjustable from fine spray to pulsating jet "turbo massage," this is the perfect showerhead for everyone. Three different spray patterns stay consistent in both low and high water pressures. Built-in "soak and soap" button reduces the flow rate to 1.0 gpm for soaping up and allows for the greatest amount of water savings possible. White. China.



**46235 Earth Massage Showerhead \$16**

## Wow Shower

Using powerful jet-pump action, our new Wow Shower filters and then recirculates warm water pooled in your tub back through the showerhead—saving water, energy and money while delivering a generous waterfall-like flow. This revolutionary system can save the average family of five up to 20,000 gallons of water per year! Pooled water is filtered constantly and refreshed with new water entering the system so you always feel clean. To return to conventional shower for a final rinse, simply depress diverter valve. Water flow delivers over 3 gallons per minute, but uses less than 1 gallon. Requires at least 35 psi of water pressure for operation. Simple five-step installation includes hardware. 72"H x 9"W x 9"D. 3.5 lbs. USA.



**01-0445 Wow Shower \$99**

## Revolutionary Water-Saving Toilet Kit

We're always looking for ways to conserve water, and this is one of the best: A complete multi-fixture kit that cuts the amount of water used by the typical bathroom in half. The centerpiece is a revolutionary porcelain toilet whose patented design is seal- and flapper-free to eliminate leaks. The best flushing model of its kind, this #1 rated toilet comes with everything needed for easy

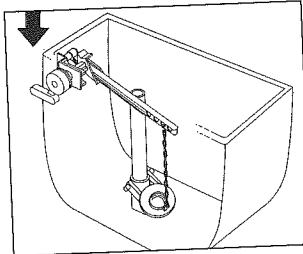


installation over both 10" and 12" rough-ins, including toilet seat, wax ring with sleeve, brass bolts, and stainless steel braided flex hose. With a large water surface to maintain a clean bowl, it uses just 1.6 gallons per flush. To complement this savings, our kit also includes a 2.0 gpm showerhead for a powerful shower without waste and a 1.0 gpm faucet aerator. We've even thrown in a kitchen aerator so you can extend your conservation efforts beyond the bathroom.

**01-0453 Revolutionary Water-Saving Toilet Kit \$185**

## Controllable Flusher

Convert your standard toilet into a low-flow toilet—without tools or a plumber—and save up to 35,000 gallons of water a year.



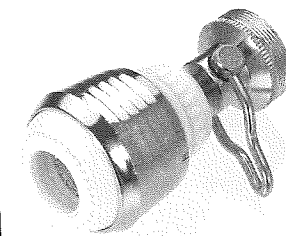
Because not all flushes need be the same, the dual-action Controllable Flusher controls the amount of water you use to flush waste matter. Push handle down for a conservative 1.5-gallon flush for liquid; lift for a powerful full flush for solids. Easily retrofits to standard front-flush toilets. 12.5"H x 5.5"W x 2"D. 5 oz. USA.

**02-0205 Controllable Flusher \$36**

## Touch Flow Swivel Spray Aerator

Our new kitchen faucet aerator has everything—swivel action for effective area cleaning, aerated jet, wide spray, and an easy touch flow restrictor. This kitchen faucet aerator not only makes your faucet more versatile and easier to use, but it will also save you money and water at only 1.5 gpm. USA.

**09-0224 Touch Flow Swivel Spray Aerator \$6  
2 or more \$ 5 each**



## Outdoor Water Conservation Kit

Conserving water outdoors can be a challenge. It's often difficult to know how much to use, and it's hard to control how much you consume. Our kit contains tools that help you demystify the process. A rain gauge, drip gauge, and soil moisture meter tell you if watering is needed. If it is, a lawn sprinkler timer with 30-minute to 3-hour settings and a six-position low-flow hose nozzle reduce the possibility of waste. There's even a handy booklet that explains how to use these devices in tandem for maximum water savings.

**14-0289 Outdoor Water Conservation Kit \$36**

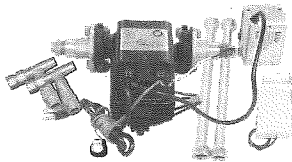
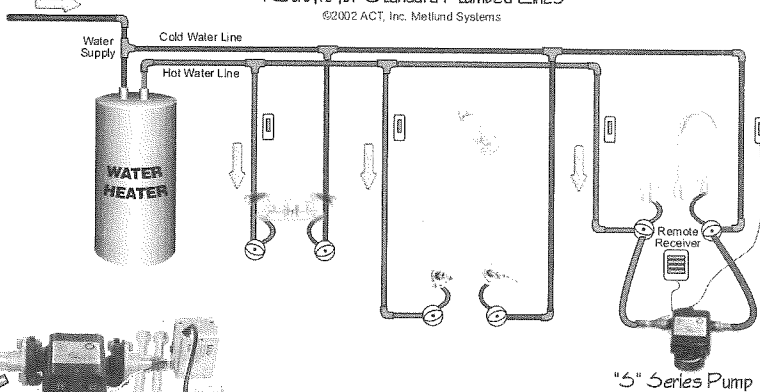


## D'mand Water Saving System

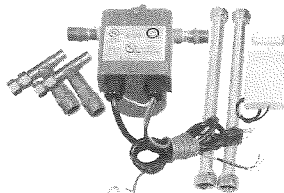
Does your house make you wait, and wait, and wait for hot water at some faucets while wasting water down the drain? Here's the cure. With the push of a button, the D'mand system whisks hot water to the most remote faucet in seconds. The displaced cold water is pumped into the cold water plumbing, returning to the heater, so there's no waste. It shuts off automatically when hot water arrives and costs less than \$1 per year

### The Metlund® Hot Water D'MAND® System

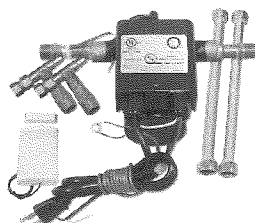
Retrofit for Standard Plumbed Lines  
©2002 ACT, Inc. Metlund Systems



D'mand S-02-PF-R



D'mand S-50-PF-R



D'mand S-69-PF-R

to operate. UL- and UPC-listed, the D'mand system is recognized by the Department of Energy as both a water- and power-saving device, and has a life expectancy exceeding fifteen years. It works with any type of water heater.

Our "no sweat" installation kit provides all the necessary plumbing bits and pieces, installs with common hand tools, and plugs into a standard outlet. Installed with a pushbutton at your furthest faucet, intervening faucets can be equipped with additional wireless push-buttons to activate the system from up to 100 feet.

The only difference between kits is pump size. Longer plumbing runs need a larger pump to keep wait time under 20 to 30 seconds. Use S-50 model for runs up to 50', S-70 for runs up to 100', S-02 model for longer or commercial use. S-50 model has three-year manufacturer's warranty, other models are five-year. USA.

<b>45-0100 S-50-PF-R Kit</b>	<b>\$299</b>
<b>45-0101 S-70-PF-R Kit</b>	<b>\$399</b>
<b>45-0102 S-02-PF-R Kit</b>	<b>\$549</b>
<b>45-0103 Additional Transmitter</b>	<b>\$20</b>

If each member of a family of four takes a five-minute shower each day, they will use more than 700 gallons of water every week—the equivalent of a three-year supply of drinking water for one person.

—from *50 Simple Things You Can Do to Save the Earth*

## STORAGE

### Rain Barrel and Diverter

Capture irrigation water at no cost with our virtually indestructible, 0.1875" thick, recycled food-grade polyethylene rain barrel. Multiple barrels can be linked with an ordinary garden hose. Features overflow fitting, drain plug, screw-on cover, and threaded spigot. Optional galvanized steel rain diverter (shown) fits any downspout (metal or plastic). When full, flip the diverter to a closed position to let downspout function as usual. 39"H x 24" diameter. 60 gallon capacity. 20 lbs. USA.

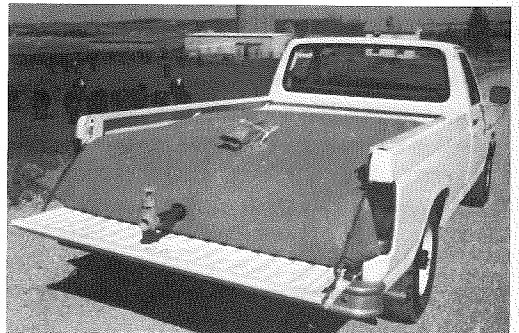


<b>14-9201 Rain Barrel and Diverter</b>	<b>\$130</b>
<b>14-0238 Rain Barrel only</b>	<b>\$114</b>
<b>46209 Diverter only</b>	<b>\$22</b>

*Allow 4-6 weeks for delivery. Can be shipped to customers in the contiguous U.S. only. Cannot be shipped to P.O. boxes. Sorry, express delivery not available.*

### Kolaps-a-Tank

These handy and durable nylon tanks fold into a small package or expand into a very large storage tank. They are approved for drinking water, withstand temperatures to 140° F, and fit into the beds of several truck sizes. They will hold up under very rugged conditions,



are self-supported, and can be tied down with D-rings. All tanks have a 1.5" plastic valve with standard plumbing threads for input/output, and a 6" diameter by 2-foot long filler sleeve at the top for filling. Our most popular size is the 525-gallon model, which fits into a full-sized long-bed (5 x 8 ft.) pickup truck. USA.

<b>47-401 73 gal. Kolaps-a-Tank, 40" x 50" x 12"</b>	<b>\$311</b>
<b>47-402 275 gal. Kolaps-a-Tank, 80" x 73" x 16"</b>	<b>\$460</b>
<b>47-403 525 gal. Kolaps-a-Tank, 65" x 98" x 18"</b>	<b>\$558</b>
<b>47-404 800 gal. Kolaps-a-Tank, 6' x 10' x 2'</b>	<b>\$645</b>
<b>47-405 1140 gal. Kolaps-a-Tank, 7' x 12' x 2'</b>	<b>\$889</b>
<b>47-406 1340 gal. Kolaps-a-Tank, 7' x 14' x 2'</b>	<b>\$995</b>



### Easy-Shape PondGard Liner

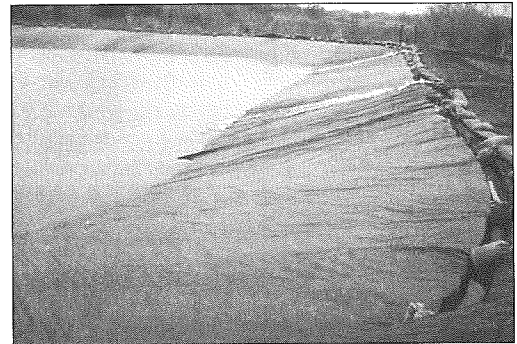
PondGard membrane is friendly to do-it-yourselfers. This EPDM synthetic rubber is a thick 45-mil waterproofing membrane that's highly flexible and stable. It's far easier to work with in small spaces than our standard pond liner material at right, which tends to be quite stiff. PondGard is specially formulated to be safe for exposure to fish and plant life in decorative ponds. It can be shaped easily to fit the unique contours of any pond. Use it for pond lining, streams and fall features, erosion control, storage tanks, or wildlife ponds. PondGard has outstanding resistance to ultraviolet radiation (UV), ozone, and other environmental conditions. It requires little or no regular maintenance once installed. Available pre-cut in sizes listed. Ships via standard UPS. USA.

<b>40-0074 PondGard Liners 10' x 10'</b>	<b>\$99</b>
10' x 15'	\$149
15' x 15'	\$225
15' x 20'	\$280
15' x 25'	\$375
20' x 20'	\$390

### Leak-Free Pond Liners

#### Heavy-duty gauges now available

A pond is a major investment, requiring lots of earth work, soil blending, and compaction. It's a gamble if it will hold water or not, or for how long. With a liner, earthwork can be kept to a minimum, and a leak-free pond can be established on any kind of soil. Our pond liners feature a very tough, UV-stabilized polyethylene that is highly resistant to punctures, tears, roots, or rodents. It's also nontoxic, nonleaching, and FDA/USDA approved for potable water supplies. Whether your plans call for a stocked aquaculture pond, an agricultural reservoir, or a garden feature, you need a liner that is absolutely leak-free to protect your investment of



time and money. Our pond liners are custom-sized in any square or rectangular configuration. Heat welded factory seams are stronger than the surrounding material. Liners are "accordion-folded" for easy spreading on large sites. Four workers can handle up to 10,000 sq.ft.

Available in tough 20-mil thickness, in super heavy-duty 30-mil, or for really extreme sites, 40-mil. Weight per 1,000 sq. ft.: 20-mil = 100 lb., 30-mil = 150 lb., 40-mil = 200 lb.

100 sq. ft. minimum order. \$15 handling charge on orders under 500 sq. ft. Free continental U.S. freight on orders over 2,000 sq. ft. USA.

*To figure size: Double the depth of your pond, add this to the width and length. Add an additional 2 to 5 feet for the buried apron. For instance, a 50' x 50' pond that's 5 feet deep needs a 62' x 62' liner at minimum.*

<b>47-212 PondLiner Fab Tape 2" x 30'</b>	<b>\$36</b>
<b>47-227 Handling Charge under 500 sq. ft.</b>	<b>\$15</b>

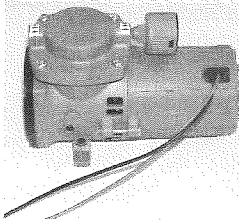
### POND LINER PRICE & COMPARISON CHART

Item #	wt.	Price per Square Foot						
		100-200	201-600	601-2,000	2,001-5,000	5,001-8,000	8,001-12,000	12,001-20,000
<b>47-203</b>	20-mil	.56/sq. ft.	.50/sq. ft.	.44/sq. ft.	.42/sq. ft.	.31 sq. ft.	.28 sq. ft.	.26 sq. ft.
<b>47-204</b>	30-mil	.66/sq. ft.	.59/sq. ft.	.54/sq. ft.	.53/sq. ft.	.37 sq. ft.	.34 sq. ft.	.32 sq. ft.
<b>47-211</b>	40-mil	.72/sq. ft.	.69/sq. ft.	.66/sq. ft.	.65/sq. ft.	.46 sq. ft.	.43 sq. ft.	.41 sq. ft.

Pond liners are made to order, so please have dimensions ready when ordering. 100 sq. ft. minimum order. Please call for pricing on larger liners.

## Solar-Powered Pond Aeration Kit

Aeration improves the aesthetics and overall health of ponds and lakes, reducing the chance of having unsightly algae blooms, the accumulation of sludge, and fish kills. To bring these benefits to your pond, you can either toss the water into the air, or you can toss the

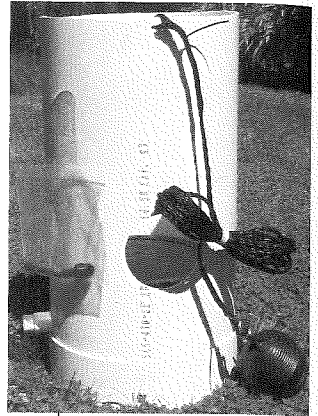


air into the water. Since air weighs a lot less, your energy expenditure will be less and go further with an air pump—such as this 12-volt model that runs directly off a PV mod-

ule or two. Our do-it-yourself kit supplies all the major pieces. The bottom-mounted diffuser delivers air as millions of tiny bubbles for better oxygenation and stirring of the pond to discourage stratification.

The Thomas 1/10 hp air pump delivers 1.4 cubic ft. per min. (CFM) at free discharge, or 0.8 CFM at 10 psi. It draws a maximum of 8.5 amps and can be driven to full output by a pair of 75- to 80-watt PV modules (sold separately below) with a linear current booster to help startup. The diffuser is properly sized to work with this pump. On site, you'll need to supply a 2.5" pipe for the pole-top mount, weather (and possibly noise) protection for the pump, wiring, small parts and weighed air line as needed by your site particulars. All products made in USA, except LCB made in Canada.

- 40-0072 Thomas 12V 1/10hp Air Pump** \$275
- 40-0073 Air Diffuser** \$240
- 41-0177 Sharp 80-watt PV Module** \$395
- 42-0185 Uni-Rac 500040 Poletop Rack** \$134
- 25-003 Solar Converters 10A LCB** \$135



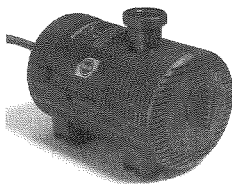
The weighted air diffuser is mounted in 12" PVC with a float. Includes 1/2" and 3/8" air fittings.

## FOUNTAIN PUMPS

### A Solar Fountain Pump That Lasts

We've searched for years for a reliable PV-direct fountain pump. The extremely high-quality German-made submersible Aquasolar 200 finally meets our needs. This brushless, solid-state, sealed DC pump is designed to run at voltages from 12 to 22 volts; it will happily operate continuously at the 16- to 20-volt output of a 12V PV module. Using only 8 watts at the pump, it is rated for 12 liters per minute (over 3 gallons) at zero lift, or a trickle at the maximum lift of 1 meter (3.2 feet). This pump will run to full output with any 10- to 15-watt PV module. Output volume is externally adjustable. The pump housing acts as a large surface area intake screen. The outlet adapter will accept 1/2" flexible tubing, or with the supplied fitting, can accept 1/2" or 3/4" threaded fittings. The housing, pump, and rotor can be disassembled easily for cleaning. Has a 15-foot cord with quick disconnect. Three-year manufacturer's warranty. Germany.

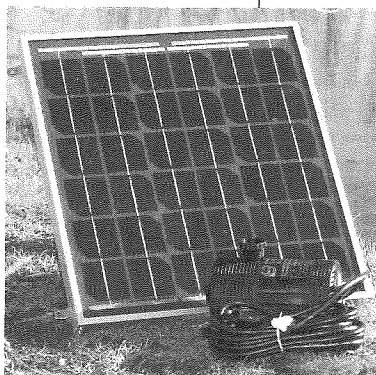
- 41914 Aquasolar 200 Fountain Pump** \$179



### Deluxe Fountain Kit: High-Volume Pump and Solar Module

Combines our 13-watt PV module with our best brushless, solid-state, sealed DC pump, the Aquasolar 200. Adjustable flow volume up to 3 gpm at zero lift (a trickle at 3-meter maximum lift); accepts 1/2" tubing; easy disassembly for cleaning; 15-foot cable, three-year manufacturer's warranty. Assembly instructions included. Germany/China. A \$318 value if purchased separately.

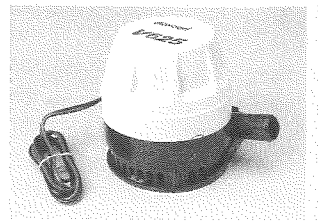
- 41919 Deluxe Fountain Kit** \$299



## ATTWOOD SOLAR FOUNTAIN PUMPS

These submersible 12-volt pumps are designed as continuous-duty marine bilge pumps. We've found they make very impressive solar-powered fountain pumps. They won't lift very high, but they move an incredible volume and use a tiny amount of power. The pump motor twist-locks onto the pump base to allow easy cleaning and removal of debris. They can withstand dry running for a limited time. Three-year manufacturer's warranty. USA.

*Tech Note: In full-time PV-direct use, these pumps can be expected to last about one summer. Attwood is great about honoring the three-year warranty, so we recommend buying two pumps, and being prepared to rotate your stock.*



### Attwood V625 Pump

Model V625 is a good match with any 10- to 30-watt module.

- Amps: 1.3 @ 3 ft. head
- Max gpm: 7.5 @ 3 ft. head
- Max head: 5 ft.

- 41157 V625 Solar Fountain Pump** \$30

### Attwood V1250 Pump

Model V1250 is a good match with any 20- to 50-watt module.

- Amps: 2.9 @ 3 ft. head
- Max gpm: 15.5 @ 3 ft. head
- Max head: 8 ft.

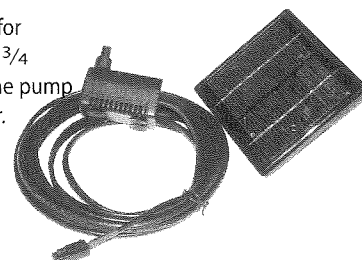
- 41158 V1250 Solar Fountain Pump** \$44

## Pump and Panel for Solar Fountains

Use this nice little kit to create your own solar fountain, or to replace the failed pump on existing fountains. Our kit includes an unbreakable PV panel that measures 4.7" x 4.4" with a locking weatherproof electrical connector, 15 feet of flexible submersible cable, and a submersible DC pump that measures 2.5" L x 1.5"W x 2.0"H with a

5/16" tubing fitting and rubber suction-cup feet for quiet, stable operation. Under full sun it delivers 3/4 gpm at zero lift, or a trickle at 24 inches of lift. The pump can be disassembled easily to clean the impeller. Motor brushes are not accessible or replaceable (expect about a two-year life). China.

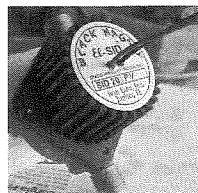
**40-0078 Sm. Solar Pump & Panel** **\$49**



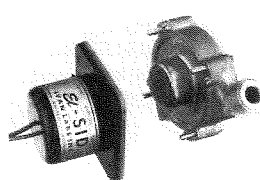
## CENTRIFUGAL PUMPS

### EI-SID Hot Water Circulation Pumps

SID stands for Static Impeller Driver, the EI- is just for fun. These completely solid-state "motors" have no moving parts! There are no brushes, bearings, or seals to wear out. The rustproof bronze pump section is magnetically driven and is an existing off-the-shelf pump head that can be replaced easily if ever necessary. Life



EI-SID 20PV model

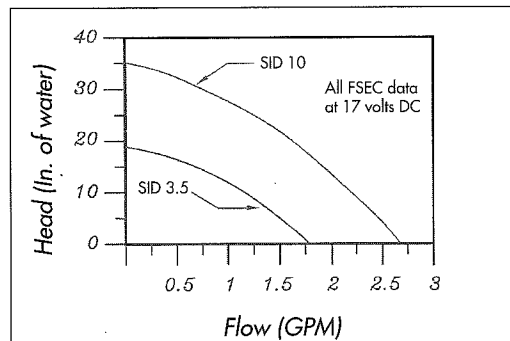


EI-SID 5 and 10 PV models

expectancy is many times longer than any other DC circulation pump.

PV-driven models are offered at 2.0, 3.3, and 6.0 gpm maximum flow rates. The battery-driven model delivers 3.3 gpm max at 12 or 24 volt. The 2.0 gpm PV pump requires a 5-watt PV module, the 3.3 gpm pump requires a 10- to 20-watt module, and the 6.0 gpm pump requires a 30-watt module. These are circulation pumps for closed-loop systems, and will not do any significant lift. See the specifications chart. Must be installed in a protected location (no rain exposure). Rated for temperatures up to 240°F, one-year manufacturer's warranty. USA.

- 41134 EI-SID 5PV 2.0 gpm Pump** **\$215**
- 41133 EI-SID 10PV 3.3 gpm Pump** **\$229**
- 40-0082 EI-SID 20PV 6.0 gpm Pump** **\$305**
- 40-0083 EI-SID 10B 12V 3.3 gpm Pump** **\$225**
- 40-0084 EI-SID 10B 24V 3.3 gpm Pump** **\$275**



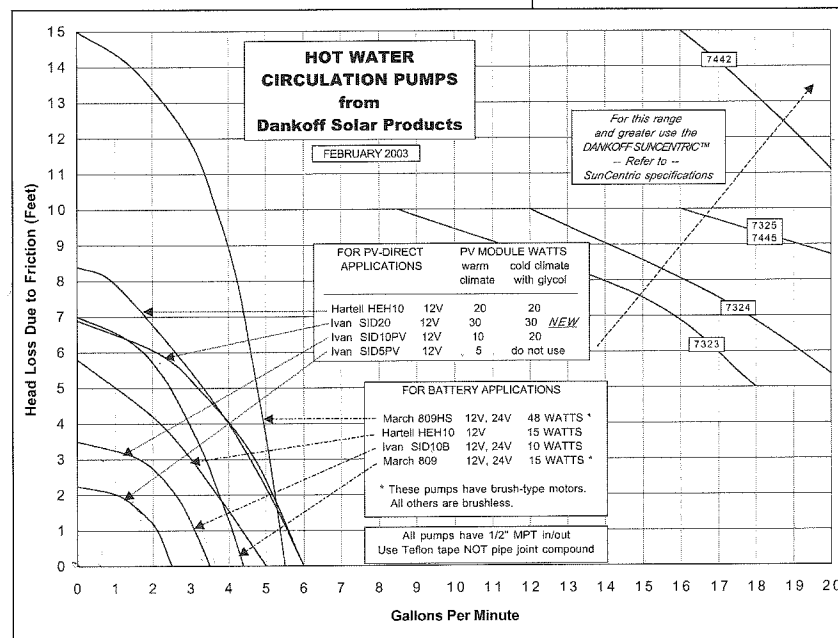
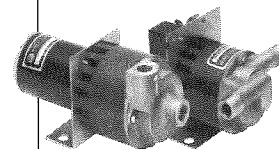
### HARTELL HOT WATER CIRCULATION PUMPS

Hartell pumps feature magnetic drive with no rotating seals. Designed for solar hot water systems or other low-flow, modest-lift applications, they will operate directly off an 18- to 20-watt PV module. Brighter sun means faster pumping. Rated for temperatures up to 200°F, and pressure up to 150 psi. Brass pump bodies have 1/2" MNPT fittings. We offer only Hartell's brushless pump model, with six-month manufacturer's warranty. USA.

#### Hartell MD-10-HEH

A brushless model that offers almost zero maintenance. Requires an 18- to 20-watt PV module. Measures 5.25" diameter by 9" length. Maximum volume, 5 gpm; maximum lift, 8 feet. See chart.

**41529 Hartell Pump MD-10-HEH** **\$410**



WATER DEVELOPMENT

## SunCentric Solar Surface Pumps

*High-temperature option available*

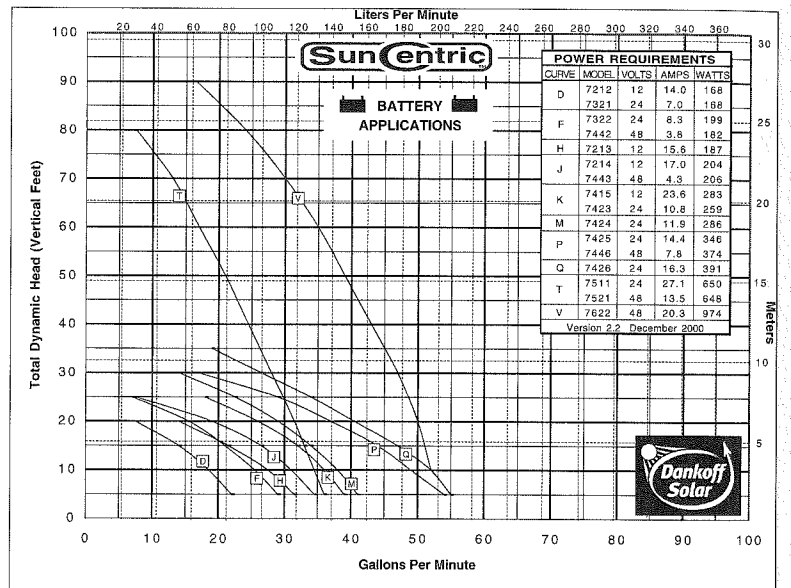
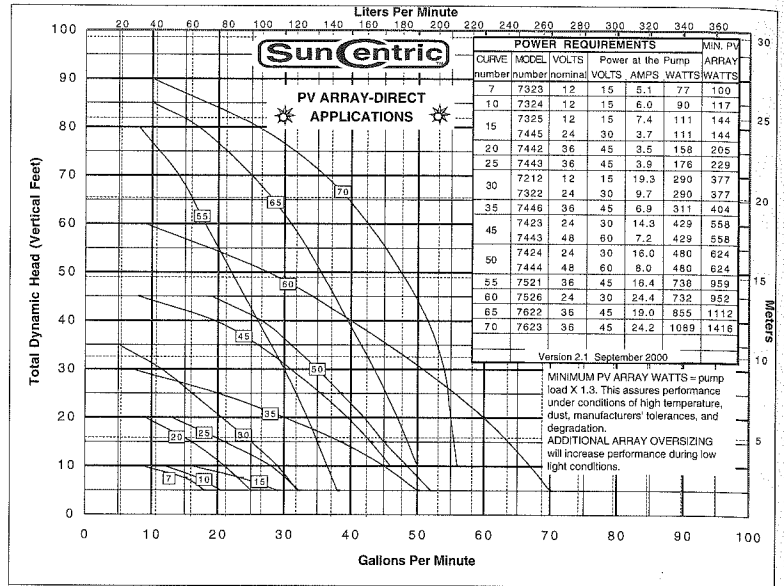
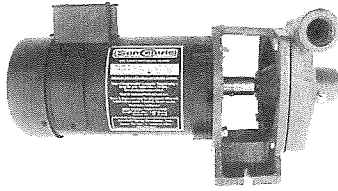
A reliable cast iron DC pump with one moving part. Good for swimming pools, agriculture, hydronic and solar heating, pond aeration, and more. Can do lifts up to 80 feet, or volumes up to 60 gpm depending on model; see performance charts. Maxi-

mum suction lift is 10 feet with a foot valve; centrifugal pumps will not self-prime. Mount the pump as close to the water source as possible, flooded inlet is best. Easy-starting on PV-direct systems; no electronic boost controls are needed. Both PV-direct and battery-powered models are available. Standard pumps use a glass-filled polycarbonate impeller with a temperature limit of 140°F. The \$50 high-temperature option upgrades to a brass impeller with a 212°F limit. HT option reduces flow volume by 15%; power input is the same. Brush life is typically three to ten years. Two-year manufacturer's warranty. USA.

41010	SunCentric 7212 Pump	\$705
41011	SunCentric 7213 Pump	\$705
41012	SunCentric 7214 Pump	\$705
41013	SunCentric 7321 Pump	\$745
41014	SunCentric 7322 Pump	\$745
41015	SunCentric 7323 Pump	\$745
41016	SunCentric 7324 Pump	\$705
41017	SunCentric 7325 Pump	\$860
41018	SunCentric 7415 Pump	\$860
41019	SunCentric 7423 Pump	\$765
41020	SunCentric 7424 Pump	\$765
41021	SunCentric 7425 Pump	\$860
41022	SunCentric 7426 Pump	\$855
41023	SunCentric 7442 Pump	\$765
41024	SunCentric 7443 Pump	\$765
41025	SunCentric 7444 Pump	\$765
41026	SunCentric 7445 Pump	\$860
41027	SunCentric 7446 Pump	\$860
41028	SunCentric 7511 Pump	\$810
41029	SunCentric 7521 Pump	\$810
41030	SunCentric 7526 Pump	\$905
41031	SunCentric 7622 Pump	\$905
41032	SunCentric 7623 Pump	\$905
40-0103	High Temp Option	\$50

## Replacement Parts For SunCentric Pumps

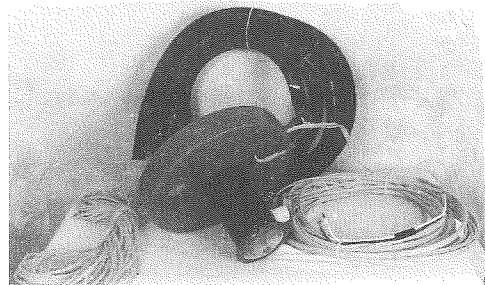
41033	SunCentric Brush Set	\$45
41034	SunCentric 7xx1 to 4 Seal & Gasket Set	\$18
41035	SunCentric 7xx5 or 6 Seal & Gasket Set	\$18
40-0104	High Temp Gasket Set (specify model)	\$38



## SunMotor M3 Solar-Driven Agricultural Pump

*Great for large fountains and aeration*

A professional, long-lived pump that floats mostly submerged in your pond. Delivers low-head, medium-volume water needs from surface water supplies. Just the thing to keep the stock from breaking down banks and



mucking up ponds. Common uses are livestock watering, small-scale irrigation, pond aeration, landscape ponds, and water transfer systems. The pump is magnetically coupled to eliminate any shaft seal and possibility of leakage. Also provides overload protection for the motor. This easy-starting centrifugal pump doesn't need a controller or booster to start. Fifty feet of submersible cable is already attached, so no watertight splice kit is needed. Motor brushes have approximately a two-year life expectancy, and are easily field replaceable with ordinary hand tools. An input screen prevents clogging by any foreign material. Anything that can pass through the screen is lifted easily by the pump. Kit includes pump, 50' wire, 50' 1/4" poly safety rope to hold pump in position, and 25' flexible output hose. Depending on lift and volume required, it needs a single 80- to 115-watt PV module with mounting to complete a system. See output chart below. Canada.

- 41468 SunMotor M3 Pump** **\$995**
- 41-0177 Sharp 80W module** **\$395**
- 41-0124 Evergreen EC115 module** **\$585**
- 42-0182 UniRac 500036 Poletop Mount** **\$121**  
(fits either module above)

### M3 AGRICULTURAL PUMP PERFORMANCE CHART

Meters Lift (Feet)	80W Liters/Min. (GPM)	Approx. Daily Output Gallons	115W Liters/Min. (GPM)	Approx. Daily Output Gallons
1 (3.3)	22.7 (6.0)	1,500	31.8 (8.4)	2,100
2 (6.6)	21.5 (5.7)	1,400	28.6 (7.6)	1,900
3 (9.8)	20.0 (5.3)	1,300	25.4 (6.7)	1,700
4 (13.1)	16.7 (4.4)	1,200	22.0 (5.8)	1,450
5 (16.4)	13.6 (3.6)	1,100	18.3 (4.8)	1,250
6 (19.7)	11.4 (3.0)	900	13.9 (3.7)	950
7 (23.0)	7.6 (2.0)	600	9.9 (2.6)	650

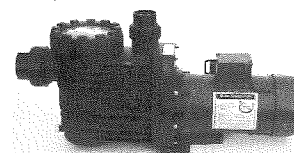
## Solar Pool-Pumping Systems

Pool pumping often can be a suburban home's largest single power use. Solar pool-pumping systems are moderately expensive initially, but run for nothing and have life expectancies measured in decades. Our solar-powered pool-pumping systems consist of a high-efficiency brushless motor coupled to a standard glass-filled polycarbonate pool pump head with a basket filter, clear cover, and 2" inlet/outlet fittings. The pump is driven directly from a solar-electric array for simplicity and next-to-no maintenance. When the sun comes up, the pump runs.

Optional AC power converter provides back-up power from utility or generator power. Pump can draw power from solar and the converter simultaneously, with solar power as priority. Mounts sold separately. Manufacturers' warranties and countries of origin: 4 years on pump motor/control; China. 10 years on racks/mounts; USA. 20 years on PV modules; USA. Pump head: Germany.

Each system includes a pump assembly with controller plus BP Solar brand PV modules in 48-volt configuration. Choose a system wattage based on pool size and filter back pressure (see lower chart). Then choose your preferred mounting style for that size system.

- 40-0059 340-watt system** **\$5,075**
- 40-0060 480-watt system** **\$5,890**
- 40-0061 600-watt system** **\$6,980**
- 48-0015 GFI Option (for roof mounted arrays)** **\$190**
- 48-0016 AC Power Converter Option** **\$755**



### SOLAR ARRAY MOUNTING OPTIONS FOR POOL SYSTEMS

Mounting Type	340-watt System	480-watt System	600-watt System
Flush Rooftop	42-0050 \$169	42-0051 \$214	42-0052 \$214
Fixed Pole-top	42-0053 \$230	42-0054 \$345	42-0055 \$360
Tracking Pole-top	42-0056 \$475	42-0057 \$995	42-0058 \$995

### POOL PUMPING SYSTEMS PERFORMANCE

Solar Array Watts	Back pressure psi	Fixed Array		Tracking Array	
		Gallons per day	Max Pool size**	Gallons per day	Max Pool size**
340	3	17,600	25,100	26,600	38,000
480	3	23,400	33,500	35,400	50,600
600	3	27,500	39,300	39,600	56,600
340	6	11,100	15,900	16,900	24,200
480	6	17,200	24,500	26,000	37,200
600	6	21,100	30,200	31,700	45,300
340	8.5	6,400	9,200	9,800	14,000
480	8.5*	11,600	16,500	17,500	25,100
600	8.5	16,100	22,900	24,300	34,700
480	11	6,400	9,100	9,700	13,800
600	11	10,300	14,800	15,700	22,400

Daily performance based on solar irradiation of 6.0 peak sun hours per day, and 17% degradation of array output due to heat, dirt, and manufacturer's tolerances.

\* 8 psi is typical back pressure for a system sized according to this selection table. Low friction (2") piping and a large cartridge-type filter can reduce it further.

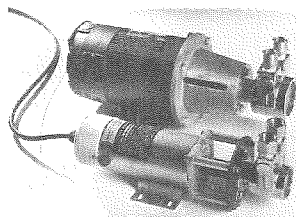
\*\* Max. pool size is based on a turnover of 70% per day. For faster turnover choose a larger system if possible.



# ROTARY VANE PUMPS

## SOLAR SLOWPUMPS

Slowpumps are the original solar-powered pumps developed by Windy Dankoff in 1983. They set the standard for efficiency and reliability in solar water pumping where water demand is in the range of 50 to 3,000 gallons per day. The surface-mounted Slowpump is designed to draw water from shallow wells, springs, cisterns, tanks, ponds, rivers, or streams and to push it as high as 440 vertical feet for storage, pressurization, or irrigation.



These positive-displacement rotary-vane-type pumps feature forged brass bodies with carbon-graphite vanes held in a stainless steel rotor. No plastic!

Motor brushes are externally replaceable, and last 5 to 10 years. Pump life expectancy is 15 to 20 years. Rebuilt/exchange pump heads are available for under \$150. Slowpumps are NSF approved for drinking water. A wide variety of pump and motor combinations are available for a variety of lifts and delivery volumes. Consult the performance charts.

Rotary-vane pumps must have absolutely clear water. They will not tolerate any abrasives. A 10-micron cartridge pre-filter is highly recommended for all installations. If your water is very dirty, improve the source or consider a diaphragm pump.

Fittings on 1300 and 1400 series pumps are 1/2-inch female, 2500 and 2600 series pumps have 3/4-inch male fittings. Sizes and weights vary slightly with model but are approximately 6" x 16" and 16 lb. One-year manufacturer's warranty. USA.

### 1/4-Horsepower PV Or Battery Powered Pumps, 12 Or 24 Volts

See chart. Specify voltage when ordering.

<b>41102</b>	<b>Slowpump 1322 pump</b>	<b>\$475</b>
<b>41104</b>	<b>Slowpump 1308 pump</b>	<b>\$475</b>
<b>41106</b>	<b>Slowpump 1303 pump</b>	<b>\$475</b>
<b>41108</b>	<b>Slowpump 2507 pump</b>	<b>\$475</b>

### 1/2-Horsepower Slowpumps

See chart. State voltage when ordering.

<b>41931</b>	<b>Slowpump 1404 Pump</b>	<b>\$695</b>
<b>41932</b>	<b>Slowpump 1403 Pump</b>	<b>\$695</b>
<b>41933</b>	<b>Slowpump 2605 Pump</b>	<b>\$695</b>
<b>41934</b>	<b>Slowpump 2607 Pump</b>	<b>\$695</b>

### AC Version of any Slowpump Model

<b>41110</b>	<b>Slowpump AC Option</b>	<b>Add \$145</b>
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### 1/4-HORSEPOWER 1300 & 2500 MODELS PV OR BATTERY POWER, 12V, 24V, OR 115VAC

Total Lift in Feet	1322		1308		1303		2507	
	GPM	Watts	GPM	Watts	GPM	Watts	GPM	Watts
20	0.51	27	1.25	30	2.50	48	4.00	57
40	0.51	32	1.25	48	2.50	60	3.95	78
60	0.51	36	1.20	54	2.40	78	3.90	102
80	0.49	40	1.20	60	2.30	93	3.90	120
100	0.49	45	1.20	66	2.30	105	3.85	144
120	0.48	50	1.20	70	2.25	121	3.80	165
140	0.47	56	1.20	75	2.20	138	3.65	195
160	0.47	62	1.20	84	2.20	153		
180	0.47	66	1.18	93	2.15	165		
200	0.45	74	1.16	101	2.15	180		
240	0.44	90	1.14	117	2.15	204		
280	0.41	102	1.12	135				
320	0.41	120	1.10	153				
360	0.41	134	1.05	171				
400	0.40	150	1.00	198				
440	0.39	168						

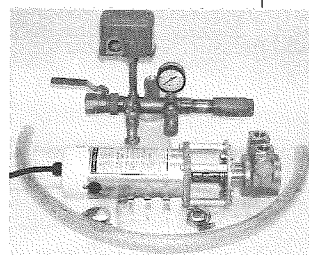
Actual performance may vary ±10% from specifications. Performance listed at 15V or 30V (PV-direct). Deduct 20% from flow and watts for battery. Watts listed are power use at pump.

### 1/2-HORSEPOWER 1400 & 2600 MODELS, 24 OR 48V BATTERY OR 36V PV DIRECT

Total Lift in Feet	1404		1403		2605		2607	
	GPM	Watts	GPM	Watts	GPM	Watts	GPM	Watts
160							4.30	283
180					3.35	280	4.25	305
200					3.33	296	4.20	338
240			2.55	266	3.30	331	4.05	396
280			2.50	302	3.25	373	4.00	444
320	1.66	255	2.50	338	3.20	410		
360	1.64	280	2.50	374	3.16	450		
400	1.62	312	2.50	406				
440	1.60	341	2.50	451				

Actual performance may vary ±10% from specifications. Watts listed are power use at pump.

## Flowlight Booster Pumps



Sharing all the robust design features of the smaller Slowpumps, these larger rotary-vane pumps are designed specifically for household water pressurization. They use one-half to one-third as much energy as a similar capacity AC pressure pump, and eliminate the starting surges that are so hard on inverters. These pumps are quieter, smoother running, and far more durable than diaphragm-type pressure pumps. For full-time off-the-grid living, this is the pressure pump you want. Life expectancy is 15 to 20 years, and then they just need a simple pump head replacement.

### BOOSTER PUMP PERFORMANCE CHART

	STANDARD MODEL				LOW SPEED MODEL			
PSI	30	40	50	65	30	40	50	65
GPM	4.5	4.3	4.3	4.1	3.4	3.3	3.1	2.7
Amps @24V	6.5	7.5	8.0	11.0	5.0	5.5	6.0	7.5
W/H per Gal	0.6	0.67	0.75	1.1	0.6	0.67	0.75	1.1

Two models are available. Standard models feature higher flow rates, but are noisier, require 1" or larger intake plumbing, and have less than 10 feet of suction capacity. Low speed models are quieter, can accept 3/4" intake plumbing and suction lifts greater than 10 feet, but have lower flow rates. Both models are available in 12 or 24 volts. Standard models also available in 48VDC and 115VAC.

A pressure tank must be used with this, or any, pressure pump. Forty-gallon capacity is the minimum size recommended; larger is better. The Booster Pump Installation Kit and the Inline Sediment Filter, as shown with the pump picture, are strongly recommended. Flexible hose input and output hose assemblies and pressure relief valve are included with the pump. One year manufacturer's warranty. USA.

<b>41141</b>	<b>Standard Booster Pump, 12V</b>	<b>\$540</b>
<b>41142</b>	<b>Standard Booster Pump, 24V</b>	<b>\$540</b>
<b>41000</b>	<b>Standard Booster Pump, 48V</b>	<b>\$695</b>
<b>41147</b>	<b>Standard Booster Pump, 115VAC</b>	<b>\$630</b>
<b>41145</b>	<b>Low Speed Booster Pump, 12V</b>	<b>\$520</b>
<b>41146</b>	<b>Low Speed Booster Pump, 24V</b>	<b>\$520</b>

## Booster Pump Installation Kit

This kit contains all the plumbing bits and pieces you'll need for installation of the Booster Pump. It includes a one-way check valve, a pressure switch, a pressure gauge, a drain valve, a shut-off valve, and the pressure tank tee all manifolded together. Shown with Booster Pump picture.

<b>41143</b>	<b>Booster Pump Install Kit</b>	<b>\$99</b>
<b>41137</b>	<b>Inline Sediment Filter</b>	<b>\$49</b>

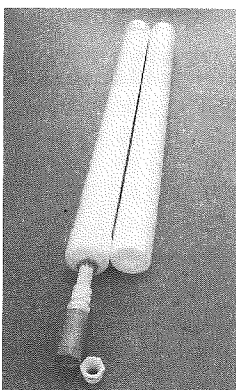
## Accessories for Slowpump Installation



### Inline Sediment Filter

This is the recommended minimum filter for every Slowpump installation. This filter is designed for cold water only, and meets NSF standards for drinking water supplies. It features a sump head of fatigue-resistant Celcon plastic, an opaque body to inhibit algae growth if installed outdoors, and is equipped with a manually operated pressure-release button to simplify cartridge replacement. Rated for up to 125 psi and 100°F, it is equipped with 3/4-inch female pipe thread inlet and outlet fittings, and is rated for up to 6 gpm flow rates (with clean cartridge). It accepts a standard 10-inch cartridge with 1-inch center holes. Supplied with one 10-micron fiber cartridge installed. USA.

<b>41137</b>	<b>Inline Sediment Filter</b>	<b>\$49</b>
<b>42632</b>	<b>10 Micron Sediment Cartridge, 2 pack</b>	<b>\$13</b>



### 30" Intake Filter with Foot Valve

A great choice for any Slowpump with a surface water source. This large, triple-size 10-micron filter with no external cover can be lowered into wells, or floated on a pond. Large surface area means less frequent replacements. Equipped with a foot valve so you won't lose your pump prime. Included bushing allows 1/2 or 3/4" pipe thread outlet. Comes with assembled filter and first replacement cartridge as pictured. USA.

<b>40-0086</b>	<b>30" Intake Filter/Foot Valve</b>	<b>\$70</b>
<b>40-0087</b>	<b>30" Filter Repl. 3-Pack</b>	<b>\$44</b>

## Dry Run Shutdown Switch

Rotary-vane pumps will be damaged if allowed to run dry. This thermal switch clamps to the pump head of any new or older Slowpump. It will sense the temperature rise of dry running and shut off the pump before damage can occur. A manual reset is required to restart the pump. This switch will pay for itself many times over even if only used once during the lifetime of your Slowpump. USA.

<b>41135</b>	<b>Dry Run Sw. for 1300 Series Pumps</b>	<b>\$50</b>
<b>41144</b>	<b>Dry Run Sw. for all Larger Series Pumps</b>	<b>\$50</b>

## Replacement Motor Brush Sets

The Slowpump brushes are easy to inspect and replace. Simply unscrew and withdraw the old brushes, then screw in the new ones if needed. Normal life expectancy is five to ten years. Sold in sets of two. USA.

<b>41111</b>	<b>12V Slowpump Motor Brush Set</b>	<b>\$20</b>
<b>41112</b>	<b>24V Slowpump Motor Brush Set</b>	<b>\$20</b>

## Replacement Pump Heads

Slowpump pump heads typically enjoy a 15- to 20-year life expectancy if the water is clean, and they don't run dry. But hey, stuff happens, and some of the early Slowpumps have been out there for over 20 years now. Here's your replacement pump head, and it isn't going to hurt too bad. Specify your model when ordering. USA

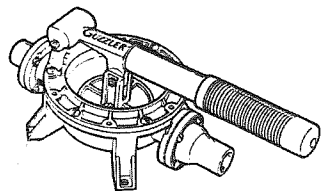
<b>41937</b>	<b>Replacement Pump Head for 1300 series</b>	<b>\$142</b>
<b>41938</b>	<b>Replacement Pump Head for 2500 series</b>	<b>\$193</b>

## DIAPHRAGM PUMPS

### Guzzler Pumps

#### Human-powered pumps

These high-volume, low-lift pumps are driven by simple, dependable muscle power. Both hand pump and foot pump models are available. These are simple self-priming, diaphragm-type pumps with reinforced flapper valves for durable, dependable pumping. All models can deliver



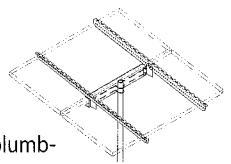
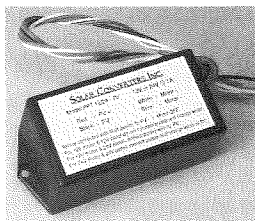
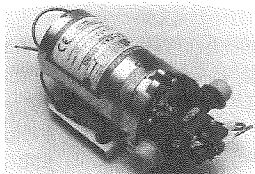
about 12 feet of suction lift below the pump, and 12 feet of delivery head above the pump. Guzzlers make excellent

emergency sump pumps, bilge pumps, or water delivery systems. The Model 400 series delivers up to 10 gpm, and uses 1" hose. Model 500 series delivers up to 15 gpm, and uses 1.5" hose. The Foot Pump models have a spring return stroke. USA.

<b>41151</b>	<b>400 Hand Pump</b>	<b>\$55</b>
<b>41152</b>	<b>500 Hand Pump</b>	<b>\$65</b>
<b>41936</b>	<b>400 Foot Pump</b>	<b>\$133</b>
<b>41937</b>	<b>500 Foot Pump</b>	<b>\$142</b>

### Solar Surface Pump Kit

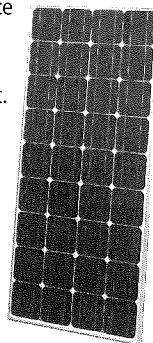
Our surface pump kit features one of our most popular pumps, the SHURflo Low Flow, along with enough PV power to lift up to 130 feet. This kit includes an Evergreen 115-watt PV module, a pole-top mount for ease of installation, an LCB for best delivery under marginal sun conditions, and a screened foot valve for reliable operation. You supply a 10-foot length of 2.5"



steel pipe for the PV mount, plumbing and wiring as needed, and a surface water supply. Mount your pump as close to the water supply as practical, with a maximum of 10-foot suction lift. Pumps would much rather push. Kit pricing saves \$47.

Delivers approximately 1.5 gpm, depending on lift and sunlight availability. In a typical six-hour summer day, it puts over 500 gallons into your garden or storage tank. All components U.S.-made, except LCB made in Canada.

**41037 Solar Surface Pump Kit \$889**



## SHURFLO PUMPS

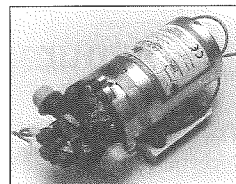
SHURflo produces a high-quality line of positive-displacement, diaphragm pumps for RV and remote household pressurization, and for lifting surface water to holding tanks. These pumps will self-prime with 10 feet of suction and a free discharge (no pressure on outlet). The three-chamber design runs quieter than other diaphragm pumps and will tolerate silty or dirty water or running dry with no damage. However, if your water is known to have sand or debris, it's best to use input filtering. Either SHURflo's small inline filter, or a standard 10" cartridge will save you trouble by preventing sand or other crud from lodging in the check valves. No damage, but you'll have to disassemble the pump to flush it out. Who needs the hassle? Put a filter on it!

Motors are slow-speed DC permanent-magnet types (except AC model) for long life and the most efficient performance. All pumps are rated at 100% duty cycle and may be run continuously. There is no shaft seal to fail; the ball bearing pump head is separate from the motor. Pumps are easily field repaired and rebuild kits are available for all models. All pumps have a built-in pressure switch to prevent over-pressurization. Some are adjustable through a limited range. Low flow model has 3/8-inch MIPT inlets and outlets. Medium and high flow models are 1/2-inch MIPT. All pumps carry a full one-year warranty. USA.

### SHURflo Low Flow Pump

For modest water requirements or PV-direct applications. Available in 12 volts DC only. Delivers a maximum of 60 psi or 135 feet of head. This is an excellent surface water delivery pump used with the 7-amp PV Direct Pump Control (25002) and PV modules as necessary for your lift. (Add 30% to pump wattage to figure necessary PV wattage.) 3/8-inch MIPT inlet and outlet.

**41450 SHURflo Low Flow Pump \$109**



#### SHURflo Low Flow 12V

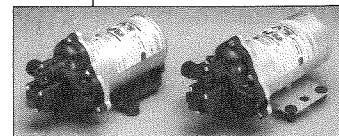
PSI	GPM	Watts
0	1.75	37
10	1.66	41
20	1.57	50
30	1.48	59
40	1.38	67
50	1.30	76
60	1.23	86

### SHURflo Medium Flow Pump

The Medium Flow is available in 12- or 24-volt DC; performance specs are similar for both (the 24V pump does slightly less volume). Maximum pressure is 40 psi or 90 feet of lift for both models. This model is a good choice for low-cost household pressurization; it will keep up with any single fixture. You must use a pressure tank with any pressurization system; obtain locally. It has a built-in 20- to 40-psi pressure switch, perfect for most households. Buzzy output can be reduced by looping 24-inch flexible connectors on both inlet and outlet. 1/2-inch MIPT inlet and outlet.

**41451 SHURflo Medium Flow, 12 Volt \$149**

**41452 SHURflo Medium Flow, 24 Volt \$165**



#### Medium Flow 12V

PSI	GPM	Amps
0	3.30	5.1
10	3.02	5.6
20	2.82	7.0
30	2.65	8.4
40	2.48	9.6

#### Medium Flow 24V

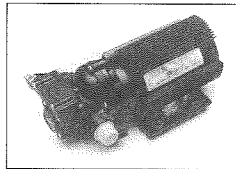
PSI	GPM	Amps
0	3.00	2.5
10	2.87	3.2
20	2.64	3.8
30	2.41	4.3
40	2.20	4.7

**SHURflo High Pressure 12V**

PSI	GPM	Amps
0	3.40	6.0
10	3.00	6.9
20	2.75	7.5
30	2.50	8.6
40	2.25	9.5

**SHURflo High Pressure Pump**

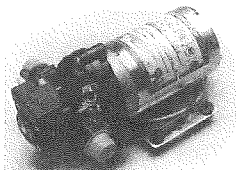
This model is higher pressure, 30- to 45-psi for household pressurization systems. For those who need slightly higher pressure than the standard Medium Flow pumps. Buzzy output can be reduced by looping 24-inch flexible connectors on both inlet and outlet. Available in 12 volts only. Maximum pressure is 45 psi or 104 feet of lift. 1/2-inch MIPT inlet and outlet.



**41453 SHURflo High Pressure Pump \$189**

**SHURflo AC Pump, 115 Volts**

For those who need to send power more than 150 to 200 feet away, this pump can save you big \$\$ on wire costs! The motor is thermally protected and under heavy continuous use will shut off automatically to prevent overheating. This should only happen at maximum psi after approximately 90 minutes of running. Pressure switch is adjustable from 25 to 45 psi. Maximum pressure is 45 psi. Weight 5.8 lb. 1/2-inch MIPT inlet and outlet.



**41454 SHURflo 115 volt AC Pump \$179**

**SHURflo 115v AC Pump**

PSI	GPM	Amps
0	3.05	59
10	2.85	65
20	2.60	82
30	2.40	96
40	2.24	108

**EXTREME PRESSURE 12V**

PSI	GPM	Amps
10	1.68	3.6
30	1.53	5.1
50	1.39	6.4
70	1.29	7.6
90	1.20	8.8
100	1.15	9.3

**SHURflo Extreme High Pressure Pump**

This is a special pump for very high pressures up to 100 psi. It can pump up to 230 feet of vertical lift. The built-in pressure switch is factory adjusted to turn on at 85 psi and off at 100 psi. Adjustment range is 80 to 100 psi. Not recommended for continuous operation. Has 3/8-inch female NPT inlet and outlet fittings. 12 Volt only. USA.

**41357 SHURflo Extreme High Pressure, 12 Volt \$109**

**ULTRAflo Pump and Accumulator Combo**

Delivering over 5 gallons per minute, SHURflo offers this pair of high-output pumps pre-assembled with a stainless steel 2-gallon accumulator tank. This is a complete water pressure delivery system for 12- or 24-volt DC



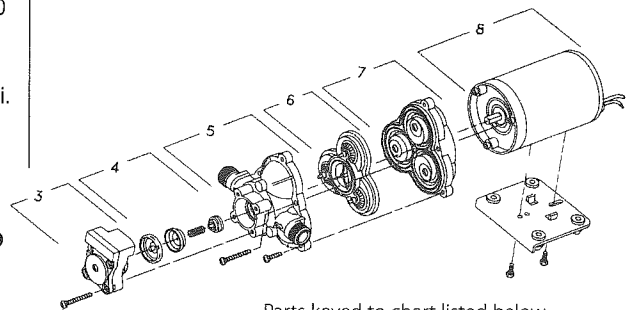
operation. The double-head diaphragm pumps deliver up to 5.6 gpm at 12v, or 6.5 gpm at 24v for multi-fixture operation. The built-in pressure switch is on at 35, off at 45 psi, with +/- 5 psi adjustment. Designed for marine and RV applications with limited space, these will perform better and live longer with the addition of a second larger pressure tank if you've got the space. 1/2" male pipe-thread outlet. 18.5"L x 14.5"H x 10"D, weighs 9 lb. One-year manufacturer's warranty. USA.

**40-0080 12v Pump/Accumulator \$339**

**40-0081 24v Pump/Accumulator \$345**

**12v Pump/Accumulator 24v Pump/Accumulator**

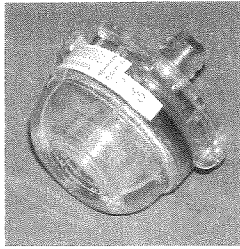
PSI	GPM	Amps	PSI	GPM	Amps
0	5.6	7.4	0	6.5	4.0
10	5.1	9.4	10	6.0	5.3
20	4.4	11.3	20	5.4	6.5
30	3.7	12.7	30	4.6	7.5
40	2.9	13.6	40	4.2	8.1



Parts keyed to chart listed below.

**SHURFLO REPAIR AND REPLACEMENT PARTS**

Pump Model	Press. Switch 3	Check Valve 4	Upper Housing 3,4 & 5	Valve Kit 6	D&D Kit 7	Motor 8
Low Flow 12v 41450	41325 \$20	41327 \$10	n/a	41331 \$20	41333 \$37	41335 \$100
Med. Flow 12v 41451	41326 \$20	41326 \$10	41329 \$25	41332 \$15	41334 \$30	41335 \$100
Med. Flow 24v 41452	41326 \$20	41328 \$10	41329 \$25	41332 \$15	41334 \$30	41334 \$119
High Press 12v 41453	n/a	41328 \$10	41330 \$50	41332 \$15	41334 \$30	n/a
115VAC 41454	41326 \$20	41328 \$10	41329 \$25	41332 \$15	41334 \$30	41338 \$169



### SHURflo Inline Filter

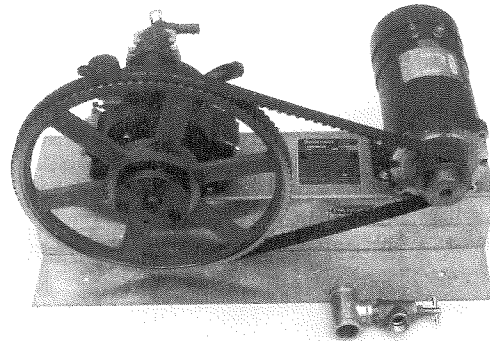
For light-duty filtering, this stainless steel screen is all the highly tolerant SHURflo pumps need. It'll keep out anything big enough to cause trouble for the pump. Screws onto 1/2" male pump inlet, has 1/2" barbed fitting to water source. Disassemble for cleaning.

**40-0088 SHURflo Inline Filter** **\$9**

### Solaram Pump

This is the highest yield, highest lift solar pump available. Using a large multi-piston industrial diaphragm pump and a permanent-magnet DC motor with positive gear belt drive, the Solaram series of pumps features models capable of lifts up to 960 feet, or over 9 gallons per minute. The performance chart shows delivery and watts required. If running PV-direct, the rated PV wattage must exceed the pump requirement by 25% or more. A pressure relief valve and flexible intake/outlet hoses are included.

In full-time daily use, yearly diaphragm replacement is recommended. Motor brushes typically last 10 years. The Diaphragm and Oil Kit provides a set of new



diaphragms and the special nontoxic oil. The Long-Term Parts Kit contains three diaphragm and oil kits, plus a gearbelt and motor brush kit.

Inlet fittings are 1.5 inches, outlet is 1 inch. Dimensions are 28" long, 16" deep, 16.5" high. Weight is approximately 150 lb. (varies slightly with model) and is shipped in two parcels. Manufacturer's warranty is one year. USA.

Specify full 4-digit model number when ordering.

- 41480 Solaram 8100 series Pump** **\$2,475**
- 41481 Solaram 8200 series Pump** **\$2,475**
- 41482 Solaram 8300 series Pump** **\$3,825**
- 41483 Solaram 8400 series Pump** **\$3,825**
- 41484 Diaphragm & Oil Kit** **\$197**
- 41485 Long Term Parts Kit** **\$345**

## Solaram™ Surface Pump Performance Chart

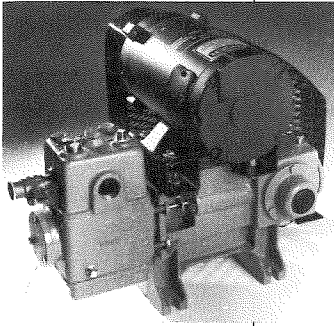
Model Numbers: **First 2 digits** \_\_\_\_\_  
**Second 2 digits** \_\_\_\_\_

TOTAL LIFT		__ __ 21			__ __ 22			__ __ 23			__ __ 41			__ __ 42			__ __ 43			Model #
Feet	Meters	GPM	LPM	Watts	GPM	LPM	Watts	GPM	LPM	Watts	GPM	LPM	Watts	GPM	LPM	Watts	GPM	LPM	Watts	Volts
0-80	24	3.0	11.4	170	3.7	14.0	207	4.6	17.4	285	6.2	23.5	258	7.5	28.4	339	9.4	35.6	465	<b>81</b> <b>24V</b>
120	37	2.9	11.0	197	3.7	14.0	238	4.5	17.1	319	6.0	22.7	305	7.3	27.7	396	9.1	34.5	539	
160	49	2.9	11.0	225	3.6	13.6	268	4.5	17.1	352	5.8	22.0	354	7.2	27.3	453	8.9	33.7	619	
200	61	2.9	11.0	247	3.6	13.6	296	4.5	17.1	388	5.7	21.6	400	7.1	26.9	513	8.9	33.7	693	
240	73	2.8	10.6	265	3.6	13.6	327	4.5	17.1	427	5.6	21.2	453	7.0	26.5	572	8.6	32.6	724	<b>82</b> <b>24V</b>
280	85	2.8	10.6	286	3.6	13.6	356	4.4	16.7	466	5.5	20.8	499	6.9	26.2	628	8.4	31.8	801	
320	98	2.8	10.6	315	3.5	13.3	388	4.4	16.7	496	5.4	20.5	548	6.8	25.8	686	8.3	31.5	869	
360	110	2.8	10.6	342	3.5	13.3	416	4.4	16.7	536	5.4	20.5	592	6.6	25.0	733	8.2	31.1	927	
400	122	2.7	10.2	363	3.4	12.9	450	4.4	16.7	572	5.3	20.1	649	6.5	24.6	782	8.7	33.0	1122	<b>83</b> <b>180V</b>
480	146	2.7	10.2	416	3.4	12.9	505	4.3	16.3	649	5.3	20.1	717	6.5	24.6	900	8.5	32.2	1265	
560	171	2.7	10.2	456	3.3	12.5	570	4.3	16.3	693	5.2	19.7	800	6.5	24.6	1045	8.4	31.8	1397	
640	195	2.7	10.2	502	3.3	12.5	623	4.2	15.9	774	5.1	19.3	893	6.5	24.6	1116	8.2	31.1	1540	
720	220	2.6	9.9	551	3.2	12.1	690	4.1	15.5	856	5.1	19.3	1031	6.4	24.3	1287	8.1	30.7	1683	<b>84</b> <b>180V</b>
800	244	2.6	9.9	589	3.2	12.1	715	4.1	15.5	931	5.1	19.3	1114	6.4	24.3	1408	8.0	30.3	1815	
880	268	2.6	9.9	647	3.2	12.1	774	4.0	15.2	1082	5.1	19.3	1206	6.3	23.9	1529	8.0	30.3	1958	
960	293	2.6	9.9	705	3.1	11.7	838	4.0	15.2	1190	5.0	18.9	1289	6.1	23.1	1650	8.0	30.3	2145	

Performance may vary ± 10 %

## PISTON PUMPS

### Solar Force Piston Pump



Built like a tank, the cast iron Solar Force is an excellent choice for high-volume delivery of 4 to 9 gpm at lifts up to 220 feet. It can be used for water delivery to a higher storage tank, for irrigation, fire protection, or pressurization. It has a 25-foot suction lift at sea level. The durable cast iron and brass pump is designed to last for decades, and routine maintenance is only required every two to six years. A Linear Current Booster is needed for PV-direct drive. LCB sizing depends on model and voltage. Our tech staff will advise. Solar Force uses a non-slip gear belt drive on PV-direct models, and standard V-belt drive on battery models. Intake fitting is 1.25 inches, output is 1 inch. A pressure relief valve is included. Measures 22" W x 16" H by 13" D. Weighs approximately 80 lb. maximum, shipped in two or three parcels depending on model. Two-year manufacturer's warranty. USA.

The Solar Force Pump is available in three basic models:  
 Model 3010: available in 12 or 24 volts battery-driven only.  
 Model 3020: available in 12, 24, or 48 volts, battery or PV-direct, also 115VAC.  
 Model 3040: available in 12, 24, or 48 volts, battery or PV-direct, also 115VAC.

Please specify voltage (12, 24, 48, or 115) when ordering.

<b>41254</b>	<b>Model 3010 Solar Force (12 &amp; 24V battery only)</b>	<b>\$1,085</b>
<b>41255</b>	<b>Model 3020 Battery Powered</b>	<b>\$1,350</b>
<b>41256</b>	<b>Model 3020 PV Powered</b>	<b>\$1,525</b>
<b>41257</b>	<b>Model 3040 Battery Powered</b>	<b>\$1,415</b>
<b>41258</b>	<b>Model 3040 PV Powered</b>	<b>\$1,595</b>
<b>41259</b>	<b>Model 3020 or 3040 115VAC Powered</b>	<b>\$1,350</b>

### SOLAR FORCE PISTON PUMP PERFORMANCE

Vertical Lift Feet	Model 3110		Model 3020		Model 3040	
	GPM	Watts	GPM	Watts	GPM	Watts
20	5.9	77	5.2	110	9.3	168
40	5.6	104	5.2	132	9.3	207
60	5.3	123	5.1	154	9.2	252
80	5.1	152	5.1	182	9.2	286
100	5.1	171	5.0	202	9.1	322
120	4.9	200	5.0	224	9.1	364
140	4.9	226	5.0	252	9.1	403
160	This model 12 or 24v battery-driven only		4.9	269		
180			4.9	280		
200			4.8	308		
220			4.7	314		

## SOLAR FORCE ACCESSORIES AND PARTS

### Heavy-Duty Pressure Switch

A DC-rated pressure switch for using the Solar Force as a pressure pump. Will handle the heavy starting surge. Good for 12-, 24-, or 48-volt systems.

**41264 Solar Force Pressure Switch \$75**

### Surge Tank

This tank is included with the PV models. It helps absorb pressure pulsations when long piping runs are required between the pump and the tank. It keeps plumbing systems from being shaken apart.

**41265 Solar Force Pulsation Tank \$90**

### Seal and Belt Kit

Contains all the repair parts needed for routine service required every two to six years. Spare gaskets, rod and valve seals, new drive belt, and two sets of piston seals are included. PV kits are higher priced due to gear belt drive instead of V-belt.

Specify pump model number when ordering.

**41267 Seal & Belt Kit for Battery Pumps \$45**

**41268 Seal & Belt Kit for PV Pumps \$75**

### Long-Term Parts Kit

Everything included in the Seal & Belt Kit above, plus a second drive belt, a replacement cylinder sleeve, motor brushes, and two oil changes.

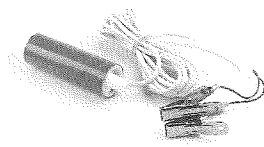
Specify pump model number when ordering.

**41269 Long-Term Parts Kit for Battery Pumps \$160**

**41270 Long-Term Parts Kit for PV Pumps \$210**

# SUBMERSIBLE PUMPS

## Amazon Submersible

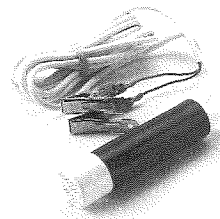


Delivers a maximum of 4 gpm at zero lift, or trickle at 30 feet of lift, this 1.1-pound pump has 13 feet of cable with battery clips, 1/2" barbed connections, and is 1.5" diameter. Draws 7 amps @ 12 volt maximum. Do not run dry or expect a long life. Intermittent use only. Great Britain.

Delivers a maximum of 7 gpm at zero lift, or a trickle at 30 feet of lift. Has 13' of cable with battery clips, 1/2" barbed connections, and is 1.6" diameter. Draws 8 amps @ 12 volt maximum. Do not run dry or expect a long life. Intermittent use only. Great Britain.

- 41950 Amazon 12-volt Pump \$87**
- 41963 Amazon 24-volt Pump \$87**

## Congo Submersible



Delivers a maximum of 7 gpm at zero lift, or a trickle at 30 feet of lift. Has 13' of cable with battery clips, 1/2" barbed connections, and is 1.6" diameter. Draws 8 amps @ 12 volt maximum. Do not run dry or expect a long life. Intermittent use only. Great Britain.

- 41956 Congo 12-volt Pump \$120**

## SHURflo Solar Submersible Pump

This small, efficient, submersible, diaphragm pump has been the standard for residential solar water pumping for over 10 years. For homesteads without large garden or orchard water needs, this is probably all the pump you need. The SHURflo Sub will deliver up to 230 feet of vertical lift and is ideal for deep well or freeze-prone applications. Remember, you're only lifting from the water surface, not from the pump. In a PV-direct application, it will yield from 300 to 1,000 gallons per day, depending on lift requirements and power supplied. Solar submersible pumps are best used for slow, steady water production into a holding tank, but may be used for direct pressurization applications as well. (See suggestions on this subject beginning on page 282.) Flow

### SHURFLO SUBMERSIBLE PUMP PERFORMANCE CHART AT 24 VOLTS

Total Vertical Lift	Gallons Per Hour	Minimum PV Watts	Amps
20	117	58	1.5
40	114	65	1.7
60	109	78	2.1
80	106	89	2.4
100	103	99	2.6
120	101	104	2.8
140	99	115	3.1
180	93	135	3.6
200	91	141	3.8
230	82	155	4.1

rates range from .5 to 1.9 gpm depending on lift and power supplied. The pump can be powered from either 12- or 24-volt sources. Output is best with 24-volt panel-direct. Because it's a diaphragm-type, this pump is untroubled by running dry, so long as it doesn't last for more than two or three months. Yes, months! So this is a great choice for low-yielding wells. The best feature of this pump, other than proven reliability, is easy field serviceability. No special tools are needed. Experience has shown that the diaphragm needs replacement every four to five years, the motor has about a ten- to eleven-year life expectancy. Repair parts sold below.

The pump is 3.75 inches in diameter (will fit standard 4-inch well casings), weighs 6 pounds, uses 1/2-inch poly delivery pipe, making easy one-person installation possible. Maximum pump submersion is 100 feet. Requires flat-jacketed style of submersible cable for the watertight splice kit. Not always available locally, we offer it below. One-year warranty. USA.

- In addition to the pump you will also need:
- PV modules and mounting appropriate for your lift (see chart)
  - A controller for PV-direct systems (PV direct controller #25002 on page 310)
  - 1/2-inch poly drop pipe or equivalent
  - 10-gauge submersible pump cable (3-wire cable okay if flat style)
  - Poly safety rope
  - Sanitary well seal

Drop pipe, submersible cable, rope, and seal are all commonly available at most plumbing supplies. Watertight splice kit for flat cable is included.

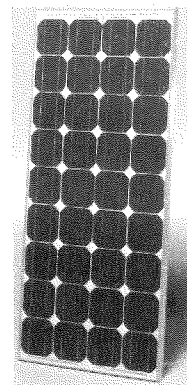
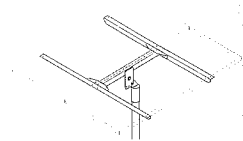
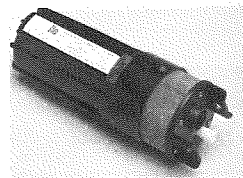
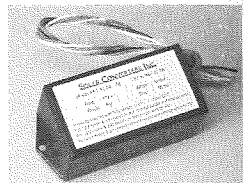
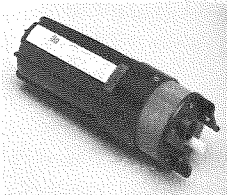
(12-volt performance will be approximately 40% of figures listed in performance chart.)

- 41455 SHURflo Solar Submersible \$695**
- 26540 10-2 Jacketed Sub Pump Cable \$1.00/ft. (specify length)**

## A Complete Solar Sub-Pump Kit

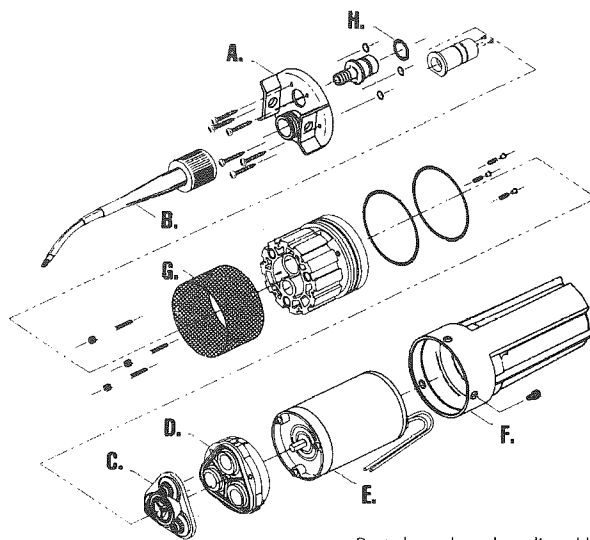
Our Sub-Pump Kit features the popular and durable Shurflo submersible pump. We've put it together with a pair of 80-watt modules for maximum output up to its maximum lift of 230 feet, a pole-top mount for ease of installation, and a current booster controller for good performance with marginal sun. Cost of components purchased separately is \$1,725. Add the float switch for automatic shut-off when your tank fills. Add the special flat-jacketed sub pump cable as needed, if this type of sub pump cable is not available locally for you. Our pole-top mount requires nominal 2.5" Schedule 40 steel pipe, provided locally to save shipping. 10 feet is usually good, with 3 feet buried. You will also be providing wiring as needed, poly safety rope, 1/2" poly drop pipe, sanitary well seal, and hole in the ground (hopefully with water at the bottom). All components made in USA except controller made in Canada.

- 41128 Shurflo Sub-Pump Kit \$1,695**
- 41638 Float Switch "D" \$35**
- 26540 10-2 Jacketed Sub Pump Cable \$1.00/ft. (specify length)**



## SHURflo Solar Sub Service Parts

The drive and diaphragm on this hard-working little pump should be replaced at four to five year intervals. Do it *before* the diaphragm starts leaking, and you'll save yourself a \$225 motor. If the lower canister (and motor) is full of water on disassembly, replace the motor. The carbon brushes soak up the water and soften. They'll only last a few days after you put it back in the well. Very frustrating doing repairs twice isn't it? O-rings should be replaced any-time you open the pump. We try very hard to keep all the common bits in stock for rush delivery. USA



Parts keyed to chart listed below.

### REPLACEMENT PARTS KIT LIST FOR SHURFLO SOLAR SUB PUMP

Complete Tool Kit	Lift Plate Kit A	Cable Plug Kit B	Valve Kit C	Drive & Diaphragm Kit D	Motor E	Canister F	Filter Screen G	Complete O-Ring Kit H
41-340	41-341	41-342	41-343	41-344	41-345	not available	41-437	41-348
\$20	\$80	\$125	\$40	\$100	\$225		\$30	\$25

## ETApump Mini Submersible

### No-maintenance solar pumping

The helical-rotor ETApumps have proven themselves to be highly efficient, incredibly long-lasting, and almost completely maintenance-free. Now there's a smaller version of this terrific solar- or battery- powered pump for residential customers with less demanding water needs. ETApump Mini features a helical-rotor-type pump with

a life expectancy equal to the best conventional AC sub pumps (15–20 years+). It has no brushes, cams, flapper valves, or plastic parts to wear out. All electronics are in the controller, at the surface, which has display lights for: system on, pump on, tank full, low water, overload, and for battery models, low battery. It runs 24-volt PV direct, or 24-volt battery-based using different models. Additionally there is a low-lift/high-volume model with lift to 65 feet, or a higher-lift/lower-volume model with lift to 165 feet, for a total of four models. Pumps can be installed in 4" or larger wells, tanks, streams, or ponds in any position, and at any submersion depth. A dry run switch with automatic 20-minute reset is included, and must be connected if there's a chance of running dry. The PV-direct model has an RPM limit adjustment for low-yielding wells.

ETApump Mini includes: 3.8" diameter pump, pump controller, low-water probe, and submersible splice kit. 1" NPT outlet. Requires 3-wire plus ground sub pump cable. Low-water probe requires additional 2-16ga. wires. Controller accepts optional reverse-logic float switch (closed contact shuts

pump OFF). German-engineered, Chinese-manufactured, USA-assembled. Two-year manufacturer's warranty.

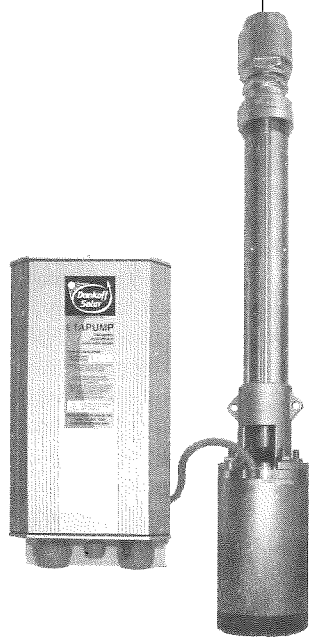
<b>40-0068 ETApump Mini 04L-PV</b>	<b>\$1,510</b>
<b>40-0069 ETApump Mini 14L-PV</b>	<b>\$1,510</b>
<b>40-0070 ETApump Mini 04L-BAT</b>	<b>\$1,375</b>
<b>40-0071 ETApump Mini 04L-BAT</b>	<b>\$1,375</b>

### ETAPUMP MINI 24V PV-DIRECT

Vertical Lift	Model 04L-PV		Model 14L-PV	
	Peak GPM	Min. PV Watts	Peak GPM	Min. PV Watts
16	1.9	60	5.8	100
33	1.7	70	5.3	120
50	1.6	80	4.8	150
65	1.5	90	4.4	200
100	1.5	100	N/A	N/A
130	1.3	120	N/A	N/A
165	1.3	120	N/A	N/A

### ETAPUMP MINI 24V BATTERY SYSTEM

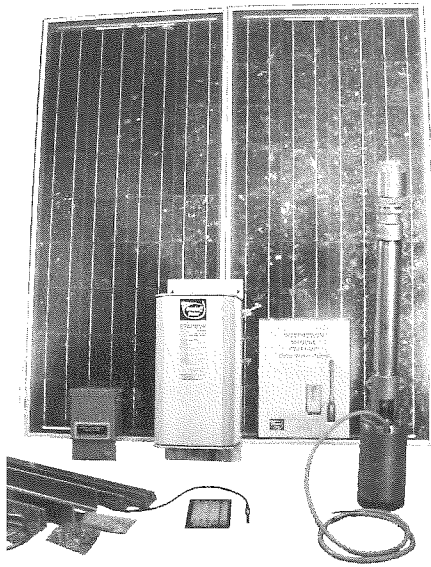
Vertical Lift	Model 04L-BAT		Model 14L-BAT	
	Peak GPM	Watts	Peak GPM	Watts
16	1.5	24	4.6	38
33	1.4	29	4.4	55
50	1.3	34	4.0	74
65	1.2	38	3.7	91
100	1.2	48	N/A	N/A
130	1.1	58	N/A	N/A
165	0.9	65	N/A	N/A





## SUBMERSIBLE ETAPUMP SYSTEMS

Complete packages with pump, controls, PV, and mounts



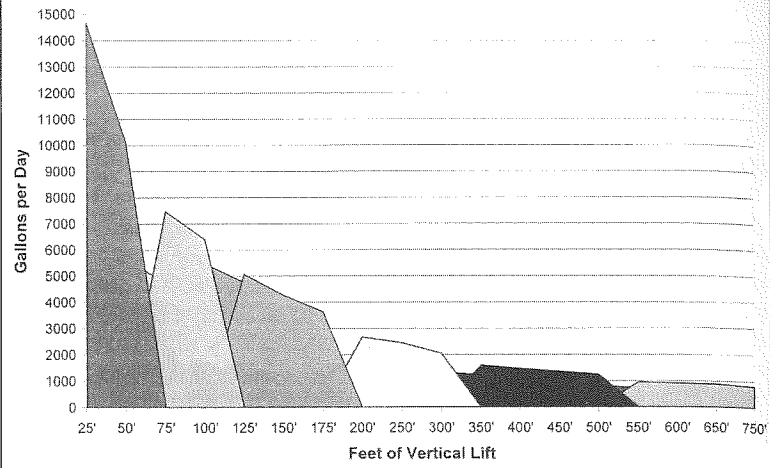
The ETApump is one of a new generation of "helical-rotor" pump types. Based on the ancient Archimedes screw, but now using a hardened stainless steel rotor in a durable flexible rubber sleeve, helical-rotor pumps feature life expectancies as long as the best traditional sub pumps (15-20 years+), with the best submersible pump efficiency we've seen from any pump type yet. Higher efficiency means more water for less PV dollars. ETApumps have all the electronic control parts above ground, and a brushless motor. No diaphragms or brushes to replace! This is probably the most trouble- and maintenance-free solar pumping system available.

ETApumps are sold as a complete system that includes pump, controller, solar modules, pole-top mounting rack, disconnect switch, submersible splice kit, low-water sensor, and a detailed, illustrated instruction manual. On site, you will supply a functioning well with 4" or larger casing, submersible pump cable (3-wire plus ground), drop pipe (1" or 1 1/4" depending on pump model), 1/4" poly or nylon safety rope, schedule 40 steel pipe for the pole-top mount, and small hardware and electrical parts as needed for your particular installation. The low-water sensor will shut off the pump to prevent dry run damage. Restart is automatic when water level recovers. Controllers are weatherproof, and will accept a float switch or other external on/off control with reverse logic. A closed float switch will turn off the pump.

ETApump models are also available for battery-based operation at 24 or 48 volts. These packages include a pump and the special battery-based controller only.

An AC Power Pack option is available for the ETApumps that will automatically use any solar energy available, then supplement it as needed with enough additional AC power to run the pump any time of day or night. Either a generator or utility power can be used. Can be set up to accept either 240 or 120vac input. PV input must be 48v nominal.

ETApump GPD range @ 6.0 hrs Sun



ETApump systems are sized for the lift and volume of water you need. There are *many* models, the performance chart printed above is only a partial listing. You must call or email our staff to size and price a system. ETApumps will lift up to 750 feet, and can deliver as much as 15,000 gallons per day (at 25' lift). Complete system prices run from \$3,700 to \$8,775, battery-based systems are \$1,765 to \$1,870. More lift and/or more volume costs more. ETApump delivery estimates are delightfully conservative and honest, they carry an excellent, industry-leading four-year warranty on the pump and controller when purchased as a complete system. German engineered, Chinese manufactured.

**Complete ETApump PV-Powered Systems** **\$3,700 – \$8,775**

**ETApump Battery-Powered Systems** **\$1,765 – \$1,870**

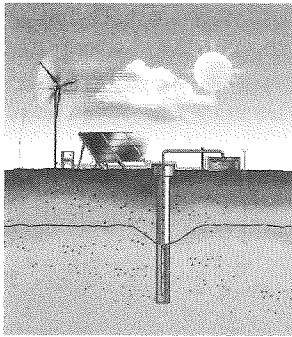
**48-0016 ETApump AC Power Pak** **\$755**

*Please call for details & sizing assistance.*

# GRUNDFOS SQ FLEX SUBMERSIBLE PUMPS

**High efficiency and adaptable to any power input**

Featuring an incredible power adaptability, the submersible SQ Flex series comes from one of the most-experienced, highest-quality, and largest pump manufacturers in the world. It features a single motor that can be fitted with seven different pump heads, depending on your pumping requirements. The SQ Flex will happily accept any DC voltage from 30 to 300 volts, or any AC

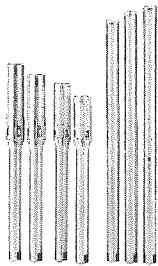


voltage from 90 to 260 volts, 50 or 60hz, just flip a switch on the optional AC/DC control box to go back and forth. This makes the SQ Flex pump extremely easy to back up with a generator or utility power. When running on DC, the SQ Flex features electronic

Maximum Power Point tracking to wring the best possible performance from your solar array. A low-water sensor is included and pre-wired to the pump input cable. Low-water shut-off and restart are automatic.

With a maximum of 900 watts input, the SQ Flex motor offers performance equivalent to a conventional 3/4- to 1- horsepower AC pump.

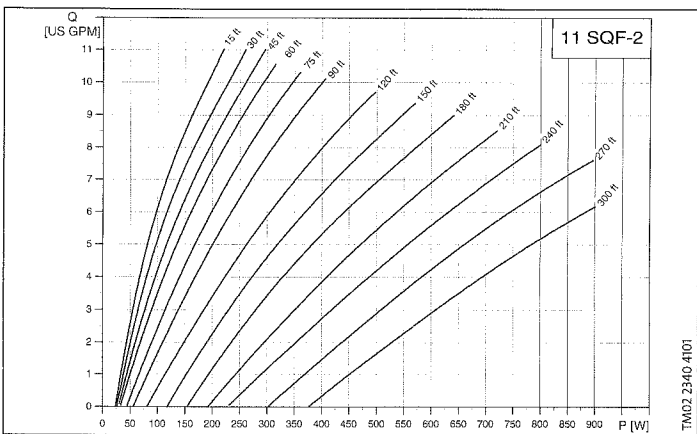
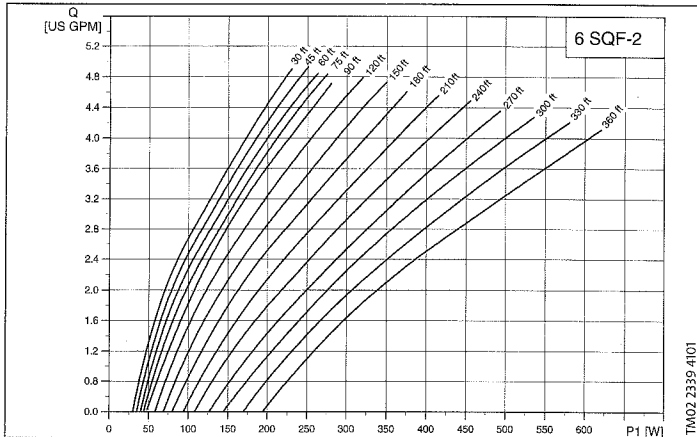
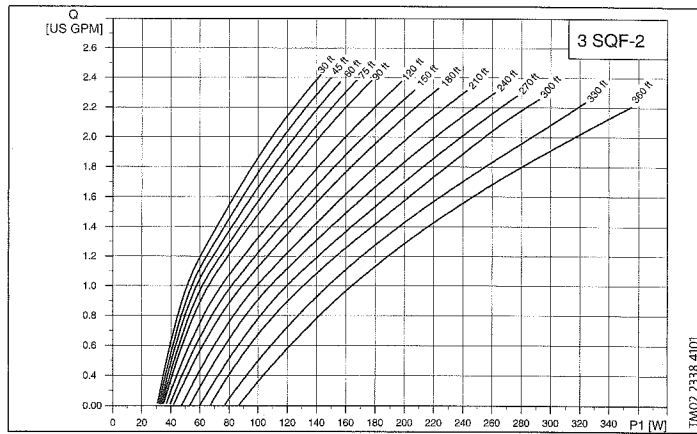
But this motor can be coupled to helical rotor pumps with efficiencies that conventional AC pumps can't even dream about. The three smaller pump heads are the new positive-displacement helical-rotor types. This is the newest pump type in the solar industry. They feature much greater efficiency than any other pump type, and don't wear out or require any routine maintenance. Water delivery ranges from over 24,000 gallons per day at a minimal 20 foot lift, to 1,000 gallons per day at the maximum lift of 525 feet. The four higher-volume pump heads are conventional centrifugal types.



An optional control box is required for switchable AC/DC operation, or for remote float level sensing. The nicely featured float control also features an LCD display of wattage consumption, operation indicator lights, on/off switch, and fault codes display.

Complete systems include pump, controller box(es), solar array, array wiring, and mounting structure. Complete system prices range from \$3,100 to \$10,900. Custom systems using 48-volt batteries, generators, or other power sources can be configured. One-year manufacturer's warranty. Made in Denmark and USA.

*Because of the wide variety of lifts, volumes, and power sources, you need to call or email our tech staff to size and price a Grundfos SQ Flex pumping system.*



Output charts for the three helical-rotor pumps.

- 41980 Grundfos 3 SQF-2 Helical Rotor Pump \$1,385**
- 41981 Grundfos 6 SQF-2 Helical Rotor Pump \$1,385**
- 41982 Grundfos 11 SQF-2 Helical Rotor Pump \$1,385**
- 41983 Grundfos 25 SQF-3 Centrifugal Pump \$1,385**
- 41984 Grundfos 25 SQF-6 Centrifugal Pump \$1,385**
- 41985 Grundfos 40 SQF-3 Centrifugal Pump \$1,385**
- 41986 Grundfos 75 SQF-3 Centrifugal Pump \$1,385**
- 25815 Grundfos IO100 std. on/off Control \$140**
- 25816 Grundfos IO101 AC/DC sw. Control \$369**
- 25817 Grundfos CU200 Float/Monitor Control \$299**

## SUBMERSIBLE PUMP OPTIONS

### The Universal Solar Pump Controllers

*Run ordinary AC pumps directly from PV power*

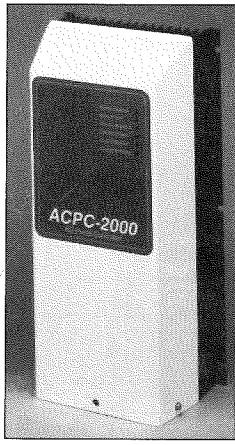
From the same incredibly innovative company that produced GM's EV1 electric vehicle, and the human-powered plane that crossed the English Channel, comes an inverter/controller that will run any standard single- or three-phase AC submersible pump directly from PV power. The advanced USPC maintains a constant volts/Hz ratio that allows standard AC pumps to run at lower speeds without distress. This allows easy soft starts, and the efficient use of lower-than-peak PV outputs with off-the-shelf pumps. Minimum speed is owner-selectable to avoid no-flow conditions. The USPC's power electronics are 97% efficient, and will provide automatic shutdown in case of dry running, motor lock, or wiring problems. The USPC can drive any standard 50- or 60-Hz three-wire single-phase pump or three-phase induction motor that has a rated input voltage of 120, 208, or 230VAC. The model 2000 will run any 0.5 to 2.0 horsepower pump. The model 5000 is for pumps up to 5.0 horsepower, and a 10-horsepower model is available by special order. The enclosure is rugged outdoor-rated NEMA 3 steel. USPC complete systems, with PV array, controller, and pump run \$5,000 to \$50,000. Two-year manufacturer's warranty. UL certified. USA.

*Please call our tech staff for help with PV sizing, which will be unique for your installation.*

<b>41913</b>	<b>USPC-2000 Pump Controller</b>	<b>\$2,320</b>
<b>41923</b>	<b>USPC-5000 Pump Controller</b>	<b>\$4,300</b>

### PV-Direct Pump Controllers

These current boosters from Solar Converters will start your pump earlier in the morning, keep it going longer in the afternoon, and give you pumping under lower light conditions when the pump would otherwise stall. Features include: Maximum Power Point Tracking, to pull the maximum wattage from your modules; a switchable 12- or 24-volt design in a single package; a float or remote switch input; a user-replaceable ATC-type fuse for protection; and a weatherproof box. Like all pump controllers, a closed float switch will turn



the pump off, an open float switch turns the pump on.

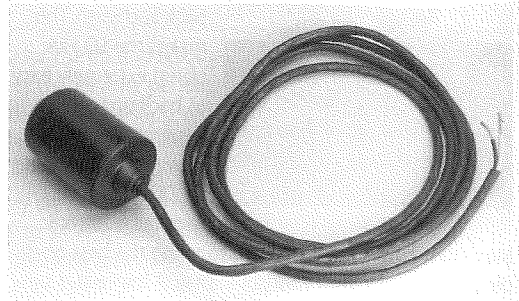
Four amperage sizes are available in switchable 12/24 volt. Input and output voltages are selected by simply connecting or not connecting a pair of wires. Amperage ratings are surge power. Don't exceed 70% of amp rating under normal operation. The 7-amp model is the right choice for most pumping systems, and is the controller included in our submersible and surface pumping kits. 7- and 10-amp models are in a 4.5" L x

2.25" W x 2" D plastic box. 15-amp model is a 5.5" L x 2.9" W x 2.9" D metal box. 30-amp model is supplied in a NEMA 3R raintight 10" x 8" x 4" metal box. One-year manufacturer's warranty. Canada.

<b>25002</b>	<b>7A, 12/24V Pump Controller</b>	<b>\$106</b>
<b>25003</b>	<b>10A, 12/24V Pump Controller</b>	<b>\$135</b>
<b>25004</b>	<b>15A, 12/24V Pump Controller</b>	<b>\$220</b>
<b>25005</b>	<b>30A, 12/24V Pump Controller</b>	<b>\$395</b>

### Float Switches

These fully encapsulated mechanical (no mercury!) float switches make life a little easier by providing automatic control of fluid level in the tank. You regulate the water level by merely lengthening or shortening the power cable and securing it with a band clamp or zip tie. Easily



installed, the switches are rated at 15 amps at 12 volts, or 13 amps at 120 volts. The "U" model will fill a tank (closed circuit when float is down, open circuit when up) and the "D" model will drain it (closed circuit when up, open circuit when down). When used with a PV-direct pump controller, the "U" and "D" functions are reversed: "D" will fill and "U" will empty.

Not sure if you want an "up" or "down" float switch? Confused by reverse-logic controllers? The Goof-Proof float switch is your salvation. This three-wire float switch can be connected either way. There's a common wire, an "up" wire, and a "down" wire. If it doesn't work right, just switch wires. 5-amp maximum current. Safe for domestic water. Two-year manufacturer's warranty. USA.

<b>41637</b>	<b>Float Switch "U"</b>	<b>\$35</b>
<b>41638</b>	<b>Float Switch "D"</b>	<b>\$35</b>
<b>41036</b>	<b>Goof-Proof Float Switch</b>	<b>\$59</b>

### Flat Two-Wire Sub Pump Cable

This flat, two-conductor, 10-gauge submersible cable is sometimes difficult to find locally. Works with the SHURflo Solar Sub splice kit. Cut to length; specify how many feet you need.

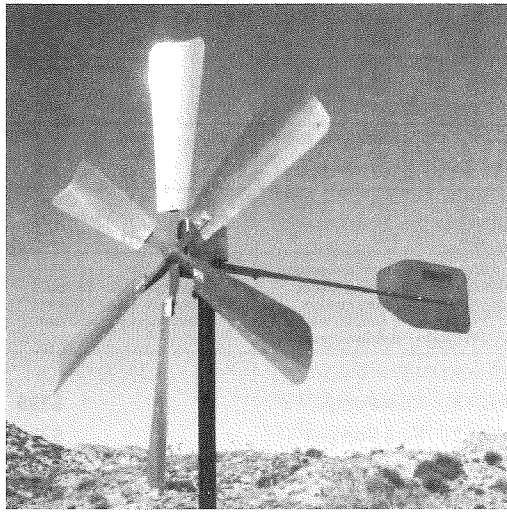
<b>26-540</b>	<b>10-2 Sub Pump Cable</b>	<b>\$1.00/ft.</b>
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# WIND-POWERED PUMPS

## Airlift Wind-Powered Water Pumps

### Water pumping for windy sites

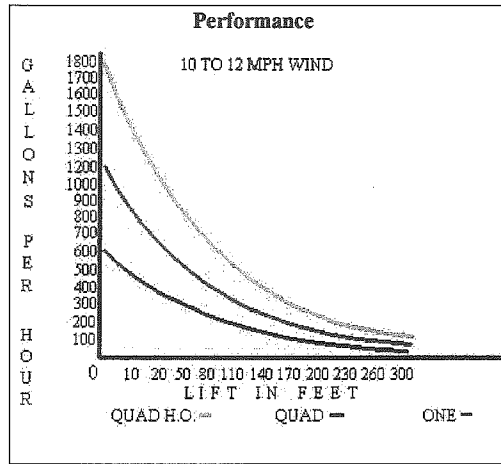
Airlift pumps use compressed air to lift water into a storage tank. Compressed air is delivered by a two- or four-cylinder air compressor driven by a wind turbine with tempered aluminum blades of 9- or 10-foot diameter, depending on the model. The variable pitch blades provide high-torque startup with winds of 4 to 6 mph, and reach optimum performance at 10 to 15 mph. In high wind conditions the turbine will automatically turn out of the wind, then return as wind speed decreases. Yearly maintenance is a simple oil change and intake filter cleaning. The turbine mounts on a 2.5" steel pipe



tower. The wind turbine can be hundreds of feet from the well. Air is routed to an air injection chamber submerged in the well. Air bubbles lift the water. Lifts up to 300 feet and 1 to 30 gpm are possible from well casings as small as 2". An air injection chamber and 200 feet of air line are included with each pump. There are no moving or wearing parts in the well. Pumped water can be moved up to 500 feet horizontally, but the delivery line must slope upwards at least slightly.

Airlift 1 will lift up to 300 feet maximum, and can deliver up to 10 gpm maximum. The Quad model is limited to 315 feet of lift, and can deliver up to 20 gpm. The Quad H.O. also lifts to 315 feet, but can deliver up to 30 gpm.

Submergence—how far the injection chamber is below water level—is critical for these simple pumps. Too little submergence and the air bubbles will separate from the water, too much submergence and the pump won't lift water. Lift is the vertical distance from the static water level to the storage tank. For lifts up to 150 feet, 70% submergence is recommended. So a 100-foot lift needs 70 feet of submergence. For lifts from 150 to 300 feet, 50% submergence is recommended.



For those lacking sufficient submergence depth, or needing to move long horizontal distances, a positive pump option is offered that will run with only 5 feet of submergence. The positive pump option will deliver approximately 20% less water than air injection. These air-powered pumps require a 10- to 20-gallon air pressure tank teed into the air line so the pump can always complete its cycle and stop in the "start-up" position. Positive pumps can lift up to 300 feet.

A 22-foot folding pipe tower kit is available, and highly recommended for ease of routine maintenance, or you can build your own. Tower is not included with pump. USA.

<b>41713</b>	<b>Airlift 1</b>	<b>\$2,495</b>
<b>41714</b>	<b>Airlift Quad</b>	<b>\$3,295</b>
<b>43-0175</b>	<b>Airlift Quad H.O.</b>	<b>\$3,895</b>
<b>42-0245</b>	<b>Airlift 22' Hinged Tower Kit</b>	<b>\$1,295</b>
<b>41-715</b>	<b>Airlift Positive Pump 3.5" x 67"</b>	<b>\$450</b>
<b>41-716</b>	<b>Airlift Positive Pump 4.5" x 48"</b>	<b>\$430</b>
<b>41-717</b>	<b>Airlift Positive Pump 6.0" x 24"</b>	<b>\$465</b>

# WATER-POWERED PUMPS

## Ram Pumps

The ram pump works on a hydraulic principle using the liquid itself as a power source. The only moving parts are two valves. In operation, the water flows from a source down a "drive" pipe to the ram. Once each cycle, a valve slaps shut, causing the water in the drive pipe to stop suddenly. This causes a water-hammer effect and high pressure in a one-way valve leading to the "delivery" pipe of the ram, thus forcing a small amount of water up the pipe and into a holding tank. Rams will only pump into unpressurized storage. In essence, the ram uses the energy of a large amount of water falling a short distance to lift a small amount of water a large distance. The ram itself is a highly efficient device; however, only 2 to 10% of the liquid is recoverable. Ram pumps will work on as little as 2 gpm supply flow. The maximum head or vertical lift of a ram is about 500 feet.

### SELECTING A RAM

**Estimate amount of water available to operate the ram.** This can be determined by the rate the source will fill a container. Make sure you've got more than enough water to satisfy the pump. If a ram runs short of water, it will stop pumping and simply dump all incoming water.

**Estimate amount of fall available.** The fall is the vertical distance between the surface of the water source and the selected ram site. Be sure the ram site has suitable drainage for the tailing water. Rams splash big-time when operating! Often a small stream can be dammed to provide the 1½ feet or more head required to operate the ram.

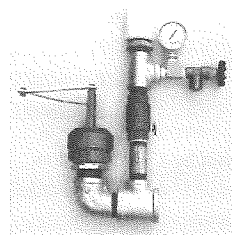
**Estimate amount of lift required.** This is the vertical distance between the ram and the water storage tank or use point. The storage tank can be located on a hill or stand above the use point to provide pressurized water. Forty or fifty feet water head will provide sufficient pressure for household or garden use.

**Estimate amount of water required at the storage tank.** This is the water needed for your use in gallons per day. As examples, a normal two- to three-person household uses 100 to 300 gallons per day, much less with conservation. A 20- by 100-foot garden uses about 50 gallons per day. When supplying potable water, purity of the source must be considered.

Using these estimates, the ram can be selected from the following performance charts. The ram installation will also require pouring a small concrete pad, a drive pipe five to ten times as long as the vertical fall, an inlet strainer, and a delivery pipe to the storage tank or use point. These can be obtained from your local hardware or plumbing supply store. Further questions regarding suitability and selection of a ram for your application will be promptly answered by our technical staff.

## Aqua Environment Rams

We've sold these fine rams by Aqua Environment for over 15 years now with virtually no problems. Careful attention to design has resulted in extremely reliable rams with the best efficiencies and lift-to-fall ratio available. Working component construction is of all bronze with O-ring seal valves. Air chamber is PVC pipe. The outlet gauge and valve permit easy startup. Each unit comes with complete installation and operating instructions.



### Typical Performance and Specifications

Vertical Fall (feet)	Vertical Lift (feet)	Pump Rate (Gallons/Day)			
		¾" Ram	1" Ram	1¼" Ram	1½" Ram
20	50	650	1350	2250	3200
20	100	325	670	1120	1600
20	200	150	320	530	750
10	50	300	650	1100	1600
10	100	150	320	530	750
10	150	100	220	340	460
5	30	200	430	690	960
5	50	100	220	340	460
5	100	40	90	150	210
1.5	30	40	80	130	190
1.5	50	20	40	70	100
1.5	100	6	12	18	25

### Water Required to Operate Ram

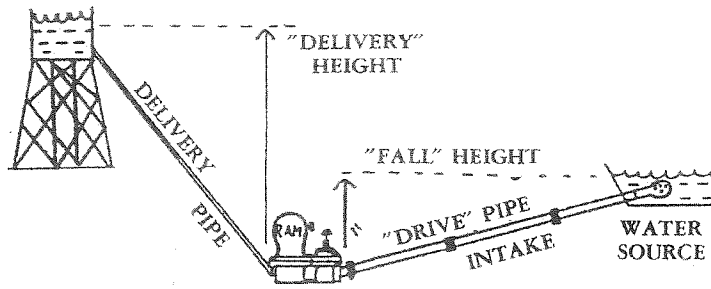
¾" Ram - 2 gallons/minute	Maximum Fall - 25 feet
1" Ram - 4 gallons/minute	Minimum Fall - 1.5 feet
1¼" Ram - 6 gallons/minute	Maximum Lift - 250 feet
1½" Ram - 8 gallons/minute	

- 41811 Ram Pump, ¾"** **\$339**
- 41812 Ram Pump, 1"** **\$339**
- 41813 Ram Pump, 1¼"** **\$415**
- 41814 Ram Pump, 1½"** **\$415**

## Folk Ram Pumps

The Folk is the most durable and most efficient ram pump available. It is solidly built of rustproof cast aluminum alloy and uses all stainless steel hardware. With minimal care, it probably will outlast your grandchildren. It is more efficient because it uses a diaphragm in the air chamber, preventing loss of air charge, and eliminating the need for a snifter valve in the intake that cuts efficiency.





### FOLK RAM PUMP CAPACITY

Folk Model Drive Pipe Size	Capacity In GPM Min.-Max.	Delivery Pipe
1"	2-4	1"
1 1/4"	2-7	1"
1 1/2"	3-15	1"
2"	6-30	1 1/4"
2 1/2"	8-45	1 1/4"
3"	15-75	1 1/4"

Folk rams require a minimum of 2 gpm and 3 feet of drive pipe fall to operate. The largest units can accept up to 75 gpm, and a maximum of 50 feet of drive pipe fall. Delivery height can be up to fifteen times the drive fall, or a maximum of 500 feet lift. The drive pipe should be galvanized Schedule 40 steel, and the same size the entire length. Recommended drive pipe length is 24 feet for 3 feet of fall, with an additional 3 feet length for each additional 1 foot of fall. Be absolutely sure you have enough water to meet the minimum gpm requirements of the ram you choose. Rams will stop pumping and simply dump water if you can't supply the minimum gpm.

To estimate delivery volume, multiply fall in feet times supply in gpm, divide by delivery height in feet, then multiply by 0.61. Example: a ram with 5 gpm supply, a 20-foot drive pipe fall, and delivering to a tank 50 feet higher.  $20\text{ft} \times 5\text{gpm} \div 50\text{ft} \times 0.61 = 2.0\text{gpm} \times 0.61 = 1.22\text{gpm}$ , or 1,757 gallons per day delivery.

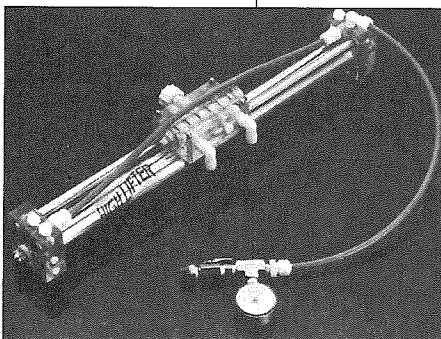
Warranted by manufacturer for one year. USA. All Folk rams are drop-shipped via UPS from the manufacturer in Georgia.

41815	Folk 1" Ram Pump	\$1,070
41816	Folk 1 1/4" Ram Pump	\$1,070
41817	Folk 1 1/2" Ram Pump	\$1,070
41818	Folk 2" Ram Pump	\$1,330
41819	Folk 2 1/2" Ram Pump	\$1,330
41820	Folk 3" Ram Pump	\$1,330

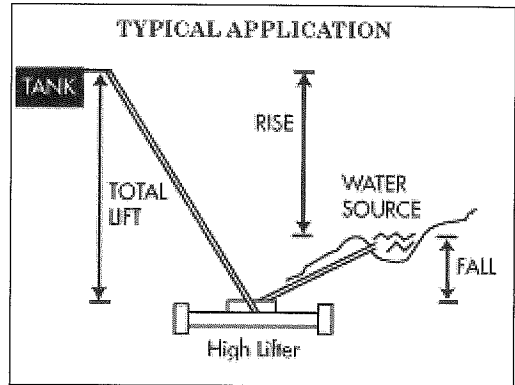
### High Lifter Pressure Intensifier Pump

The High Lifter Water Pump offers unique advantages for the rural user. Developed expressly for mountainous

terrain and low summertime water flows, this water-powered pump delivers a much greater percentage of the input water than ram pumps can. This pump is available in either 4.5:1 or 9:1 ratios of lift to fall. The High Lifter is self-starting and self-regulating. If inlet water flow slows or stops, but will self-start when flow starts again.



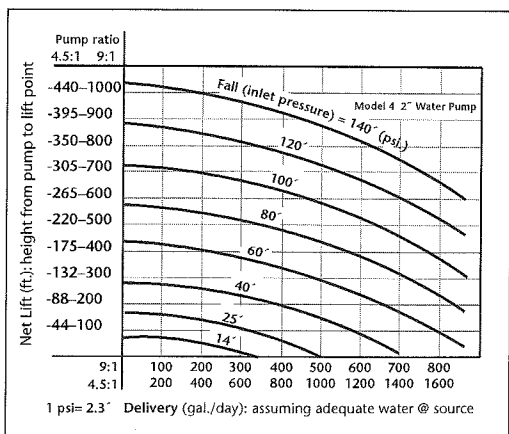
The High Lifter pump has many advantages over a ram (the only other water-powered pump). Instead of using a "water hammer" effect to lift water as a ram does, the High Lifter is a positive-displacement pump that uses pistons to create a hydraulic lever that converts a larger volume of low-pressure water into a smaller volume of high-pressure water. This means that the pump can operate over a broad range of flows and pressures with great mechanical efficiency. This efficiency means more recovered water. While water recov-



ery with a ram is normally about 5% or less, the High Lifter recovers 1 part in 4.5 or 1 part in 9 depending on ratio. In addition, unlike the ram pump, no "start-up tuning" or special drive lines are necessary. This pump is quiet, and will happily run unattended.

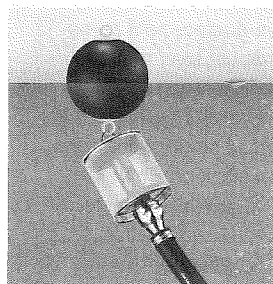
The High Lifter pressure intensifier pump is economical compared to gas and electric pumps, because no fuel is used and no extensive water source development is necessary. A kit to change the working ratio of either pump after purchase is available, as are maintenance kits. Maintenance consists of simply replacing a handful of O-rings. The cleaner your input water, the longer the O-rings last. Choose your model High Lifter pump from the specifications and High Lifter performance curves. One year parts and labor warranty from manufacturer. USA.

41801	High Lifter Pump, 4.5:1 Ratio	\$895
41802	High Lifter Pump, 9:1 Ratio	\$895
41803	High Lifter Ratio Conversion Kit	\$97
41804	High Lifter Rebuild Kit, 4.5:1 ratio	\$65
41805	High Lifter Rebuild Kit, 9:1 ratio	\$65



## Pump Accessories

### Floating Suction Filters



Get water from the cleanest point in your storage system—just below the water surface. Improves the quality of your rainwater and protects pumps from drawing up sediment without a need for pre-filtering. The floating ball lets the suction point rise and fall as well as preventing the filter from sinking to the bottom. Includes a float, fine filter housing with a non-return valve, and 1" barbed connection. Germany.

**42908 Float Suction Filter \$149**

### Inline Sediment Filter

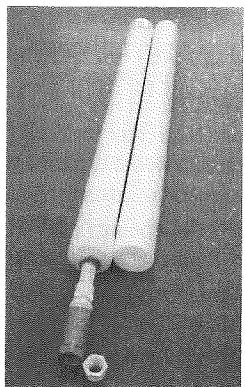


This filter is designed for cold water only, and meets NSF standards for drinking water supplies. It features a sump head of fatigue-resistant Celcon plastic, an opaque body to inhibit algae growth if installed outdoors, and is equipped with a manually operated pressure-release button to simplify cartridge replacement. Rated for up to 125 psi and 100°F, it is equipped with 3/4-inch female pipe-thread inlet and outlet fittings, and is rated for up to 6 gpm flow rates (with clean cartridge). It accepts a standard 10-inch cartridge with 1-inch center holes. Supplied with one 10-micron fiber cartridge installed. USA.

**41137 Inline Sediment Filter \$49**

**42632 10 Micron Sediment Cartridge, 2 pack \$13**

### 30" Intake Filter with Foot Valve



A great choice for any Slowpump with a surface water source. This large triple-size 10-micron filter with no external cover can be lowered into wells, or floated on a pond. Large surface area means less-frequent replacements. Equipped with a foot valve so you won't lose your pump prime. Included bushing allows 1/2 or 3/4" pipe-thread outlet. Comes with assembled filter and first replacement cartridge as pictured. USA.

**40-0086 30" Intake Filter/Foot Valve \$70**

**40-0087 30" Filter Repl. 3-Pack \$44**

## Nominal Pipe Size vs. Actual Outside Diameter for Steel and Plastic Pipe

Nominal Size	Actual Size
1/2"	0.840"
3/4"	1.050"
1"	1.315"
1 1/4"	1.660"
1 1/2"	1.900"
2"	2.375"
2 1/2"	2.875"
3"	3.500"
3 1/2"	4.000"
4"	4.500"
5"	5.563"
6"	6.625"

# Friction Loss Charts for Water Pumping

## HOW TO USE PLUMBING FRICTION CHARTS

If you try to push too much water through too small a pipe, you're going to get pipe friction. Don't worry, your pipes won't catch fire. But it will make your pump work harder than it needs to, and it will reduce your available pressure at the outlets, so sprinklers and showers won't work very well. These charts can tell you if friction is going to be a problem. Here's how to use them:

PVC or black poly pipe? The rates vary, so first be sure you're looking at the chart for your type of supply pipe. Next, figure out how many gallons per minute you might need to move. For a normal house, 10 to 15 gpm is probably plenty. But gardens and hoses really add up. Give your-

self about 5 gpm for each sprinkler or hose that might be running. Find your total (or something close to it) in the Flow GPM column. Read across to the column for your pipe diameter. This is how much pressure loss you'll suffer for every 100 feet of pipe. Smaller numbers are better.

Example: You need to pump or move 20 gpm through 500 feet of PVC between your storage tank and your house. Reading across, 1" pipe is obviously a problem. How about 1 1/4"? 9.7 psi times 5 (for your 500 feet) = 48.5 psi loss. Well, that won't work! With 1 1/2" pipe, you'd lose 20 psi... still pretty bad. But with 2" pipe you'd only lose 4 psi... ah! Happy garden sprinklers! Generally, you want to keep pressure losses under about 10 psi.

If you try to push too much water through too small a pipe, you're going to get pipe friction. Don't worry, your pipes won't catch fire.

Friction Loss in PSI per 100 Feet of Scheduled 40 PVC Pipe

Flow GPM	Nominal Pipe Diameter in Inches							
	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	3"	4"
1	3.3	0.5	0.1					
2	11.9	1.7	0.4	0.1				
3	25.3	3.5	0.9	0.3	0.1			
4	43.0	6.0	1.5	0.5	0.2	0.1		
5	65.0	9.0	2.2	0.7	0.3	0.1		
10		32.5	8.0	2.7	1.1	0.3		
15		68.9	17.0	5.7	2.4	0.6	0.1	
20			28.9	9.7	4.0	1.0	0.1	
30			61.2	20.6	8.5	2.1	0.3	0.1
40				35.1	14.5	3.6	0.5	0.1
50				53.1	21.8	5.4	0.7	0.2
60				74.4	30.6	7.5	1.0	0.3
70					40.7	10.0	1.4	0.3
80					52.1	12.8	1.8	0.4
90					64.8	16.0	2.2	0.5
100					78.7	19.4	2.7	0.7
150						41.1	5.7	1.4
200						69.9	9.7	2.4
250							14.7	3.6
300							20.6	5.1
400							35.0	8.6

Friction Loss in PSI per 100 Feet of Polyethylene (PE) SDR-Pressure Rated Pipe

Flow GPM	NOMINAL PIPE DIAMETER IN INCHES							
	0.5	0.75	1	1.25	1.5	2	2.5	3
1	0.49	0.12	0.04	0.01				
2	1.76	0.45	0.14	0.04	0.02			
3	3.73	0.95	0.29	0.08	0.04	0.01		
4	6.35	1.62	0.50	0.13	0.06	0.02		
5	9.60	2.44	0.76	0.20	0.09	0.03		
6	13.46	3.43	1.06	0.28	0.13	0.04	0.02	
7	17.91	4.56	1.41	0.37	0.18	0.05	0.02	
8	22.93	5.84	1.80	0.47	0.22	0.07	0.03	
9		7.26	2.24	0.59	0.28	0.08	0.03	
10		8.82	2.73	0.72	0.34	0.10	0.04	0.01
12		12.37	3.82	1.01	0.48	0.14	0.06	0.02
14		16.46	5.08	1.34	0.63	0.19	0.08	0.03
16			6.51	1.71	0.81	0.24	0.10	0.04
18			8.10	2.13	1.01	0.30	0.13	0.04
20			9.84	2.59	1.22	0.36	0.15	0.05
22			11.74	3.09	1.46	0.43	0.18	0.06
24			13.79	3.63	1.72	0.51	0.21	0.07
26			16.00	4.21	1.99	0.59	0.25	0.09
28				4.83	2.28	0.68	0.29	0.10
30				5.49	2.59	0.77	0.32	0.11
35				7.31	3.45	1.02	0.43	0.15
40				9.36	4.42	1.31	0.55	0.19
45				11.64	5.50	1.63	0.69	0.24
50				14.14	6.68	1.98	0.83	0.29
55					7.97	2.36	0.85	0.35
60					9.36	2.78	1.17	0.41
65					10.36	3.22	1.36	0.47
70					12.46	3.69	1.56	0.54
75					14.16	4.20	1.77	0.61
80						4.73	1.99	0.69
85						5.29	2.23	0.77
90						5.88	2.48	0.86
95						6.50	2.74	0.95
100						7.15	3.01	1.05
150						15.15	6.38	2.22
200							10.87	3.78
300								8.01