170 GALLONS A DAY

How to Purify ANY Water – Even Urine – To Store, Drink or Cook With AFTER a Disaster

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170 GALLONS A DAY

Advanced Urban Water Techniques

Water, Water, Everywhere, and Not A Drop To Drink!

One of the biggest problems with survival in an urban area is water. While you can fit your daily caloric needs into a survival bar the size of a Brad Thor novel, you're going to need at least one half gallon per person per day for basic survival and even more for heat, exercise, and stress. You will also need additional water for hygiene and basic cleaning (like dishes)

The biggest problem with water is how big and heavy it is. Since a gallon of water weighs just over 8 pounds (8.3) and takes up just over 1/7th of a cubic foot (.133 cubic feet to be exact or 7.5 gallons per cubic foot), it is impractical for most people in an urban area to store water for an extended survival situation.

In this book, we're going to talk about how you can take care of your long-term water needs in an urban area during a disaster situation, how to collect water, recycle urine, and make the most putrid and polluted water sources drinkable…even if it's full of road runoff, animal waste, and salts.

City water vs. wilderness water

In the wilderness, you can either collect water from streams, lakes, ponds, rivers, and plants or you can harvest it with a still. Once you've got

the water, the main concerns are what's living in

it, like bacteria, viruses, protozoa, larva, worms, etc. Fortunately, these are all relatively easy to get rid of with filters, chemicals, or by boiling.

In most urban areas, it is harder to find water and make it drinkable than in a wilderness area. There are two main reasons for this: 1. Proximity & 2. Polluted water. Sure, most city centers are located near water sources, but is your house? As we just discussed, water is both heavy and bulky. You may not be able to travel extended distances to obtain water because of safety concerns or physical limitations.

Even if you live right next to a water source, it may not be drinkable. Do you really want to drink fertilizer runoff from a beautiful golf course lake? Do you really want to drink the road runoff that runs into canals, urban streams, creeks, and rivers? How about tar, aggregate, & bird poop from your roof runoff?

Don't worry…just because water starts out disgusting doesn't mean it will be by the time you drink it.

Let's look real quick at some of the things that we want to remove from our water in an urban survival situation. They include:

- Bacteria, viruses, protozoa, insect eggs/larva
- Sediment
- Salts
- Oils/gas/Volatile organic compounds
- Pesticides
- Herbicides
- Road runoff
- Industrial runoff
- Heavy metals
- Plastics
- Human and animal waste

Some of these are obviously redundant, but included to get your mind thinking about what all may be in the water you need to make drinkable. As an example, human waste will have bacteria, salts, and more. Industrial runoff will have VOCs and heavy metals.

So how big is this stuff? Well, the small stuff is REALLY small:

Contaminant	**Size**
Human hair (for reference)	50-100 microns
Protozoa	1-15 microns
Bacteria	.2-5 microns
Viruses	As small as .004 microns

In other words, they're TINY. Some contaminants, like salt, chlorine, and many

VOCs are in solution and will go through physical filters, no matter how fine, so you need another method to get rid of them.

There's no perfect **single** solution to remove all of the potential contaminants in urban water. As an example, boiling, portable camping filters, and chemical treatments will work great in most wilderness situations, but none of them will work on water contaminated with salts and few will do anything to pesticides or herbicides. Heck, most camping filters won't even work to purify your water during a trip to Mexico.

So, what can you do to make water polluted with urban contaminants drinkable? We'll start with the easiest situation.

Municipal Water—Low pressure & boil warnings

After hurricanes, the hardest hit municipalities will issue warnings to residents to boil all of their water before drinking it. Why is this? When water pipes break or pumping stations have problems, water pressure drops allowing groundwater and/or sewage to seep into the water supply, bringing e-coli and other contaminants with it. When you see a boil warning, water authorities either know that human waste (e-coli in particular) is in the water system or they have concerns that it might be.

It doesn't take a hurricane for municipalities to issue boil warnings. If you do a news search on Google for "water boil warning", you'll quickly see that at least one gets issued almost every week in the US.

In addition to hurricanes, low pressure/ruptured pipes can happen after inland flooding, tornadoes, earthquakes and many other disasters that may happen but are unlikely. In addition, they can happen if there is a simple problem with a water treatment facility. If you find yourself in a survival situation where your water supply is unreliable or intermittent, get as much water as you possibly can during the times when it is working, regardless of whether it is drinkable or not.

If waterborne bacteria is all that you're concerned about, boiling municipal water is a very simple method of killing it off and getting safe, drinkable water fairly quickly… if you have fuel necessary to boil water. In a survival situation, fuel will likely be a concern, so we'll cover purification alternatives to boiling that are simple, taste great, and don't use fuel in a minute, but first…

How to Drink Your Own Urine…and Like It

One thing that you learn when studying or practicing wilderness survival skills is that you can drink your own urine up to 3 times before the salt concentration gets too high. If you have to do this, you want to toss the first urine of the morning and save/drink the rest.

I've done this and I am not a big fan of it. I'm not going to suggest that you do it, and if you do, I don't suggest telling your friends or neighbors. They'll think you're strange.

I won't do it again unless I'm demonstrating it for a class or in a severe survival situation where I don't have means to make it safer to drink. But I will drink it after I've removed all of the impurities and turned it back into plain old water. And here's how you can do just that with items that you probably have around your house already:

The first step in making your urine drinkable is to get rid of the solids (if you're purifying sewage in addition to urine) and salts by running it through a distiller or a solar still. I mention using a distiller only because it is a good technology to purify water. The process of distilling water is very fuel intensive, and if you don't have a distillation setup and a heat source going for another reason, it is a very inefficient use of fuel in a survival situation.

The reason why distilling is so fuel intensive is that in addition to bringing your water up to boiling temperature, you have to keep applying heat until all of the water has been converted to steam. Converting water to steam takes a LOT of energy. In fact, it takes 6 times more energy/fuel/time to convert a liter of water to steam than it does to heat it from 60 degrees to 212 degrees. And this assumes that you're not losing any heat in the process.

You can reduce the energy required to distill water by using a partial vacuum, but that is beyond the scope of this book.

Solar stills, on the other hand, use NO fuel…they use the sun. They work on the principal of evaporation and condensation and the most relatable example of it is when you find a plastic bag lying your lawn or garden in the morning. If you pick it up early enough, it will have collected condensation and be wet.

Solar stills use the same principal of condensation and can range from VERY simple to VERY complex. One of the simplest designs is from the US Army Survival Manual.

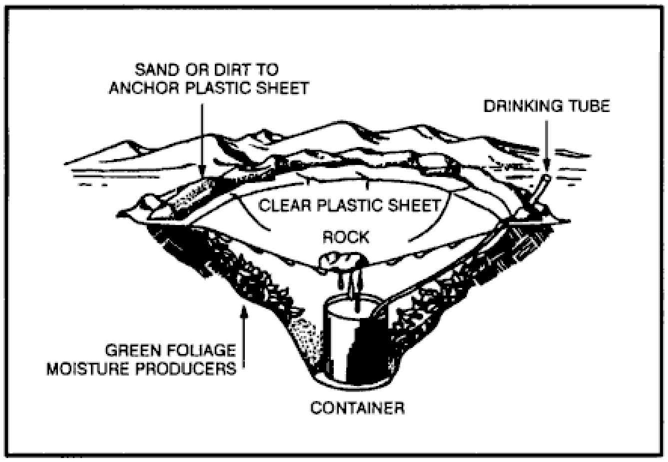


Figure 6-7. Belowground still.

In short, you dig a hole, put a clean container in the middle to collect the water that you're going to drink, put your urine or other questionable water around the clean container, cover the hole with plastic, secure the plastic to the sides of the hole, and put a small rock on the plastic so that the low point is directly over your clean container. The sun's UV rays will go through the plastic and cause the water to evaporate. The evaporated moisture will condense and collect on the plastic and flow to the lowest point (right over your clean container) and drip into your clean container. If you've run a drinking tube from the clean container to the outside of the solar still, you can start drinking or collecting water without taking the still apart.

These stills will work, but they are not very efficient. A still that is 4 feet in diameter and 3 feet deep will produce approximately a quart of water per day in the desert or more if you add liquids to it.

Three tips for improving a basic "pit" solar still:

1. Put non-poisonous leaves, grass and/or branches into the pit around your clean container. This will provide an additional water source and it will wick up moisture from the dirt and give the water more exposed surface area so that it evaporates quicker.

2. Run a second tube into the pit outside of the clean container so that you can add dirty water to your still without taking it apart.

3. If you have particularly nasty water, dig a shallow trench around your pit, close to the edge and pour the nasty water into this trench. As the water

percolates through the soil, many of the contaminants will be removed before reaching the pit. Keep in mind that when you pour the water into the trench, in addition to going into your solar still, some of the water will evaporate, some will go down, and some will go away from your pit. In other words, don't use the trench unless you have a LOT of water that you can waste in the process of getting drinking water.

Solar stills are used in many parts of the developing world as a primary means of water purification. An example of a solar still that is much more efficient and long term is the following design from the El Paso Solar Energy Association:

I'll link to their site on the resource page. They sell plans for building your own solar still, like the one pictured above.

It uses the same basic process of solar evaporation-condensation-collection, but is made of glass, wood, and food grade plastic. Each unit is about the size of a household door, which makes them prohibitively large for most city-dwellers to build "just in case." With a surface area of just under 18 square feet, this setup will make an average of 3 gallons of water per day in the summer and 1-2 gallons per day in the winter.

This provides us with a rough calculation for how big your solar stills need to be to support yourself and/or your family. You will need at least 6 square feet per gallon per day in the summer and 12 square feet per gallon per day in the winter.

You can also build an improvised solar still using an outdoor hot tub, a children's pool, or a backyard water feature like a waterfall (this may be a great excuse for you to build one—it looks nice, probably will get support from your spouse, AND it is another way to store a couple hundred gallons of water without using up storage space.)

Like I said…in many parts of the world, this is the technology that they depend on for their everyday drinking water. BUT, they are using food grade equipment to collect the water and you might be using a tarp and a baby pool.

I'll also link to a really neat plastic cone solar still on the resource page. It has a diameter of only 31 inches, but produces up to 1.7 liters of water per day.

Solar stills are the best low-energy solution for removing salt from water, but this process can also cause other liquids besides water to evaporate and condense into your "clean" cup like ammonia. You can end up with ammonia in your urine if you are on a high protein/low carb diet, and/or if your body is in a state of ketoacidosis.

When you're running other water sources through this system, you can also end up with some environmental contaminants like radiator fluid (ethylene glycol) condensing into your clean cup as well. Ethylene glycol can kill pets and humans in relatively low quantities, so you want to avoid water that has been contaminated with it, unless you intend to distill the water or run it through a reverse osmosis system.

In the rare event that the condensate in your clean cup smells like ammonia, you can help speed the removal of it by adding approximately one drop of chlorine bleach per gallon of water. !!Mixing chlorine and ammonia releases chlorine gas, which is lethal, so do this step in an open area with plenty of ventilation!! When the chlorine is mixed with the ammonia, it will allow the next step to remove both chemicals.

So, the easiest thing to do is run the soon-to-be-delicious urine through one more step. Again, I'm going to show you the most basic solution first, and then show you a simpler, smaller, lighter, more high tech one.

This method of filtration has been around since 2000 BC and is still in use around the globe. It's simple, cheap, reliable and durable. To make it, you need a container like a 3 liter bottle or a 5 gallon bucket, crushed charcoal, sand (chemical free), pea gravel, large gravel, and a few other items like lengths of pipe, fittings, and valves, depending on how complex you get.

Here is an example setup from aqsolutions.org:

I have included a PDF with the complete plans for this system on the resource page for this book. It is only an example…you can easily make the setup more or less complex.

This setup uses 1.83 kg of activated charcoal, which will (very) conservatively purify 1830 liters of relatively clean water, like rain water or water that has gone through a solar still. 1830 liters will last a five person household 6 months at a rate of 2 liters per person per day. Estimates are that activated charcoal will purify up to 10 times this amount, but since it is so cheap, it is smart to replace the activated charcoal every 1800-2000 liters.

Your imagination is the limit on altering the design. Instead of using a bucket, you can use a length of PVC pipe, a 2 liter bottle, or any other container that will hold the aggregate and allow you to get water in one end and out the other.

Where do I get the charcoal?

Great question. Here's one place NOT to get it. DO NOT USE INSTANT BRIQUETTES or briquettes with accelerants, chemical binders, coal, or fillers.

Three places to get your charcoal from easiest to hardest:

1. You can buy bulk activated granular charcoal online or in pet/aquarium stores. The activated granular charcoal will be approximately 5 times more effective than low grade charcoal, but they will both work. Any charcoal that doesn't say "activated" is low grade charcoal.

2. You can buy chemical free charcoal at Wild Oats and other stores. They sell an "all natural" charcoal that is free from all of the additives mentioned.

3. You can also make your own charcoal. I've included a link on the resource page on how to do this. One benefits of making your own is that you essentially create a gasifier when you make your charcoal setup. If you're not familiar with gasifiers, they generate wood gas, which can be used to power an internal combustion engine, like a generator. More on this on the resource page as well.

If you buy or make your own low grade charcoal, you simply need to pulverize it so that it is roughly the size of a grain of rice. A little bigger is fine, but you don't want the dust. An easy way to do this is to put it in a burlap sack and hit the lumps with a sledge hammer. When you're done, spray down the entire bag or dip it in water repeatedly to rinse off the charcoal powder.

Keep in mind that it takes approximately 5 grams of charcoal (and approximately 1 gram of activated charcoal) to purify one liter of water. When you've run that much water through your filter, you need to replace it.

The more compact, lighter, and simpler solution

I included the solar still and the sand-gravel-charcoal solution because you can make either of them work with minimal supplies almost anywhere in the world…all you need is the basic knowledge of how to set them up. They are also solutions that you can quickly and easily talk friends/neighbors through in a disaster situation. That being said, both are VERY bulky.

If you want a simpler solution, I am a BIG fan of the Sawyer line of filters. I have dozens of water filtration systems and purifiers, including drops, pills, iodine impregnated filters, UV purifiers, inline filters, straws, pumps, hanging filters and more. That being said, the Sawyer filters are the ones I use and travel with.

2 examples of Sawyer bacterial/viral filters

In short, they are guaranteed to filter 1 MILLION gallons of water and will protect you from bacteria, protozoa, larvae, AND the virus filter even removes viruses, which are 100 times smaller than bacteria. They are the only portable filtration devices currently made that removes viruses mechanically. (Lifesaver Systems makes a purifier bottle that removes viruses, but it has a limited service life, is much slower than the Sawyer filter, and can't be backwashed.)

I've shown two separate systems above. The one on the left uses two bags (one for dirty water, and one for clean) with the filter in between. (I travel with this one.) The one on the right uses ANY size bucket and the filter and comes with a whole saw and all of the necessary fittings. Both configurations will filter up to 170 gallons per day, although you could double, triple, or quadruple the bucket system by simply adding more filters (and holes) to the bucket.

In talking with John Smith (yes…it's his real name) from Sawyer, I found out that they actually test every single filter by attempting to blow .02 micron spheres through it. They don't do batch testing…they test every single filter. The filters only get sold if they pass this test without a single sphere passing through the filter. They also have a model that is about half the price of the virus filter that does a great job on bacteria and protozoa. They test every one of these filters as well…just with larger spheres.

Won't the spheres clog the filter?

That actually brings up a very neat feature of the Sawyer filters. You can clean/declog them by simply backwashing the filter with clean/filtered water. This is the reason that they're able to guarantee the filters for 1 million gallons. The ability to backwash is fairly common, but the 1 million gallon guarantee is not.

John told me about testing the filters on raw sewage and on particularly nasty bacteria filled retention ponds in Florida. Even without using a pre-filter, he's regularly able to filter 10 gallons of water through the filter before the flow rate becomes unacceptable.

When the flow rate drops too low, back washing is simply a matter of squeezing the clean water bag and running a quart or so of clean water backwards through the filter.

We've got one last step to improve taste and get rid of taste and environmental contaminants.

I have added one other piece of hardware to my setup…a carbon charcoal filter from Katadyn:

I use it instead of the bacteria/protozoa/virus filter if I'm traveling in the US and staying in a hotel, and I use it in addition to my Sawyer filter otherwise because of its ability to filter fertilizers, pesticides, organic chemicals, and volatile organic compounds like fuel. You can get them at REI or other outdoor retailers for about $15 and refill them with aquarium activated charcoal. This setup allows me to make my own chemical free water when I'm staying in hotels. Since I travel quite a bit and drink 2-4 liters of water per day, the filter system has paid for itself many times.

Sawyer is working on their own inline activated charcoal filter and I hope to be one of the testers for it. If not, I'll be one of the first customers. Either way, I'll let you know how it works as soon as I've got good data on it.

As with the bucket filter, you can buy or make charcoal or activated charcoal to refresh the filter as needed.

Back To Filtering Water Other Than Urine

So I know that the chances of you needing to recycle urine or raw sewage are very slim, but I wanted to give you an idea of what was possible with VERY simple materials.

You're much more likely to have mundane filtering needs in a travel or urban survival situation, like filtering municipal water during a boil warning, filtering stagnant water, creek/pond water, purifying pool/hot tub water or filtering water from a rooftop.

The filter/purifier that you use or the combination of filters/purifiers that you use is going to depend on what you're trying to remove from your water. Here is a chart that can help you figure out which methods of filtration you need to use based on the contaminants in the water:

Which Filter To Use For Various Contaminants

	Charcoal	Sawyer Viral	Solar Still	Sand/Gravel/Char
Bacteria	-	++	++	++
Virus	-	++	++	mixed
Protozoa	-	++	++	+
Parasites	-	++	++	+
sediment	-	++	++	++
solids	-	++	++	+
salts	-	-	++	-
taste	++	+	++	++
VOCs	++	-	++	+
chlorine	++	-	mixed	++
pesticides	++	-	mixed	++
herbicides	++	-	mixed	++
fertilizer	++	-	mixed	++
lead	-	-	++	+
Ammonia	+*	-	-	-
arsenic	+	-	++	+
Antifreeze***	mixed	--	--	--
Radiation	--	--	--	--

**Ammonia can be removed from water with charcoal if you first use 1 drop of chlorine for each 2-4 quarts of water to convert the ammonia and chlorine to chloramine.*

*** This chart is meant only as a guide. You should do your own research and make your own* *decisions when it comes to filtering harmful contaminants from your water. Drinking improperly filtered water can kill you. If you find new/updated information for this chart, please let me know on the resource page for this book.*

**** Avoid water contaminated with antifreeze. You can remove it with distillation (NOT solar) or reverse osmosis, but the effectiveness of any of the above treatments are questionable and antifreeze directly affects the central nervous system.*

As you can see, either the combination of the Sawyer viral purifier and the carbon charcoal filter OR the combination of the solar still and the sand/gravel/charcoal bucket will purify several sources of water that you come in contact with in an urban survival situation. The edge goes to the solar still for removing salt from water (or urine), but other than that, you can do quite well with the smaller, faster Sawyer + carbon charcoal filter setup.

How to get and store water in urban areas

With the knowledge about how to remove so many contaminants from water relatively easily, you will have many more options than your neighbors who only have chlorine, iodine, or even a basic camp filter. Although not ideal, you can take nasty water from a golf course or retention pond and, in most cases, make it drinkable quite quickly and easily.

You also have a few more options available for storing water. As an example, most people who have swimming pools, hot tubs, roof water tanks, or backyard water features don't intend on actually drinking that water in an emergency. They intend on using it for laundry, hygiene, dishes, flushing, or watering plants, but not for drinking. You now know how easy it is to make this water drinkable.

If you haven't looked into rain catchment from your roof/gutter yet, keep this in mind. If you live in a desert and only receive 10 inches of rain per year and you live in a house with a 1000 square foot roof, you could collect 6,250 gallons of water per year. If you only collect from ½ of your roof, that's STILL 3,125 gallons per year. You'll lose some to surface tension and evaporation, but you'll still end up with a lot of water.

To figure out how much water you could collect from YOUR roof, take the number of inches of rainfall that you get per year X the square feet of your roof X .625 to get the number of gallons of water you can collect. Using the above example:

$$10 \text{ inches per year} \times 1000 \text{ square feet} \times .625 = 6{,}250 \text{ Gallons}$$

Just to emphasize how much water this is, at a gallon per day, you'll only need 365 gallons per year.

Water pasteurization using salvaged TV screens and satellite dishes

One of the most basic ways to purify water is to use the energy of the sun, and one of the most tried and tested ways of purifying water with the sun is to create a solar still.

The problem with solar stills is how long it takes to make water with them. With direct sunlight, it takes 1 square yard (or meter) of plastic to make 1 liter (or quart) of water per day.

But, we're going to cover the tactic of collecting and focusing the sun's energy to purify water and a few improvised tools that speed up the process considerably over a traditional solar still.

We're going to cover what to do when you have relatively clean water (no chemical contaminants) that you suspect has creepy crawlies like bacteria, viruses, or protozoa in it. This could be collected rain water, water that was stored too long or any other source of water that doesn't contain chemical pollutants.

Using focused solar energy does much more than simply speed up the water generation process over using a solar still. Solar stills generate water by using heat to cause water to evaporate and then collecting that water as it condenses in an attempt to physically separate the creepy crawlies from the water. The tactics that we're going to discuss here will simply kill all the creepy crawlies in your water.

In fact, two of the tools that we're going to be covering can QUICKLY generate 1000 degree heat without the use of a flame. This is hot enough to boil high-temperature grill paint, melt some glass, and crack a mason jar full of water in under 5 seconds. It's vital that you NEVER put any part of your body into the focal areas and that you're ESPECIALLY careful with your eyes. In fact, I suggest that you wear eye or face protection, including sun glasses when using these tools.

Tactic #1—Water Pasteurization using a Fresnel lens (TV screen)

Fresnel lenses are very thin (credit card thickness) plastic magnifying glasses. They're a fascinating tool that I could dedicate an entire chapter to. You can find credit card and book sized ones in book stores to help with reading.

You can also find larger (much larger) ones in rear projection TVs. You can tell the ones that use Fresnel lenses because the image is only visible when you're directly in front of the TV and quickly disappears as you move off to the side.

How powerful are Fresnel lenses? Well, I've got a 50" (diagonal) Fresnel lens salvaged from a TV.

It focuses all of the light that hits the lens onto a 1" x 5" focal area. My digital thermometer maxes out at 500 degrees and when I line up the lens with the sun, it hits the 500 degree mark in just a few seconds on a clear day and will light a 2x4 faster than a lighter. According to research I've done, it will hit 1000-1100 degrees in optimal conditions.

You can get Fresnel lenses by salvaging them from rear projection TVs, or you can buy them pre-mounted on a wood frame through ebay for around $100. If you salvage them and can get a number of them for free, there's a possibility of creating a small home business by salvaging them, mounting them on wood, and selling them locally or nationally.

The Truth about Boiling Water

You don't need to boil water to kill everything in it. You can simply pasteurize it by heating it to

158 degrees Fahrenheit, and that happens pretty quickly with a big Fresnel lens. As a quick note, all temperature readings in this article will be given in Fahrenheit.

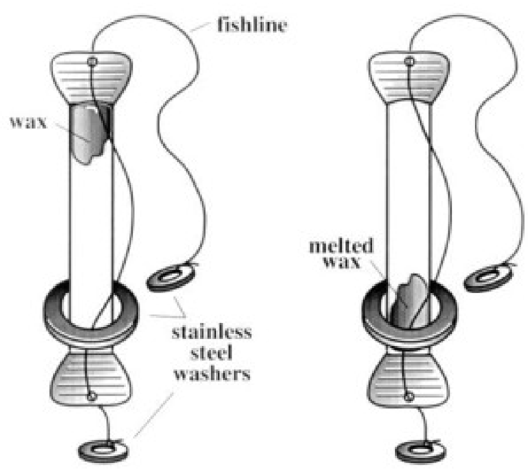
I know you've probably heard for years that you have to heat water to boiling to make it drinkable, but here are the facts on the matter.

Worms Giardia, and Cryptosporidium quickly die at 131 degrees Fahrenheit.

Bacteria like cholerae, E. coli, Shingella, Salmonella, and Rotavirus are quickly killed at 140 degrees Fahrenheit.

Hepatitis A virus is quickly killed at 149 degrees Fahrenheit.

Notice that I say that the creepy crawlies are "quickly" killed and not "instantly" killed at these temperatures. Because of this, the accepted standard is to heat the water to 158 degrees Fahrenheit. This process is also called pasteurization. This is important because it takes significantly less energy to heat water to 158 degrees than it takes to heat it to 212 degrees. (108 fewer BTUs per quart under perfect conditions. In reality, it takes a LOT more energy to heat water 54 degrees from 158 to 212 than it does to heat it 54 degrees from 104 to 158 because of heat loss.)



Why 158 degrees and not something simple like 160? That's a great question, and it's not because of the Metric system. It has to do with something called a WAPI. A WAPI is a small (1.5 inches long) reusable Water Pasteurization Indicator that is simply a closed plastic vial that contains a small amount of soy wax that happens to melt at 158 degrees.

WAPIs have been distributed around the globe by aid organizations to help people get the safest possible water while using the least amount of fuel. You don't NEED a WAPI to pasteurize water—you can simply use a thermometer—but WAPIs are cheap, easy to use, durable, proven, and convenient, if you can find one.

Back to the process. We've got our heat source

(Fresnel lens+sun), we've got our temperature

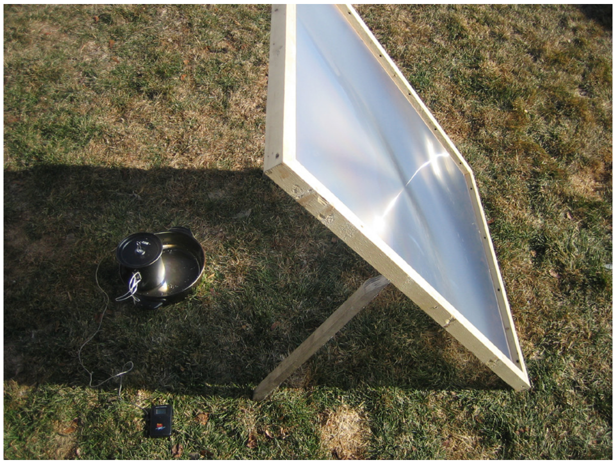
target (158 degrees), and we know that we need either a thermometer or a WAPI. Now all we need is a container to heat the water in, and that's pretty simple. You can use any black metal container that you can put a lid on that can handle being heated. The smaller container you use, the quicker it will heat up, but the more batches of water you'll need to pasteurize per day.

My suggestion is to use a pre-painted black cooking cup with a lid. One of the easiest places to get one is from REI. Here is the URL for the specific set that I've found to work well that is easy to find:

http://www.rei.com/product/799277

There's nothing magic about that particular set of cups, other than that REI has many locations around the country and people who don't have an REI near them can order online. You probably already own something that will work.

Once you have everything, simply place your container on the ground or on a platform, place your Fresnel lens between the sun and your jar, and adjust it until as much of the focal area as possible is on your container and wait for your water to heat up. Remember that these focused rays are hot and can burn you, so use tongs or heavy gloves when you're manipulating items in the hot zone.



In this picture, you can see that I'm using a remote cooking thermometer. On an 18 degree day, it took 10 minutes and 28 seconds to heat the water from 58 degrees to 158 degrees. The lid being cracked made a BIG difference. The next time I did it, I didn't use a thermometer and the lid stayed closed. As a result, the temperature of the water was 177 degrees after 9 minutes. A few more minutes, and I would have had boiling water and I could have drawn off the steam and had distilled water.

Here are some tips:

- You want your Fresnel lens to be perpendicular to the sun. I rotate the base so that it's perpendicular to the sun and then tilt the lens down until the sides are perpendicular to the sun.
- You want as much of your focal area hitting your container below the water level. The water will still heat up if your focal area is above the focal area, but not as quickly.
- We are used to heating water from the bottom and having all of the water heat up at roughly the same rate. With solar heating, since the heat is not being applied from the bottom and since heat rises, the bottom will heat up last. In practice, this means that when I'm using a remote grilling thermometer that's measuring the temperature at the bottom of 16 ounces of water, simply stirring the water will make the temperature at the bottom jump up 5-10 degrees. So, if your temperature has plateaued anywhere over 150 degrees, stirring has the potential of bumping the temperature over 158 degrees.
- Most, if not all big Fresnel lenses are directional and will work much better if they're pointed in the right direction. After testing mine both ways, I put an arrow on the edge of the frame that points to the sun and wrote "sun" on it.

- One of the biggest issues with any heating system is minimizing heat loss. In this case, the two biggest losses of heat are due to air sucking heat from the walls of your container and steam escaping out of the top of your container.

- You don't want an air tight lid, or else you have the potential of creating a bomb, so you'll always lose some heat through the lid. In addition, you'll lose heat when you open your lid to check on your WAPI or use a thermometer to check the temperature. (Ever heard the saying, "a watched pot never boils?") I usually use a remote grilling thermometer when I'm testing new configurations and they make it so I don't ever have to remove the lid, but the lid is always cracked some. Once you know how long it takes to heat up a given amount of water, simply set a timer for a minute or two longer, walk away, and confirm that you've hit 158 degrees.

- One of the easiest ways to prevent heat loss due to the air conducting it away from your container is to put your container in an oven bag, like what you'd use for cooking a turkey or ham. They do reflect a significant amount of the sun's energy away from the container, but if you've got high winds, low temperatures, high humidity, or a combination, the reduction in lost heat due to conduction is worth it. Since you're dealing with very high temperatures, you want to try to keep your oven bag 3-6" away from your container so it won't hit your cup and melt. Remember that it only took 9 minutes to heat water from 62 to 177 degrees on an 18 degree day without an oven bag, so you probably won't need one.

- An advanced strategy, if you have an enclosed solar oven, is to put your container in the solar oven and use the Fresnel lens to focus the sun's energy into the oven and onto the container.

- Also, keep in mind that it will take more or less time depending on several factors, including cloud cover, air quality, elevation, latitude, (I did these tests in Salt Lake City in January. Because of the elevation and latitude, it is a great location for solar applications) temperature, humidity, wind, and time of day. The more you can block the wind, the better.

On the topic of cloud cover and air quality…Salt Lake City, where I did the tests, regularly has 5-7 day periods where the sun isn't visible due to air quality and storms. In a post-disaster survival situation, you can count on increased air pollution due to people using inefficient wood stoves to heat and cook with. There is still solar energy getting through when you can't see the sun, but heating times are longer.

The other thing to keep in mind is that this is a strategy that you will probably only use in warm or cool weather. In cold and very cold weather, it's likely that you'll be using fire of some sort to heat all or part of your house and you can heat water with the same fire.

Tactic #2 – Water Pasteurization Using a Used Satellite Dish

Satellite dishes also collect and focus the sun's rays, but instead of being between your container and the sun, your container will sit between the satellite dish and the sun.

The beautiful thing about satellite dishes is that they are designed to take parallel rays from space and focus them...and they have mounting hardware where the rays converge!

You can use any size satellite, but the bigger satellite dish you use, the more of the sun's energy it will collect and the quicker you'll be able to pasteurize water. So, if you've got an old monster satellite dish from the 80s that's been collecting dust and rain, now you've got a way to make it useful again.

The first step is actually the hardest. Since the paint on satellite dishes is made to be VERY non-stick, we need to get rid of it. You can do this with a chemical stripper, sand blaster, or with a sander. If you're going to use a stripper, I suggest calling a local paint store and asking them for "aircraft stripper." It's nasty stuff, so make sure to use thick, chemical resistant gloves and face protection. Another option is to take it to a paint shop and have them do it for you. They'll use about $5 worth of stripper. Application, sit time, and cleanup will take 30-60 minutes, and it'll cost you $20-$40.

Next, you're going to want to take mylar or aluminum tape and coat the concave portion of the satellite dish. You want it to be as smooth and mirror-like as possible. In a pinch, you can also use a space blanket or aluminum foil and glue, but the tape is much easier. Many smaller modern dishes are aluminum and once you remove the paint, you may be able to polish and wax the surface to get enough reflectivity without attaching anything. I haven't tried this and mylar tape works so well that I'd only try the polish-and-wax approach in a pinch.

You can buy mylar or aluminum tape on Amazon.com. Since you're taping flat tape on a concave surface, one of the challenges is to minimize bubbles. You can buy 1" tape instead of 2" tape to minimize the number of bubbles, but it's debatable whether or not it will cause a noticeable increase in performance.

Next, remove the electronics that sit out in front of the dish, since that's where the sun's rays will converge and you want to put your jar right where the electronics are. Depending on the type of dish you have (6', 8', Hughes, Primestar, Dish, DirecTV, etc.) you may be able to use the mounting arms that held the electronics to hold the container that you're going to heat.

I've got a DirecTV dish. I stuck a small piece of wood out of the end of the mounting arm and hang my cup from it.

Let's use the simplest setup, which is to put the dish on the ground facing the sun and leaning against a rock, brick, or wall. Place your container in front of the dish on the ground at approximately the same distance from the dish where the electronics were mounted. (or hang it like I did) I like to find the focal point by moving a stick around until I find a spot where it starts smoking. Once I've found the focal point, I put my container of water there. Remember that these focused rays are hot and can burn you, so use tongs or heavy gloves when you're manipulating items in the hot zone.

You can keep this setup as simple or sophisticated as you want. You can use the mount that typically mounts small modern dishes to a house to mount the dish to a platform on the ground. Depending on the particular dish that you have, you can modify the arm so that you can set or hang items where the sun's rays are focused, like I have.

You'll notice that with both the Fresnel lens and the parabolic reflector, my setups are unrefined. I actually did this on purpose. I could have easily spent 2-3 times longer making a swiveling easel for my Fresnel lens, making a fancy mounting bracket for my dish, making the tape PERFECTLY smooth on my dish, or any of a dozen other modifications. The fact is that I wanted you to be able to look at the pictures and say, "I can do better than that!" and actually take action rather than look at a perfectly refined setup and not take any action because the project looks intimidating. Both of these setups are EASY. You can copy them and improve on them both and I encourage you to do so and send me your pictures and results when you do.

If you're using a full sized satellite, you'll be able to collect enough sunlight to quickly go over 1000 degrees. With a smaller dish like a DirecTV dish, you'll still be able to light paper and wood on fire and pasteurize water, but it will take a little longer.

Of course, you don't have to use a satellite dish as your reflector. You can use a reflective automobile windshield shade or even a cardboard box coated with aluminum foil or mylar. (When I go winter camping, I use a 1' square piece of aluminum foil to melt snow for drinking) They key is to gather as much of the sun's energy as possible and focus it into as tight of a beam as possible by using reflective surfaces that are as big, smooth, and reflective as possible, and as close to a parabolic shape as possible.

You've probably figured out by now that with this much heat, you can also do much more than just pasteurize water, boil, and distill water.

You can also cook food (also called a solar oven) by placing the appropriate container in the focal point of your lens or reflector.

If you're particularly handy, you can also use a Fresnel lens or parabolic reflector to increase the efficiency of a solar still or even make a solar distiller. This could be of particular value to people who live near salt water and want a very inexpensive way to desalinate water.

I want to encourage you to start looking for Fresnel lenses and a discarded satellite dish to try this on your own. One place to look is FreeCycle.org. It's a site where people post items that they want to give away rather than throw away. Chances are good that you'll have people trying to get rid of broken rear projection TVs and satellite dishes in your area.

I really like these two tools because they are small and have a lot of uses in a survival situation. In addition, they're simple projects that will open your eyes to all of the lenses and reflectors around you and their power to heat food, water, and you.

Make sure to visit the resource page at

http://urbansurvivalplan.com/706/advanced-urban-water-techniques

or

http://urbansurvivalplan.com/706

to see the resources for this book and to let me know what you thought. I REALLY value your comments.

God Bless,

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