Building a Plastic Bottle Greenhouse

Blue Rock Station Style

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Introduction:

A few years ago, Annie and I did some consulting at a wonderful place in Scotland called SCI (Sustainable Communities Initiative - you can find them at http://www.sci-scotland.org.uk/). This place is just as you imagine it should be. The original farm buildings stood tall, cold and silent, ancient stone mammoths carved from the hillside. They overlook a deep blue loch (lake for the more pedestrian among us) and soft green hillsides.

If you climb to the top of the hill, there stands a community garden, constantly beaten by the crisp winds flowing off the bay. On a clear day you can see across the Firth of Forth to Edinburgh.

At the base of the hill, near the lock they decided to build an Earthship (Europe's first) as part of an existing sustainability center. This is what brought us to the ancient kingdom of Fife, but while there an interesting little greenhouse caught our eye.

The small greenhouse was made mostly of 2-liter soda bottles... simple in both concept and design. The idea was so cool, that we decided to modify the process a bit and come up with our own design. As they say, there is nothing new under the sun (CSI got the idea from a park ranger in northern Scotland who probably got the idea from someone else who read about it somewhere in a Shakespeare sonnet). So, off we go Horatio...

The "original" plastic bottle greenhouse under construction near Edinburgh, Scotland.

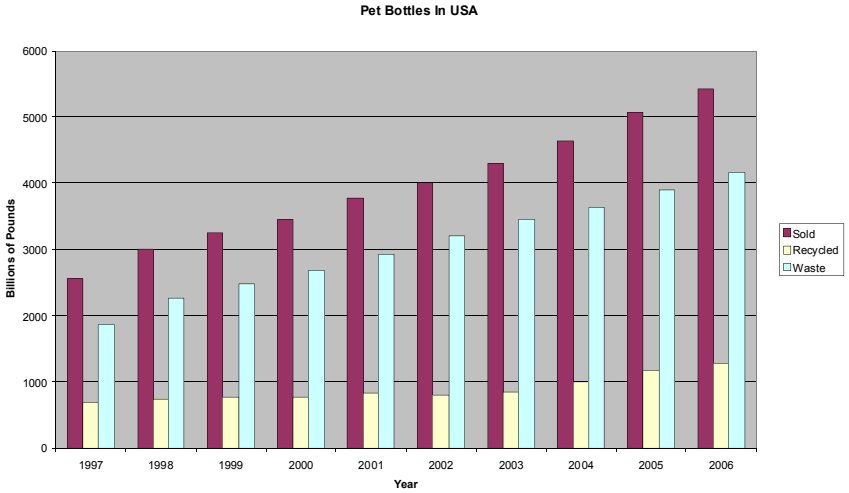
The Problem:

You already know the problem - or you would not have bought this book. But maybe you are a bit fuzzy about the numbers.

The problem, simply stated, is that there are a lot of plastic bottles cluttering up our world and our landfills.

There is an interesting organization called NAPCOR (the *National Association for PET Container Resources)* that knows more about plastic bottles (they refer to them as PET, which sounds a bit friendlier than *polyethylene terephthalate).*

Well, according to NAPCOR, only 23.5% of all the plastic bottles manufactured in the US in 2006 found their way to the various recycling centers. This is down from a high of 39.7% in 1995, but up from a recent low of 19.6% in 2003. No matter how you slice it, a whole bunch of bottles (4,152 billion pounds of the stuff, again according to NAPCOR) found their way into our nation's landfills in 2006. That's about 60 million plastic bottles thrown away each day (according to the Container Recycling Institute).



From data in the *2006 REPORT ON POST CONSUMER PET CONTAINER RECYCLING ACTIVITY*, published by NAPCOR (www.napcor.com)

And these things don't seem to go away. Estimates range from "a long long time" to "many, many decades" to 450 years (from Ocean Watch) to 1,000 years (often quoted by folks who have no better idea than you or I - think about it - how many plastic bottles were around at the battle of Hastings?)

One thing is clear from the data. We, as a nation, are buying more and more plastic bottles (up 113% in the past 10 years) and recycling less. Only about 4% of all plastic bottles are made from recycled plastic bottles.

So how do we draw attention to this issue?

This is an ideal project for school groups - helping them learn of the waste cycle problem as well as giving them a fun project to work on - plus a greenhouse at the end of the day.

Make Stuff Out of Trash:

We humans love a good visual. So why not build something out of trash - sort of stick it right in front of our collective noses so we can't easily ignore it? Which brings us back to the plastic bottle greenhouse.

We have found that this project is a really cool way to demonstrate the "reuse" portion of the 3-R (reduce, reuse, recycle) mantra. School kids learn this concept once a year - around Earthday - and then promptly forget it. This project is a great way to get classes talking about the issue, collecting the bottles, then working as a team to create the project.

Coming Up With Your Design:

Okay, here is were I am going to be of no help at all. Designing a building falls into the same category as "How long is a piece of string?" or "How deep is a hole?"

Basically, the project can be as big or as small as you wish it to be. Bear in mind that the plastic bottles will not be structural in any way. They are simply the fill material between the structural bits. This gives you lots of flexibility.

What this means in practice is that your design can pretty much be whatever you wish it to be, as long as you leave space between the vertical supports that you can then fill with bottles.

But keep in mind, the larger the building, the more bottles you will need. So start small and expand your horizons as you acquire more time, patience, help and empty bottles.

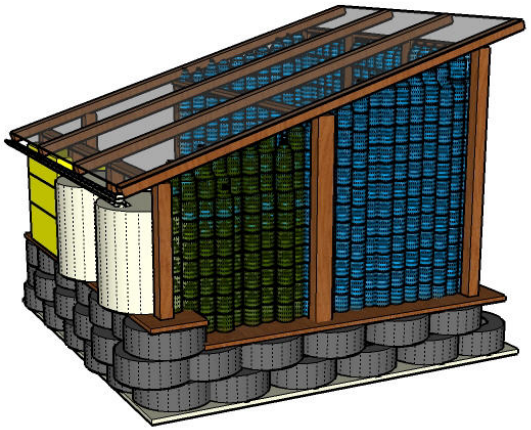
In this booklet we are going to explore a few different concepts first, then move on to the actual building. If you understand the concepts behind the design, then you can sit down with your own blank piece of paper and create a monument to your own cleverness. Don't worry, this stuff really is pretty simple.

So, as your design begins to take shape in the dark recesses of your brain, there will be a few common elements that we all must face as we move forward on this project. These include:

- ✓ Permits
- ✓ Site Location and Drainage
- ✓ Orientation
- ✓ Wind
- ✓ Heat & Cold
- ✓ Materials

Our Design:

But first, just a sneak peak at the project that we are going to use as an example in this booklet. I find it always helps to begin a project at the end - with a clear goal in mind. With that in mind, we came up with our own design for a pretty cool greenhouse. Feel free to copy this design (I will try to give you enough information in this booklet to allow you to do that) or come up with something even better.



Our greenhouse has a 10' x 10' "footprint", uses old tires as its foundation, captures water into two 55-gallon rain barrels that are part of the north wall, uses a bit of straw bale, and also incorporates about 1000 2-liter plastic soda bottles. Neat, huh?!

Permits:

We will ignore this area for very practical reasons (*"Permits, we don't need no stinkin' permits..."*)

First, the need for permits varies widely from location to location (in our neck of the woods you don't need any permits for a small outbuilding such as a greenhouse - in other areas you will practically need a note from your doctor and a papal decree). So you are on your own. Check with your local code enforcement office - or, as Annie would say, "Ask forgiveness rather than permission."

I simply mention this subject because you don't want to find yourself completing your masterpiece only to have some local official inform you that you have to tear it down. So, if in doubt, talk with your local building or zoning department. Get what they say in

writing (if you can). Often what they will assure you is the law is simply one person's opinion of what they think the law means - only to deny they ever said it later or be over-ruled by another inspector at some future date.

Site Location:

It is usually a good idea to build your project on your own land (and you thought there would be no useful advice in this book). Seriously, though, make sure of your property lines before starting. And while you are at it, you may want to check to make sure you are not planning to settle your project on any **easements**, or violate set-back rules that will cause you heartache and heartburn in the future.

So, assuming you have the right to build where you want to build - there are just a couple other practical considerations in locating your greenhouse.

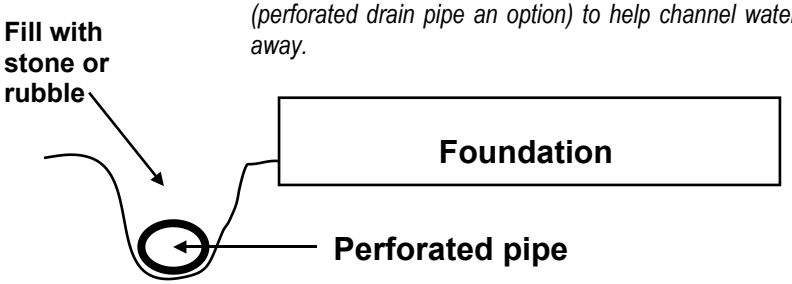
First, remember you are trying to **capture the sun** in the autumn, winter and spring for as much of the day as possible. So locate the structure where there is sun (duh!). This means, keep it away from tall buildings or structures that will block the sun and (this is probably more an issue) try to steer clear of any trees that will shade the building.

When in doubt, we like to mark out the building (small orange flags are nice) and then study the site for a while. Check at different times of the day and (if you are very patient) at different times of the year to see how the sun hits that site.

Another site consideration is **water** (specifically, drainage). Nobody likes to live in a swamp (well, maybe some folks do - but they are likely not building a greenhouse), so let's avoid this if we can. If you are building in a low, wet area, you may need to build the site up a bit to ensure adequate drainage.

On a sloped site, you may also wish to consider building "French drains" around your project to help channel water away.

French Drain *- just a trench around the building (on as many sides as necessary) filled with gravel or rubble (perforated drain pipe an option) to help channel water away.*

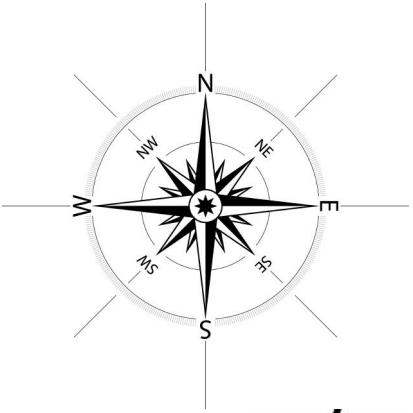


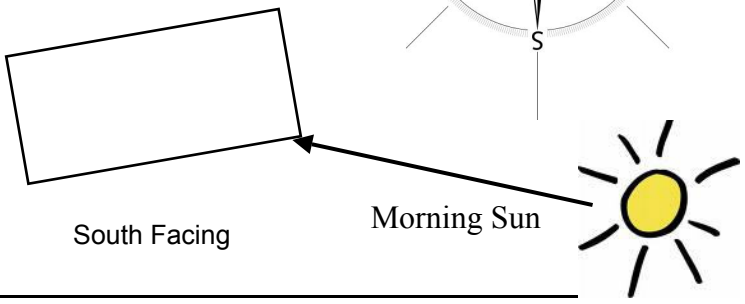
In dry climates this may not be an issues. But if surface water may be a problem - this is a cheap and effective way to make that problem go away. Also, it is much easier to do at the time of construction (when you have the motivation and perhaps, even, a bit of help) than trying to tackle it later.

Orientation:

For the sake of this book, we are going to assume that you live in the Northern Hemisphere. For those of you who live down south,

If possible, align your greenhouse so it faces just east of south. This will take advantage of the morning sun (heating the building earlier in the day).





you are probably used to living upside down - so just reverse everything.

So on most days (we hope), the sun rises in the east, sets in the west, and depending on your position on the globe and the time of the year, tracks across the southern sky.

This is important for several reasons. First, if it didn't do this we have bigger problems to deal with than building a greenhouse will solve. But secondly - assuming all is well with the universe - knowing where the sun is and will be is very helpful in creating an ideal growing space for your plants. Orient your building to absorb as much of the winter sunlight as possible.

With this in mind, the northern side of your building is a total waste of space. It will never get any sun, and is, in essence, a giant sucking hole that will sap your building of heat if given half a chance. We will discuss later in this book how to use this space to our advantage.

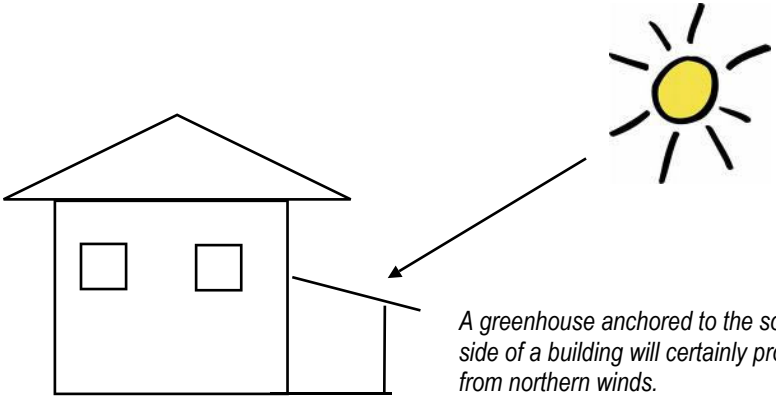
Wind:

Because we are trying to locate our greenhouse where it gets plenty of sun, the site may also be quite exposed to other elements of nature. Simply bear this in mind when planning your greenhouse.

This is the voice of experience talking. One of our early prototypes of the plastic bottle greenhouse was picked up and dismantled during a particularly nasty storm. This particular prototype was designed to me mobile (we moved it from place to place for demonstration purposes) - but that mobility was supposed to be at a time and place of our choosing.

So, as you are selecting the location for your greenhouse, bear in mind that weather is unpredictable and often harsh. Use windbreaks where necessary and practical, or make sure your structure is firmly anchored.

Often folks like to construct their greenhouse directly adjacent to their home or another building. This will certainly help protect the



A greenhouse anchored to the south side of a building will certainly protect it from northern winds.

more fragile greenhouse - just make sure you still have good exposure to the southern (and hopefully eastern) sky.

Heat & Cold:

Now, of course the entire reason you build yourself a greenhouse is to create an environment where it is warmer inside than outside (with lots of light so your little plant friends will be healthy and happy).

So you obviously want it to absorb those passive solar rays, building up heat within (hence the name, the Greenhouse Effect) and making it warm and toasty inside, even when it is cold outside.

Essentially a greenhouse is a very large solar oven. Here at Blue Rock Station we often cook with solar ovens and let me assure you, they can get awfully hot inside. On a sunny day, those little ovens can easily reach temperatures hot enough to boil water (212°F or 100°C). Even on a cloudy day the temperature will reach about 100°F.

The reason I mention this, is that your design must incorporate some way to vent out excessive heat. Small windows at the peak (hot air rises don't you know) that can be opened are a good way to allow hot air to escape are a good idea.

Your plants (and you for that matter) don't like extreme temperatures. Obviously you don't want to cook your plants (until you are ready) - hence the vents. Also, you don't want them to freeze. So there are a couple neat (and cheap) ways to keep your little leafy friends warm.

These methods include:
- ✓ Passive Solar
- ✓ Thermal Mass
- ✓ Heat Absorbing Materials
- ✓ Insulation

Passive Solar:

Well now, here we are at long last at the entire point of a greenhouse. Greenhouses work by allowing the rays of the sun to penetrate into the building, but then block the heat from escaping (to a point) resulting in the interior of the building growing warmer and warmer.

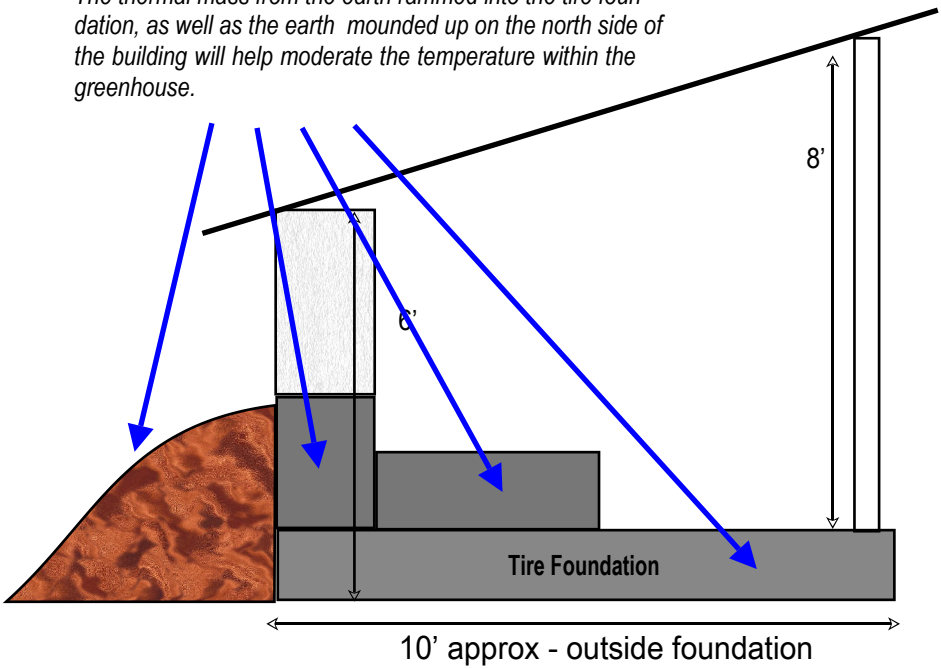
Intuitively we know that clear items will allow the sun's rays in - and opaque (or dark) items will block the sun. Since we intend to build the walls of our greenhouse out of soft drink bottles - we will need to collect clear bottles. It is through this wall of clear bottles (and remember to use clear bottles) that passive solar heating will work its magic.

Thermal Mass: The Earth is Your Friend

In our design, we are also going to use the earth to provide *thermal mass*, assisting us in keeping the greenhouse at bit warmer when it is cold and miserable outside. The earth also will help keep things a bit cooler when it is hot. The earth moderates the temperatures - radiating heat when it is cold and absorbing heat when it is hot.

This is the same effect you feel when you enter a cave. The earth maintains a fairly constant temperature (below the frost line that

The thermal mass from the earth rammed into the tire foundation, as well as the earth mounded up on the north side of the building will help moderate the temperature within the greenhouse.



is) of about 56°F or 14°C. So we want to take advantage of this natural phenomenon in the building of our greenhouse.

Here at Blue Rock Station we live in an **Earthship** (just Goggle the name and you will find out more about it than we could ever cover in this booklet). The Earthship depends upon thermal mass for most of its heat. This is achieved through rammed earth walls (compressed within discarded automobile tires) and earth mounded against the north wall.

So we are going to take advantage of some of the lessons learned in building Earthships to build a really efficient passive solar greenhouse.

With this in mind - our design (you can, of course, modify this to suit your fancy) will use a rammed earth foundation. If you are interested in this technique - we do offer another little booklet

(*Building a Tire Foundation*) that goes into great detail on this subject.

Remember, we noted that the north side of the building is of no use at all - from a solar gain perspective. It will never get any sunshine - so why waste our time building a bottle wall on that side? And why not mound some dirt up against the tire foundation on the north side? This will help in temperature control as well as drainage. The little bit of earth we will mound up in the example outlined in this booklet will not change the temperature much - but you could expand upon this, even building into the side of a hillside. Such a design would benefit greatly from the thermal mass of the earth.

Pollution is nothing but the resources we are not harvesting. We allow them to disperse because we've been ignorant of their value.
- R. Buckminster Fuller

Materials:

Buckminster Fuller (designer of the geodesic dome - among other things) was certainly right. We have already produced everything we need.

One of the really cool aspects of this project is that it takes things that would normally be thrown away and gives them a useful second life.

The materials we will use in this project are:

- Discarded automobile tires (for the foundation)
- Reclaimed lumber (for the framing)
- Plastic bottles (to provide walls as well as insulation)
- Straw bales (infinitely renewable and often discarded)
- Water (don't forget that rain falls from the sky, often wasted)

Heat Absorbing Materials:

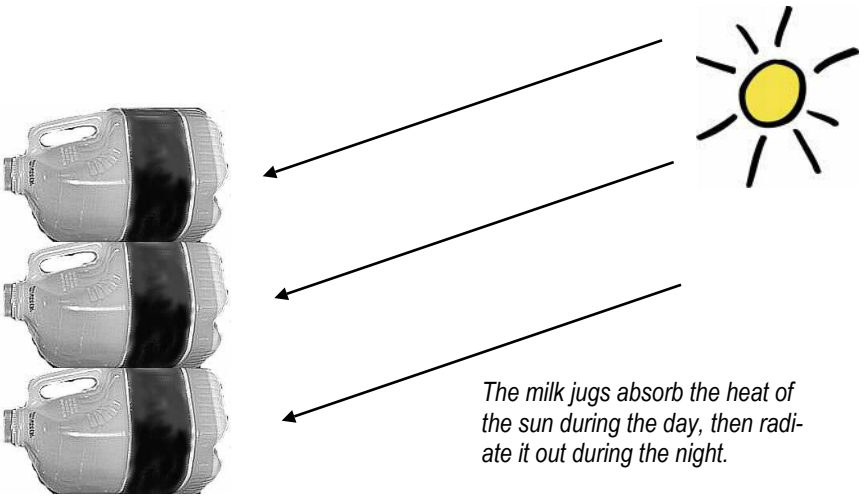
When it comes to absorbing heat, black is your best friend. Painting interior surfaces a dark color will help you absorb just that little bit more heat.

But another idea described in great detail in James McCullagh's 1978 book, *The Solar Greenhouse Book* (published by Rodale Press, Inc) is to use water to catch and store heat.

The idea is similar in concept to thermal mass. Allow the water to absorb heat during the day - then radiate it back out into the greenhouse during the night. In this way you moderate the temperatures.

These water storage systems can become fairly complex. But the method we like (because it is so simple) is to use one-gallon milk jugs filled with dyed water (remember, keep it dark) to capture the heat.

You can line the entire inside north wall with these jugs if you wish - or simply place them in convenient sunny spots throughout the building. The more the merrier - and they will work best if compacted together into a larger mass (creating a larger "tank" of water - so to speak).



The milk jugs absorb the heat of the sun during the day, then radiate it out during the night.

Insulation:

Once you have captured the heat in your building - it would kind of be nice to keep it. This is where insulation comes into play. We could, of course, insulate the walls and ceiling in a normal fashion -with blown or rolled insulation. But then we would block any chance of light getting in - pretty much negating the whole reason we built this greenhouse in the first place.

Fortunately - there is a solution in garbage. Those discarded 2-little bottles can be combined to form a tube of air (we will discuss how you do this in just a minute). And it is air, mis amigos, that really provides insulation. Trapped air, that is.

In fact it has been demonstrated that simple trapped air is about 1/4th (inch for inch) as good an insulator as the stuff you buy in rolls. What this means is that a sealed 4" bottle of air will insulate about as well as a one inch layer of insulation. Not spectacular - but good enough for our purposes.

The Bottles:

Before you begin your project, you must somehow come up with about 1,000 empty 2-liter soft-drink bottles. Unless you consume huge quantities of the stuff (and heaven help you if you do), you will probably need some help. We have found that this is a great project for schools, scout troops, or any other groups with a lot of children.

Not only will they happily help you gather the bottles - but it gives you a chance to lecture them on the evils of consuming sugar-water drinks (bear in mind that this lecture will go in one ear and out the other).

Kids are also a big help in washing the bottles - which has to be the most thankless job of this project. Some labels come off easily, some you simply cannot remove for love or money. Soapy water is your best bet (any solvents will dissolve the bottles and are not environmentally happy. So be prepared to work at getting them clean.

Building With Bottles:

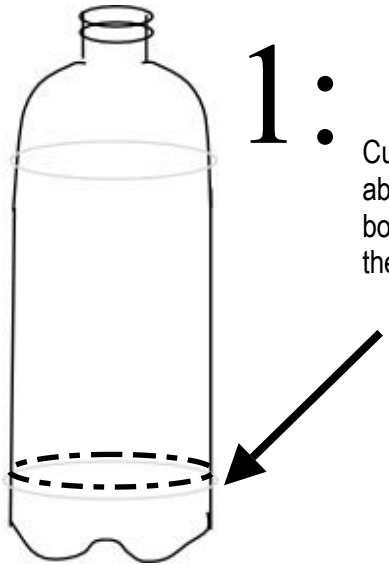
You will understand much when you understand that the basis of green building (or any building process for that matter) is simply the art of "filling space with stuff." (And isn't that really what America is all about?)

The framing of this building is what holds the building together (and keeps the roof above your head). But the plastic bottles, as well as the straw bale that we will use in the north wall, are just occupying space.

What we wish to do with the bottles is to create many long tubes that will combine to fill the gaps between the wooden wall supports.

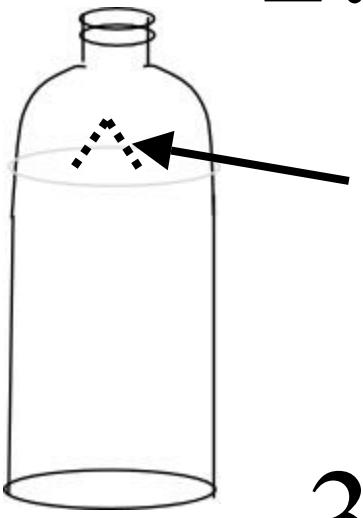
Cutting the Bottles:

In order to make your cylinders of air (which is what the plastic bottles will form), you will need to cut them.



1: Cut off the bottom of the bottle just above the slight bulge where the bottom attaches to the midsection of the bottle.

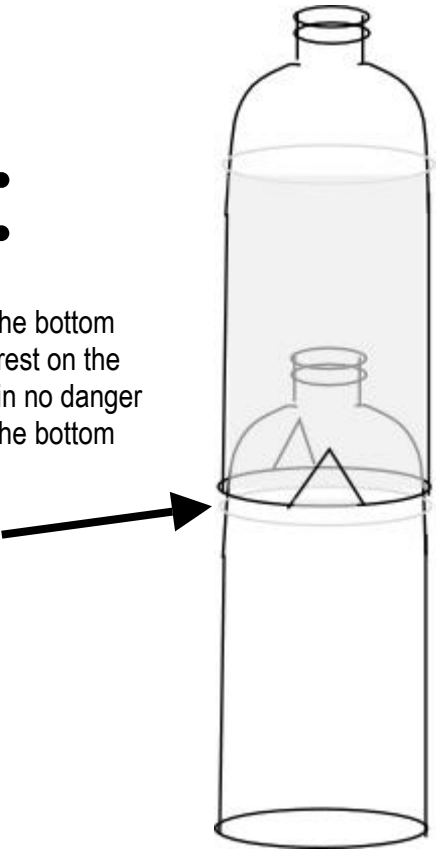
2:

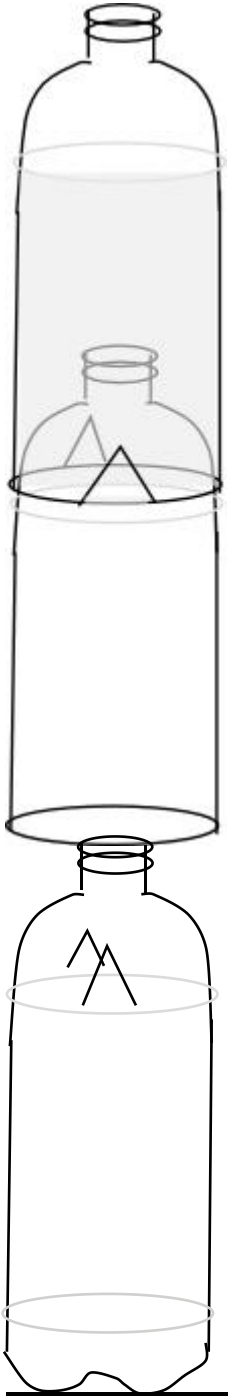


Cut a small tab on two sides of the bottle. Be sure to only cut two sides of the triangle. We don't want to create a hole in our bottle.

3:

Now you will find that the bottom edge of top bottle will rest on the tab you just cut and is in no danger of slipping lower over the bottom bottle.





The first step is to cut the bottom off a number of bottles. Fortunately there is typically a guide line on most bottles where the base transitions into the main portion of the bottle.

Just above this small bulge, cut the bottle (using scissors, a razor knife - but be careful! - your teeth, or whatever you have handy).

Okay, we are making progress... Now, you will see that the bottom of this cut bottle will slip nicely over the top and neck of another similar empty (did I mention before these bottles are empty - makes the entire project much cheaper) bottle. But you will also find that, given enough pressure, this bottom-less bottle will actually slip quite a way down over the bottle beneath it. So we need to make another cut to avoid this problem.

In this way, we simply repeat the process and link the bottles together into as long a tube of air as we need.

These tubes have the double attraction of not only allowing sunlight (passive solar) to pass through, but they also trap air which forms an insulating wall. While the seal is not perfect (and it doesn't need to be) - it will help to retain the heat within the plastic bottle greenhouse.

The Bottom of Each Row:

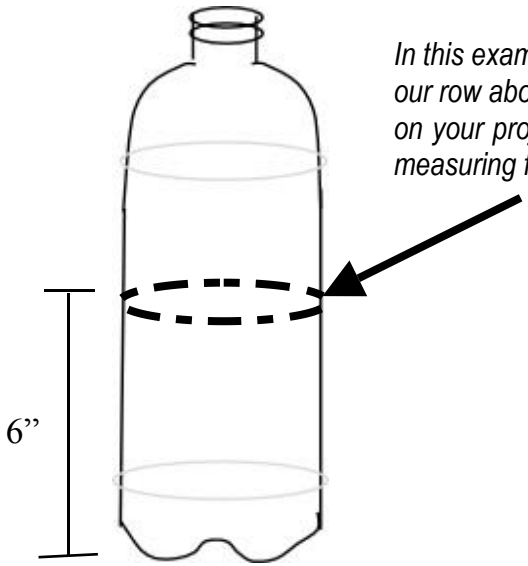
For the bottom of each row, simply make your little "tab" cuts in a "complete" uncut bottle (with the bottom still on it). This bottle will form the base of each row of plastic bottles in your masterpiece.

The Top of Each Row:

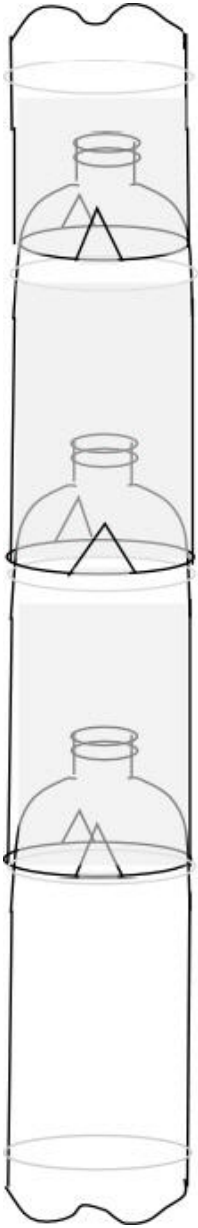
To finish off the top of each row, simply measure the remaining space you need to fill in each tube of bottles (this will be more clear later as we show how to place the bottles), and cut a bottle to fit. In this instance, the part we want is the bottom of the bottle - not the top.

For example, you have stacked you bottles into the space you wish to fill, and find that at the top you have a gap of about 5 inches. Measure up from the bottom of the bottle 6 inches, and cut it. Turn the bottom of the cut bottle upside down (so the bottom is now at the top) and use it as a cap to top off the row. If you make it just a little long, you will find that the bottles actually have a bit of spring (compression) that will help hold them in place.

Now, the bottom of your freshly cut bottle makes a perfect cap to your row of bottles. And speaking of caps - you may wish to remove the multi-colored caps from the bottles. They will block just a tiny bit of the sun. But if you like a bit of color - leave them in. Not a big deal either way.



In this example, we need a cap for our row about 6” high (this will vary on your project). Cut the bottle, measuring from the bottom.



4:

We turn the bottom of our cut bottle upside down and place it as the cap or top of our row of bottles.

And there you have it. A complete row of plastic bottles, ready for installation.

5:

For the bottom of our row of bottles, we simply take a complete, uncut 2-liter bottle, cut the tabs and place bottles on top of it.

Our Project:

The greenhouse we will use as an example in this booklet is simply a convenient size and shape for our purposes here at Blue Rock Station. You may wish to make yours larger - smaller - rounder - whateverer.

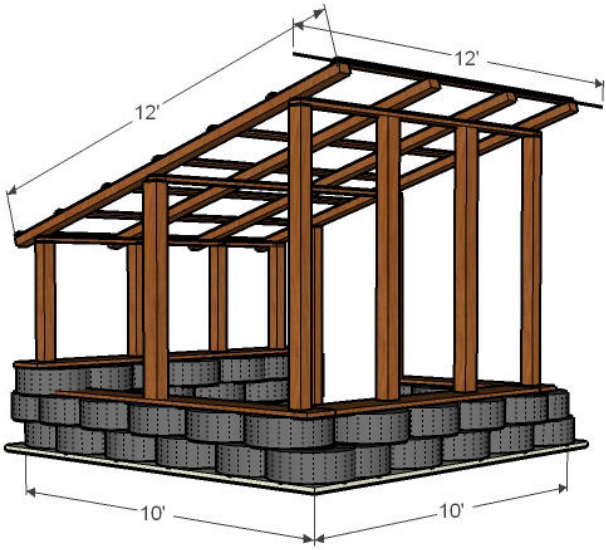
But since we have to start somewhere, well, here we are.

We intend to build our greenhouse on a a rammed earth (pounded tire) foundation. As mentioned earlier, we have a booklet that goes into detail on how to do this - or you can research it elsewhere or make up your own method. You could just as easily build this project on a traditional foundation, a rubble foundation, or no foundation at all (it is, after all, a greenhouse). But, as one of our first greenhouses blew away - we want to keep this one for a while. So we are putting it on a foundation.

Our greenhouse tire foundation midway towards completion. Notice we left a space for the door (important if you want to get inside when the thing is finished).

We also intend to use as little purchased materials as possible (we love to scrounge and recycle things). But one thing we must purchase for this project is the corrugated plastic roofing. We have decided to use clear plastic roofing to increase the amount of sunlight getting into the building - but you will find that this step is probably unnecessary - so use whatever roofing is handy.

But since we have decided on our roofing - and this roofing comes available in sheets that are 12 feet long (a word of warning to our friends who live outside the USA and use a sensible scale of measurement - you will need to do some conversions. Sorry!), let's give ourselves a little overhang and make the structure about 9' 6"



We start with the assumption that we want a 12' x 12' roof - and work from there. This means we will need a base at least 10' x 10' so that we leave about a 18" overhang for the roof in all directions. (trust me on this)

square (see how much thought went into that?) This is definitely "back-of-a-napkin" carpentry.

So having decided our footprint is going to be 9' 6" square, our tire foundation will have to be at least that big. Tires are usually about 2'4" in diameter (more or less) - so 5 tires on each side should be more than enough.

We also want to build our foundation at least 2 tires high (about 17 inches) just to keep everything high and dry.

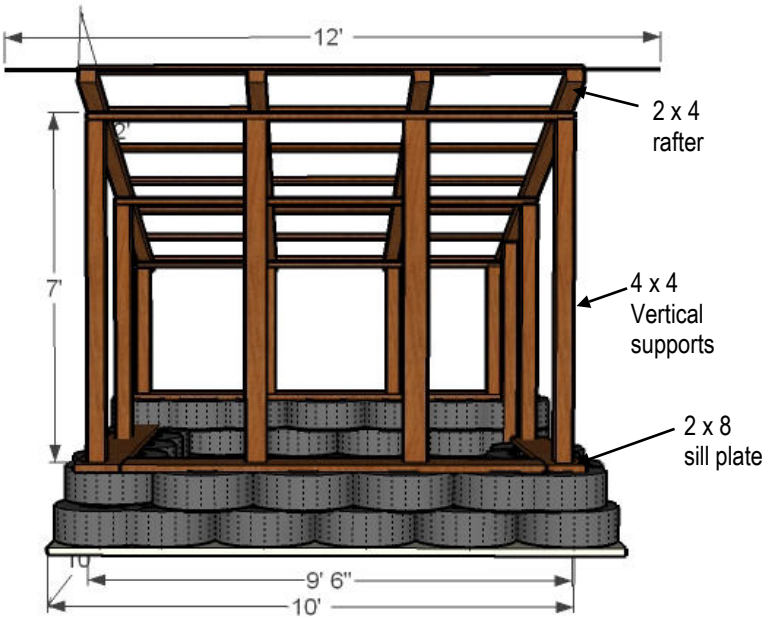
Okay, so our project is starting to come together. We will leave a gap in the tire foundation for a door (we decided to place the door on the back of the east side of the building. This is away from the wind and will not interfere too much by blocking the sun. We are just going to use a reclaimed narrow door that we salvaged.

We intend to mound some earth up against the north wall of the greenhouse (taking advantage of thermal mass), so we will build up the tire foundation one extra row in the back. We could have built the entire north wall with pounded tires - but we have decided to be clever (and lazy) and incorporate two 55-gallon rain barrels into the wall.

We will then finish off the remainder of the north wall with straw bales.

The only thing left to decide is the pitch of the roof. Since this roofing material (corrugated plastic) is not the strongest thing known to man, we probably want a fairly steep pitch if we think we might get any snow to amount to anything. Also, in order to capture as much sun as possible, we want to go as high as practical on the south side, giving the face of the building a large area to collect the rays of the sun.

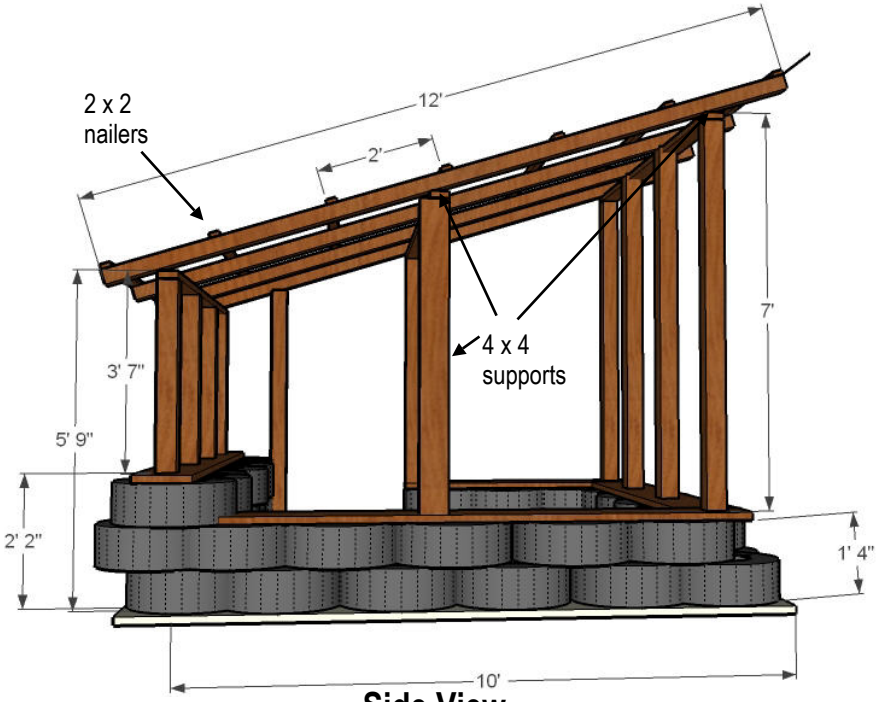
We also need enough headroom in the back to avoid cracking our (really my skull as Annie is only just over 5 feet tall) noggin. Six feet at the back should do it. And nine feet at the front should be more than enough.



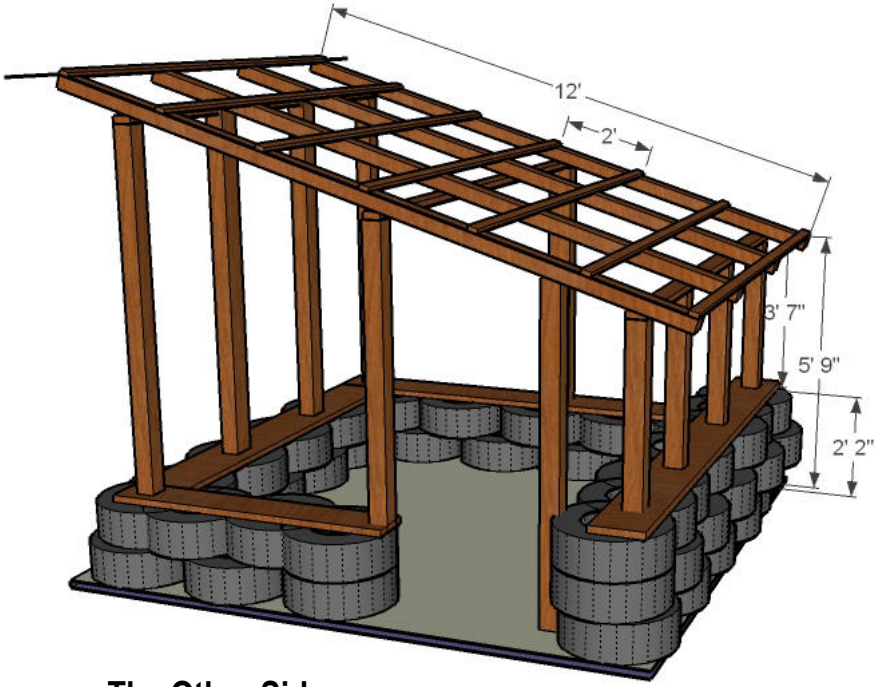
Front View

Framing the Project:

Just as this booklet is not about building foundations, it is also not really about framing. We will assume that you have a hammer and some nails and at least a passing familiarity with how to connect two pieces of wood together. But just in case you want to copy our example, we have included some drawings with all (hopefully) the dimensions you will need.



Side View



The Other Side

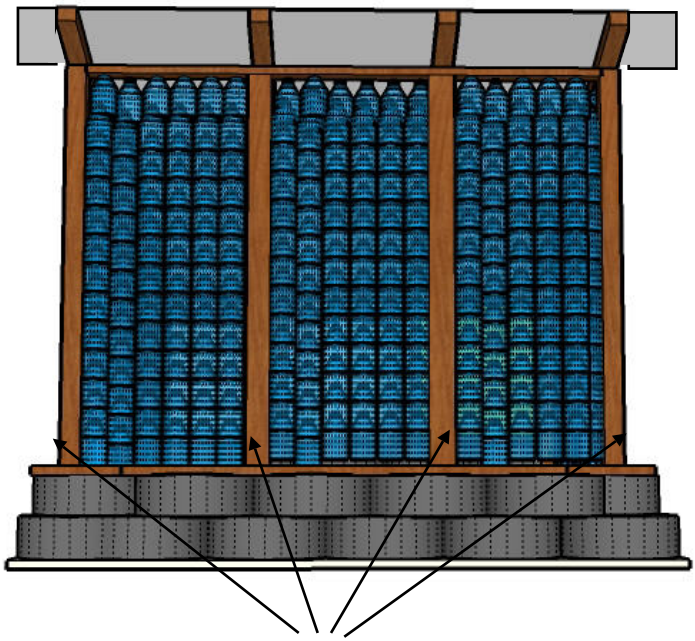
We decided to place the door on the east side (near the back). Since the door area does not perform any support function - just frame it as you wish. We simply left a gap in the tire foundation - then found an old door that fit the area and framed in around it.

Locating the vertical support posts:

One very important step before you begin to rely on my measurements for your projects. You will want to locate your vertical supports based on the size of the bottles that you are going to use in your walls.

If you used standard 4 x 4 vertical supports (standard in the US anyway), the bottles will fit nicely between the studs. This is because a "standard" 4 x 4 is really only 3 1/2" x 3 1/2" (don't ask). Since the standard 2-liter bottle is about 3 3/4" in diameter - you can see it will fit nicely in the space provided.

You will want to place the vertical supports based on where the bottles line up - as it is a lot easier to move the board than it is to make the bottles change size.



Place your vertical supports so that full-size bottles fit snuggly between them. As the dimensions of the building are not critical - you don't want to end up with "half-bottle" gaps in your walls. I have found it best to simply lay out the bottles on the foundation sill plate and then mark where the vertical supports will be placed.

Hopefully this photo will make the process clearer. The vertical posts are spaced so that a whole number of bottles fit snuggly between them. In this project the cavities were 8 bottles on the left, 9 bottles in the center, and 8 bottles on the right.

Placing the bottles:

Now that we have completely confused you with the framing of your project - it is time to move on to fresh opportunities for befuddlement.

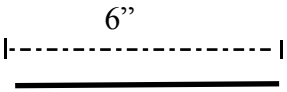
It is a fairly simple matter to place the bottles in the wall cavities (remember, we are filling space with stuff). But if you try to stick in your entire "bottle tube" (top to bottom) all at one time - you are just asking for a frustrating afternoon.

So we advise that you begin at the bottom and work your way up (just like in business, my young apprentice). As each level is completed, we will use wire (electric fence wire works well) to strap the bottles in place. Simply stretch the wire across the midsection of each level of bottles, and then nail (or staple) the wire to the wooden vertical support post.

The wires are stretched across the midsection of each layer of bottles - then stapled to the 4 x 4 support posts. This gives the wall quite a lot of rigidity, and of course keeps the bottles from falling out.

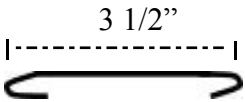
Run the wire on **both** sides of the bottle (inside the greenhouse and outside). By doing this, you create a wire "sleeve" that holds the bottles firmly in place.

You can make your wall even stronger and more rigid if you use a tiny wire "clip" to clamp the two wires together, putting tension on the bottles. This is really a case of "a-picture-is-worth-a-thousand-words" - so rather than waste 1,000 words, I will try to illustrate it for you.

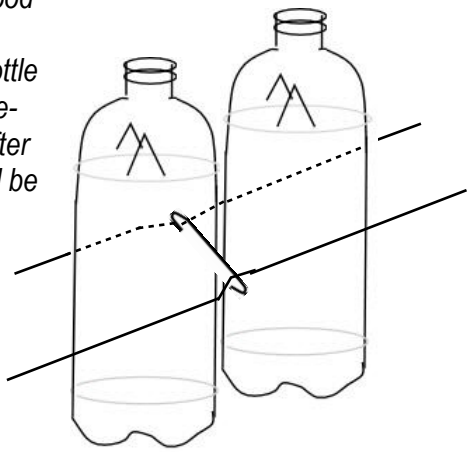


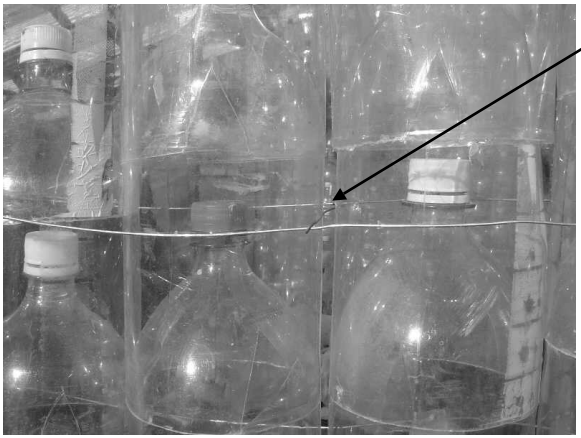
1) *Cut a bit of the wire you are using into 6 inch (more or less) lengths.*

2) *With a pair of needle-nose pliers, turn the ends in so that the straight section is about 3 ½ inches long.*



3) *Then use this clip to draw the two wires together, getting a good tight clamp between the wires. Do this between every other bottle or so on each level. You will begin to see where it needs it. After you complete this step, you will be amazed how strong your wall has become.*





The wire clip between bottles. Almost disappears - but amazingly strong.

Another little tip (and isn't this booklet just full of them), is to turn any bits of label that you haven't been able to wash or scrape off toward the bottle directly next to it. In this way, all the bits of label will not be blocking sunlight coming through the bottle.

So to review...

Step One: We have begun to build the rows of bottles, slowly, from the bottom up. The first layer will consist entirely of complete uncut bottles (the bottles that still have the bottoms on them).

Lay out a row of uncut bottles (these will fit very nicely between your vertical supports, because you measured that back before you began framing the building).

Step Two: Staple a strand of wire across the midsection of the first row of bottles. Be sure to do this on both sides (the inside of the greenhouse, as well as the outside).

Step Three: Cut your wire clips and clamp together the wires in the gap between every other bottle.

Step Four: Begin building the next row. On this row (and every other row until you reach to top of the wall) you will use the bottles that have had the bottoms removed.

As you slide the bottom of your cut bottle over the top of the bottle beneath it, you will need to pry the two tabs out a bit, so the base of the top bottle rests on the little support created by the tabs of the bottles beneath it.

Step Five: Repeat steps 2-4 until you reach the top of the area of wall that you are filling.

Step Six: Now we need to cut and place the cap (as we discussed back on page 20). I usually avoid cutting the caps until they are needed, because the space at the top of each row will vary. Cut the cap about an inch longer that you need - so that when you place it - it will actually compress the entire bottle "tube" below, giving a nice tight seal.

Step Seven: Step back and admire your work. Feel smug about a job well done, using materials that otherwise would have been land fill.

When the wall is completed, you will have a nice tight, insulated, transparent surface on your greenhouse.

Water, the other resource:

Remember, the entire reason for this building is to grow plants. To do this, we need sunlight, heat, and... of course... Water!

So where are we going to get the water? Well, if you live near where we live (planet earth), the water falls out of the sky. So what do we do with this amazing, free, abundant supply of water? We typically let it hit the ground, run into drains, wash toxic chemicals into our rivers - then we gather it up, filter it, add chlorine, floride, and who knows what else to it - then pump it back to the place it fell in the first place. Oh yeah, we also get to pay for this chemical water. (How's that for being preachy?)

So let's skip the middleman and take all the water we need right off the roof of our cute little greenhouse.

In our example, we linked two 55-gallon rain barrels together and integrated them into the north wall. The north wall of our greenhouse is worthless as far as solar gain - so why not use it for something productive?

Also, if we paint the rain barrels black - we may just find that the water within will heat up in the sun, and provide quite a bit of ra-

Standard gutters are used to collect the rain water off the roof. It is then channeled into two rain barrels. These are connected at the bottom - so both fill at the same time with only one inlet. Note the overflow pipe that allows excess water to run away from the building. Once these are painted black, they will actually absorb heat during the day and radiate it back out at night.

diant heat at night to help keep our tender little sprouts warm and cozy in the early spring.

Another advantage of painting the tanks black, it that it will warm the cold water in the winter, avoiding sending your seedlings or greens into shock by dowsing them in a cold shower each morning.

Of course, once you have gathered your water, you will need to get at it. Most rain barrels come equipped with a spigot. If you are making your own - be sure to orient the intake and overflow to the outside of the greenhouse - and keep the spigot on the inside.

The rest of the north side of the greenhouse, we simply finished off in straw bale. A good coating of earth plaster will make this portion quite attractive (but then - all that is discussed in another book).

Another quick word about wind, heat and cold:

After having completed the greenhouse walls, you will no doubt notice (observant as you are) that the seal between the rows of bottles is not absolute.

“Will this not allow warm air to escape?” “Won’t cold winds roar through my lovely building, harming my precious plants?”

Our answer to this is... “Perhaps.”

Our goal with this greenhouse is to extend the growing season. But bear in mind that this building (as designed) does not have a heating system (like a wood stove) that will protect our plants during extreme (we are talking -10°F temperatures here) weather. So there are some limitations.

Normally, when you stand inside the building you cannot feel a breeze - even if it is quite windy outside. The trapped air (within and around the bottles) appears to create a pretty effective seal. However, during gale-force winds I would not want to bet the ranch that this seal will remain as effective.

With this in mind, you may want to rig up a system of tarps or blankets that can be lowered around the bottle walls to protect the building's contents during extremely harsh weather. That way you can tuck your plants in during a storm and keep them cozy.

Alternatively, you may also want to rig up some blinds to limit the amount of sun coming into your greenhouse - as, even on a very cold sunny day - it can get pretty warm inside.

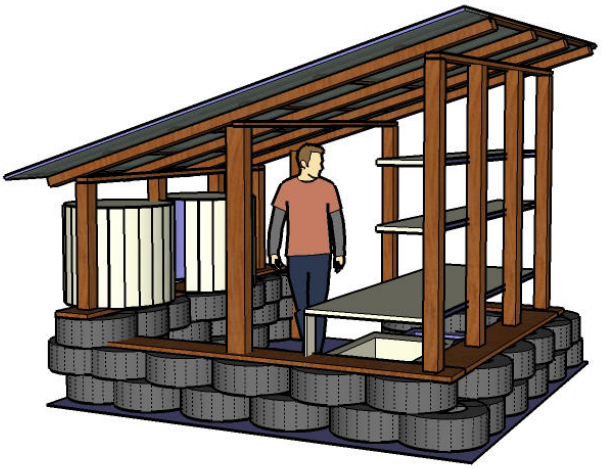
Finishing off your project:

Now is your chance to get creative. At this stage you have a room (about 8 ' square of usable space). Plenty of room to begin a relatively aggressive home garden.

But to be a truly effective work space, you will need a few things. These may include:

- A table
- Storage for tools & supplies
- Shelves for your plants
- Potting soil container
- And even the kitchen sink (use your imagination - Annie incorporated an old cast iron bathtub to grow greens)

Suddenly 8' x 8' doesn't seem so terribly big. But if you are efficient in your design - it is plenty. Enjoy!



Your plastic bottle greenhouse has plenty of room for shelves, a table, storage, potting soil, bathtubs or whatever else you want to incorporate into your design.

Acknowledgements: Our sincere thanks to...

Little Square Farm (www.littlesquarefarm.com) - Columbus, OH: Providers of terrific rain barrels for this project

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Additional Booklets from Blue Rock Station -

- ✓*Building a Tire Foundation*
- ✓*Building a Vaulted Straw Bale Wall*
- ✓ *Natural Gardening*

About the Authors:

Annie and Jay Warmke are having the time of their lives - creating and running Blue Rock Station, a sustainable living center near Philo, Ohio. Besides being full time grandparents they raise llamas and rare-breed chickens,, milk goats, conduct tours of their home (an Earthship) they built out of tires and garbage, serve on several local life-changing & patience-testing committees and are avid readers of *THE GUARDIAN*, their favorite British newspaper.

Annie Warmke is a noted activist and writer - as well as an alumni of Ohio University. Her career spans a lifetime of working with and writing about women in a variety of settings. She has translated for SOS FEMMES, led women's delegations overseas, organized shelters for battered women, served on think tanks, and traveled around the world raising money and crusading for women's safety.

Annie served as the contractor during the construction of Ohio's first Earthship - pounding more tires, throwing more mud and building more bottle walls than she cares to remember. She also decided that a tire foundation on the greenhouse might keep it from blowing away.

Jay Warmke obtained his degree in journalism from Ohio University, learning just enough about journalism to know he never wanted to be one. He later enrolled in the MBA program at the University of South Florida - attempting to learn a bit about business. He should have known better.

After working in the comic book industry for a number of years, he then followed a typical career path - leaving comics behind to become executive director of one of the world's largest telecommunications associations. Shortly after being named one of the top ten most influential people in the telecommunications industry by *Cabling & Installation Maintenance Magazine*, he decided it was time to leave (if he was the best they had, the whole industry must be in trouble).

Through it all, Jay maintained a love of building and carpentry - determined that when he had enough of life in an office - he would chuck it all and become a simple carpenter. Having now achieved at least half his goal (the simple part, he is still working on the carpenter bit) he continues to experiment with and practice alternative building techniques.