

Appendix

Wood Mold Construction Manual



ohorizons

Table of Contents

The Wood Mold: Common Problems and Solutions.....	2
Parts of the Wood Mold	12
Hardware Purchasing Guide	20
Proper Tool Use and Safety	24
How to Fill the Wood Mold	32
Dagger Board Removal Tips	34
Selecting a Diffuser Basin	36
Diffuser Basin Designs	37
Selecting a Lid.....	47
Lid Designs	48
Wood Selection	50
Location Selection.....	53
After Care: Supplementary Information	54
Finding Sand and Gravel.....	56
Sieve the Sand and Gravel	61
Wash the Filtration Sand and Gravel.....	69
What Will Tell Me if a Filter is Working Well?	74
Additional Resources	76

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You must follow proper safety guidelines and procedures at all times when constructing the Wood Mold. Basic safety procedures and guidelines are outlined in this appendix and the construction manual, but you should always consult the operations and maintenance guide for the specific device you are using. You assume the risk of any injury or harm arising out of the use of the information in this Appendix.

If you have further questions, please visit our website (www.ohorizons.org) or email us: info@ohorizons.org

This Appendix is up to date as of August 17, 2016. Please check our website regularly to make sure you have the most current version of this Appendix and the Construction Manual.

The Wood Mold: Common Problems and Solutions

I'm having problems finding the exact materials listed in the manual.

Please use the [Hardware Purchasing Guide](#) to provide an explanation on the use of the listed hardware. This will help you find suitable alternatives available in your area.

I can't find a circular saw.

It is perfectly acceptable to cut the Wood Mold on a table saw or using a handsaw. However, be aware of the angled cuts. These are vital to the proper function of the Mold. A handsaw will make this difficult. It may be advisable to do all other cuts first, and then bring the pieces with angle cuts to a carpenter with access to a power saw. When cutting these angles if you cannot be exact, it is better to cut more of an angle rather than less.

I have several SC pieces left unused. Is this normal?

Yes, this is perfectly normal and done purposely. We suggest you DO NOT throw out extra pieces since they may become useful later. Often, a part weakened from repeated use can be replaced or supported by these extra SC pieces. Alternatively, some Wood Mold users have used them during a filter pour to help stabilize the inner core or to protect the Mold from a metal hammer blow if rubber mallets are unavailable.



Use scrap pieces to protect the Mold from being directly hit by the hammer. This will increase the life of the Mold.

How many filters does the Wood Mold make?

Our lab tests have shown the Wood Mold can make approximately 50 filters before a major repair is needed. The number of filters may be more or less depending on the type of wood and the care and maintenance of the Mold. Please ask us for a Mold Tracking Sheet so you can keep track of how many filters each Mold produces and report back to us.

There is no lip in the Wood Mold filters. How do I make a diffuser plate?

Please see the sections [Selecting a Diffuser Basin](#) and [Diffuser Basin Designs](#) for common alternatives to a diffuser plate and a guide on how to make them.

My outlet tube shows through the concrete. Is this a problem?

No, this is not a problem. The only issue you may have with the tube showing is aesthetic. It will not hurt your filter's functionality. You can also cover this spot with some mortar (cement and water) if you prefer. You can prevent this from happening by rotating the inner core lid so that the tube hole is farthest from the nose side. This will allow for a more gradual bend in the tubing, preventing it from hitting the sides of the Mold.

The outlet tube is coming up through both layers of gravel. Is this a problem?

Yes this is a problem, but it has a simple solution. Simply take a knife or scissors to the outlet tube and shorten it. The tube end should be as close to the concrete floor as possible. Then, it is advisable to take particularly large rocks and form a small rock dome over the end of the tube. This will help prevent it from getting clogged.

My filter is leaking water through tiny holes in the concrete and is very porous.

How do I fix this?

Most likely you used very wet concrete when making this filter. Next time you pour, make your mix slightly dryer. The filter with the tiny holes can be fixed by using a mortar (cement and water) on the inside and outside walls of the filter. You can paint this on with a brush or use a trowel and putty knife.



Mix cement and water and apply on the inside and outside of your filter to seal any holes.

If your filters are still coming out porous even after modifying your concrete mix, you may have bought poor quality cement. This is rather common. Try changing the brand until you find one that works.

My filter is crumbling when removing it from the Mold.

This tends to happen when you make your concrete mix too dry. Test your concrete for the proper consistency while mixing by taking some in your hand and making a ball. This ball should hold together rather easily, but also be dry enough that it doesn't stick much to your hand or glove. If doing this with bare hands, quickly wash the concrete mix off your hands. Wet concrete is highly acidic and will dry out your hands occasionally causing blisters.



The filter may crumble if your concrete mix is too dry.

The support material and bolts aren't lining up correctly during assembly.

This is most likely an error with your C and D boards. Occasionally one gets flipped the wrong way or the SMB and SMC are put in each other's locations. Please double check that you have the SMC (smaller pieces) on the bottom of the board and the SMB (larger pieces) towards the top.



Make sure the C and D board are placed correctly.

NOTE: This is the correct position of the Mold BEFORE it is flipped for demolding.

SMB pieces should be toward the top. These are larger than the SMC pieces.

SMC pieces should be towards the bottom. These are the smaller pieces.

There is a gap in the nose assembly between the pointed edge of Part UV and the edge of Part S and/or T. Is this okay?

If the gap is extremely small like a pin, it is okay. Any gap larger than a pin should be fixed. It is a problem because this space will fill up with concrete. Any large gaps are going to cause the mold to leak concrete. The easiest way to fix this problem is to simply add a small piece of scrap wood to the end of S and T to block the gap. We recommend securing this extra piece with a screw to the edge of UV rather than trying to adhere it to S or T.



ABOVE: The angled edges of UV should be flush to Parts C/D. The pointed end of UV should not go beyond the edge of Part S or Part T. There should be no light showing when looking at the pieces.

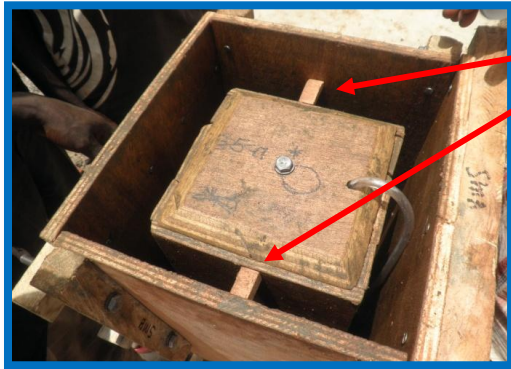


In the pictures to the Right and Left, Piece UV is longer than Part T. Use a piece of scrap wood to cover the gap (as shown). You should attach the scrap wood to UV.



My inner core keeps moving while I'm filling the Mold with concrete.

Make sure you fill the center in a circular pattern keeping the height of concrete equal on all sides. The inner core will be easy to move until the Mold is roughly half full. At this point, make sure your inner core is exactly where it should be before filling the rest of the way. If the center is moving an exceptional amount, it may be advisable to place wooden blocks between the inner core and the walls to prevent it from moving while filling the Mold. Make sure to remove these blocks when you reach the top.



You can use SC pieces or other small pieces of wood to stabilize the inner core while filling with concrete.

The filter nose isn't filling all the way with concrete.

Fill the Wood Mold until the concrete level is just above that of the nose. Stop filling and use a rubber mallet to vibrate the nose area (this is called tamping). DO NOT directly hit parts U and V (making the triangle of the nose). These parts are one of the weakest and hammering may cause them to fail. However, DO hit the support material and the top and bottom of the nose.



DO NOT directly hit the sides of the Nose (Parts U and V). This will damage the nose.

Only strike the top or bottom of the Nose.

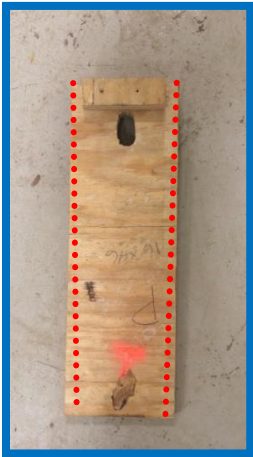
You can stop tamping when you see water seeping out from around your outlet tube hole. You may need to add more concrete during this process. Now continue filling the rest of your Mold, continuing to tamp the other areas. If there is no water coming out of the seams of the Mold, your concrete is most likely too dry.

Questions Specific to Demolding:

The dagger board doesn't come out.

There are a number of reasons why this may be happening. Please read the following as well as the [Dagger Board Removal](#) section.

Please check that your dagger board has the same width at the top, bottom, and middle. If your dagger board is wider at the bottom or the middle than it is at the top, it will most likely stick from the pressure of the concrete. Your dagger board should either be even or have a slightly smaller bottom (maybe .5 cm difference).



If you need to add draft, make sure the widest point is at the top of the dagger board. The sides should become thinner at an equal rate.

You can also try rubbing dry bar soap on the edges of the dagger board and in the space between the Y pieces. This will make the piece more slippery.

Prior to pouring concrete, make sure the dagger board is placed nearest to the base of the Mold. When you flip the Mold over, the lower your dagger board is in the center, the harder it will be to remove.



Side view of dagger board placed towards base of Mold PRIOR to flipping



Top view of dagger board placed towards base of Mold PRIOR to flipping



After flipping the Mold for demolding, the dagger board will be towards the top, easing removal

Try to slightly shorten your dagger board by 8 cm.

By putting a hole in the middle/top of the dagger board, you can tie rope around a beam. Then use the beam as a lever to remove the board.



Attach a rope through the hole in the dagger board and around a scrap piece of wood.



Use the wood as a lever to lift the dagger board upwards out of the inner core.



If rope is not available, another strong material that can be tied around the wood and dagger board will also work. In this picture, mesh material was used.

You can use a second piece of scrap wood to assist you as you lift the dagger board upwards.

You can also try using a crowbar and hitting up on the bottom of the dagger board.

Your dagger board may be slightly too wide. Use sand paper to reduce the width of your dagger board so that it is easy to put in and out of your inner core, but keep it wide enough that it still helps the inner core holds its proper shape.

Check that the screws between the Y pieces are completely flush. If these are sticking above the wood then they will catch the dagger board.

The inner core pieces with hinges attached will not come out. The ear or hinge flaps will fold in, the top will move forward, but the bottom is sticking.

In this situation, typically the problem is with the angle cuts or lack of angle cuts on pieces E and/or F. Please look to make sure that the angles are in fact there. If it is hard to see the angle, make it larger. If there is no angle, add one. The sides of pieces E and F require a slight angle to relieve the pressure of the concrete. Without the angles these pieces will be nearly impossible to remove.



Make sure both E and F have angle cuts on the sides. The hinge flaps (pieces H,I,G,J) should also have angles. If there is an angle, you can try to make it bigger.

If this doesn't help, make sure that pieces E and F are straight with the top and bottom having the same width measurement.



If you're having trouble removing E and F, make sure the pieces are cut straight and that the top and bottom of each piece has an equal width.



You can try to use a hammer and support material to remove pieces E/F and/or use a chisel (or similar tool) to move the pieces away from the concrete.

If the E and F pieces are sticking to the bottom of the Mold, you can try to use a long wood stick or metal rod to remove them. This usually happens because they are stuck to some concrete at the base. If they are impossible to get out, it is probably because the angles are missing or not large enough.



The W and X pieces on the base are coming off when I remove the Mold.

This problem, although annoying, does not affect the function of the Mold. Simply add the pieces back to the base with additional screws. As long as these pieces stay in place during the pour, they serve their function.

The Nose (parts U and V) is starting to come apart.

This is typically a result of hammering on this piece too much. Because only screws attach it, it is particularly weak. The first fix would be to add more screws between the existing screws. The second fix would be to add scrap pieces of wood to the corner of part UV. Please see the image below as an example.



Using the scrap pieces (pieces marked SC) leftover from the initial cuts, you can attach extra support to the nose as shown if it has started to come apart.

I'm having a hard time removing the bolts from the Mold while demolding.

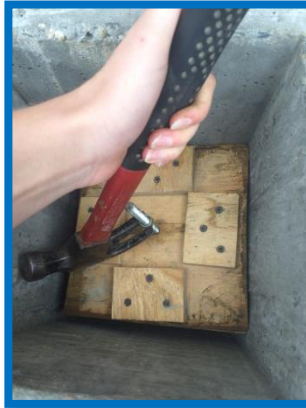
Either the holes that you made for the bolts are too small and the threads are sticking or the holes aren't aligned straight. Either way this means you need to re-drill these holes. Keeping the entire Mold assembled while you re-drill each hole is the best way to do this. Overtime concrete may get on the bolts. Use a wire brush to scrape this off.

The lid (Part O) isn't coming out.

Most likely concrete has seeped over the edge of the lid. You can use rebar or a long stick to scrape and tap the edges of this piece to break away any extra concrete. Make sure you are using the hammer's optimal function by levering the piece out rather than simply pulling. You may need to lower the nut to tighten the claw's grip.



Use the claw of the hammer against the nut. Make sure when you are assembling the Mold the nut sits halfway! DO NOT TIGHTEN!



Use the hammer as a lever, do not simply pull upward.



The lid will come out if the hammer is used properly as a lever.

Parts of the Wood Mold

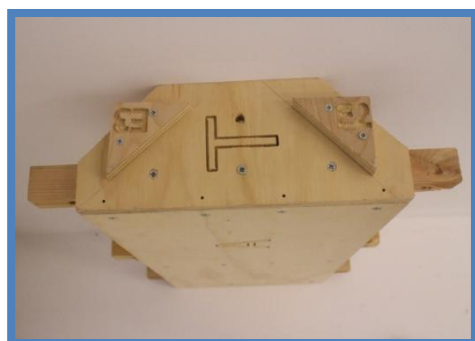
This section discusses the 13 completely assembled parts of the Wood Mold. By completely assembled part, we mean you have gone through Sections 1 (Cutting the Plywood) through Section 9 (Hardware Installation) of the Creating the Wood Mold part of the manual and are ready to fully assemble the Mold and pour a filter. **Please closely follow the directions in the Construction Manual for assembling each Wood Mold part and use this information and pictures as supplementary.**

Part A

Part A should be assembled with three (3) SMA pieces and part T (with two ear pieces).



Part A fully assembled with Part T and SMA pieces.

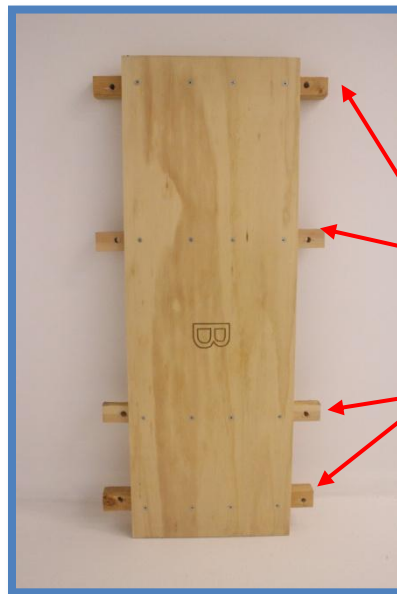


Part T should be flush with Part A.

Part B

Part B is assembled with four (4) SMA pieces. This will be the back of your filter. You might find it helpful to have an upward arrow so you know how to orient Part B for full Mold assembly. In this picture, the arrow indicates the way Part B should be oriented during Mold assembly prior to pouring concrete. The spacing of the SMA pieces is specific and it DOES matter how Part B is oriented. It must align correctly with Parts C and D.

Also, be sure that the screws are flush to the plywood. If the screws are sticking up above the plywood, they will leave an indentation in the concrete and subsequently on your filter. **This is true for any part of the Mold that comes into contact with concrete.**



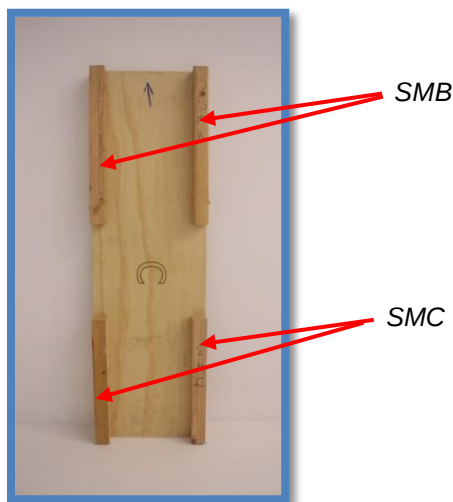
A front and back view of Part B. Note that the spacing between the top two SMA pieces is larger than between the bottom two SMA pieces. This is because these SMA pieces will align with the SMB and SMC pieces, respectively, on Parts C and D.

The top of Part B (as it is oriented in this picture) will align with the SMB pieces of Part C and D.

The bottom of Part B will align with the SMC pieces of Part C and D.

Parts C and D

Parts C and D should be identical, or as close to identical as possible. They have the same dimensions and are assembled in the same way with two SMB pieces and two SMC pieces.



A front and back view of Part C (Part D is identical). Two SMB pieces are placed across from each other and two SMC pieces are across from each other.

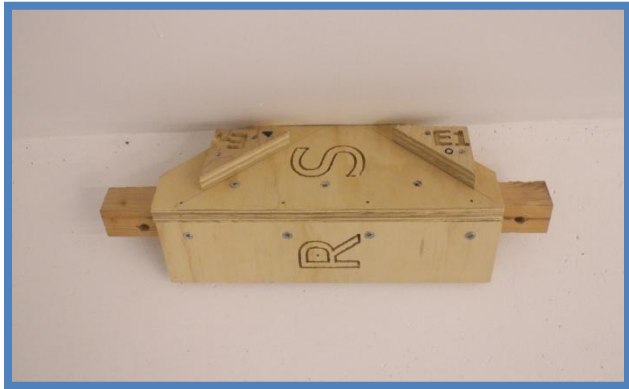


The SMB and SMC pieces should be flush to the top and bottom of Part C as well as to the sides.

In these pictures, a finger is used to show that the pieces should be flush.

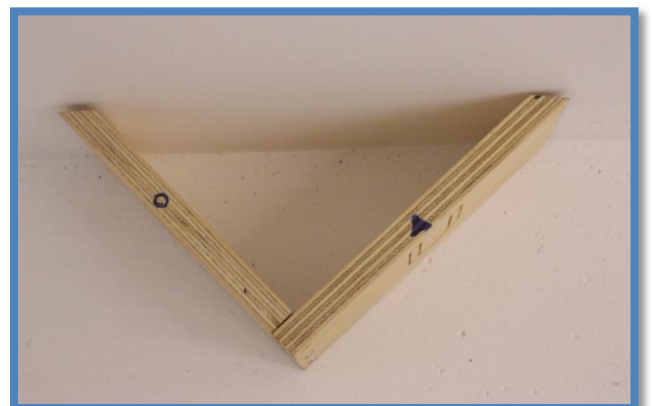
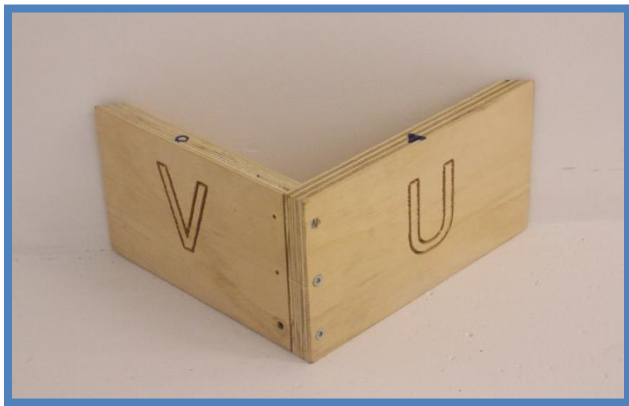
Part R

Part R is affixed to Part S (which has two ear pieces) and an SMA piece. Part S should be flush with Part R.

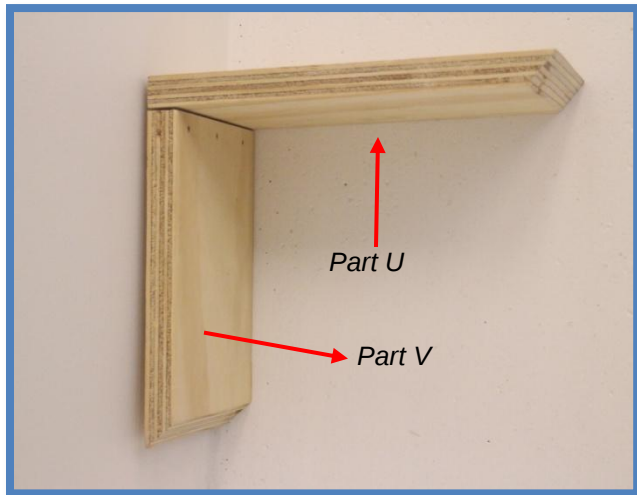


Part UV (Nose)

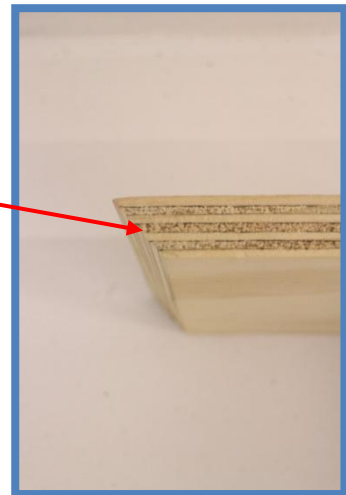
Part UV will be the nose of your filter. Part U is LONGER than Part V; they are 23.5cm and 21.5cm respectively. Both ends should have a 45 degree angle cut.



A front and aerial view of part UV.

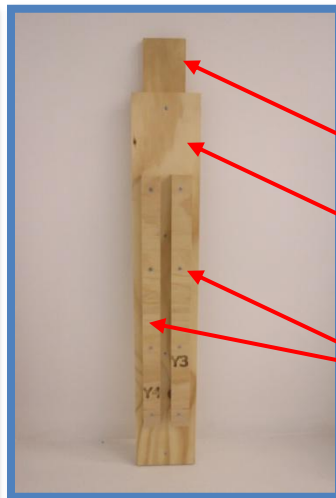


Do not forget the 45 degree angle cut. There should be an angle cut on both Part U and Part V.



Part K/N and Part L/M

Part K is affixed to Part N, along with two Y pieces. Part L is affixed to Part M, along with two Y pieces. Once fully assembled these two Parts should be identical.

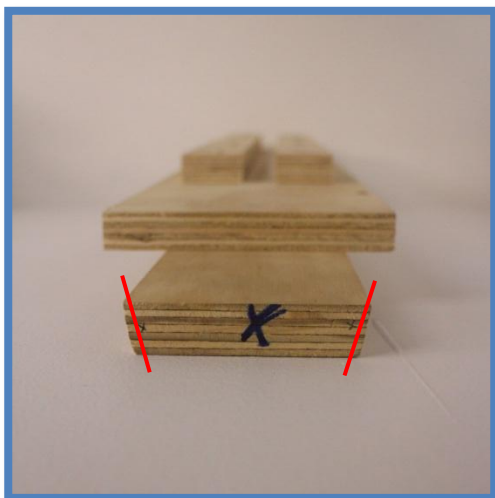


A front and back view of Part L/M. Part K/N is identical.

Part L

Part M

Parts Y3 and Y4 (the four Y pieces should be identical. It does not matter which Y pieces go onto Part M or N. For instance, you could have Y1 and Y3 on Part N and Y2 and Y4 on Part M).



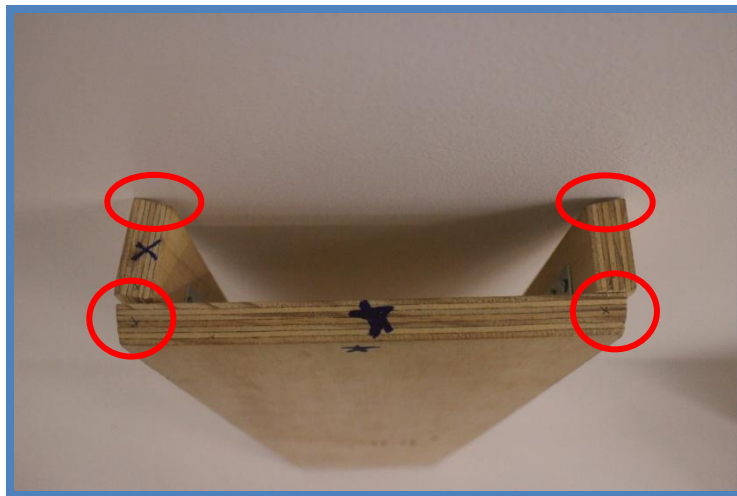
Left: There are 10 degree angle cuts on both sides of Part L (K). Red lines are used in this picture for clarity and are not drawn at exactly 10 degrees.

Right: When placing the Y pieces onto Part N (M), make sure there is room for the dagger board (Part P) to fit in between. You should be able to slide the dagger board up and down.

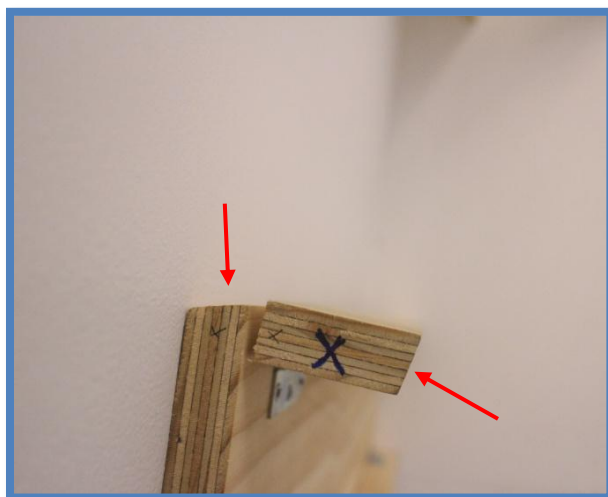


Part E and Part F

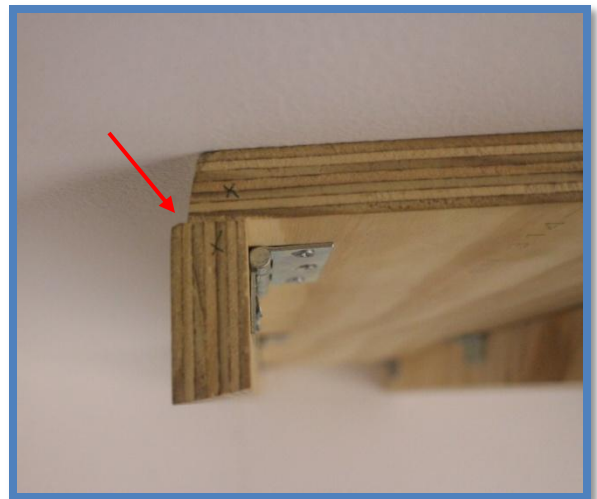
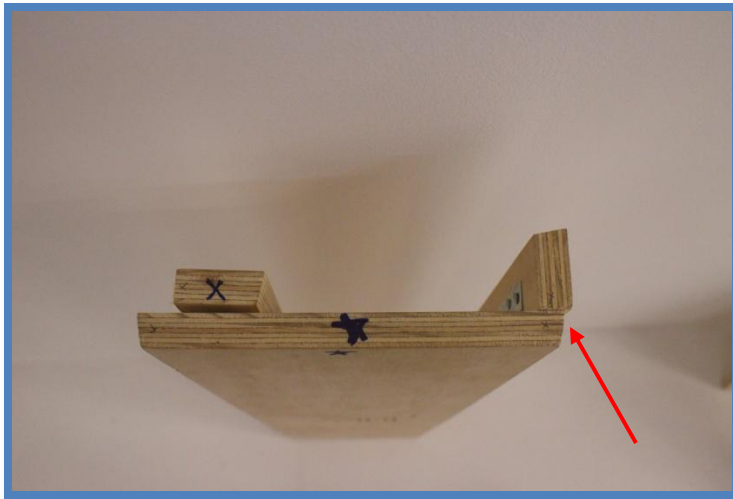
Parts I and H are affixed to Part E. Parts J and G are affixed to Part F. These pieces, when completed, should be identical.



Left: Pay close attention to the angle cuts on these pieces. Both sides of Part E (F) receive a ten degree angle cut. One side of Parts G, H, I, J receive a ten degree angle cut.



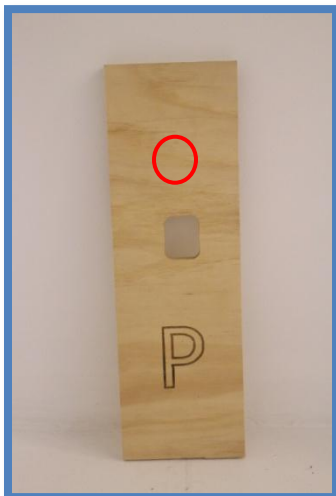
Left: A close-up of the angle cuts.



The hinged pieces (Parts G, H, I, J) should be approximately 1 mm offset of Part E (F) as shown in the above pictures. **These pieces should NOT be flush to the sides of Part E (F).** If they are completely flush, you may not be able to remove the pieces from the Mold once concrete is poured.

Part P

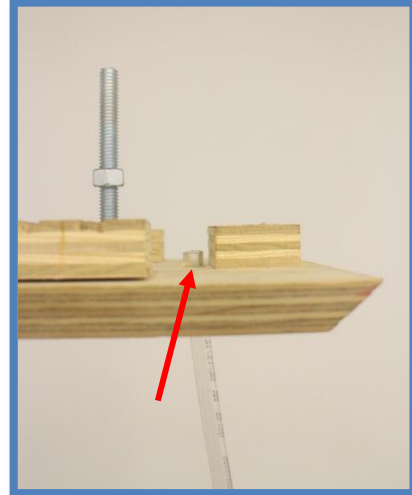
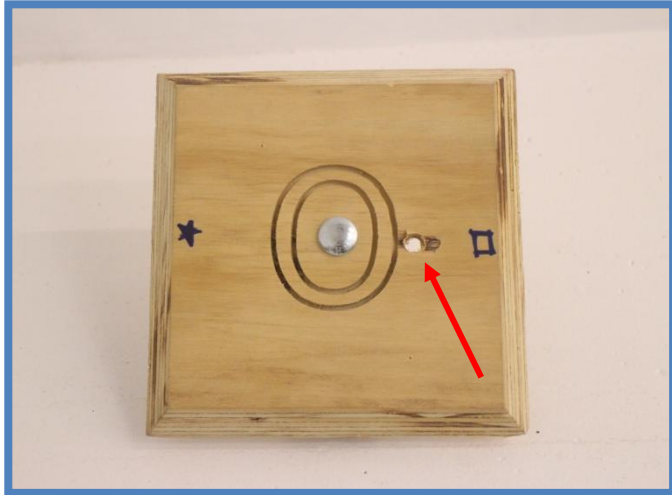
Part P is also called the dagger board. The dagger board goes inside the inner core and prevents it from collapsing on itself. The dagger board is crucial to the proper functioning of the Mold. If it is too wide, your inner core will not fit together properly. Similarly, if it is too thin, the inner core will get pressed in too much once the concrete gets poured and it could impact the inner dimensions of the Filter.



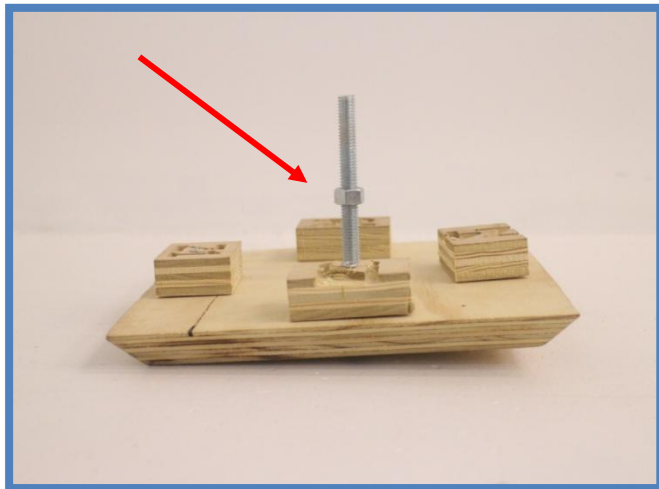
We recommend making a hole near the top of the dagger board; this will make it easier to remove (see the section on [Dagger Board Removal](#)). In this picture, the hole is at the center of the board. This is fine, but you might find it useful to place it more towards the top, as shown by the red circle. This way, the hole will be towards the top of the Mold during de-molding and it will be easier to tie a rope through the hole to remove the dagger board.

Part O

Part O is the inner core lid.



Above: Do not forget the tube hole. The outlet tube should only stick out slightly from the hole (see top right). If the tube sticks out too much, some of the smaller gravel in your filter could block the tube and it will prevent the filter from working properly. If you end up with this problem, you should use scissors to cut the outlet tube.



Left: The nut should sit halfway on the bolt. **DO NOT TIGHTEN IT ALL THE WAY.** The nut needs to sit halfway on the bolt so that during de-molding, the claw of a hammer (or crowbar) can be used to remove Part O. If the nut is tightened all the way you will not be able to grip it properly and will not have enough leverage to remove it.



Left: There are 40 degree angle cuts on all 4 sides of Part O. Without these angle cuts, it will be very difficult (nearly impossible) to remove Part O without damaging it or other parts of the Mold.

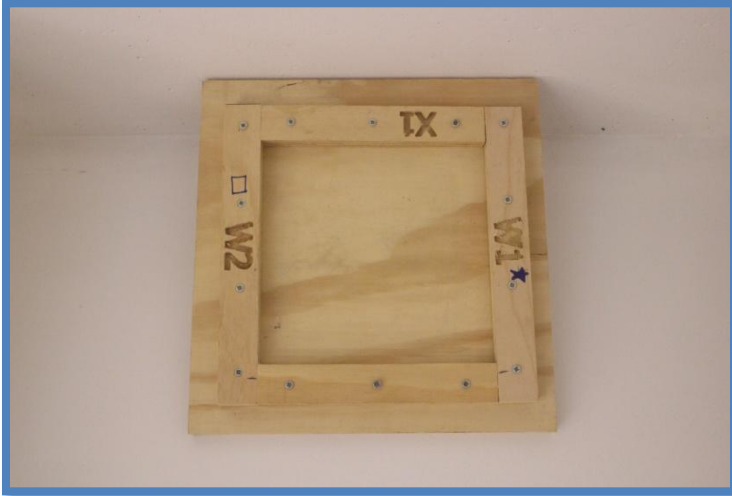
In this picture, you can see the bolt has a round head. It is called a carriage bolt. You only need a carriage bolt for this part of the Mold; you may use hexagon bolts for the rest of the Mold. If you are unable to find a carriage bolt, a hexagon bolt is fine. The round tip is helpful because it will create a smoother surface on Part O, but it is not absolutely necessary. The bolt should be tightly fitted (use a hammer) into Part O. It is loose in this picture only to show the round head.

Part Q

This is the base of the entire Mold. W1/W2 and X1/X2 are affixed to Part Q to form the base.



Part Q is NOT square. Because of this, your filter will not be square. It will be a rectangle.



The inner core will sit inside the rectangle created by the W and X pieces. The outer shell pieces (A, B, C, D) will sit on the outside. The width of the W and X pieces will correspond to the thickness of your filter walls. Try to keep the width of these pieces the same. Parts E and F of the inner core should be placed next to the W pieces when assembling the inner core because they are the wider pieces of the inner core.

Hardware Purchasing Guide

Although having access to the exact tools and materials referenced in the manual will make the Wood Mold easier to use and make, it is not mandatory. It is, however, vital that the hardware purchased is serving its purpose correctly. This guide allows you to better understand the purpose of each piece of hardware so that you can find alternative local options if necessary.

Bolts

The bolts are used to keep the outside of the Mold together tightly and securely.



The bolts help keep the outside of the Mold together while the concrete is curing.

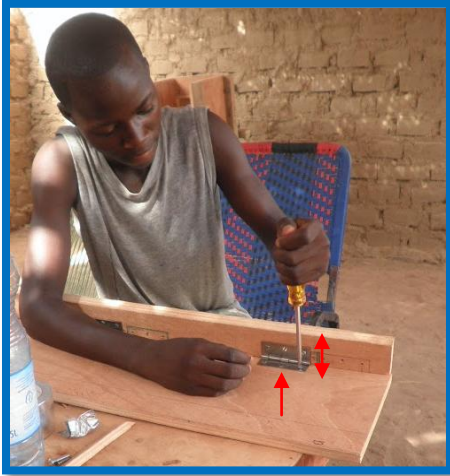
We recommend using at least 1, but preferably two washers, with each bolt. This helps protect the support pieces (SMA, SMB, SMC). If you are able to use two washers per bolt, we recommend placing one washer between the bolt head and the support piece and the other washer between the nut and the support piece.

We recommend you use a hexagon bolt 5 inches long, $\frac{1}{4}$ inch thick, and fully threaded. We choose 5 inches long because it's just long enough to get through the support material and allows room to add the nut and washer. The longer your bolt the more difficult it will be to remove. Also if your bolts are too long, they become hazardous in the workspace, catching and ripping clothing or tarps and occasionally cutting a leg or two if you aren't careful. **Please don't buy anything longer than 7 inches.**

We recommend a minimum of $\frac{1}{4}$ inch thick bolts; anything smaller is likely to bend. Although you can use a bolt thicker than $\frac{3}{4}$ inch, it would be excessively strong. The hexagon head allows you to grip the bolt with a wrench for tightening and loosening. The threads are very important. If you buy bolts that are not fully threaded you limit how much you can tighten your bolts. With partially threaded bolts, the unthreaded section often sticks out past the end of the support material leaving you with a leaking, dysfunctional Mold. The key to buying nuts and bolts is to match every nut with a bolt BEFORE leaving the store. Occasionally a nut that seems the right size is a bit too loose, or sometimes your bolt will have a dent in the threads that will make it unusable.

Hinges

The hinges need to be anywhere from 2in. to 3in. long. We use particularly small hinges because they are attaching particularly thin pieces of plywood. These hinges will attach to a piece that is only 4.7cm wide. If you use a larger hinge, then it may be too big for the pieces it's meant to connect. However if you find hinges that are longer, but not wider than 1.8 inches, those are acceptable as well.

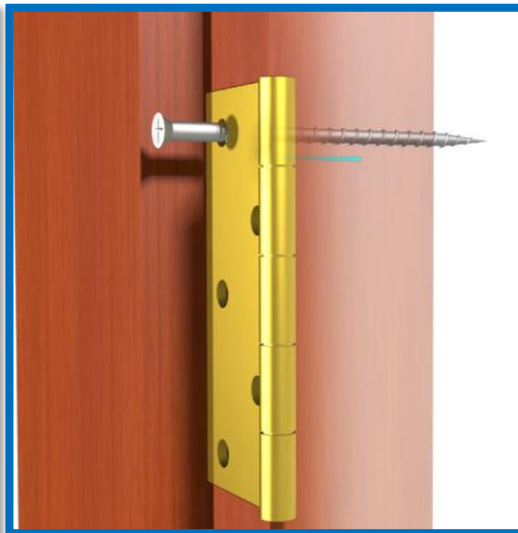


Make sure your hinges are the correct width. They should not be wider than the I,H,G,J pieces they are connecting.

Hinge Screws

These screws are particularly short because they are going into a SINGLE layer of plywood. This means that they cannot be longer than 3/4in. or they will stick out of the back of your plywood. Be sure to check that the head of the screw will still fit comfortably with the hinges you are using.

Make sure your hinge screws are the correct length.



If your hinge screws are too long, they will go through the plywood.

Nuts

We prefer hexagon nuts since they are easy to grip with a wrench and are typically the cheapest. It is okay to substitute with wing nuts. The key to buying nuts is to match every nut with a bolt **BEFORE** leaving the store. Occasionally a nut that seems the right size is a bit too loose, or sometimes your bolt will have a dent in the threads that will make it unusable.



Hexagon Nuts are recommended by OHorizons and are usually cheaper.



Wing Nuts are an acceptable alternative.

Washers

We use these to increase the life of the support material. The hexagon points will dig into the lumber when tightening without these small metal washers to protect it. Simply try the washers with your nut/bolt combinations. The washers inside hole should be large enough to get around the bolt, but small enough that the nut will keep it in place.



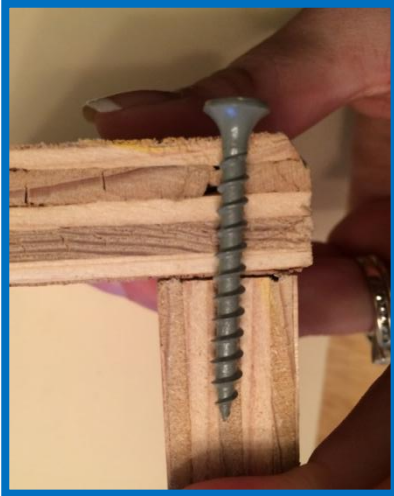
If possible, we recommend two washers per bolt for extra durability. We recommend placing one washer between the bolt head and the support piece and the other washer between the nut and the support piece.



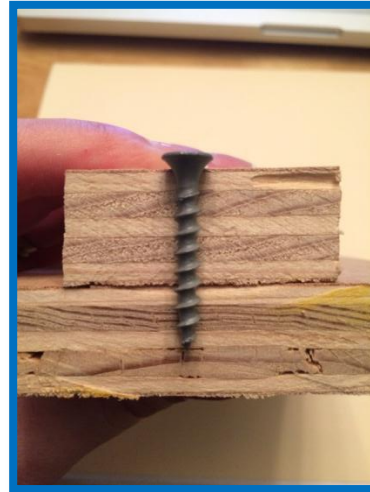
The washers are used to protect the support material from the head of the bolts. Using them will increase the life of your Mold.

Screws

We recommend using two different size screws with the Wood Mold. The 3 cm screws are used exclusively when two pieces of plywood are laid on top of each other. The 4 cm screws are used to attach plywood to support material, or to attach plywood into the edge of another sheet of plywood. **Pay attention to the directions in the manual to be sure you are inserting the correct size screws.** Be careful when purchasing your screws that you buy the best quality available. Ideally, you want galvanized wood screws. Do not buy drywall screws, they will be too weak for this project and the screw heads will likely snap off.



4 cm screws are used to attach two pieces of plywood OR a piece of plywood to support material.



3 cm screws are used to attach two pieces of plywood to each other.



Read the manual carefully to make sure you are using the correct size screw.

*Left to Right:
Hinge screw, 3 cm screw, 4 cm screw.*

Carriage Bolt

You only need one of these bolts for each Mold. This is an optimal design as the round head will minimize the impact the Mold will have on the concrete. If there are only hexagon bolts available these will work as well. This bolt also needs to be fully threaded to allow the nut to sit around halfway. The nut must sit halfway so the lid can be removed during demolding.



Make sure the nut is NOT tightened completely. It should sit halfway on the bolt so the lid can be removed during demolding.

Proper Tool Use and Safety

Please carefully review the following sections to ensure proper safety and tool usage when constructing the Wood Mold. Properly using your tools will not only ensure a safe working environment, but also allow tools to last longer and make your Mold construction process more efficient.

General Safety and Tips

- Please consult a local expert in the use of the following tools to ensure proper usage of your model.
- NEVER wear loose clothing while using power tools. They can get caught in the turning mechanisms, pulling you towards the blade.
- ALWAYS wear closed toe shoes, safety glasses, and gloves when using any tool.
- With any machine, it will last longer if you maintain it well. Most manufacturers recommend using clean cloths to remove dirt, dust, oil, and grease after every use.
- Check to ensure you are using the right type of blades and drill bits. There are specific styles for tiles, wood, metal, and masonry. The tool packaging will typically specify. Also be sure that the saw blade you purchase fits the tool. A table saw uses larger blades than a circular saw. If the blade is too big or too small it can be dangerous.

Circular Saw

Circular Saws are used to make straight and angled cuts in the plywood. These saws can be very dangerous if used incorrectly. However, with the proper precautions and knowledge they are easy to use.

Do's and Don'ts:

- Always have a partner around in case of emergency.
- Always wear safety glasses while using a saw.
- Only hold the saw on the proper handholds. DO NOT touch the silver platform while using the saw.



Use the handholds on the circular saw.



Be careful NOT to touch the silver platform while cutting.

- Never reach across the path of the blade.
- The saw should only be on and running while near the wood. DO NOT turn around or wave the saw while it is on. As soon as you have finished your cut, allow the saw blade to stop before moving the saw.
- Never start the saw with the blade touching the wood, it should be slightly behind the wood.
 - Always use the silver platform/guide to keep your cuts level and straight.
 - Look down at the saw from the top, not the side while cutting. Looking from the side will cause you to veer off the cut line or angle your blade. Looking from the top will keep you balanced and allow you to use the guides on the platform.

Kickback: this is when the saw unexpectedly tries to move backward while running because something has stopped the blade from turning.

- Everyone near the saw needs to be aware of this possibility and keep his or her hands, arms, and bodies out of the way of a potential kickback.
- It is the saw user's responsibility to try to control the kickback by stopping the movement and immediately releasing the 'on' trigger.
- Kickback is usually very mild and can usually be controlled.
- Kickback is EASY to prevent, if the saw is used correctly.
- If the blade is getting stuck or you are experiencing kickback it may be due to the following:
 - You have run out of battery.
 - The piece you are cutting is unsupported and is pinching the blade.
 - You have changed the angle at which the blade is cutting and caused the blade to pinch.
 - Don't try to cut through metal. Check your piece of wood for nails or screws before cutting. Metal will ruin the blade
 - If you veer from the cut line, avoid the natural tendency to twist and bend the saw blade so it gets back on track. This will only result in an uneven and rough cut. Instead, stop sawing and bring your blade back to the point where you veered off. Start cutting again on the line.

Drill

- An electric drill will be used to create pilot holes, add screws, and create holes for bolts. Drills are relatively easy to use, but also require caution and understanding for appropriate use.
- Only turn on the drill when it is in position for use. Do not turn on the drill and wave it around.
- Do not touch drill bits or driver bits directly after use; they will be very hot.
- Most drills have a torque adjustment. The torque is the setting where the drill disengages so that it won't burn out the motor. If you need more torque, use a higher number. But, if you are just starting out, try it on a lower setting. Keep in mind a high torque setting can cause the screw head to sink in too far or break off completely.
- There is a button on each side that is used to change the drill rotation direction. Clockwise to drill and drive screws. Counter-clockwise to remove screws.



SIDE VIEW: Push the button to change the direction of the drill.



FRONT VIEW: Push the button to change the direction of the drill.

Clockwise to insert screws.

Counterclockwise to remove screws.



Drilling holes:

- To be effective, the drill bit must maintain the same angle the entire time. You are likely to break a drill bit if your angle changes during use.



Keep the drill bit at the same angle while drilling, do not change directions. Try to drill at a straight angle.



- When holding the drill, make sure your shoulder is aligned directly behind the drill. This will help you provide pressure and support.



Align your shoulder behind the drill.

- Always start your drill slowly using gentle pressure, and then increase the speed once you've started your hole.
- A standard drill bit uses only the very tip of the bit as a cutting surface. The sides of the bit will not cut wood.
 - It is common to try to expand a whole by pressing the drill bit to the sides. This will not work. You must use the tip of the drill bit to do this.
- If your drill bit wanders from the point you would like to drill, try using a nail to make a small hole before drilling. This will help keep your drill bit in place.



You can make a small hole with a nail to help guide your drill bit.

Inserting Screws:

- First make sure that your driver bit is the appropriate size for the screws you are using. If the cross is too small, it will strip the screw.



Make sure the drill bit properly fits the screw head.

- The most effective way to insert a screw is to start with a small pilot hole. The pilot hole will provide a guide for the screw, and prevent the wood from splitting.
- When using the drill to insert a screw, always start your drill slowly then speed up as the screw catches the wood.
- Make certain that the crosses are fully engaged while drilling or you are likely to strip the screw.
- When adding and removing screws, you should ALWAYS be pressing the drill forward, positioning your shoulder directly behind the drill.

Handsaw

The handsaw is an alternative to using a circular saw or table saw. Occasionally you may prefer the hand saw for very small cuts to reduce the danger of using a high-powered blade near fingers.

Things to Check When Shopping for a Handsaw:

- **Sharp cutting edge or teeth.** Run your thumb lightly over the cutting edge or teeth. If they're properly sharp, they'll catch your skin with little snagging tugs. Do not cut yourself.
- **Straight blade.** Hold the handle of the saw up to your eye and look down the edge of the blade. If there is even a slight bend in the saw it will cause problems. Check the handle as well. A crooked one makes sawing inaccurate and tiring.
- **Evenly set teeth.** Squint toward the teeth from the back of the saw. If all teeth on one side are farther from the middle than those on the other side, the blade will twist.
- **Proper flexing.** Your saw should flex or bend easily when you bend it, but quickly straighten when you let you go.

When you make the first cut, use your thumb or the knuckle of your thumb on the hand holding the wood as a guide to ensure you cut along the cutline.



Use your thumb to guide the saw as you slowly start to make the first few strokes cutting the wood.



Make a few slow strokes with the blade to get the cut started. Once this cut is started, move your guide hand away from the saw. While cutting, hold your blade at a 45-degree angle and hold your elbows close to your body to prevent the blade from twisting.



Hold the saw at a 45 degree angle while cutting



Keep your elbows close while cutting

If you veer from the cut line, avoid the natural tendency to twist and bend the saw blade so it gets back on track. This will only result in an uneven and rough cut. Instead, stop sawing and bring your blade back to the point where you veered off. Start sawing again on the line.

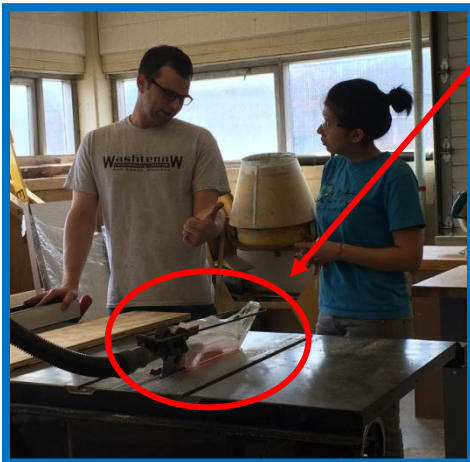
Prevent the wood from binding your saw blade by using a nail or wood shim in your cut near the blade.



Use a nail or wood shim to prevent pinching

Table Saw

- **DO NOT USE A TABLE SAW WITHOUT CONSULTING A LOCAL CARPENTER FOR PROPER USE.**
- The table saw is one of the most dangerous saws to use because it will not shut off by simply releasing a trigger.
- If you have the option, use a table saw with guards already in place. This will help prevent injury.



If available, use a table saw that has guards in place.

ALWAYS use safety glasses when using a saw.

- If your table saw has guides, use these as often as possible. These guides will provide maximum accuracy and the straightest lines.
- When cutting large pieces, always use a partner to help support the wood.
- When cutting, slowly and carefully press your piece forward and against the guard (if in use). Steady pressure will allow for greater accuracy.



Keep your hands away from the blade as you push the wood.

- If you veer from the cut line, avoid the natural tendency to twist and bend the saw blade so it gets back on track. This will only result in an uneven and rough cut. Instead, stop sawing and bring your blade back to the point where you veered off. Start sawing again on the line.
- The blade height should only be slightly taller than the wood you are cutting. The shorter the blade, the safer it is to use. The higher the blade, the fewer teeth are in the wood at any time, causing more friction and more heat; hence more potential for kickback.



The blade should not be much higher than the height of the wood. You can adjust the height of the blade if it is too low or high.

- Start the saw and allow it to reach full speed before moving the wood close to the blade.
- You can also use a stick to help keep your hands away from the blade.
- Never over-reach or try to cut a piece that is too long or too wide to be managed easily. Don't push the wood into the blade; just feed it into the blade with a little pressure. Forcing the wood causes extra friction and it could kick back.
- Allow the blade to come to a full stop before removing a piece of wood from the blade.

How to Fill the Wood Mold

1. Start with a fully assembled and oiled Mold.
2. Check to make sure your bolts are tightened so that no light is seen in the middle of the Mold.
3. Check that your outlet tube is in place. The tube should not touch the sides of the Mold.
4. Start filling your Mold in a circular pattern keeping the height of concrete equal on all sides.
5. When the concrete is just above the level of the nose, STOP filling and use a rubber mallet to vibrate the nose area (this is called tamping).
 - DO NOT directly hit parts U and V (making the triangle of the nose). These parts are one of the weakest and hammering may cause them to fail.
 - DO hit the support material and the top and bottom of the nose.



You can tamp the Mold with a rubber mallet.

- You can stop tamping when you see water seeping out from around your outlet tube hole.
 - You may need to add more concrete during this process.
6. Continue filling the rest of your Mold. Tamp the Mold throughout this process.
 - If there is no water coming out of the seams of the Mold, your concrete is most likely too dry.
 - If this happens, dip your fingers in water and sprinkle it into your mixture until you've reached the desired consistency. Then continue filling the Mold.
 - Test your concrete for the proper consistency while mixing by taking some in your hand and making a ball. This ball should hold together rather easily, but also be dry enough that it doesn't stick much to your hand or glove. If doing this with bare hands, quickly wash the concrete mix off your hands. Wet concrete is highly acidic and will dry out your hands occasionally causing blisters.
 7. The inner core will be easy to move until the Mold is roughly half full. At this point, make sure your inner core is exactly where it should be before filling the rest of the way.
 - If the center is moving an exceptional amount, it may be advisable to place wooden blocks between the inner core and the walls to prevent it from moving while filling the Mold. Make sure to remove these blocks when you reach the top.



You can use SC pieces or other small pieces of wood to stabilize the inner core while filling with concrete.

8. Once the Mold is completely filled, use a flat piece of wood or a trowel to level off the concrete on the top.
9. Cover your Mold with plastic sheeting or a tarp to help it retain moisture and protect it.
10. Allow your filter to cure overnight.

Dagger Board Removal Tips

There are several ways to remove the dagger board from the inner core. We recommend using the lever method as the primary method of removal and using other methods as necessary.

1. Lever (OHorizons' recommendation)

- Using a long piece of lumber or metal, wrap a piece of rope through the hole in your dagger board and around the lumber. Then use this lumber as a lever to lift the board out of the Mold.



Attach a rope through the hole in the dagger board and around a scrap piece of wood.



Use the wood as a lever to lift the dagger board upwards out of the inner core.



If rope is not available, another strong material that can be tied around the wood and dagger board will also work. In this picture, mesh material was used.

You can use a second piece of scrap wood to assist you as you lift the dagger board upwards.

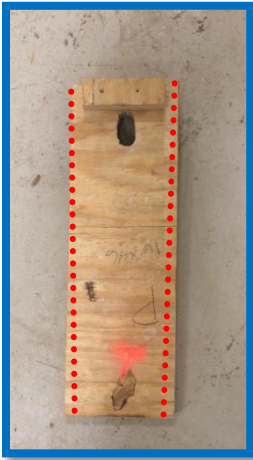
2. Crowbar

- Use a crowbar or other long metal pole with a hooked end. Place the hook below the bottom of the dagger board and thrust upward.

3. Draft

- Draft is when the top of the board is slightly wider than the bottom. There should only be about $\frac{1}{4}$ - $\frac{1}{2}$ cm difference between the two widths. This concept helps because as the dagger board moves out of the Mold, the thinner side will have less pressure on it making it easier to remove.
- Draft is optional and not required for functionality.

- You should have the top of the dagger board as the widest point, and then it should gradually get thinner towards the end. Both sides of the dagger should become thinner at an equal rate.

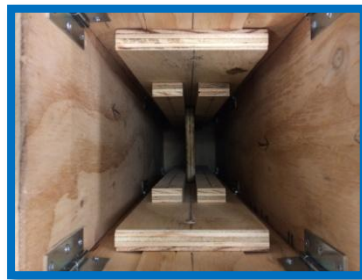


If you need to add draft, make sure the widest point is at the top of the dagger board. The sides should become thinner at an equal rate.

- **CAUTION:** If the dagger board is drafted incorrectly, e.g., widest in the middle or widest at the bottom, then the board may get stuck in the Mold.
- **When inserting the dagger board into the Mold, make sure the WIDEST part is at the very bottom touching the base.** The hole you have created in the dagger board should also be toward the bottom. This is because when you flip the Mold after the concrete has cured, the hole will be towards the top of the Mold.



Side view of dagger board placed towards base of Mold PRIOR to flipping.



Top view of dagger board placed towards base of Mold PRIOR to flipping.



After flipping the Mold for demolding, the dagger board will be towards the top, easing removal.

Tip: rubbing a bar of soap along the edges of the dagger board will increase its slipperiness and allow it to move more freely. This can be done as often as the Mold is used.

Selecting a Diffuser Basin

This section contains information on what materials can be used and how to build a diffuser basin for a BioSand Filter made from the OHorizons Wood Mold. This section contains information modified from the CAWST BioSand Filter Construction Manual. The full CAWST Manual can be found at www.cawst.org.

The purpose of the diffuser is to protect the top of the sand from moving around when you pour water into the filter. This protects the biolayer. The diffuser also makes sure the water drips onto the sand evenly across the top of the sand. This way all of the sand can be used to treat the water.

Diffuser Basin Material Options

Use a material that you can find locally and that someone local has the skills to work with.

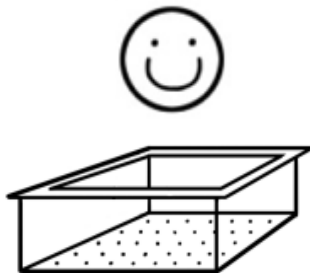
Material Options

- **Sheet Metal Diffuser**
- **Plastic Bucket Diffuser**
- **Injection Molded Diffuser**

Use a Diffuser Box. OHorizons *strongly recommends* using diffuser boxes with our filters. Diffuser boxes work much better than diffuser plates. If you still decide to use a diffuser plate, attaching handles are necessary because a filter made from the Wood Mold will not have a lip for the diffuser plate to rest on.

Tip: The most practical options for most operations are a Sheet Metal Diffuser or a Plastic Bucket Diffuser. Injection Molded Diffusers need to be sourced from a factory and only become a practical option when doing very large BSF operations (+10,000 filters).

Diffuser Box vs. Diffuser Plate



Diffuser Box



Diffuser Plate with handle



Diffuser Plate with no handle

Diffuser Basin Designs

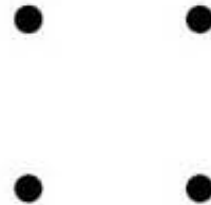
Option 1: Metal Diffuser Box and Lid (pg. 38-45)

Option 2: Plastic Bucket Diffuser (pg. 46)

Option 3: Injection Molded Plastic Diffuser (pg. 46)

Design:

- ☐ Holes should be 3 mm (1/8") in diameter. You can use a 3 mm (1/8") nail to make the holes. Larger holes will result in disturbance of the surface of the sand. Smaller holes will restrict the flow through the filter, possibly causing the flow rate to drop.
- ☐ Holes should be spaced out by 2.5 cm (1") in a grid pattern.
- ☐ The diffuser should fit tightly inside the filter, and there should not be any gaps between the diffuser and the concrete walls. A gap allows water to travel along the walls of the filter, rather than being distributed evenly through the holes of the diffuser plate. A tight fit also keeps the diffuser from floating.
- ☐ The diffuser should be easy to remove.



Hole size (3mm) and
spacing (1") (actual size)



Note: Caution! Be careful of sharp edges and wear hand protection if needed.

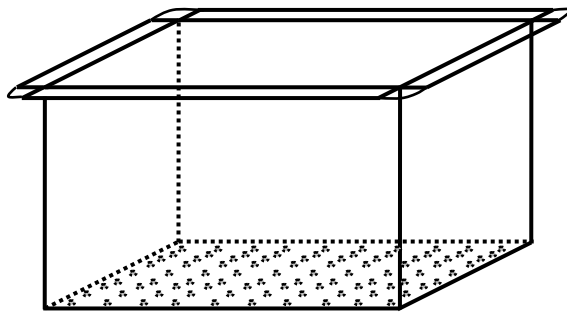
Option 1 – Metal Diffuser Box and Lid

Tools:

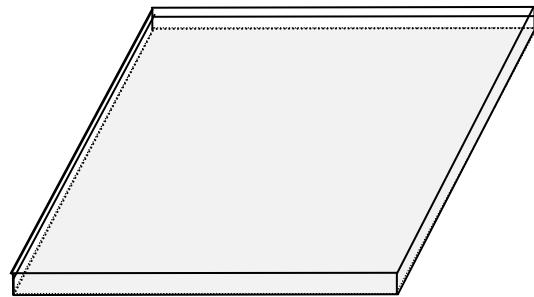
- ☐ Long straight edge or ruler (120 cm/48" or longer)
- ☐ Tape measure
- ☐ Square or right angle
- ☐ Marker
- ☐ Metal cutters suitable for 28 gauge galvanized sheet metal
- ☐ Drill with 3 mm (1/8") drill bit
- ☐ Hammer
- ☐ Folding tool (e.g. bending brake)
- ☐ Anvil or steel plate set in a vice to hammer sheet metal against

Materials:

- ☐ 1 sheet of galvanized sheet metal 2438 mm x 1219 mm (4' x 8'), 28 gauge thick (0.46 mm or 0.018")



Diffuser Box



Filter Lid

Steps:

1. Lay out the sheet metal and mark lines for cutting the outline of each piece according to the dimensions shown on **Figure 1**.
2. Cut out the side walls, bottoms, lids and corner pieces.
3. Measure and mark cut lines (solid line) and fold lines (dashed) for each piece according to dimensions provided in:
 - i. **Figures 2 & 3:** Filter lid
 - ii. **Figure 4 & 5:** Side walls and corner pieces
 - iii. **Figure 6 & 7:** Bottom piece
4. Cut along solid lines and fold along dashed lines as shown in the folding sequence provided in each Figure.

Figure 1
Layout for cutting sheet metal for 4
diffuser boxes

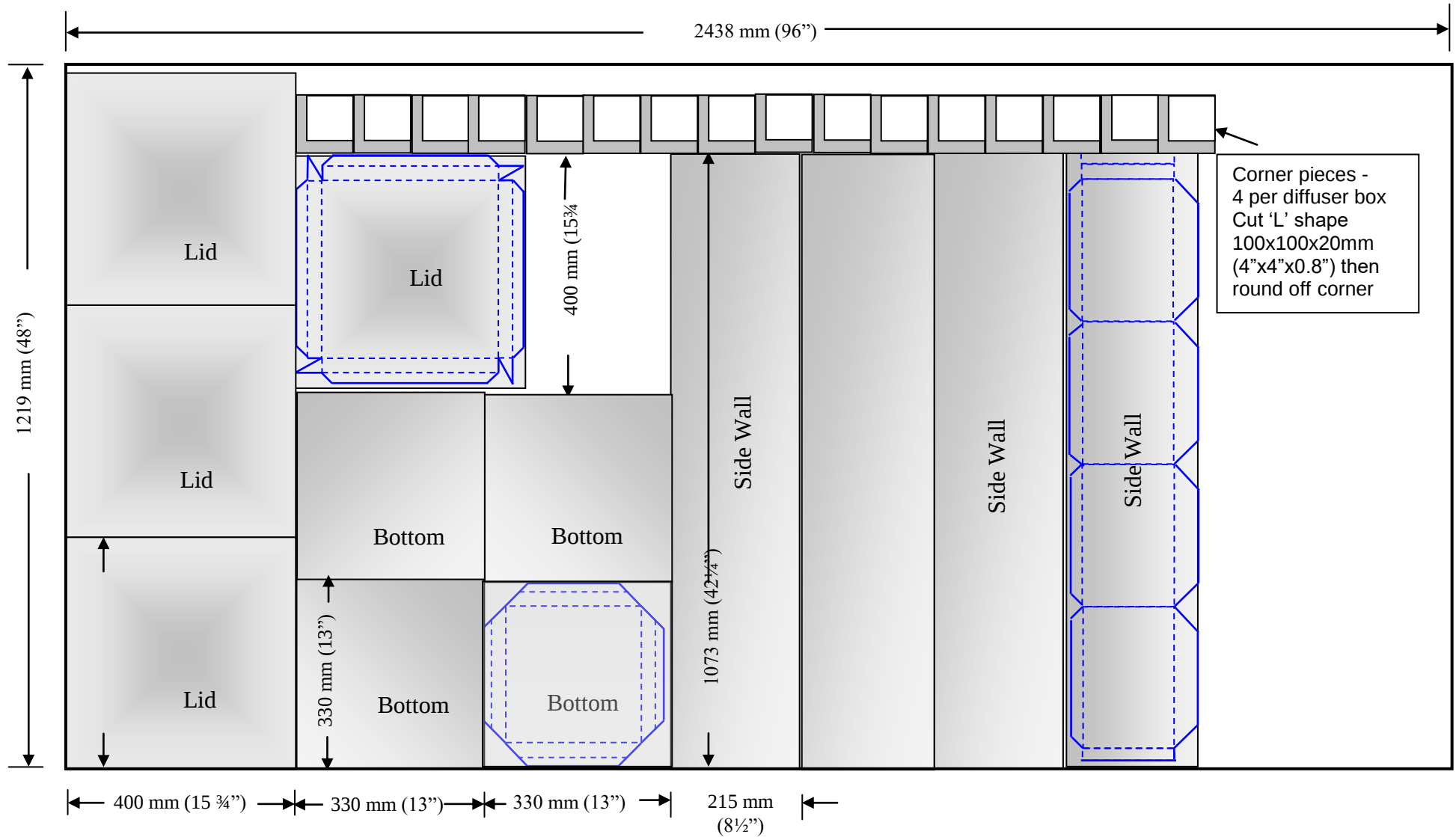
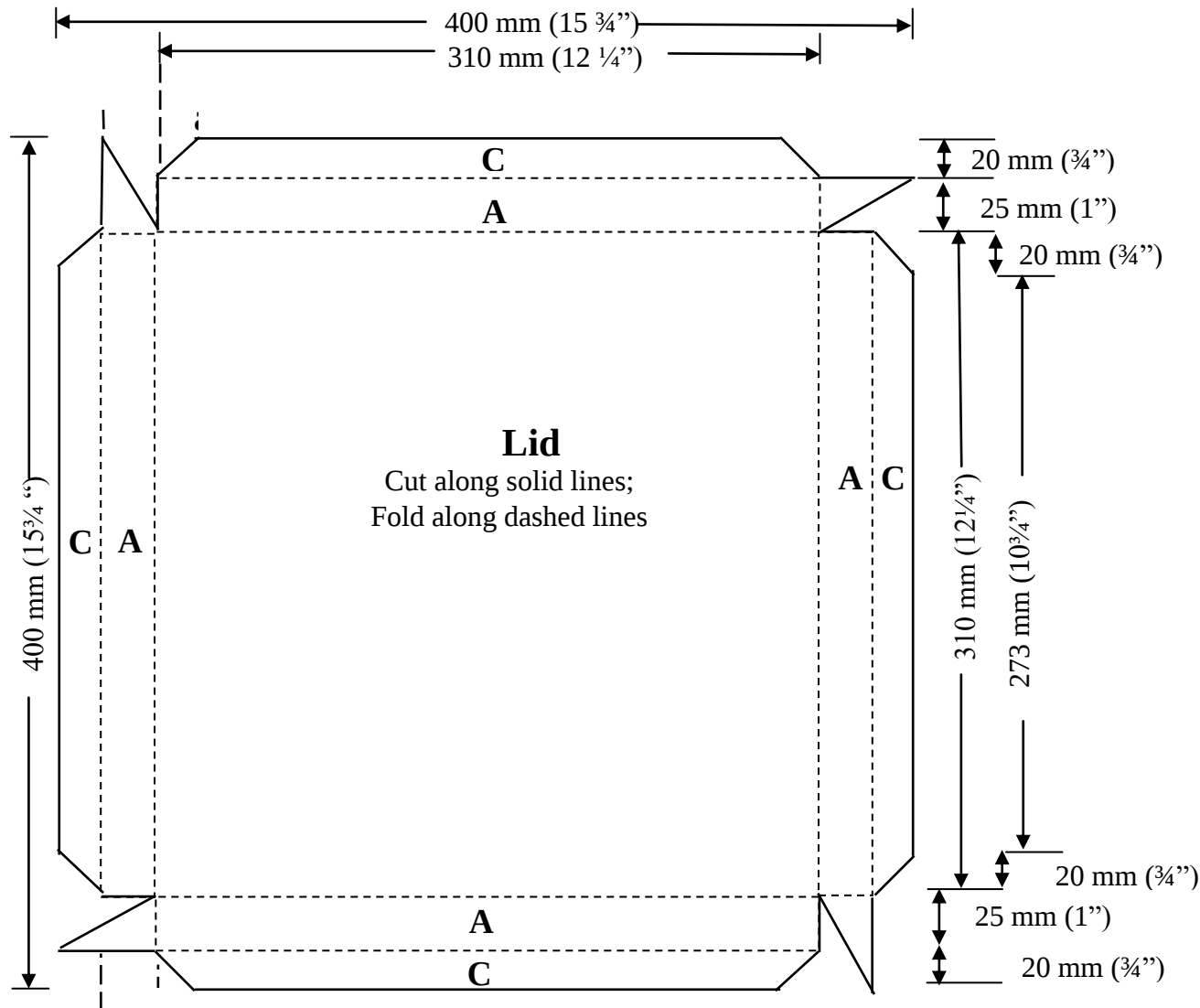


Figure 2
Filter Lid



Folding Sequence for Lid:

1. Fold four **A** flanges down along bend line **a - a**.
2. Fold flaps **B** 90° inward so they lie alongside (parallel to) flange **A**.
3. Fold flange **C** upwards along **c - c** and press to lock flaps **B** in place.

Figure 3
Folding Detail for Filter Lid

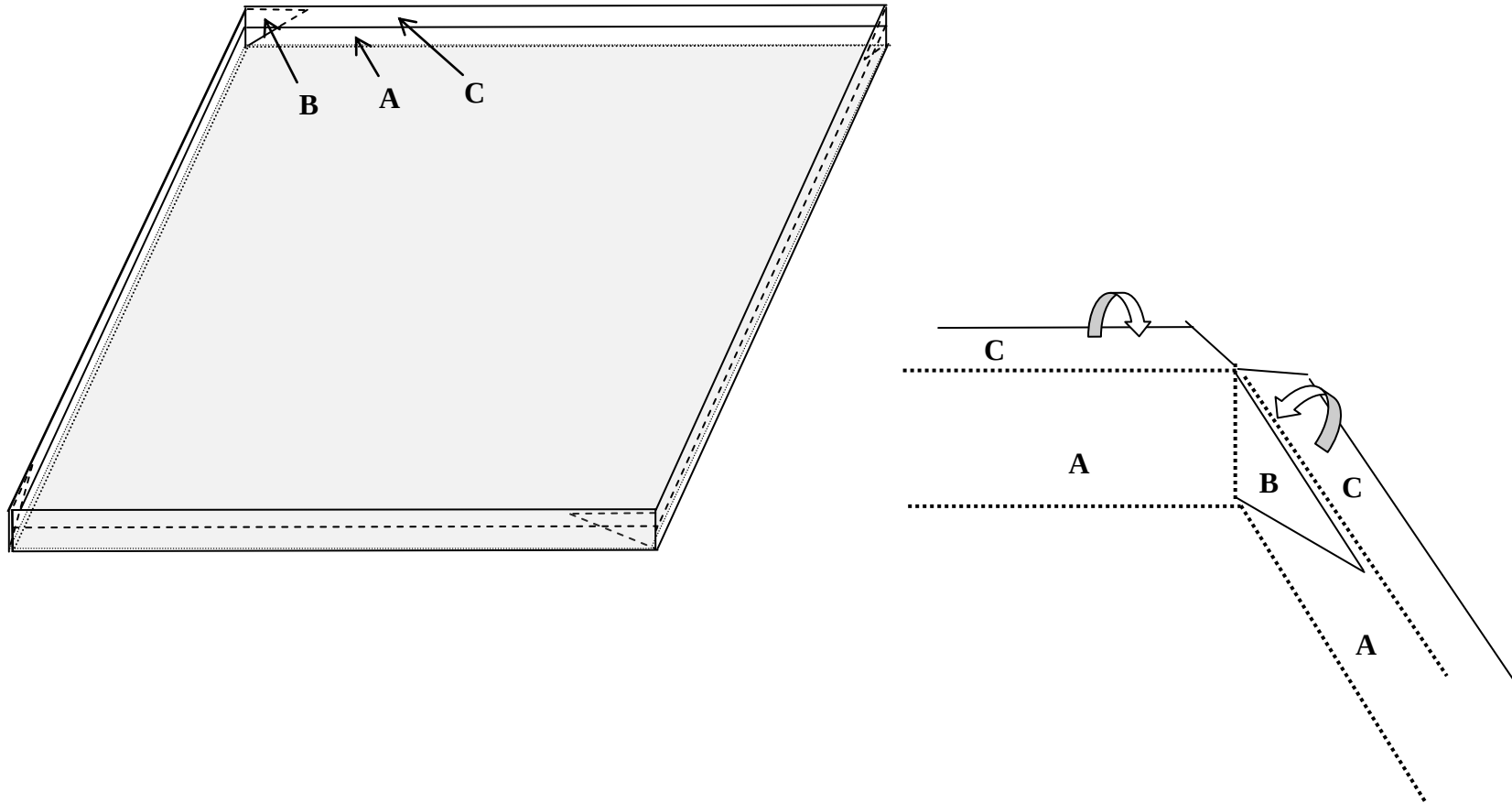
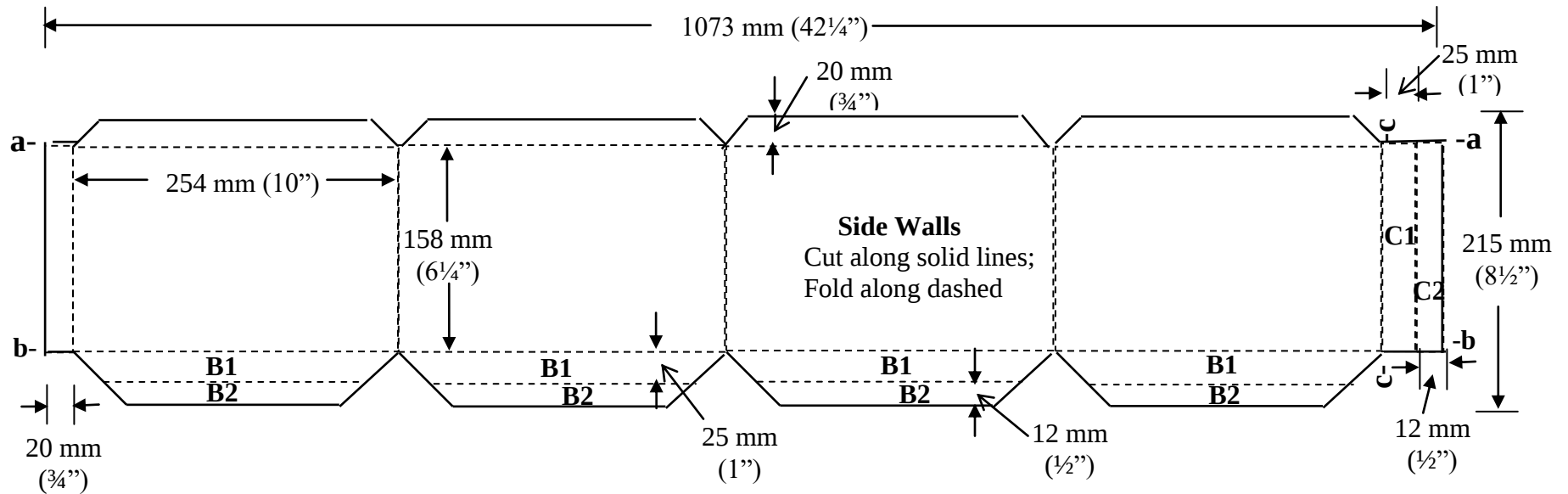


Figure 4
Side Walls and Corner Pieces



Folding Sequence for Side Walls

1. Fold flanges **A** to 90° along bend line **a- a**. These flanges will be on the outside of the box and attach to the Bottom Piece.
2. Fold flange **B** (tabs **B1** and **B2**) down 90° along **b-b**
3. Fold **B1** (outer tab of flange **B**) to 90°. This **B** flange will form a lip around the outside of the box. This lip will sit on the top of the walls of the filter to suspend the box in the filter. Tab **B2** will be on the underside of the lip of the box.
4. Fold **C2** (outer tab of flange **C**) to 90°. This flange will be on the outside of the box.
5. Fold flange **D** to 90°. This flange will be on the outside of the box.
6. Fold the box into a square and then fold the locking seam, first folding the outer tab **C2** tightly over flange **D**, then folding along line **c-c**
7. Lay in 2 corner pieces and then finish folding one flange **B** pressing it to lock the corner pieces in place. Work around the rim inserting corners, folding the remaining **B** flanges.

Corner Pieces

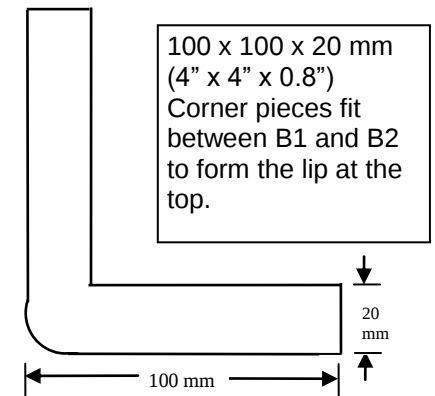


Figure 5
Folding Detail for Side Wall Piece

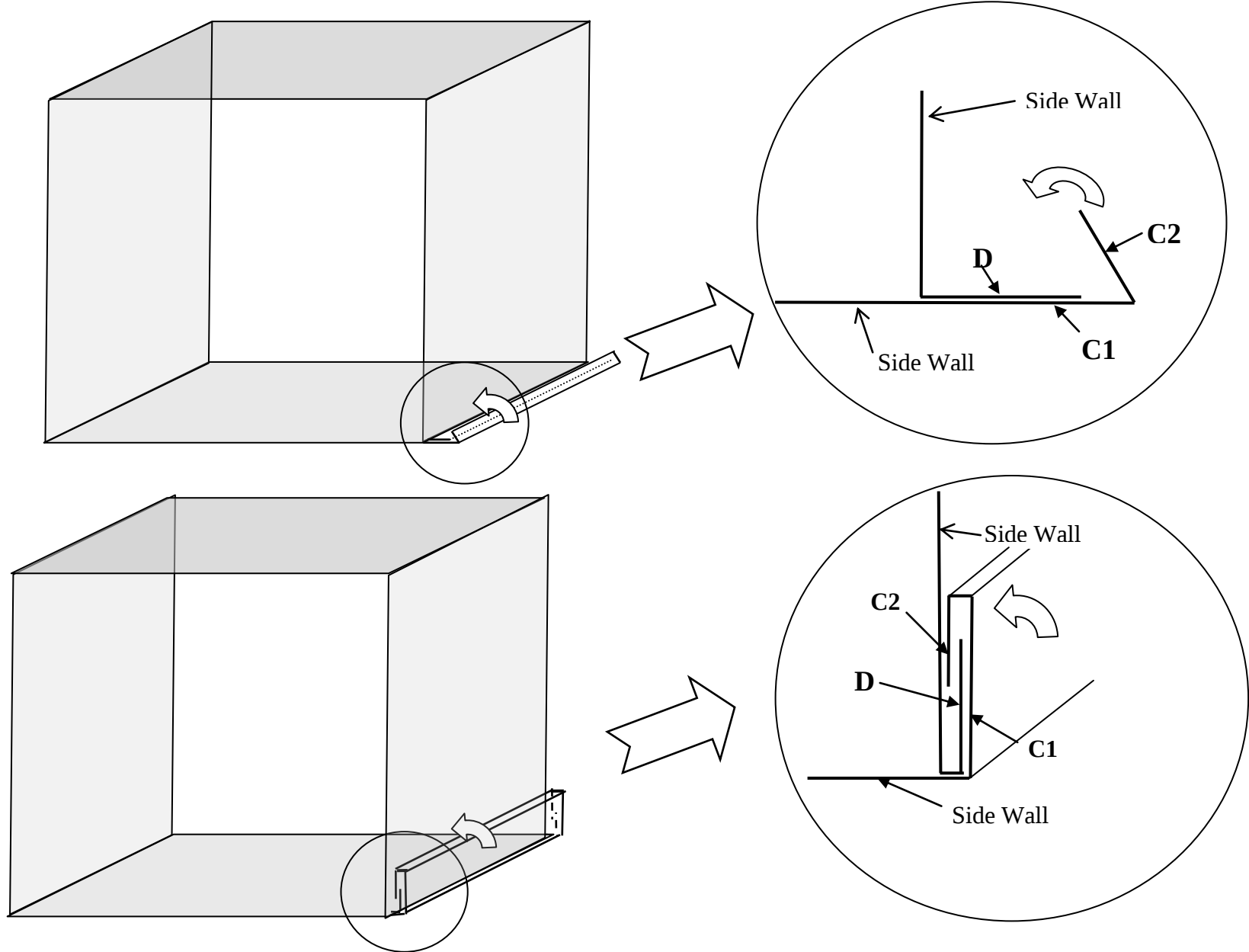
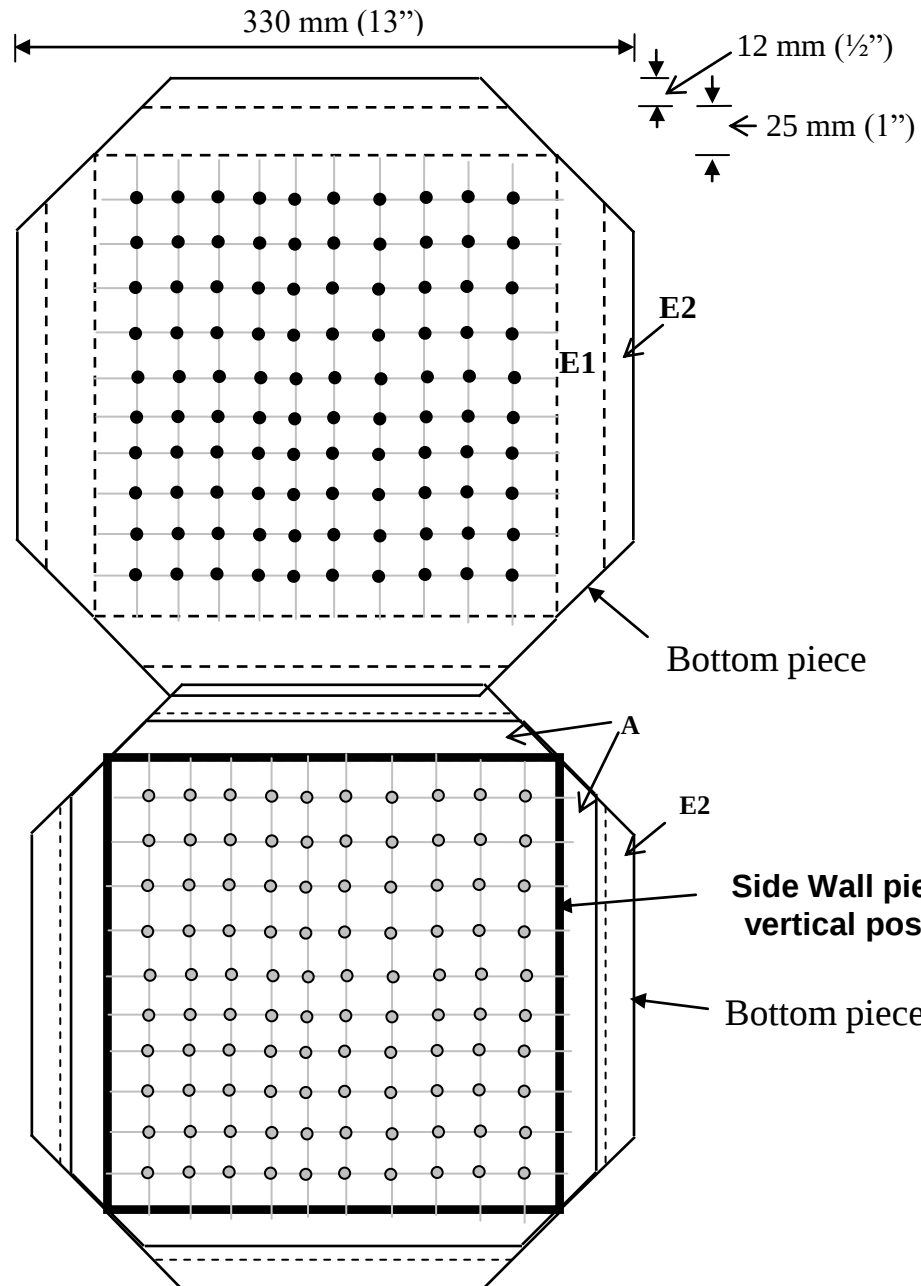


Figure 6
Bottom Piece

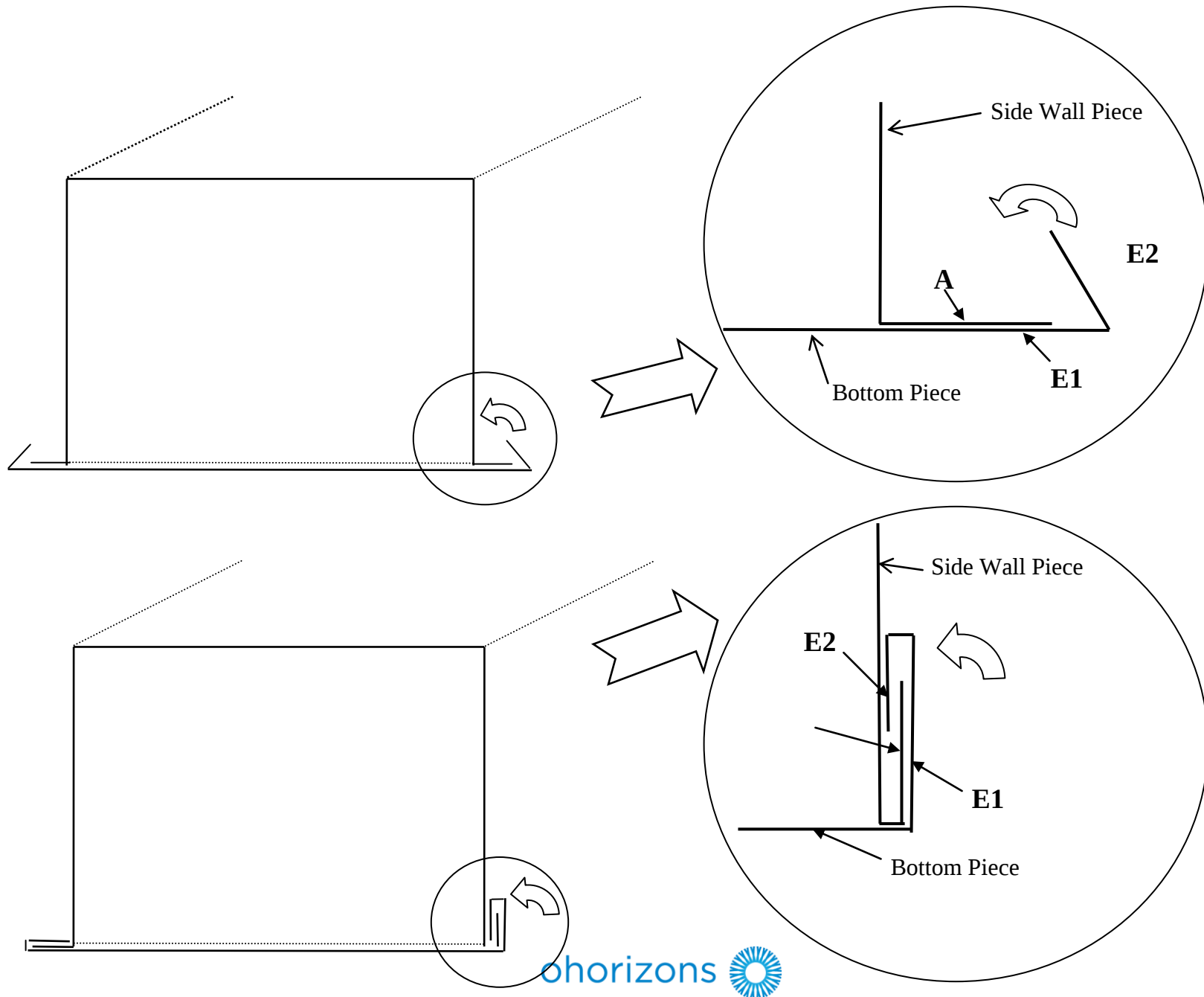


Folding Sequence for Bottom Piece

1. Punch or drill holes in the Bottom Piece
 - holes to be 3 mm ($\frac{1}{8}$ ") in diameter
 - space holes 2.5 cm (1") apart
 - make 80 to 100 holes
2. Fold E2 (outer tab of flange E) to 90°
3. Set the box (bold outline below) on the base and fold flanges E2 tightly over flanges A on the bottom sides of the box.
4. Fold up flange E against the outside of the box.

See also Figure 7 – Folding Detail for Bottom Piece

Figure 7
Folding Detail for Bottom Piece



Option 2 – Plastic Bucket Diffuser

Tools:

- ☐ Long straight edge or ruler (120 cm/48" or longer)
- ☐ Tape measure
- ☐ Square or right angle
- ☐ Marker
- ☐ Drill with 3 mm (1/8") drill bit
- ☐ Hammer

Materials:

- ☐ Plastic Bucket

Note: This can be done a number of ways, but the following is the most ideal

Steps:

1. Measure the inside widths of the filters made from your Wood Mold and use that measurement to determine the size of the bucket you need. Make sure the buckets you find are a minimum of 34cm (13.5 inches) deep. Optimally, look for a square bucket, although a round bucket will work as well.
2. Punch 100 evenly spaced holes into the bottom of the buckets you've chosen for your diffusers.
3. Using a wood or plastic square, cut a hole in the middle the size of your diffuser. Then attach your diffuser so it hangs 6-10cm above the sand.
4. Make sure to include a lid for your design to prevent bugs or other unwanted inhabitants.

Option 3 – Injection Molded Diffuser and Lid

Steps:

1. Determine the exact size dimensions of your concrete filter and create a diagram to send to a plastic mold fabrication company. **Note:** A diffuser basin mold typically costs \$13,000-\$20,000 USD and weighs around 500 lbs.
2. Once the Mold is manufactured, have it sent to the injection molding business that will make your diffuser basins. **Note:** You will have to inquire as to pricing, but expect \$1.00-\$2.00 per unit plus shipping. Buying in larger quantity typically lowers the per unit costs.
3. Ship diffuser basins to your project location.



If you decide to use an injection molded diffuser. Consider also utilizing this service to create your lids.



Injection Molded Diffusers typically only become a financially practical option when doing very large BSF operations (+10,000 filters). Check with a manufacturer to get accurate pricing for your region if you have a large project.

Selecting a Lid

This section contains information on which materials can be used and how to build a lid for a concrete filter made from the OHorizons Wood Mold. This section contains information modified from the CAWST BioSand Filter Construction Manual. The full CAWST Manual can be found at www.cawst.org.

The purpose of the lid is to stop anything from getting inside the filter. Lids will always be on the filters, inside people's homes. They should look nice.

Lid Material Options

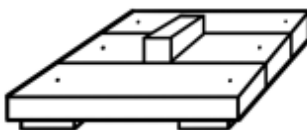
Use a material that you can find locally and that someone local has the skills to work with.

Material Options

- **Sheet Metal Lid**
- **Simple Wood Lid**
- **Injection Molded Lid**



Sheet metal lid



Wood lid + handle



Injection molded lid + handle

Lid Designs

Option 1 – Sheet Metal Lid (pg. 40-41)

Option 2 – Simple Wood Lid (pg. 49)

Option 3 – Injection Molded Lid (pg. 46)

Design:

- ☐ The lid should cover the entire top of the filter. It should not be easily knocked off the filter. It should be easy to take off and put on again.
- ☐ Some lids have handles, some don't. If there is no handle, people can store items on top of the filter lid.
- ☐ On wooden lids, the handle should be attached to the lid with at least 2 nails going into the lid at different directions, so that the handle does not pull out when you lift the lid.
- ☐ Wood lids should be painted with an oil-based paint to stop mold from growing inside the lid.

Option 2 – Simple Wooden Lid

Tools:

- ☐ Hammer
- ☐ Tape measure
- ☐ Saw

Materials:

- ☐ 2.5 cm x 10 cm (1" x 4") lumber (or whatever is locally available)
- ☐ Nails or screws

Steps:

1. Measure the outside width of the concrete filter at the top. If the filter is not perfectly square, you may need to measure the width in both directions.
2. Cut pieces of wood sufficient to cover the entire top of the filter. These pieces will form the lid itself.
3. Place these pieces in the shape of the lid, with the underside facing up.
4. Measure the top inside of the filter reservoir. If the filter is not perfectly square, you may need to measure the width in both directions.
5. Mark the size and position of the opening on the pieces of your lid (from Step 3). Cut two pieces of wood the length of the opening of the filter.
6. Place those two pieces of wood perpendicular to the other pieces, on top of the others.
7. Centre those two pieces of wood so that in both directions, they line up with the opening of the filter that you marked in Step 5. (Those two pieces will sit inside the opening on the filter and will stop the lid from moving in either direction.)
8. Nail each of the two pieces onto all of the other pieces.
9. Flip your lid over and ensure that it fits on the filter. (The two pieces from Step 6 should just fit inside the filter, and the other pieces should cover the entire top edge of the filter.)
10. Attach a handle. This handle is optional as the top of the filter can be used as storage if the handle is not attached (see photo below). If no handle is attached, the filter lid will still be easy to remove.



Top of a wooden lid with block



Under side of a wooden lid

Tip: Nails straight through the lid into the handle don't hold the handle on very well. Use at least two nails at different angles or a screw.

Wood Selection

Please review this section for suggestions on choosing the best and most appropriate kind of plywood for your Wood Mold project.

Standard Plywood

Standard plywood is usually the most affordable and easily accessible plywood in most regions.

Size

- OHorizons requests you use a 4ft x 8ft (121.6cm x 243.5cm) piece of plywood to create a Mold. This is a commonly available size in most countries. Our manual is specific to this size and we minimize waste from this sized plywood. If there is a major error in cutting the plywood, most likely there will not be a way to fix this and still create the Wood Mold from one sheet of plywood.
- This does not mean that other sizes of plywood or wood planks will not work. However, OHorizons has not yet tested these or created manuals to maximize their effectiveness. The largest piece of the Mold is 13.46in. x 38.85in. (34.2cm x 98.7cm). You need to be able to find wood that is at least that size in order to effectively use the Wood Mold.

Smoothness

- The two (2) largest sides of the sheet of plywood should be smooth to the touch.
- There should be few, if any, visible knots in the wood.
- One side may be rougher than the other. This is okay; simply make sure that during assembly you face the rough side of each piece of plywood away from the concrete. Your smooth side will take longer to react to the water and chemicals in concrete than the rough side.



Make sure the smooth side of the plywood faces the concrete.

Grades

- Often you will see a plywood grade stamped onto the wood. This represents the smoothness of the plywood.
- We prefer A or B grade plywood. However, if one side of the plywood is C or BB grade this is okay, simply face the C or BB side away from the concrete.
- If the labels are anything other than A, B, C, or BB do not purchase that piece of plywood. Look somewhere else.

Thickness

- Check that your plywood is $\frac{3}{4}$ in (1.84cm) thick.

- Preferably, your plywood will have 5 or more layers. The more layers the stronger the plywood.



The more layers, the stronger your plywood and the longer your Mold will last.

- Look along the sides for any holes. Small (1in or 2cm) holes are okay, but anything larger should not be used.

Straightness

- You want the plywood to be straight to make your Mold stronger. To check this, simply hold your plywood up with one long edge on the ground the other in your hand. Now move your eye so that it is on the same level as the edge in your hand. When looking along this edge, if you can see it bend to one side or the other, look for a new piece of plywood.



Look along the edge of the plywood to ensure it is straight.

Other Types of Wood:

Tropical or Marine grade plywood

- Marine grade plywood is a premium type of wood. It maintains very high standards, is exceptionally smooth to the touch, has no knots in the veneer, and is made using fully waterproof structural adhesive.
- This plywood is generally much more expensive, but will likely greatly increase the life of your Mold. If marine grade plywood is easy to find and affordable, then this is a premium choice.

MDF or Particle Board

- OHorizons does not support the use of MDF or particle board to create Wood Molds. Often this type of plywood is not water resistant and will quickly degrade when exposed to water and cement.



Do not use MDF or particle board to make your Mold.

Location Selection

Location selection for making the Mold:

- Ideally you will have access to a carpenter's shop. This will allow you to have a variety of tools on hand.
- If a carpenter's shop is not available, then you will need a large open space, approximately 20ft x 20ft (6m x 6m).
- There will be a large amount of sawdust created. Sawdust is highly flammable. Make sure you aren't near any open flames, like a kitchen.
- You should have a roof over your work area or over part of the area to keep equipment and materials dry. If not, have extra tarps on hand so you can quickly protect your tools and materials.

Location selection for pouring filters:

1. This location will depend on the size of your operation. If you create around 30 filters a month before delivery you will need a large open space, approximately 20ft by 20ft or 6 meters by 6 meters.
- Regardless of the size of your operation, you will need:
 - Easy access to water.
 - A dry area to store sand, gravel, and cement.
 - An acceptable "wet" area used to mix concrete and pour filters, preferably on a concrete slab, in a mixer, or in mixing buckets. If mixing on packed dirt, be very careful not to mix dirt into your concrete mix.
 - An area to store curing filters.
 - An area to paint and ready filters for installation.

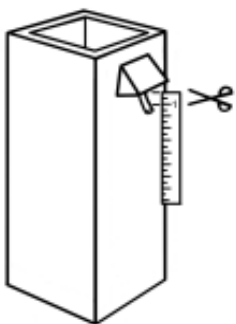
After Care: Supplementary Information

This section provides additional information to the After Care section of the Wood Mold Construction Manual. This section contains information modified from the CAWST BioSand Filter Construction Manual. The full CAWST Manual can be found at www.cawst.org.

Finishing the Filter Body



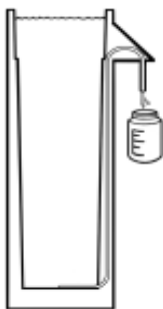
1. Write a filter number on the filter. Fill in the Filter Tracking Form (please ask OHorizons for a Tracking Form).



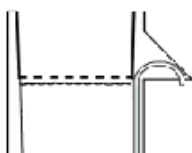
2. Check the outlet tube. It should be about 1 cm long. If it is too long, cut it shorter.



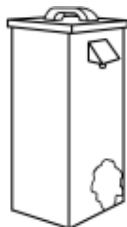
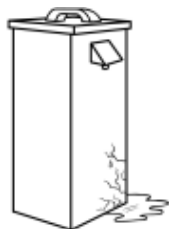
The water level in the filter is determined by the end of the outlet tube. Due to a siphoning effect, the water will stop flowing when the standing water is at the same level as the end of the outlet tube. If the tube is too long, the standing water may be too shallow or even down inside the sand.



3. Fill the filter with water. Measure the flow rate—it should be about **1 liter per minute** (about 33.8 fluid oz US per minute).



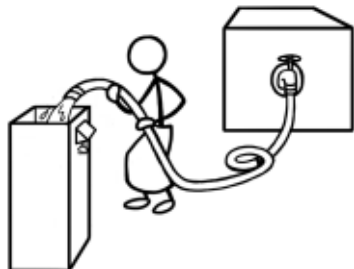
4. Once the water stops flowing, look at the water level inside the filter. Make sure it is below where the diffuser will be. If not, try to see if there is something blocking the outlet tube.



5. Check the filter for cracks and leaks.

If there are leaks, chip out the crack with a hammer and chisel. Make a paste with cement and water. Put the paste on the crack inside and outside the filter. Make it smooth. Be very careful not to break the walls of the filter as the concrete is still weak.

Wait for the paste to dry before moving to the next steps.



6. Plug the outlet tube with tape, cloth or a stick.



7. Fill the filter to the top with water. Cover the filter with a cloth, tarp or plastic sheet.

8. **Leave the filter to cure for 7 days.** Keep it full of water. Do not move the filter for 7 days. The concrete will get stronger the longer it cures.



Letting the filter **cure** means to let it rest. As it cures, the concrete will become stronger. If you try to move it before 7 days, the concrete may break.



9. After the filter has cured for 7 days, wash it out with soap. Rinse the inside of the filter with clean water until the filter is clean and there is no soap left.

Store the clean filter with other clean filters.



10. Make the filter look nice. Filters can be painted or tiled

Store the finished filters in an area with other filters that are ready to be transported to homes for installation.



Paint a filter number somewhere on the filter so you can keep records of the filters in each home.

Finding Sand and Gravel

This section contains information on where to find sand and gravel appropriate for both making concrete and using as filter media. This section contains information modified from the CAWST BioSand Filter Construction Manual. The full CAWST Manual can be found at www.cawst.org.

Selecting and preparing the filtration sand and gravel is very important for the treatment efficiency of the BioSand filter. While not complicated, the steps in preparing the filtration sand must be followed exactly as presented. Poor selection and preparation of the filtration sand could lead to poor performance and a lot more work to fix the problem.

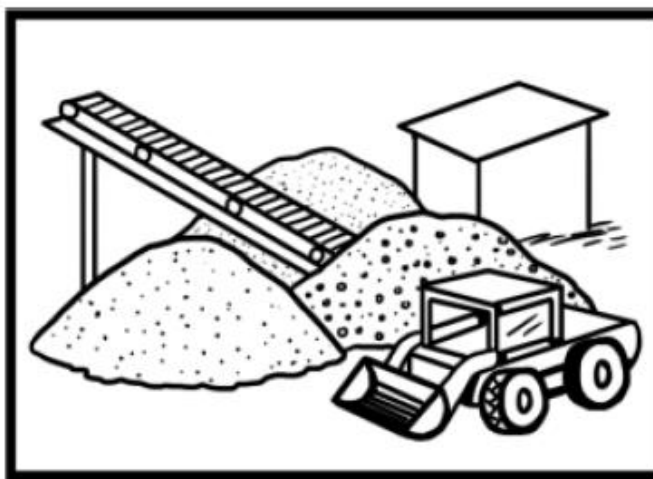
What kind of sand do I need?

Sand with **MANY DIFFERENT GRAIN SIZES** and **CLEAN** with no leaves, sticks, or salt.

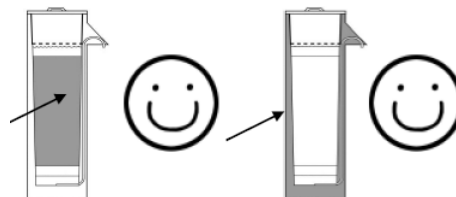
Where can I find sand?

#1 ROCK CRUSHER

Sand and gravel from a rock crushing machine is called crushed rock. Crushed rock has a good mixture of grain sizes, which is important for proper functioning of the filter. It is also less likely to be contaminated by pathogens or organic matter.



Crushed rock is the **BEST** sand and gravel to use for inside the filter. You can also use it for the concrete (filter body).



Gravel pits or quarries are the best places to obtain crushed rock, and are common in most parts of the world. You can also ask local construction, road work, or concrete manufacturing companies where they get their crushed rock.

At first, quarry rock may not seem proper for sieving because of the large amounts of dust. You need to select the rock load and the crusher properly to make sure that there are not a lot of large chunks of rock and dust. Often, you can even sieve the load at the quarry site and only pay for what you take. This greatly reduces the waste and cost.

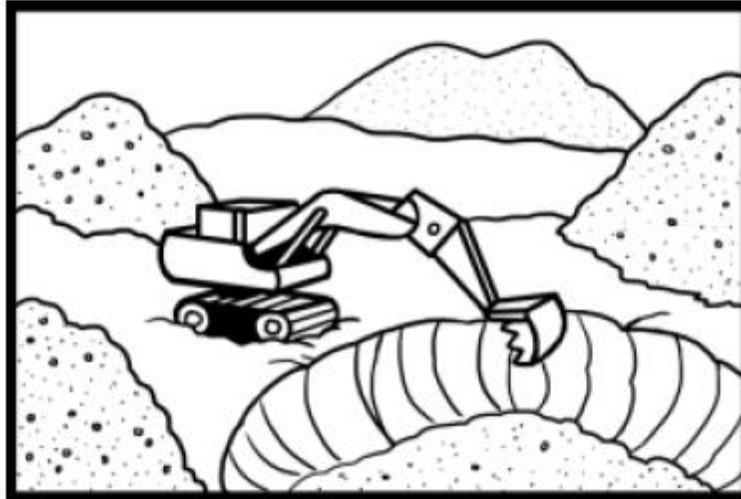
Crushed rock may be difficult to locate, more expensive, and require transportation to your production site. However, it is critical in providing the best water quality and is worth the extra time, effort, and cost.



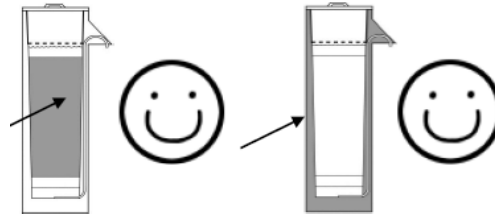
If you have trouble finding a local source, please contact us and we may be able to help you find a local source or help connect you with a source being used by other projects.

#2 SAND QUARRY

If crushed rock is absolutely not available, the next choice is sand from a sand quarry or pit. Sometimes you can get gravel there too. It is usually not as clean as crushed rock- it may be contaminated with pathogens or organic matter.

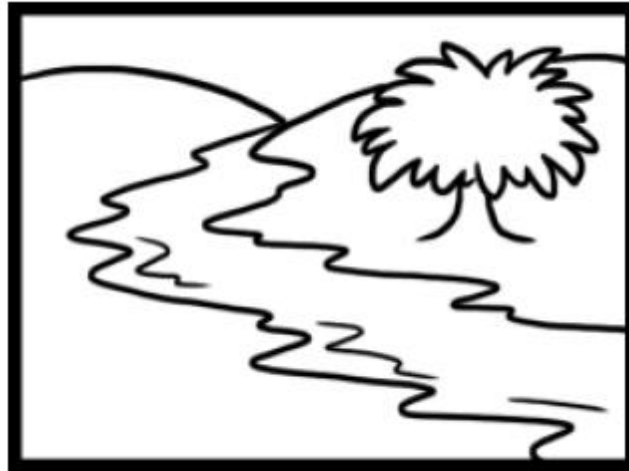


Use quarry sand if you cannot find crushed rock. Check to make sure the sand has a variety of grain sizes and that it is clean.

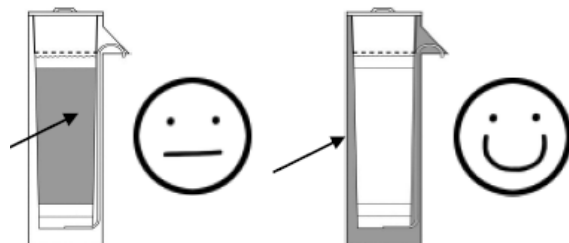


#3 RIVER

The sand and gravel from a river are not clean. They have dirt, leaves and sticks, and pathogens in them. If you use river sand, it takes more work to make it clean.



You can use river sand to make the concrete filter body. River sand is not good sand for inside the filter.

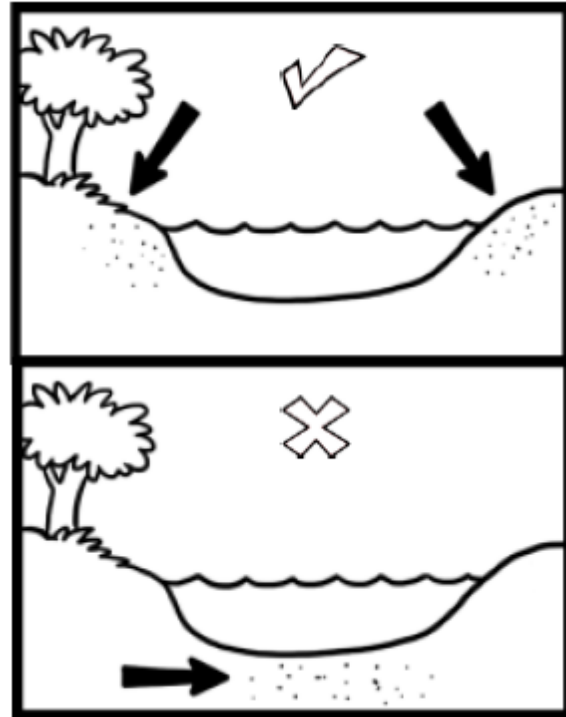


#3 River- Continued-

Try to find quarry sand and gravel for inside the filter. If you have to use river sand, use sand from high up the side banks of the river, not from the bottom of the river. Sand from the banks has less pathogens in it and may have a better mixture of grain sizes.

River sand is usually contaminated with pathogens (from human and animal fecal matter) and contains organic material such as leaves and sticks. Putting contaminated sand in the BioSand filter may actually result in worse water quality than the original source water used. This happens because the organic matter is a food source for pathogens and helps them to grow and multiply in the filter until all of the food is consumed.

River sand is almost always contaminated with fecal matter (pathogens) and organic matter. The organic matter provides food for bacteria, and may encourage bacteria to grow deep inside the filter. The pathogens can be removed from the sand through a disinfection method (laying it out in the sun or chlorinating it). However, the organic matter can only be removed from the sand by heating the sand to very high temperatures to burn off the organic material. This process is very costly, time consuming, and not practical in most situations. For these reasons it is better to spend your time and money to find a source of crushed rock that provides the best water quality.



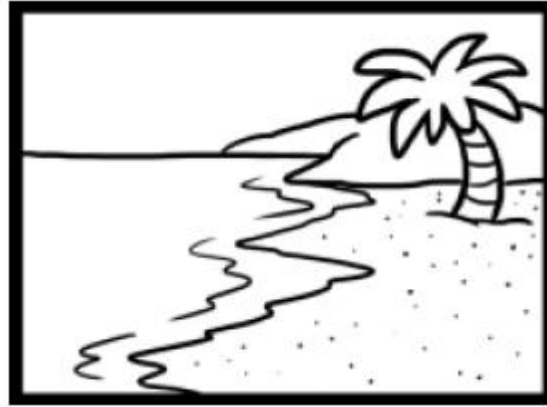
Crushed rock makes the best filtration sand. It may be hard to find and it may be more expensive than river sand. But you should use crushed rock!

If crushed rock is very expensive, buy crushed rock to use only for the sand and gravel inside the filter. You can buy river sand and construction gravel to make the concrete filter body.

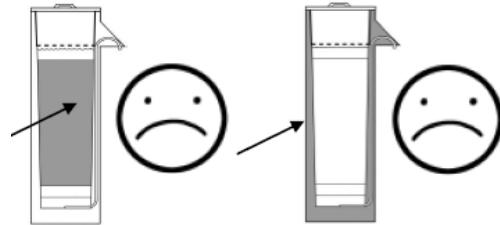
#4 BEACH

Beach sand is well sort, meaning it does not have many grain sizes. It also has organic matter and dirt in it, so it takes a lot of work to make it clean. There is also salt stuck to the sand. This makes the filtered water taste salty at the beginning.

You have to flush the beach sand with fresh water to remove the salt and other contaminants.

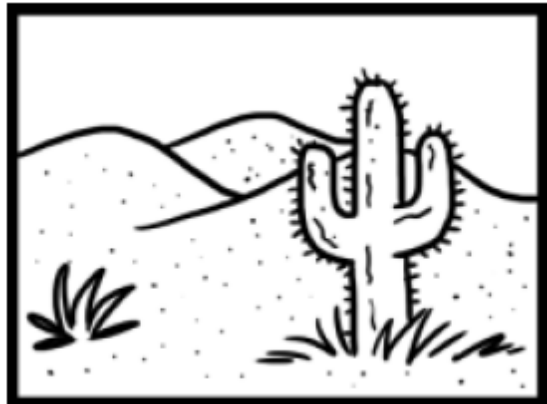


Don't use beach sand for the sand inside the filter or to make the filter container.

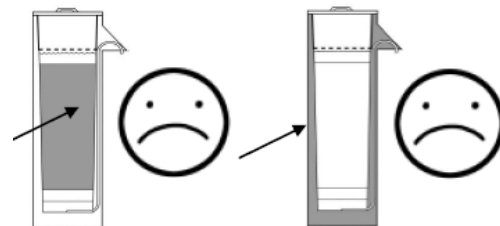


#5 DESERT

Sand from the desert does not have many different sizes. It is not very good sand to use.



Don't use desert sand for the sand inside the filter or to make the filter container.



TIP: You can buy sand from one place, and gravel from another place. Often you can buy sand and gravel mixed together.

When you are selecting a source for filtration sand, also take into consideration the tips in the table below.

Things to Look for when Selecting Sand for Inside the Filter

✓	✗
• When you pick up a handful of the sand, you should be able to feel the coarseness of the grains. • You should be able to clearly see the individual grains, and the grains should be different in shapes and sizes. • When you squeeze a handful of dry sand and then open your hand, the sand should all pour smoothly out of your hand. • If you are buying mixed sand and gravel, it should have a lot of gravel pieces up to 12mm (1/2") in diameter.	• It should <u>NOT</u> contain any organic material (e.g. leaves, grass, sticks, loam, dirt). • It should <u>NOT</u> contain possible microbiological contamination. • It should NOT be from an area that has been used a lot by people or animals. • It should <u>NOT</u> be very fine sand nor sand that is mostly silt and clay. • When you squeeze a handful of dry sand, it should <u>NOT</u> ball up in your hand or stick to your hand. If it does, it probably contains a lot of dirt or clay. • It should <u>NOT</u> have much gravel larger than 12mm (1/2"). Any gravel larger than 12mm (1/2") is waste and will not be used inside the filter or in the concrete.

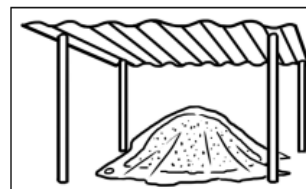
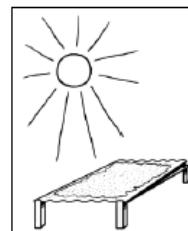


TIP: A sand grain size analysis kit and spreadsheet is also available to help you select the best possible filtration sand. If you analyze the grain, it helps make sure that the sand has an appropriate range of grain sizes. This analysis kit and spreadsheet was developed by CAWST and can be found on their website (www.cawst.org). OHorizons can provide you with these materials as well (email us for a copy).

Dry the sand and gravel

When the sand and gravel are delivered to your production site, you need to dry it and store it until you are ready to sieve it.

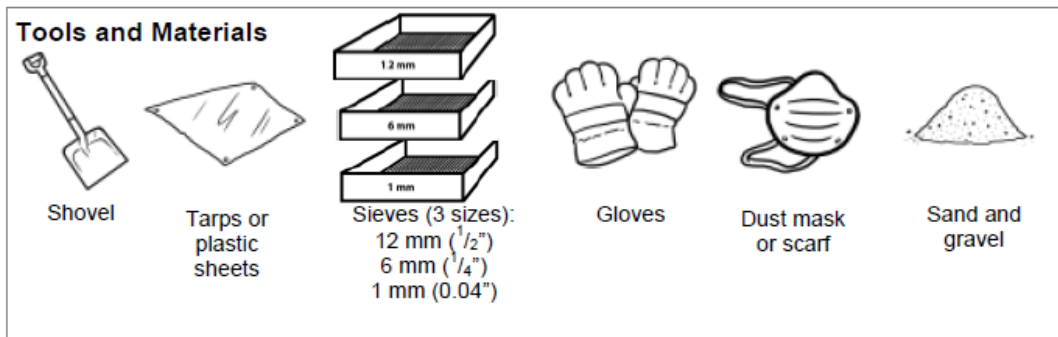
- If the sand is wet, dry it.
- Spread the sand very thinly on a platform or table that is up above the ground. Turn it with a shovel sometimes so it all gets very dry.
- Be careful the sand does not get dirty. Dirt and leaves can be blown into the sand while it is drying.
- Store the dry sand where it will stay dry and clean.



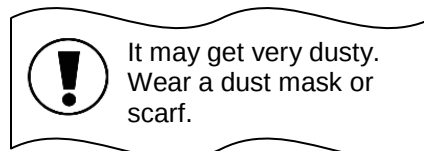
Sieve the Sand and Gravel

You will have to sieve the sand and gravel you buy to meet the specific grain size requirements for the filter. This section details how to sieve sand for both the filter body and the filter media (sand and gravel inside the filter). This section contains information modified from the CAWST BioSand Filter Construction Manual. The full CAWST Manual can be found at www.cawst.org.

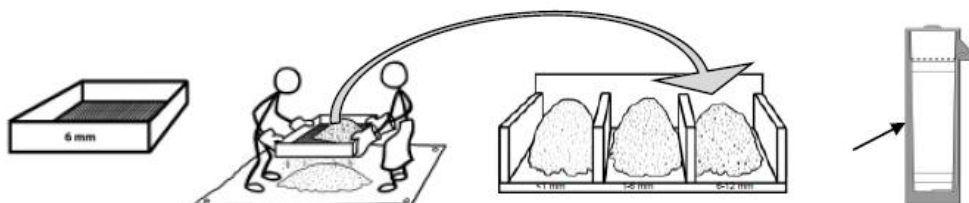
Concrete sand and gravel (for making the filter body)



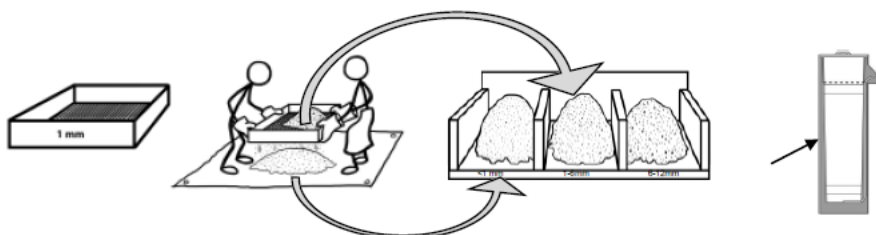
1. Put the sand and gravel through the 12mm ($\frac{1}{2}$ ") sieve. **Throw away any rocks that stay on top of the 12mm sieve** – they are too big to use in the BioSand Filter.



2. Pick up all the materials that went through the 12mm sieve. Put it through the 6mm ($\frac{1}{4}$ ") sieve. **Store all the gravel that stays on top of the 6mm sieve in the 6-12mm gravel storage pile.** This pile is used for two things: large gravel when you make the concrete and drainage gravel that goes inside the filter.

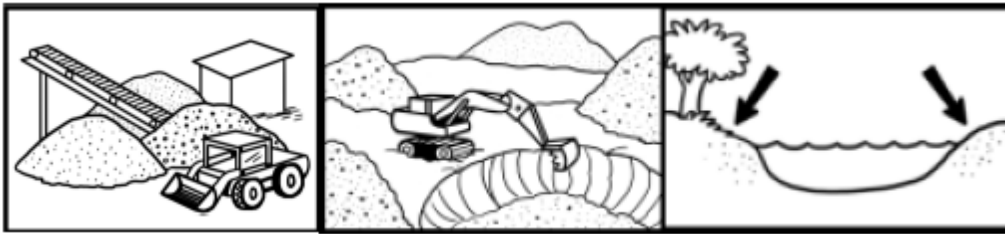


3. Pick up all the material that went through the 6mm sieve. Put it through the 1mm (.04") sieve. Store all the gravel that stays on top of the 1mm sieve on the 1-6mm gravel storage pile. Use this small gravel for making concrete.
4. Store all the sand that fell through the 1mm sieve in the <1mm sand storage pile. Use this sand for making concrete.

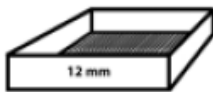


Concrete sand and gravel – Continued

Recommended Sources:

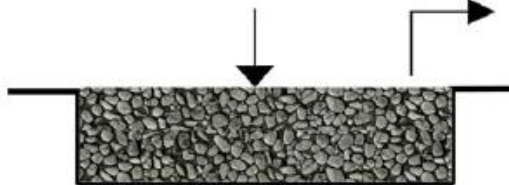
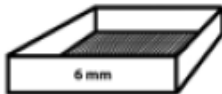


Sieve 1: 12mm (1/2")



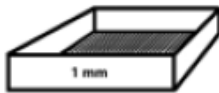
Throw away rocks bigger than 12mm (1/2")

Sieve 2: 6mm (1/4")



Store Large Gravel
6mm (1/4") – 12mm (1/2")

Sieve 3: 1mm (0.4")
(mosquito mesh)



Store Small Gravel
1mm(0.04") -- 6mm (1/4")



Store Concrete Sand
≤ 1mm (0.04")



Concrete Sand
≤ 1mm (0.04")

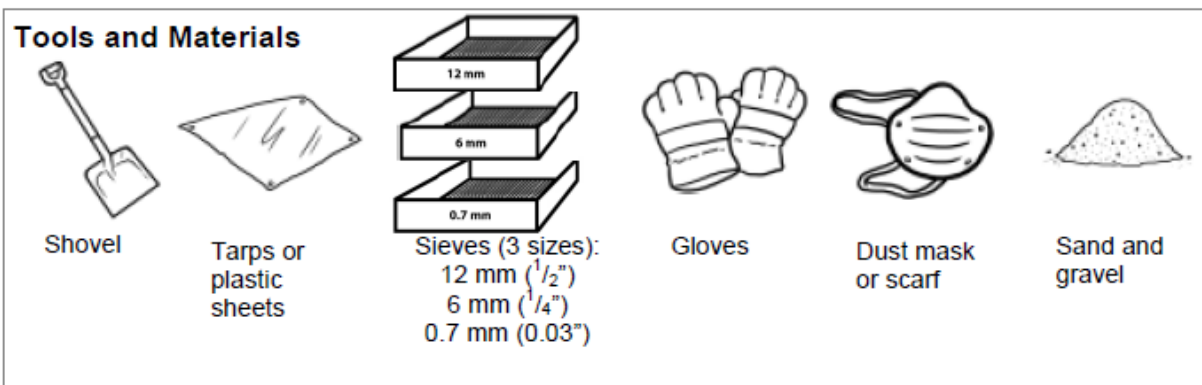


Small Gravel
1mm (0.04") - 6mm (1/4")



Large Gravel
6mm (1/4") – 12mm (1/2")

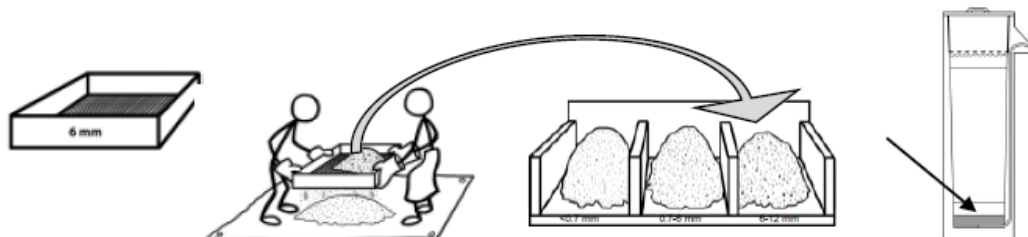
Filtration sand and gravel (for inside the filter)



1. Put the sand and gravel through the 12mm ($\frac{1}{2}$ ") sieve. **Throw away any rocks that stay on top of the 12mm sieve – they are too big to use in the BioSand Filter.**

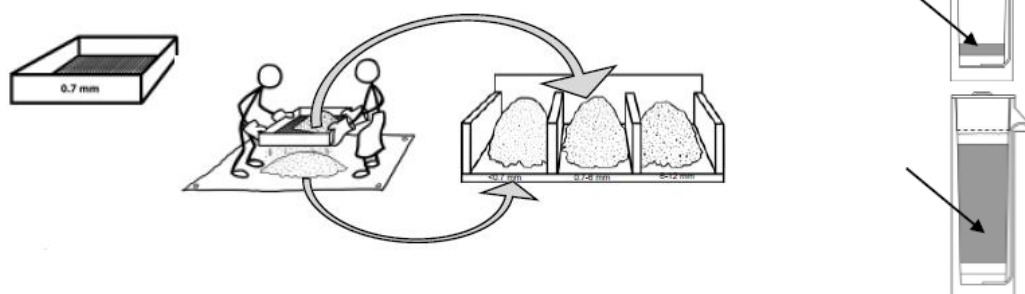


2. Pick up all the material that went through the 12mm sieve. Put it through the 6mm ($\frac{1}{4}$ ") sieve. **Store all the gravel that stays on top of the 6mm sieve in the 6-12mm gravel storage pile.** This pile is used for two things: large gravel when you make the concrete and drainage gravel that goes inside the filter.



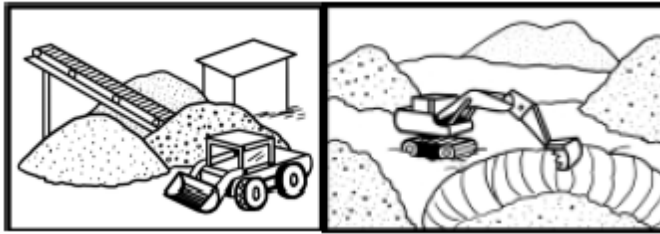
3. Pick up all the material that went through the 6mm sieve. Put it through the .7mm (0.3") sieve. **Store all the gravel that stays on top of the 0.7mm sieve in the 0.7-6mm storage pile.** This is the separation gravel for inside the filter.

4. **Store all the sand that fell through the 0.7mm sieve in the <0.7mm sand storage pile.** This is the filtration sand for inside the filter.

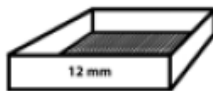


Filtration sand and gravel (for inside the filter) – Continued

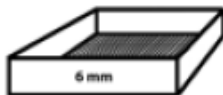
Recommended sources:



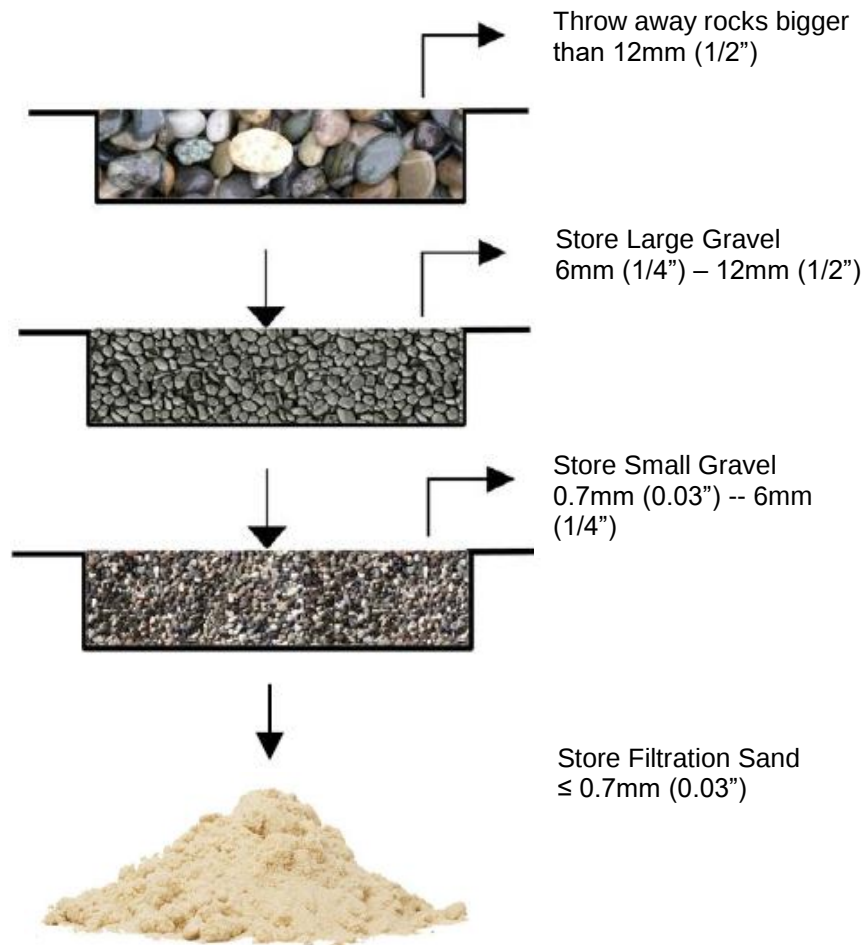
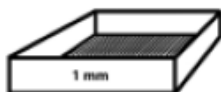
Sieve 1: 12mm (1/2")



Sieve 2: 6mm (1/4")



Sieve 3: 0.7mm (0.03")
(#24 mesh)



Filtration Sand
≤ 0.7mm (0.03")



Separating Gravel
0.7mm (0.03") - 6mm (1/4")

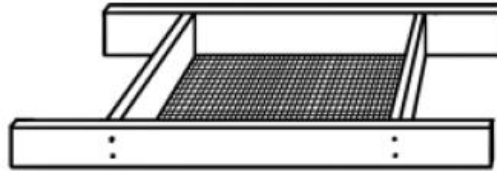


Drainage Gravel
6mm (1/4") - 12mm (1/2")

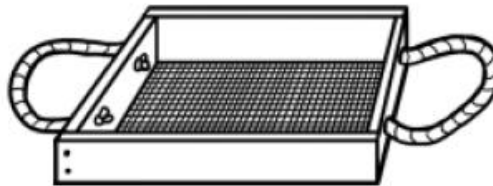
Sieve Options

You can make good sieves in a few different ways. These are some examples of different types of sieves.

Requires 2 people for sieving.



Requires 1 person for sieving.

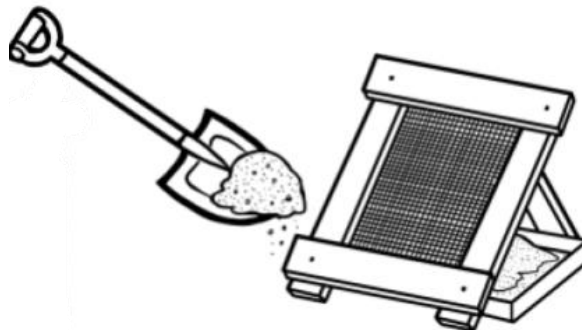


Requires 2 people for sieving.

Requires 1 person for sieving.

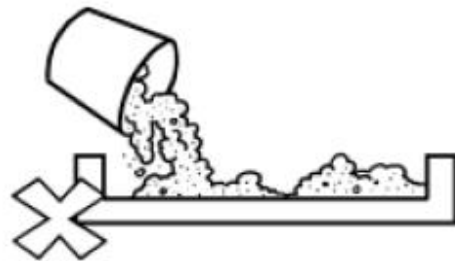
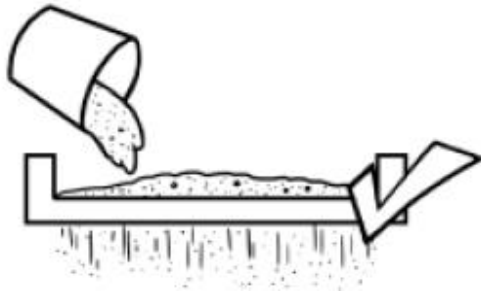


With this method, it is difficult to keep the sieved sand separate from the un-sieved sand. You must be very careful. Collect the sieved sand in a box. Be careful when lifting the sieve up so no un-sieved sand falls into the box.



Tips for sieving the sand and gravel

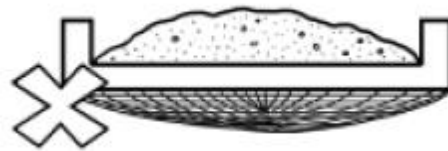
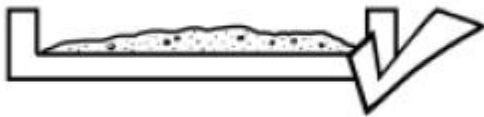
- Dry sand completely before sieving. Wet sand will not go through the sieve.



- The sand must be clean. Use sand with no pieces of grass, leaves, sticks or other materials in it.



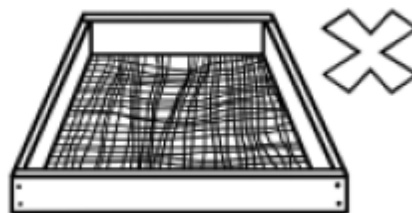
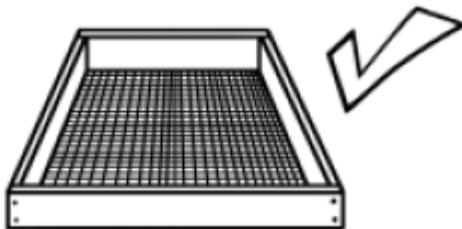
- Don't pile too much sand on the sieve. It will break the sieve.



- Keep sieving until very little or no sand falls through the sieve. If there is still a lot of sand that falls through, keep sieving.



- Repair sieves when they break. The wires in the mesh should be evenly spaced and the holes all the same size. Do not use broken sieves.



- Wet sieving is a process that can be used if the sand cannot be dried. It uses water to force or wash the sand through the sieve. It requires a large amount of clean water.
- Depending on the source of your sand and gravel, the sieving procedures described here may be a little different. For example, if you get filtration sand and gravel and concrete sand and gravel all from the same source, you may want to sieve all of the material through the 12mm and 6mm sieves, then put some of the sand through the 1mm sieve and the rest of the sand through the .7mm sieve.
- No matter how you sieve the gravel, there are two important factors:
 - You must end up with filtration and construction materials that are the proper sizes, as listed in the manual.
 - Your filtration sand and gravel must be of good quality and not contaminated with pathogens, chemicals, human waste, or organic materials such as leaves.

Store the sieved sand and gravel

- Store the piles of sieved sand and gravel where they will stay clean and dry.
- Make sure you keep your piles tidy and separate so that they do not mix with each other or with un-sieved sand. Poor sand quality, due to stray rocks and mixed sand sizes, will reduce the treatment efficiency of the filter. If this happens, you have to sieve the sand again.

Concrete Sand and Gravel

You need piles of materials that will go into the concrete:

- Sand (<1mm) (0.04")
- Small gravel (1-6mm) (0.04-1/4")
- Large gravel (6-12mm) (1/4-1/2")

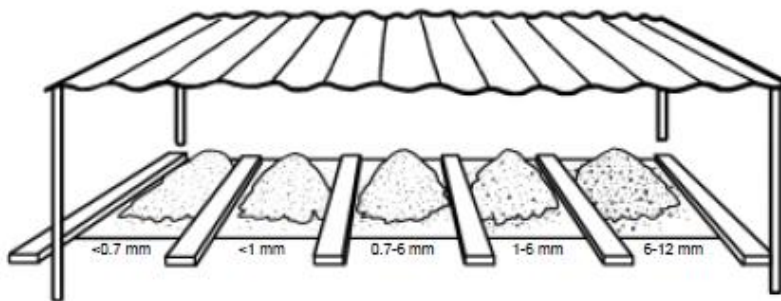
Filtration Sand and Gravel

You will need piles of materials that will go inside the filter:

- Sand (<0.7mm) (<0.03")
- Separating gravel (0.7-6mm) (0.03-1/4")
- Drainage gravel (6-12mm) (1/4-1/2")

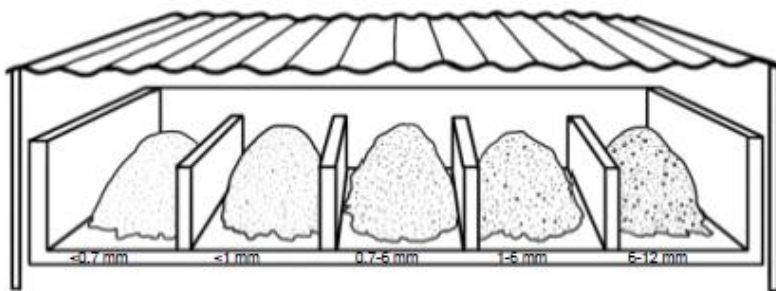


This gravel is the same size. It can all go in one pile.



Simple Storage Area: Piles of sand and gravel are separated by pieces of wood. The ground is covered by a tarp or a sheet.

It is very easy for sand and gravel to get mixed, so be very careful.



Improved Storage Area: Piles of sand and gravel are separated by tall concrete walls. The floor is concrete.

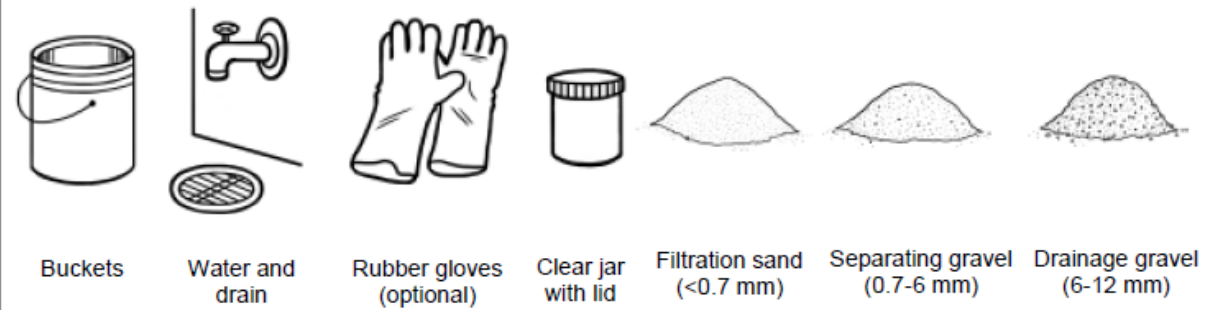
This storage area helps to keep the piles separated.

You do not have to store all the sand and gravel piles in the same location. You can store the concrete sand and gravel near the filter pouring area, and the filtration sand and gravel near the area for washing sand and gravel.

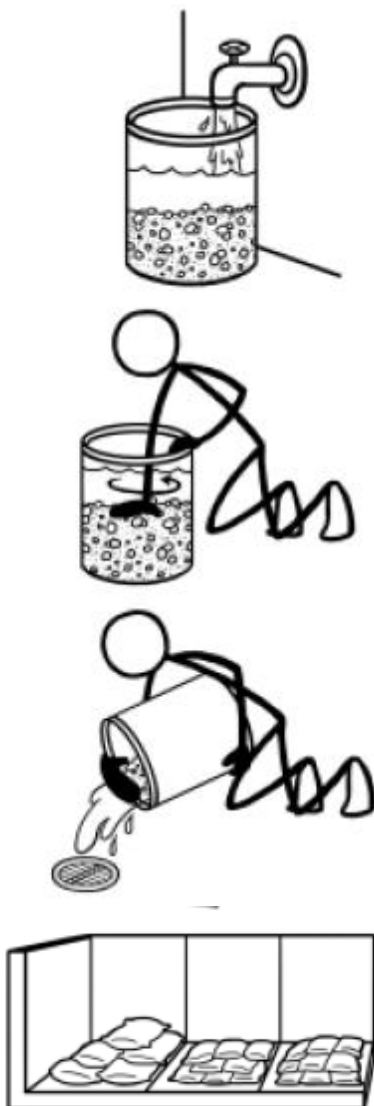
Wash the Filtration Sand and Gravel

It is very important to wash the filtration sand and gravel, please read this section carefully! This section contains information modified from the CAWST BioSand Filter Construction Manual. The full CAWST Manual can be found at www.cawst.org.

Tools and Materials



Wash the separation and drainage gravel (for inside the filter)



1. Put some sieved separation gravel or drainage gravel in a bucket.

2. Fill the bucket half full with clear water.

3. Swirl the gravel around the water using your hand or a clean stick or spoon.

4. Dump the water out of the bucket. Hold back the gravel with your hand so it does not fall out of the bucket.

Pour the water down a drain or into a settling tank. If you use a settling tank, you can reuse the water when the dirt has settled to the bottom.

5. **Repeat steps 2,3, and 4 until the gravel is completely clean and the water you dump out is clear.**



Wash gravel until it is completely clean!

6. Store clean gravel in a dry, clean place. Or dry it and then put it in bags ready to take for installation. For one filter, you will need a bag with about 3 L of washed drainage gravel (or about 2.7 quarts) and another bag with about 3 1/4L of separation gravel (or about 3 quarts).

Wash the filtration sand (for inside the filter)



1. Put some sieved filtration sand in a bucket. This is sand that has gone through the 0.7mm (0.03") screen.
2. Fill the bucket half full with clear water.
3. Swirl sand around in the water using your hand or a clean stick or spoon.



4. Dump the water out of the bucket. Hold back the sand with your hand so it does not fall out of the bucket.

Pour the water down a drain or into a settling tank. If you use a settling tank, you can reuse the water when the dirt has settled to the bottom.

5. Repeat steps 2,3, and 4 a few times. Count how many times you wash the sand.



The water you dump out of the bucket should still be a little dirty when you finish washing the sand.



DO NOT wash the sand until it is completely clean!



HOW DO I KNOW IF THE SAND IS WASHED ENOUGH?

1. Do a jar test (optional, but recommended).
2. Install a filter and check the flow rate.



When you are more experienced at washing sand, you will be able to tell quickly if the sand has been washed enough. But every load of sand you buy will be different. Always check the washed sand by doing a trial filter installation (described 2 pages later) once for every truck load of sand you get.

Wash the filtration sand (for inside the filter) –Continued

Check the sand: do a jar test (Recommended)

After you have washed the sand 3 or 4 times, do a jar test. This is one way to find out if you need to wash the sand more.



1. Put a little sand in the bottom of a clean jar.

2. Fill the jar with water. Put on the lid.

3. Shake the jar.

4. Stop shaking the jar. Wait 4 seconds.

5. After 4 seconds, look into the side of the jar.

If you cannot see the top of the sand, it is too dirty. Keep washing the sand. Do another jar test after 1 or 2 more washes.



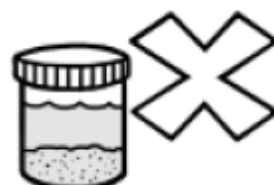
If you can see the top of the sand, but not clearly, it is good.

Wash the rest of the sand the same number of times.



If the water is clear or almost clean and you can see the top of the sand very easily, the sand is too clean. It has been washed too much. Throw the sand away.

Start again, and wash the new sand fewer times before doing a jar test.



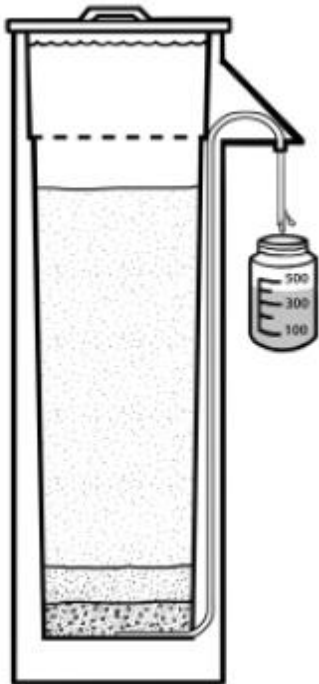
Wash the filtration sand (inside the filter) –Continued

Check the sand: Install a test filter and check the flow rate



Note: The flow rate for a filter made from the Wood Mold is different from the flow rate for a filter made from the steel mold. Make sure you are using the numbers outlined in **the OHorizons Appendix and Construction Manual** to be sure you are checking for the correct flow rate.

To make sure the sand will work well in the filters, install 1 filter and check the flow rate.



1. Install 1 filter with washed sand and gravel (See section titled “Install a Filter” in the Wood Mold Construction Manual). This test is usually done at the filter production site.
2. Put a diffuser into the filter. Fill the filter with water.
3. Catch filtered water in a container with marked measurements on it.
4. You should get 340 ml or less in 1 minute.

Or if you are filling a 1L bottle, it should take about 2 minutes and 54 seconds (or longer) to fill the bottle.
5. Check the flow rate against the boxes below. Change the number of times you wash the sand if you have to.

Too Fast! Wash Less

If the flow rate is over 400ml/minute, the sand has been washed too much. Do not use the sand inside the filters. Try washing the sand less.

340ml/min Good

If the flow rate is around 340ml/min, the sand is good. You can use this sand inside the filters. Wash the rest of the sand the same number of times.

Too Slow! Wash More

If the flow rate is less than 240ml/minute, it may be too slow for users. The filter will be good for treating water, but people may not use it because it is too slow. Try washing the sand a little more.

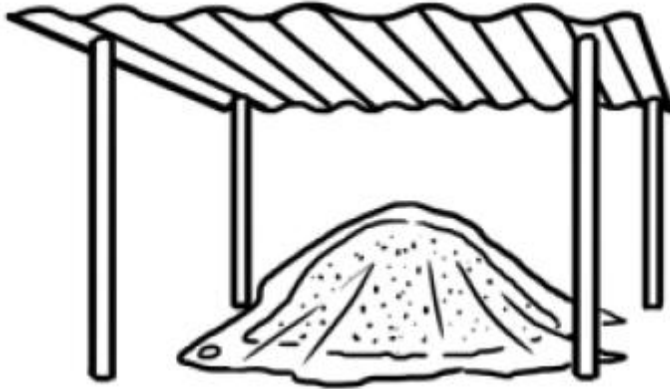
Every load of sand you buy will be different. Check every batch of sand by:

- Washing enough sand for 1 filter,
- Installing 1 filters and
- Testing the flow rate

Store the filtration sand and gravel

Storing Washed Sand and Gravel

Store washed sand and gravel in a dry, clean place.



You can also store washed sand and gravel in bags ready to take for installation. When you go to install filters, you will need to take 1 bag of sand, 1 bag of separation gravel, and 1 bag of drainage gravel for each filter you are going to install.

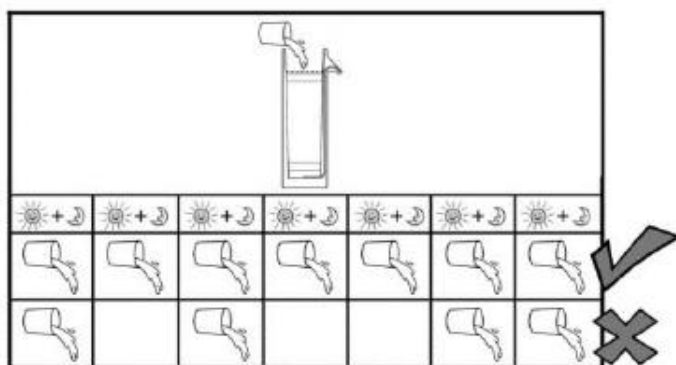
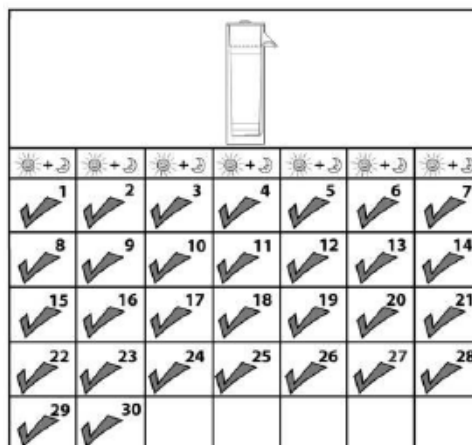
- Washed Sand: 27.4 L per bag (29 quarts)
- Washed Separation Gravel (0.7-6mm): 2.5 L per bag (2.6 quarts)
- Washed Drainage Gravel (6-12mm): 2.5 L per bag (2.6 quarts)

What Will Tell Me if a Filter is Working Well?

This section contains information modified from the CAWST BioSand Filter Construction Manual. The full CAWST Manual can be found at www.cawst.org.

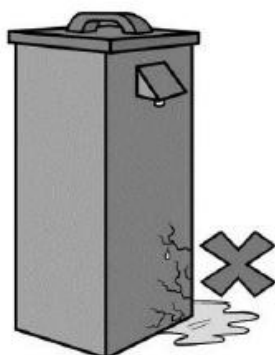
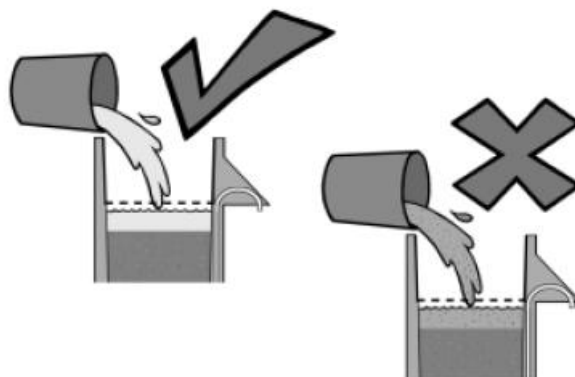
There are 8 points that can tell you if a filter is treating water well. They are called the **8 Key Filter Performance Points**. If these 8 points are met, you can be confident that the filter is removing most microbiological contaminants.

1 The Filter was installed more than 30 days ago. It takes 30 days for the biolayer to grow and be working well.



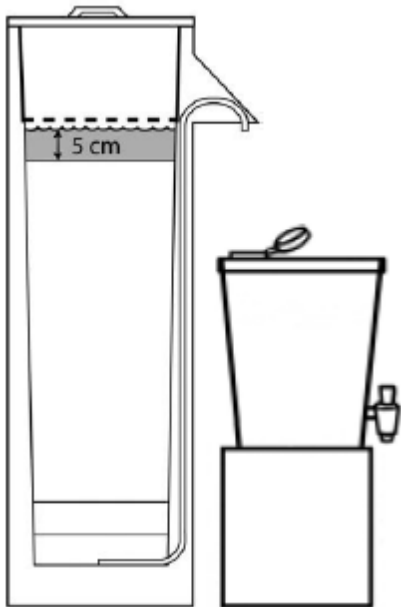
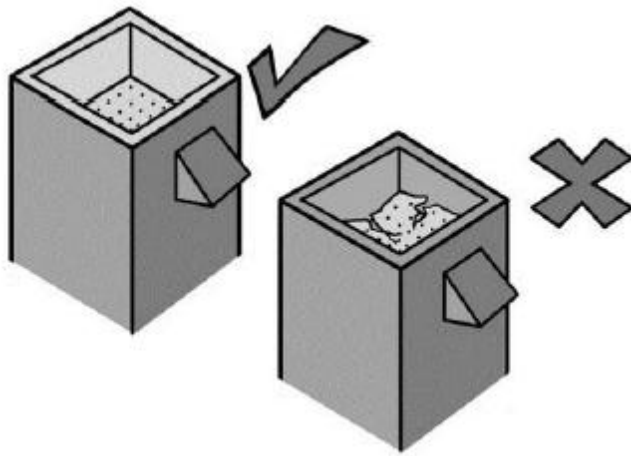
2 The Filter is used at least once every day, with water from the same source every time. Don't forget the pause period: after the water stops running, you must wait at least 1 hour before filling it again.

3 The water poured into the BSF is clear. The water source should be less than 50 NTU. If you only have dirty or cloudy water, leave it in a bucket until the sediment has settled to the bottom. Then pour the clear water in the bucket into the BSF. Do not pour the sediment in.

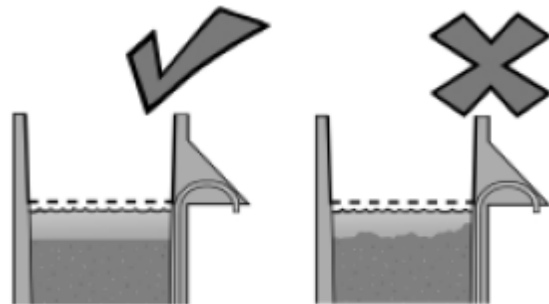


4 The filter container does have cracks and is not leaking. Users may not use filters that don't look nice or that make a mess. Also, a leak may cause the standing water level to be too shallow, and the biolayer may be damaged.

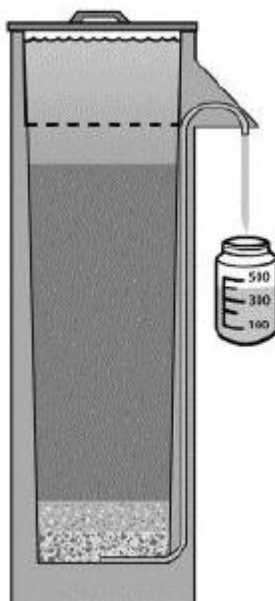
5 There is a diffuser. It should be in good condition, so the biolayer is protected when you pour the water in. There should be no cracks or large holes in the diffuser.



6 When the water stops running, the water surface is 5cm (2") above the top of the sand. If you don't have a ruler with you, 5cm is about the length of your middle finger from the tip to the second knuckle. It is okay if the water depth is between 4 to 6cm (1.5-2.5").



7 The top of the sand is flat and level. If there are dents, holes, or "valleys" in the sand, the biolayer may be damaged.



8 When the filter is full, the flow rate is 340 mL or less per minute. If you get more than 340 mL in 1 minute, the filter may not be operating at its highest possible treatment efficiency.

Additional Resources

This concludes the Appendix to the OHorizons Wood Mold Construction Manual. If you would like more information on educating the user, troubleshooting problems with filter installation, surveys to give to users, and other project planning resources, please contact OHorizons.

Have questions or comments about this document? Was a section confusing or difficult to understand? Please send us an email at info@ohorizons.org