300 Liter per Day Water Treatment System

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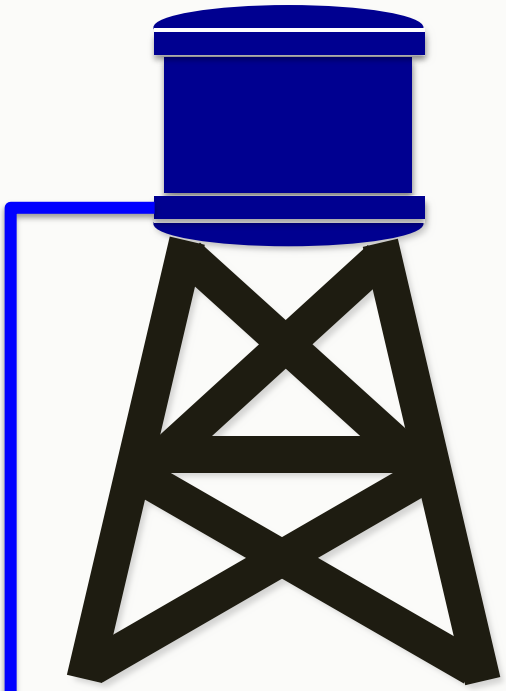
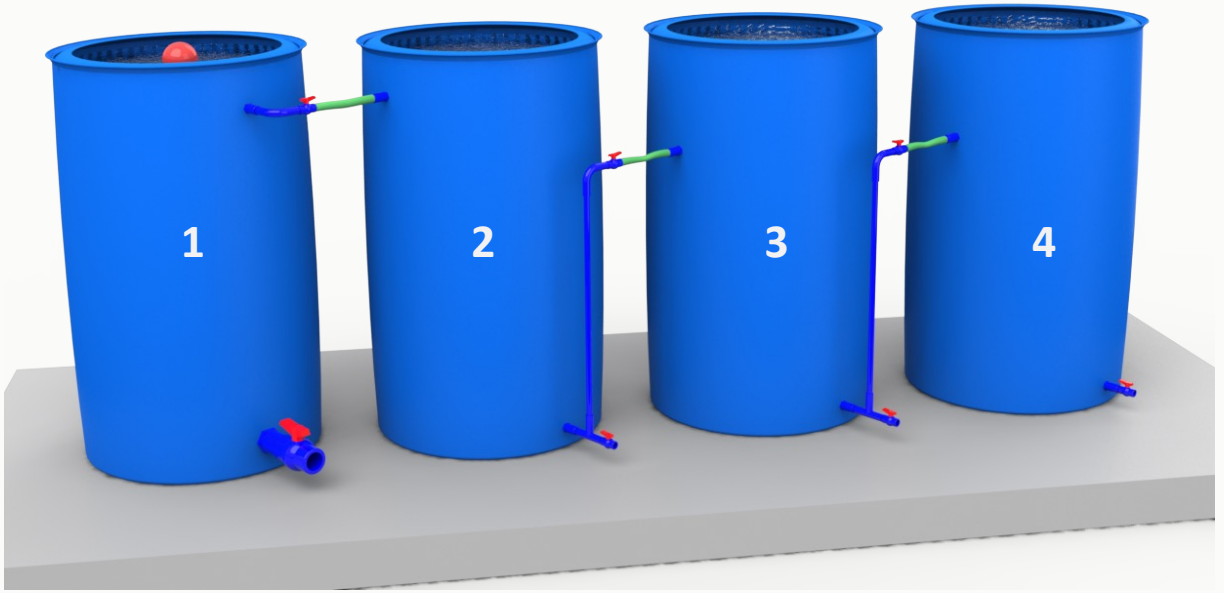
Treatment Flow Diagram



200 Liter HDPE (Plastic) Drums

Select drums that are new, or used for transporting foodstuffs, soap, or other benign and easy-to-clean substances.



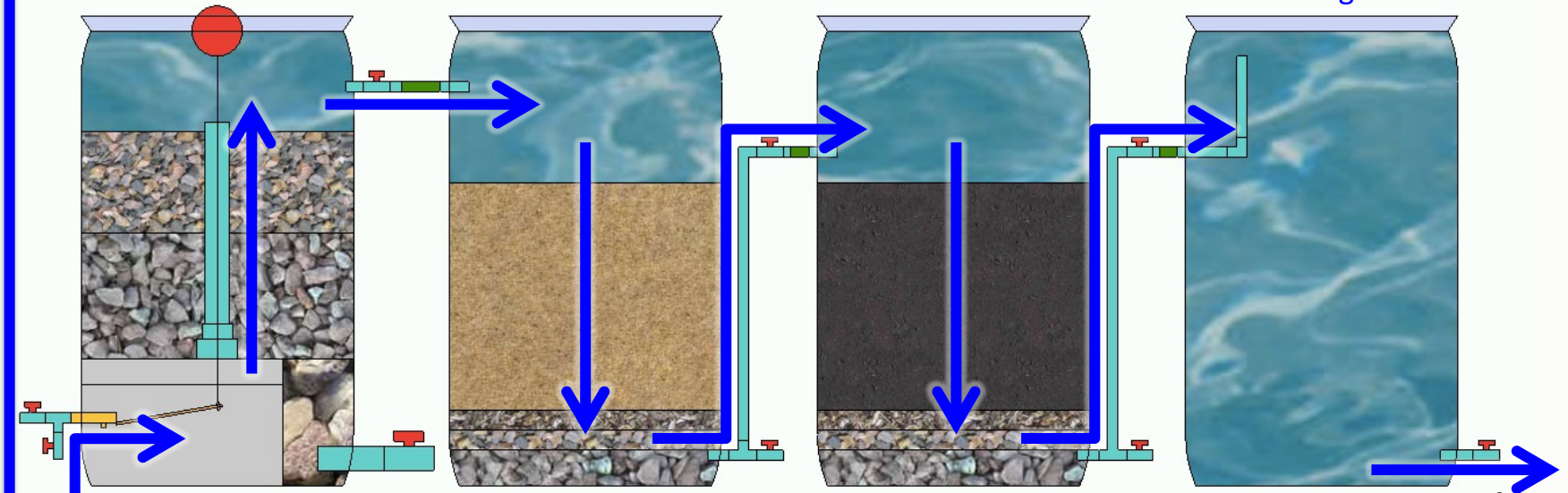
Gravity-fed water supply

1 Gravel Roughing Pre-filter

2 Slow Sand Biofilter

3 Biochar Adsorber

4 Treated Water Storage



To point-of-use

Gravel Roughing Pre-Filtration

Removes sediment, particulate organic matter, and some microorganisms

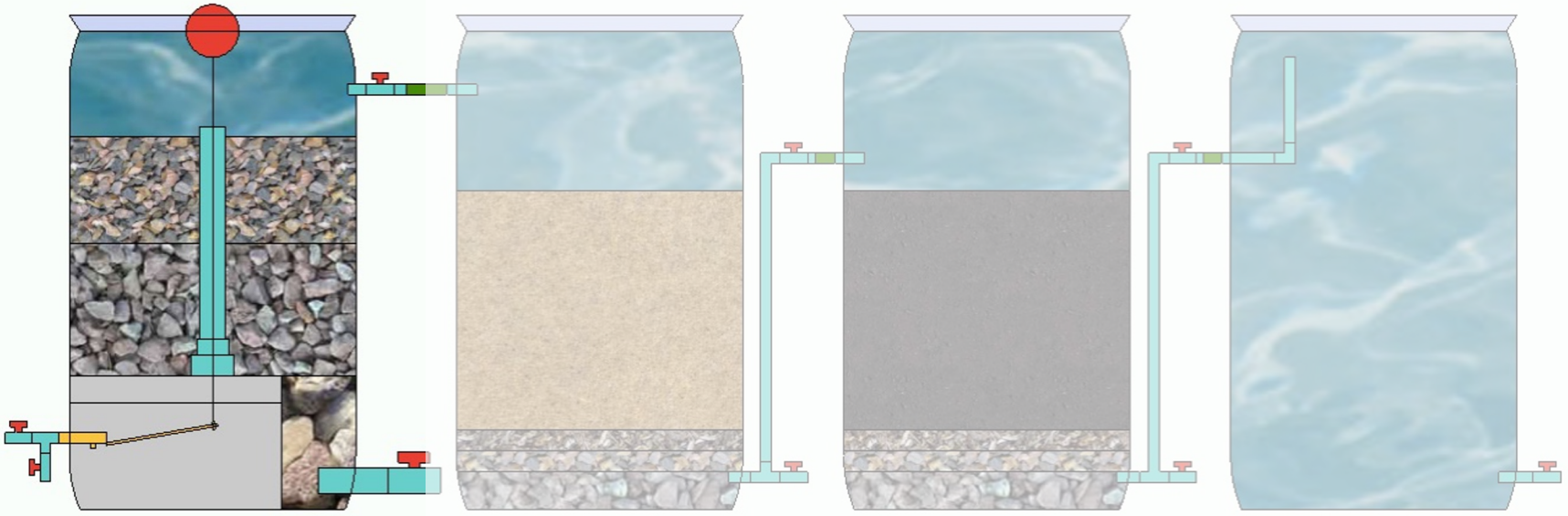
In this treatment step, water flows slowly upward through the gravel allowing sediment and other solid matter to settle to the bottom of the tank. Some harmful microorganisms attached to solid particles also settle out.

Maintenance: Monthly Backwashing

At least once per month open the large valve at the bottom of the tank to flush out the accumulated solids. Open the inlet cleanout valve to flush out sediment that accumulates in low areas of the water supply pipe.

Under normal conditions the gravel does not need to be replaced.

Deforestation, agriculture, and urban development can increase erosion of soils and sediments, especially during the rainy season.



How It Works

Microbial pathogens (protozoa, bacteria, and viruses) can live in water contaminated by human and animal wastes.

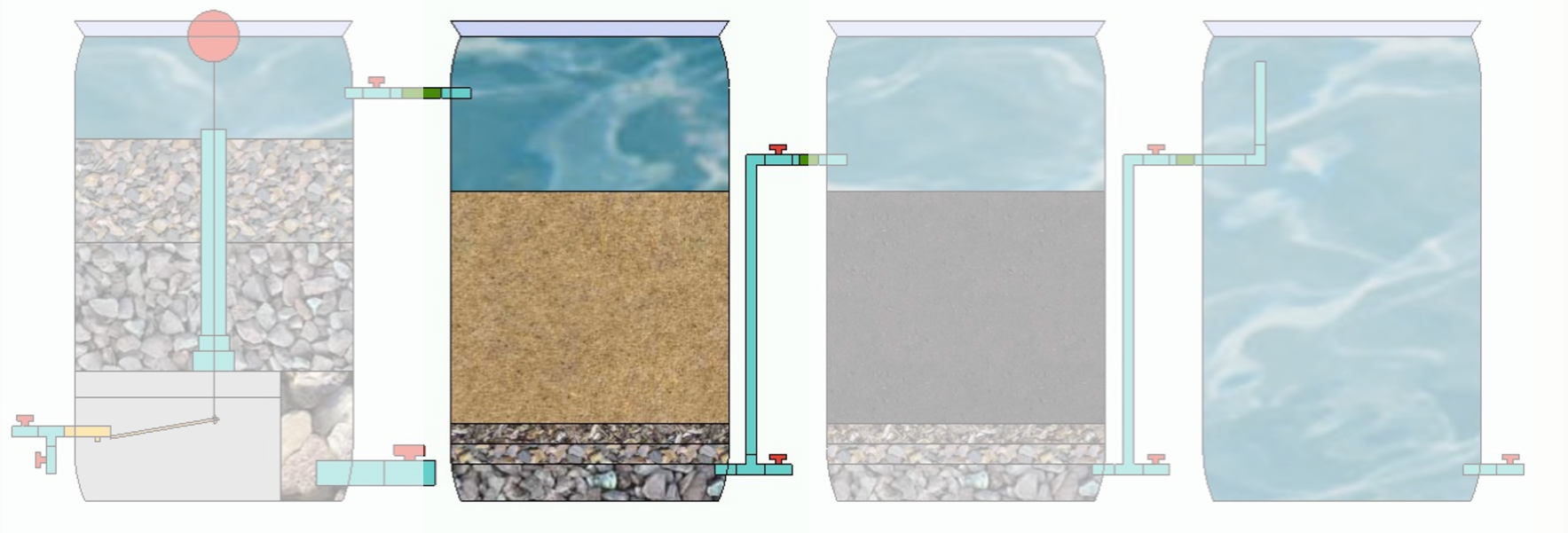
Slow Sand Biofiltration

Removes fine particles, biodegradable dissolved organic matter, and microbial pathogens

In this treatment step, water flows downward through a bed of fine sand. Small particles are removed by physical straining and some pathogen cells are removed by adsorption to sand grains. Over time a natural biofilm of beneficial microorganisms forms in the top 1-2 cm of the sand. The biofilm removes microbial pathogens by interception, competition, and predation. It also removes biodegradable dissolved organic matter, including some synthetic chemical water contaminants.

Maintenance: Filter Harrowing

Over time, as the biofilm develops and fine particles settle at the top of the sand, flow rate through the filter decreases. To restore the design flow rate, gently stir the water above the sand bed suspending some of the accumulated sediment and biofilm. Use a dipper to remove the turbid water, allowing sand particles with attached biofilm to resettle.



Biochar Adsorption

Removes organic chemical contaminants

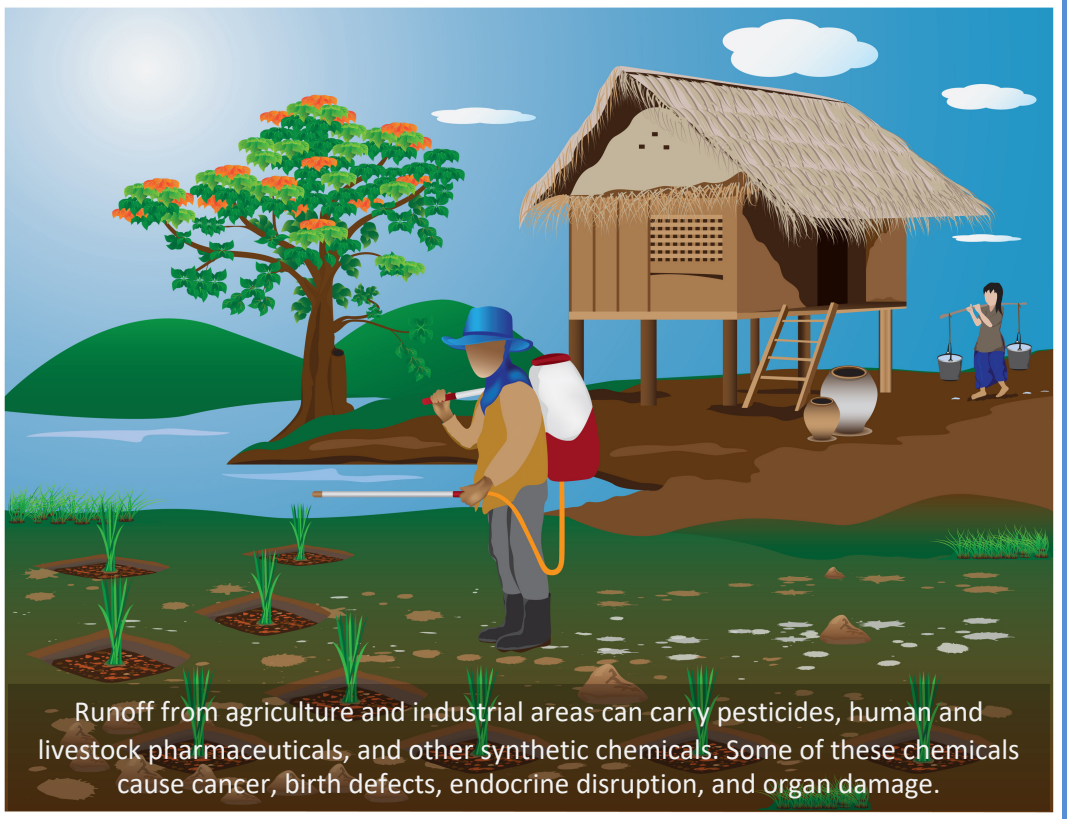
In this treatment step, water flows downward through a bed of crushed biochar.

Biochar made specially for water treatment (i.e., different than common cooking charcoal) is a highly porous material with a large internal surface area. Dissolved chemical contaminants are drawn into fine micro-pores where they adsorb onto the biochar surface. A sparse biofilm of beneficial microorganisms also lives in the char. Mechanisms of adsorption and biodegradation act to remove synthetic chemical water contaminants.*

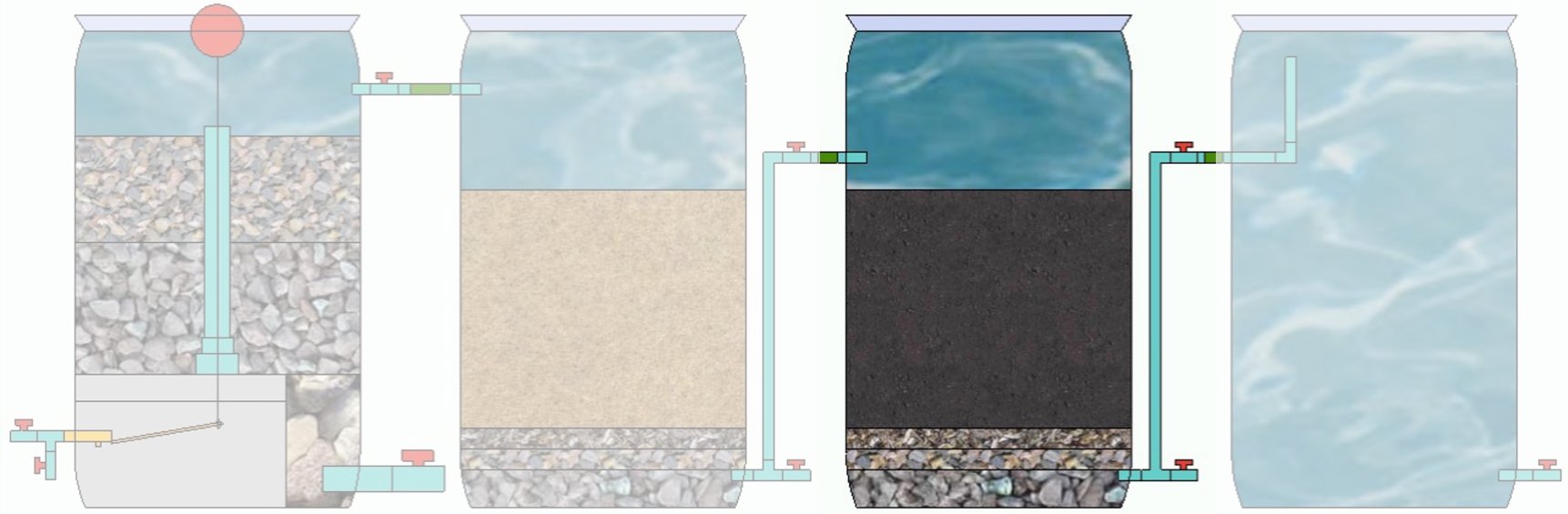
Maintenance: Yearly Biochar Replacement

Once per year the biochar should be removed, safely disposed of, and replaced with fresh crushed char.

* Note: Not all synthetic organic compounds are easily adsorbed or readily biodegraded – water sources impacted by such contaminants should be avoided where possible.

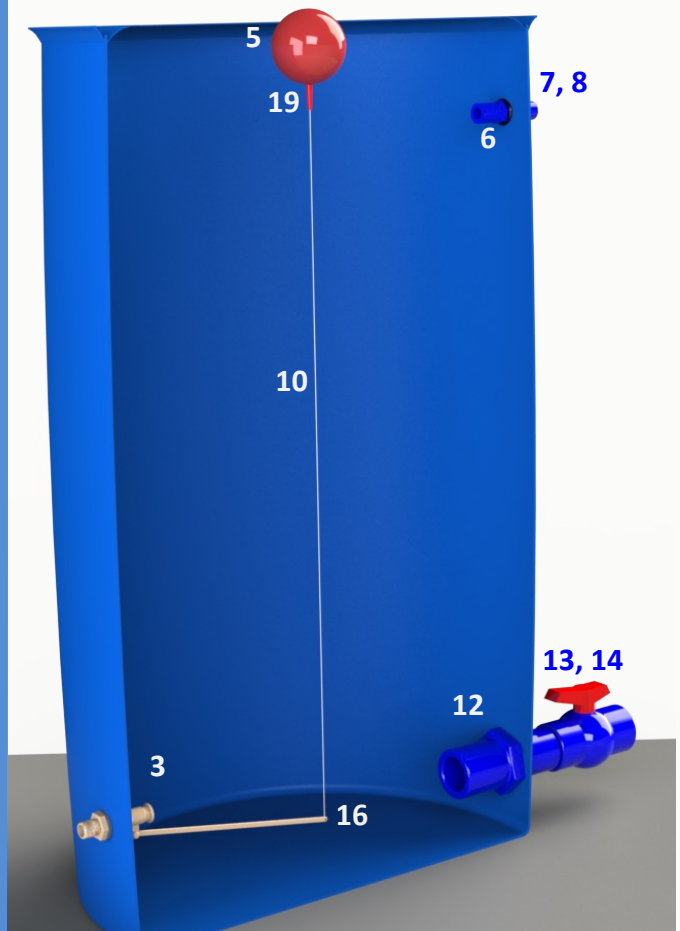


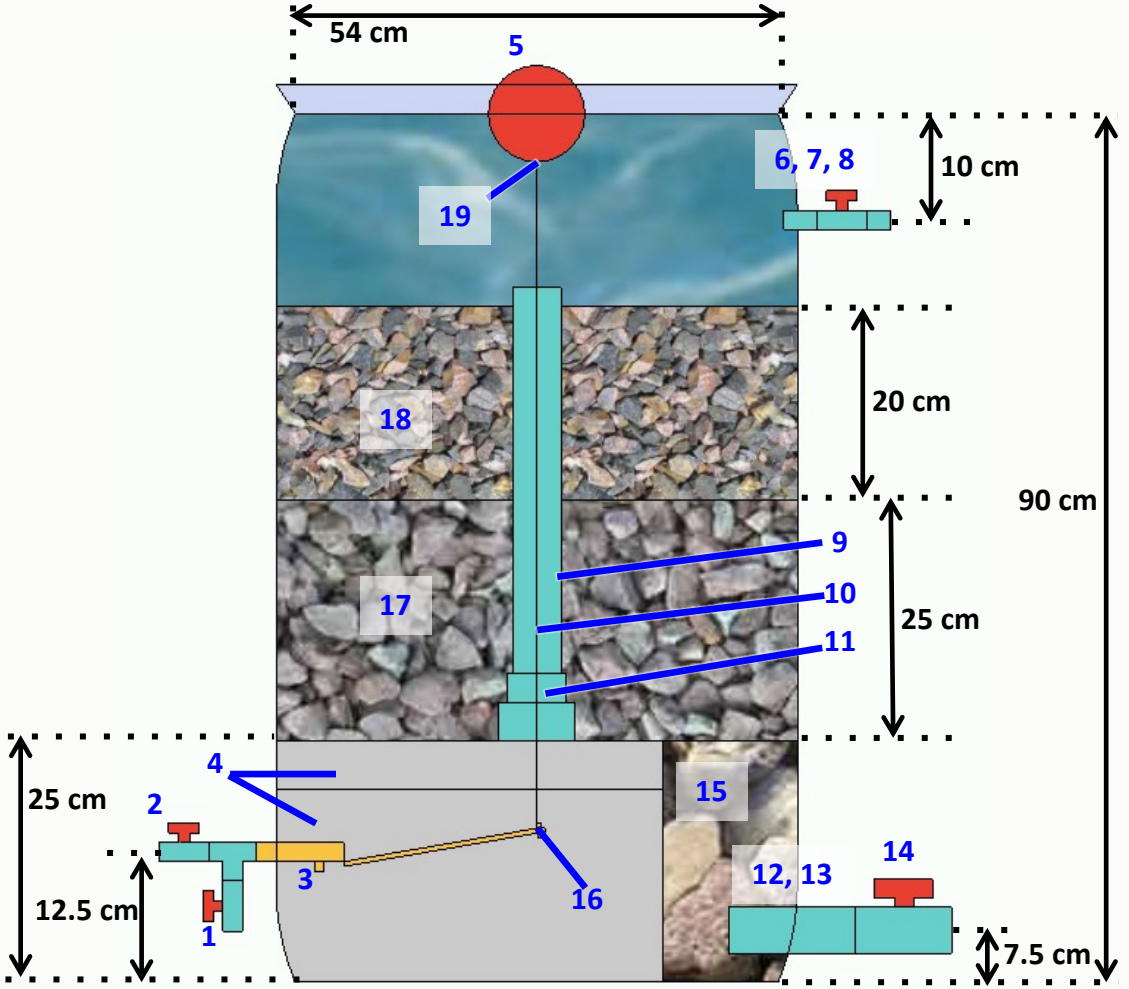
Runoff from agriculture and industrial areas can carry pesticides, human and livestock pharmaceuticals, and other synthetic chemicals. Some of these chemicals cause cancer, birth defects, endocrine disruption, and organ damage.



Gravel Roughing Pre-Filter

1 Inlet valve (½")
2 Inlet cleanout valve (½")
3 Float valve, water inlet (½")
4 Concrete block chamber
Permits unimpeded vertical motion of float valve arm.
Make a 1 ½" dia. hole in top block for floater string.
5 Floater
6 Female coupler (½")
7 Male coupler (½")
8 Outlet valve (½")
9 Floater string housing (1 ½")
10 Floater string
11 Floater string housing base (2 x 1 ½")
12 Male coupler (1 ½")
13 Female coupler (1 ½")
14 Backwash valve (1 ½")
15 Underdrain: fist-sized stones, gravel
16 Nut and washer (floater string attachment)
17 Coarse gravel (10-20 mm dia.)
18 Pea gravel (5-10 mm dia.)
19 Bolt and washer (floater string attachment)





Alternative Float Valve Design Options

20 PVC adapter (½" to 1") and elbow (1") assembly
21 Hudson-type float valve (1" threaded inlet)
22 4" PVC pipe housing

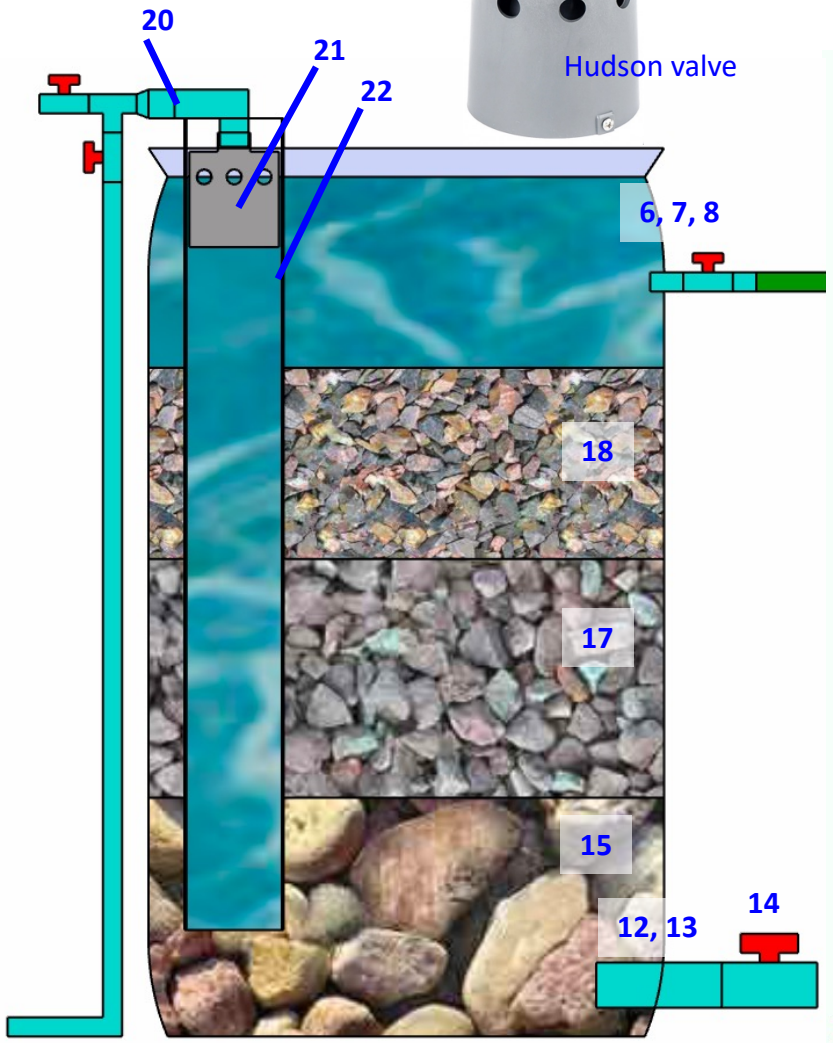
Hudson valve

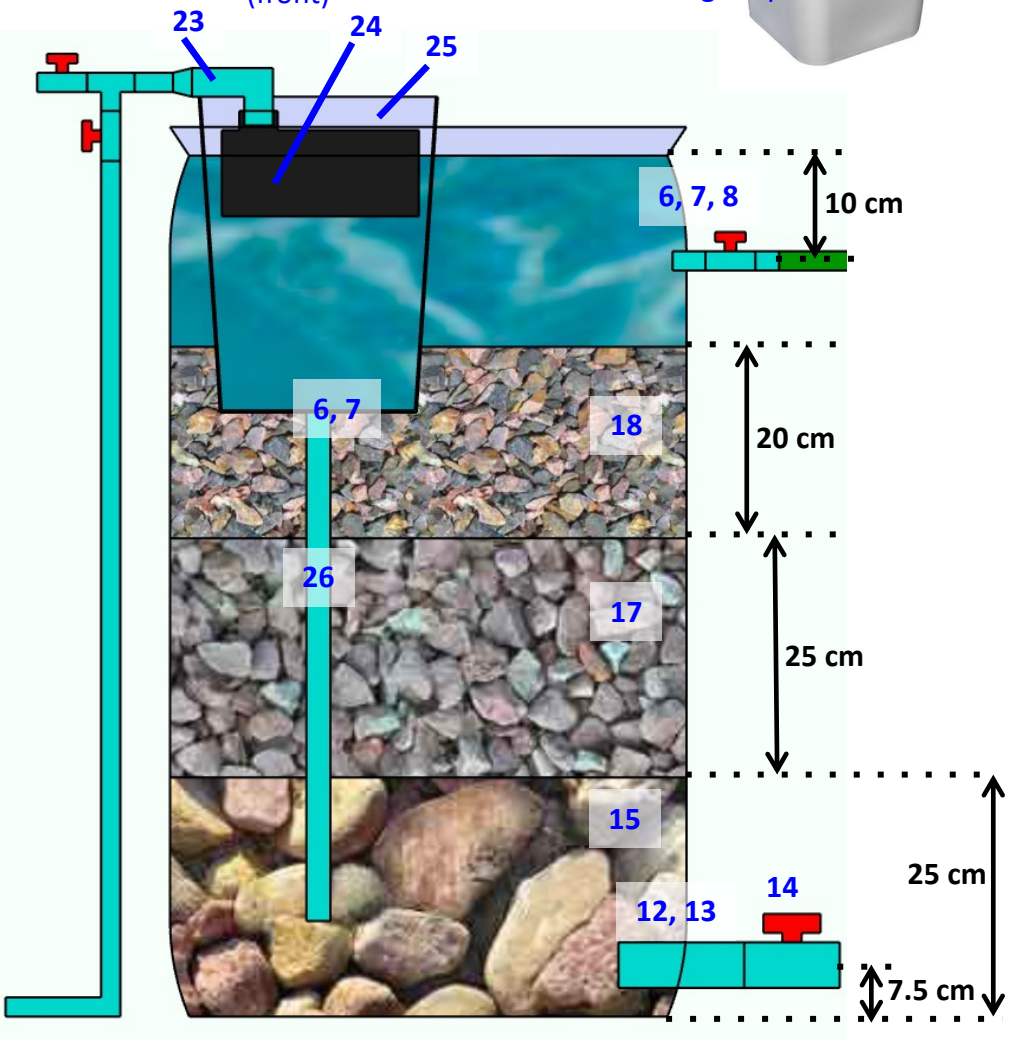
23 PVC adapter (½" to 3/4") and elbow (3/4") assembly
24 Stock-tank-type float valve (3/4" threaded inlet)
25 Square plastic bucket (4-gal)
26 ½" PVC pipe

Stock tank valve (front)

(rear)

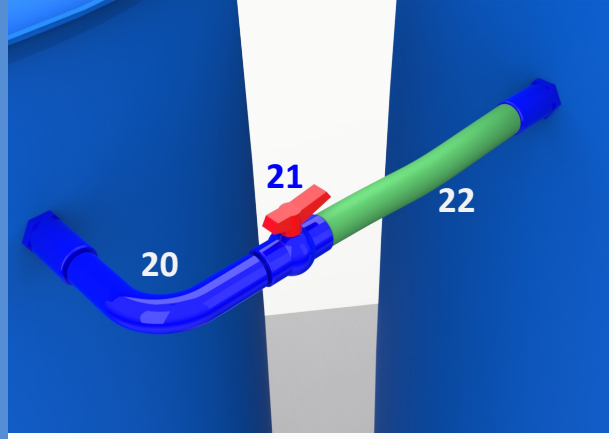
4-gal square bucket

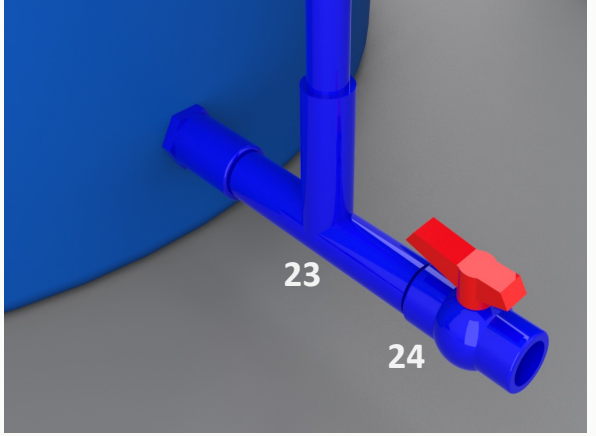


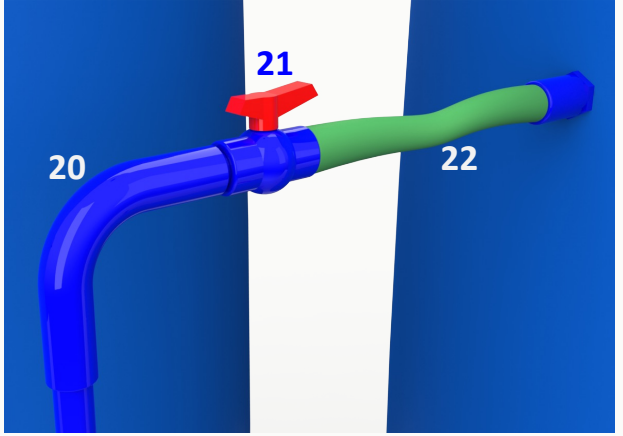


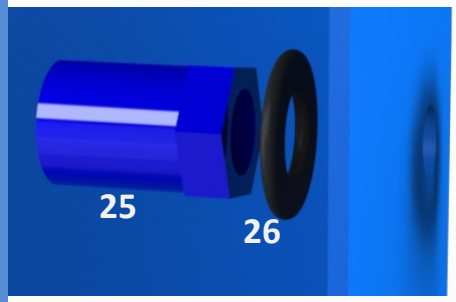
Gravel Roughing Pre-Filter

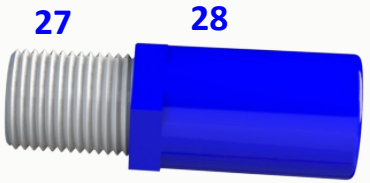
Tank Connections







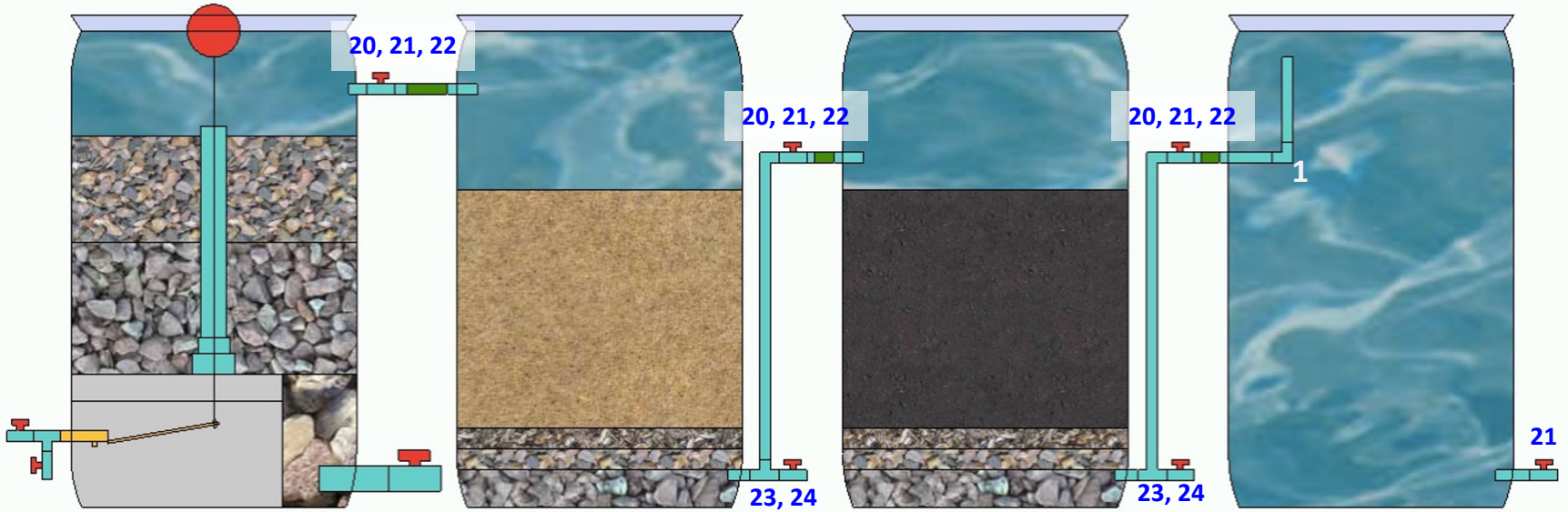




20	Elbow junction (½")	25	Female threaded coupler (½")
21	Outlet valve (½")	26	Rubber gasket or silicone
22	Flexible hose	27	Teflon tape
23	Tee junction (½")	28	Male threaded coupler (½")
24	Cleanout valve (½")		

Cut holes in tanks manually with a pocket knife, or using a drill and hole saws: 20 mm for ½" fittings, and 48 mm for 1 ½" fittings.

Use short segments of ½" PVC pipe to connect flexible hose to fittings.

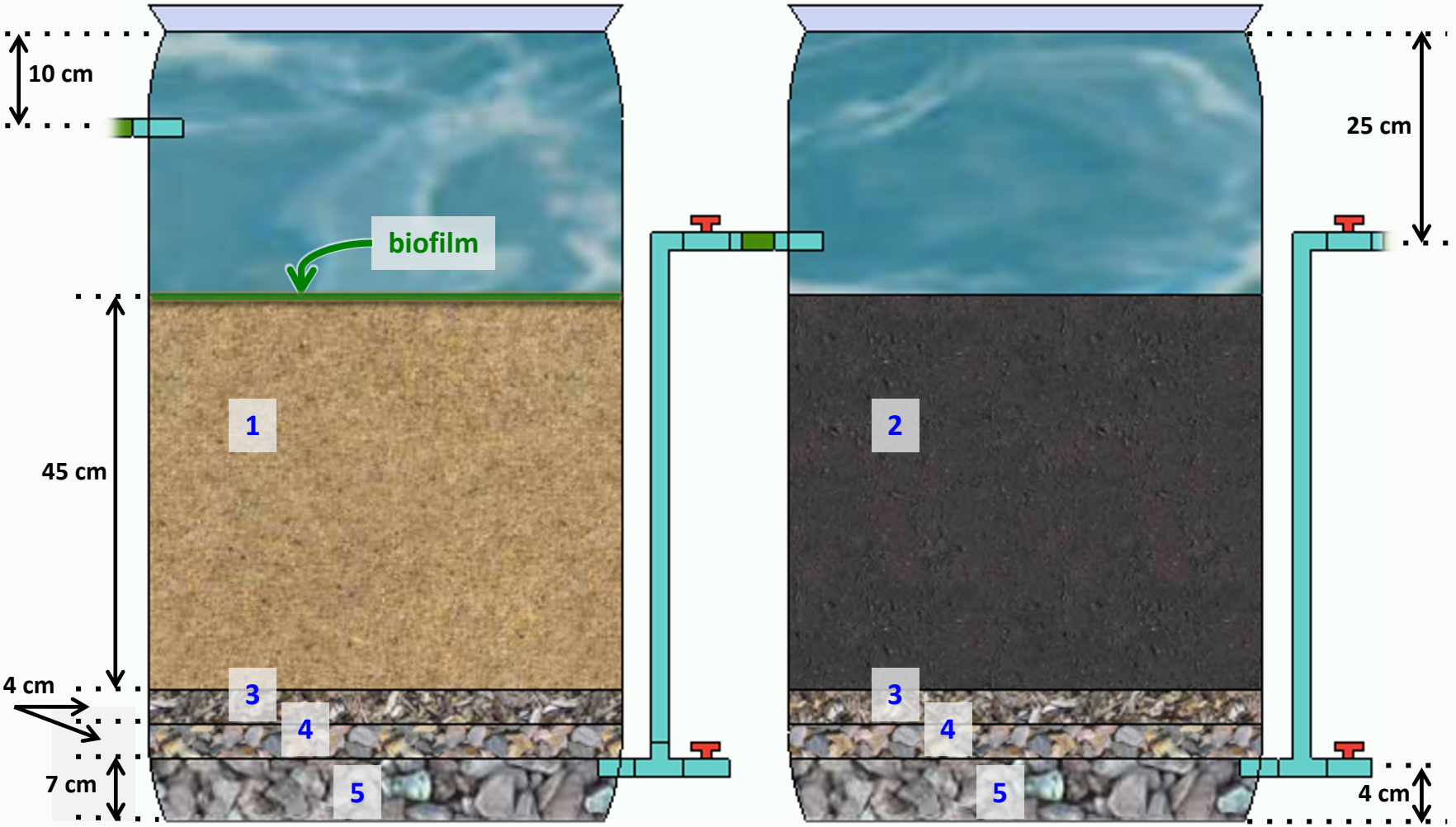


Slow Sand Biofilter & Biochar Adsorber

MEDIA SPECIFICATIONS

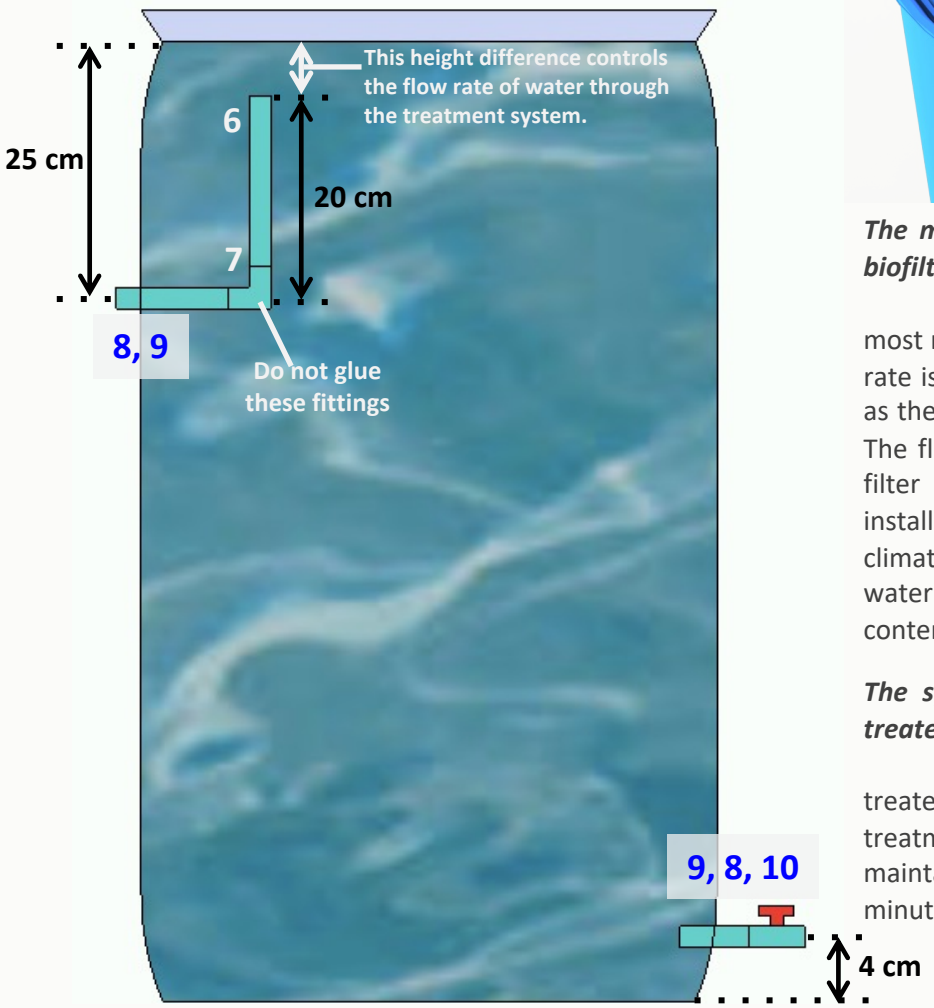
1 Fine sand [0.1-2.5 mm dia.]
2 Crushed biochar [1-5 mm dia.]
3 Coarse sand [2.5-5 mm dia.]
4 Pea gravel [5-10 mm dia.]
5 Coarse gravel [10-25 mm dia.]

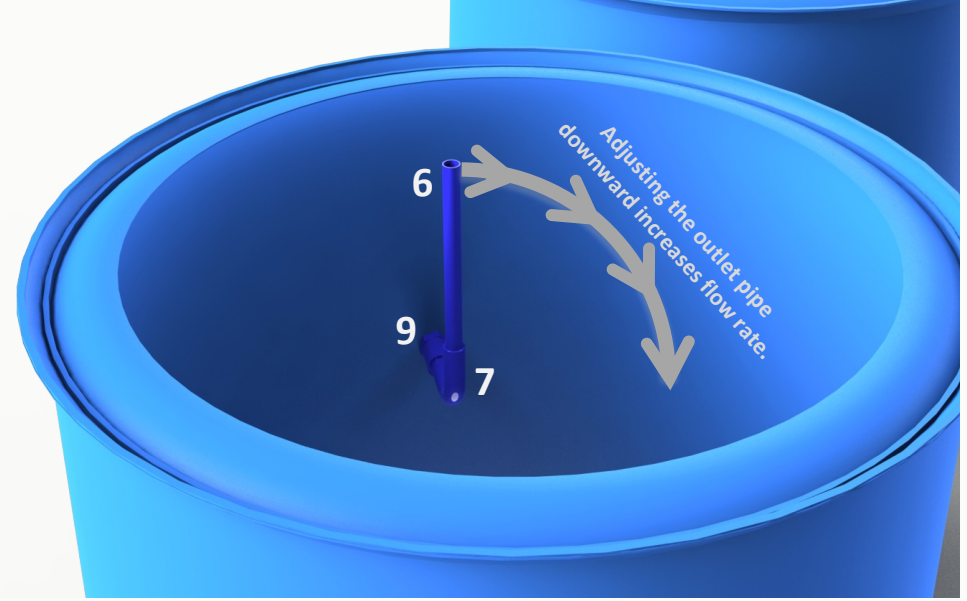
All media should be washed very well before installation in order to eliminate "fines" (powder, silt, rock dust, etc.).



Treated Water Storage Tank

6 Outlet pipe (½" dia. x 20 cm)
7 Elbow junction (½")
8 Male threaded coupler (½")
9 Female threaded coupler (½")
10 Outlet valve (½")





The maximum flow rate through the system is limited by the slow sand biofilter.

The sand filter utilizes the finest grain size media and so provides the most resistance to the flow of water through the treatment system. The flow rate is highest during the first few weeks after initial installation. Over time, as the biofilm in the sand filter develops ("ripens"), the flow rate decreases. The flow rate will also vary within a smaller range over the course of sand filter maintenance cycles. The rates of biofilm ripening after initial installation, and reestablishment after filter maintenance, depend upon local climate (average and high/low daily and seasonal temperature) and source water quality parameters (such as dissolved oxygen and organic matter content).

The system flow rate is controlled by adjusting the outlet pipe in the treated water storage tank.

The height of the outlet pipe (6) relative to the waterline when the treated water storage tank is full sets the flow rate of water through the treatment system. Adjust the angle of the outlet pipe (6) as shown to maintain the system at the design flow rate (300 L per day, or approx. 5 minutes per liter).

Maintaining the system flow rate at 100-300 L/d is important for optimal treatment and water quality.

Platforms & Shade Structures

Install the system on a sturdy, level foundation or raised platform. Cover tanks securely using string and fine mesh or plastic to exclude dust, dirt, leaves, and pests. Ensure tanks are well shaded.

Treatment System Conditioning

After installing media and connecting plumbing

1. Fill and flush the gravel tank two to three times to rinse the media.
2. Using water from the gravel filter, fill and flush the sand tank two to three times, or until the water comes out clear.
3. Use water from the sand filter to fill and flush the biochar tank two times. Ensure that particles of sand and biochar are not being passed through the outlet pipes or the sand or biochar tanks.
4. Using water from the char tank, fill and flush the water storage tank one time.
5. To condition the sand biofilter and stabilize the treatment system, fill and flush the water storage tank once per day for one to two weeks after installation. This water can be used for cooking or preparing hot beverages but should not be used for direct consumption.

Facilitating biofilm development

The treatment system will attain optimal performance when the biofilm in the sand filter is well established. Biofilm development is influenced by local environmental variables such as temperature and source water characteristics. Warm temperatures and well aerated water facilitate biofilm development. Biofilm maturation can be assisted by leaving the sand tank exposed to sunlight for a few weeks following initial installation. (A 1 mm screen should be used as a cover to exclude dirt, leaves, and debris.) A small amount of photosynthetic algae will grow in the water column and help to nourish the biofilm. When the biofilm becomes visible on the top of the sand, cover the tank to avoid excess algal growth. In warm, sunny locales this should occur within two to three weeks.

Optimal system performance requires continuous flow

Ceasing water flow through the system for long periods (i.e., for more than a few days at a time) will deplete dissolved oxygen and impair water quality and aesthetics. For best treatment results the system should be used continuously.

Tools

- small serrated hand saw and pocket knife for removing drum lids and making holes for tank fittings
- *optional:* drill, 21 and 48 mm dia. hole saws
- dish soap and scrubber/brush
- feedbags and buckets for media
- tape measure, pliers
- magic marker, scissors

part	*quantity*
200 L HDPE drum	4
float valve	1
bolt, nut, two washers (set) to fit float valve	1
1/2" tap/faucet	1
1/2" PVC female, threaded	9
1/2" PVC male, threaded	7
1/2" PVC tee	3
1/2" PVC elbow	3
1/2" PVC valve	8
1 1/2" PVC male, threaded	1
1 1/2" PVC female, threaded	1
1 1/2" PVC valve	1
1 1/2" - 2" PVC adapter	1
flexible hose (1 m)	1
1/2" PVC pipe (4 m)	1
1 1/2" PVC pipe (4 m)	1
PVC glue (small can)	1
nylon string or steel wire (20 m)	1
silicone/acrylic sealer (tube)	1
teflon tape (roll)	1
shade cloth (2x10 m bag)	1
poultry netting 1 mm screen size (90 cm x 10 m)	1
plastic netting 10 mm screen size (1 m x 2 m)	1
plastic netting 5 mm screen size (1 m x 2 m)	1
plastic netting 2.5 mm screen size (1 m x 2 m)	1
platform and shade structure	1
plumbing and connectios from source, and to point-of-use	user defined

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G Emidi, P Phuhual

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