

Gravity Fed Water Treatment System – Mod 1*

I. Discussion

Water is essential to sustain human life. In many types of disasters, access to clean drinking water may become a problem. Often times ground water sources and tap water sources will become polluted, which can lead to sickness, disease, and the potential for epidemics. During a crisis, the ability to treat water can sometimes mean the difference between life and death. Individuals can only survive for approximately 3 days without clean drinking water.

Although water filtration systems are sold that can biologically filter water at the individual and family level, filtration systems providing the pure drinking water requirements for a small community are very limited.

Ceramic water filters are expensive and few members of our society will have the foresight to purchase one. I felt there has to be a better means to filter drinking water in an emergency. I visited my local plumbing supply store and designed & constructed a high volume Gravity Feed Water Treatment System. This system is designed to filter 100,000 gallons of biologically contaminated ground water from rivers, streams, ponds, lakes, rainwater runoff, or biologically contaminated tap water converting it into drinking water at a rate of approximately 130 gallons per hour during a crisis, enough water for a small town.

II. Design Goal

This system is designed to take biologically polluted surface water from streams, lakes, ponds, rivers and rainwater runoff and filter out biological threats in order to produce clean drinking water.

- Heavy Duty Capacity: Converts 100,000 gallons of biologically contaminated surface water to drinking water.
- High Rate: Filters approximately 130 gallons of water per hour.
- Operates without electricity.
- Relatively Low Cost (0.6 cents per gallon)
- Filters contaminants (0.5 microns or larger) from ground water rendering water microbiologically safe.
 - Removes greater than 99.99% of E. Coli bacteria
 - Removes greater than 99.99% of Vibrio Cholerae (Cholera) bacteria
 - Removes greater than 99.999% of Shigella bacteria
 - Removes greater than 99.999% of Salmonella Typhi (Typhoid) bacteria
 - Removes greater than 99.999% of Klebsiella Terrigena bacteria
 - Removes greater than 99.999% of Cryptosporidium cyst
 - Removes greater than 99.999% of Giardia cyst

* This is a conceptual design. I have constructed and tested the original Gravity Feed Water Treatment System. <http://personals.galaxyinternet.net/tunga/138.htm> But not this modification. This revision substitutes a Doulton Rio 2000 High-Flow Ceramic Whole House Water Filter in place of the American Plumber W.5CPHD 0.5 micron water filter. <http://www.pure-earth.com/PDF/Rio%202000.pdf> The design may require additional engineering to ensure effective operations.

III. Parts List & Supplies

Quantity	Item (or equivalent)	Unit Price	Total Price
1	55-Gallon Open Head Plastic Water Drum (Food Grade)	\$ 60.97	\$ 60.97
1	Water Filter Housing – American Plumber W10-PR	\$ 39.95	\$ 39.95
2	1" x 6" Brass Nipples	\$ 7.26	\$ 14.52
1	1" x 2" Brass Nipple	\$ 2.35	\$ 2.35
1	1" Ball Valve – Apollo #70-105-01	\$ 13.76	\$ 13.76
2	1" PVC NIBCO PVC-1 D1 D-2466 (1" Female Pipe to 1" Male) One connector should have a high ridge at end of threads to allow brass washer to rest against. (Refer Fig. 1)	\$ 0.49	\$ 0.98
1	1" PVC Male to Male Coupler	\$ 0.45	\$ 0.45
2	1" ID Rubber Washers	\$ 1.00	\$ 2.00
2	1" ID Thin Brass Washers	\$ 1.00	\$ 2.00
1	Electrical Type 1" Nut	\$ 0.20	\$ 0.20
1	1" PVC I NSF Female Adapter Insert	\$ 1.26	\$ 1.26
1	1" PVC I NSF Male Adapter Insert	\$ 0.38	\$ 0.38
60 Feet +	1" ID PVC SPA-Flex Pipe	\$ 1.97/ft	\$ 118.20
2	¾" to 1 ½" Metal Clamps	\$ 0.59	\$ 1.18
40 Yards	100% Bleached Cotton Cheese Cloth (36" wide)	\$ 0.80/yd	\$ 32.00
10	5 Micron Filter Cartridges – American Plumber Model W5CPHD	\$ 10.63	\$ 106.30
1	Doulton Rio 2000 High-Flow Ceramic Whole House Water Filter	\$ 249.00	\$ 249.00
1	Filter Wrench – American Plumber Model WWHD	\$ 4.83	\$ 4.83
2	5-Gallon Heavy Duty Plastic Buckets	\$ 6.00	\$ 12.00
	Grand Total		\$ 601.36

IV. Construction

* Purchase the materials identified in the parts list. Most of parts are available in a plumbing supply store. Cheese Cloth can be obtained from a fabric store, such as Jo Ann Fabrics. I obtained the Doulton Rio 2000 and the 55-gallon drum by mail order.

* Drill a one-inch hole at the base of one 55-gallon plastic drum, approximately 5" from the bottom. Compare drill bit with PVC Connectors prior to drilling to ensure proper hole size.

* Using Multi-Purpose (PVC, CPVC, ABS) Cement join the 1" PVC D-2466 connector to the 1" PVC Male-to-Male Coupler, to the second 1" PVC D-2466 connector. To cement the connections, apply cement to both sides of each connection, push the joint together and give them a small twist. Allow the cement to cure for 4 hours prior to use. This will create a male to male threaded PVC Assembly.

* Insert the PVC Assembly into the 55-gallon drum. The side with the flat mounting surface should be placed into the barrel. Refer to Figure 1. If required, use a round file on the drum to increase the size of the hole slightly to allow the assembly to slide into the hole snugly. Clean out plastic filings from the inside of the drum.

* Slide the brass washers onto the PVC Assembly. If required, use a small round file on the washers to increase the size of the inside hole to allow it to slide onto the PVC Assembly.



Figure 1. 55-Gallon Drum Connections



Figure 2. Filter Housing Connections

* Coat both sides of one thin brass washer and one rubber washer with a silicon sealant. Place the thin brass washer onto the PVC Assembly. Next place the rubber washer. Insert the PVC Assembly into the 55-gallon drum. On the inside of the drum, insert an untreated rubber washer and a thin brass washer and then an electrical type 1" nut. Tighten the assembly.

* Push a 1" Female Adapter Insert into the PVC SPA-Flex Pipe. This pipe is semi-rigid. Use a rubber mallet to drive the insert into the pipe. Use a metal clamp to secure.

* On the other side of the sixty-foot pipe repeat the above step and drive a Male Adapter Insert into the pipe.

* Next, fabricate the Water Filter Assembly. This will join the two Water Filter Housings with two 1" x 6" Brass Nipples. The assembly is connected as follows: Outlet side of gray American Plumber Filter Housing #1 to Nipple #1 to Inlet side of blue Doulton Filter Housing #2. Outlet side of blue Filter Housing #2 to Nipple #2.

* Assemble the 6 ceramic filter candles into the interior housing of the Doulton Rio 2000 filter assembly. The first step is to find the directions. They are well hidden wrapped around a plastic pipe in the middle of the package. Follow these directions to prepare the inner housing for assembly.

* Insert the 5-micron Filter Cartridge into the gray Water Filter Housing #1 (Drum Side). Insert the 0.5 Micron Ceramic Filter assembly into the blue Water Filter Housing #2 (water outlet side). Follow filter cartridge instructions for installation details. The Water Filter Housings o-ring should be lubricated. Clean petroleum



Figure 3. Doulton Ceramic Filter Assembly

jelly is a lubricant that can be used for this purpose. Exercise care in handling this assembly in order to prevent damage to the ceramic filters.

* Connect female side of Hose Assembly to a 1" x 2" brass nipple to a 1" Ball Valve. Verify proper orientation. The outlet side of the Ball Valve should be connected to the hose assembly. The control valve should move freely once the Ball Valve is connected to the drum. Now, connect the other side of the Ball Valve to the PVC Assembly on the 55-gallon drum. I recommend two persons perform this step in order to keep the hose assembly from getting twisted or damaged.

* Connect the male side of the Hose Assembly to the inlet side of the Filter Assembly. I recommend two individuals perform this step in order to prevent damage to the Filter Assembly.

* Use solid objects such as bricks or rocks to provide strain relief on the hose exiting the water barrel and also to prop the filter assembly to keep it rigid.

V. Operation

* Close the ball valve on the 55-gallon drum.

* Fill a 5-gallon bucket with ground water. Place cotton cheese cloth over a second 5-gallon bucket and slowly pour the water from the first bucket into the second. The cheese cloth will remove large contaminants (such as leaves and twigs) as you pour the water into the drum.

* The 55-gallon drum should be placed at the top of a hill and the filter assembly must be placed at the bottom. The hill should have a 20-degree incline or steeper, in order for the system to work effectively.

* Open the ball valve and check for leaks. Tighten connections. Allow water to flow for 5-6 minutes before using the system for the first time. After purging collect filtered drinking water in biologically clean containers.

* The Filter Assembly should use a 1" Inside Diameter (ID) hose that is a minimum of 60 feet long. The gravity fed system requires a minimum head pressure to operate effectively. The head pressure can be increased by lengthening the hose. But under no circumstance should the flow rate exceed the rated flow rate of the Doulton Rio 2000 ceramic filters of 900 gallons per hour (~15 gallons per minute). Using a shorter hose length or a smaller diameter hose will defeat this system.

* The Water Purification System will require periodic maintenance. Filters will need to be removed and cleaned or replaced. Most of the contamination will be concentrated in the first filter assembly containing the 5-micron filter. The Doulton Rio 2000 comes with its own cleaning brush for the ceramic filters. Replacement ceramic candles can be purchased as required.

VI. Limitations

* This system is not designed to treat water contaminated with oil, chemicals, heavy metals, dissolved salts or strong acids/bases. Additional steps may be required to treat these problems.

* This system is not designed to treat muddy water. Muddy water will clog the 5 micron filter quickly and require constant filter cleaning/replacement. In this condition it might be better to prefilter the water in a finer filter than cheese cloth or let the mud water settle out in the 5-gallon buckets before pouring the cleaner water into the 55-gallon drum.