

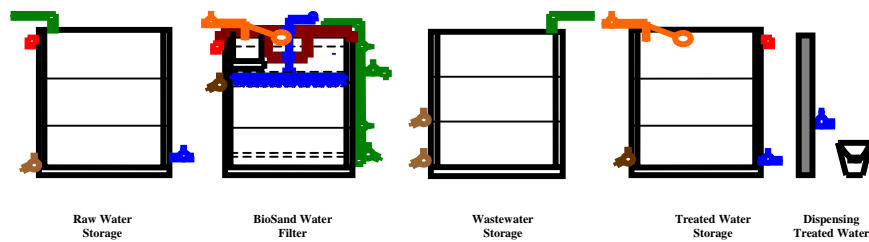
BSF Community Scale Drinking Water Supply Station V 1.0
Using Concrete Ring and Base Construction

By

Dr. David H. Manz, P. Eng.
July 17, 2005



Factory for manufacturing concrete rings and bases for latrines, wells and water storage tanks.



1.0 Background

Water supplied or otherwise available for domestic use in most of the warm climate developing countries is not safe for drinking. It may be perfectly adequate for laundry, bathing, toilets, etc. but not for drinking, cooking and washing of fresh vegetables, eating utensils, cooking utensils and eating area. Often the water that is supplied is available irregularly or in an unpredictable fashion.

The BioSand Water Filtration technology has been developed over a period of more than fifteen years for applications in developing countries (all over the world) and developed countries such as Canada and the United States of America. The BioSand Water Filtration (BSF) technology has proven its utility several times in independent laboratory and field testing around the world.

The BSF technology was adapted for use in Canada and the USA or it would not have been accepted in the households or small communities there. These adaptations included the use of aesthetically acceptable and manufacturable plastic filter bodies, introduction of automation and standards for quality control.

A major challenge has been how to adapt the BSF technology to serve the needs of the larger communities in developing countries while considering the formidable design constraints associated with need to meet World Health Organization (WHO) Water Quality Guidelines, very low capital costs, very low operating costs, very low cost of product to intended consumer, local manufacture, negligible power requirements, ease of operation and finally, appropriateness and sustainability.

Experience with the BSF technology and other supporting technologies in both developed and developing countries have provided sufficient guidance. The following observations are important:

1. Community scale water treatment systems such as those mandated in Europe and North America are just not practical in most of the regions of the world. Of course there are several exceptions but they are not the communities of interest. The economies, which support water treatment and distribution systems that are capable of providing sufficient water to the consumer that is safe for drinking, are very substantial by world standards. Most of the countries in the world do not maintain economies capable of meeting and sustaining the same drinking water standards. This means that most of the world cannot afford to establish water treatment and distribution systems that can guarantee safe water delivery to the home; and, cannot afford to contemplate the establishment of such a water treatment and distribution system in their community.
2. Most of the consumers in the world who are obliged to cope with supplies of water that is unsafe for drinking, do what is necessary to either treat the unsafe water so that it is safe for drinking or purchase special water that they believe or know is safe to drink. The latter alternative is usually quite expensive and may, in the lower income segments of the community, constitute a considerable

fraction of their disposable income. The expense is justified in that it is much less costly to provide safe drinking water than it is to purchase the medical services (often not available) and drugs necessary for the treatment of water borne diseases.

3. There is no hope that safe drinking water will ever be provided through distribution systems throughout the developing world. It is just too expensive.
4. Household treatment systems for the production of safe water are expensive when considering household incomes and demands on that income. Small cash outlays for what is considered an essential, sustaining food, such as water, are justified.
5. With the exception of the household BioSand Water Filter, most water treatment technologies made available to households for point of use treatment are too expensive to buy, too expensive to operate or simply don't work. As inexpensive as the household BioSand Water Filter is, consumers in developing countries still find the cost of purchasing one difficult to accommodate.
6. Community water treatment systems are difficult to sustain. Many communities are simply not accustomed to collecting fees (taxes) for any reason including the operation and maintenance of a community water treatment system, much less a community water distribution system. Many of the same individuals are quite prepared to purchase safe drinking water if it is available to them.
7. It is not uncommon for consumers to find themselves obliged to use a water supply that is very difficult to treat to a safe drinking water standard. The required treatment may not be expensive but it may be complex to use. Often key treatment elements need to be replaced and are often not available. Point-of-use treatment systems are not usually practical in these instances.
8. A very large proportion of the populations in the developing world have very small amounts of disposable income.

The BSF Community Scale Drinking Water Supply Station is able to meet the safe drinking water needs of all. The BSF Community Scale Drinking Water Supply Stations can meet the needs of the most disadvantaged consumers in a manner that they can afford; they can participate in while enhancing local economies and local employment opportunities.

2.0 Design Criteria for the BSF Community Scale Drinking Water Supply Station V

1.0

The following design criteria are proposed:

1. A single water treatment system must provide water for 200 families.
2. Each family consists of 5 persons.
3. Each family will require up to 20 litres of water per day of safe drinking water.
4. The capital cost for the water treatment plant should cost no more than \$5,000 US.
5. All construction materials must be locally supplied.
6. All administration, operation and maintenance must be locally supplied.
7. Water treatment should guarantee water free of toxins and pathogens while still being aesthetically pleasing to consume.
8. The sustainability of the treatment facility must be independent of the creation of community organizations and tax systems.
9. Safe drinking water should be available to the poorest of the community.
10. Safe drinking water should be available to the maximum number of people in the community.

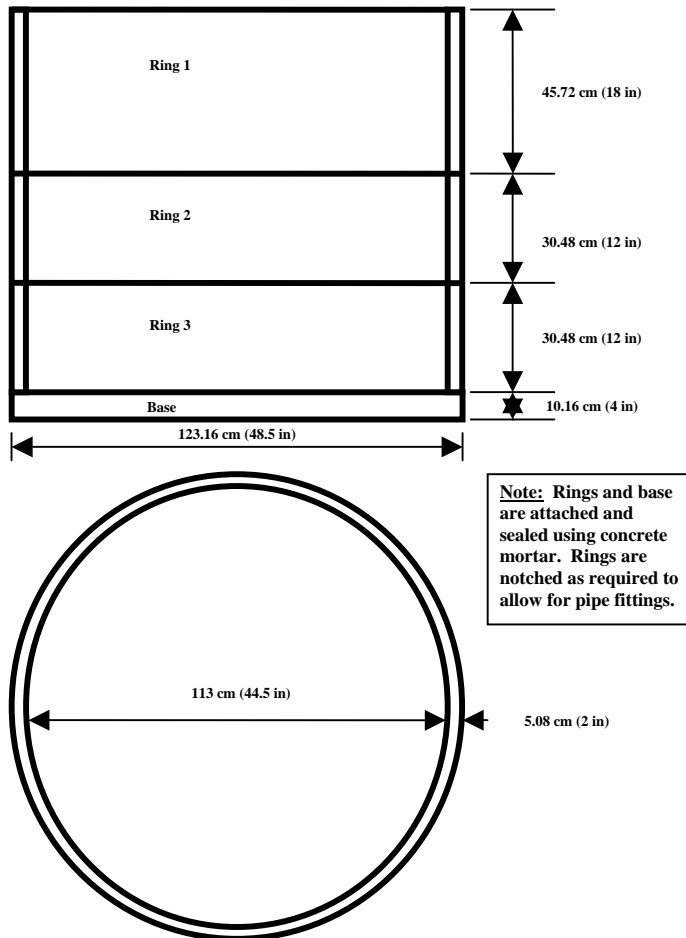
The BSF Community Scale Drinking Water Supply Station Concept meets all of these criteria.

3.0 Design of Containers Using the Pre-cast Concrete Rings and Base

1. Use of pre-cast concrete rings to form tanks.

The following sketch illustrates the use of pre-cast concrete rings to form tanks. If the tanks are constructed such that openings for piping are located near the edges, the rings may be used to construct virtually any type of tankage required.

The front cover of this report shows a number of the concrete rings and various base designs available for purchase in a small manufacturing facility in Bangladesh.

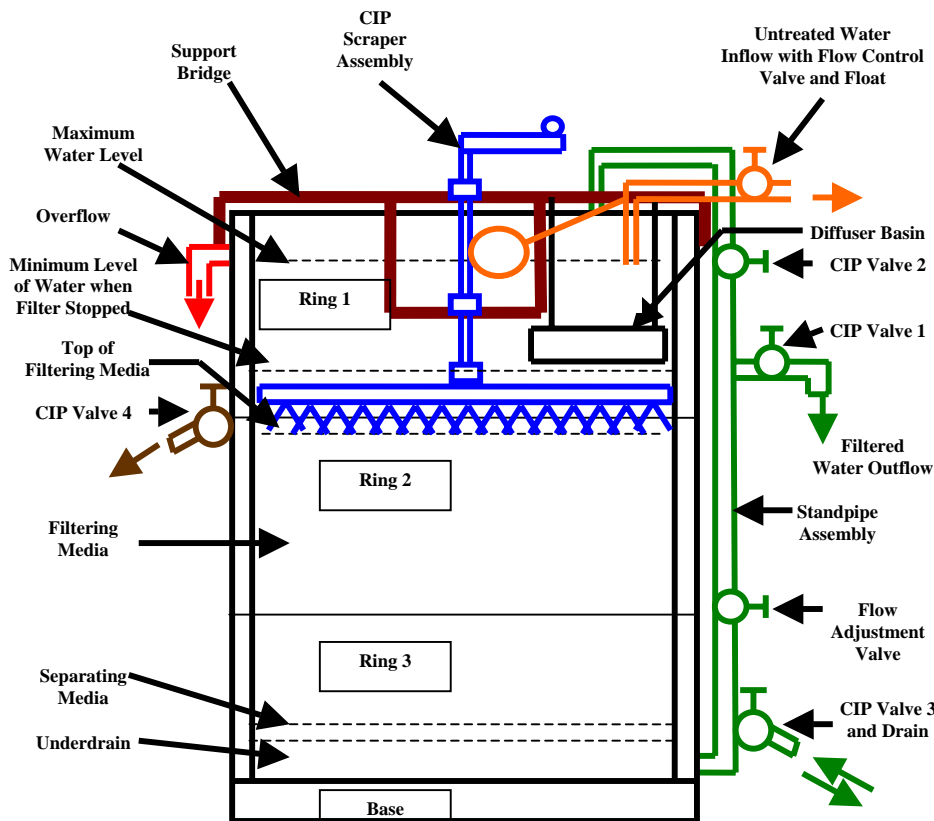


**Concrete Ring Design for
BioSand Water Filter, Raw Water Storage Tank, Treated Water Storage Tank
and Wastewater Storage Tank
Copyright claimed: Dr. David H. Manz, P. Eng. July 12, 2005**

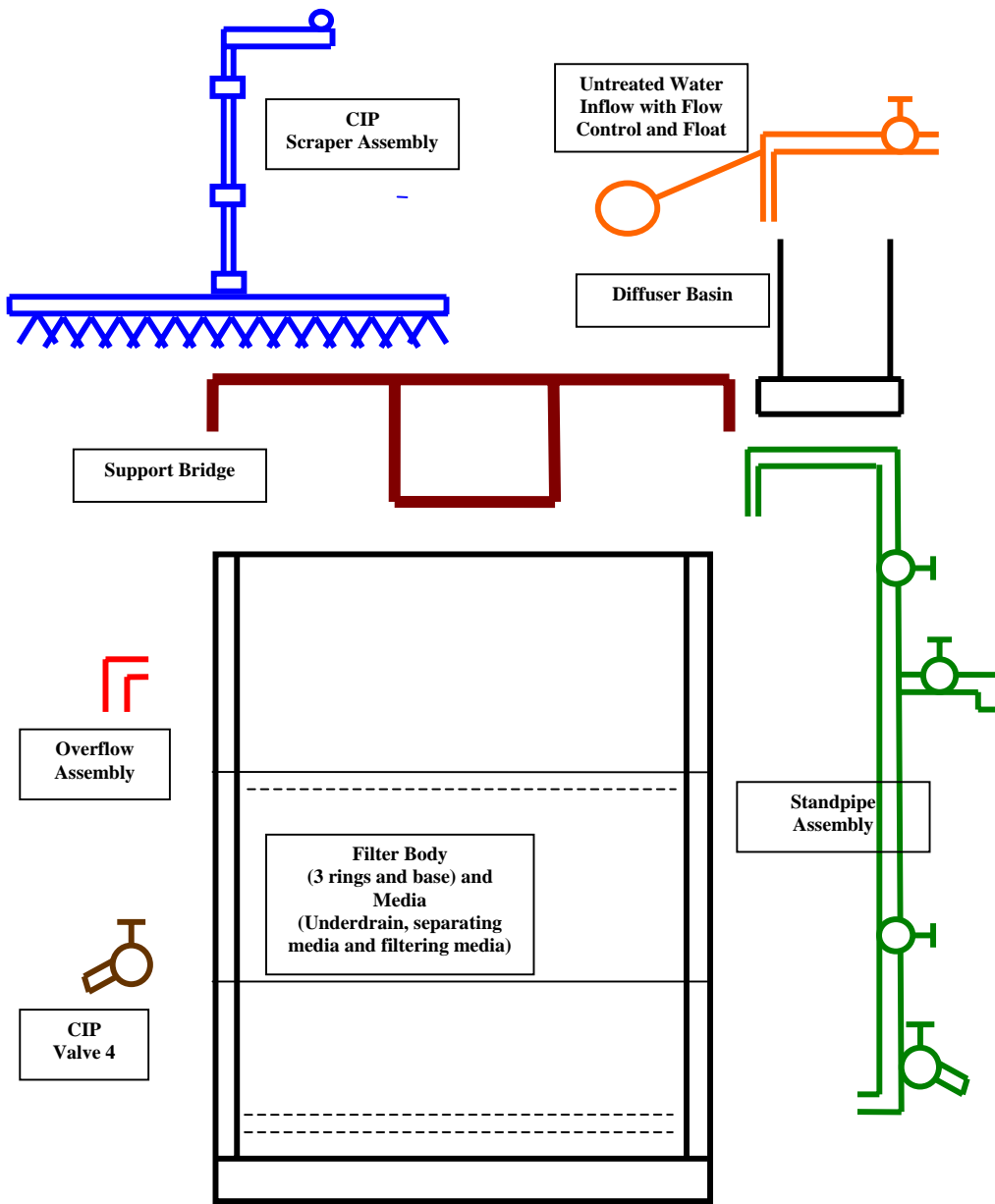
2.0 BSF

The community scale BSF was designed to use local products and technologies. The use of pre-cast concrete rings that could be stacked as required on a pre-cast concrete base met these criteria. In Bangladesh the cost of a single ring is around \$3.00. The cost of an entire BSF filter body, assembled, that could be used to treat up to 600 litres per hour is slightly more than \$15.00. All of the elements used in the 600 lph BSF are readily available or capable of being manufactured locally. The total cost for a single 600 lph BSF is estimated to be in the order of \$150.00.

The design of the rings and base and their use in the BSF and the design of a 600 lph BSF that uses the concrete rings follow.



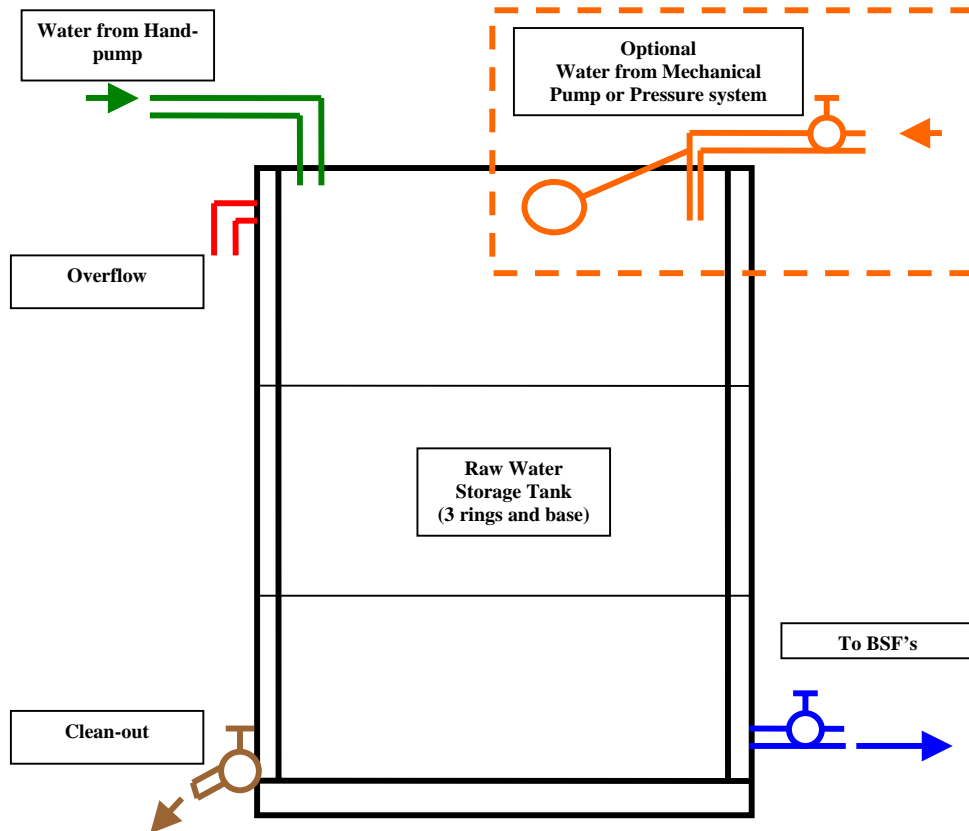
**Assembled BioSand Water Filter - Community Scale – Small Concrete
(Copyright claimed: Dr. David H. Manz, P. Eng. July 12, 2005)**



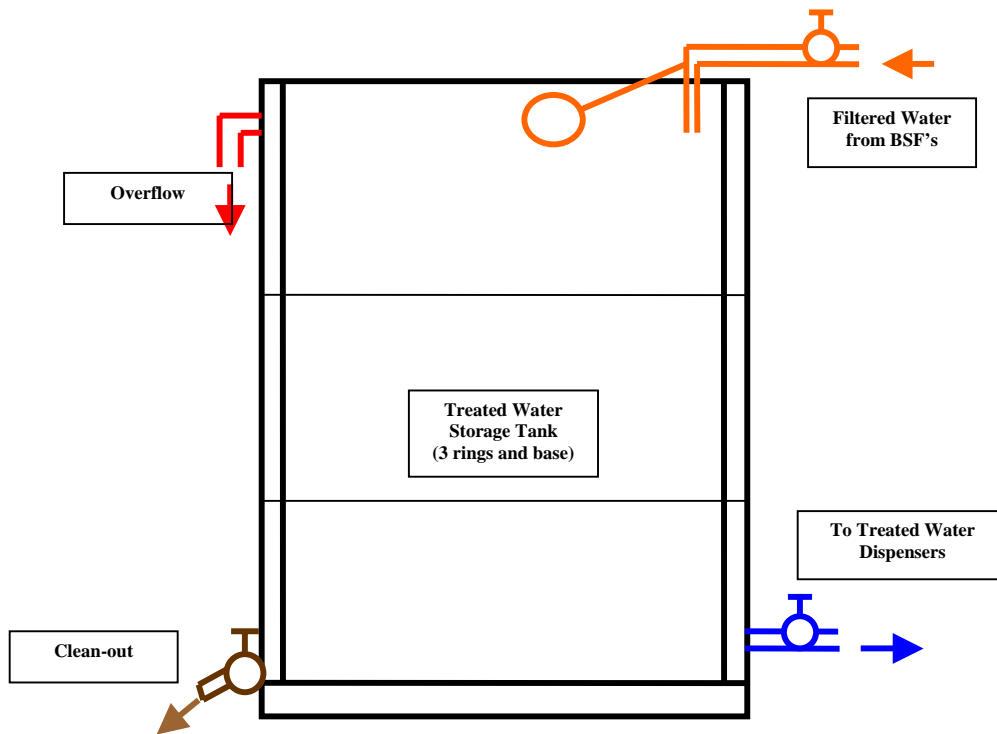
Exploded View of the BioSand Water Filter - Community Scale – Small Concrete
 (Copyright claimed: Dr. David H. Manz, P. Eng. July 12, 2005)

3.0 Construction of Raw Water Storage, Treated Water Storage and Wastewater Storage Tanks Using Pre-cast Concrete Rings.

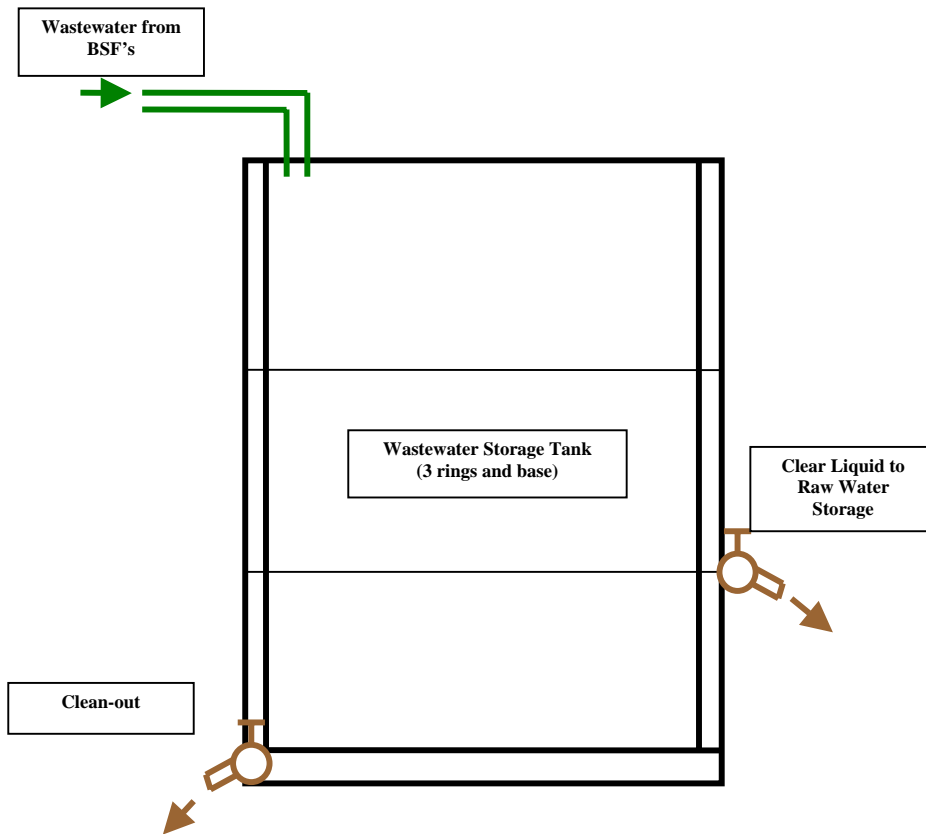
Designs for Raw Water Storage Tanks (used to hold untreated water before the BioSand Water Filters), Treated Water Storage Tanks and Wastewater Storage Tanks follow:



**Raw Water Storage Tank for Community Treatment System.
(Copyright claimed: Dr. David H. Manz, P. Eng. July 11, 2005)**



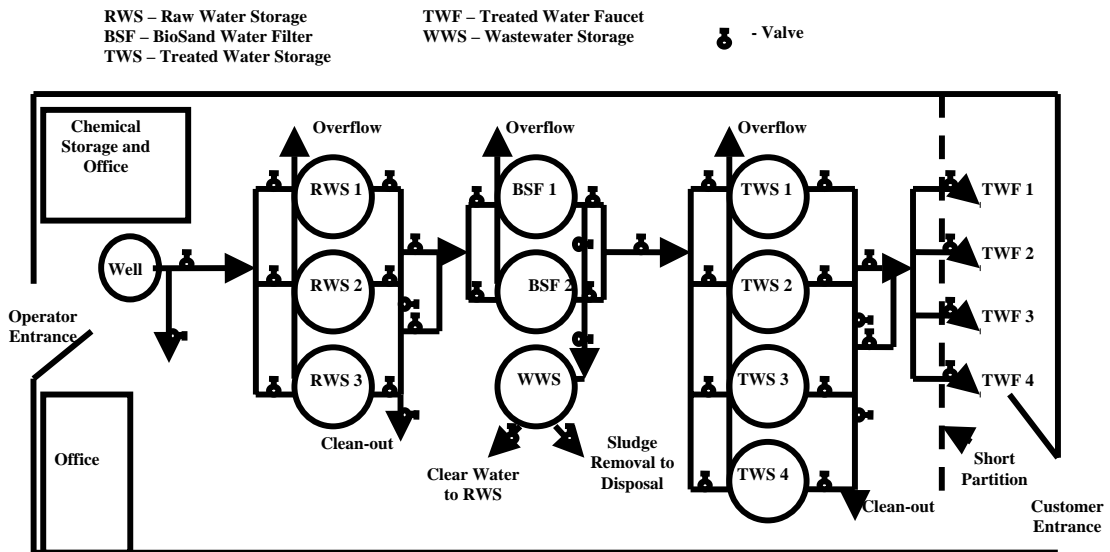
Treated Water Storage Tank for Community Treatment System.
(Copyright claimed: Dr. David H. Manz, P. Eng. July 11, 2005)



**Wastewater Storage Tank for Community Treatment System.
(Copyright claimed: Dr. David H. Manz, P. Eng. July 11, 2005)**

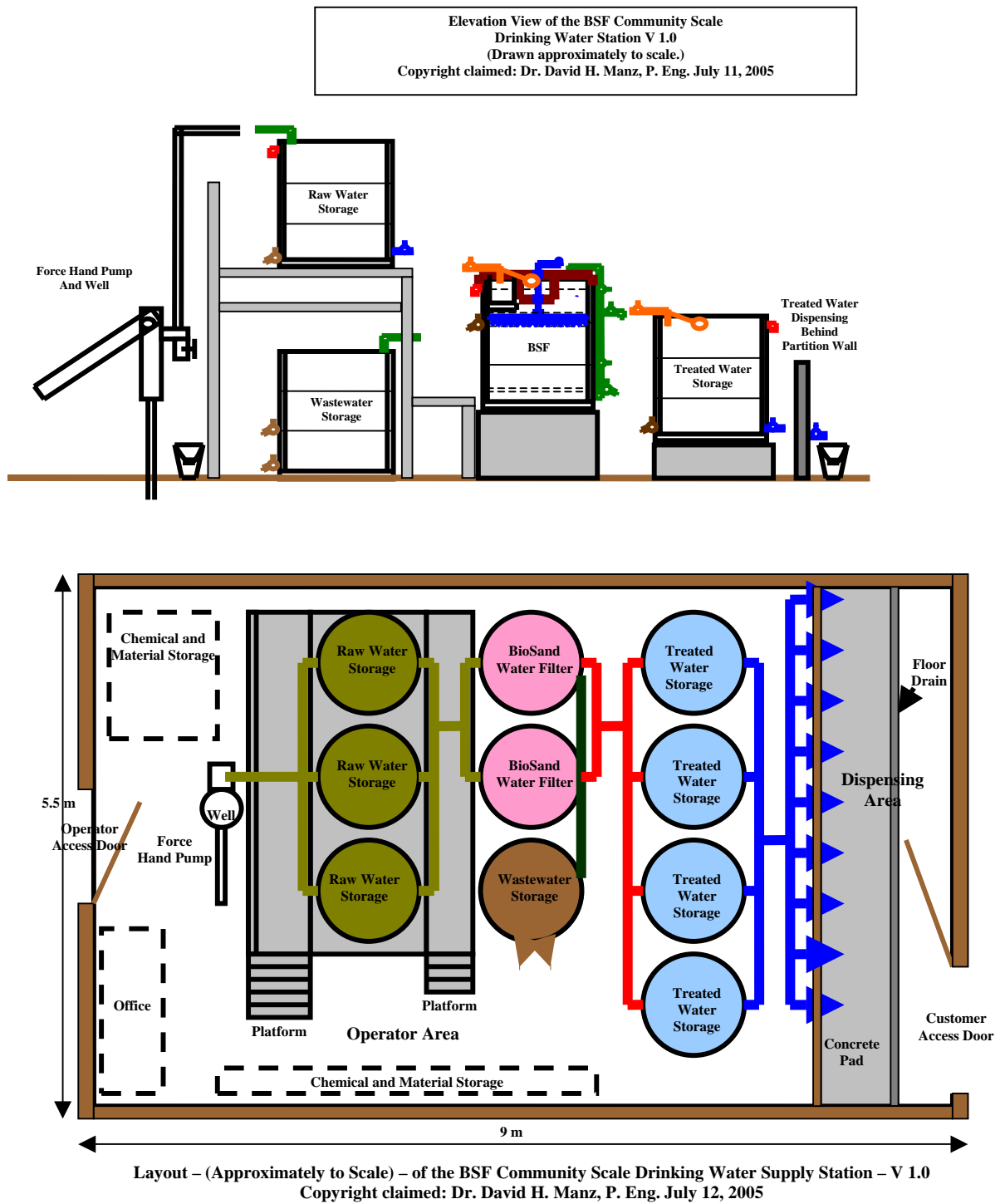
4.0. Process and Flow Diagram for BSF Community Scale Drinking Water Supply Station

A process and flow diagram of the BSF community scale drinking water treatment and dispensing system is shown below.

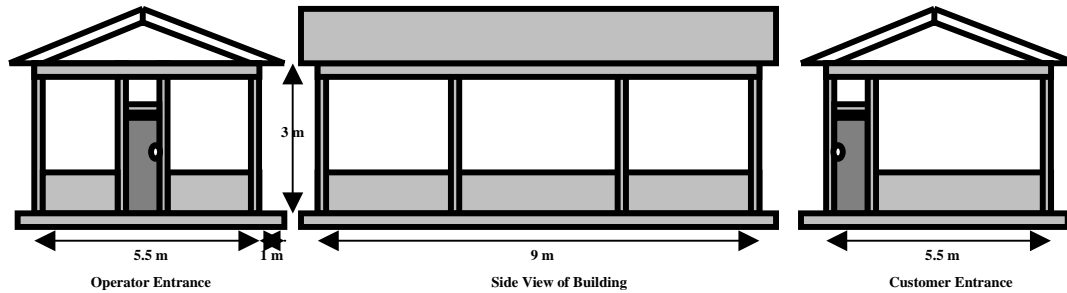


Process and Flow Diagram – BSF Community Scale Drinking Water Supply Station – V 1.0
 (Not drawn to scale.)
 Copyright claimed: Dr. David H. Manz, P. Eng., and July 12, 2005

5.0. Elevation and Plan Views of BSF Community Scale Drinking Water System.



A sketch of a building that could be used to house the treatment plant is shown in the sketch below.



Note:

1. Building is rectangular in plan (9 m by 5.5 m) to be constructed with a concrete floor with good drainage away from the building all around. It may be advisable to extend the concrete floor at least 1 m all around the building to accommodate splash from rain coming off the roof.
2. Corrugated galvanized steel roof.
3. Solid lower walls approximately 1.5 m in height.
4. Open areas between solid lower walls and doors to roof to be secured with chain link fence type materials.
5. Doors to be solid and lockable.

**Building to House BSF Community Scale Drinking Water Station V 1.0
Copyright claimed by Dr. David H. Manz, P. Eng. July 12, 2005**

6.0. Explanation of Treatment Plant Design and Operation.

This plant is designed and operated as follows:

1. Each treatment plant (TP) would have its own well or water supply.
2. The TP is either manual or gravity operated. There is no need for an external power supply though this would clearly be useful.
3. Once water is lifted to the Raw Water Storage Tanks (RWS) gravity will move the water to the BioSand Water Filters (BSF) and the Treated Water Storage Tanks (TWS) from where it is dispensed to consumers. The RWS and TWS tanks each have a volume of 1000 litres.
4. Consumers must pay for water before they are permitted to fill their containers.
5. The basic operation consists of an operator filling one of the RWS tanks while one RWS tank is feeding both of the BSF's. The third tank (three RWS tanks is considered the minimum number of RWS tanks.) may be full waiting to be filtered or it may be being pretreated prior to being sent to filtration (e.g. through addition of chemicals).

6. The BSF's normally operate in parallel (together). The filtered water is sent to one or more of the TWS tanks. Valves are used direct the flow as required. At least one of the TWS tanks will be available for dispensing water to clients. Once a TWS is filled it may be disinfected using chemicals such as a solution of sodium hypochlorite.
7. The BSF's should normally be cleaned (maintained) once the flow drops below 300 litres per hour. Each of the BSF's may be isolated and cleaned while the other is filtering. Wastewater resulting from the BSF cleaning is sent to the Wastewater Storage (WWS) tank where it is allowed to clarify. After several days the clarified water is manually transferred to a RWS tank that is in the process of being filled.
8. The TP is intended to be operated seven days a week but for no more than 10 hours a day.
9. If the BSF's in combination produce a minimum of 600 litres of filtered water per hour, 10 hours of production will yield 6000 litres of filtered water.
10. All TWS tanks should be full, disinfected and available for dispensing at start of business in the morning..
11. Assume that 2 minutes will be required to fill a 20 litre container. Each dispenser can deliver 30 containers per hour or 600 litres per hour.
12. Assume that TWS tanks will be opened in sequence as required. That is, no more than one TWS will provide water to dispensers at a time.
13. Assume that a maximum of 3000 litres will be dispensed per hour. This will require 5 dispensers.
14. After the first of the RWS tanks is emptied (the fourth will be made available for dispensing), the BWF's will start producing filtered water at a minimum rate of 600 litres per hour. By the time the fourth TWS is required the first will be refilled, disinfected and available for disinfecting. Assuming this scenario the maximum delivery during the day to consumers will be 600 litres per hour. During the approximately 10 hours of operation the TP will produce approximately 6000 litres.
15. At the end of the day it is expected that at least one of the TWS tanks will be full or partially so and all of the RWS tanks will be full and available for filtration (including a suitable pretreatment).
16. During the evening all the valves connecting the RWS tanks to the BWF's are open as are all valves connecting the BSF's to the TWS tanks that were empty at the end of the day. The TWS tanks (3 maximum for the design presented) will be filled by next morning. The RWS tanks will be empty by morning and available for immediate filling. 3000 litres of water can be treated overnight.
17. First thing in the morning the three TWS tanks that were filled overnight must immediately be disinfected so that they are available for dispensing. The three RWS tanks that were emptied overnight must be filled one at a time and made ready for delivery to the BWF's and production to the first available empty TWS tank.
18. The total production of water per day is slightly less than 9000 litres. This provides for more than 400 dispenses at 20 litres per fill.

19. Since the TP will need to operate 7 days a week at least 3 operators will be required, one supervisor, one assistant supervisor and one operator.
20. All money collected during the day and all other sales and purchasing records should be removed from the TP at the end of each day for safe keeping and/or deposit.
21. Chemicals and supplies could be stored on site if suitable security was provided. It is recommended that suitable 24 hour security be provided for each TP.
22. It is possible to expand the plant production to over 14,000 litres per day by adding three RWS tanks and four TWS tanks without the addition of any additional BSF's. Each additional BSF, without addition of RWS or TWS tanks, will add a potential 3000 litres of production per day. A maximum of four BSF's is considered practical at this time. If all RWS and TWS tanks and two additional BSF's are added, the TP capacity can be expanded to 18,000 litres without altering the footprint of the TP building, though it would be cramped and busy. An 18,000 litre per day plant is considered a practical maximum at one location using this model.
23. Though the RWS tanks and the BSF's are shown sitting on platforms, concrete rings, similar to those used to construct the containers, may be used as well. Raised platforms for accessing the control valves will still be required but will not need to be as substantially constructed.

7.0 Financial Assessment Model

1. Capital cost

It is estimated that a single TP, as proposed in this document, capable of producing approximately 8000 litres per day will cost \$5,000. This does not include the price of the land required to site the building.

Each additional BSF, RWS tank, TWS tank or WWS tank will add approximately \$200.00 to the capital cost.

2. Operating costs per day

i.	Operators (3 at \$5.00 per day)	\$15.00
ii.	Administrator	\$10.00
iii.	Administration costs	\$10.00
iv.	Chemicals for producing 8000 litres per day.	\$ 5.00
v.	Security (24 hours per day)	\$ 6.00
vi.	Maintenance of TP	\$ 1.00
vii.	Interest on investment	\$ 3.00
	Total	\$50.00

3. Revenue and margin per day

This will depend on how much is charged for one 20 litre fill.

If the charge per fill is \$0.20, 250 fills will be required to break even on operating costs. If there are 400 fills per day the revenue will be \$80.00 resulting in a margin of \$30.00 per day.

If the plant is expanded to one that can produce 700 fills per day the operating costs may only increase by \$10.00 to \$60.00 per day. Revenue would increase to \$140.00 per day. The margin will increase to \$80.00 per day.

If the plant is expanded to a maximum capacity of 900 fills per day the operating costs may increase to \$70.00 per day. Revenues would increase to \$180.00 per day. The margin will increase to \$110.00 per day.

8.0 Conclusions

The BSF Community Scale Drinking Water Supply Station V 1.0 meets or exceeds the design criteria imposed.

The TP may be easily constructed anywhere in the world. The actual construction methods used are readily adapted to use local materials and expertise.

In order to implement the technology it will still be necessary to acquire the detailed construction drawings of each of the containers and the TP itself. Also, very detailed installation, commissioning, operation and maintenance procedures will need to be developed for each plant in English and in the local language. A training program will need to be developed.

Finally, an overall organization to implement a development program that would be responsible for the creation of TP's of the type described would need to be established.