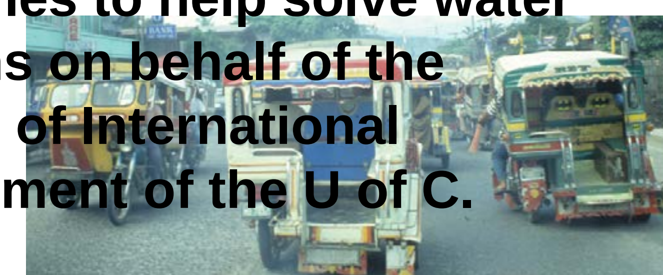
Legends: ‘Safe Water for the World’
The Water Filter Story – Part 1

June 13, 2018

Dr. David H. Manz, P. Eng.

The development of the BioSand Water Filter was inspired by visits to disadvantaged communities in Africa and Asia (1988 and 1989).

Visit to Kwazulu, Natal, South Africa – help with water problems on behalf of the Division of International Development at the U of C.



Island of Mindanao Philippines to help solve water problems on behalf of the Division of International Development of the U of C.

Outhouse and well behind store in Heritage Park, Calgary.
(typical situation in early prairie years if you don’t know better)

It was evident that people needed a point-of-use treatment system.

The treatment technology of choice is known as

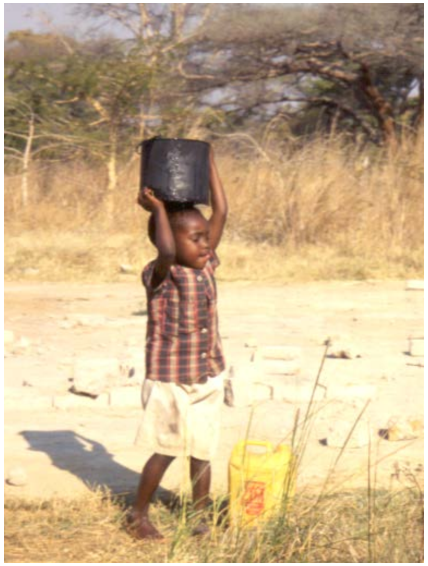
‘Slow Sand Filtration’.

Slow sand filtration has been used around the world, for over 180 years to treat water for drinking purposes.

Household filters that use sand have been in use for several thousand years. (Such as the one in China shown above.)

Alone Slow Sand Filters remove:

- **Parasites - typically 100%**
- **Bacteria - 90 – 99%**
- **Viruses - 90 – 99%**
- **Sand, silt and other particles**
- **Organic and inorganic toxins (substantially reduced)**



Objective: Develop a version of slow sand filtration that could be used in a household.

For a treatment technology to be successful it must be:

- Effective (it has to work)
- Affordable (within consumer budget)
- Sustainable (integrated into the local culture and economy)

Brief History

Characteristics of Traditional Slow Sand Filter were problematic.

- **Must be continuously operated.**
- **Cleaned using a very time consuming process involving removal of top 5 cm or sand which ultimately must be replaced.**
- **Performance is lost after each cleaning – takes several days to recover.**

Traditional Slow Sand Filter design needed to modified for use in homes.

First BioSand Filter Ever!

Original Testing of Ideas: 1991 – 4th year Civil Engineering Student Project (David Lee).

Budget: $75.00 and some free water testing from the Province of Alberta.

The proposed BioSand Water Filter design needed to overcome all of the problems associated with traditional slow sand filters.

That is:

- **Operated when required without loss of performance.**
- **Cleaned in less than 5 minutes using a very simple process using a method that does not impair filter performance.**
- **Easily used in a home environment by normal people.**

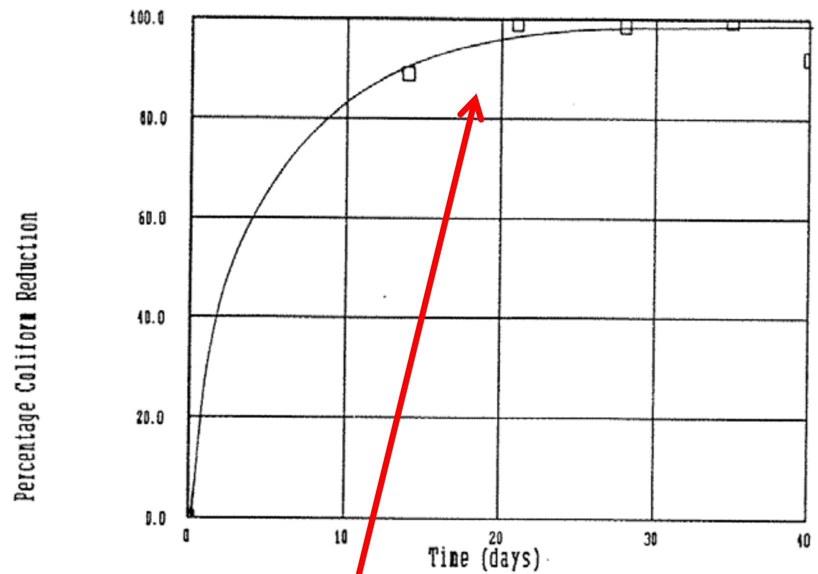


Figure 4.1 Reduction in Total Coliforms

The theories behind the BSF innovation were demonstrated to be true!

I realized that the results of our little study were very important.

A variation of slow sand filtration suitable for household (small scale) use had been demonstrated.

I decided to do whatever was necessary to bring the ‘new slow sand filtration technology’ to practical use.

It was important to confirm the study results and develop practical designs before going to actual projects.

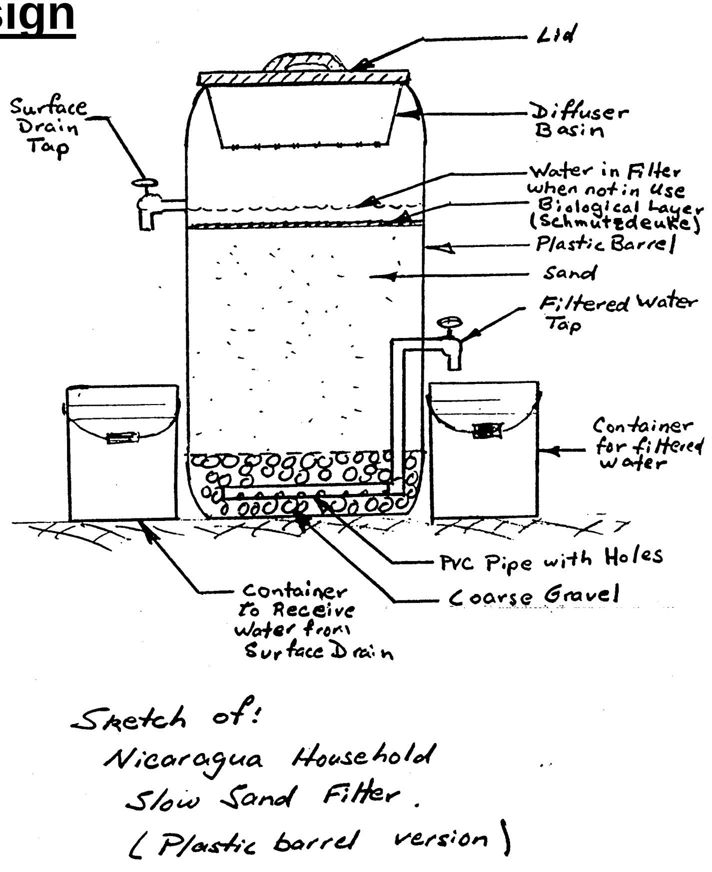
First filter used in initial lab work at the University of Calgary

First prototype of the modern BioSand Filter

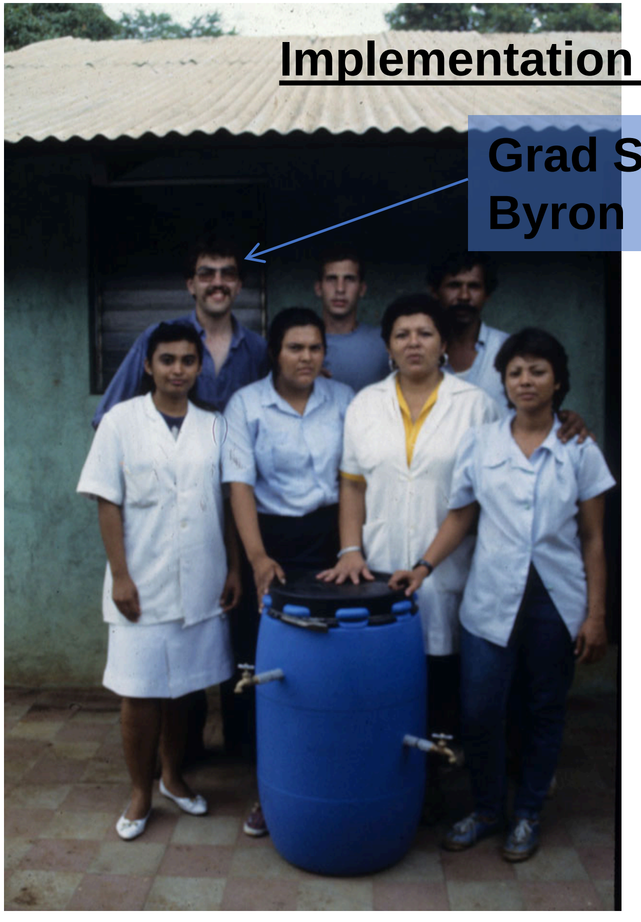
Also, would people want to use the BioSand Filter?

Our first project (4 plastic filters) was in Nicaragua in 1993 – south of the city of Managua.

Design



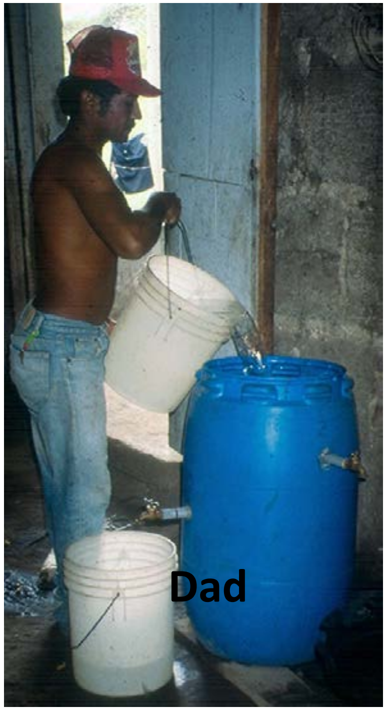
Implementation Team



Grad Student
Byron Buzunis

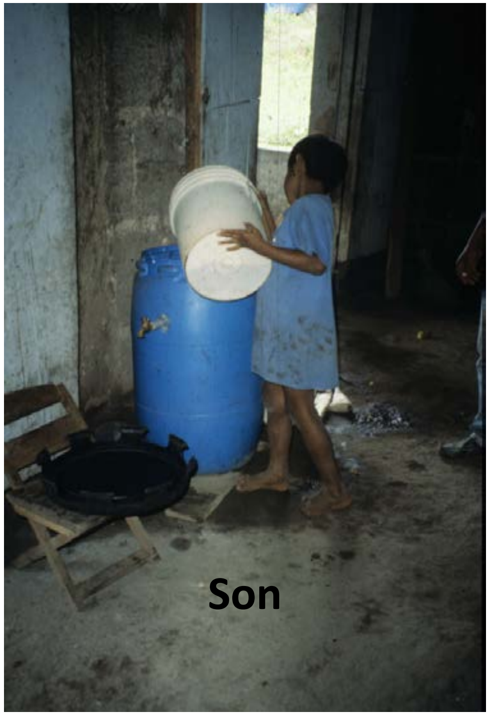
Funded by the Pan American Health Organization through a project managed by the University of Calgary.

Typical filter installation and use in Nicaragua.



Dad

Mom

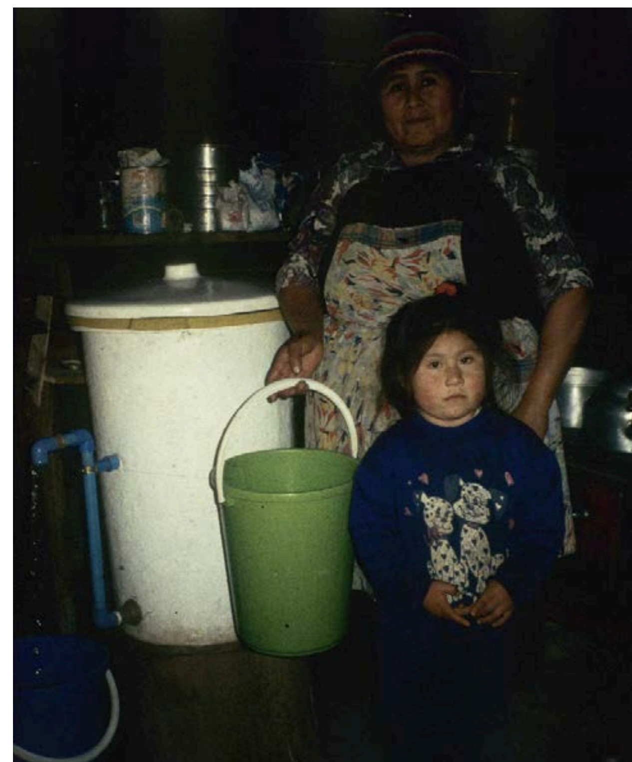


Son

Honduras - 1994

Filters worked, were accepted but needed a better design.

Chile - 1994



Iron removal using the BSF in Chile and the discovery of the commercial potential of the technology in Canada.

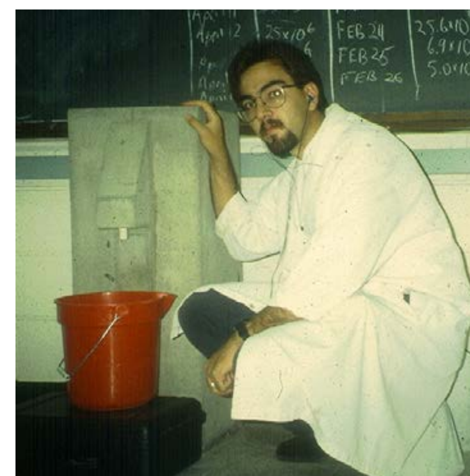
Development of the Concrete Version of the BioSand Water Filter (BSF).

Second cast concrete BSF at U of C.

Ferro-cement construction of BioSand Water Filter at University of Calgary.

First cast concrete BSF at U of C.

Byron Buzunis – my Grad Student evaluating performance of prototype of first cast concrete BSF to be used in Nicaragua.



Another grad student from Germany, Ole Mrklas, who did his masters degree assessing the use of the filter in warm and very cold environments. Here discussing the method we used to produce contaminated water with a visitor from El Salvador.

Terry Nail, Senior Technologist from the University of Calgary – with First Concrete Filter made in Nicaragua.

First Concrete Filter Factory in Nicaragua.

Concrete BSF Factory in Nicaragua in 1994.

First concrete filters manufactured using a wood mold.

Nicaragua 1994: 60 homes. Eliminated diarrheal diseases - including cholera!

In 1996 I received the Association of Professional Engineers, Geologists and Geophysicists of Alberta, Project Achievement Award in recognition for the development of the <u>BioSand Water Filter</u> technology that uses the <u>Canadian Water Filtration Process</u>.

Despite the apparent success of the Nicaragua water filter project, the Government of Canada and the University of Calgary discontinued support.

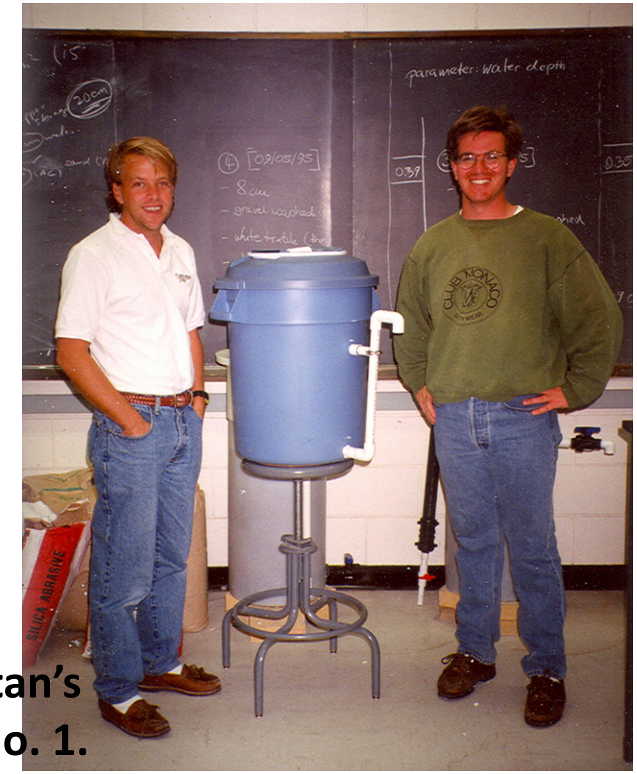
There was no contact with the community in Nicaragua for two years.

This turned out to be a blessing as the people of the community continued to use and maintain their filters without any outside assistance. They 'loved' their filters as they later explained.

Their health was greatly improved and their neighbors also wanted filters – none were to be had.

The water filter project was discovered by Samaritan's Purse Canada. They were impressed and wanted to use the technology – which I had continued to develop independently.

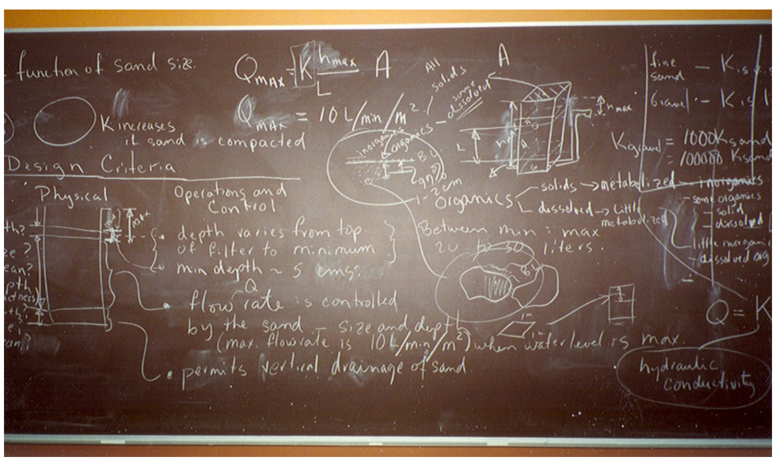
News of the successful Nicaraguan filter project spread and instruction was demanded.



First courses on filter construction offered at the University of Calgary.

Samaritan's Purse No. 1.

El Salvador - CESTA



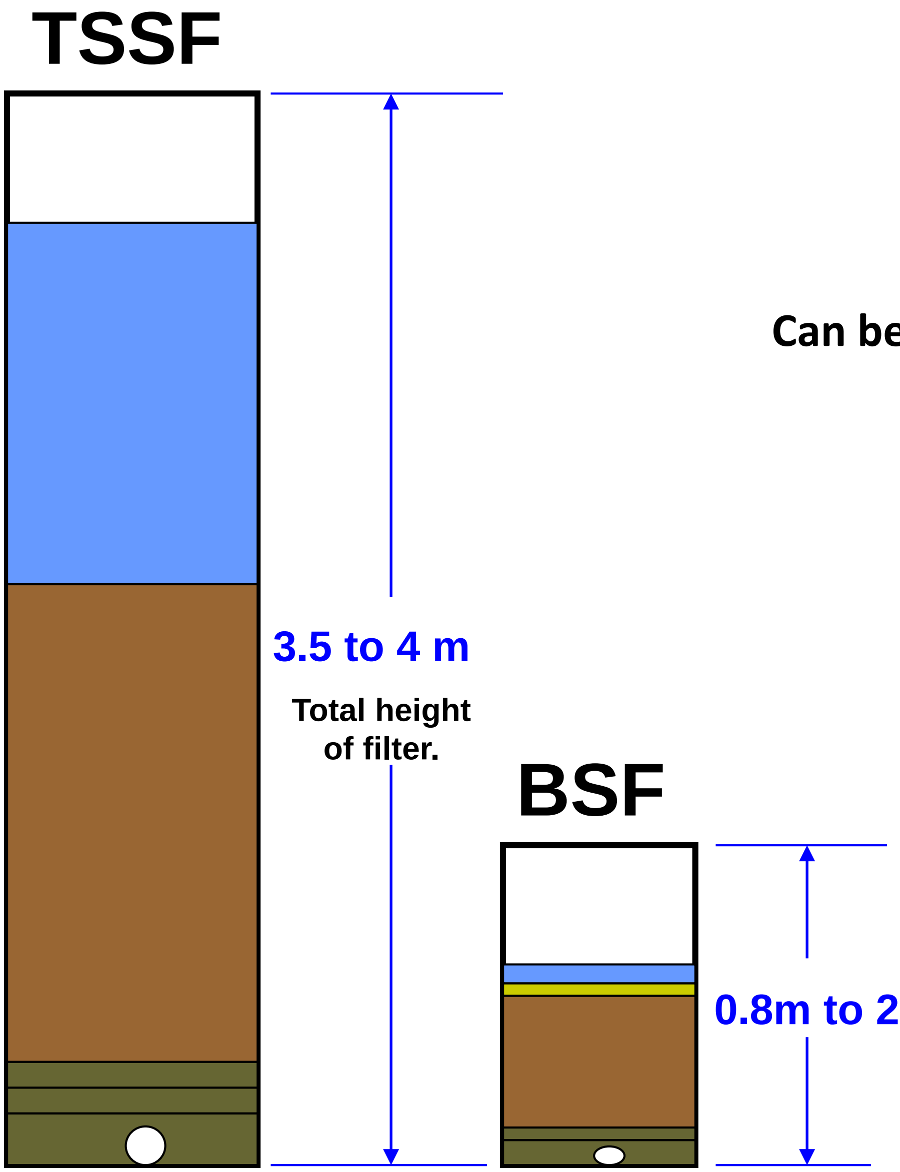
What makes the BioSand Filter BSF special?
What's the difference between the BSF and Traditional Slow Sand Filtration (TSSF)

1. Operation

TSSF: Continuous flow – operation cannot stop or will temporarily lose ability to remove bacteria and viruses.

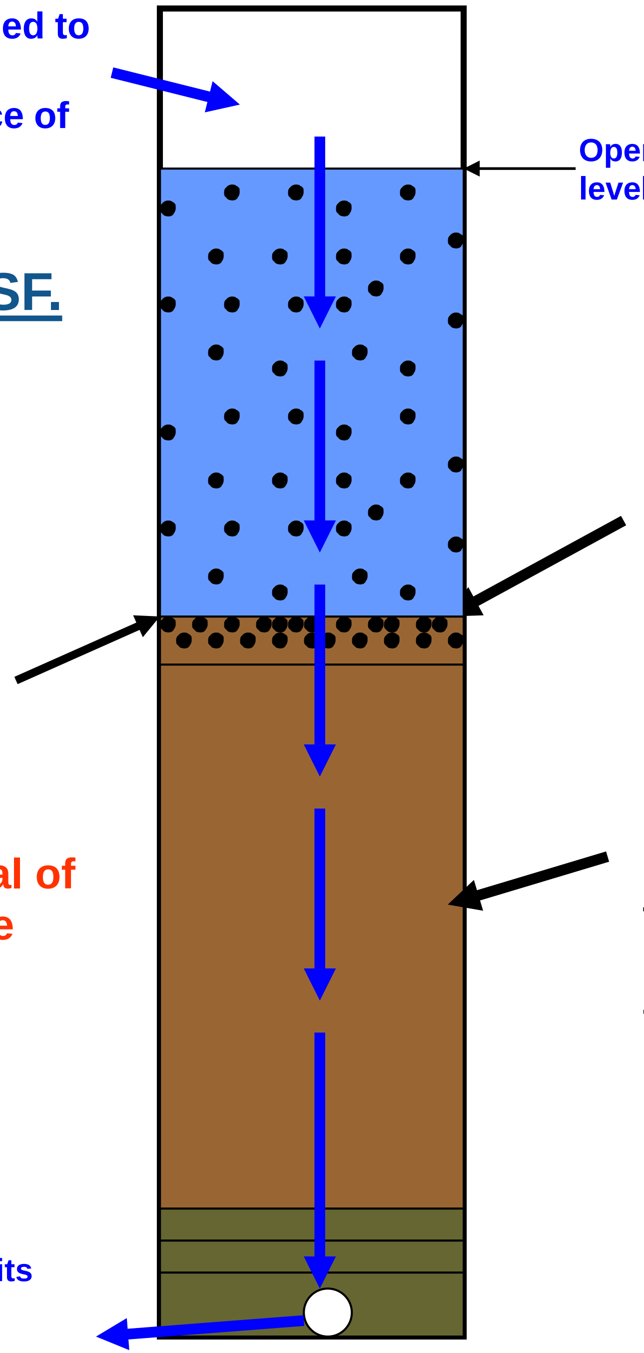
BSF: Operated when required. (Used when needed like in a home.)

2. Scale



Can be used by 'real' people.

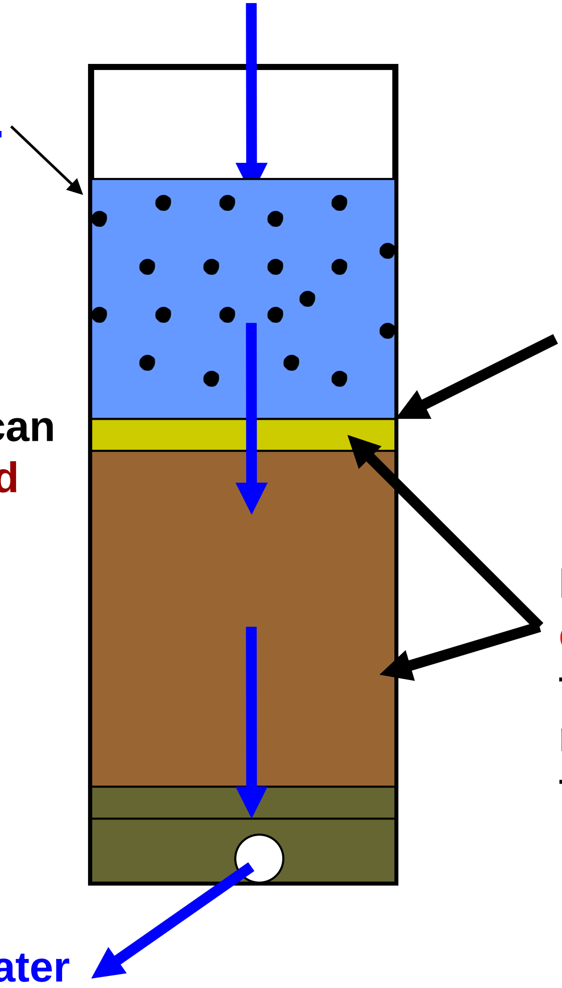
Operation of the TSSF.



Operation of the BSF.

Raw water is added to filter without disturbing surface of media.

Operating water level.



Unlike traditional slow sand filtration, the BSF can be operated on a demand basis when removing micro-organisms.

Similar to traditional slow sand filtration, particulate material is captured on or near surface of the very fine filtering media.

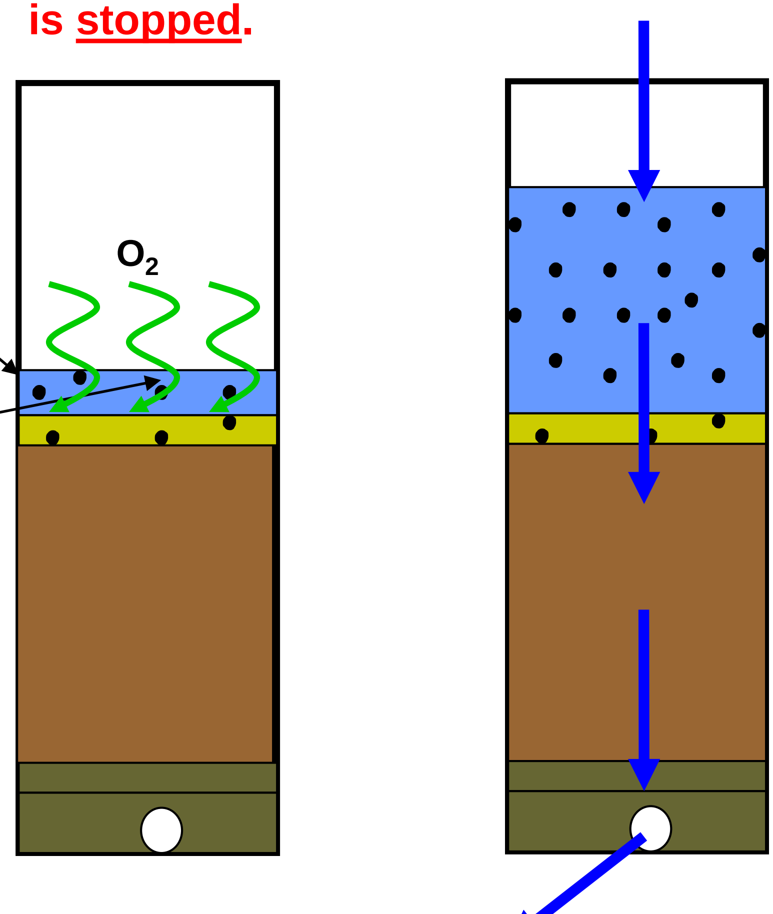
No particulate material is captured within media because the water is not forced into the media as it is in rapid sand filtration or pressure filtration.

Filtered water exits filter.

Operation of the BSF when flow is stopped and resumes.

Water level drains to paused or minimum depth – minimum 5cm.

Sufficient oxygen can diffuse through the shallow layer of water to keep aerobic biolayer alive.



Note: Paused depth should NOT be less than 5 cm as the biolayer will be disturbed when water is added. Paused depths much greater than 5 cm may limit transfer of oxygen to the biolayer impairing its performance. **5 cm is considered the optimum.**

Look at a concrete BSF.

- Untreated water enters filter when the lid is removed and water is poured in directly.

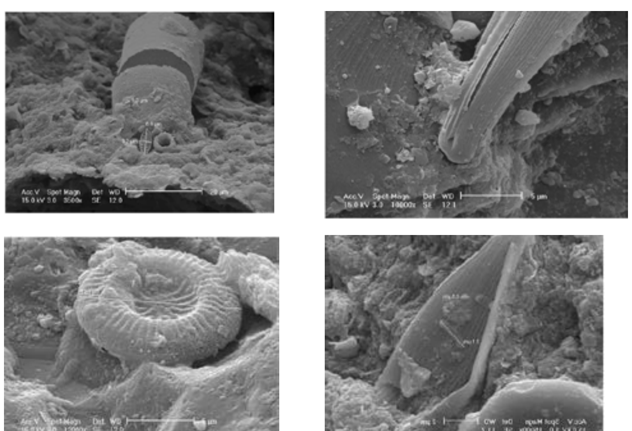
BioSand Water Filter

- **Water passes through the sand to the underdrain, up the standpipe and out into the bucket below.**

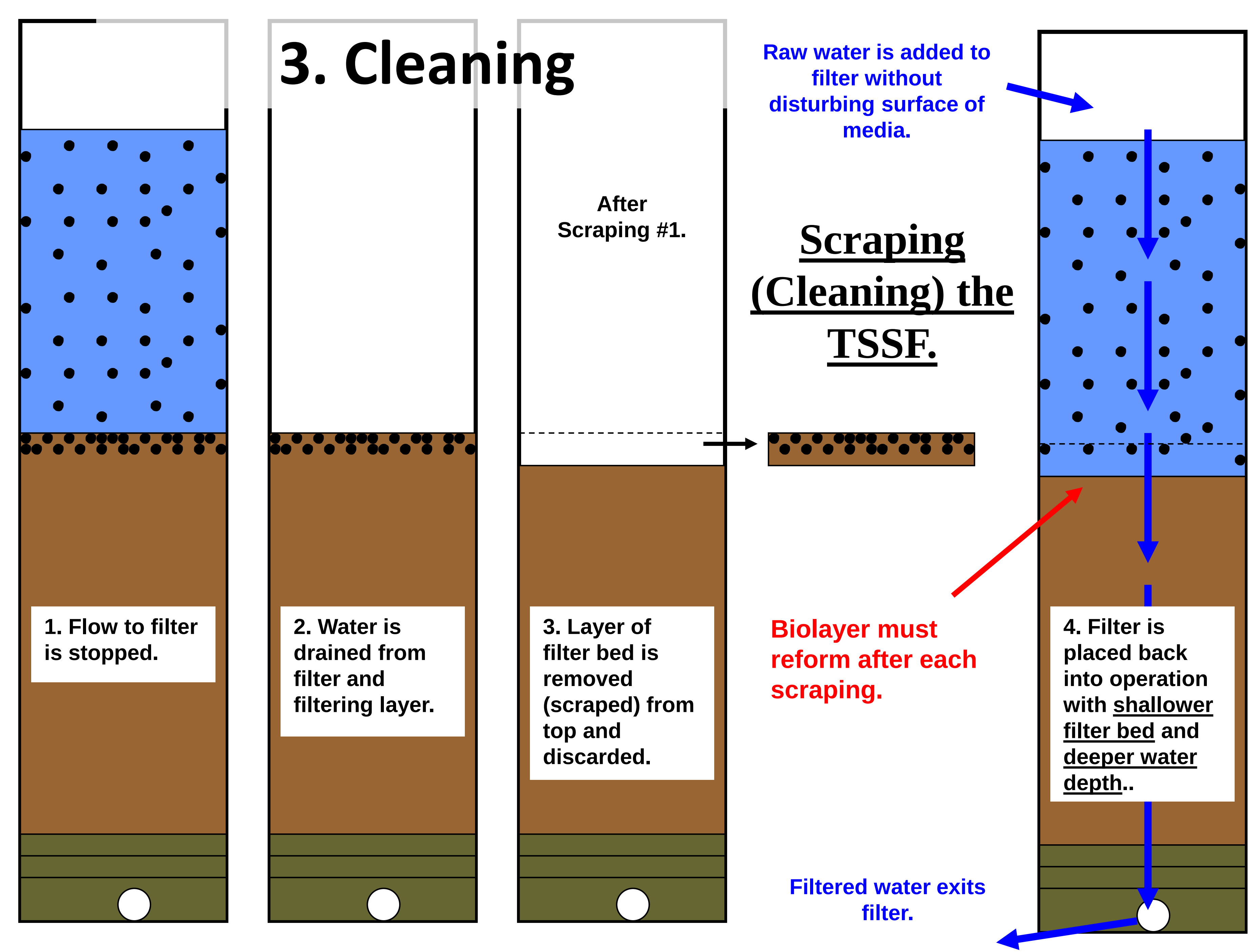
The biological layer forms naturally as the organisms in the water are captured and collect on the top of the filter sand.

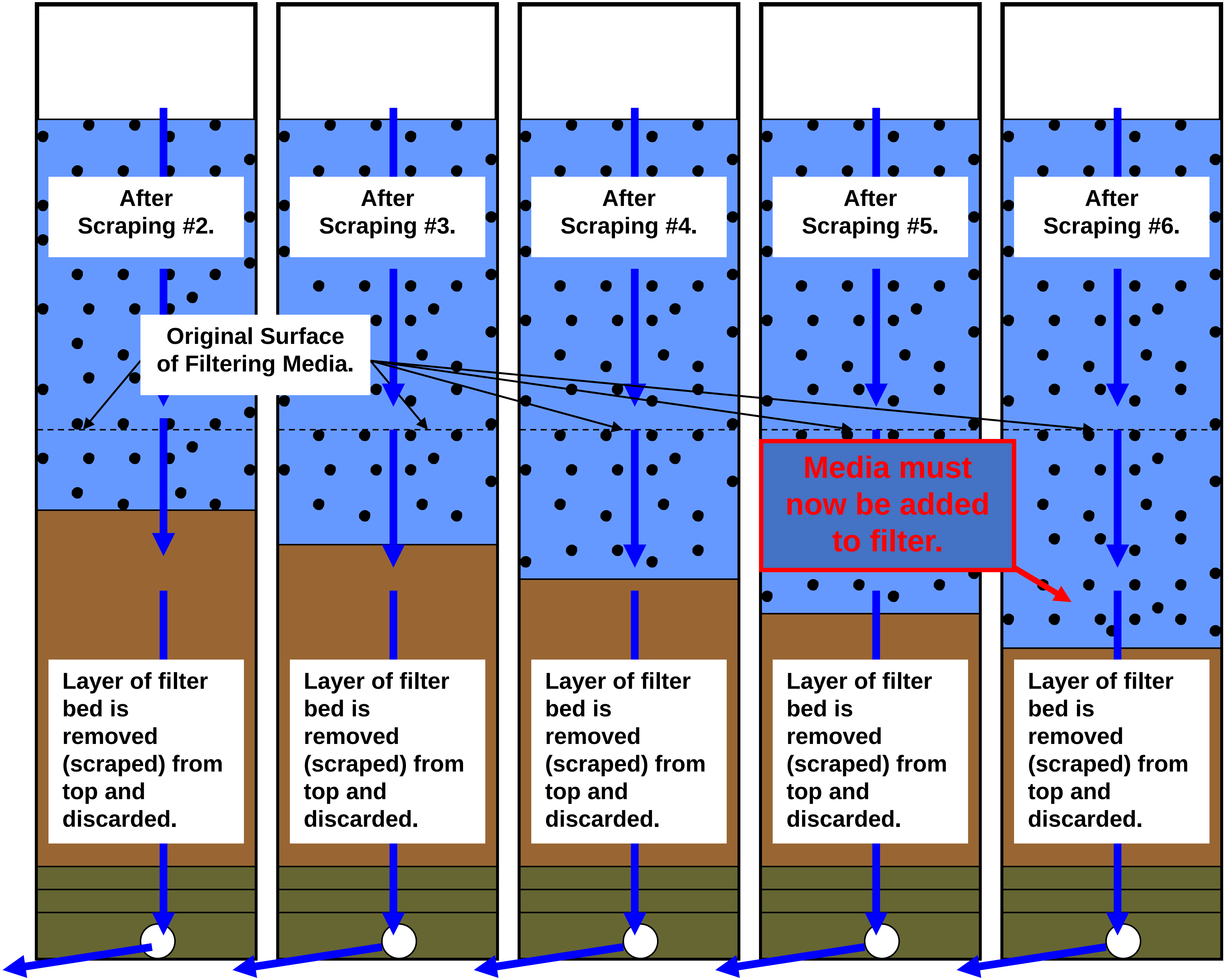
Biological layer is absolutely necessary for pathogen removal and must be kept alive and healthy.

Biological layer forms naturally.



Organisms on media (sand) particles that form the biological layer as seen through an electron microscope.


3. Cleaning
Raw water is added to filter without disturbing surface of media.
After Scraping #1.
Scraping (Cleaning) the TSSF.
1. Flow to filter is stopped.
2. Water is drained from filter and filtering layer.
3. Layer of filter bed is removed (scraped) from top and discarded.
Biolayer must reform after each scraping.
4. Filter is placed back into operation with shallower filter bed and deeper water depth..
Filtered water exits filter.


After Scraping #2.
After Scraping #3.
After Scraping #4.
After Scraping #5.
After Scraping #6.
Original Surface of Filtering Media.
Media must now be added to filter.
Layer of filter bed is removed (scraped) from top and discarded.
Layer of filter bed is removed (scraped) from top and discarded.
Layer of filter bed is removed (scraped) from top and discarded.
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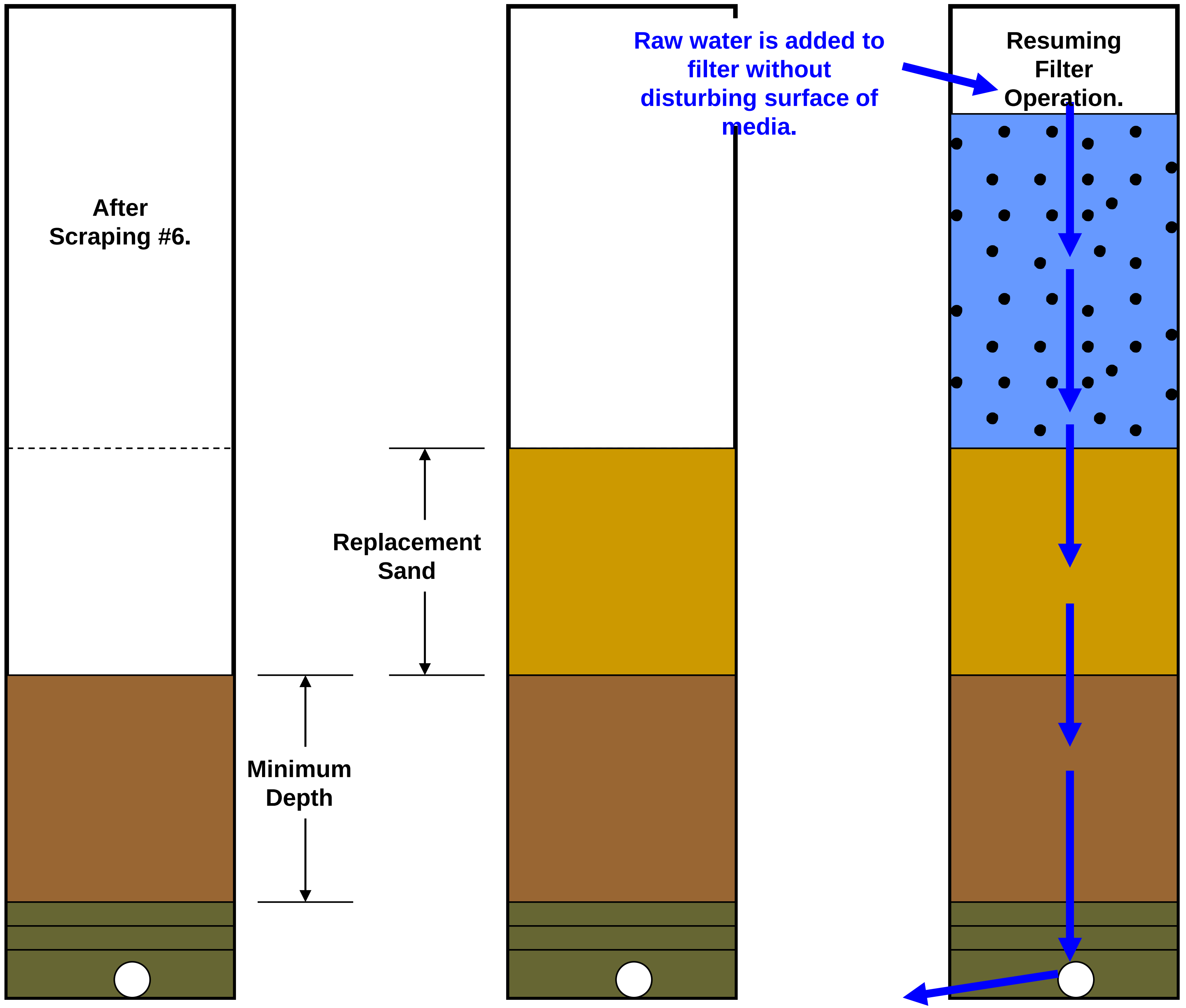
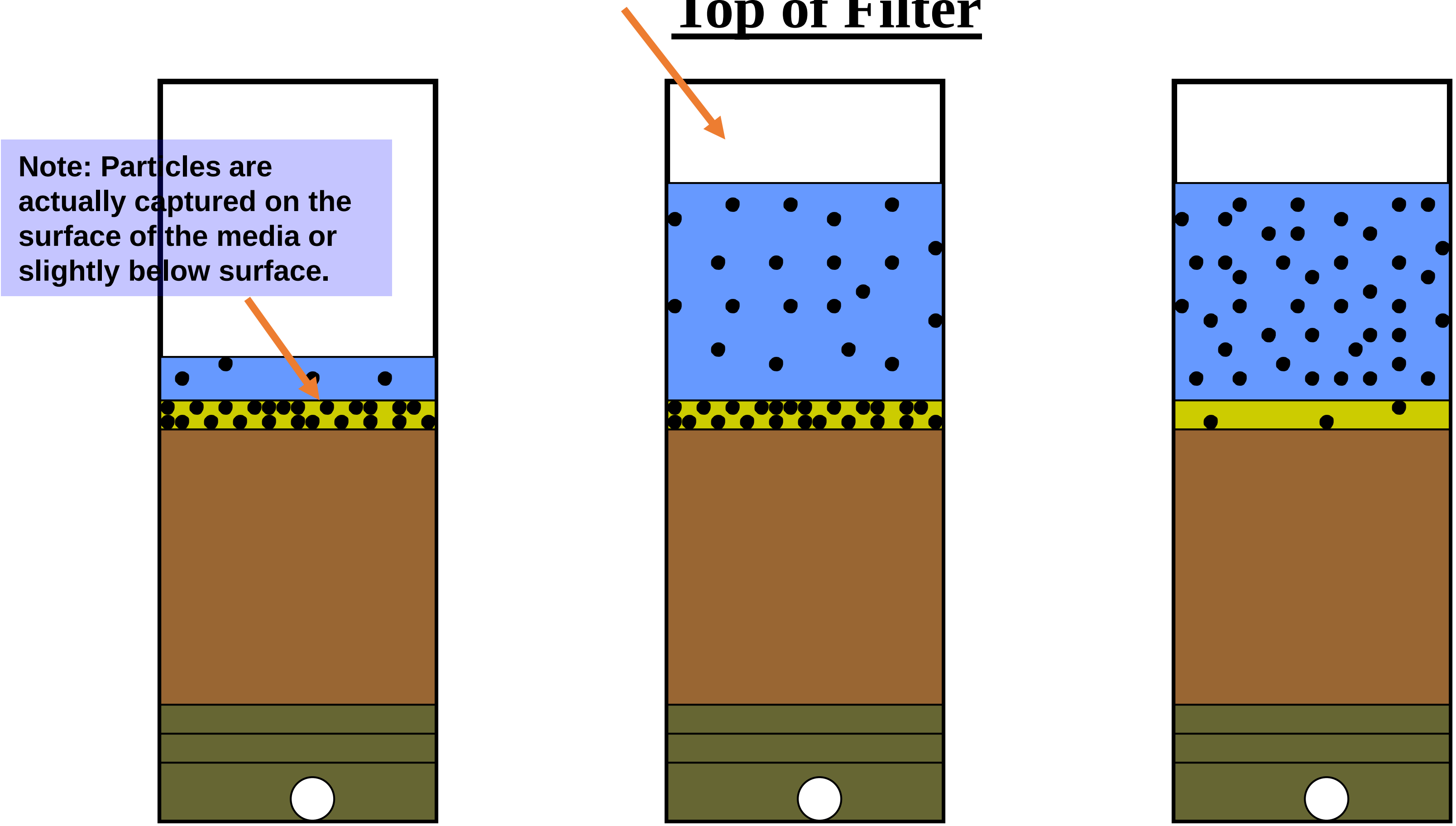

After
Scraping #6.
Replacement
Sand
Minimum
Depth
Raw water is added to
filter without
disturbing surface of
media.
Resuming
Filter
Operation.

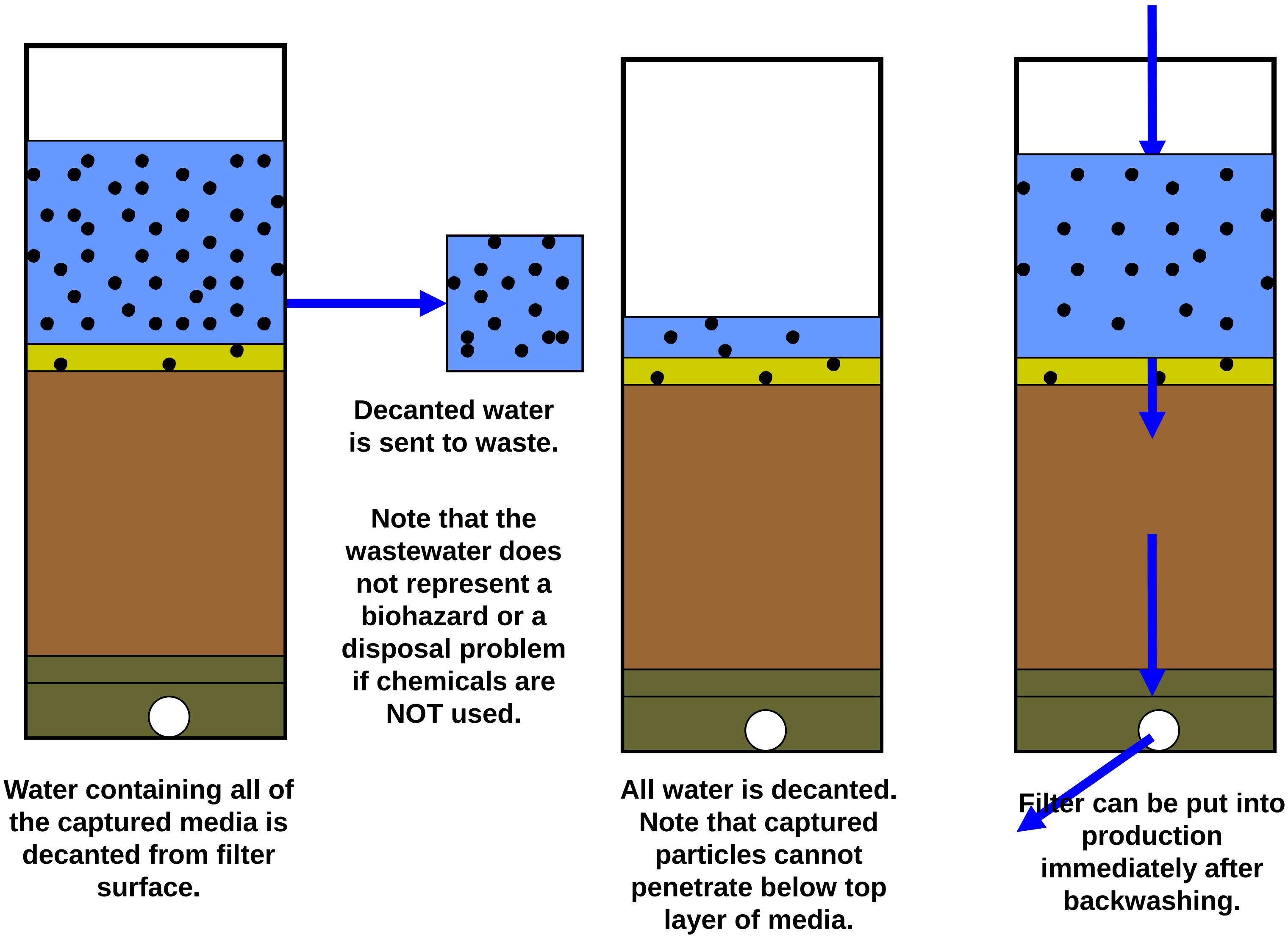
Normal Cleaning the BSF – Raw Water Added to Top of Filter



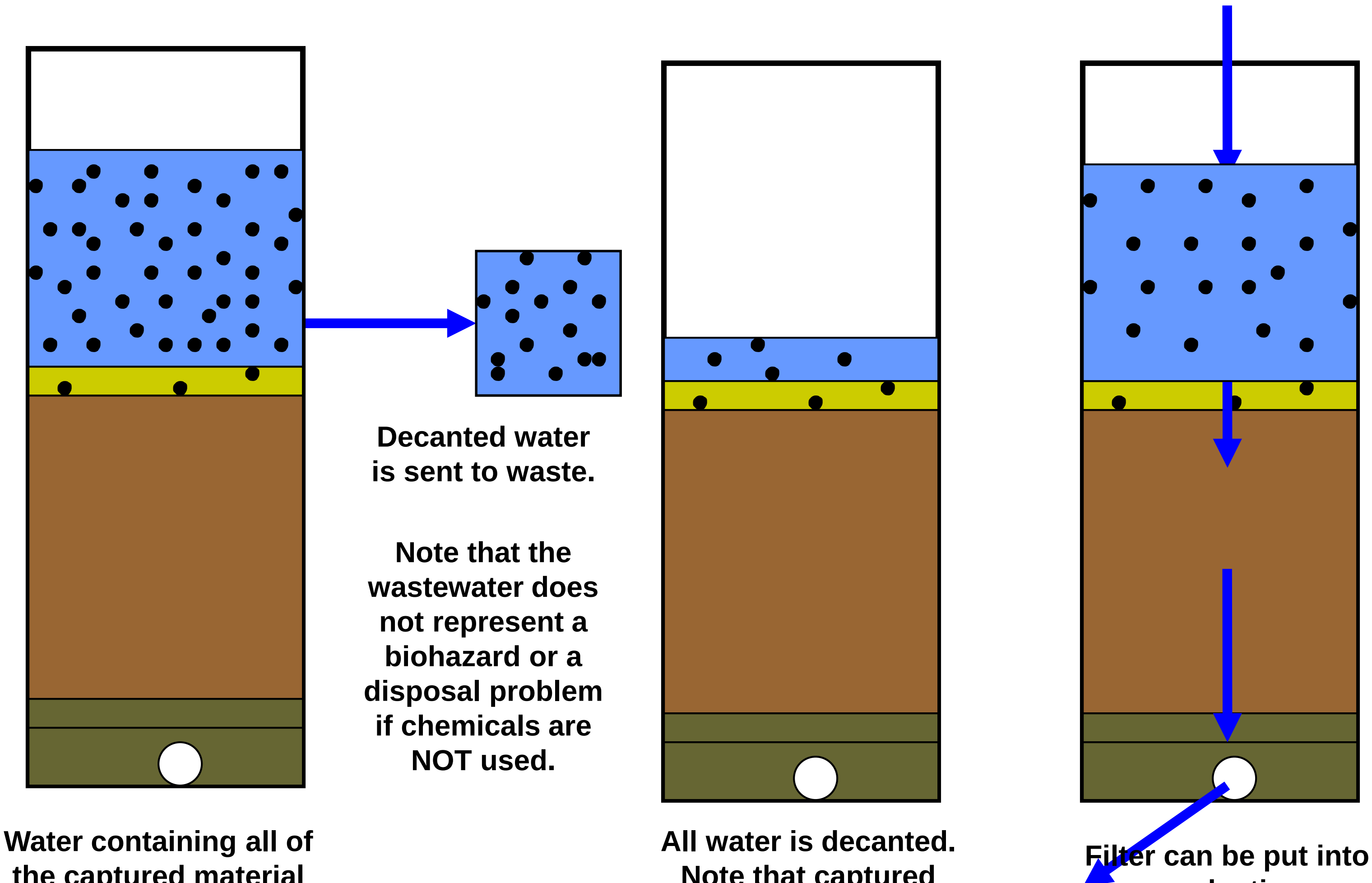
Water level in filter is at the paused depth – could be at any depth.

Untreated water is added until there is at least 0.2 to 0.3 m of depth above top layer of media.

Surface of top layer of media is agitated. This action suspends most of the captured particles.


Decanted water is sent to waste.
Note that the wastewater does not represent a biohazard or a disposal problem if chemicals are NOT used.
Water containing all of the captured media is decanted from filter surface.
All water is decanted. Note that captured particles cannot penetrate below top layer of media.
Filter can be put into production immediately after backwashing.

Filter media is NEVER replaced.
(ideally)



Water containing all of the captured material is decanted from filter surface.

All water is decanted. Note that captured particles cannot penetrate below top layer of media.

Filter can be put into production immediately after backwashing.

US006123858A

United States Patent [19]

Manz

[11] **Patent Number:** 6,123,858

[45] **Date of Patent:** *Sep. 26, 2000

[54] SLOW SAND FILTER FOR USE WITH INTERMITTENTLY FLOWING WATER SUPPLY AND METHOD OF USE THEREOF

[75] Inventor: David H. Manz, Calgary, Canada

[73] Assignee: **University Technologies International Inc.**, Calgary, Canada

[*] Notice: This patent is subject to a terminal disclaimer.

[21] Appl. No.: **09/168,864**

[22] Filed: **Oct. 9, 1998**

Related U.S. Application Data

[63] Continuation-in-part of application No. 08/788,497, Jan. 28, 1997, Pat. No. 5,993,672, which is a continuation-in-part of application No. 08/509,628, Jul. 31, 1995, abandoned, which is a continuation-in-part of application No. 08/141,598, Oct. 27, 1993, abandoned.

[51] **Int. Cl.**[7] **B01D 37/04**

[52] **U.S. Cl.** **210/744**; 210/104; 210/143

[58] **Field of Search** 210/744, 807, 210/86, 104, 143, 289, 291, 456, 272, 290

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,547,816	12/1970	Horiguchi et al.	210/272
3,817,378	6/1974	Ross	210/274
4,765,892	8/1988	Hulbert et al.	210/290
5,032,261	7/1991	Pyper	210/137

OTHER PUBLICATIONS

Visscher et al., "Slow Sand Filtration for Community Water Supply", Technical Paper No. 24, International Reference Centre for Community Water Supply and Sanitation, The Hague, The Netherlands, 198, p. 31.

Huisman, "Slow Sand Filtration", World Health Organization, Geneva, 1974, p. 32.

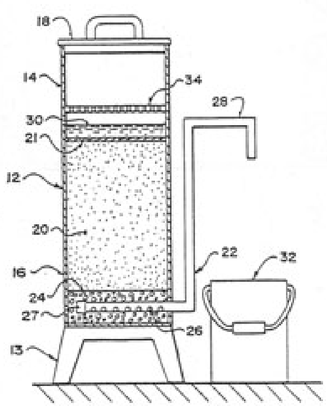
Buzunis, "Intermittently Operated Slow Sand Filtration: A New Water Treatment Process", Dept. of Civil Engineering, The University of Calgary, Mar. 1995, 220 pgs.

Primary Examiner—Ivars Cintins
Attorney, Agent, or Firm—Oyen Wiggs Green & Mutala

[57] ABSTRACT

This invention relates to a novel intermittent slow sand filter and a method of using the intermittent filter. More particularly, this invention pertains to a novel slow sand filter which remains effective, even when intermittently operated, and which can be periodically cleaned without disturbing the action of the intermittent filter. A slow sand filter apparatus comprising: a container having an upper portion and a lower portion; a water inlet in the upper portion of the container, the water inlet being connected to a supply of water; a filter material filling at least the lower portion of the container, the filter material having a top surface below the water inlet; a schmutzdeuke layer on the top surface of the filter material; a water outlet in the lower portion of the container below the top surface of the filter material; and a water level maintenance device in the upper portion which maintains water in the upper portion of the container at a maintenance level above the top surface of the filter material, the maintenance level being a balance between (1) a water maintenance level that is sufficiently deep that water falling from the water inlet onto the top of the water in the container does not significantly disturb the schmutzdeuke layer; and (2) a water maintenance level that is sufficiently shallow that oxygen from the air above the water level can diffuse through the water and reach the schmutzdeuke layer so that the schmutzdeuke layer is maintained in living condition even when there is no flow of water through the water inlet.

17 Claims, 9 Drawing Sheets

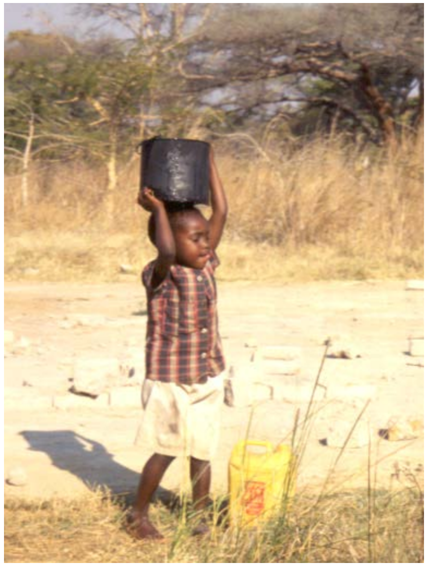


This is the second of two US patents.

Both patents have since lapsed.

The commercial potential of the BSF was always recognized. The technology was assigned to the University of Calgary for commercialization but the humanitarian use (concrete filters) was exempted.

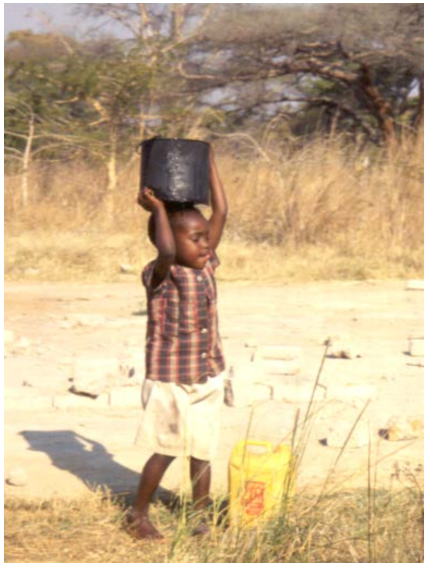
Recall: Alone BioSand Water Filters remove:



- **Parasites - typically 100%**
- **Bacteria - 90 – 99%**
- **Viruses - 90 – 99%**
- **Sand, silt and other particles**
- **Organic and inorganic toxins (substantially reduced)**

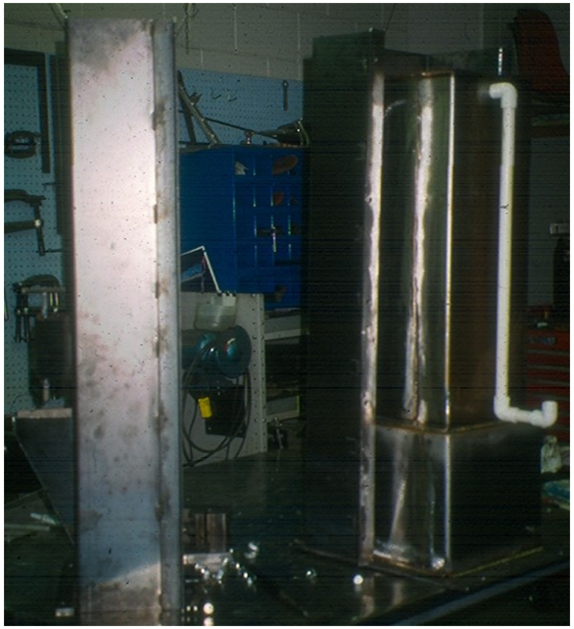
With pre/post- treatment BioSand Water Filters remove:

- Parasites 100%
- Bacteria 100%
- Viruses 100%
- Sand, silt and other suspended solids (turbidity 0.3 NTU or less)
- Oxidized iron, manganese and hydrogen sulfide 100%
- Organic and inorganic toxins
- Arsenic
- Algae
- Colour, taste and odour



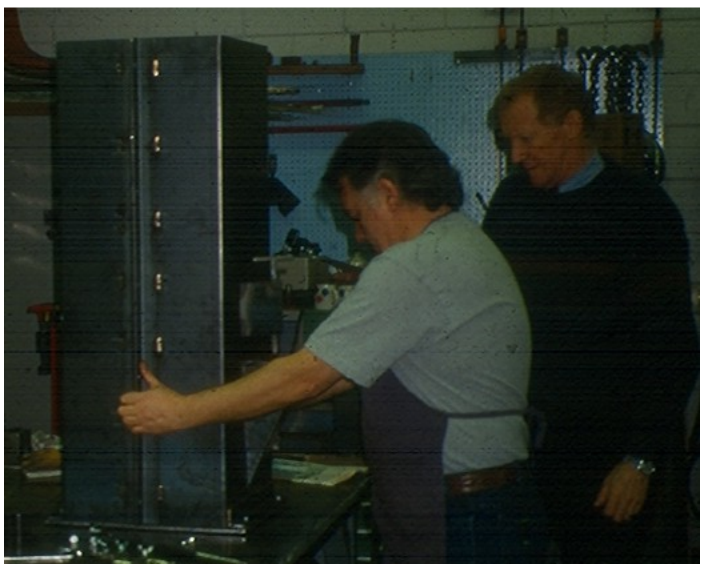
The first order of business was to replace the wood mold with a steel mold – better quality control and longer lasting.

Several prototypes were developed before achieving a satisfactory design.



Development of the first steel mold for construction of the concrete BWF at the University of Calgary.

Special thanks to Terry Nail and other Civil Engineering and central shop staff.






Practicing BSF construction behind our house in Calgary with John Clayton (Samaritan's Purse) and his wife Michelle around 1994.

One of several training manuals used in the water filter training course.

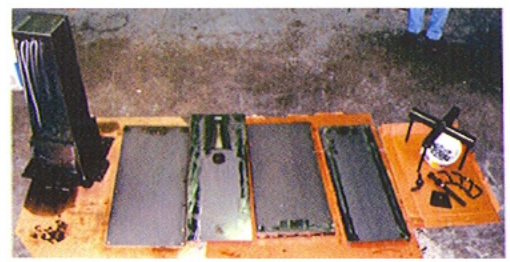
Concrete

BioSand Water Filter

Construction Manual

Book 3: Construction of the Concrete Filter Body

Dr. David H. Manz, P. Eng.



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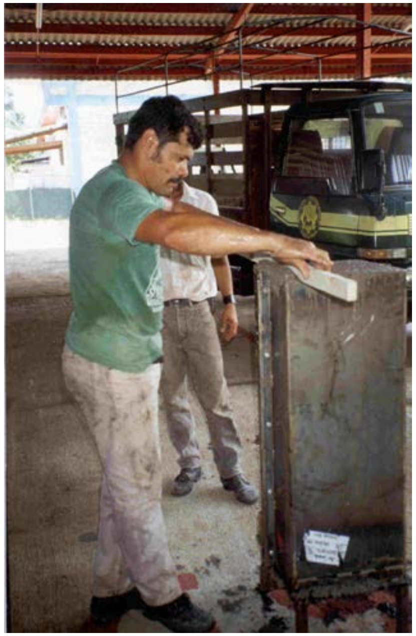
Email: Davidmanz@shaw.ca

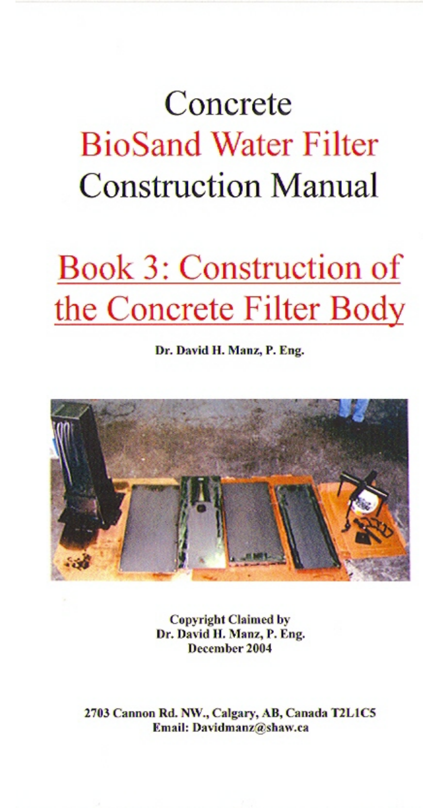
Samaritan’s Purse Canada, in association with the International Development Research Center of the Government of Canada sponsored a short course on the concrete BSF in Costa Rica - 1996.



‘Big Nose’ Steel Mold variation of the Davnor Steel Mold developed by Samaritan’s Purse after Costa Rica short course.

With the development of an adequate steel mold design a training program with good manuals could be developed and the ‘sharing of the BSF technology with interested individuals and organizations could begin.

Designs and training program continued to evolve as more experience was gained.



Concrete
BioSand Water Filter
Construction Manual

Book 3: Construction of
the Concrete Filter Body

Dr. David H. Manz, P. Eng.

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December 2004

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Email: Davidmanz@shaw.ca

Samaritan's Purse received funding from the Rotary Club of Calgary South for their first concrete filter project in Ethiopia in 1997.

ROTARY CLUB OF CALGARY SOUTH

SERVICE ABOVE SELF - HE PROFITS MOST WHO SERVES BEST

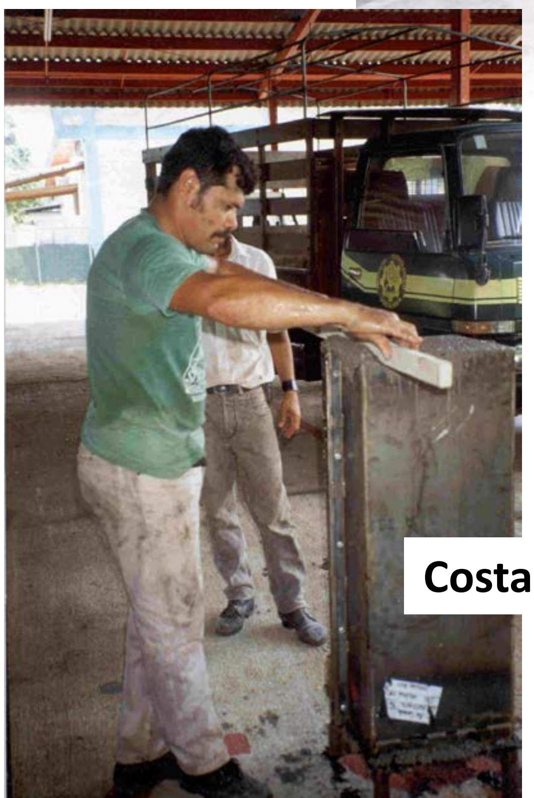
This project has been very successful.

This project received considerable additional funding from the Canadian International Development Agency to construct and install thousands more of the concrete filters in the remotest parts of the country.

CARE International Indonesia Project – in Indonesia.

Samaritan's Purse established a filter manufacturing centre in Nicaragua – going strong.

Students at the University of Calgary.



Costa Rica






Grand Rapids 2004


Catalina


Catalina


Rotary – Aquinas College
Concrete Filter Workshop
Michigan Feb 2006


Dominican Republic
Media Workshop
August 2006

Concrete Filter Project in Chiapas, Mexico – another Samaritan's Purse Canada Project.

Viet Nam

Mozambique

Kenya

Cambodia

Some other Samaritan's Purse Projects around the world.

Map of Republic of Haiti

Haiti

ROTARY CLUB OF CALGARY SOUTH

SERVICE ABOVE SELF - HE PROFITS MOST WHO SERVES BEST

Training in Haiti – no electricity – no audio visual! Round table, picture books and a translator!

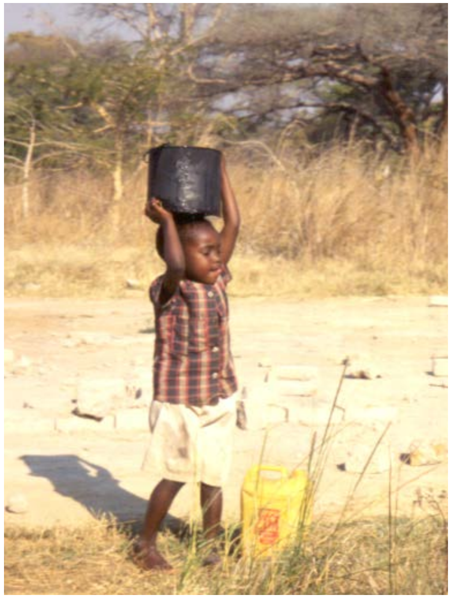
Dominican Republic - 2000

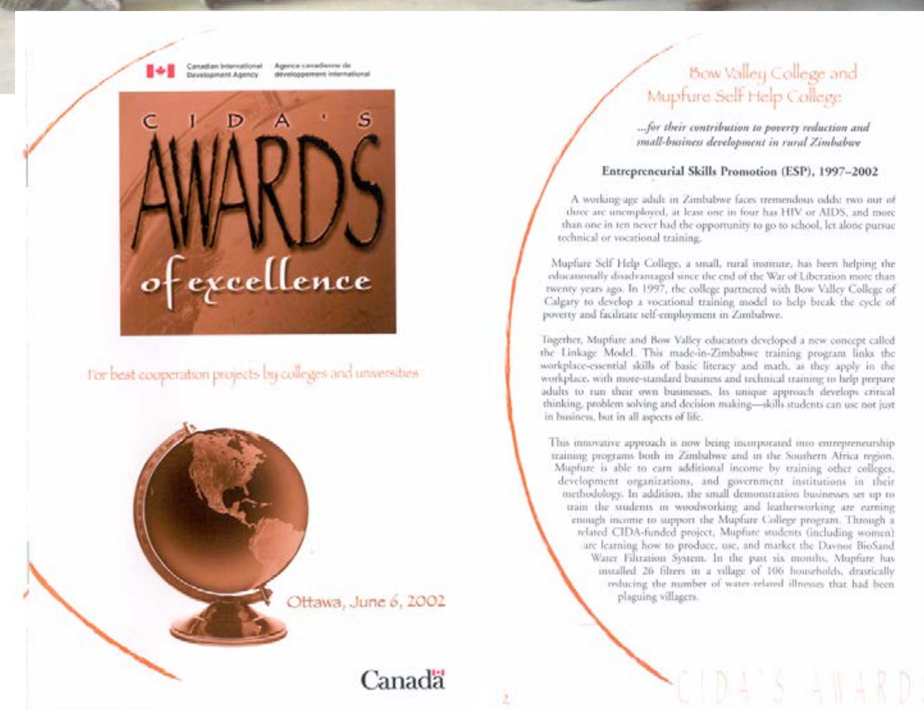
Jan Tollefson

and the BioSand Water Filter Projects she developed and raised funds for.


Factory

A Project in Zimbabwe supported by a committed individual, Gerry Simon, and Bow Valley College, Calgary – 2001 to 2002.





Canadian International Development Agency / Agence canadienne de développement international

CIDA'S AWARDS of excellence

For best cooperation projects by colleges and universities

Ottawa, June 6, 2002

Canada

Bow Valley College and Mupfure Self Help College

...for their contribution to poverty reduction and small-business development in rural Zimbabwe

Entrepreneurial Skills Promotion (ESP), 1997–2002

A working-age adult in Zimbabwe faces tremendous odds: two out of three are unemployed, at least one in four has HIV or AIDS, and more than one in ten never had the opportunity to go to school, let alone pursue technical or vocational training.

Mupfure Self Help College, a small, rural institute, has been helping the educationally disadvantaged since the end of the War of Liberation more than twenty years ago. In 1997, the college partnered with Bow Valley College of Calgary to develop a vocational training model to help break the cycle of poverty and facilitate self-employment in Zimbabwe.

Together, Mupfure and Bow Valley educators developed a new concept called the Linkage Model. This made-in-Zimbabwe training program links the workplace-essential skills of basic literacy and math, as they apply in the workplace, with more-standard business and technical training to help prepare adults to run their own businesses. Its unique approach develops critical thinking, problem solving and decision making—skills students can use not just in business, but in all aspects of life.

This innovative approach is now being incorporated into entrepreneurship training programs both in Zimbabwe and in the Southern Africa region. Mupfure is able to earn additional income by training other colleges, development organizations, and government institutions in their methodology. In addition, the small demonstration businesses set up to train the students in woodworking and leatherworking are earning enough income to support the Mupfure College program. Through a related CIDA-funded project, Mupfure students (including women) are learning how to produce, use, and market the Davnor BioSand Water Filtration System. In the past six months, Mupfure has installed 26 filters in a village of 106 households, drastically reducing the number of water-related illnesses that had been plaguing villagers.

CIDA'S AWARDS


Introduction of the BioSand Water Filter

Eastern Cape Province, South Africa

Summer 2007 (Lethbridge Community College Project)


CHOLERA

First Filter after almost 20 years.

Cambodia 2015 – Samaritan's Purse project – going stronger than ever!

- 200,000 + filters
- 35,000 more each year
- Provided opportunity for sound epidemiological studies

More than 90% of the BSF's are the small household concrete version that are locally constructed.

Calgary not-for-profit organizations:

Samaritan's Purse and

The Centre for Affordable Water and Sanitation Technology (CAWST)

and many, many others in Canada and around the world

support NGO managed BioSand Water Filter programs globally.

Calgarians believed in the good the BSF's would have in the developing world.

Calgarians have provided millions of dollars to support to BSF projects worldwide.

The world has followed.

Epidemiological studies (impact on human health) have demonstrated up to 45% reduction in diarrheal diseases.

Subsequent studies indicate up to 70% reduction in diarrheal diseases with very good sustainability.

The World Health Organization and even the World Bank have noted the impact of the introduction of the BSF on community health.

The BSF technology is now recognized as the best available point-of-use water treatment in the world.

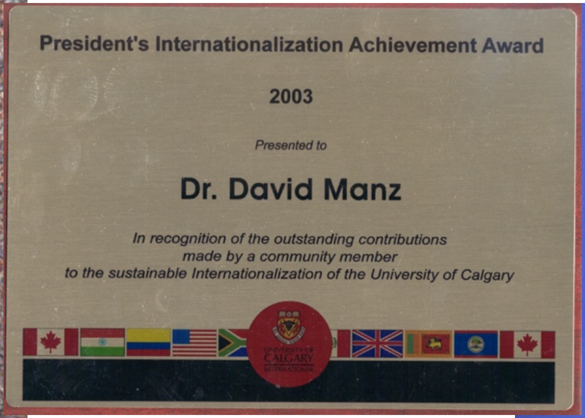
Today it is estimated that more than 2 million filters are in operation with several hundreds (thousands) more concrete BSF's being built and installed every day.

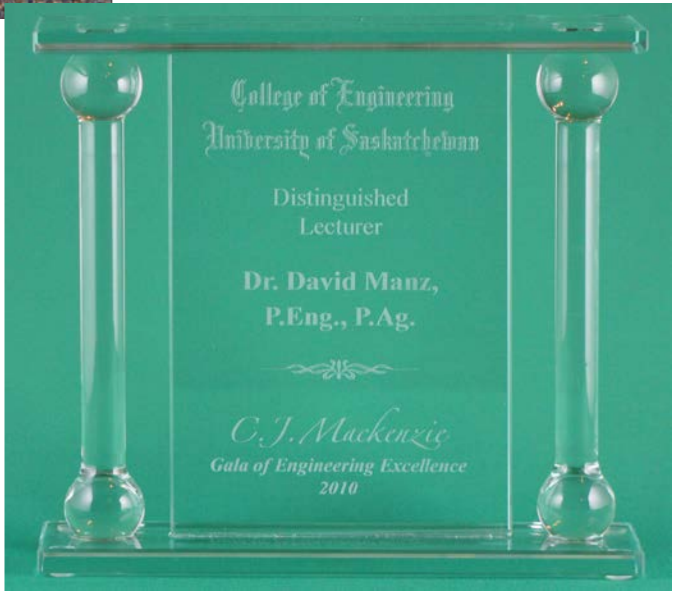
CAWST is born!

CAWST was founded in 2001 as a result of conflict-of-interest between interests of a publically traded for-profit company, Davnor Water Treatment Technologies Ltd., and not-for-profit initiatives.

Decided to co-found Centre for Affordable Water and Sanitation Technology with Camille Dow-Baker who would be the CEO. Intention was that CAWST would carry on with my vision for the BSF, and a broader non-commercial agenda that included sanitation.

Under Camille's leadership CAWST became very effective at disseminating the concrete BSF technology.





Considerable recognition for BSF.

This year:

- **Selected by the Editorial staff of the Calgary Herald as one of 20 compelling Calgarians for 2018.**
- **The honour of being selected to give this presentation. and**
- **Alberta Order of Excellence.**

All for the development and support of the BSF.

Alberta Order of Excellence

End Part 1