



**WATER EXPERTISE AND TRAINING CENTRE**  
Action Research on Small Community Size Intermittently-operated  
Slow Sand Filter (ISSF)



**August 2016**

**Wazirabad, PO Box 208, Kabul, Afghanistan**  
**Phone: (+93)(020) 220 17 50 Mobile (+93)(0)70 28 82 32**  
**E-mail: [dacaar@dacaar.org](mailto:dacaar@dacaar.org) Website: [www.dacaar.org](http://www.dacaar.org)**

## Contents

<b>1. Background</b>	<b>3</b>
<b>2. Rationale of the Research</b>	<b>4</b>
<b>3. Research Topic:</b>	<b>4</b>
<b>4. Objectives of the Study:</b>	<b>4</b>
<b>5. Methodology</b>	<b>5</b>
<b>6. Staffing</b>	<b>6</b>
<b>7. Budget</b>	<b>6</b>
<b>9. Water quality Tests' Results</b>	<b>7</b>
<b>9.1. Biosand Filter</b>	<b>7</b>
9.1.1. Bacteria Removal Efficiency	7
9.1.2. Turbidity Removal Efficiency	7
<b>9.2. ISSF</b>	<b>7</b>
9.2.1. Bacteria Removal Efficiency	7
9.2.2. Turbidity Removal Efficiency	8
<b>10. Result Comparison of the Filters</b>	<b>8</b>
<b>11. Operation and Maintenance.</b>	<b>9</b>
<b>12. Challenges</b>	<b>9</b>
<b>13. Conclusion</b>	<b>10</b>
<b>14. Recommendations</b>	<b>10</b>
<b>15. Annex</b>	<b>10</b>
<b>15.1. Complete Design of ISSF</b>	<b>10</b>
<b>15.2. Installation Diagram of Water Tank of ISSF</b>	<b>10</b>
<b>15.3. Summary of Water Analysis of BSF, ISSF and Source Water</b>	<b>10</b>

## **1. Background**

Established in 1984, DACAAR is an apolitical, non-governmental, non-profit development organization that supports vulnerable people in rural areas of Afghanistan achieve improved livelihood through community driven interventions and sustainable activities. It operates according to its current competence or thematic areas of Water, Sanitation and Hygiene (WASH), Natural Resources Management (NRM), Women Empowerment (WE), and Small Scale Enterprise Development (SSED). In addition to these, DACAAR is a partner in the National Solidarity Program (NSP).

DACAAR's interventions primarily target returnees, internally displaced persons (IDPs), and their host communities with particular focus on the most vulnerable such as female, disabled and youth headed households. DACAAR's interventions have benefitted approximately 10 million Afghans across 29 of Afghanistan's 34 provinces since its establishment.

DACAAR's main office is located in Kabul. Projects are currently implemented in 12 provinces of Afghanistan through six regional offices located in; East (Jalalabad), Central (Kabul), North-east (Taloqan), North (Mazar), North-west (Maimana) and West (Herat).

DACAAR has more than two decades of experience in implementing WASH activities in Afghanistan and has established more than 43,000 public water points and 129,000 latrines across Afghanistan.

In partnership with CAWST, one of DACAAR's key programs is as a Water Expertise and Training Centre (WET Centre) established in July 2010 to provide water and sanitation training to WASH stakeholders, technical consulting to newly forming or existing WASH programs and action research.

DACAAR WET Centre has an equipped drinking water quality testing laboratory that was established in 2003 when there was no water quality testing lab at national level. The field kits-based laboratory has all the required lab equipments for testing physical, bacteriological and chemical qualities of water. The laboratory provides water quality testing services to DACAAR WASH projects and external clients.

DACAAR is a model organization in implementing rural water supply and introducing household water treatment technology in Afghanistan. Therefore, the DACAAR WET Centre decided to launch an action research on an intermittently-operated slow sand filter (ISSF) designed for use in schools or in institutions such as a health facility. Furthermore, this technology can be applicable for a private residence and small villages.

The Small Community Size Intermittently-operated Slow Sand Filter is a filtration system originally developed by Clear Cambodia and Samaritan's Purse Cambodia. It has been introduced in Cambodian schools. The water filtration is a similar principle to the household-sized concrete biosand filter. The removal mechanisms such as mechanical trapping, predation, absorption and natural death are the same. A significant difference is that it uses a float valve to maintain a constant hydraulic head of water above the sand during the run

period. This arrangement provides a means to feed the water from the raw source water storage tank into the filter tank at a rate that matches the filtration rate in the filter. This allows much more water to be filtered through a single sand filter by operating over a longer period of time, such as overnight or over the school weekend. This long filtration run times, combined with the much larger filter container area, approximately 0.6 m<sup>2</sup> versus 0.06 m<sup>2</sup> for the concrete biosand filter (BSF), will provide 1000+ litres of filtered water per day (2000+liters per 24 hours), sufficient for very small communities or institutions and schools.

## **2. Rationale of the Research**

DACAAR is a pioneer to introduce household water treatment in Afghanistan. WET Centre has a four-day implementation of the biosand filter project training workshop which is organized annually to train different government and non-government organizations' staff. In the rural communities, it is common to find rural water points that have failed long before the end of their planned lifetime. The regular use of household water treatment technology gives a safeguard to protect the health of children, elders, women and all family members.

DACAAR has been promoting health and hygiene education including chlorine, concrete biosand filters and hand washing practices. It would be good to provide different household water treatment technology options to the community people so that they have opportunity to adopt technology based on their own interest and choices. Therefore, WET Centre decided to install Small Community Size Intermittently-operated Slow Sand Filter (the ISSF) in schools and/or in health facilities as a model to be replicated by other agencies working in WASH in schools in Afghanistan.

## **3. ResearchTopic:**

Performance Evaluation of the Small Community Size Intermittently-operated Slow Sand Filter (ISSF).

## **4. Objectives of the Study:**

The biosand filter (BSF) in concrete boxes for households has been studied extensively but the Community Size Intermittently-operated Slow Sand Filter is a concept that has only recently been developed and requires further study. The main purpose of this action research is to demonstrate the effectiveness of the Small Community Size Intermittently-operated Slow Sand Filter to remove contaminants from the water and develop experience in the construction, installation and operation of the filter. The specific objectives of this study include:

1. To identify the removal efficiency of E-coli bacteria and turbidity of source water using the Small Community Size Intermittently-operated Slow Sand Filter over time.
2. To compare the performance of the ISSF filters with the performance of the CAWST version10 (v10) BSF by setting-up one or two BSFs for the action research in the same locations as the ISSF filters and using the same water source.
3. To identify the effectiveness of the swirl and dump method for the maintenance of the ISSF filter.

4. To document the methods and costs involved in building, installing and operating the filters.
5. To disseminate the finding of research on the efficiency of Small Community Size Intermittently-operated Slow Sand Filter to other WASH related organizations in a learning exchange.

## 5. Methodology

Eight hundred litre capacity plastic tank (of 85cm diameter) was installed with 7 centimeter separating gravel, 13cm drainage gravel and 76cm filtration sand (fine sand) with 5cm standing water level and 20.5cm reservoir water column. (see Annex 15.1 and 15.2). The source water was from river or stream pumping to a reservoir through a water pump system.

The following steps were applied on the research methodology:

### Step-1: Market assessment for materials

- Listed the materials required for the filter.
- Searched market for availability of plastic tanks and other necessary materials.
- Identified roughly the cost of mentioned materials and was matched with the available budget.

### Step-2: Selection of site for ISSF and BSF filter installation

- Collected water samples from schools and health facilities in Kabul, Kapisa and Nangarhar and assessed the feasibility of installation for Small Community Size Intermittently-operated Slow Sand Filter such as space for reservoir, filter and storage tanks, availability of abundant water and water pumping system.
- Analysed the collected samples for bacteriological and physical qualities and identified sites with high bacterial and physical contamination.
- Selected the Nasaji Girls's High School (in Hissa-e-Awal district of Kapisa province) which had the worst situation in respect to bacteriological and physical quality of water.
- Discussed with the headmaster and respective education directorate the purpose and importance of the research and got their approval.

### Step-3: Procurement of materials and construction of filter

- Procurement of materials required for Small Community Size Intermittently-operated Slow Sand Filter was done in Kabul as many of the materials for fabrication of filter was not available at the site of filter installation.
- Constructed or fabricated the Small Community Size Intermittently-operated Slow Sand Filter.
- Procured and prepared sand and gravel for filter installation.
- Installed the gravel and sand filtration media according to the biosand principle.
- Fabricated and installed one V10 BSF in the same location.
- Trained a person at school on how to use and maintain the filter.

### Step-4: Water quality analysis

- Samples from source water and filtered water was collected on weekly basis for both filters; biosand and Intermittently-operated Slow Sand Filter.

- Bacteriological and physical water quality tests of source water and filtered water for both filters were done once a week for almost 2 months.
- A lab technician was assigned to regularly collect and analyze the water samples from source water, CAWST version 10 BSF and ISSF filtered water.
- All water quality testing findings were recorded in readily made format and kept for the analysis.

#### Step-5: Reporting

- Mid-term progress report was submitted to the WET Centre Manager and head of program. The details of all aspects of the ISSF filtration system as it was constructed for this research was provided with the mid-term progress report.
- Final report including filter fabrication, research methodology, water quality testing details and research outcome and recommendations will have been provided after the completion of research study.

## 6. Staffing

Two people (Shir Ahmad and Shir Habib) was responsible for purchasing, transportation of materials, fabrication and installation of the filters. One person (Lab Technician) was assigned to collect and analysis the water samples from ISSF, BSF and source water. Performed water quality tests and documented the data.

## 7. Budget

The following is the expenses ( in AFN) for construction and installation of ISSF in Nasaji Girls High School, Kapisa.

Items	Unit Cost	Quantity	Total	Remarks
Plastic water tank (reservoir) 2000L	9000	1	9000	
Plastic water tank (Storage) 2000L	9000	1	9000	
Plastic water tank (BSF) 800L	2600	1	2600	
Gate Valve 3/4"	250	2	500	
Tap 1/2"	250	4	1000	
PE Pipe 1/2" (Length 4m)	140	1	140	
Float Valve 1/2"	200	1	200	
Reducer Threaded 3/4" x1/2"	70	3	210	
Reducer sample 3/4" x1/2"	15	1	15	
Gate Valve 1.1/2"	380	1	380	
GI Pipe 1/2"	120	5 m	500	
Elbow 1/2"	40	1	40	
GI Socket 1/2"	40	2	80	
GI Tee 1/2"	40	1	40	
GI Pipe 3/4"	120	1m	120	
Basin	200	1	200	
Filtration sand	1000	Lot	1000	
Gravel	100	Lot	300	
Washing of filter media	1500	Lot	1500	

Shelter	15,000	1	15,000	
Labour	350	6 days	2100	
Transportation to the site	8000	One time	8000	
Collection of sample	1500	11	13500	
Total			65,445	

## 8. Design

The design of the Intermentently-operated Slow Sand Filter was done very technically by the water expertise and training centre manager and some information was taken from design done by CAWST, for details such as amount of gravel, sand and height of filter tanks and etc refer to annex 15.1.

## 9. Water quality Tests' Results

### 9.1. Biosand Filter

#### 9.1.1. Bacteria Removal Efficiency

*Bacterial Removal Efficiency was 100%*

The bacterial removal from source water was very good and on the first test there was no bacteria found in the filtered water, while the source water had bacteria more than 250 cfu/100ml . Refer to table # 1 for details.

Table #1: Bacterial comparison of source and filtered water (BSF)

Statistics	Bacteria in BSF Filtered Water	Bacteria in Source Water
Maximum	0	250
Minimum	0	180
Average	0	209

#### 9.1.2. Turbidity Removal Efficiency

*Turbidity Removal Efficiency was 98.20%*

The turbidity of filtered water was much better than the source water; average filtered water turbidity was 0.9 NTU, while the average turbidity of source water was 105 NTU. Refer to table # 2 for details.

Table # 2: Turbidity comparison of source and filter water (BSF)

Statistics	Filtered of BSF Water Turbidity	Source Water Turbidity
Maximum	1.5	644
Minimum	0.5	12.4
Average	0.9	105

### 9.2. ISSF

#### 9.2.1. Bacteria Removal Efficiency

*Bacterial Removal Efficiency was 99%*

The bacterial removal from source water was very good and on the first test there was only 8

bacteria found in the filtered water, while the source water had bacteria more than 250 cfu/100ml. After the third week, the water testing for bacteriological quality showed no bacteria presented in the ISSF filtered water. Refer to table # 3 for details.

Table # 3: Bacterial comparison of source and filter water (ISSF)

Statistics	Bacteria of ISSF Filtered Water	Bacteria in Source Water
Maximum	8	250
Minimum	0	180
Average	1.4	209

### 9.2.2. Turbidity Removal Efficiency

*Turbidity Removal Efficiency was 98.10%*

The turbidity of filtered water was much better than the source water; average filtered water turbidity was 0.8 NTU while the source water turbidity was 105 NTU. Normally, the turbidity of drinking water should be lower than 5 NTU according to the Afghanistan National Water Quality Standard.

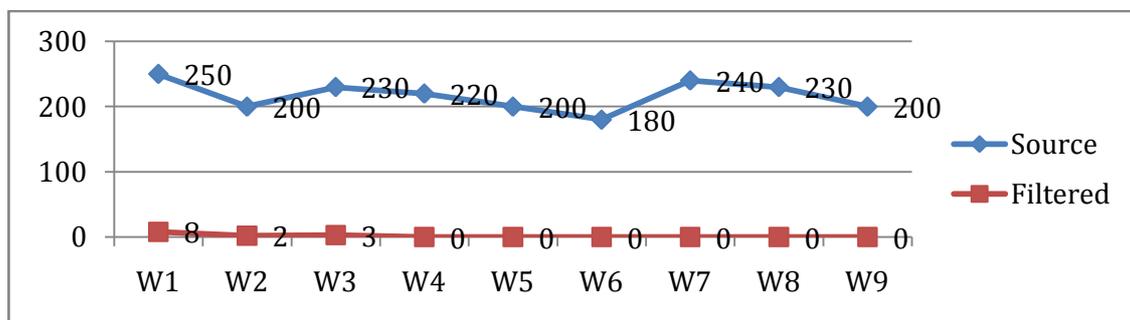
Table # 4: Turbidity comparison of source and filter water (ISSF)

Statistics	Turbidity of ISSF Filtered Water	Turbidity of Source Water
Maximum	1.23	644
Minimum	0.51	12.4
Average	0.8	105

## 10. Result Comparison of the Filters

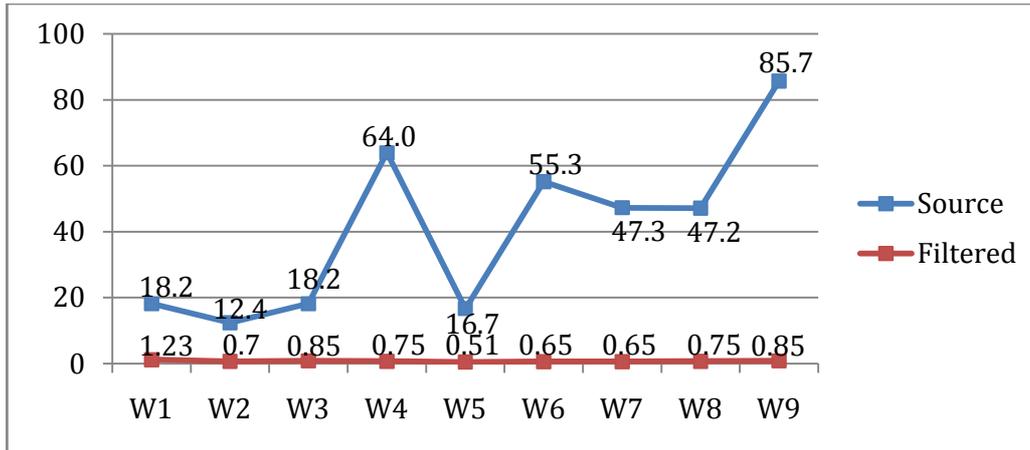
Normally, the BSF become mature after 30 days of usage, in respect to this convention it is clear that the biosand filter bacterial efficiency was very fast and quick than the ISSF as on first test of the filtered water after one week of the installation there was no bacteria found in the BSF filtered water. While in the ISSF filtered water there was 8 cfu/100ml, which is also not bad in comparison to source water which had bacterial count more than 250 cfu/100ml. After third week the bacteria count in ISSF filtered water also came down to the zero. Refer to the following chart for trend of bacterial removal.

Chart# 1: Trend of bacterial removal



Turbidity removal was very close to each other as on the first test the turbidity of source water was 18.2 NTU, BSF's filtered water was 0.9 NTU and ISSF's filtered water was 0.8 NTU. Refer to the chart#2 for trend of turbidity removal.

Chart #: Trend of turbidity removal



Refer to table # 5 for details. It is to mention that the turbidity of source water was changeable due to the weather condition, if there was raining the turbidity was to be increased due to small flooding.

Table # 5: Comparison of source, BSF and ISSF water quality

Statistics	Source Water		ISSF Water		BSF Water	
	Bacteria	Turbidity	Bacteria	Turbidity	Bacteria	Turbidity
Maximum	250	645	8	1.23	0	1.5
Minimum	180	12.4	0	0.5	0	0.5
Average	209	105	1.4	0.8	0	0.9

## 11. Operation and Maintenance.

As the flow rate at the beginning of the research of ISSF was 900 ml/minute and BSF was 400 ml/minute and at the end of the research, the flow rate of ISSF decreased to 760 ml/minute and BSF decreased to 280 ml/minute. Therefore, operation and maintenance of the filters was required. It was communicated with school head master to introduce a guard to be responsible for operation and maintenance of the filter in the future. She introduced two guards and they were trained by water expertise and training centre's senior trainer and lab technician in a practical session to handle the O&M issues in future.

## 12. Challenges

Since the filter was installed far away from Kabul at a school in Kepisa province, therefore the access to the site was time consuming and costly as well. The filter was supplied with water from a stream, but sometimes the stream was became dried purposely as on the down side the construction working on the stream was on progress, therefore we were obliged to hire water tanker to bring water for ISSF. Dealing with head mater of the school who was a female was difficult as she was thinking that DACAAR's staff are her personnel servant and therefore, she was not that much cooperative, but anyway we tried best on our level to complete this research successfully.

Another challenge was quality of the PVC water tanks which were leaking after installation and we had to change them which waste our time and resource. Therefore it is recommended

to procure high quality of PVC water tanks for ISSF and ensure guarantee for replacement in case of any defect or leakage in the PVC water tanks.

### **13. Conclusion**

Small Community Size Intermittently-operated Slow Sand Filter was effective in removal of bacteria and turbidity from the source water. The result of both filters was very close to each other in term of bacterial and turbidity removal from source water. Even though, the biosand filter was a bit faster in bacterial removal. While turbidity removal for the both filter was very close such as turbidity removal for BSF was 0.9 NTU and ISSF was 0.8 NTU which is very close figures to each other.

### **14. Recommendations**

Based on the study findings, it is strongly recommended to expand the Small Community Size Intermittently-operated Slow Sand Filter to the whole country. ISSF to fabricate and install in places where there are abundant surface water and no access to safe sources of drinking water. It is especially recommend to install the ISSF in those schools those don't have access to safe water source and have abundant surface water and city power to pump water to a reservoir from the stream or river.

### **15. Annex**

#### **15.1. Complete Design of ISSF**

#### **15.2. Installation Diagram of Water Tank of ISSF**

#### **15.3. Summary of Water Analysis of BSF, ISSF and Source Water**