

# LifeStraw®

Safe drinking water  
interventions for *home  
and outside use*



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# The LifeStraw® Concept

The Millennium Development Goals (MDGs) call for a reduction of the proportion of people without sustainable access to safe drinking water by half between 1990 and 2015. Yet, an estimated 884 million people in the world, 37% of whom live in Sub-Saharan Africa, still use unimproved sources of drinking water<sup>1</sup>.

Lack of access to safe drinking water contributes to the staggering burden of diarrhoeal diseases worldwide, particularly affecting the young, the immunocompromised and the poor. Nearly one in five child deaths – about 1.5 million each year – is due to diarrhoea. Diarrhoea kills more young children than AIDS, malaria and measles combined<sup>2</sup>. Drinking contaminated water also leads to reduced personal productive time, with widespread economic effects.

Approximately 43% of the global population, especially the lower-income populace in the remote and rural parts of the developing world, is deprived of household safe piped water. Thus, there is a pressing need for effective and affordable options for obtaining safe drinking water at home. Point-of-use (POU) treatment is an alternative approach, which can accelerate the health gains associated with the provision of safe drinking water to the at-risk populations. It empowers people to control the quality of their drinking water. Treating water at the household level or other point of use also reduces the risk of waterborne disease arising from recontamination during collection, transport, and use in the home, a well-known cause of water-quality degradation<sup>3</sup>. In many rural and urban areas of the developing world, household water-quality interventions can reduce diarrhoea morbidity by more than 40%<sup>4,5</sup>. Treating water in the home offers the opportunity for significant health gains at potentially dramatic cost savings over conventional improvements in water supplies, such as piped water connections to households<sup>6</sup>.

Water filters have been shown to be the most effective interventions amongst all point-of-use water treatment methods for reducing diarrhoeal diseases. The Cochrane review<sup>7</sup> demonstrates that it is not enough to treat water at the point-of-source; it must also be made safe at the point-of-consumption.



LifeStraw® and LifeStraw® Family are both point-of-use water interventions – truly unique offerings from Vestergaard Frandsen that address the concern for affordably obtaining safe drinking water at home and outside. These complementary safe water tools have the potential to accelerate progress towards the MDG target of providing access to safe drinking water, which would yield health and economic benefits; thus contributing to the achievement of other MDGs like poverty reduction, childhood survival, school attendance, gender equality and environment sustainability.

## The Link between LifeStraw® Water Filters and Millennium Development Goals

### Goal 1: Eradicate Extreme Poverty and Hunger

LifeStraw® safe water interventions minimise the risk of waterborne disease, promoting economic gain by reducing healthcare expenses and increased productivity.

### Goal 2: Achieve Universal Primary Education

The consumption of safe drinking water through LifeStraw® water filters prevent children from acquiring diarrhoea and other waterborne diseases, helping ensure that children wake up healthy each morning to continue their education.

### Goal 3: Promote Gender Equality and Empower Women

LifeStraw® water filters empower women and girls by facilitating access to safe drinking water. LifeStraw® Family works on highly turbid water, which allows women to convert 'dirty' water collected from any nearby source into safe drinking water. Saved time, particularly for women and young girls, is a major benefit. Beneficiaries of water and sanitation projects in India reported benefits like less tension/conflict in homes and communities; community unity, self-esteem, women's empowerment (less harassment) and improved school attendance (WaterAid 2001).

### Goal 4: Reduce Child Mortality

The consumption of contaminated water exposes children to waterborne diseases like hepatitis A and E, cholera, typhoid, poliomyelitis and other diseases that cause diarrhoea. By affecting normal consumption of food and reducing the adsorption of nutrients, diarrhoea is also an important cause of malnutrition, which can lead to impaired cognitive development and physical growth<sup>8</sup>, reduced resistance to infection<sup>9</sup>, and potentially, long-term gastrointestinal disorders<sup>10</sup>. The use of LifeStraw® point-of-use water filters prevent morbidity and mortality resulting from diarrhoea among infants and children under five.

### Goal 5: Improve Maternal Health

Diarrhoea is amongst the indirect medical causes that weaken pregnant women's immune systems. Provision of clean drinking water through LifeStraw® has a positive impact on maternal health.

### Goal 6: Combat HIV/AIDS, Malaria and Other Diseases

Globally, there are about four billion cases of diarrhoea each year<sup>11</sup>. It is a leading cause of child mortality, morbidity and malnutrition. Diarrhoea is also a very common symptom of HIV/AIDS and a cause of significant morbidity and mortality amongst the HIV-infected. Safe drinking water through LifeStraw® filters ensures healthier lives for the immunocompromised, including children under five, pregnant women, the elderly and those living with HIV/AIDS.

# Drinking Water Crisis



**884 million\***

deprived of improved sources of drinking water<sup>1</sup>

**4 billion**

annual cases of diarrhoeal illness<sup>11</sup>

**1.8 million**

lives lost each year due to diarrhoeal disease<sup>11</sup>

**443 million**

school days lost each year from water-related illness<sup>12</sup>

**117 million**

disability adjusted life years (DALYs) lost annually due to diarrhoea and intestinal worm infections<sup>13</sup>

\*Hundreds of millions more rely on "improved" water sources that are nevertheless subject to frequent and extensive microbial contamination.<sup>4</sup>



# The Link between Diarrhoea and HIV

- Diarrhoea affects 90% of people living with HIV/AIDS and results in significant morbidity and mortality<sup>14,15</sup>.
- Diarrhoea is one of the leading causes of morbidity and mortality among HIV-infected children<sup>16</sup>.
- In HIV-positive children, diarrhoea is often the result of frequently aggressive common childhood infections caused by pathogens such as *Campylobacter*, *E. coli*, *Salmonella*, *Shigella* or rotavirus<sup>17</sup>.
- Persistent diarrhoea occurs with increased frequency in HIV-infected children, and is associated with an 11-fold increase in mortality compared to uninfected children<sup>18</sup>.
- In Africa, diarrhoea is four times more common among children with HIV and seven times more common among adults with HIV than their HIV-negative household members<sup>19</sup>.
- A study found that although common diarrhoea-causing enteric pathogens are found in many babies, HIV-positive babies with acute diarrhoea were six times more likely to develop persistent diarrhoea. HIV-negative babies born to HIV-positive mothers were also at 3.5 times greater risk of developing recurrent bouts of diarrhoea than babies born to HIV-negative mothers<sup>20</sup>.
- A study that compiled case reports of cryptosporidiosis found a mortality rate of 46% in AIDS patients and 29% in patients with 21 other immunodeficiencies<sup>21</sup>.
- A study of HIV-infected persons and their families in Uganda showed that use of a simple, home-based safe water system reduced the incidence of diarrhoeal episodes by 25%, the number of days with diarrhoea by 33%, and the frequency of visible blood or pus in stool<sup>22</sup>.
- In a study among HIV-infected persons in Uganda, use of safe water decreased diarrhoeal illness by 36%<sup>22</sup>.



# The Health Impact of Water Filtration

In the year 2006, the Cochrane Collaboration published a systematic review of 38 randomised, controlled trials of various water quality interventions to prevent diarrhoea titled, "Interventions to Improve Water Quality for Preventing Diarrhoea." These trials covered more than 53,000 subjects from 19 countries over 20 years.

The objective of this review was to assess the effectiveness of interventions to improve water quality for preventing diarrhoea. This review, which

covered both point-of-source and point-of-use household-level interventions, found that household interventions were twice as effective in preventing diarrhoea as common source-based interventions (wells, boreholes and communal tap stands).

**Among household interventions, filters were consistently the most effective in preventing diarrhoea, with an average 63% reduction.**

## Filtration vs. other Point-of-Use Interventions<sup>7</sup>

Intervention Type (no. of trials)	% Reduction (1-RR) in Diarrhoea	95% Confidence Interval of Estimate*
Filtration (6)	63%	0.28 to 0.49
Chlorination (16)	37%	0.52 to 0.75
Solar Disinfection (2)	31%	0.63 to 0.74
Flocculation/Disinfection (7)	52%	0.20 to 1.16
Flocculation/Disinfection (ex Doocy)	31%	0.58 to 0.82
Improved storage (1)	21%	0.61 to 1.03

\*Estimates outside this range have a likelihood of less than 5%

***"Household interventions were twice as effective in preventing diarrhoea as common source-based interventions"***



LifeStraw® Family





# LifeStraw® Family – Product Features

## ***Instant Microbiological Water Purifier***

- Is a point-of-use water treatment system providing instant access to clean and safe drinking water
- Filters up to 18,000 litres\* of water, enough to supply a family of five with microbiologically clean drinking water for three years, thus removing the need for repeat intervention
- Ensures high flow rate and high volume of purified water
- Complies with US Environmental Protection Agency 1987 Guide Standard and Protocol for Testing Microbiological Water Purifiers:
  - Removes minimum 99.9999% of bacteria (>LOG 6 reduction)\*
  - Removes minimum 99.99% of viruses (>LOG 4 reduction)\*
  - Removes minimum 99.9% of protozoan parasites (>LOG 3 reduction)\*
- Removes turbidity
- Requires no electrical power, batteries or replacement parts
- Requires no running water or piped-in water supply
- Has an easy-to-clean prefilter and purification cartridge
- All raw materials are US Food and Drug Administration compliant or equivalent

\*Clasen, T. *et al.* 2009. Laboratory assessment of a gravity-fed ultrafiltration water treatment device designed for household use in low-income settings. *Am. J. Trop. Med. Hyg.*, 80(5), 2009, pp. 819–823



# LifeStraw® Family – Functioning



- ① **Feed water bucket with prefilter**  
2L capacity container for filling with unpurified water
- ② **Prefilter**  
the 80 micron prefilter removes coarser turbidity and is easy to clean
- ③ **Halogen chamber**  
releases low-level chlorine to prevent membrane fouling
- ④ **Plastic hose (one metre long)**  
gravity creates sufficient pressure on the membrane cartridge in order to reach a high flow rate
- ⑤ **Membrane cartridge**  
ultra filtration takes place in the membrane cartridge – a pore size of 20 nanometre retains bacteria, viruses, parasites and fine dirt particles
- ⑥ **Blue tap**  
outlet for purified water
- ⑦ **Cleaning bulb**  
backwashing of the membranes is done by squeezing the bulb three times
- ⑧ **Exit valve**  
disposes the dirt and impurities

At the time of first use, opening the exit valve removes all the air trapped inside the hollow-fibre membrane and moistens the membrane surface, allowing an optimal filtration of the untreated water. The exit valve must be closed after 3 seconds.

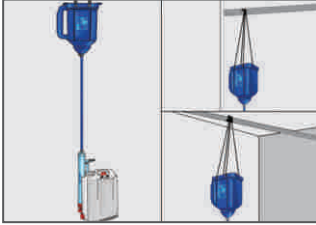
When untreated water is poured into the feed water bucket, the prefilter removes coarse particles larger than 80µm. Gravity pushes the water with particles finer than 80µm to flow down the plastic hose towards the purification cartridge. The purification cartridge, which contains an ultrafiltration (hollow-fibre) membrane of 20nm porosity, stops all particles larger than 20nm (including all microbes: protozoan parasites, bacteria and viruses). Turbidity particles are also stopped by the membrane by size exclusion. The untreated water is pushed through the ultrafiltration (hollow-fibre) membrane by gravity, i.e. by the pressure applied by the 1m long plastic hose, which corresponds to 0.1 bar pressure. This 0.1 bar pressure forces the water through the pores of the hollow-fibre membrane; particles and microbes larger than 20nm stay on the dirty side of the membrane and clean/purified water passes through the membrane. Purified water can be collected from the blue tap. When the cleaning bulb is squeezed, dirt particles on the dirty side of the membrane are lifted by backpressure and then removed by flushing through the exit valve.

Since all microbes are stopped by the 20nm membrane, the purified water complies with the USEPA requirements of LOG 6/4/3 reduction of microbes concentrations for water purifiers. The 0.1 bar pressure which allows the purification process to take place also leads to a flow-rate of 12-15L/hour of purified water.

The LifeStraw® Family filter also contains a chlorine chamber located below the top container. This chamber elutes low amounts of active chlorine, which protect the ultrafiltration membrane from fouling (small amounts of active chlorine slow down the bio film formation on the hollow-fibre membrane). The low amounts of active chlorine protect the ultrafiltration cartridge and that way lead to an extended lifetime of the LifeStraw® Family water purifier.

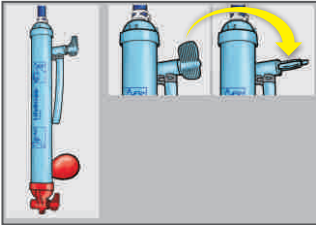
# LifeStraw® Family – Usage

## 1. To Begin

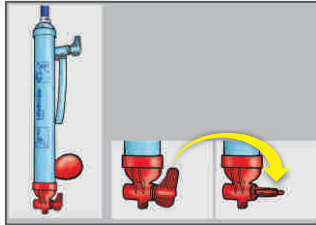


a) **Hang** the filter straight up.

## 2. To collect purified water



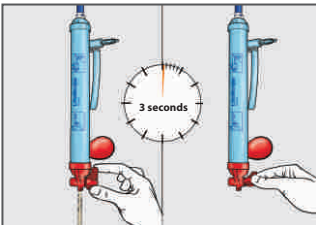
a) **Close** the light blue tap.



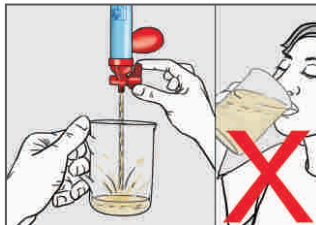
b) **Close** the red tap.



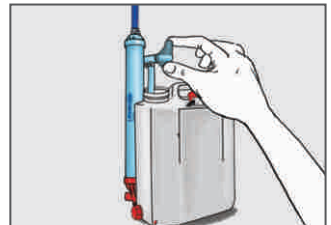
c) **Fill** the dark blue container with water.



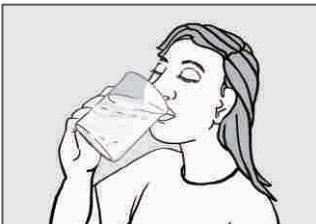
d) **Open** the red tap until some water is released for 3 seconds.  
**Close** the red tap.



e) **DO NOT** drink water released from the red tap.



f) **Collect** drinking water from the light blue tap using a safe storage container.



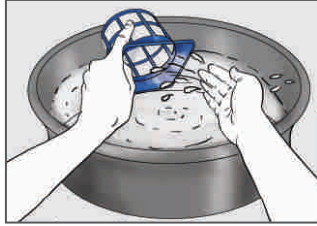
g) The water collected from the light blue tap is **clean** and **safe**.



### 3. To clean prefilter everyday



a) **Take** the prefilter out from the dark blue container.

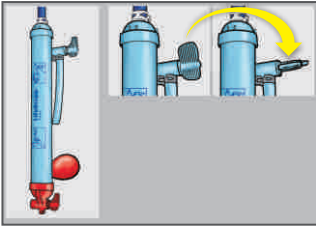


b) **Wash** the prefilter to remove all the dirt that may have collected in it.

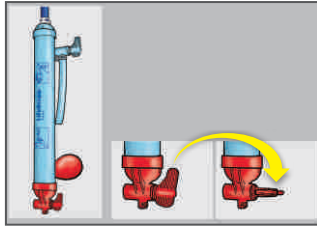


c) **Place** the clean prefilter back into the dark blue container.

### 4. To clean membrane cartridge everyday



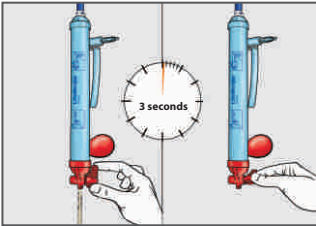
a) **Close** the light blue tap.



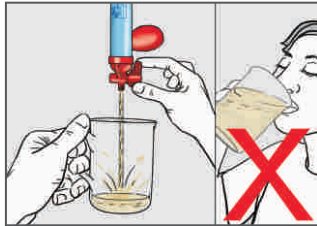
b) **Close** the red tap.



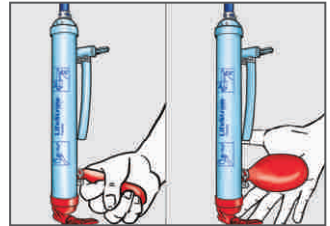
c) **Fill** the dark blue container with water.



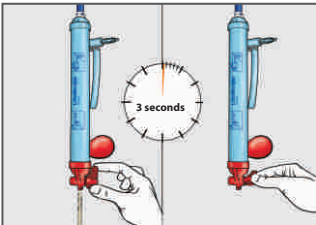
d) **Open** the red tap until some water is released for 3 seconds. **Close** the red tap.



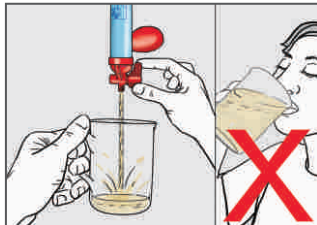
e) **DO NOT** drink water released from the red tap.



f) **Squeeze** the red bulb until it is flat. **Wait** till it is refilled. Do this process **three times**

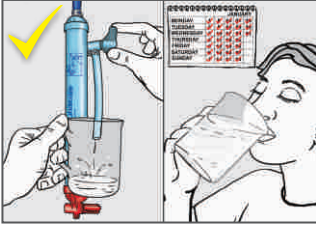


g) **Open** the red tap until some water is released for 3 seconds. **Close** the red tap.

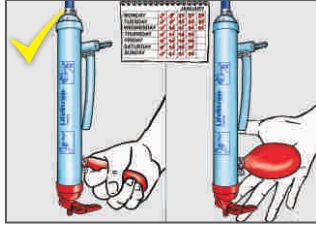


h) **DO NOT** drink water released from the red tap.

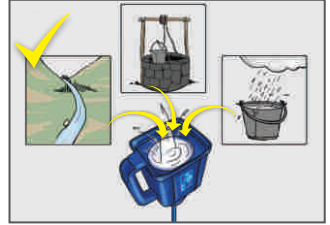
## Do's



a) **Do** use the filter daily to improve the health of you and your family.

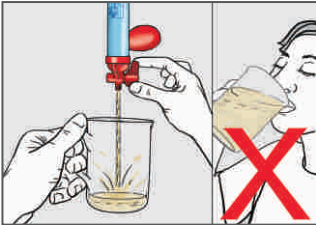


b) **Do** clean the membrane cartridge regularly to increase the life of your filter.

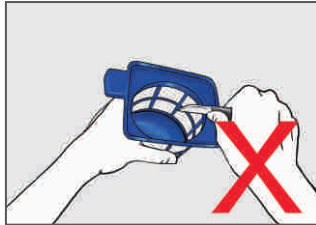


c) **Use** river, well or rain water to increase the life of your filter.

## Don'ts



a) **DO NOT** drink water released from the red tap.



b) **DO NOT** use sharp objects to clean the prefilter.

# LifeStraw® Family – Comparison to other Point-of-Use Interventions for Safe Drinking Water

## Microbiological Performance

Intervention	Bacteria	Virus	Protozoan Parasites	Meets Environmental Protection Agency protocol
<b>LifeStraw® Family</b>	Minimum 99.9999%	Minimum 99.99%	Minimum 99.9%	Yes
<b>Boiling</b>	99.9999%	99.99%	99.9%	Yes
<b>Flocculation disinfection (Pur)</b>	99.9999%	99.99%	99.9%	Yes
<b>Chlorination</b>	Depends upon the contact time and quantity of variable chlorine			No
<b>Bio sand filter</b>	90%-99%	50%-90%	99.9%	No
<b>Ceramic filter</b>	>99%	Low	99.9%	No
<b>SoDis</b>	99.999%	99.99%	50%-99%	Unclear



## Physical Performance

Intervention	Water treatment capacity	Processing time/ Flow rate	Factors affecting performance	Impact on water taste/ appearance	Repeat intervention required
<b>LifeStraw® Family</b>	18,000 litres	Instant access Average 9 litres/hour	Safe storage if water not consumed directly	Neutral for taste; positive for appearance	No
<b>Boiling</b>	Not applicable	20 minutes (includes heating water to 100°C, 1 min. boiling, cooling)	Boiling temperature and safe storage	Neutral or negative for taste; neutral for appearance	Yes
<b>Flocculation disinfection</b>	10 litres	30 minutes	Exposure time, chemical concentration in mix	Negative for taste; positive for appearance	Yes
<b>Chlorination (dilute NaOCl<sub>2</sub>)</b>	1000 litres	30 minutes contact time after preparation and dosing	Exposure time, turbidity, chlorine demand	Negative for taste; neutral for appearance	Yes
<b>Bio sand Filter</b>	Up to 50 litres/day	Instant access 0.1/ 0.3 metre/hour (when the average depth of sand filter is 0.7 metres)	Proper construction, operation and maintenance	Neutral for taste; positive for appearance	No
<b>Ceramic filter</b>	5000-10,000 litres	Instant access 1-3 litres/ hour	Pore size and consistency: bacteriostasis; maintenance	Neutral for taste; positive for appearance	No
<b>SoDis</b>	1-2 litre per bottle average	6 hours	Sunlight, turbidity, dissolved solids	Neutral for taste and appearance	No

# LifeStraw® Family – Microbiological Performance

**Field study:** Clasen, T. *et al.* 2010. **Field assessment of a novel household-based water filtration device: a randomised placebo-controlled trial in the Democratic Republic of Congo.** *PLoS One* **September 2010**

**Study design:** 12-month RCT among 240 households (1144 persons) in remote, rural Congo

**Outcome:** Very high antimicrobial efficacy: While 75% of 580 source water samples had contamination levels >1000 TTC/100ml, 64% of filtered samples taken at the household level were free of TTC and 27% had levels between 1-10TTC/100ml

**Field study:** **LifeStraw® Family use, acceptability and performance – Phase I (Kenya)**

**Partner:** Centers for Disease Control – SWAP

**Outcome:** High antimicrobial efficacy: 70% or more of water samples from the LifeStraw® Family taken into consideration were free of contamination (faecal coliforms)

**Laboratory test:** **LifeStraw® Family Quality Inspection (Intertek Vietnam)**

**Outcome:** Successfully passed Intertek Quality Inspection and complies with the USEPA protocol on bacteria removal of >99.9999%, on virus removal of >99.99%, on protozoan parasite removal of >99.9%. Complies with the USEPA maximum admissible chlorine residual levels < 4mg/L and with the maximum product water permissible turbidity < 0.5 NTU (NSF/ANSI 63)

**Field study:** **Testing the efficiency of LifeStraw® Family in purifying drinking water (Institute of Technology of Cambodia)**

**Study design:** 3 months, 22 households in rural Cambodia (Pursat and Kandal Province)

**Outcome:** High antimicrobial efficacy: All filters removed >99.99% of bacteria (total plate count, total coliforms, thermotolerant coliforms and *E. Coli*). However 45% of the filters showed some recontamination issues between week # 2 and week # 12, due to insects/dust/poor hygiene practices.

High turbidity removal efficacy: LifeStraw® Family effectively removes turbidity

**Field study:** **LifeStraw® Family pilot project in Ethiopia**

**Partner:** Christian Children Fund of Canada

**Outcome:** Extremely high antimicrobial efficacy; extremely high water aesthetics improvement: turbidity removal, improvement of taste

**Laboratory test:** Clasen, T. *et al.* 2009. **Laboratory assessment of a gravity-fed ultrafiltration water treatment device designed for household use in low-income settings.** *Am. J. Trop. Med. Hyg.*, **80(5), 2009, pp. 819–823**

**Outcome:** >LOG 6/4/3 reduction on bacteria, virus and parasites; 18,000L capacity (tested up to 110% i.e. 20,000L)

**Laboratory test:** **Various laboratory assessments of LifeStraw® Family in various countries**

**Partners:** Pro-Lab (Brazil), Universidad de Antioquia (Colombia), Instituto Departamental de Salud de Narino (Colombia), Ministry of Water Resources Lab (Ethiopia), Water Research Institute (Ghana), Laboratoire Vétérinaire et de Contrôle de Qualité des Aliments de Tamarinier (Haiti), Delhi Test House (India), Kenya Bureau of Standards (Kenya), Water Aid Lab (Madagascar), Laboratorio Nacional de Higiene de Alimentos e Aguas Mizau (Mozambique), Qualibet (Philippines), Rwanda Bureau of Standards (Rwanda), National Health Laboratory Service, Public Health Laboratory (South Africa), Umgeni Water Amanzi (South Africa), SPLA Medical Crops IGHQs Diagnostic Center (South Sudan), Environmental Engineering Lab (Zambia), Food and Drugs Control Laboratory, Ministry of Health (Zambia)

**Outcome:** 100% reduction in total and faecal coliforms; when assessed, high reduction in turbidity and improvement of taste and colour

# LifeStraw® Family – Health Impact

**Field study:** Clasen, T. *et al.* 2010. **Field assessment of a novel household-based water filtration device: a randomised placebo-controlled trial in the Democratic Republic of Congo. PloS One September 2010**

**Study design:** 12-month RCT among 240 households (1144 persons) in remote, rural Congo  
**Outcome:** Health impact: 15% reduction in risk of diarrhoea, though not statistically significant. Investigators emphasised that the measured reduction may underestimate the actual effect because the comparison group used an intended placebo that actually removed more than 90% of TTC from their water. The study was not powered to achieve statistical significance at the 15% level

**Modeling study: Efficacy of a water quality intervention: accounting for systematic bias**

**Study design:** Development of Quantitative Microbial Risk Assessment Models (QMRA) to evaluate the impact of bias on estimates of intervention efficacies and to generalize the effectiveness of an intervention to different contexts.

**Partners:** Michigan State University (USA), University of California Berkeley (USA), University of Michigan (USA), London School of Hygiene and Tropical Medicine, UK

**Outcome:** Assuming the device was used 100% of the time by 69% of the people there was an estimated 50% decrease in diarrhoea (compared with a 15% reduction when an imperfect placebo is used, study by Clasen T. 2010)

Under the assumption of a perfect use (100% of the time by 100% of the participants) this translates to a 75% reduction in diarrhoea.

\*study included both LifeStraw® and LifeStraw® Family

**Field study:** Dye, T.D. 2009. **“You can take water any place you are:” A qualitative assessment of water-related illness beliefs, behaviors, and community acceptance of novel personal water filtration devices (under publication)\***

**Partner:** Department of Public Health and Preventive Medicine, SUNY Upstate Medical University, New York

**Outcome:** 35% of the study group reported decrease in diarrhoeal cases

**Field study:** **Investigating the functioning and acceptability of LifeStraw® Family by its intended target group in the Democratic Republic of Congo**

**Partner:** USAID-funded project AXxes (2007)  
**Outcome:** Several participants mentioned that their children had no diarrhoea since using the product





# LifeStraw® Family – Durability

**Test:** **Assessment of the performance of LifeStraw® Family after exposure to conditions representing lifetime of field use (durability testing)**

The testing program was especially designed to ensure that the basic functionality of the product (namely producing clean purified drinking water in the anticipated quantities) was not compromised by these lifetime representative conditions. LifeStraw® Family is considered to be exposed to all these conditions during its lifetime and therefore all tested samples were subjected to all the below tests:

- Simulation of transport conditions
- Simulation of a drop during transport
- Aging/ weathering of the product under elevated temperature (50°C) and elevated humidity (30, 50 and 100% RH)
- Simulation of a drop of the LifeStraw® Family at home
- Simulation of static load on the ultrafiltration cartridge
- Endurance of all moving parts: blue tap, red tap, and red plastic bulb
- Over-pressurization of the ultrafiltration cartridge
- Antimicrobial efficacy, final control

**Partner:** BPO, The Netherlands

**Outcome:** LifeStraw® Family was able to withstand all the tests specified in the product durability testing program;  $\geq 97.5\%$  of the products functioned well after being exposed to all these tests: the membrane units were still intact, all parts and components were functioning, cleaning/backwashing of the product could be performed properly and enough clean purified water could be drawn from the blue tap



# LifeStraw® Family – User Acceptability\*

- Field study:** **Clasen, T. *et al.* 2010. Field assessment of a novel household-based water filtration device: a randomised placebo-controlled trial in the Democratic Republic of Congo. PloS One September 2010**
- Study design:** 12-month RCT among 240 households (1144 persons) in remote, rural Congo
- Outcome:** Very high acceptability  
76% current users after 14 months  
83% adults and 95% children reported drinking from LifeStraw® Family the previous day  
56% correct use (understood instructions of use)  
High flow-rate (12L/h)
- Field study:** **Testing the efficiency of LifeStraw® Family in purifying drinking water**
- Study design:** 3 months, 22 households in rural Cambodia (Pursat and Kandal Province)
- Partner:** Institute of Technology of Cambodia
- Outcome:** High user acceptability: All households liked the LifeStraw® Family and used it to purify their drinking water. The households found the filter easy to operate. The LifeStraw® Family produced enough water for their daily consumption, the average flow-rate of 12L/h was well accepted and was maintained throughout the study in a remarkable manner.
- Field study:** **To investigate the functioning and acceptability of LifeStraw® Family by its intended target group in the Democratic Republic of Congo**
- Partner:** USAID-funded project AXxes (2007)
- Outcome:** After the purpose and usage of the product was explained and demonstrated, the product was greatly appreciated and accepted by all families. The products showed no malfunction or damage after a month's usage, and showed impressive flow rate of one litre in less than five minutes. The participants found them easy to use and maintain
- Field study:** **LifeStraw® Family pilot project in Ethiopia**
- Partner:** Christian Children Fund of Canada
- Outcome:** Good product uptake: 50% same day or regular use  
High perception: 70% products hanging in house, product considered desirable/ prestigious.  
Customers understood the instructions of use and found the product easy to use
- Field study:** **Dye, T.D. 2009. "You can take water any place you are:" A qualitative assessment of water-related illness beliefs, behaviors, and community acceptance of novel personal water filtration devices (under publication)\*\***
- Partner:** Department of Public Health and Preventive Medicine, SUNY Upstate Medical University, New York
- Outcome:** High product uptake: 83% current users after 2 months  
Savings in firewood consumption  
\*based on self-reported data  
\*\*study included both LifeStraw® and LifeStraw® Family

# LifeStraw® Family – Certificate of Quality

Each shipment of LifeStraw® Family is accompanied with a Certificate of Quality (COQ).

COQ summarises quality control testing data, including antimicrobial efficacy and physico-chemical parameters for every batch or shipment of LifeStraw® Family. It is sent to the customer at the time of shipment.

A sample of the COQ can be seen below:

## Certificate of Quality

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**Product information**

Customer:	Customer Company, Country
Product:	LifeStraw® Family
Order N°:	SPOXXXXX
Quantity:	2,000 pieces
Batch N°:	13D17, 13D20, 13D26

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**Quality control conclusion**

*Antimicrobial efficacy*

Test organism / Reference method*	Microbe concentration reduction requirements		Conclusion
<i>E. coli</i> ISO 9308 (membrane filtration method)	USEPA / NSF P 231	≥ 99.9999% (or ≥ Log <sub>10</sub> -6)	Passed
<i>MS2 virus</i> US EPA Method 1602 (modified)	USEPA / NSF P 231	≥ 99.99% (or ≥ Log <sub>10</sub> -4)	Passed
<i>Protozoan cysts</i> (3µm spheres surrogate): US EPA Method 1623 (modified)	USEPA / NSF P 231	≥ 99.9% (or ≥ Log <sub>10</sub> -3)	Passed

*Physico-chemical parameters*

Test / Reference method*	Requirements		Conclusion
<b>Turbidity</b> 2130B American Standard Method for the examination of water and waste water	NSF/ANSI 53	≤ 0.5 NTU	Passed
<b>Active chlorine residuals (free or combined)</b> 4500-Cl G American Standard Method for the examination of water and waste water	USEPA / NSF/ANSI 61	≤ 4 mg/L	Passed
<b>Initial flow-rate</b> Internal method SOP LSF 5.2	SOP LSF 5.2	≥ 12 L/h	Passed

\* Test methods and specific water testing conditions are available upon request

**QUALITY CONTROL PASSED**  
VESTERGAARD FRANDSEN LABORATORIES

We, the undersigned, hereby declare that the products under the batch numbers stated above conform to Vestergaard Frandsen S.A. quality control criteria.

Date and signature    Cao Thu Le Laboratory Manager, Waterborne Disease Control	Date and signature    Sicco Roorda Chief Production Officer
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DISEASE CONTROL TEXTILES

## LifeStraw® Family – Guarantee

### LifeStraw® Family Guarantee

Vestergaard Frandsen conducts 100% testing and inspection of LifeStraw® Family when the filters leave the factory. While some field failures can be attributed to the challenging environments in which this product is used, we guarantee that at least 90% of the units will meet 90% of the specified microbiological performance levels for three years based on purifying capacity of 18,000 litres after invoicing, if used and maintained in accordance with the manufacturer's instructions. If any shipment of LifeStraw® Family filters fails to meet this guaranteed performance threshold, Vestergaard Frandsen will satisfy this guarantee by making up the deficiency with replacement filters.

Lausanne, Feb. 3, 2010









# LifeStraw® – Product Features

## Portable Water Filter

- Offers easy access to clean and safe drinking water away from home
- Filters\* at least 1000L of contaminated water
- Removes minimum 99,9999% of waterborne bacteria (>LOG 6 reduction)
- Removes minimum 99,9% of waterborne protozoan parasites (>LOG 3 reduction)
- Reduces turbidity by filtering particles of approximately 0.2 microns
- Contains no chemicals
- Has a high flow rate
- Requires no electrical power, batteries or replacement parts

\*Note: The quality of the filtered water is not guaranteed if the product is submitted to other conditions than the ones encountered during its normal use.

## LifeStraw® – Usage



Place LifeStraw® in water and sip through the mouthpiece.



Regularly blow air through LifeStraw® after drinking to keep the filters clean and to prevent them from clogging.

# LifeStraw® – Complementary Tool to LifeStraw® Family

LifeStraw®, a portable water filter, is a complementary tool to LifeStraw® Family. It provides access to safe and clean drinking water away from home.

The following study indicates the need and frequency of water consumption away from home:

**Field study**      **Onyango-Ouma, W. and Gerba, C.P. 2010. Away-from-home drinking water consumption practices and the microbiological quality of water consumed in rural western Kenya (underpublication)**

## Key Findings

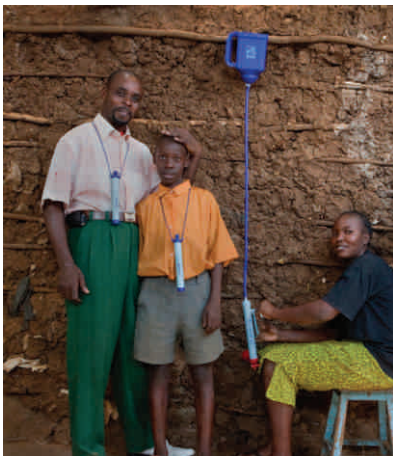
- 97% of the people report drinking water while away from home.
- Main sources of water are rivers (31%) and boreholes (14%).
- Volume of water consumed away-from-home is in average 260mL, which is equivalent to two glasses.
- Overall microbiological quality of water is poor and unfit for consumption, especially water from unprotected springs (protected springs are contaminated as well, to a lesser extent).

## Outcome

There is a need for innovative approaches to address away-from-home drinking water consumption in resource-poor settings in order to complement and maximize the benefits of point-of-use water treatment at the household level. It is very clear that local populations in resource poor settings consume water outside home as dictated by the pattern of daily activities; and that the microbiological quality of this water is very poor. Population awareness of the poor away-from-home water quality has to be improved.

The first portable water filter takes its origin in the PVC pipe filters used for the eradication of Guinea Worm disease. Vestergaard Frandsen has for many years been a sole supplier for Pipe Filters used in The Carter Centers' Guinea worm eradication program. The success of the Pipe Filter triggered ideas behind the development of the LifeStraw®.

Dr. Ernesto Ruiz-Tiben, Technical Director of the Carter Center Guinea Worm Eradication Program (GWEP) quotes: *"Persons who travelled away from the household for extended period of times did not have a way of protecting themselves from the Guinea Worm Disease. In 1994, we tested (at CDC) the efficacy of PVC pipe filters in the removal of copepods, and what length and diameter would be ideal for their use. Those results led to their large scale use in the Guinea Worm Eradication Programs."*



# LifeStraw® – Longevity and Efficacy

**Laboratory test** Evaluation of Vestergaard Frandsen's hollow fiber LifeStraw® for the removal of *Escherichia Coli* and *Cryptosporidium* according to the US Environmental Protection Agency guide standard and protocol for evaluation of microbiological water purifiers

**Partner** Naranjo, J. and Gerba, C.P. Department of Soil, Water and Environmental Science, University of Arizona, USA (2010)

**Outcome** Longevity of LifeStraw® was successfully assessed in laboratory conditions (harsher conditions than what is required by the EPA in terms of turbidity and organic matter), up to 1600L (approximately 160% of design life)

**Backwash frequency** used was once every 5L (corresponds to more or less a daily cleaning during real use)

**Flow-rates** varied as follows in average:  
280mL/min at the beginning  
280mL/min between 10 and 200L  
250mL/min between 200 and 500L  
170mL/min between 500 and 1000L  
200 mL/min overall between 0 and 1000L

**Antimicrobial efficacy** of LifeStraw® was successfully assessed in the same laboratory conditions (EPA 1987 protocol for microbiological water purifiers testing) and showed that LifeStraw® meets the EPA requirements of LOG 6 reduction for bacteria and LOG 3 reduction for protozoan parasites:

Micro-organism	LifeStraw® efficacy*	EPA requirements*
<i>Escherichia coli</i>	>7.3	6.0
<i>Cryptosporidium oocysts</i>	>3.9	3.0

\*Note: results in Log reduction values (LRV)

**Turbidity** was removed during the challenges by 99.6% in average:  
influent challenge water turbidity: 104 NTU  
effluent challenge water turbidity: 0.4 NTU

**Laboratory test:** Various laboratory assessments of LifeStraw® in various countries

**Partners:** Laboratorio de Pruebas y Ensayos Tecnicos Asociados (LAPETSA, Colombia), SPLA Medical Crops IGHQs Diagnostic Center (South Sudan)

**Outcome:** 100% reduction in mesophile aerobic, total coliforms and *E. Coli*; *K. aerogensa*, and *St. Faecalis*



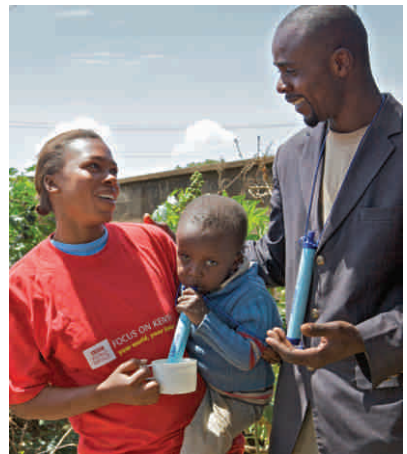
# LifeStraw® – Health Impact

- Field study** Clasen, T. *et al.* 2009. Randomized controlled trial in rural Ethiopia to assess a portable water treatment device. *Environ. Sci. Technol.*, 43 (15), pp 5934–5939
- Study design** 8-month randomized controlled trial among 313 households (1516 individuals) in remote, rural Ethiopia.
- Outcome** High health impact: 25% statistically significant reduction in diarrhoeal prevalence.
- 
- Field study** Elsanousi, S. *et al.* 2009. A study of the use and impacts of LifeStraw in a settlement camp in southern Gezira, Sudan. *Journal of Water and Health*; 07.3
- Study design** 647 people from 134 households participated. Study design included no control group, seasonal influence on diarrhoea not taken into account.
- Outcome** 15.3% of participants reported a diarrhoeal incident (recalled for the previous 2 weeks) at 3–4 months before distribution of LifeStraw®, whereas only 2.3% reported diarrhoea (recalled for the previous 2 weeks) at the follow-up survey four months after distribution of LifeStraw®.



# LifeStraw® – User Acceptability

<b>Field study</b>	<b>Elsanousi, S. et al. 2009. A study of the use and impacts of LifeStraw in a settlement camp in southern Gezira, Sudan. <i>Journal of Water and Health</i>; 07.3</b>
<b>Study design</b>	647 people from 134 households participated. Study design included no control group, seasonal influence on diarrhoea not taken into account.
<b>Outcome</b>	Compliance rates were good with 86.5% of people saying they always used the LifeStraw®. 9.8% saying they were occasional users and 3.7% saying they had never used it.
<b>Field study</b>	<b>Dye, T.D. 2009. “You can take water any place you are:” A qualitative assessment of water-related illness beliefs, behaviors, and community acceptance of novel personal water filtration devices (under publication)**</b>
<b>Partner</b>	Department of Public Health and Preventive Medicine, SUNY Upstate Medical University, New York
<b>Outcome</b>	High product uptake: 83% current users after 2 months. 17% stopped using the product because they found it was too difficult to draw up water through it.  ** study included both LifeStraw® and LifeStraw® Family





# LifeStraw® – Awards and Accolades

*"Good design should have a positive effect on the user and if possible on society. LifeStraw® meets these basic criteria, truly an excellent design solution. LifeStraw® offers a simple, elegant solution to a large and complicated problem that profoundly affects many people's lives around the world. By addressing this problem the designers are opening possibilities of limiting the number of people without clean water – and thereby reducing deaths resulting from this lack, especially in the developing world."*

*- Jury of INDEX: 2005 International Design Award (September 2005)*

*"LifeStraw® is a very simple and elegant solution to a problem that kills millions of people. Let's get it out there."*

*- Saatchi & Saatchi Award for World Changing Ideas Judge Peter Gabriel (February 2008)*



## Awards

**2008 Saatchi & Saatchi Award**  
for World Changing Ideas

**'INDEX: 2005'**  
International Design Award

**'Well-Tech 2006'**  
Innovation Technology Award

## Accolades

**'Best Invention of 2005'**  
Time Magazine (November 2005)

**'Europe's Best Invention'**  
Reader's Digest (July 2006)

**'Innovation of the Year'**  
Esquire Magazine (December 2005)

**'Invention of the Century'**  
Gizmag (December 2005)

**'A Water Purifier for the Masses'**  
Popular Science Magazine (December 2005)

**'A Water Purifier That Could Save Lives'**  
New York Times (October 2006)

**'Gadget Produces Safe Drinking Water'**  
Newsweek (June 2007)

**One of the 'Ten Things That Will Change The Way We Live'**  
Forbes Magazine (February 2006)

**'Tools for Better Living'**  
Fortune Magazine (December 2006)

**'Design for the Rest of the World: LifeStraw®'**  
The New York Sun (May 2007)

# Acronyms/ Definitions

**Aging water:** Water passed through the filter with determined known PH-TOC-total dissolved solids and turbidity to measure the filter's resistance to clogging, flow-rate and lifetime.

**CDC:** Centers for Disease Control, USA.

**CFU:** Colony-Forming Unit (CFU) is a measure of viable bacterial numbers. It allows users to assess the degree of contamination in samples of water.

**Challenge water:** Water passed through the filter for microbiological efficacy tests. In this water, disinfectant is completely removed and residue level should be non-detectable. This is to ensure that there is no interference from residual chlorine (most tap water is chlorinated) on the contaminants introduced in the water and give a more accurate measure of the filter's microbiological efficacy.

**Environmental Protection Agency:** The Environmental Protection Agency (EPA or USEPA) is an agency of the federal government of the United States charged with protecting human health and safeguarding the natural environment, namely air, water, and land.

**Log reduction:** "LOG" stands for the logarithm function: 1, 2, 3 and 4 LOG reductions correspond to 90%, 99%, 99.9% and 99.99% reduction respectively, and so on.

**LRV:** Log Reduction Value.

**MS2:** A virus which is easily cultivated in laboratories and used to measure viral reduction efficacy of the filter.

**NSF International:** The Public Health and Safety Company™, a not-for-profit, non-governmental organization based in the United States, is the world leader in standards development, product certification, education, and risk-management for public health and safety.

**NTU:** Nephelometric Turbidity Units. Turbidity refers to how clear the water is. The greater the amount of total suspended solids (TSS) in the water, the murkier it appears and the higher the measured turbidity.

**PFU:** Plaque-Forming Unit (PFU) is a measure of viable numbers of viruses in the water.

**Point-of-use interventions:** For those who have access to sufficient quantities of water but whose water is of poor microbiological quality, an alternative is to treat water at the household or other point of use. Such a household treatment may minimise recontamination in the home, a well-known cause of water quality degradation<sup>21</sup>. Interventions used in the studies include: filtration (ceramic), solar disinfection, chlorination, flocculation/disinfection and improved storage.

**RR:** Rate of reduction.

**RTC:** Randomized Control Trial.

**TOC:** Total organic carbon: material in the water derived from decaying vegetation, bacterial growth, and metabolic activities of living organisms or chemicals.

**TTC:** Thermo Tolerant Coliforms.

**Turbidity:** Turbidity is the cloudiness or haziness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in air.

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# Customer Support

With 10 regional offices across Africa, Asia, Europe and the Americas, Vestergaard Frandsen provides an exceptional local and international customer service. Being close to the market is an unequivocal benefit for our customers and partners, allowing rapid and proactive service and market intelligence.

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