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**Final Report: Assessment of Usage Methods of GS886 Sustainable  
Deployment of the LifeStraw Family in Rural Kenya**

**Prepared for Gold Standard Foundation**

**Berkeley Air Monitoring Group**

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## **Authors**

*George Washington University*  
Jay Graham, PhD

*Berkeley Air Monitoring Group*  
Maneet Kaur  
David Pennise, PhD

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# 1 Introduction

## 1.1 Measuring usage of household water filters

Lack of compliance to correct, consistent, and sustained use of household water filters (HWFs) is a significant challenge. Unlike piped water distribution systems, HWFs require households to regularly treat small batches of water on a consistent and frequent basis. For the purposes of this review of usage assessment methods for Gold Standard Foundation (GSF), we focus solely on household water filters, rather than chlorine or solar-based water treatment methods, given the intrinsic differences that may entail a set of barriers different than that of HWFs. There is evidence that use of HWFs can be high, however, a number of studies of HWFs have reported reduced use of filters over time – highlighting the importance of rigorous monitoring methods.

### Reported Use of Household Water Filters

Self-reporting is a commonly used method for recording information about behavioral practices in program evaluations and research studies on household water treatment. However, there is evidence that when people are asked about household hygiene-related behaviors, they consistently over-report good practices – much higher than what is observed (Manun’Ebo et al., 1997; Curtis et al., 1993; Halder et al., 2010). There is also the tendency for respondents to give answers that they think the interviewer wants to hear (i.e. courtesy bias). Many studies analyze multiple measures of HWF usage, to reduce courtesy bias, which can result in over-reported product usage (Luby et al., 2008).

Recall bias may also be a potential issue faced in evaluations. Research has found that the longer the recall period of survey questions, the greater the imprecision of respondents’ ability to recall information (Schmidt et al. 2011). Therefore, monitoring efforts that use timeframes considering the past 24 hours (or “on the day of or day prior to the day of visit”) are considered to more reliably estimate use and reduce recall bias than timeframes considering longer periods (e.g. 7 days or 2 weeks). There is some evidence that recall can be more complete in groups of higher socio-economic status, leading to bias when comparing different populations (Manesh et al., 2008). It is unclear whether and how intensive surveillance that may include frequent home visits affects the reported use of HWFs.

In the “Memorandum to Gold Standard, 22 April 2013”, two critiques were made that were relevant to recall bias and courtesy bias. One specific comment was that, “Questions assessing use of a given intervention require respondents to refer to an actual, representative drinking water sample presented and referenced throughout the course of the survey questions.” By having the household refer to the actual drinking water present at the time of the visit, households are more likely to recall whether that water was filtered in comparison to a non-specific drinking water sample.

There were several critiques (see: Memorandum to Gold Standard, 22 April 2013) that were inconsistent with how Vestergaard Frandsen (VF) conducted their monitoring of usage. VF did use an open-ended question about what water treatment technology respondents use, rather than asking about use of a specific technology. Second, VF did use objective measures to assess usage, rather than relying solely on respondent self-reports.

### Going Forward

There is concern among experts in the water, sanitation, and hygiene (WASH) sector that the current tools used for measuring HWF use are limited. Given the challenges of measuring HWF use, many WASH experts emphasized the need to establish more rigorous and objective measures of HWF use, rather than relying on self-reported use. Two experts suggested that a set of questions, or an index using a

combination of questions, be used to determine use of the LifeStraw Family (LSF) filter, which would include both observations and self-reported use.

## **2 Methods**

In order to remain objective, actions were taken to collect all information before asking Vestergaard Frandsen (VF) for specific responses. All information was then reassessed with VF's responses in context prior to making final decisions and conclusions.

### **2.1 Processing**

We repeated the processing steps VF used to identify and remove outliers and non-users from the raw data file "Spot\_Check\_Data (date filtered) - 2012.11.28" in the VF-MR2-Survey. We also confirmed the logic of the processing steps in order to ensure a correct usage rate was calculated. VF was informed of any errors, and resulting corrections were verified to ensure the correct usage rates.

### **2.2 Comparison of VF-MR2 Survey to WHO Toolkit**

VF-MR2-Survey questions were compared to the WHO Toolkit for Monitoring and Evaluating Household Water Treatment and Safe Storage Programmes using past VF documents and the current survey. The publication was released in 2012 and provides indicators to assess correct and consistent use of household water treatment and safe storage.

### **2.3 Characterization of usage indicators from literature**

In order to compare VF's usage questions and methods to the WHO toolkit and current methods in scientific literature, we performed a review of the literature on water filtration studies. Methods of assessing water filter usage in the literature and the WHO toolkit were summarized into a table along with the VF MR2 survey questions.

### **2.4 Interviews with experts**

Additionally, we conducted seven semi-structured, in-depth interviews with household water treatment and safe storage experts. Interviews explored ideal filter usage questions and those questions currently used by Vestergaard Frandsen. Four of the seven individuals interviewed also completed a survey to characterize the strength of the usage-related questions used by VF. The sampling method was purposive sampling. Prospective respondents were selected based on experience with water filter programs, particularly the LifeStraw Family filter. Potential interviewees were identified through various publications on household water treatment and safe storage. Each interview lasted between 20-35 minutes and was conducted over the phone.

### **2.5 Interviews with VF Enumerators /Auditor**

We conducted three interviews with VF enumerators and one interview with an auditor from ERM CVS. Five enumerators were randomly selected, and three were reached for interviews. Interviews explored on-the-ground issues with usage-related questions currently used by Vestergaard Frandsen.

### **2.6 Summary of best practice usage indicators**

Based on feedback from interviews, VF documents, and the WHO Toolkit, a summary of usage question types was produced to prepare for a comparison with VF-MR2's questions.

## 2.7 Analysis of VF-MR2-Survey questions

The VF-MR2-Survey questions were then analyzed against the summary and WHO Toolkit. New usage rates were calculated by question and by categories. Feedback was also requested from the VF team in order to understand the field context of the questions and assess whether the usage calculations were justified. Interviews with surveyors were also used to assess the field context and compare to VF's responses.

## 2.8 Recommendations

Final recommendations were made based upon analysis of the VF-MR2 questions and responses from VF and surveyors.

# 3 Results

## 3.1 Processing

Although the same final numbers were obtained, we found key issues in the VF method and thus performed some additional processing methods to correct those issues.

The first issue we identified was the method for removing outliers for processing step 2. Processing step 2 removed households that filtered more than 70 liters of water per day as outliers (e.g. those that reported unrealistic filtering quantities). In order to calculate the quantity of water filtered per day, a frequency factor for how often the participant reported filtering was multiplied by the quantity of filtered water used per day. If a participant reported "do\_not\_filter\_water", there is no frequency factor, and thus when the quantity filtered per day was calculated, instead of "0", "#N/A" appears. The VF processing removed these "#N/A" values that represented people who "do not filter water" as outliers. These households did not meet the criteria of filtering more than 70 liters per day, and should not have been removed. This is further illustrated by step 4, which removed households that "do not filter water". In the "VF-MR2-Survey-Processed" spreadsheet, the number of households does not change after step 4 as these households were previously removed as outliers.

The second processing issue we identified was with how the quantity filtered per day was calculated. As previously mentioned, a frequency factor was multiplied by the quantity of filtered water used per day in order to identify outliers. VF obtained this quantity from the question that asks "How many LITERS of filtered water does your family use for drinking, washing fruits and vegetables, and hand washing each day?" There was, however, another question that asked about quantity: "How many LITRES of LifeStraw filtered water do you use for cooking, making coffee or tea, or the other purposes that were mentioned?" When calculating the quantity filtered per day, the amounts from both of these questions should be included. A corrected processing method was performed taking both issues into account and a new usage rate was calculated. VF was informed of the issues and after VF corrected their processing, we verified the calculations. Results are summarized in the table below<sup>1</sup>.

**Table 1: Processing Results**

Method	Total (minus outliers)	Total Non-Users	Total Users	Usage Rate
<b>VF Processing</b>	20211	1463	18748	92.76%
<b>Corrected Processing</b>	20220	1940	18280	90.41%
<b>Corrected VF Processing</b>	20220	1940	18280	90.41%

<sup>1</sup> Berkeley Air processing work can be found in "BerkeleyAir\_Data\_user\_nonuser\_correctedprocessing\_v9.xlsx"

### 3.2 Comparison of VF-MR2 Survey to WHO Toolkit

Table 2 below shows the final questions used in VF’s calculation of usage compared to the questions VF originally reported as relevant to the WHO Toolkit<sup>2</sup> and additional questions that we deemed relevant to the WHO Toolkit. Three of those VF reported questions were not used in the calculation of usage (colored in blue in the table). Of the additional questions from VF-MR2 that apply to the WHO Toolkit, one was not used (darker purple). The other two questions (lighter purple) were not used as independent indicators of use, such that a response in the affirmative to either question qualified the household as a user.

In addition to the indicators for “reported and observed use,” the WHO Toolkit indicators for “correct, consistent use and storage” are also applicable to the LifeStraw Family filter because they relate to knowledge required to use the filter, and it is likely that inability to demonstrate use would indicate non-use.

3.2.1 **Table 2: VF-MR2 and WHO Toolkit**

Indicator	WHO Toolkit	VF Questions	
1	<b>The participant self-reported treating drinking-water</b>	What do you use to make your water safe now?	The WHO toolkit recommends using these indicators for <b>“reported and observed use”</b>
2	<b>The surveyor observed the drinking-water treatment upon request</b>	Is the LifeStraw hanging correctly, with ropes so the pre-filter can come out? Does anything on the LifeStraw need to be replaced?	
3	<b>The participant self-reported safely storing water</b>	Is there a designated safe storage container?	
4	<b>The surveyor observed safely stored drinking-water</b>	OBSERVE: How big is the safe storage container in LITERS?	
5	<b>The participant displayed knowledge of correct use</b>	Which tap is used for safe water?	The WHO toolkit recommends these indicators for <b>“correct, consistent use and storage”</b>
6	<b>The participant demonstrated correct use</b>	Can the person demonstrate how to filter water using the LifeStraw correctly?	
7	<b>The participant demonstrated safe water extraction</b>	Can the person you are interviewing demonstrate how to backwash the LifeStraw correctly?	
8	<b>The frequency of non-use by most vulnerable</b>	N/A for determining usage	
9	<b>The participant consistently treats drinking-water with treatment method</b>		
10	<b>The participant uses improved drinking-water source</b>		

### 3.3 Characterization of usage indicators from the literature

Reviews of the literature on water filtration studies illustrated a spectrum of methods for assessing usage. A meta-analysis of water quality interventions found that most studies had not assessed compliance directly (Clasen et al., 2007). While many studies often assumed usage or accepted reported usage, current studies use more accurate methods with a combination of reported and observed usage (Mäusezahl et al., 2009; Brown et al., 2007; Peletz et al., 2012; Boisson et al., 2010). Usage indicators also vary by water treatment method. While treatment by chlorine can be confirmed by simple tests for chlorine residual, filtration is much more difficult to confirm. Testing for thermo tolerant coliforms can indicate consistency and safety of use, but cannot rule out a respondent as a non-user. Water sensors that

<sup>2</sup> These questions were obtained from a table described in “VF Responses to GS TAC.pdf” (Appendix 5.1).

measure flow, similar to a water meter, however, could provide detailed information about usage and quantity used, but introduction of this method is relatively new (Thomas et al., 2013). Although usage of filters will likely move toward monitoring by sensors, the current methods for confirmed usage are limited for many filters. Therefore, assessing for usage requires asking the respondent questions and/or making observations in the household. See Appendix 5.2 for a table of usage assessment questions/methods used in various water filtration studies. These results were used to create a summary table of usage indicators (Table 4).

### 3.4 Interviews and questionnaire

#### 3.4.1 Table 3: Description of experts interviewed for this review.

Name	Title	Organization	Relevant Experience
<b>Dr. Daniele Lantagne</b>	Assistant Professor	Tufts University	Lead technical advisor on WHO's "Tool kit for monitoring and evaluating household water treatment and safe storage programmes"
<b>Dr. Margaret Montgomery</b>	WASH Technical Officer	World Health Organization	Coordinates the International Network on Household Water Treatment and Safe Storage for UNICEF and WHO
<b>Dr. Robert Quick</b>	Epidemiologist	Centers for Disease Control and Prevention (CDC)	Dr. Quick has lead a large number of studies on household water treatment and safe storage, including the LifeStraw Family Filter
<b>Ms. Neringa Pumputyte</b>	Client Account Manager	ERM Certification and Verification Services	Auditor/DOE who worked in the field in Kenya to evaluate use of the Life Straw Family filter
<b>Dr. Rochelle Rainey</b>	Water Quality Advisor	U.S. Agency for International Development	Dr. Rainey has worked on household water treatment and safe storage programs for USAID for over 10 years and is familiar with large intervention programs globally
<b>Thomas Blackburn</b>	Carbon Project Officer	Nexus-Carbon for Development - Cambodia	Mr. Blackburn has experience documenting usage of ceramic filters for carbon credits
<b>Samuel Bryan</b>	Carbon Project Officer	Nexus-Carbon for Development – UK	Mr. Bryan has experience documenting usage of ceramic filters for carbon credits

#### 3.4.2 Summary of expert comments on VF usage questions

The experts generally leaned towards using a combination of self-reported and observational measures to determine use. Four experts suggested that there should be a subset of households selected for a more in-depth analysis. The goal of this "subset analysis" would be to better understand which specific questions/observations – individually and in combination – are associated with filter use. Two suggested that filter use could be measured by using microbiological methods (e.g., *E. coli* or total coliforms) to confirm that the water was made safe. One suggested using observational methods, and one suggested using more frequent visits to fewer houses, which would limit recall bias.

The auditor/DOE who had observed the LifeStraw Family filter used in the field said that most households who used the filter would filter either daily or every other day, and that a very small number of users would filter less than this. Additionally, the individual noted that it would be useful to do a subset analysis to better estimate the quantity of water filtered, such as going 3 days consecutively to determine how many jerry cans, for example, were filtered.

Among the experts who had worked specifically with the LSF filter, there was consensus that a household should not be considered a user if the filter was not working at the time of the visit. Further, most experts felt strongly that a household should not be a user if they could not demonstrate how to backwash the LifeStraw Family filter correctly.

Additionally, one expert provided their recommendation of the set of questions needed to assess usage of the LifeStraw Family filter, where the respondent would be classified as a user if he/she responded in the affirmative to all the questions/observations listed (Appendix 5.5). The one observation recommended by

this expert was that the filter must be moist in order for the household to count as a user. In interviews with Nexus, it was noted that it is much clearer regarding who a user is because the water storage receptacle is part of the filtering device – this is in contrast to LSF filter that is not connected to a storage receptacle. Nexus reported that for ceramic filters, usage was observed by noting water in the storage receptacle or observing that the ceramic filter, which holds water, is moist.

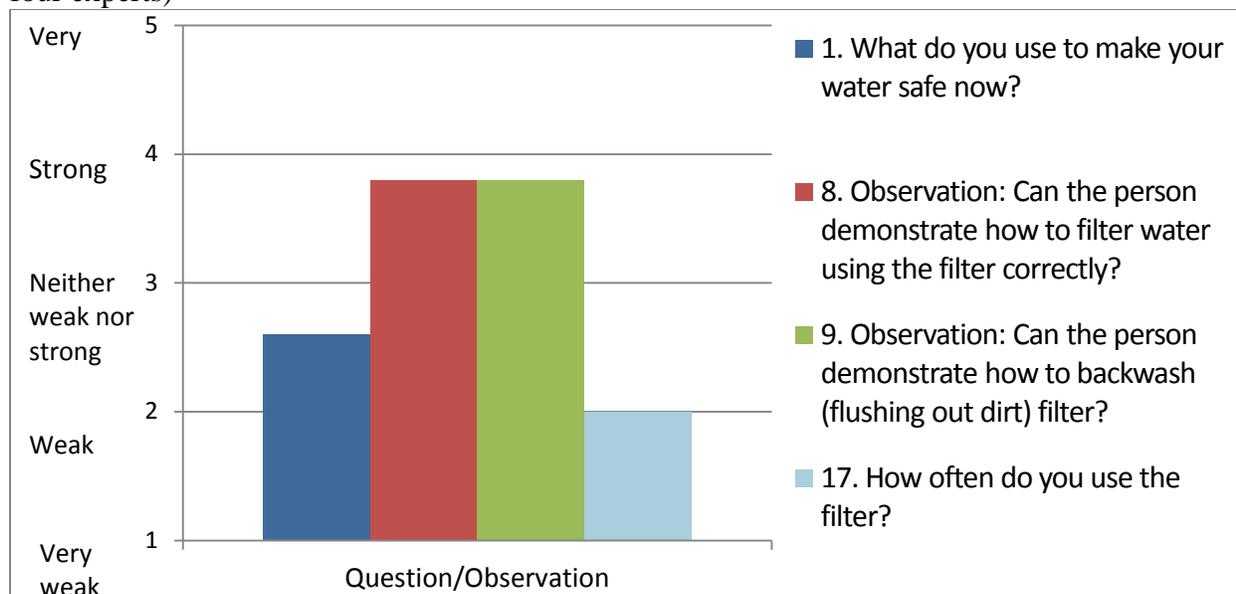
See Appendix 5.4 for a table summary of the expert comments. See Appendix 5.8 for the full questionnaire.

### 3.4.3 Summary of expert questionnaire results

Results were separated by category of questions. Figure 1 shows questions that VF used in the calculation of their final usage rate. Experts found VF’s main question (1.What do you use to make your water safe now?) to be weak, as reported use is often unreliable and biased. Furthermore, experts generally believed observations were stronger for assessing usage. A combination of questions was considered more reliable than a select few.

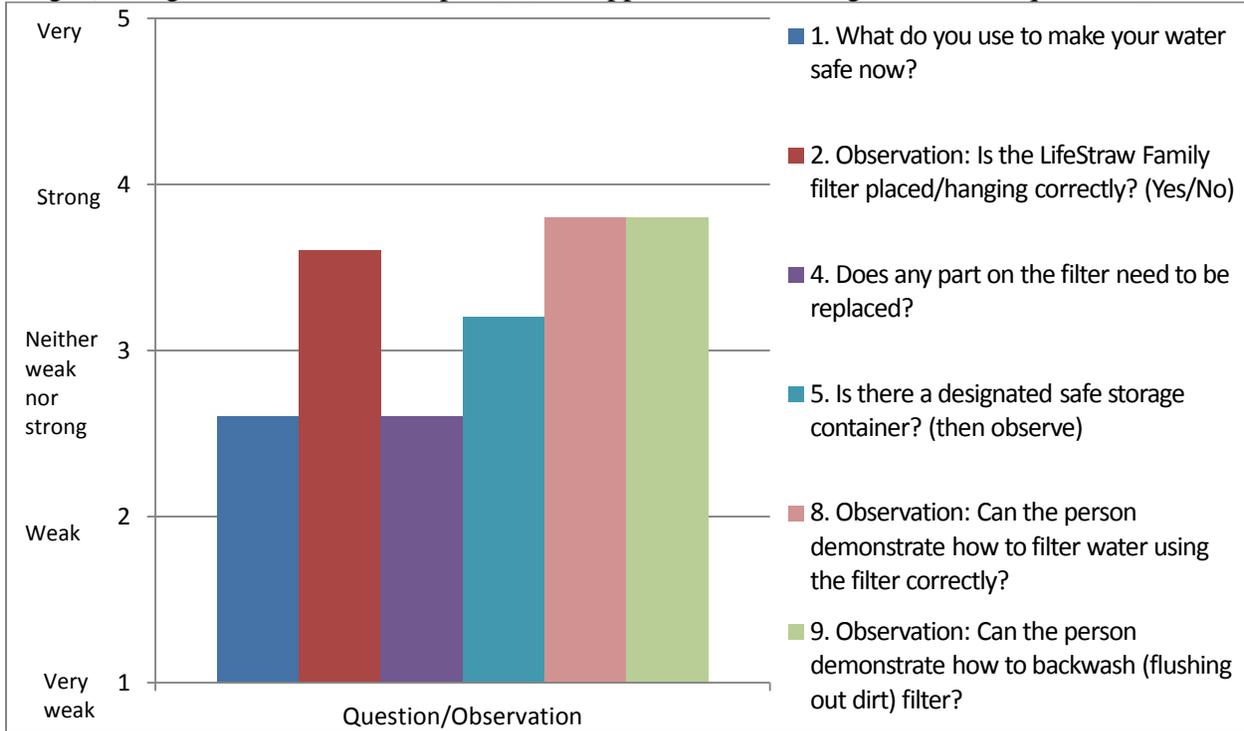
Figure 2 shows VF’s questions that were originally reported by VF as relevant to the WHO Toolkit<sup>3</sup>. Figure 3 shows all of VF’s questions that we deemed relevant to the WHO Toolkit. The last figure in Appendix 5.2 shows the responses to all potential indicator questions from the VF-MR2 survey. The questions were graded on a scale of very weak (1) to very strong (5) and averaged by scale value.

**Figure 1:** Survey results regarding the strength of VF’s questions for usage (average score from four experts)

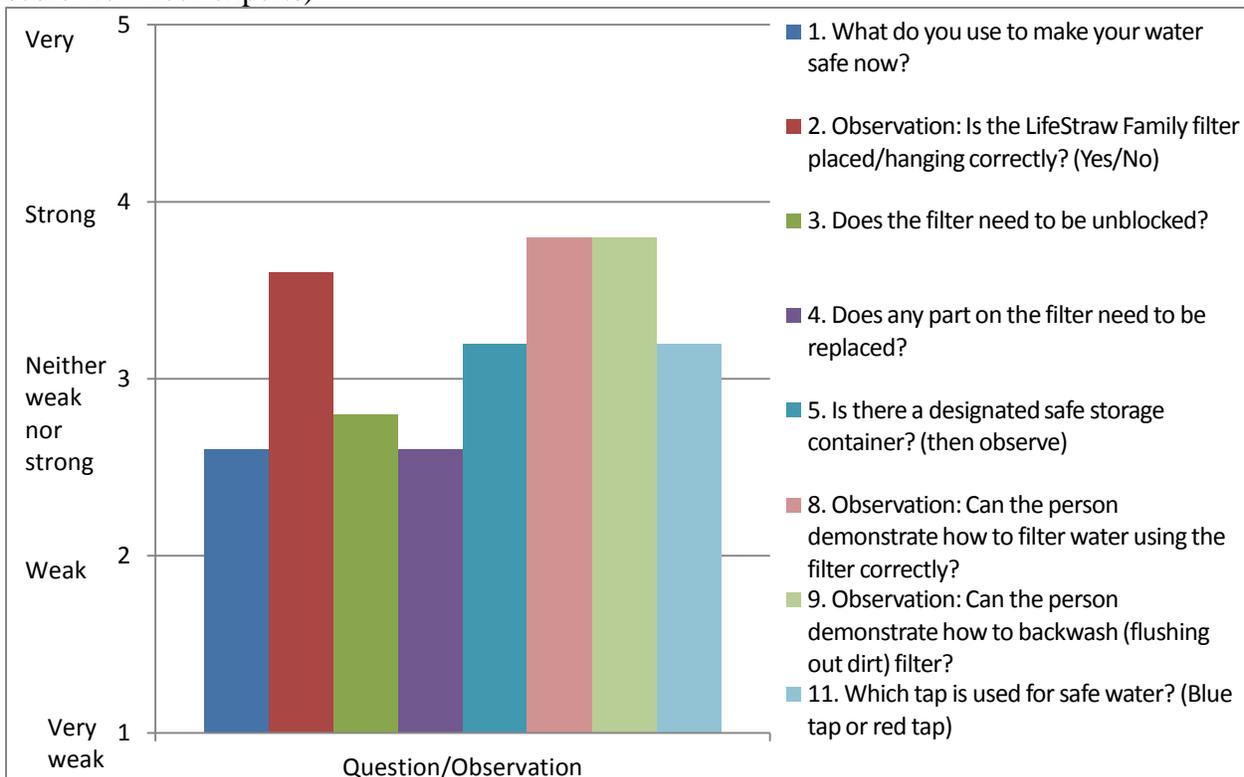


<sup>3</sup> These questions were obtained from a table described in “VF Responses to GS TAC.pdf” (Appendix 5.1)

**Figure 2:** Survey results regarding the strength of VF's Reported WHO Toolkit questions for usage (average score from four experts) (See Appendix 5.1 for original table of questions)



**Figure 3:** Survey results regarding the strength of all WHO Toolkit questions for usage (average score from four experts)



### 3.5 Summary of best practice usage indicators

Based upon in-depth interviews and surveys of water filtration experts, a review of literature on water filtration studies, and the WHO toolkit, the most accurate usage rate should include both reported usage and observed usage indicators where possible. The following table provides a summary of the sorts of questions that can be implemented to assess usage. This table will be used in Table 5 to analyze the VF-MR2 questions.

3.5.1 **Table 4:** Summary of usage-related question types for best practice

Topic	Question	Type	Reasoning	LSF Usage	WHO Toolkit
<b>Introductory question</b>	Whether the respondent does anything to their water to make it safe (w/o reading out options)	Reported	This should be asked before water treatment questions in order to avoid leading bias.	This will rule out non-users that do not do anything to their water, <b>but leading in the field.</b>	
<b>Water treatment</b>	What the respondent uses to make their water safe (w/o reading out options)	Reported	This question will address the specific filter in question.	This will rule out non-users that do not use the LSF.	Indicator 1
<b>Rate of usage</b>	How often the respondent uses the water treatment	Reported	This question checks the previous question by quantifying it	The will rule out users that report low rates	
<b>Water storage</b>	Ask and observe whether and how the respondent stores safe water	Reported and observed	This question will inform whether safe water can be or is being stored.	This will rule out unlikely users for the LSF that do not store safe water.	Indicators 3 & 4
<b>Reference object</b>	Ask the individual responsible for filtering for a cup of water that would be provided to their child	Observed	The purpose of this question is to observe the treatment and have a reference to reduce recall bias.	This would rule out respondents that do not use the LSF as non-users, <b>but not appropriate in field.</b>	Indicator 7
<b>Demonstration &amp; knowledge</b>	Ask the individual responsible for filtering to demonstrate use either directly or by asking for water	Observed	Capability to use is necessary for being a user.	Inability to use the LSF would rule the respondent out as a non-user.	Indicators 2, 5, & 6
<b>Usage with reference</b>	Whether and/or what the respondent did to the cup of water to make it safe (w/o reading out options)	Reported with reference	This question acts as a check for the first question.	This will rule out non-users that report not using the LSF, but not appropriate in field.	Indicator 1
<b>Functionality</b>	Observe whether the filter is currently functional	Observed	This question asks about the ability to use the filter.	This would rule out unlikely users with a non-functional LSF.	Indicator 2
<b>Other physical signs of usage</b>	Observe to see if the filter shows signs of usage, e.g. wet	Observed	This question asks as an observational check.	This could distinguish usage, but is <b>not very applicable to LSF.</b>	
<b>Confirmation Test</b>	A test that confirms usage of the water treatment	Observed	Water sensors would confirm usage against reported usage.	Could be used for the LSF	

### 3.6 Analysis of VF-MR2 Questions

The bulleted list below describes our analysis of VF-MR2's potential usage-related questions. The table following this list (**Table 5**) summarizes the results from the analysis. Upon examining the questions and Vestergaard's responses (See Appendix 5.7), we decided to interview surveyors in order to gain more insight on the questions' field context (see Appendix 5.9 for the questions we asked the VF surveyors).

- Q1/10 is the main question asked to indicate usage based on a respondent reporting the LifeStraw Family filter (LSF). Not using an introductory question to ask about whether the household treats is justified by VF's response that it may be more leading than Q1/10.
- Asking about usage with the reference of a cup of water is a suggestion by experts, but it could put surveyors at risk and be culturally inappropriate to ask. VF responded that their field team was reluctant to use this question, so we found this justification reasonable.
- Q5/13 asks about the LSF hanging correctly, a question endorsed by many experts and used in a previous study (Boisson et al., 2010). We categorized this question as a potential indicator of use because it would act as an observational check on functionality (see Table 4 on functionality). However, VF's response provided a field context that clarified why the question was not a good indicator.

- *VF Response: "The specific part about ropes hanging properly so the filter can come out is because if ropes are strung the wrong way, then it is harder to clean the pre-filter. However, if this is the case, that does not prevent people from actually filtering water. We also do not use this question for calculation of usage because over time we have observed that some households put their filter away to protect it from theft or animal damage when they are not using it, so arriving at the household to see the filter visually hanging properly with the ropes properly strung was not necessarily an accurate assessment of whether it is being used. However, we continue to ask the question to inform about level of education that has been provided."*

VF's response that households commonly put filters away in order to protect them is reasonable, and the positioning of the ropes does not affect functionality of the filters. There should, however, be evidence of this occurring, such as an additional question asking why filters were not hanging correctly. The VF surveyors commented that the filter not hanging correctly did not indicate non-use. One surveyor commented that the household "would keep it somewhere else." The two other surveyors stated the filter was not hanging correctly typically due to the low height of the ceiling in the household. The surveyors also mentioned the filter touching the ground, and we would like to point out that the clean tap touching the ground could be a potential source of contamination, and training could address this issue.

- Q6/18 and Q7/21 ask about the presence of a designated safe storage container and Q7/21 acts as an observational check by asking for the size of the designated safe storage container. A safe storage does not distinguish use in the strict terms of usage in the calculation, as a household can filter using an unsafe container. It does, however, indicate unsafe use. The households that reported not having a safe storage container can still be filtering but may be doing it unsafely. As a health indicator, this question should be reported in order to assess the health benefits of the project but should be differentiated from the calculation of usage for credits.
- Similarly, Q\_/14 and Q\_15 asked about unblocking the pre-filter and cartridge. It was assumed that "blockage" meant the filter was non-functional. VF stated that the questions were not assessing "blockage" in those terms but rather as a slowed flow rate, so a filter needing to be "unblocked" was not necessarily non-functional. VF also claimed these questions were employed in the October survey to assess maintenance of the filters and were not meant for assessing usage.
  - *VF Response to unblocking the pre-filter: "Unblocking done at the household level is to support a higher flow rate of the filter. It was not indicative of whether or not it was being used – rather if the*

*CHW felt that it was flowing slower than it should be. You can still filter water with a blocked prefilter – it just moves slower or people pour water directly into the bucket or through a cloth instead.*

- *VF Response to unblocking the cartridge: “You can still use the filter – this just means it needed extra backwashing to improve flow rate. We tested these two questions in the October survey to see what level of maintenance was now required after 1.5 years in the field... We won’t be using these questions on future surveys and will just be asking about if anything is broken so as not to confuse the two.”*

The VF surveyors, however, distinguished that the filter could be partially or fully blocked such that in some households water could not pass through the filter whereas in others households, the flow rate was diminished.

*“[pre-filter] was completely blocked in some households; others it was slow”*

*“It depends on how blocked [pre-filter] is...fully or partially”*

*“It’s hard to filter water in those households with a blocked [pre-filter]”*

*“[cartridge] still able to work by maybe ¼ or ½ of flow rate”*

*“if cartridge is blocked you can’t get water”*

The surveyors’ responses provided insight that the filter may not be functional if blocked. Of the households in the survey that needed unblocking, some may have had non-functional filters while others may have had filters that functioned with slower flow rates. As this question was only asked in the October phase of the survey and the overlapping question on demonstration of backwash provides a more conservative estimate, this question should not be used in the calculation; however, a new question should be employed in future surveys to clarify whether filters are completely blocked (i.e. no flow) and are thus non-functional or have a diminished flow rate.

- Q\_/16 asks about filters needing replacement parts. We felt this could be an indicator of usage as it referred to the functionality of the filter – that is, we assumed that a filter requiring replacement parts was non-functional. VF responded that the question was not asking about filter functionality and that if the filter was not functional, the enumerator went back and changed the household to not filtering.

- *VF Response: “This was a question asked for the purpose of our staff members to follow-up and make repairs and replacements of the filter. Some items that would need to be replaced such as damage to the prefilter, kinking of the hose, rusting of the clamps, do not mean that the household cannot use the filter, it is just an indicator for pro-active maintenance. The enumerators were instructed during the MR2 training that if the filter was actually broken and unable to be used that they should go back and answer that the family was not filtering even if they said they normally do. We actually had push-back from our surveyors saying that some of the families that had damaged filters they could tell had been strong users, but we instructed them that they had to note that at that point in time, they were not current users, because we take different surveys at different points in time for this very purpose.”*

The VF surveyors’ comments, however, conflicted with VF’s response:

*“No, it can’t work properly if part is broken or missing”*

*“It needs everything for it to work effectively”*

*“It needed all the parts to function”*

When asked if the surveyor changed the household with a broken part to a non-user, the surveyors’ responses were:

*“Depends on part that is broken”*

*“Maybe on the comments you could indicate that the HH is not using it because it has a broken part”*

*“...they would be counted as a user after you changed the part”*

Based on the surveyors’ feedback, the surveyors were not following the process of changing the household to a non-user as VF had described. Additionally, the surveyors’ responses regarding the functionality of the filter conflicted with VF’s response. It appears that some of the households that needed replacement parts had non-functional filters and thus in order to be conservative, this question should be used to calculate usage in this survey. Furthermore, we feel that there remains

no clear question asking about filter functionality, and thus we recommend that a question, or observation, should be added to future surveys to address complete non-functionality (i.e. no water flow versus reduced flow).

- Q18/\_ asked about knowledge of the filter in terms of distinguishing the blue tap versus the red tap for safe water. This question asks about basic knowledge of the filter and also safe use of the filter as the red tap releases dirty water. Q17/26 asked how often the household backwashed or cleaned the filter and some reported never, which makes it unlikely for the household to be a user as backwashing and cleaning the pre-filter is taught to be done daily and filters can become clogged over time. VF stated that these questions were not robust as less than 0.2% and 1% respectively would have been considered additional non-users. Although this question only adds additional 25 and 79 non-users respectively, any amount of non-users is significant, so it should still be used in the calculation of usage. For future surveys Q18/\_ may be redundant to use as the criteria for Q16/25 on the ability to demonstrate use includes demonstrating that the blue tap is for safe water and that the red tap is for dirty water.
- Q13/24 asks households to demonstrate use of the filter, and failure to demonstrate is essential for using the filter. VF agreed that failure likely indicated a non-user. As this is such a vital question, it should be used independently of Q16/25.
- Q16/25 asked about ability to demonstrate backwashing. This question was thought to be required to maintain usage of the filter as educators taught households to backwash daily, but we received mixed responses from individuals regarding the question. Based upon VF's response the question was designed to assess the education campaign by understanding how well households understood the exact education, which differs from the ability to backwash. The enumerators were trained to assess strictly for what the households were educated on: squeezing the red bulb 3 times before opening the red tap for 3 seconds. The ability to backwash is less strict and can differentiate in number of pumps, time tap opened, sequence, etc.
  - *VF Response: "In observation of the CHW's conducting the survey, we found that the surveyor could answer "no" to this question if the household did a backwashing step out of sequence or did not do 1 of the steps exactly as trained. For example, the appropriate training includes squeezing the red bulb 3 times before opening the red tap for 3 seconds to drain the contaminated water. A CHW would answer that the household was not able to demonstrate how to backwash if the person squeezed the bulb 4 times or 2 times before opening the red tap. Or could answer "no" to the question if the person opened the red tap for 30 seconds instead of 3 seconds. However, a person that squeezes the bulb 2 or 4 times or opens the red tap for 30 instead of 3 seconds is still cleaning the filter and still may be a consistent user. We considered the consequences of training the surveyor to be more flexible in answer the question – accepting a range of demonstration that would be recorded as a "yes" answer – but this approach caused confusion in the question and resulted in reduction in quality of the answer at all. Therefore, we choose to use this question as an indicator that the household needed a refresher on the recommended backwashing procedure rather than an indication of usage. We then combined it so that if the household was also not able to demonstrate basic filtering, that they were not considered a user (processing step #7)."*

Interviews with surveyors revealed that some strictly abided the educational material and others were more lenient in understanding the ability to backwash. One surveyor responded the household must "close the blue tap and the red tap; squeeze the red bulb 3 times; open red tap for 3 seconds" while another responded "water has to be in the red bulb...if flow from tap is good then that means it was done correctly." When asked if a household that could not demonstrate usage was a non-user, two surveyors responded "no, they can still be using the filter" while the other responded "at a certain point it will probably block up completely." One of the WASH experts responded with uncertainty as to whether someone without the ability to demonstrate use was a non-user, but the expert also said "if someone doesn't know how to backwash after presumably using something for a year, it makes me wonder if they really use it." Other experts found the demonstration aspect

strong. The auditor/DOE responded that households that couldn't demonstrate backwash should be considered non-users. In the education campaign backwashing is taught to be done daily, and thus someone that has had the filter for approximately one year and repeatedly been educated on the importance but fails the demonstration may be a non-user. Furthermore, lack of backwashing can eventually lead to blockage, but it is unknown at what point of time a filter will completely stop if it is not backwashed and whether this time period is within the scope of the survey. Complete blockage of the filter is likely a result of several factors, including: 1) the amount of time the filter has not been backwashed; 2) the turbidity of the water used in the filter; and 3) the volume of water filtered. Understanding this requires a more technical analysis of the filter. Considering the contention over the question, there is the risk of being overly conservative and penalizing VF versus not being rigorous enough. In order to take the most conservative approach, we recommend this question be used in the calculation of usage and in future surveys be targeted towards primary users to avoid being overly conservative. We also suggest a more thorough analysis of the factors that lead to blockage of the filter to understand whether it is reasonable that a household not know how to backwash, but yet have a functional filter within the time span of the study.

- Q24/32 similarly asks how often the household uses the LSF, and households using the filter less than once per two weeks is reasonable for the LSF usage patterns. Furthermore the quantities reported would be taken into account in the emissions calculations. Although many studies and experts ask about usage in the past 24-48 hours for current use and reduced recall bias, this is not necessarily applicable for the LSF, as VF stated that households may not filter for several days (Peletz et al., 2013; Boisson et al., 2010).
- Q12/\_ asks whether there is LSF filtered water in the safe storage container. Although this question does not clarify a user necessarily, it is a good indicator for non-users as storing LSF filtered water aligns with the range of usage patterns of the LSF. This question has been used to assess usage for the LSF (Peletz et al., 2012; Peletz et al., 2013). The question does not, however, ask about LSF filtered water in a non-safe storage container (households that reported not having a safe storage container), and thus in the next survey, should be worded to address the presence of LSF filtered water in whichever container the household uses.
- Other signs of physical usage are not applicable to the LSF, as moisture dries quicker than common usage patterns for the filter. The filter may be wiped or dried in a few hours when the household filters twice per week, so enumerators would not be able to use those signs.
- Confirmatory tests are possible for the LSF. Thermotolerant coliform counts could indicate safe use, but not necessarily usage in general. New water flow monitoring sensors, however, could reveal very detailed information about usage. Although visible sensors may change a household's usage patterns, the information would still act as a very significant check to the largely reported usage.

3.6.1 **Table 5:** Analysis of VF-MR2 survey usage questions by category and VF responses

VF-MR2 Question (Q# = April-May/Oct) [Not real VF questions]	Used by VF in final usage?	VF Reported WHO Toolkit Questions	Additional WHO Toolkit Questions	Additional summary of best practice usage indicators	Question topic relating to usage (see Table 4)	Purpose	VF Responses	Justified by VF Response?	Expert Score of Strength (1-5)
[Do you treat your water?]	No	-	-	-	Introductory question	Asking before water treatment questions to avoid leading bias.	Leading in the field; Q1/10 is more open	Yes	-
Q1/10 What do you use to make your water safe now?	Yes	Indicator 1	Indicator 1	X	Water treatment	To remove those that do not say LSF	No VF response required; essential question	n/a	2.6
[Can you provide me a cup of water that you would prepare for your child? OBSERVE]	No	-	Indicator 7 Indicator 1	X	Reference object; Usage with reference	To observe the treatment and have a reference to reduce recall bias.	Surveyors felt it was too uncomfortable to ask for water and feel obligated to drink it	Yes	-
Q5/13 Is the LifeStraw hanging correctly, with ropes so the pre-filter can come out?	No	Indicator 2	Indicator 2	X	Functionality	If the filter is not in a correct position, it is unlikely to be used	Households often put the filter away for safety; filter can still be used if not hanging correctly	Yes, but provide evidence	3.6
Q6/18 Is there a designated safe storage container?	No	Indicator 3	Indicator 3	X	Water storage	It is unlikely to be using the LSF and not have a container to store it	All households have some type of container	Yes, indicates safe usage	3.2
Q7/21 OBSERVE: How big is the safe storage container in LITERS?	No	Indicator 3	Indicator 4	X	Water storage	As a physical check for the previous question	Same as above	n/a	-
Q_/16 Does anything on the LifeStraw need to be replaced?	No	Indicator 2	Indicator 2	X	Functionality	If the filter is not functioning, it cannot be used	Not indicator of broken filter (if broken household was changed to not filtering)	No, conflicts with surveyor response	2.6
Q_/14 Did you have to unblock the pre-filter?	No	-	Indicator 4	X	Functionality	It is unlikely to be filtering as the filter was blocked	Flow rate slowed, but filter can still be used	conflicts with surveyor response	2.8
Q_/15 Did you have to unblock the cartridge?	No	-	Indicator 4	X	Functionality	It is unlikely to be filtering as the filter was blocked	Flow rate slowed, but filter can still be used	conflicts with surveyor response	2.8
Q18/_ Which tap is used for safe water?	No	-	Indicator 5	X	Demonstration & knowledge	Those that cannot demonstrate proper knowledge are unlikely to be users	Makes up only 0.2% and thus not robust for usage	Should still be used	3.2
Q13/24 Can the person demonstrate how to filter	If respond no to this	-	Indicator 6	X	Demonstration & knowledge	It is unlikely to be filtering if they are	Used the question in combination with the next	Should still be used	3.8

water using the LifeStraw correctly?	question and next					unable to filter	question	alone	
Q16/25 Can the person you are interviewing demonstrate how to backwash the LifeStraw correctly?	If respond no to this question and previous	-	Indicator 6	X	Demonstration & knowledge	It is unlikely to be filtering if they are unable to perform an essential task, such as backwashing	Can still filter w/o backwashing; enumerators interpreting too strictly	No, conflicting responses	3.8
Q24/32 How often do you use the LifeStraw Family filter?	Yes user if >once per week	-	-	X	Rate of usage	To remove those that report <once per 2 weeks	Usage patterns of LifeStraw tested	Yes	2
Q17/26 How often do you backwash and clean the pre-filter? (Response: never)	No	-	-	X	Rate of usage and functioning	To remove those that never backwash as they are unlikely to be users	Considered negligible and not robust because makes up <1%	Should still used	2.2
Q12/_ Does the safe storage container have LifeStraw filtered water in it? (Response: no)	No	-	-	X	Water storage	To remove those that report they do not have LifeStraw filtered water in their container, as it is unlikely they filtered	Surveyors felt could not get accurate answer	Should be used because indicates non-users	3.2
[Observing for physical signs of usage]	No	-	-	-	Other physical signs of usage	As an observational check for usage	Moisture dries quickly and dirt not good indicator	Yes	-
[Water sensors deployed]	No	-	-	-	Confirmation test	Water sensors would confirm usage against reported usage.	Cannot hide sensors, would change household usage patterns	No	-

### 3.6.2 Usage rates by question and category

**Table 6:** Usage rates by question for Corrected Processing<sup>4</sup>

Corrected Processing Q[April-May]/[October]	Total (minus outliers)	Reported Rate	Total Non-Users	Additional Non-Users	Total Users	Usage Rate
Original	20220	9.6%	1940	0	18280	90.41%
Q12/_ No LSF water in safe storage container	20220	10.2%	3358	1418	16862	83.39%
Q13/24 Cannot demonstrate use	20220	6.9%	2097	157	18123	89.63%
Q16/25 Cannot demonstrate backwash	20220	14.9%	3458	1518	16762	82.90%
Q13&16/24&25 Cannot demonstrate at least one	20220	15.8%	3615	1675	16605	82.12%
Q17/26 Report never backwash/clean	20220	3.2%	2019	79	18201	90.01%
Q18/_ Don't report Blue tap as safe water	20220	0.3%	1965	25	18255	90.28%
Q5/13 Filter not hanging correctly	20220	5.0%	2530	590	17690	87.49%
Q_/14 Had to unblock pre-filter	20220	3.7%	2507	567	17713	87.60%
Q_/15 Had to unblock cartridge	20220	3.5%	2457	517	17763	87.85%
Q_/14&15 Had to unblock pre-filter or cartridge	20220	5.2%	2725	785	17495	86.52%
Q_/16 Need filter part replacement	20220	2.1%	2198	258	18022	89.13%
Q6/18 No safe storage container	20220	5.2%	2616	676	17604	87.06%

**Table 7:** Usage rates of categories

Corrected Processing	Total (minus outliers)	Reported Rate <sup>5</sup>	Total Non-Users	Additional Non-Users	Total Users	Usage Rate
<b>Original</b>	20220	-	1951	0	18269	90.40%
<b>VF Reported WHO Toolkit<sup>6</sup></b>	20220	11.0%	2790	850	17430	86.20%
<b>Additional WHO Toolkit<sup>7</sup></b>	20220	25.8%	5278	3338	14942	73.90%
<b>All combined<sup>8</sup></b>	20220	32.4%	6391	4451	13829	68.39%
<b>Recommended<sup>9</sup></b>	20220	21.9%	5060	3120	15160	74.98%

<sup>4</sup> Berkeley Air processing work can be found in “BerkeleyAir\_Data\_user\_nonuser\_correctedprocessing\_v10\_final.xlsx”

<sup>5</sup> The reported rate describes the percentage of non-users for that question(s) divided by the total before any households were removed as non-users. The reported rate will not equal with the usage rate, as it does not include the households that VF removed as non-users.

<sup>6</sup> VF Reported WHO Toolkit = Q5/13, Q\_/16, Q6/18 (Q7/21)

<sup>7</sup> Additional WHO Toolkit = Q5/13, Q\_/16, Q6/18 (Q7/21), Q\_/14, Q\_/15, Q18/\_, Q13/24, Q16/25

<sup>8</sup> All combined = Q12/\_, Q5/13, Q\_/16, Q6/18 (Q7/21), Q\_/14, Q\_/15, Q18/\_, Q13/24, Q16/25, Q17/26

<sup>9</sup> Recommended = Q12/\_, Q\_/16, Q13/24, Q16/25, Q17/26, Q18/\_

The recommended usage defined non-users as households that met the following criteria:

- reported not having LSF filtered water in their safe storage container
- needed a replacement part
- could not demonstrate use or backwash
- reported never backwashing/cleaning
- did not report blue tap as for safe water

Removing these households led to a usage rate of 74.98%. It is important to note that the VF-MR2 survey is split between April-May and October, so each phase did not contain the same questions as illustrated by the “\_” next to the “Q.” Question Q\_/16 was only asked in the October survey, and Q12/\_ and Q18/\_ were only asked in April-May survey. As Q12/\_ makes up more than 90% of the additional non-users in the April-May survey, the recommended usage rate would be lower had both surveys asked each question. Table 6 describes usage rates by question for the final “Corrected Processing” while Table 7 describes usage rates for the different categories we defined. The separate usage rates by phase (April-May and October) can also be found in Appendix 5.6.

## 4 Conclusions

In summary, usage for this VF LSF project relied largely on self-reported data, generally agreed upon by experts as poor proxy measures of use. Experts agreed that observations were vital for providing a more accurate estimate of usage. Assessing usage for the LSF by observation, however, is limited because of a lack of visual checks to confirm usage simply due to the filter design and field context; however, evidence should still be provided to confirm how filter design and field context can prevent these essential observations. For this reason, some of the WHO Toolkit indicators and expert opinions were not applicable. Thus, any questions and methods that can help inform use or non-use are vital, such as demonstrations of using or backwashing the filter. Although some questions and/or observations may remove both users and non-users, it is recommended that the more conservative approach be taken. Furthermore, usage assessment will likely move towards the use of water sensors in the future. Confirming usage and quantity used (another unreliable, self-reported measure) with newly introduced water sensors is essential to accurately estimating the volume of water filtered. Our final assessment of the quality of the VF usage rate methodology and usage rate is that additional questions must be employed in order to obtain a more accurate estimate of usage. Our recommendations are presented below:

- Evidence should be provided for Q5/13 (filter hanging correctly) to show that it is not applicable because families often store their filters. This could be an additional question that asks why filters were not hanging correctly. We also recommend additional training to educate households about the risk of contamination when filters are touching the ground.
- Q\_/16 regarding filter part replacement should be used in this survey’s calculation of usage.
- A new question asking whether the filter is broken or non-functional should be employed in future surveys to replace the ambiguity of Q\_/14, Q\_/15, and Q\_16.
- Q18/\_ regarding the safe water tap and Q17/26 regarding never backwashing/cleaning the filter may not be fully robust questions, but should be used in the calculation of usage.
- Q13/24 regarding demonstration of filter use should be used independently in the calculation of usage.
- Q16/25 regarding the ability to demonstrate backwashing should be used independently and a more technical analysis of the factors that can lead to blockage within a certain time period should be done.
- Q12/\_ regarding presence of LSF filtered water in the safe storage container should be used in the

calculation of usage and be reworded in future surveys to ask about any water storage container used.

- Q6/18 on the presence of a designated safe storage container should be reported for health assessment but not for the calculation of credits.
- Water sensors should be employed in a subset of the households to confirm usage.

We would like to highlight the importance of both treatment, as well as safe storage, as a part of the effort to improve health and development. Usage in the VF project was interpreted solely as whether the household used the filter to treat water for credible purposes, however, this does not address safe storage. Most studies that have focused on health benefits aim to also understand whether households properly store their treated water to prevent recontamination. The purpose of a water filter is to provide safe water, and so safe use addresses whether this purpose is indeed fulfilled. In a systematic review of studies assessing contamination of household drinking water, between the point of water collection and the point of consumption, Wright and colleagues (2004) found that most water quality analyses showed a significant decline in water quality between the two points. The authors noted that when drinking water had low counts of bacteria at the point of consumption, much of that was explained by households using covered water storage vessels (i.e. safe storage). The study concluded that the probable cause of contamination was “hands and cups being dipped into water vessels,” highlighting the importance that safe water storage plays in achieving health benefits from household water treatment projects {Citation} (Wright et al. 2004).

Moving forward, it should be considered whether the prevalence of usage for carbon credits should encompass usage within the scope of improving health outcomes. If so, a more rigorous approach will be needed in future surveys with an assessment of the microbiological quality of water in addition to questions on designated safe storage.

Using these recommendations applicable to the current VF survey data, the best estimate of the LifeStraw Family filter usage rate in this VF project is 74.98%. It should be noted that as each question was not present in both phases of the surveys, the usage rate would theoretically be lower.

## 5 Appendices

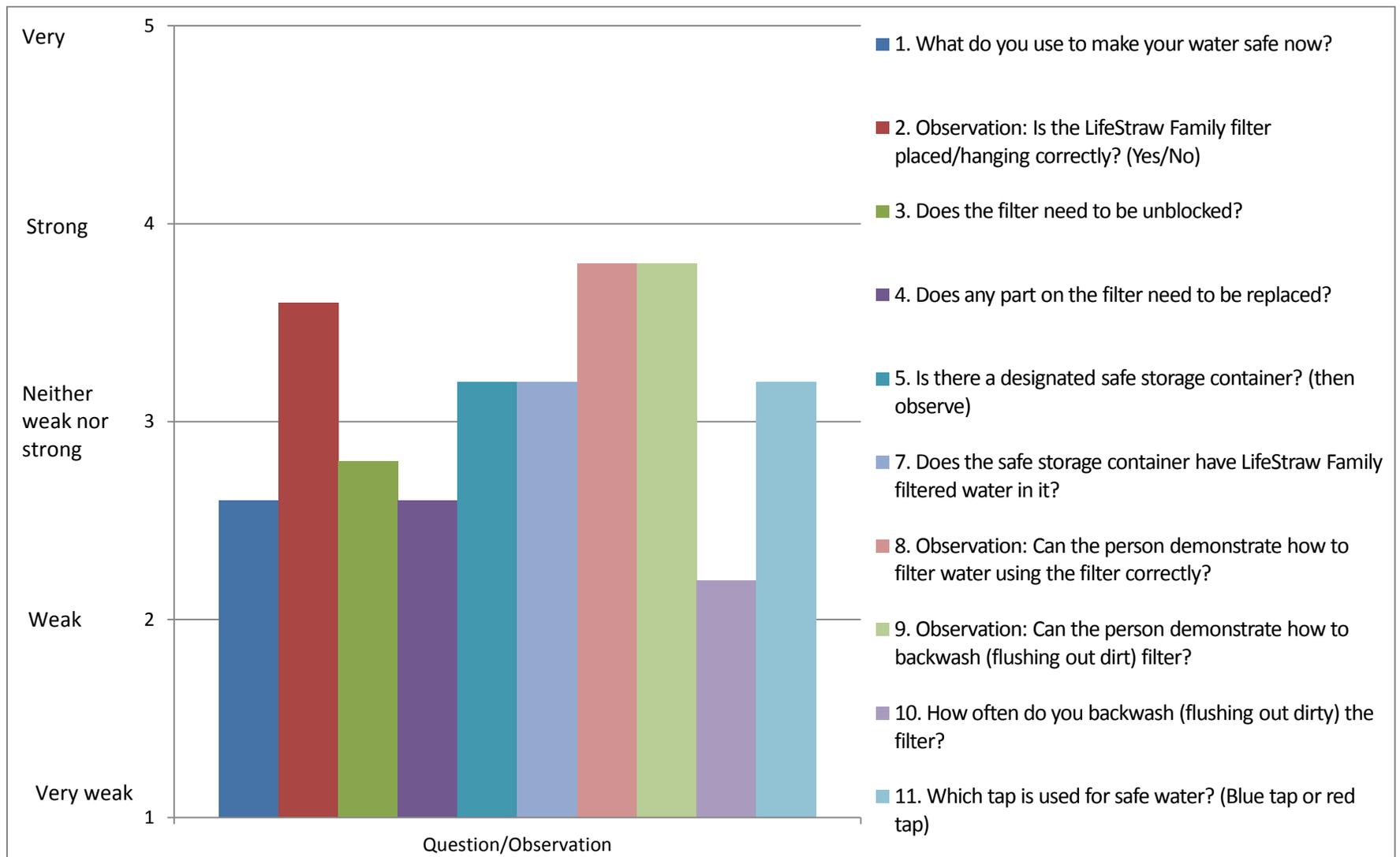
### 5.1 VF WHO Toolkit Questions (Screenshot of “VF Reponses to GS TAV.pdf”)

Below are the WHO suggestions on reported and observed use questions to prevent bias and the comparison to the questions asked in the Vestergaard survey:

Table 1: Reported and observed use indicators

	INDICATOR	QUESTION/REQUEST	ANSWER/OBSERVATION	Vestergaard Ques.
1	Self-report treating drinking-water	What do you usually do to the water to make it safer to drink? (more than one answer may be possible)	Nothing Water is already safe Boil Bleach/chlorine Strain through cloth Filter Solar disinfection Stand and settle Other (specify) Do not know	What do you use to make your water safe now? (DO NOT READ OUT THE OPTIONS) -LifeStraw -Treat with Chlorine/Waterguard -Treating with PUR -Sieving with cloth -Ceramic filter -Boiling -Other (specify) - Nothing
2	Observation of drinking-water treatment method	Ask to see drinking-water treatment method.	Observe boiled water, fuel source Observe chlorine bottle/tablets, test FCR Observe cloth, and if it appears intact Observe filter, and if it appears intact (i.e. not broken) Observe if bottles are in house/on roof Observe settling containers or sediment Other (if other option listed) None	Is the LifeStraw hanging correctly, with ropes so the pre-filter can come out? Does anything on the LifeStraw need to be replaced? Which part needs replacement: (multiple select)?
3	Self-report safely storing water	How do you store your drinking-water? (more than one answer may be possible)	Do not store water In container with no lid or cover In container with lid but no spigot/tap In container with lid and spigot In narrow-mouthed container Other (specify) Do not know	Is there a designated safe storage container? What type of water container do you use?
4	Observation of safely stored drinking-water	Ask to see stored drinking-water. (more than one answer may be possible)	Completely covered with lid Open, uncovered Narrow opening Spigot Beyond reach of animals Clean (free of dirt, debris, garbage, faecal matter, etc.) Dirty Other (specify)	How big is the safe storage container in LITERS? Does the container used to store water have a cover? Can the person explain the purpose of using safe storage?

## 5.2 Questionnaire results of strength of all indicators questions for usage



### 5.3 Table of usage questions/indicators from published water filter studies

Study	Indicator Identifier	Water Treatment Usage Indicators	Review of Indicator
Peletz et al., 2012 (LifeStraw Family filter)	A	The filter was observed in household at the time of visit	The authors used this indicator in combination with Indicator B and C to determine whether household was a “ <b>Reported User</b> ”
	B	The drinking water storage vessel (provided in the intervention) reported to be treated at the time of visit	The authors used this indicator in combination with Indicator A and C to determine whether household was a “ <b>Reported User</b> ”
Peletz et al., 2013 (LifeStraw Family filter)	C	The respondent reported using the filter on the day of or day prior to the day of visit	The authors used this indicator in combination with Indicator A and B to determine whether household was a “ <b>Reported User</b> ”
	D	There was at least a 1 log reduction in thermotolerant coliforms /100mL of drinking water between filtered and unfiltered drinking water	The authors used this indicator in combination with Indicator A, B and C to determine whether household was a “ <b>Confirmed User</b> ”
	E	Stored drinking water quality was < 10 thermotolerant coliforms/100mL	The authors used this indicator in combination with Indicator A, B and C to determine whether household was a “ <b>Confirmed User</b> ”
Rose et al., 2006 (solar radiation bottles)	F	Respondent reported not drinking unfiltered water in the day of or day prior to the interview as reported by the mother	The authors used this indicator to determine “ <b>Exclusive Use</b> ”
	A	The water bottles were observed to be placed in the sun for solar radiation over several visits	The author used the times the bottle was observed in the sun as “ <b>percent compliance</b> ”
	A	Participants reported using the filter ‘today or yesterday’	The author used this indicator in combination with indicator B to determine whether household was a “ <b>current user</b> ”
	B	The field investigator found the filter hung for use with water in the top vessel of the device	The author used this indicator in combination with indicator A to determine whether household was a “ <b>current user</b> ”
	C	Respondent reported not drinking unfiltered water within the previous day	The author used this indicator to estimate “ <b>consistency of use</b> ”
	D	Random sample of filters and placebos was visited and asked if respondent could use and clean filter correctly	The author used this indicator with indicators E and F to determine “ <b>operation/maintenance and acceptability</b> ”
Boisson et al., 2010 (LifeStraw Family filter)	E	Influent and effluent water samples were collected and tested for TTC using membrane filtration technique	The author used this indicator with indicators D and F to determine “ <b>operation/maintenance and acceptability</b> ”
	F	If there was a safe storage vessel, a third sample was collected and tested for TTC using membrane filtration technique	The author used this indicator with indicators D and E to determine “ <b>operation/maintenance and acceptability</b> ”
	A	The participant purchased the Pureit	The author used this indicator to determine whether the participant was a “ <b>adopter</b> ”
Freeman et al., 2012 (Pureit filter)	B	The adopter reported treating current water for drinking with Pureit	The author used this indicator to determine whether the participant was a “ <b>user</b> ”
	C	The participant was using the Pureit to store water at the time of the survey	The author used this indicator with indicator D to determine whether the participant displayed “ <b>compliance (correct, consistent use)</b> ”
	D	The participant reported using Pureit to treat the water they were actually drinking	The author used this indicator with indicator C to determine whether the participant displayed “ <b>compliance (correct, consistent use)</b> ”
	A	The filter was in good working order (filter element, tap, and receptacle intact and apparently functional) as determined by interview and visual inspection at time of follow up	The author used this indicator with indicator B to determine whether the filter was in “ <b>current use</b> ”
Brown et al., 2007 (ceramic filter)	A	The filter was in good working order (filter element, tap, and receptacle intact and apparently functional) as determined by interview and visual inspection at time of follow up	The author used this indicator with indicator B to determine whether the filter was in “ <b>current use</b> ”

<b>Mäusezahl et al., 2009 (SODIS bottles)</b>	B	The filter contained water or was damp from recent use as determined by interview and visual inspection at time of follow up	The author used this indicator with indicator A to determine whether the filter was in <b>“current use”</b> (filters take 3+ days to dry)
	A	The number of SODIS-bottles exposed to sunlight	The author used indicators A, B, and C as an objective measure establish a <b>“mean compliance rate”</b> . Judgment criteria for this main compliance indicator study included observing regular SODIS practice and bottles exposed to sun or ready to drink in the kitchen and being offered SODIS-treated water upon request.
	B	The number of bottles ready-to-drink in the living space	
	C	The personal judgment about families’ user-status provided by community-based field workers living among the families in the intervention arms	The author used this indicator to as a <b>subjective measure</b> to compare to the “mean compliance rate.” The study concluded “that self-reported SODIS use may overestimate compliance and a combination of reported and objectively measurable indicators provides more accurate SODIS-compliance data.”
<b>Brown et al., 2008 (Ceramic water purifier)</b>	D	The participant self-reported and displayed knowledge and attitudes toward the intervention	The author used this indicator to determine whether the household was a <b>“compliant user”</b>
	A	The participant with the filter intervention reported using the filter	
<b>Elsanousi et al., 2009 (LifeStraw Family filter)</b>	A	The participant reported they always used the filter	The author used this indicator to determine whether the household was <b>“user”</b>
	B	The participant reported they occasionally used the filter	The author used this indicator to determine whether the household was an <b>“occasional user”</b>
<b>Clasen and Boisson, 2006 (ceramic filter)</b>	A	The participant reported using the filter	The author used this indicator to state that the household was <b>“using the filter”</b> , but acknowledged not using rigorous means to assess compliance
<b>Walson et al., 2013 (LifeStraw Family filter)</b>	A	The participant reported drinking purified water and then reported using the filter	The author used this indicator to determine the household was a <b>“user”</b>
<b>Thomas et al., 2013</b>	A	Water sensor data	The author compared this indicator to indicator B and found over reporting by 5-10% in the surveys versus the sensors
	B	Self-reported data	

## 5.4 Summary table of expert comments on the Vestergaard usage questions

Question	Comments
<b>1. What do you use to make your water safe now? (DO NOT READ OUT THE OPTIONS): filter with LifeStraw Family; filter with waterguard; filter with PUR; sieving with cloth; ceramic filter; boiling; other; nothing</b>	<p>"In our experience, reported use is an unreliable measure of actual or current use, particularly for someone who has received a free water treatment product."</p> <p>"It is self-reported only, people will report what they think they should do/what the enumerator would want them to do, not what they actually do."</p> <p>"should be followed...by the observations"</p>
<b>2. Observation: Is the LifeStraw Family filter placed/hanging correctly with ropes so the pre-filter can come out? (Yes/No)</b>	<p>"having a filter hanging doesn't indicate actual use...more likely that the person is actually using the filter. The question could be strengthened by observing whether it is wet or dry."</p> <p>"Since this is an important part of the correct functioning of the filter, this is an important, and straightforward question"</p> <p>"May also check to see that: -all parts are present -evidence of recent use...wet filter, storage container nearby with water, etc."</p>
<b>3. Does the filter (pre-filter or cartridge) need to be unblocked?</b>	<p>"If the filter is blocked, it could be that the filter was used but is not used now...[or] it could be that they were using it and would likely unblock it in their next use of the filter. It seems like if it was blocked and the blocked materials was dry then it might not count as being used."</p> <p>"If the filter is blocked, they, by definition, can't be using it...suggests that although it was likely used in the past, they have discontinued use because they allowed it to dry out and become blocked."</p> <p>"triangulate the response to get as close to the 'actual' situation as possible"</p>
<b>4. Does any part on the filter need to be replaced?</b>	<p>"This really depends on if it's out of order temporarily or if there was no intention to get it replaced."</p> <p>"The question suggests past, but not necessarily current, use."</p>
<b>5. Is there a designated safe storage container? (then observe)</b>	<p>"This is important as you need that container to use the filter."</p> <p>"Having a container per se doesn't indicate use. Being in a usable addition would add strength."</p> <p>"The answer to this may or may not reflect use of the filter"</p>
<b>6. Observation: Is the blue tap attached to the safe storage container?</b>	<p>"If the filter is hanging and the tube from the tap is going into a container, then the filter is in a position of use. If the filter is wet and there is water in the container, the question becomes stronger."</p> <p>"may have already filtered for the day and thus no longer have the filter end attached"</p> <p>"may have already filtered for the day and thus no longer have the filter end attached"</p>
<b>7. Does the safe storage container have LifeStraw Family filtered water in it?</b>	<p>"The only weakness is in verifying where the water came from. If the filter is in the container and is wet, then it is a strong variable."</p> <p>"Leading and bias"</p> <p>"training materials for enumerators would need to discuss [using the storage container for unfiltered water] and figure out how to elicit that information"</p>
<b>8. Observation: Can the person demonstrate how to filter water using the filter correctly?</b>	<p>"someone might be able to demonstrate the filtering process and not actually use it"</p> <p>"Ability to use properly is the first step to actual use, but by itself doesn't indicate use."</p> <p>"need to make sure the person is the one who would/could/should be using the filter in the household"</p>
<b>9. Observation: Can the person demonstrate how to backwash (flushing out dirt) filter?</b>	<p>"This might be a slightly stronger question given that it's a bit more complicated than the last demonstration."</p> <p>"strong only if the enumerator watches the person do this"</p> <p>"demonstrations are very powerful sources of information"</p>

<b>10. How often do you backwash (flushing out dirt) and clean the pre-filter?</b>	"could depend on how turbid the water is" "assumes people backwash... leading...self-reported with all the biases." "depends on the quality of the water and use so I assume would vary by household"
<b>11. Which tap is used for safe water? (Blue tap or red tap)</b>	Similar to above
<b>12. What do you use the LifeStraw filtered water for? Options: Drinking, Washing hands, Cleaning fruits and vegetables, Feeding livestock, Washing linens, Cooking, Making coffee or tea, Other</b>	Similar to above
<b>13. How many LITERS of filtered water does your family use for drinking, washing fruits and vegetables and hand washing each day? (based on amount of the jerry can used)</b>	"Estimates are notoriously unreliable" "not sure it is possible for families to divide out their water use like this - it is too detailed a question" "if the jerrycans are 20liters, then you should know within plus or minus 20 liters how much they use" "should be followed up with observation of the containers where this filtered water is stored"
<b>14. How many LITRES of filtered water do you use for feeding livestock, washing linens, cooking making coffee or tea or the other purposes that were mentioned? (based on the amount of the jerry can used)</b>	Similar to above "people would be confused by the two categories of uses"
<b>15. Do you do anything else to the filtered water to make it safe before using it for drinking, hand washing or washing fresh fruits and vegetables? (DO NOT READ ANSWERS OUT LOUD) Options: Boil, chlorine, other, nothing else</b>	"Reported treatment is a very weak variable."
<b>16. How much filtered do you boil in liters?</b>	"Most people don't boil drinking water and reported volumes are notoriously inaccurate." "quantitative questions are always an issue, the enumerator might have to ask "which pot do you use for boiling" and "how many times do you boil" then estimate the liters him or herself" "I would turn this into a question about habit...to get a better of idea of what they are actually doing"
<b>17. How often do you use the filter?</b>	"I would throw this out and instead ask "have you done anything to make your water safe today or yesterday?" If yes, what did you do? If they answer that they used the LSF, then ask how much water was filtered today or yesterday?" "Reported" "Self-reported only"
<b>18. Why don't you use the LifeStraw Family filter?</b>	Could be leading and confusing "difficult especially if the family does not want to 'offend' those that gave them in the filter"
<b>19. In your expert opinion, what household survey question or combination of questions (not limited to the ones mentioned above) are generally most necessary to make an accurate determination of water filter usage or non-usage in a reasonable and cost-effective manner?</b>	"These questions above combined with some observational questions" "Gold standard: microbiologic quality of water" "HWTS M&E Toolkit" "Household Water Treatment network's recent publication on monitoring" "water quality sampling in a sub-set to spot check the validity of the answers...Multi-variate analyses are crucial here as no single answer can confirm or not confirm use. In addition, doing some observations for 3-6 hours during the times which households said they filtered...would help validate the responses."

## 5.5 Recommended usage survey questions from an expert on the WHO household water treatment guidelines

### Survey questions that would provide rigorous, yet conservative, estimates of LifeStraw Family filter use.

<b>Self-Reported Usage Measures</b>			
Q 1	Do you do anything to make your water safe for drinking?	Yes..... No..... Don't know..... Refuse to answer.....	Skip to Q Skip to Q Skip to Q
Q2	What do you do to make your water safe for drinking?	Boil..... Use LSF filter..... Use chlorine..... Other:_____	Skip to Q Skip to Q Skip to Q
Q3	Can you provide me a cup of water that you would prepare for your child?	Yes..... No..... Don't know..... Refuse to answer.....	Skip to Q Skip to Q Skip to Q
Q4	Did you do anything to make this water safe for drinking?	Yes..... No..... Don't know..... Refuse to answer.....	Skip to Q Skip to Q Skip to Q
Q5	What did you do to make this cup of water safe for drinking?	Boil..... Use LSF filter..... Use chlorine..... Other:_____	Skip to Q Skip to Q Skip to Q Skip to Q
Q6	Is your LifeStraw Family Filter working now?	Yes..... No..... Don't know..... Refuse to answer.....	Skip to Q Skip to Q Skip to Q
<b>Observational Usage Measures</b>			
Q7	May I observe your LifeStraw?	Yes..... No..... Not observable	Skip to Q Skip to Q
Q8	Is the LSF hanging correctly, with ropes positioned to allow the pre-filter to come out?	Yes..... No.....	Skip to Q
Q9	Is the filter wet or moist?	Yes..... No.....	Skip to Q

## 5.6 Usage rates by question and processing method

Corrected Processing (April-May)	Total (minus outliers)	Reported Rate	Total Non-Users	Additional Non-Users	Total Users	Usage Rate
Original	13308	8.6%	1150	0	12158	91.4%
Q13/24 Cannot demonstrate use	13308	6.1%	1265	115	12043	90.5%
Q16/25 Cannot demonstrate backwash	13308	12.3%	1954	804	11354	85.3%
Q13&16/24&25 Cannot demonstrate at least one	13308	13.4%	2069	919	11239	84.5%
Q17/26 Report never backwash/clean	13308	3.1%	1200	50	12108	91.0%
Q18/_ Don't report Blue_tap as safe water	13308	0.4%	1175	25	12133	91.2%
Q5/13 Filter not hanging correctly	13308	4.1%	1459	309	11849	89.0%
Q6/18 No safe storage container	13308	3.0%	1367	217	11941	89.7%
Q12/_ No LSF water in safe storage container	13308	15.5%	2568	1418	10740	80.7%
VF Reported WHO Toolkit	13308	6.4%	1319	169	11989	90.1%
Additional WHO Toolkit	13308	17.4%	2502	1352	10806	81.2%
All combined	13308	27.4%	3614	2464	9694	72.8%
Recommended	13308	22.2%	3290	2140	10018	75.3%

Corrected Processing (Oct)	Total (minus outliers)	Reported Rate	Total Non-Users	Additional Non-Users	Total Users	Usage Rate
Original	6912	11.4%	790	0	6122	88.6%
Q13/24 Cannot demonstrate use	6912	8.5%	832	42	6080	88.0%
Q16/25 Cannot demonstrate backwash	6912	20.0%	1504	714	5408	78.2%
Q13&16/24&25 Cannot demonstrate at least one	6912	20.6%	1546	756	5366	77.6%
Q17/26 Report never backwash/clean	6912	3.4%	819	29	6093	88.2%
Q5/13 Filter not hanging correctly	6912	6.7%	1071	281	5841	84.5%
Q_/14 Had to unblock pre-filter	6912	10.8%	1357	567	5555	80.4%
Q_/15 Had to unblock cartridge	6912	10.2%	1307	517	5605	81.1%
Q_/14&15 Had to unblock pre-filter or cartridge	6912	15.1%	1575	785	5337	77.2%
Q_/16 Need filter part replacement	6912	6.3%	1048	258	5864	84.8%
Q6/18 No safe storage container	6912	9.5%	1249	459	5663	81.9%
VF Reported WHO Toolkit	6912	19.9%	1471	681	5441	78.7%
Additional WHO Toolkit	6912	41.9%	2776	1986	4136	59.8%
All combined	6912	42.0%	2777	1987	4135	59.8%
Recommended	6912	21.2%	1770	980	5142	74.4%

## 5.7 VF Responses to Berkeley Air Questions Regarding VF-MR2 Survey

### I. Questions regarding Processing

1. **In Step 2, households are removed if the quantity filtered per event is >70 liters. Quantity filtered is calculated by multiplying quantity/day and a frequency factor for how often the household uses the filter. In the processing sheet, there is not a frequency factor for “Do\_not\_filter\_water” and thus some households are calculated as “#N/A” for the quantity filtered per event, and resultantly removed as outliers. Why were these households removed as outliers?**

*Response: This was an oversight in processing the full data set – it had been done correctly for the EXP data but not the Oct and April-May surveys. We have provided a revised calculation spreadsheet.*

2. **As a part of calculating quantity filtered per event, only the quantity from credible purposes is included. For instance, in the April-May VF-MR2 survey, only Q20/a is included but Q21/a is not included in that calculation. Why did quantity filtered per event not include all quantities of water reported?**

*Response: This was an oversight in processing the full data set – it had been done correctly for the EXP data but not the Oct and April-May surveys. We have provided a revised calculation spreadsheet.*

### II. Questions regarding WHO Toolkit

**The following questions from the VF-MR2 survey were described as relevant to the WHO Toolkit “reported and observed indicators” in the file “VF Responses to GS TAV.pdf”. Please explain why each question was not included in the final processing for the usage rate and provide any other relevant information if needed.**

3. ***Is the LifeStraw hanging correctly, with ropes so the pre-filter can come out?***

*Response: The original question was included to assess the quality of the original installation- to assess whether the community health workers were installing the units in each household correctly. It was an indicator for CHW performance. The specific part about ropes hanging properly so the filter can come out is because if ropes are strung the wrong way, then it is harder to clean the pre-filter. However, if this is the case, that does not prevent people from actually filtering water. We also do not use this question for calculation of usage because over time we have observed that some households put their filter away to protect it from theft or*

animal damage when they are not using it, so arriving at the household to see the filter visually hanging properly with the ropes properly strung was not necessarily an accurate assessment of whether it is being used. However, we continue to ask the question to inform about level of education that has been provided.

#### **4. Does anything on the LifeStraw need to be replaced?**

*This was a question asked for the purpose of our staff members to follow-up and make repairs and replacements of the filter. Some items that would need to be replaced such as damage to the prefilter, kinking of the hose, rusting of the clamps, do not mean that the household cannot use the filter, it is just an indicator for pro-active maintenance. The enumerators were instructed during the MR2 training that if the filter was actually broken and unable to be used that they should go back and answer that the family was not filtering even if they said they normally do. We actually had push-back from our surveyors saying that some of the families that had damaged filters they could tell had been strong users, but we instructed them that they had to note that at that point in time, they were not current users, because we take different surveys at different points in time for this very purpose.*

#### **5. Is there a designated safe storage container? How big is the safe storage container in LITERS?**

*Response: We did not provide safe storage cans but have included safe storage education in our follow-up training and health education visits. The CHW's have identified a safe storage container in each house and taught the family how to use and maintain it. Safe Storage containers vary in size, with the most common jerry can 20L. Due to ranges in family size, some families need 5L can per day while others may need several 20L cans. It is a clear part of our training for every campaign that they understand how to identify the size of the can to measure usage. The purpose is not to correlate presence of a safe storage container to usage but to assist in the accuracy of the calculations of the quantity of water being used per day. Some people will tell you they don't have one because they want the program to buy them new jerry cans – this comes up every campaign... but every household has some form of storage container either bucket, jerry can, clay pot etc.*

**The following questions from the VF-MR2 survey could apply to the WHO Toolkit's "correct, consistent use, and storage indicators". Please explain why each question was not included in the final processing for the usage rate and provide any other relevant information if needed.**

#### **6. Which tap is used for safe water?**

*Response: We decided to use the ability to properly demonstrate in place of this because it is more comprehensive than just asking which tap is used for safe water. Enumerators are instructed that if the household does not actually demonstrate with the blue tap for fetching safe*

water than they have not performed an accurate demonstration. You will note in the spreadsheet that very few households do not answer this question correctly. It can be added to the compendium for the usage calculation but we only asked this question in the April survey and of the 14,059 respondents, only 58 answered the red tap, and of those, 31 would have been counted as non-users anyway. So, this was less than 0.2% that would have been additional non-users. What we try to do is put together the most robust indicators for usage, and we felt this one did not add a lot of value.

### **7. Can the person demonstrate how to use the filter correctly?**

*Response: This was used in the final processing of the usage rate – processing step #7, we removed any household that was not able to demonstrate how to filter and how to backwash. We felt that if the household miss one demonstration – for example – backwashing, but knew how to filter, they were likely still users but if they could not perform either, they should not be counted as users. This was agreed by the auditors who felt they saw this in the field.*

### **8. Can the person demonstrate how to backwash the filter?**

*Response: In observation of the CHW's conducting the survey, we found that the surveyor could answer "no" to this question if the household did a backwashing step out of sequence or did not do 1 of the steps exactly as trained. For example, the appropriate training includes squeezing the red bulb 3 times before opening the red tap for 3 seconds to drain the contaminated water. A CHW would answer that the household was not able to demonstrate how to backwash if the person squeezed the bulb 4 times or 2 times before opening the red tap. Or could answer "no" to the question if the person opened the red tap for 30 seconds instead of 3 seconds. However, a person that squeezes the bulb 2 or 4 times or opens the red tap for 30 instead of 3 seconds is still cleaning the filter and still may be a consistent user.*

*We considered the consequences of training the surveyor to be more flexible in answer the question – accepting a range of demonstration that would be recorded as a "yes" answer – but this approach caused confusion in the question and resulted in reduction in quality of the answer at all.*

*Therefore, we choose to use this question as an indicator that the household needed a refresher on the recommended backwashing procedure rather than an indication of usage. We then combined it so that if the household was also not able to demonstrate basic filtering, that they were not considered a user (processing step #7).*

## **III. Other VF-MR2 questions**

### **Why were the following observational questions not included in determining usage?**

### **9. Did you have to unblock the pre-filter?**

*Response: Unblocking done at the household level is to support a higher flow rate of the filter. It was not indicative of whether or not it was being used – rather if the CHW felt that it was flowing slower than it should be. You can still filter water with a blocked prefilter – it just moves slower or people pour water directly into the bucket or through a cloth instead.*

### **10. Did you have to unblock the cartridge?**

*Response: You can still use the filter – this just means it needed extra backwashing to improve flow rate. We tested these two questions in the October survey to see what level of maintenance was now required after 1.5 years in the field. However, our surveyors had some problems with these questions and were confused about whether this meant just backwashing or they needed full replacement. We won't be using these questions on future surveys and will just be asking about if anything is broken so as not to confuse the two.*

**Why were these specific responses to the following questions not used to classify households as non-users?**

### **11. How often do you backwash the filter? (those that report “Never”)**

*Response: Response:  
This question is mainly asked to gauge maintenance practices and see how well we are doing with our education – we did not intend for it to be used as a usage question... note that most other guidance does not suggest asking questions about cleaning and maintenance – this is something we do for our own program goals. However, the numbers are negligible: Only 29 HH from October and 52 from the April survey representing far less than 1%. We try to use what we think are several of the most robust indicators for usage – we did not think this was one of them.*

### **12. Does the safe storage container have LifeStraw Family filtered water in it? (those that respond “No”)**

*Response:  
This one we have struggled with – we even suggested to Jay at UNC that you all may want to suggest it be used within a compendium of other indicators going forward for the usage calculation because the Clasen and Peletz paper used something similar. Our surveyors did not like the question because they felt like they couldn't get an accurate answer, which is why we removed it in the October survey, but we are open to putting it back in. We further explained below whether the presence of water may not always indicate usage.*

**Why were the following questions/information not asked by Vestergaard in the VF-MR2 survey?**

### **13. Asking if the individual you are interviewing the primary user of the filter?**

*Response:*

*We instruct the surveyors once they determine if the household is a user of the filter to find out if the primary user is home and focus their questions on them. However, we also want to take a conservative approach and our feeling is that any member of the household should be able to perform a basic demonstration because our education focuses on the whole family. That is why we do ask if they received education, but not if they are the primary user.*

### **14. Asking the respondent if they do anything to make their water safe (before asking what they do to make their water safe)?**

*Response: Our feeling is that for this context, when you start off asking this type of Yes or No question, people feel they are being tested and they all know they should say yes, which then leads them to guessing what type of water treatment you are looking for them to answer. This is because in Western there has been a lot of education around treating your water. When you start by simply asking what do you do to make your water safe and leave it open-ended and say you are from the Ministry of Public Health, they feel more comfortable giving a variety of answers, including nothing. But, most people will say something even if they don't use Lifestraw like occasionally using Waterguard, sieving with a cloth, boiling etc, and you will see we still do get the "Nothing" answer. We are however, open to piloting it in the next survey.*

### **15. Is the filter wet or moist?**

*Response: Water left standing on the plastic tubing can attract rats, insects and other livestock. For this reason, some households report drying/wiping down the filter after use. In addition, when the weather is hot and sunny like it is most of the day, the filter will only stay "wet or moist" in terms of the pieces that can actually be felt (pre-filter, taps) for at most an hour or two. Most people do not filter continuously – they do it a couple of days a week or daily at a certain time, so it is highly likely that when you arrive, even if they are consistent users, the filter will not appear wet. Because you cannot open the cartridge to see if the actual membrane is dry, we felt a wet or moist filter was not an indication of use.*

### **16. Referring to a specific cup of water e.g. asking for a specific cup of water and asking if they did anything to make their water safe and if yes, what did they do to make that water safe?**

*Response: We talked to our local staff about this question when it came out in the toolkit and they felt it was rude and it also made them uncomfortable in the household. They felt it was rude to ask for the water and also accusatory to the household if they had already answered they used LifeStraw and filtered water and it would be perceived like the surveyor didn't believe*

*them. They also felt they would then be obliged to drink the water from the cup on the insistence that it was safe water, and were concerned because even if the water was filtered, the cup may be dirty. If they turned down the offer, this was even worse. This was a question that garnered some of the strongest objections from our local staff, so we do not use it.*

***17. Is there water in the safe storage container (if they have a safe storage container)?***

*Response: While storage of filtered water is commonly done in Western, some households filter in the morning – use the water from the jerry can and then filter again in the evening. In these cases, there is not water in the safe storage container during a survey. As mentioned, we have struggled with variations of this question, and are open to reinstating it should you all have suggestions about how to get the best information with regard to filtered water actually being in the safe storage container and correlating that to use.*

## 5.8 Copy of Berkeley Air's expert questionnaire

### Strength of Filter Usage Questions

The following is a survey to gauge the strength of certain household survey questions in determining whether a household that received the LifeStraw Family filter is either a user or a non-user. Each question allows you to choose what you believe the strength of that question is. At the end of each question, there is a space for commentary. There will also be space at the end of the survey to provide feedback on what you believe is the best practice, most reasonable, yet accurate method of determining usage/non-usage.

\* Required

Name: \*

Your name will be kept confidential and not used in any reporting purposes. It is simply to ensure the correct individuals respond to the survey.

This is a required question

1.a. Answer how strong you believe the question is in determining usage

What do you use to make your water safe now? (DO NOT READ OUT THE OPTIONS): filter with LifeStraw Family; treat with waterguard; treat with PUR; sieving with cloth; ceramic filter; boiling; other; nothing

- Very strong
- Strong
- Neither weak nor strong
- Weak
- Very weak

1.b. Comments on the question

Question: What do you use to make your water safe now? (DO NOT READ OUT THE OPTIONS): filter with LifeStraw Family; filter with waterguard; filter with PUR; sieving with cloth; ceramic filter; boiling; other; nothing

2.a. Answer how strong you believe the question is in determining usage

Observation: Is the LifeStraw Family filter placed/hanging correctly, with ropes so the pre-filter can come out? (Yes/No)

- Very strong
- Strong
- Neither weak nor strong
- Weak

- Very weak

2.b. Comments on the question

Observation: Is the LifeStraw Family filter placed/hanging correctly with ropes so the pre-filter can come out? (Yes/No)

3.a. Answer how strong you believe the question is in determining usage

Observation: Does the filter (pre-filter or cartridge) need to be unblocked?

- Very strong
- Strong
- Neither weak nor strong
- Weak
- Very weak

3.b. Comments on the question

Observation: Does the filter (pre-filter or cartridge) need to be unblocked?

4.a. Answer how strong you believe the question is in determining usage

Observation: Does any part on the filter need to be replaced?

- Very strong
- Strong
- Neither weak nor strong
- Weak
- Very weak

4.b. Comments on the question

Observation: Does any part on the filter need to be replaced?

5.a. Answer how strong you believe the question is in determining usage

Is there a designated safe storage container? (Then observe)

- Very strong
- Strong
- Neither weak nor strong
- Weak
- Very weak

5.b. Comments on the question

Question: Is there a designated safe storage container? (then observe)

6.a. Answer how strong you believe the question is in determining usage

Observation: Is the filter end attached to the safe storage container?

- Very strong
- Strong
- Neither weak nor strong
- Weak
- Very weak

6.b. Comments on the question

Observation: Is the filter end attached to the safe storage container?

7.a. Answer how strong you believe the question is in determining usage

Does the safe storage container have LifeStraw Family filtered water in it?

- Very strong
- Strong
- Neither weak nor strong
- Weak
- Very weak

7.b. Comments on the question

Question: Does the safe storage container have LifeStraw Family filtered water in it?

8.a. Answer how strong you believe the question is in determining usage

Observation: Can the person demonstrate how to filter water using the filter correctly?

- Very strong
- Strong
- Neither weak nor strong
- Weak
- Very weak

8.b. Comments on the question

Observation: Can the person demonstrate how to filter water using the filter correctly?

9.a. Answer how strong you believe the question is in determining usage

Observation: Can the person demonstrate how to backwash (remove dirty water) the filter?

- Very strong
- Strong
- Neither weak nor strong
- Weak
- Very weak

9.b. Comments on the question

Observation: Can the person demonstrate how to backwash (flushing out dirt) filter?

10.a. Answer how strong you believe the question is in determining usage

How often do you backwash (flushing out dirt) and clean the pre-filter?

- Very strong
- Strong
- Neither weak nor strong
- Weak
- Very weak

10.b. Comments on the question

Question: How often do you backwash (flushing out dirt) and clean the pre-filter?

11.a. Answer how strong you believe the question is in determining usage

Which tap is used for safe water? (Blue tap or red tap)

- Very strong
- Strong
- Neither weak nor strong
- Weak
- Very weak

11.b. Comments on the question

Question: Which tap is used for safe water? (Blue tap or red tap)

12.a. Answer how strong you believe the question is in determining usage or quantity used?

What do you use the LifeStraw filtered water for? Options: Drinking, Washing hands, Cleaning fruits and vegetables, Feeding livestock, Washing linens, Cooking, Making coffee or tea, Other

- Very strong
- Strong

- Neither weak nor strong
- Weak
- Very weak

12.b. Comments on the question

Question: What do you use the LifeStraw filtered water for?, Options: Drinking, Washing hands, Cleaning fruits and vegetables, Feeding livestock, Washing linens, Cooking, Making coffee or tea, Other

13.a. Answer how strong you believe the question is in determining quantity used  
How many LITERS of filtered water does your family use for drinking, washing fruits and vegetables and hand washing each day? (based on amount of the jerry can used)

- Very strong
- Strong
- Neither weak nor strong
- Weak
- Very weak

13.b. Comments on the question

Question: How many LITERS of filtered water does your family use for drinking, washing fruits and vegetables and hand washing each day? (based on amount of the jerry can used)

14.a. Answer how strong you believe the question is in determining quantity used  
How many LITRES of filtered water do you use for feeding livestock, washing linens, cooking making coffee or tea or the other purposes that were mentioned? (based on amount of the jerry can used)

- Very strong
- Strong
- Neither weak nor strong
- Weak
- Very weak

14.b. Comments on the question

Question: How many LITRES of filtered water do you use for feeding livestock, washing linens, cooking making coffee or tea or the other purposes that were mentioned? (based on the amount of the jerry can used)

15.a. Answer how strong you believe the question is in determining usage or quantity used

Do you do anything else to the filtered water to make it safe before using it for drinking, hand washing or washing fresh fruits and vegetables? (DO NOT READ ANSWERS OUT LOUD)

Options: Boil, chlorine, other, nothing else

- Very strong
- Strong
- Neither weak nor strong
- Weak
- Very weak

15.b. Comments on the question

Question: Do you do anything else to the filtered water to make it safe before using it for drinking, hand washing or washing fresh fruits and vegetables? (DO NOT READ ANSWERS OUT LOUD) Options: Boil, chlorine, other, nothing else

16.a. Answer how strong you believe the question is in determining usage or quantity used  
How much filtered water do you boil in liters?

- Very strong
- Strong
- Neither weak nor strong
- Weak
- Very weak

16.b. Comments on the question

Question: How much filtered do you boil in liters?

17.a. Answer how strong you believe the question is in determining usage or quantity used  
How often do you use the filter?

- Very strong
- Strong
- Neither weak nor strong
- Weak
- Very weak

17.b. Comments on the question

Question: How often do you use the filter?

18.a. Answer how strong you believe the question is in determining usage  
Why don't you use the LifeStraw Family filter?

- Very strong
- Strong
- Neither weak nor strong
- Weak
- Very weak

18.b. Comments on the question

Question: Why don't you use the LifeStraw Family filter?

19. In your expert opinion, what household survey question or combination of questions (not limited to the ones mentioned above) are generally most necessary to make an accurate determination of water filter usage or non-usage in a reasonable and cost-effective manner?

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## 5.9 Survey for VF Enumerators

[First, make them feel comfortable. Let them know you are calling as an auditor and are working with Berkeley Air Monitoring Group, an independent, private environmental health consulting company based in Berkeley, CA, USA]

The goal of this phone call is to understand more about what it was like to visit the households that were given the LifeStraw Family Filter, and what it was like to conduct certain survey questions for the filter. I realize it may have been a long time ago, so if you don't recall the answer to a question, that is fine. The phone call will be short and should be less than 20 minutes.

1. When did you start working on the LifeStraw Filter project?
2. Were you involved in conducting the survey in October of last year?
3. Were you also involved in conducting the survey in May of last year?

Great, I am now going to ask you some questions about certain parts of the survey. To start, I would like to ask you about how you determined if the LifeStraw Filter was hanging correctly.

### HANGING CORRECTLY

4. How would you decide if the LifeStraw Filter was hanging correctly in a home?
5. If the LifeStraw was not hanging correctly, what was the most typical reason why?
6. If a LifeStraw Filter was not hanging correctly, did that typically indicate that the household was not using it?

### BACKWASH

I am now going to ask you about the part of the survey where you ask the person you are interviewing to "demonstrate how to backwash the LifeStraw Filter correctly".

7. How did you decide if the backwash was performed correctly?
8. What would you mark down on the survey if the person squeezed the red bulb less than 3 times? What if they squeezed the red bulb more than 3 times?
  - a. [Clarification] Could they still count as backwashing correctly if they squeezed the bulb too many times or too few times?
9. What would you mark down on the survey if the person left the red tap running for less than 3 seconds?
  - a. [Clarification] Could a person still count as backwashing correctly if they left the red tap running for less than 3 seconds?
  - b. Could the person count as backwashing correctly if they left the red tap open for 20 seconds?
10. Do you think that someone who cannot demonstrate how to backwash correctly does ***not*** use the filter?
11. Can a person continue to use the filter without ever backwashing?

### UNBLOCKING FILTER (October survey only)

I am now going to ask you about the part of the survey where you check on whether you need to unblock the pre-filter and the cartridge.

12. What did “unblock” mean in these survey questions?
13. In households where you had to unblock the pre-filter, what was usually the problem?
14. In households where you had to unblock the pre-filter, was the filter typically still working at some level, or had it completely stopped working?
15. In households where you had to unblock the cartridge, what was usually the problem?
16. In households where you had to unblock the cartridge, was the filter typically still working at some level, or had it completely stopped working?

#### **REPLACEMENT PARTS (October survey only)**

I am now going to ask you about the part of the survey where you check to see if there are parts that need to be replaced on the LifeStraw Filter.

17. If a household needed a part to be replaced on their LifeStraw Filter, what typically was the part?
18. Can the LifeStraw Filter work properly without that part?
19. If the LifeStraw Filter was broken, did you go back in the survey and change the survey to indicate that household was not using the LifeStraw Filter?

#### **SAFE STORAGE**

I am now going to ask you about the part of the survey that asks about the safe storage container.

20. How would you decide if there was a designated safe storage container in the household?
  - a. Did the household have to show you the container?
  - b. Did the container have to be covered to be considered safe?
  - c. Did the container have to have a small opening to be considered safe?
  - d. Would an open bucket that was only used for LifeStraw filter water be considered a safe storage container?
  - e. Would a small cup that was only used for LifeStraw Filter water be considered a safe storage container?

#### **CUP OF WATER QUESTION**

Finally, I would like to ask your opinion of a set of 3 questions that some researchers believe are a good way to measure if a household is using their LifeStraw Filter or not.

21. The 3 questions are: 1) Can you provide me a cup of water that you would prepare for your child? 2) Did you do anything to make this water safe for drinking? And 3) What did you do to make this cup of water safe for drinking?
22. Do you think these questions would be useful for deciding if a household is using their LifeStraw Filter or not?

Great. Thank you so much for your time. It was a real pleasure speaking with you!

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