

A RESEARCH ON A NEW HOUSEHOLD WATER TREATMENT DEVICE, THE WATER BOX

A report compiled for the Water Box Volunteers

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CHAPTER ONE: INTRODUCTION

1.1: Introduction.

This report describes field trials conducted in Kajjansi, Uganda, to determine customer feedback for a new household water treatment product called the Water Box. The Water Box is a point-of-use water treatment product that was developed by the Water Box Volunteers (WBV) to disinfect tap water from municipal water utilities (Berg, 2010). The WBV are an informal group of professionals organized under SAGE of Portland, Oregon, USA.

The Water Box uses Ultraviolet radiation (UV) light, which is a proven technology for drinking water disinfection (EPA, 1999). The field trials were conceptualized and funded by the Water Box Volunteers. They were managed by Engineering Ministries International-Uganda (eMi) in cooperation with Uganda Christian University (UCU).

All contacts with participating households were conducted by field technicians Nagemi Peter and Agabiirwe Natasha, two recent engineering graduates from UCU. Both of them are Ugandan and are fluent in Luganda, the local language. The trials took place in May and June 2022.

1.2. Background.

In most parts of the world, people in cities do not have access to reliably safe drinking water (Lisle, 2000). It is common for the water quality to be microbiologically compromised when being pumped from the municipal treatment facilities and therefore, point-of-use (household) water treatment is warranted. Various approaches and devices have been developed to address this issue. One approach is to use chlorine dosing to disinfect water since it is relatively inexpensive and effective (Simya, 2019). However, chlorine treatment may impart an off-taste to the water and requires continual replenishment of chlorine (Djamel Ghernaout, 2018). Furthermore, many people are uncomfortable with the idea of adding a chemical to their water, particularly a chemical commonly used for laundry.

A second approach is to boil the water. Most of the people in the world opt to boil water as a means of ensuring that it is safe for drinking (Berg, 2015). Some people boil their water in electric kettles while others boil the water on charcoal stoves or on Liquefied Petroleum Gas (LPG) stoves. However, these methods are only available to people who are able to afford electricity, LPG or charcoal (Berg, 2015). In addition, boiling requires a significant amount of both energy and time to effectively treat the water to safe drinking standards. The minimum power used by an electric kettle is about 1200 Watts of electricity while most kettles have a maximum power rating of 3000 Watts of power and often treat water for about 7 minutes (Murray et al., 2016). The time required to treat water over charcoal is dependent on both the volume of water and the heating capacity of the kettle which is influenced by the material from which the kettle was made (Juran & MacDonald, 2014). The most common fuel used for boiling is charcoal, which presents many hazards. Additionally, the water must cool after boiling, which can take quite a bit of time.

Combustion of charcoal emits a great deal of carbon monoxide which has a choking effect on human health since it binds with hemoglobin, which reduces the blood's ability to carry oxygen (Masekameni et al., 2016). Charcoal combustion also emits carbon dioxide which is a greenhouse gas that causes global warming, and it releases particulate matter which has dire effects on human health and the environment (Nielsen et al., 2011). It is for such reasons that the Water Box Volunteers developed the Water Box, as an alternative tool of water treatment.

The Water Box is a container with a capacity of approximately 4 liters (L) with a germicidal UV bulb mounted above the water surface on the inside of the lid. Other components include the bulb ballast and electrical hardware to allow for

operation using the 220V line power. The box runs on a standard 12V adapter and the electronics in the box convert the 12V DC into the current needed to run the bulb.

The Water Box operates in a batch mode. It is filled through a self-closing opening on the lid with the aid of a funnel. The treatment process is initiated when the user flips the switch on the control box and lasts about 4 minutes, automatically stopping after that time. The treated water is removed from the box by opening a valve located at the bottom of the container. The control box has a UV-filtered viewpoint which allows the user of this product to tell that the Water Box is working is by checking if the ultraviolet light is on.

The Water Box uses ultraviolet radiation to disinfect drinking water and is very energy conservative since it uses 24 Watts of electricity and treats about 4 liters of water in a small amount time: about 4 minutes. Therefore, the Water Box provides a substitute method for obtaining safe drinking water since it provides the following advantages over boiling:

- It is more convenient: the time to treat a batch is less than the time to boil the same volume, and the water is immediately available for drinking whereas boiled water must first cool (Berg, 2015).
- It reduces the carbon footprint: boiling is energy intensive and boiling over a biomass-fueled cookstove releases a significant of carbon (Berg, 2015).
- It reduces indoor air pollution: This is due to the fact that the Water Box does not emit particulate matter or carbon monoxide when treating water.

On the other hand, the Water Box faces one major limitation attributed to the fact that it uses UV light to treat water: it requires the source water to have a relatively high UVC transmissivity. Reduction of transmissivity occurs when water has a high level of dissolved organic matter. An elevated level of turbidity may also contribute to lower transmissivity although the impact of turbidity on UV disinfection is generally negligible for turbidities of less than 10 ntu. The central treatment provided by municipal systems generally provides water with an acceptable level of transmissivity for UV disinfection, even if the microbiological quality is compromised during distribution.

1.3. Problem Statement

The Water Box was developed to serve as an alternative method of household water treatment. It was designed to conserve energy and time as compared to the available water treatment methods. These field trials were designed to

gather feedback as to whether people found the Water Box a desirable treatment tool for their drinking water. This study also confirmed that its treatment was still effective under the field conditions.

1.4. Field Trial Objectives

1.4.1. Main Objective

To gather potential customer feedback for a new household water treatment product called the Water Box.

1.4.2. Specific Objectives

- i) To determine how effective treatment by the Water Box was under field conditions.
- ii) To determine what aspects of the Water Box participants found appealing and unappealing.
- iii) To determine how desirable the Water Box was to the community as compared with the previous or current forms of water treatment.
- iv) To determine what modifications to the Water Box would make it more attractive to participants.
- v) To determine how much the Water Box users were willing to pay to purchase the box if it were on the market.

1.5. Justification

In most parts of the world, people do not have sustainable access to safe drinking water (Lisle, 2000). Thus, people have to treat water to safe drinking standards before consuming it. The WBV developed the Water Box as an alternative household water treatment device that relies on UV light to treat water and desired to conduct field trials to gather feedback from people as to whether they found the Water Box a desirable alternative treatment option for their drinking water since it requires a small amount of time (4 minutes) and power (24W) to treat water. The feedback is necessary as it informs the developers on what modifications to make unto the Water Box to make it more attractive and also enables them to have an estimate of the price the Water Box will command during full-scale production.

Hence, the purpose of this research is to determine the viability of the Water Box as an appropriate, effective and cost-effective treatment unit as compared to the current methods of water treatment.

1.6. Scope

This study was limited to places within or nearby Kajjansi and specifically targeted households with NWSC as their main water supply. As a result, the study focused on water users within Bweya, Bulonde, Katale and Kitende.

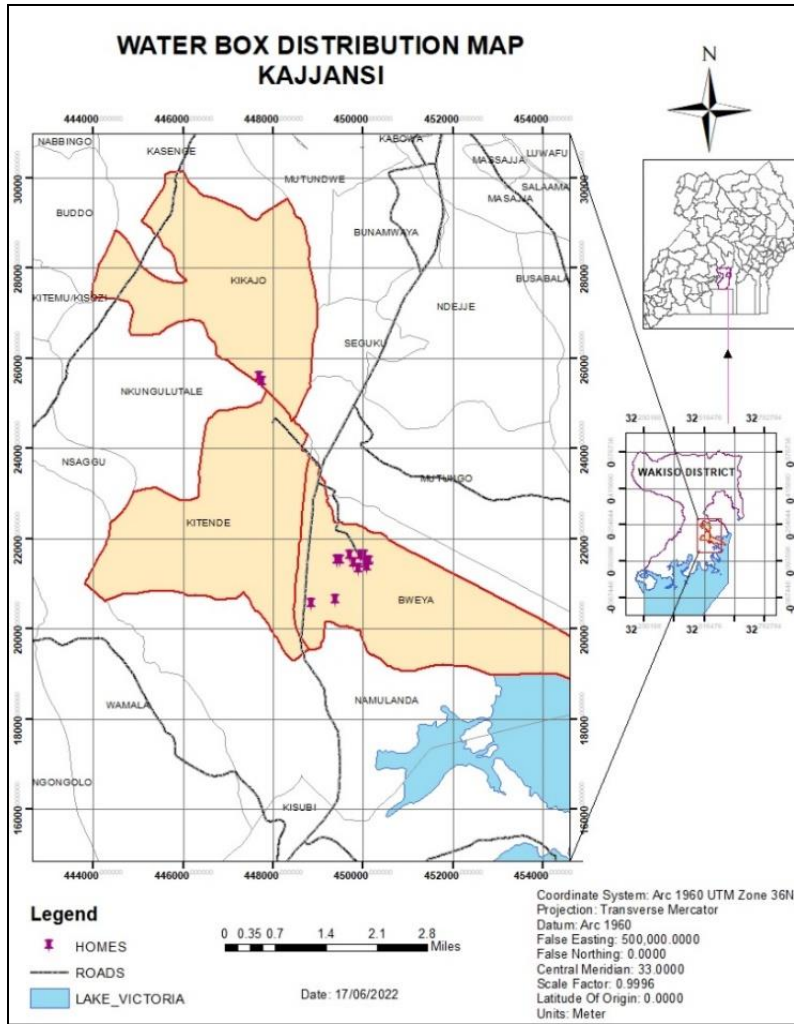


Figure 1.0: Water Box distribution area
 This research was conducted from May to June 2022.

CHAPTER TWO: LITERATURE REVIEW

2.1 Household water treatment

Household water treatment refers to the application of means (physical or chemical methods) to render water safe for drinking or other domestic use at the point of use.

Over 2 billion people globally lack access to safely managed drinking water services. This has severe consequences for human health. Approximately 485,000 diarrheal deaths in low and middle income countries each year are attributed to unsafe drinking water (World Health Organization, 2022). HWT can reduce the risk of diarrheal diseases by as much as 61% when effective HWT methods are used correctly and consistently by populations that are at risk of water borne diseases (World Health Organization, 2019).

One way to assess HWT performance is according to the WHO Household Water Treatment Technology Evaluation Scheme (<https://www.who.int/tools/international-scheme-to-evaluate-household-water-treatment-technologies/products-evaluated>). This requires treatment technologies to meet treatment targets for three categories of pathogens: bacteria, viruses, and protozoa.

WHO performance criteria for HWT technologies

Performance classification	Bacteria (log ₁₀ reduction required)	Viruses (log ₁₀ reduction required)	Protozoa (log ₁₀ reduction required)	Interpretation (with correct and consistent use)
★ ★ ★	≥ 4	≥ 5	≥ 4	Comprehensive protection
★ ★	≥ 2	≥ 3	≥ 2	
★	Meets at least 2-star (★ ★) criteria for two classes of pathogens			Targeted protection
–	Fails to meet WHO performance criteria			Little or no protection

The fundamental difference between community systems and household water treatment is not the underlying mechanism for treating the water but the point where the treatment is implemented. It therefore requires households to take responsibility for their own drinking water safety by drinking water safety by treating the water at the home and prevent its recontamination.

2.2 UV light in treatment of drinking water

The use of UV light has been done for a number of years and various studies have been carried out to ensure that UV is an effective way to treat water for drinking.

WHAT IS UV

UV disinfection is a physical process. UV light in the light ranges of 200-300nm is referred to as germicidal because this UV-light is absorbed by DNA and RNA [citation needed]. When the UV photons are absorbed, they cause changes in the DNA and RNA (namely, thymine dimerization) which render the affected organisms incapable of replicating, and thus unable to cause disease.

How well the UV system works depends on the energy dose that the organism absorbs. If the energy dose is not high enough, the organism's genetic material may only be damaged rather than disrupted. The amount of energy required to inactivate a given organism is referred to as its **lethal dosage**.

An effective dose depends on several factors, including the lamps intensity, proper wave length, exposure time, physical and chemical properties of the water, flow rate and the microorganism's type and source. However, the most commonly measured parameters that determine dosage are intensity and exposure time.

2.2.1 Establishing the dosage of UV

UV DOSAGE=INTENSITY x TIME

Anna Chase in her study with a UV water purification device on its usability and impact noted that such a device had potential for both manufacturing and marketability due to its price and fast mode of treating water compared to what was readily available in the market. The Better Water Maker is a UV light device that uses a manually turned crank to generate 12V electricity to power it and pump water through the cylindrical UV light chamber. Anna distributed the device to a school, hospital and household to be able to obtain feedback from different use cases. In this research, there was difficulty in trying to use the device as a communal asset or a source of accessible water for a price. She concluded that such a product is best purchased for household water treatment (Chase, 2013).

Reygadas in his study to assess the contamination risk associated with UV treated water observed that 74% of the UV treated and safely stored water fell

in the low risk contamination category (< E.coli/100ML) (Reygadas et al., 2015).

Ashok Gadgil tested the treating of water in South Africa using a UV treatment device with a bare UV lamp supported below a reflector, above the free surface of flowing water. A borehole water source containing 4000 CFU/100mL coliform including 200 CFU/100ML *E. Coli* entered the device and no coliforms were detectable in the water leaving the UV unit (Gadgil et al., 1997).

Reygadas on measuring the compliance and cost efficiency of safe drinking water used a UV treating device that includes a bucket for the source water, the ultraviolet disinfection chamber, a safe storage container for the treated water and instructions for use. Observations were done for 8-10 months noting that equivalent compliance was achieved across communities concluding that habit formation could lead to improvements in consumptions of safe water (Reygadas et al., 2018).

The ability of UV light used in this study to treat water for drinking is ascertained in the studies highlighted above.

CHAPTER THREE: METHODOLOGY

3.1: Introduction

This chapter addresses the methods and tools of data collection, and the research design for the accomplishment of this study. The tests to determine the quality of the source water and treated water were conducted at the eMi offices.

3.2: Research Design

The research design refers to the conceptual framework of methods and techniques that were used to achieve the specific objectives (Megel & Heermann, 1993).

3.2.1: Tools for Data collection

Different tools were used in conducting this research. The table below summarizes the various tools and the purpose for which they were used.

Table 3.0: showing tools used to carry out the research

TOOL	PURPOSE
Whirlpak® Thio-Bag®	Carrying samples from the field to the eMi offices for testing. (Aquagenx, 2021)
Surveys	Collect data from participants on whether they found the Water Box a desirable tool for treating water, what they found appealing and unappealing about the Water Box, what modifications they desired to have on the Water Box and how much they were willing to pay for the Water Box as a product in the market. Refer to Appendix A for survey questions.
eMi facilities and equipment	To facilitate the determination of turbidity, <i>E. coli</i> and Total Coliforms in the source and treated water samples. (Aquagenx, 2021)
<ul style="list-style-type: none">• HACH 2100Q portable Turbidimeter• Aquagenx tests• Incubator• UV torch light	To decontaminate the sample at the end of the process. (Aquagenx, 2021)
Sodium hypochlorite (bleach)	
Microsoft Excel	Storage of data
KoBo app	Storing survey data

3.2.2: Methods of Data Collection

The methods of data collection were both quantitative and qualitative. Qualitative data about behavioral changes that manifested in the water users

of the various local households were generated from oral interviews, whereas quantitative data were generated from the loggers and the bacteria tests.

3.3: Pre-trial Quality Assurance

The WBV desired that the Water Box meet the requirements of the 2-star rating of the World Health Organization's (WHO) Household Water Treatment Evaluation Scheme. The Water Box has not yet been tested by the WHO and therefore, the 2-star rating can be considered an estimate prior to formal testing. A 3-star testing is the highest category but, according to WHO, both 2- and 3-star products provide comprehensive protection against a range of microbiological contaminants (WHO, 2017).

Significant variation was observed in treatment during initial trials at the eMi office. For this reason, boxes were subjected to UV intensity tests. During these tests, a sensor was placed at the bottom of an empty box and the box was turned on. The UV intensity was recorded every ten seconds during a 120-second trial. A total fluence was then calculated based on the trapezoidal method of numerical integration. A fluence of 250 - 300 mJ/cm², with a maximum intensity of 2600 - 3000 μW/cm², was observed for most boxes that had performed well in bacteria tests. Box 93 was unable to achieve these targets, even with several different bulbs, and so was removed from the trials. Results from these trials are provided in Appendix B.

Most Water Boxes, when run for four minutes, would adequately treat water. However, a more serious issue was the failure of the timing mechanism in the boxes. This would prevent a box from automatically turning off. In several instances, boxes that remained on for 30 minutes or longer burned out (with damage apparently being done to the ballast). These boxes would still turn on, but the UV lamp would not light. This was highly undesirable, as participants might think the device was working but would in fact be ingesting untreated water. For this reason, it was determined that only Water Boxes that showed a low variance in treatment times would be deployed in the field. First, boxes that had obviously failed by remaining on for long amounts of time during initial modification and testing were removed from the trial. This removed 12 of the 28 boxes (after the removal of box 93). Each remaining box was tested 10 times, and there was a clear distinction between boxes with low variance of sampling times (3-30 s²), and those with high variance in sampling times (over 2000 s²). Of the Water Boxes that passed the bacteria tests, 2 boxes with high variance were disqualified and the 14 boxes with low variance were selected for use. Results for all timing tests (of which the ones reported here are only the most recent) are provided in Appendix C.

The 2-star rating of World Health Organization Household Water Treatment Evaluation requires a 2-log reduction for both bacteria and protozoa and a 3-log reduction for viruses (WHO, 2016). The devices went through lab testing in North America prior to the beginning of the study, with results indicating that 4 minutes of treatment time were required to meet these criteria. To confirm this in the field, each Water Box was tested for its ability to remove *E. coli* and total coliform bacteria at the EMI office prior to distribution of the Water Boxes to households. Aquagenx CBT EC+TC Most Probable Number (MPN) Kit tests were used for this study since they simultaneously detect and quantify *E. coli* (EC) and Total Coliform in a 100 mL sample (Aquagenx, 2021). To be reasonably certain that the Water Box performed according to 2-star standards, it was required that the Water Boxes remove all the *E. coli* and show a 2-log reduction in total coliforms when treating the water in the eMi office. This was conservative since the water quality at the office was poorer than that found in the local households. Untreated office water averaged 1116 MPN *E. coli* and 4650 MPN Total Coliforms: both of these values indicate that the water is unsafe for consumption in accordance with World Health Organization standards (Oshiro, 2002). Two tests were carried out on each box to ensure repeatable performance. During these tests, box 91 removed *E. coli* but was unable to produce a 2-log reduction in Total Coliforms. For this reason, it was removed from the trial. Results from bacteria tests are provided in Appendix D.

Of 29 Water Boxes shipped to Uganda by the WBV, only 13 Water Boxes passed all quality assurance tests laid out above. These were the devices used for the field trials.

3.4: Household Preferences and Participant Feedback

In order to measure household preferences, primary data was collected including reconnaissance, field surveys and oral interviews.

Household sampling (selection)

Snowball sampling was used for this research: this means that participant recruitment was done through word of mouth. In this way, each participant has the potential to recruit more participants, resulting in a “snowball” effect of a growing participant pool (Bondmass, 2021). Functionally, as the sample size of this study was small, most participants were recruited through incidental contact by the field technicians.

When sampling, only households with a NWSC supply as their main water source and with household electricity were considered. This was due to the fact that NWSC water is clear, which is a requirement for the efficacy of the UV

treatment used by the Water Box. We considered only households that have electricity since, at the time, the Water Box relied on an external source of power.

The Water Box was designed with a hand-crank generator, however, the challenge tests performed by the WBV were unable to confirm adequate treatment performance using the generator. It was therefore decided that the generator feature should not be part of the field trials, and the generators were removed from the units before distribution. The WBV are considering modifications to the Water Box that will enable it to deliver an adequate UV dose when powered by a generator.

Interviews and field surveys:

Interviews and field surveys are a qualitative method of data collection (Alshenqeeti, 2014). In order to determine whether the Water Box is a viable treatment unit for the local households, the field technicians engaged various local households through dialogue to determine whether or not they were interested in participating in the research and using the Water Box as an alternative treatment unit for their drinking water. They then interviewed the interested participants using questions developed beforehand by the WBV in consultation with eMi.

At the beginning of a visit, field technicians would introduce themselves and the purpose of the visit. They would then introduce the Water Box as an alternative treatment tool for drinking water and explain how it operates. They would also explain to them how water is treated by UV light and also show examples of water bottling companies that use the same technology to treat their water. They would then address their concerns about the Water Box and after seek their consent as to whether they would like to participate in the survey. If they were willing, field technicians would hand them an ethics approval consent form that they would then sign (provided in Appendix A). Technicians would then ask them to demonstrate to us that they had learnt how to operate the Water Box.

Field technicians would then ask them survey questions to gather feedback about what treatment methods they use to treat their water, if those methods are effective, their likes and dislikes about those methods and how much drinking water they consume daily. Technicians made follow up visits to ensure that the Water Box was still functional and to address potential concerns about the Water Box, or, to find out if the participants did not feel like continuing with the study. During a final visit, field technicians collected feedback from

the participants regarding their experience with the Water Box, the number of times they used it, their likes and dislikes, and, their willingness to pay. Survey questions were developed beforehand with the goal of obtaining consistent feedback from participants. The survey questions for the final visit are available in Appendix A. Additionally, the Water Box had the capacity to collect usage data on a logger which provided information regarding how often the Water Box was used. This provided an objective confirmation of the information the participants provided orally regarding how often they used the Water Box.

The feedback, from the participants, provided useful insight regarding would be modifications to be made onto the Water Box and how much people would be willing to buy it if it were to be put on the market for sale. The visits were four in number: the first visit when we engage the household, two follow ups and one final visit when we retrieved the Water Box. The visits were done on a weekly basis as advised by UCU ethics committee and were done to gather feedback about the Water Box as a new household water treatment device.

The plan was to have the field trials spanning for a period of three weeks. However, this was not achieved because some of the participants were unavailable at the times they were visited. Hence, the field trials spanned a period of four weeks. The feedback obtained from the participants was recorded in the Kobo tool app (KoBo Toolbox, Cambridge, MA) exactly as it was given by the participants.

For the final visit, participants were compensated with UGX 60,000 (approximately \$17) each as a token of appreciation for participating in the field trials. The Water Box was then retrieved.

3.5. Determination of physiochemical parameters

The physicochemical parameters for the scope of this research were *E. coli* and total coliforms in both treated and untreated water. This allowed us to obtain a partial measure of field treatment performance. Measurement of *E. coli* removal does not provide the same confirmation of performance as lab measurements of MS-2 removal, but the latter is extremely challenging to do in the field, and a measurement of field performance is highly desirable due to the additional factors present in a real-use case.

Physiochemical Sampling:

Samples for both source and treated water were picked. Each sample for source water was collected from the tap of a participant household. Water

from this same tap was then treated in the participant's Water Box, from which we collected a treated water sample. The samples were stored in plastic bags known as Whirlpak® Thio-Bags®. These were then transported to the eMi office within a time span of not more than 3 hours.

Precautions before sampling (in line with Occupational Safety and Health):

- Wore latex gloves to cut-off direct contact when picking samples (Aquagenx, 2021).
- Labelled the Whirlpak® Thio-Bag® before sampling (WHO, 2006).

Precautions when picking the samples (Quality Assurance):

- To prevent contamination of picked source and treated water samples, the Whirlpak® Thio-Bag® were sealed off by whirling them and ensuring that there was no leakage from the bags (Blando, 2004).
- Wiped the outlet valve (tap) with alcohol pads before picking the treated sample to ensure that the sample was not contaminated by the tap before testing (Aquagenx, 2021).
- Following wiping with alcohol, flushed the tap for about one minute before picking the treated sample from the Water Box (United States Environmental Protection Agency, 1995).

Procedure:

- At the sampling point, the Whirlpak® Thio-Bags® were labelled.
- The bags were then held horizontally and the sample collected at the fill line of the Whirlpak® Thio-Bag®.
- The bags were whirled tightly to avoid spillage and contamination of the samples.
- The samples were then delivered to the laboratory within 3 hours (Aquagenx, 2021).

The collected water samples were used to determine the physicochemical parameters as per the first objective of this research.

3.5.1. Test for Turbidity

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates (Quality, 2008).

Procedure:

- Sterilize the cuvette with boiled water.
- Poured the part of the sample into the cuvette

- Placed the cuvette into the HACH 2100Q portable Turbidimeter and read and recorded the NTU value. (Manual, 2021)

3.5.2. Determination of Total Coliforms and *E. coli*

Total Coliforms are a group of bacteria that are not harmful to humans with a few exceptions. However, they have been selected as an indicator of other harmful biological organisms in drinking water for two main reasons; first, if total coliform bacteria are found in a water sample, it indicates surface contamination has reached the water and disease-causing organisms may be present and secondly because total coliform bacteria can be readily measured in drinking water, providing some idea of the efficacy of disinfection measures (Oshiro, 2002).

E. coli (Escherichia coli) is a common indicator of fecal contamination and therefore widely used by the drinking water industry as an indicator of human or animal contamination (CDC, 2016).

In order to achieve specific objective one of this research, tests for both total coliform and *E. coli* were conducted on both the source and treated water samples that had been collected during field trials (Aquagenx, Chapel Hill, NC). These bacteria tests fall under quantitative data as a method of data collection. In order to determine the total coliforms and *E. coli* content, a proprietary growth powder medium with a glucose substrate called X-Gluc (also known as Aquagenx EC+TC growth medium) was used as a reagent along with the procedure addressed below:

Procedure:

- Prepared the work area by sanitizing it with disinfectant, wiping with paper towels or wipes.
- Unwhirled the Whirlpak® Thio-Bag® containing both the source water and treated water and added Aquagenx EC+TC growth medium to each bag whilst ensuring that we do not touch the inside of the bags to avoid contaminating the samples. Whirled the bags thereafter and squeezed the clumps of powder until all the medium dissolved.
- Poured the sample with dissolved medium from Thio-Bag into the Aquagenx Compartment Bag. Thereafter, we ensured that there was an even fill to the top of the fill line across all five compartments and then sealed them by attaching plastic seal clips at the fill line and then whirling the compartment bags. We then labelled the compartment bag with a marker.

- The compartment bags were then placed in an incubator whose ambient temperature was set to 35° C to enable growth of *E. coli* and/or total coliforms. The time at which the compartment bag was placed in the incubator was noted since readings for *E. coli* and total coliforms were read after 20 - 24 hours.
- The MPN test results for *E. coli* and total coliforms were scored by holding the compartment bag next to the Aquagenx table: *E. coli* MPN was determined by viewing the colour of each compartment bag in the presence of ambient light whereas the MPN for total coliforms was determined by shining UV light (365 nm) on the Compartment Bag in dark environment. Yellow/ yellow-brown color indicated absence of *E. coli* and total coliforms (i.e., negative for *E. coli* and total coliforms) while blue or blue-green color indicated presence of *E. coli* and total coliforms (i.e., positive for *E. coli* and total coliforms).
- Finally, the compartment bags were decontaminated with sodium hypochlorite, and were left to stand for 30 minutes. After this period of time, the content from the compartment bags was poured into the toilet and the plastic seal clips were washed with liquid soap and later reused.

(Aquagenx, 2021)

CHAPTER 4: RESULTS

4.1 BACTERIA TESTS

One sample was not adequately treated by the Water Box: this sample showed >100 MPN for both *E. coli* and Total Coliforms in the source water, and 48.3 MPN *E. coli* and >100 MPN Total Coliforms in the treated sample. However, this sample was from a rainwater storage tank, and it was determined that this source was likely highly contaminated. Since the households in the study were required to have National Water as their main water source, this sample was discarded from subsequent analysis, and another sample from the National Water tap in this household was taken. This sample, when treated, showed 0 MPN *E. coli* and 4.83 MPN Total Coliforms, which was deemed acceptable performance. An additional sample showed more *E. coli* after treatment than before; it was determined that this sample was probably contaminated during handling. With these two samples removed, source water in the community averaged 12 MPN *E. coli* (median and mode both 0) and >78 MPN Total Coliforms (median and mode both >100). Water treated by the Water Box averaged 0.13 MPN *E. coli* (median and mode both 0) and 30 MPN Total Coliforms (median and mode both 13.6). Bacteria test data is available in Appendix D.

4.2 VISIT STRUCTURE

The intent of the initial visit was to make the participants familiar with the Water Box, to demonstrate to them how it operates, and to provide them with the option to take part in the field trials.

The second and third visits were follow-up visits intended to check on the participants, answer any questions about the box, ensure they were properly using the box and confirm that they were still willing to be part of the field trials.

During these visits, it was determined that all participants were able to operate the Water Box according to how it was demonstrated. These visits also gave participants opportunities to express their concerns or appreciations of the box. For example, some of the participants revealed that they would prefer if the box was bigger or produced water that had a different taste as that from the tap.

The final visit was conducted at the end of the three-week trial period. During this visit, survey data intended to answer the primary research questions was obtained. The questions and responses from this visit are summarized below.



Figure 1; The enumerators and one of the participants during the final visit



Figure 2; Children drinking water from the Water Box after demonstration

4.3 RESPONSES FOR QUESTIONS ASKED DURING THE EXIT VISIT

Raw data from surveys is provided in Appendices F, G, and H.

1. How often did the participants use the Water Box to treat their drinking water?

PARTICIPANT NUMBER	WATER BOX NUMBER	TIMES USED ACCORDING TO PARTICIPANT (Times per day unless noted otherwise)	TIMES USED ACCORDING TO LOGGER (Times per day)
01	96	1	0
02	112	1 a week	4
03	101	3	3
05	94	4 times a week	10
06	100	4 times a week	Unknown
07	099	1	1
08	103	3 times a week	4 (one ineffective)
09	089	1	25
11	97	3	2 (one ineffective)
14	92	3 times a week	3
15	095	2	16
16	098	1	0
17	102	2 times a week	Unknown

Table 1: Usage rates for the Water Box.

Notes:

1. Loggers from boxes 102 and 100 didn't present any data from the field trial. This is attributed to the poor wiring of the loggers, and was identified during the removal of the loggers from the Water Boxes.
2. Boxes 99 and 97 appeared to have been used once after the demonstration
3. Boxes 96 and 98 only had data from the demonstrations and were perhaps not used at all

4. Box 89 was used more than one time, but the data has not yet been checked.
5. Data from use loggers is provided in Appendix E.
- 2. What the water was used for in the households?**

All households used the water from the boxes mostly for drinking. Some households also used for other purposes like making of juice (1 household) and medical purposes (1 household).

- 3. How the participants felt about the box?**

11 of the participants in the trial felt good about the box, 1 of the participants liked the box though visitors to their home had doubts about the box while the 1 of the participants was uncertain about the box but remained curious.

- 4. Did the participants think the water treated by the box was safe?**

12 of the participants felt the water was safe because no sicknesses were recorded in the household while using the box while 1 of the participants was unsure about the safety of water treated by the box.

- 5. What did visitors think about the product?**

Of the 12 participants that received visitors during the trial period, 3 participants noted that their visitors did not trust that the water from the Water Box was treated and could not drink the water treated by the Water Box given that nothing about the water from the Water Box was different from that of the water collected from the tap.

6 participants noted that their visitors were curious about how the box operated and treated the water but did not have trouble drinking the water from the boxes.

3 of the participants` visitors liked the box because of its convenience in use.

- 6. Did having the Water Box solve any problems in the households, and if so which ones?**

Using the Water Box in the households solved the following problems;

1 participant noted that using the Water Box reduced expenses on charcoal used to boil drinking water

2 participants noted that it provided instant drinking water to the households without waiting for the water to cool.

All participants noted it saved time wasted in boiling water and filtering water due to its short running time to treat drinking water

Two participants noted that using the Water Box reduced the consumption of power required to treat water for drinking relative to using an electric kettle. The Water Box consumes less power and operates for a shorter time.

7. Were other methods of treating water used during this period?

6 of the households used only the Water Box during the trial period, 5 of the households also boiled their drinking water on charcoal stoves, 1 household boiled water on a gas stove, and 1 participant used bottled water from companies during this period.

8. If so, how many times per day did they use other methods of treatment?

The five households that boiled their water for drinking during the trial period were households with boxes 99,101, 112, 92 and 95. These boiled their water for drinking once per week, once per day, once per day, twice per week, twice per day and once per day respectively

9. What part of the product was easy to use?

All participants noted that the Water Box was easy to use. This is attributed to its general operation which required only a few steps to be able to use the Water Box.

One of the participants noted that it did not require one to be educated to use the Water Box.

10. What part of the product was difficult to use?

3 of the participants had trouble handling the box since the box had to be carried to a raised area near an electric socket to be used.

1 of the participants was concerned that the electronics box could easily be damaged in case of a fall.

2 of the participants had trouble storing the box due its design and make.

2 participants noted that the location of the tap created difficulty in emptying the box. The tap had to be tilted so as to be able to fully empty the box.

2 of the participants had an issue with taps that leaked.

2 of the participants found that in case of a power outage, they had no emergency power source like an extra battery or solar to use, thus the box was rendered useless.

11. Would the participants recommend the Water Box to their friends, family and neighbors?

9 of the participants were confident about recommending the Water Box to their friends and family. 2 of the participants would recommend the Water Box to their family and friends if they understood the operation of the Water Box and trusted it. 1 would recommend the Water Box to family and friends if it was affordable. 1 of the participants would find it hard to recommend the Water Box to friends and family.

12. How would you rank the different water treated options from best to worst?

1	2	3	4
Water Box	Boiling	Chlorine tabs	Others
Water Box	Boiling	Others	Others
Water Box	Boiling	Chlorine tabs	Others
Water Box	None	Others	Others
Water Box	None	Others	Others
Water Box	None	Others	Others
Filter	Water Box	Boiling	Chlorine tabs
Water Box	Boiling	Others	Others
Water Box	Boiling	Others	Others
Water Box	Boiling	Others	Others
Water Box	Boiling	Others	Others
Liquid chlorine	Water Box	Others	Others
Liquid chlorine	Water Box	Others	Others

Table 2: Ranking of household water treatment products by participants. Note: the majority of the households were not familiar with using some of the listed water treatment methods. Therefore, in this table, the word “others” is used to refer to the treatment methods that these people were not familiar with.

13. How would the current or previous method of water treatment compare to this product?

12 of the participants in the field trial noted that compared to the other methods of water treatment, the Water Box was a better option because it is convenient to use, takes a short time to treat water and uses less power to treat water.

1 of the participants preferred a filter (a locally-made Purifaaya clay pot filter) because they said the water pot in the filter could be put on fire to heat the water (though this is not intended in the filter design).

14. Would introduction of this product to the community have a positive or a negative impact? And how?

All participants believed that introduction of the product into the community would have a positive impact on the community because of the following reasons:

- Saving energy used in treating water using other methods like the electric kettle.
- Providing safe drinking water to the general community
- Saving time in treating drinking water which would encourage people to take safe water and prevent diarrheal diseases like cholera.

1 participant believed that the Water Box would also reduce the cost of living for people in the society since people would have an asset that did not cost much to use or maintain.

15. If this product was sold on the local market, how much money would people be willing to spend to buy it?

BOX NO	How much money would people be willing to spend to buy it? (UGX)	Equivalent in USD
99	100000	26.67
102	50000	13.33
100	700000	186.66
89	100000	26.67
101	250000	66.67
97	150000	40
95	100000	26.67
103	50000	13.33
112	70000	18.66

94	100000	26.67
92	80000	21.33
96	150000	40
98	100000	26.67

Table 3: Income level of participants and how much (in Ugandan Shillings) each participant would be willing to pay for the Water Box.

16. What would you change about the product if you could change one thing?

- 4 participants would change the position and design of the electronics box
- 1 participant would change the switch so that it automatically flipped to the “off” position, as does a switch on an electric kettle.
- 1 participant would change the Water Box shape to cylindrical
- 5 participants would make the box larger to treat larger amounts of water at the same time
- 1 participant would provide a mechanism to change the taste of the water
- 1 participant would add an emergency battery for when there is no electricity while 1 other would add a solar power source to the box
- 2 participants would cover the holes on the side of the box
- 1 participant would provide for a sieve instead of a funnel.

17. What features would you like to be added to this product?

All participants would like for the Water Box to be made bigger in size to allow for a greater water quantity in each treatment batch.

1 participant suggested that it would be better if it had a direct connection to the tap instead of using jerry cans that could be dirty.

2 of the participants would prefer that the Water Box be able to heat the water so that they can make tea.

1 of the participants would like for the Water Box to have a water-cooling chamber just like a water dispenser

1 participant would have liked a stand for the Water Box so that they did not have to keep shifting the Water Box from place to place when they needed to use it

1 participant desired better instructions on the Water Box so that people are able to easily read and understand the Water Box.

2 participants thought that another power source on the Water Box for example a solar power source or an emergency battery would be a great addition to the box

1 participant desired that the tap on the box have a 90-degree bend, with a downward-facing opening, like taps on community water distribution points.

1 participant desired the shape of the Water Box to look cylindrical.

1 participant preferred that the control box be enclosed within the main housing of the Water Box.

18. What was the favorite part of using this product?

Most of the participants found the general operation of the Water Box pleasing. Only a few steps are required to use the Water Box.

It also takes a short time to treat the water

19. What would make this product more attractive if one saw it in the market?

Better instructions on its operation

The price

A label from a foreign manufacturer (people tend to trust exotic manufactures more than local manufacturers)

All participants believed that people understanding its method of treating water would make this product more attractive in the market

20. Which of men or women do you think are most likely to buy this product?

5 of the participants thought that men would be most likely to buy the product.

5 of the participants thought that women would be more likely to buy the product

3 of the participants thought that both men and women would most likely buy the product.

21. What appeals to you about this product?

All participants like the fact that the Water Box treated water in a short period of time

22. What does not appeal to you about this product?

All participants would have preferred that the box was larger in size

23. Are there any other products you would rather own than the Water Box?

All participants would rather have the Water Box, except one who preferred the Purifaaya due to her use of this filter to heat water (by placing the ceramic filter directly over a fire).

However, the electric kettle was preferred in making hot water for tea and other purposes

24. What changes in this product would make it more desirable to the people in your community?

(See responses to question 17)

25. How much would you be willing to pay for this product?

2 of the participants would be willing to pay UGX 50000 (approximately USD \$14) for the product

1 of the participants would be willing to pay UGX 70000 (approximately USD \$19) for the product

1 of the participants would be willing to pay UGX 80000 (approximately USD \$21) for the product

5 of the participants would be willing to pay UGX 100000 (approximately USD \$27) for the product

2 of the participants would be willing to pay UGX 150000 (approximately USD \$40) for the product

1 of the participants would be willing to pay UGX 700000 (approximately USD \$187) for the product

4.4 DISCUSSION

Likes

Considering all responses, the participants in this trial were pleased with the operation of the box. Some of the things that cut across all participants in terms of what they liked about the box included the short time it takes the

Water Box to treat water, and the few steps needed to operate the box. (See responses to questions 3, 6, 9, 22, 18)

Some of the other factors that are attributed to this included the ease with which the Water Box could be used: for example, children could easily treat their drinking water, as the operation was not overly complex. (See response in question 3)

The general positive attitude towards the box is also derived from the rankings, comparisons options, willingness to retain the box and if the participants would be willing to recommend the product to their family and neighbors (see responses to questions 11, 12, 13 and 23).

Also, when provided with the option of keeping the box, four of the participants were willing to keep the box rather than take the compensation money that had been offered in appreciation of taking part in the field trial.

Dislikes

Dislikes on the Water Box can be categorized into what the users found difficult to use on the Water Box and what did not appeal to them, what changes they would make on the product, the comparison made with other products, how they felt about the product, what visitors thought about the product and if they thought the water from the product was safe to drink (see responses to questions 3, 4, 5, 10, 13, 16, 19, 23)

The things that the participants did not like about the box where about its make for example some participants did not like the location of the electronics box while some feared that it could get damaged, all participants found the size of the box to be limiting in terms of the quantity of water it could treat at a time.

There was also difficulty in handling and storing the box in terms of where to put it when treating the water, where to place it when using water from the box and where to keep it when it was not in use.

Due to the current power system of the Water Box, there was no extra or emergency power source that could be used in case there was no electricity. This means that the Water Box is not well-suited for areas that have frequent power outages or that do not have power. It is sometimes difficult to determine the real availability of electricity: the field technicians needed to recover and re-deploy two boxes because the original participants, while connected to power lines, did not have power during the trial period.

Willingness to pay for the product

As can be seen above, there is quite a range of willingness to pay for the Water Box, from USD \$14 to USD \$187. This might be related to the monthly income of the participants, which also varied widely. The table below provides these two values for each participating household.

PARTICIPANT NO	WATERBOX NO	Participant's monthly income (UGX)	Participant's monthly income (USD)	AVERAGE perceived cost (UGX)	AVERAGE perceived cost (USD)
7	99	Declined to answer		100000	\$27
17	102	0 - 500,000 UGX	\$0 - \$133	50000	\$13
6	100	>1,500,001 UGX	>\$400	70000	\$19
9	89	0 - 500,000 UGX	\$0 - \$133	80000	\$21
3	101	>1,500,001 UGX	>\$400	250000	\$67
12	97	500,001 - 800,000 UGX	\$133 - \$213	100000	\$27
15	95	>1,500,001 UGX	>\$400	100000	\$27
8	103	>1,500,001 UGX	>\$400	50000	\$13
2	112	800,001 - 1,500,000 UGX	\$213 - \$400	70000	\$19

5	94	0 - 500,000 UGX	\$0 - \$133	100000	\$27
		500,001 - 800,000 UGX	\$133 - \$213	80000	\$21
14	92				
1	96	>1,500,001 UGX	>\$400	150000	\$40
		500,001 - 800,000 UGX	\$133 - \$213	175000	\$47
3	98				

Table 4: This table shows the perceived cost of the box. This number is the average between their stated willingness to pay, and their estimate for how much someone would be willing to pay for the box in the market.

This data can also be expressed as a range and an average of perceived value, aggregated by income category. This is shown in Figure 3, below.

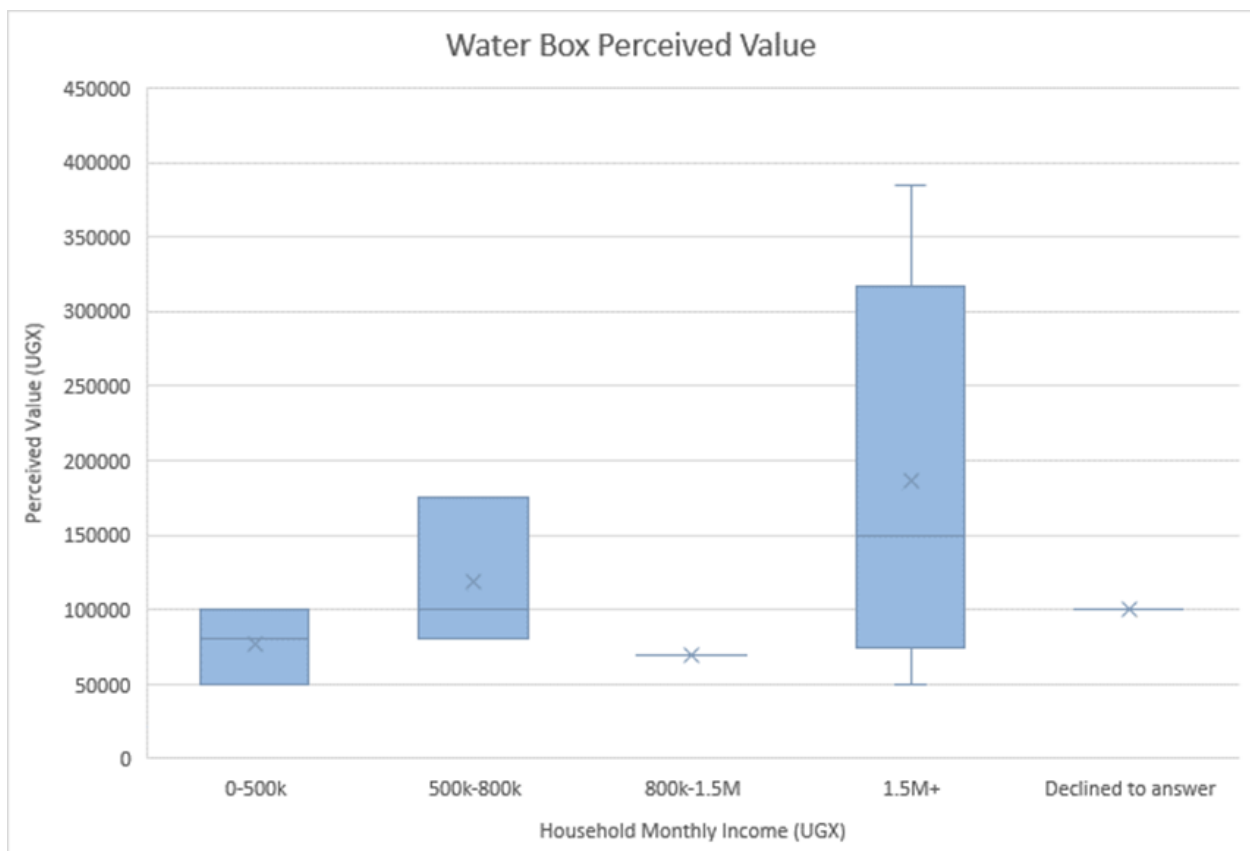


Figure 3: Perceived value of the Water Box by participants from different income categories. The overall median valuation is about UGX 118000 (\$31.50)

4.5 RECOMMENDATIONS FOR PRODUCT IMPROVEMENTS

In this section, the field technicians synthesize feedback from the community into concrete recommendations for improvements to the Water Box.

It should be noted and emphasized that the desire to increase the size of the Water Box to treat larger quantities of water cut across all participants. Due to factors like time, power consumed and usability, all households suggested that a larger container would be best suited for this product so that treatment of water would not have to be done regularly but once in a while for larger quantities.

In regards to the make or design of the Water Box, most of the participants would have preferred that the electronics box on the Water Box either be enclosed in the box, or its position be switched to the side of the box rather than on top of it.

Still on the design of the Water Box, it was suggested that the Water Box be designed in a shape to relate to the water containers available. This would be a jerry can, bucket or something cylindrical.

Further still, the tap on the Water Box should be moved to a new position. Its design could also be improved: for example, the tap could have a bend to allow the water to easily be emptied from the box.

A stand for the Water Box was also recommended to ease the handling, usage and storing of the Water Box.

Concerning an emergency or supplementary power source, it was suggested that the Water Box have an emergency battery or other power source to cater for cases or areas where electricity is unavailable.

A mechanism to change the taste of water was also recommended as an improvement for the boxes so that the taste of the water treated by the Water Box was not similar to that obtained from the tap. The feedback on changing the taste of the water may be because the user wanted confirmation of effective treatment. It is noted that the electric kettle is preferred by one participant because it is able to make water hot.

A water heating system for the water in the Water Box was also desired by one participant. This would give people an option to make tea from water treated in the Water Box.

Automation of the switch was also recommended. Just like an electric water kettle, an automatic switch with a clear indication that the treatment cycle is complete (such as movement of the switch as occurs on an electric kettle) would make using the Water Box much easier.

A sieve instead of a funnel was also recommended as an improvement for the Water Box. Considering the containers that people store their water in or sometimes the quality of water in the taps, a sieve would improve the appearance of the water. In cases of extreme turbidity (above 10 ntu), removal of particles could improve treatment performance. The sieve would also affirm to people that the water they are putting in the Water Box is at least clean from the eyes view.

A clear manual or instructions on the Water Box would also make the Water Box more desirable. The manual should clearly explain how the box works and most importantly how the water from the box is treated.

A secure seal for the Water Box, one that prevents the user from opening it, would improve its quality. This is so as to seal the box off from insects and dust that could further cause contamination on the water in the box.

(See answers to question 13, 16, 17, 19, 22, and 24.)

4.6 NOTES FROM ENUMERATORS

During the field trial, explaining the use of UV light to disinfect water by water bottling companies like Rwenzori was good and key in improving people's responses to the Water Box.

Also, the responses towards the trial were different. Some of the people were unwilling to take part in the study and some needed a little convincing. However, the majority of the people contacted in the community were very enthusiastic about the Water Box and were willing to take part in the study.

This can also be re-affirmed by the number of participants (almost half) that were willing to forego getting the UGX 60,000 compensation to be able to retain the boxes.

Some loggers indicated use of the box only during the demonstration by the field technicians (two of the 13 participants). It can be noted from the engagements with these particular participants that their responses about using the Water Box was in general less excited than other participants.

4.7 CONCLUSION

From the all visits carried out during this trial, it was clear that the community is willing to use the Water Box provided they understand how UV treatment works and its reliability in providing quality drinking water.

From all feedback gathered during the various visits conducted, there was clear willingness and interest in using the Water Boxes for the majority of the households. From the data collected from the loggers, some of the low rates in usage of the Water Box were explained by the schedules of those that stay in these households. Some participants were barely home during the day, and so did not have much opportunity to use the Water Box.

Still, due to its mode of operation, the Water Box would be an ideal household water treatment method that would not only boost the rate of treating water, but would also be a convenient way for people to have safe drinking water in their households. Consideration should be made about what appealed to the participants, what did not to appeal to them, and especially to the various changes and features that participants would like to see in the next generation of Water Box.

Factors like affordability would also have to be considered before the Water Box is released for official use. While people in communities are willing to use

a product like the Water Box, it becomes of concern if the cost of purchasing this product overwhelms the household income. Therefore, price should be highly considered in further production of the Water Box.

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APPENDIX A: SURVEY QUESTIONS AND CONSENT FORMS

Background Information:

- Where do you collect your water?
- How often is water available at that collection point(s)?
- How often is there no water at that collection point(s)?
- How many people live in your house?
- How much water do you use each day?
- Do you boil your water or provide any other treatment, such as using a filter?
- How much do you pay for water at the collection point(s)?
- How much do you pay for treatment (buying charcoal for boiling, filters, chlorine tablets)?
- What is your occupation?
- How would you rank the following water treatment options: Boiling, Filter, Chlorine tablet, Liquid chlorine

Final Survey:

- How many times per day do you use the water box?
- To what use do you put the water treated by the water box?
- Please describe how you feel about the product
- Do you think water treated by this device is safe to drink?
- What did visitors think about this product?
- Did having this product in your house solve any of your problems? If so, which ones?
- Did you use other methods of water treatment over the past month?
- If so, how many times per day did you use other methods of water treatment?
- What part of the product was easy to use?
- What part of the product was difficult to use?
- Would you recommend buying this product to your family? To your neighbors?
- How would you rank the following water treatment options, from best to worst?
Boiling, Filter, Chlorine tablet, Liquid chlorine, Water Box
- How would you comparing using this product to your current or previous method of water treatment?
- Would the introduction of this product have a positive or a negative impact on your community? In what ways?
- If this product was sold in a local market, how much money would people be willing to spend to buy it?
- If you could change one thing about the product, what would you change?
- What features would you like to see added to this product?
- What was your favourite part about using this product?
- What would make this product more attractive (desirable) if you saw it in the market?
- Do you think men or women would be more likely to buy this product in the market?
- What appeals to you about this product?
- What does not appeal to you about this product?

- Are there other products you would rather own than the Water Box? (Electric kettle, candle filter, etc?)
- What changes in this product would make it more desirable to people in your community?
- How much money would you be willing to pay for this product?

Willingness-to-Pay: Transaction and follow-up question

- As we mentioned at the beginning of the study, the Water Box is yours to keep. However, if it is still in good working order, we would like to offer you the opportunity to sell it back to us for ____ UGX. Would you like to sell it back, or would you prefer to keep it? We will be happy with whichever option you choose.
- Now, please pretend that you do not own / have never owned a Water Box. If you saw the device in the market, having just heard of it, how much would you be willing to pay for it?

Obubaka obunnyonnyola ebyafaayo:

- Amazzi gammwe mugakima wa?
- Mirundi emeka amazzi lwe gabaawo mu kifo oba mu bifo gye mugakima?
- Mirundi emeka amazzi lwe gatabaawo mu kifo oba mu bifo gye mugakima?
- Bantu bameka ababeera mu maka gammwe?
- Amazzi ge mukozesa buli lunaku genkana wa?
- Mufumba amazzi gammwe oba mugalongoosa mu ngeri endala yonna, okugeza nga okukozesa akasengejja?
- Musasula ssente mmeka mu kifo oba mu bifo gye mukima amazzi?
- Musasula ssente mmeka okugalongoosa (okugula amanda ag'okufumba amazzi, obusengejja, amakerenda ga chlorine)?
- Okola mulimu ki?
- Bubonero ki bwe wandiwadde enkola zino ez'okulongoosa amazzi: Okufumba, Okusengejja, ekkerenda lya Chlorine, Chlorine ow'amazzi

Okubuuliriza Okusembayo:

- Mirundi emeka buli lunaku gye mukozesa ekyuma kya water box?
- Amazzi agalongooseddwa ekyuma kya water box mugakozesa ki?
- Osabibwa okunnyonnyola engeri gy'owuliramu ku kyuma kino
- Olowooza amazzi agalongooseddwa ekyuma kino malungi okunywa?
- Abagenyi baalooza ki ku kyuma kino?
- Okuba n'ekyuma kino mu nnyumba yo kyagonjoola ebimu ku bizibu byo? Bwe kiba bwe kityo, bye biruwa?
- Wakozaako enkola endala ez'okulongoosa amazzi mu mwezi oguyise?
- Bwe kiba bwe kityo, mirundi emeka buli lunaku gye wakoza enkola endala ez'okulongoosa amazzi?
- Kitundu ki eky'ekyuma ekibadde ekyangu okukozesa?
- Kitundu ki eky'ekyuma ekibadde ekizibu okukozesa?
- Oyinza okukkiriza okugulira amaka go ekyuma kino? Baliraanwa bo?
- Bubonero ki bw'oyinza okuwa enkola zino ez'okulongoosa amazzi, okutandikira ku esinga obulungi okutuuka ku esinga obubi? Okufumba, Okusengejja, ekkerenda lya Chlorine, Chlorine ow'amazzi, Water Box
- Ogerageranya otya okukozesa ekyuma kino ku nkola gy'okozesa kati oba gye wali okozesa mu kusooka ey'okulongoosa amazzi?
- Okwanjula ekyuma kino kunakola bulungi ekitundu kyammwe oba kunakiyisa bubu? Mu ngeri ki?
- Singa ekyuma kino kibadde kitundibwa mu katale akomu kitundu, abantu bayinza kwagala kukozesa sente mmeka okukigula?
- Singa osobola okubaako ky'okyusa ku kyuma, kiki kye wandikyusizza?
- Bintu ki bye wandiyagadde okulaba nga byongerwa ku kyuma kino?
- Kitundu ki ky'osinze okwagala ku kukozesa ekyuma kino?

- Kiki ekiyinda okufuula ekyuma kino okwongera okuba ekisikiriza (ekyegombewa) singa okiraba mu katale?
- Olowooza abasajja n'abakazi bayinda okugula ekyuma kino mu katale?
- Kiki ekikusikiriza ku kyuma kino?
- Kiki ekitakusikiriza ku kyuma kino?
- Waliwo ebyuma ebirala bye wandiyagadde okuba nabyo mu kifo kya Water Box? (Ebbinika ey'amasannyalaze, candle filter, n'ebirala?)
- Nkyukakyuka ki mu kyuma kino eziyinda okowongera okukifuula ekyegombesa eri abantu b'omu kitundu kyammwe?
- Sente mmeka ze wandiyagadde okusasula okufuna ekyuma kino?

Obweteefuteefu okusasula: Obuguzi n'ekibuuzo ekirondoola

- Nga bwe twagambye ku ntandikwa y'okunonyereza, ekyuma kya Water Box ogenda kukyesigaliza (kikyoo). Wabula, bwe kiba nga kikyakola bulungi, twagala tukuwe omukisa okituguze ku siringisi ____ UGX. Wandiyagadde okukituguza, oba oyagala kukyesigaliza? Tugenda kuba basanyufu ku ngeri yonna gy'osalawo.
- Kati, osabibwa okwefuula nga atalina/ atabangako na kyuma kya Water Box. Singa olaba ekyuma kino mu katale, nga wakiwulirako buwulizi, oyinda kuba mweteefuteefu kukisasulira sente mmeka?

Explanation of Research

Project Title: Field Trials of a Prototype Household Water Treatment System Employing Ultraviolet Light as a Means of Action

Principal Contact: David Wituszynski, David.Wituszynski@emiworld.org, +256 076 922 138

Sponsor: Water Box Volunteers, paul.berg.water@gmail.com

Version Date: October 15, 2021

You are being asked to help test a product that the sponsor has developed. This product is a household water treatment system that uses ultraviolet light to make water safe to drink. If you choose to participate in this study, you will be provided with one of these units and trained how to use it. You will be asked to use this unit to treat water for yourself and your household during the project trial. You may use other forms of water treatment if you wish, but we request that you use this product whenever it is feasible for you to do so.

We will visit you three times during this project: Once to teach you how to use the product, and to ask some basic questions about your current water source and treatment practices. Within the next week we will return and make sure you know how to properly use the product. We will also answer any questions you have about it. Finally, one month after the start, we will return for a third visit and ask you questions about your use of the product. We will additionally ask for ideas about how to make the product better (for example, easier or more enjoyable for you to use), and for your valuation of the product. We anticipate these visits to take no more than one hour each.

Your responses will help the sponsor design a more useful product, which they hope to market to households in this region. At the end of the study, if your device is in good working order, we will offer to buy it back from you for a price which we will disclose at that time. You may choose to keep the device instead, at no additional cost.

Ultraviolet water treatment is an established technology that is used around the world to make water safe to drink. The units being provided to you have undergone testing by private laboratories in the United States and have been shown to provide safe drinking water. However, several factors might affect their ability to provide safe drinking water to you and your household. These include the quality of water you are treating (particularly if the water is very cloudy) and the way in which you operate the device. The device is designed to treat municipal water from a public tap stand or faucet. It is not designed to treat water from a river or other source. You will be trained how to use the device properly, and we are reasonably confident that when the device is used in this way it will produce water that is safe to drink. However, we cannot guarantee that your use of the device will always result in safe water. As part of this trial, we will ask to take water quality samples both from the source of the water you use, and from the water treated using this product. To the extent practical, we will share these results with you.

It is possible that people might learn that you participated in this study. However, the information you provide will be kept secret and will not be shared directly with anyone outside of the project. Only a summary of results will be shared. We will provide you with a summary of the results if you request one.

Participation in this study is entirely voluntary. You do not have to participate in this study. Choosing not to participate will not affect your relationship with any parties. If you choose to participate in this study

now, but later change your mind and do not want to be part of this study, you may leave this study by withdrawing your consent at any time.

This research was approved by Uganda Christian University Research Ethics Committee, registered number **UCUREC-2021-204**. In case of research ethics concerns, please contact the UCU REC chairperson, Professor Peter Waiswa, pwaiswa@musph.ac.ug or +256772405357 or UCU REC secretariat, Mr. Osborn Ahimbisibwe, oahimbisibwe@ucu.ac.ug or +256775737627

Clearance for this project was sought from the Uganda National Council for Science and Technology (UNCST).

If you have any questions about this study, please contact the study team using the information on this business card.

Signature of participant

Signature of Researcher

Date

Ebigambo ebikwata ku Kunoonyereza

Omutwe gwa Pulojekiti: Field Trials of a Prototype Household Water Treatment System Employing Ultraviolet Light as a Means of Action

Omukulu Atukirirwa: David Wituszynski, David.Wituszynski@emiworld.org, +256 076 922 138

Ataddemu ssente: Water Box Volunteers, paul.berg.water@gmail.com

Ennaku z'omwezi ez'ekiwandiiko: October 15, 2021

Osabibwa okuyambako okugezesa ekyuma ekyakolebwa ataddemu ssente. Ekyuma kino ekyakolebwa kironogoosa amazzi agakozesebwa mu maka nga kikozeza amaanyi ag'enjawulo ag'ekitangaala (ultraviolet light) okufuula amazzi okuba amalungi okunywa. Singa osalawo okwetaba mu kunoonyereza kuno, ogenda kuweebwa ekimu ku byuma bino era otendekebwe engeri y'okukikozeza. Ogenda kusabibwa okukozeza ekyuma kino okwerongoosezza amazzi g'okozesa n'ab'omu maka go nga pulojekiti egezesebwa. Oyinza okukozeza engeri endala okulongoosa amazzi bw'oba oyagadde, naye tusaba okozese ekyuma kino ekyakolebwa buli lwe kibeera ekyangu gy'oli okukola.

Tugenda kukukyalira emirundi esatu nga pulojekiti eno egenda mu maaso: Omulundi gumu ogukuyigiriza engeri y'okukozeza ekyuma ekyakolebwa, n'okubuuzayo ebibuuzo ebikwata ku gye muggya amazzi n'ebikolebwa okugalongoosa. Mu wiiki eddako tugenda kukomawo era tukakase nti omanya engeri y'okukozeza obulungi ekyuma ekyakolebwa. Era tugenda kwanukula ebibuuzo byonna by'olina ku kyo. Ekisembayo, omwezi gumu oluvannyuma lw'okutandika, tugenda kukomawo okukyala omulundi ogw'okusatu era tukubuuze ebibuuzo ebikwata ku bw'okozesa ekyuma ekyakolebwa. Tugenda era kubuuzo ebirowoozo ku ngeri y'okulongoosa omutindo gw'ekyuma (ekyokulabirako, okukifuula ekyangu era ekyeyagaza gy'oli okukozeza), n'okugerageranya omuwendo gw'ekyuma ekyakolebwa. Tusubira okukyala kuno okutwala obudde obutassuka ssaawa emu buli kumu.

By'oyanukula bigenda kuyamba ataddemu ssente okukola ekyuma eky'omugaso ennyo, ky'asuubira okuguza amaka agali mu kitundu kino. Ku nkomerero y'okunoonyereza, singa ekyuma kyo kiba kikola bulungi, tugenda kukikugulako ku bbeeyi gye tugenda okukubuulira mu kiseera ekyo. Mu kifo kya kyo oyinza okusalawo okusigaza ekyuma, awatali kwongera kusasula.

Okulongoosa amazzi n'amaanyi ag'enjawulo ag'ekitangaala (Ultraviolet water treatment) ye tekinologiya amanyiddwa obulungi akozesebwa mu nsi yonna okufuula amazzi okuba amalungi okunywa. Ebyuma ebibaweebwa byagezesebwa mu makeberero ag'obwannanyini mu United States era biragibwa okuba nga biwa amazzi amalungi okunywa. Wabula, ensonga eziwerako ziyinza okukosa obusobozi bwabyo okuwa amazzi amalungi okunywa gy'oli n'eri amaka go. Muno mulimu omutindo gw'amazzi g'olongoosa (naddala singa amazzi gabaamu ebikyafu) n'engeri g'okozesaamu ekyuma. Ekyuma kyakolebwa okulongoosa amazzi g'omu kibuga agava ku taapu ey'olukale. Tekyakolebwa kulongoosa mazzi gava mu mugga oba mu kifo ekirala. Mugenda kutendekebwa engeri y'okuzesamu obulungi ekyuma, era tuli bagumu bulungi nti ekyuma bwe kikozezebwa mu ngeri eno kigenda kuwa amazzi amalungi okunywa. Wabula, tetuyinza kukakasa nti bw'okozesa ekyuma kino ogenda kuba nga ofuna amazzi amalungi bulijjo. Nga ekitundu ku kugezesa kuno, tugenda kusaba tutwale sampulo z'omutindo gw'amazzi okuwa mu kifo ewava amazzi ge mukozesa, n'okuwa ku agalongooseddwa nga mukozesa ekyuma kino. Nga bwe kisoboka okukolebwa, tugenda kubawa ebivuddemu.

Kisoboka abantu okumanya nti weetaba mu kunoonyereza kuno. Wabula, obubaka bw'otuwa bugenda kukuumibwa nga bwa kyama era tebugenda kuweebwayo butereevu eri omuntu yenna atali mu

pulojekiti. Ebivuddemu ebiri mu bufunze byokka by'ebigenda okuweebwayo. Tugenda kukuwa ebivuddemu ebiri mu bufunze singa obisaba.

Okwetaba mu kunoonyereza kuno kwa kyeyagalire ddala. Tolina kwetaba mu kunoonyereza kuno. Okusalawo obuteetabamu tekikosa nkolagana yo n'abantu bonna. Singa osalawo okwetaba mu kunoonyereza kuno kati, naye oluvannyuma n'okyusa endowooza yo n'otayagala kubeera kitundu ku kunoonyereza kuno, oyinza okuva mu kunoonyereza kuno nga oyita mu kusazaamu olukusa lwo ekiseera kyonna.

Okunoonyereza kuno kwakirizibwa ab'akakiiko ka Uganda Christian University Research Ethics Committee, ennamba eyawandiisibwa **UCUREC-2021-204**. Singa wabeerawo ensonga ku mpisa y'okunoonyereza, osabibwa okutuukirira ssentebe wa UCU REC, Professor Peter Waiswa, pwaiswa@musph.ac.ug oba +256772405357 oba woofiisi y'omuwandiisi wa UCU REC, Mr. Osborn Ahimbisibwe, oahimbisibwe@ucu.ac.ug oba +256775737627

Olukusa lwa pulojekiti eno lwafunibwa okuva eri akakiiko ka Uganda National Council for Science and Technology (UNCST).

Singa obeera n'ebibuuzo byonna ebikwata ku kunoonyereza kuno, osabibwa okutuukirira abakola ku kunoonyereza nga weyambisa obubaka obuli ku bizineesi kaadi.

Omukono gw'ayeetabyemu

Omukono gw'Omuwandiisi

Ennaku z'omwezi

APPENDIX B: RESULTS OF UV INTENSITY TRIALS

Date	Time	Box	Bulb	Fluence Delivered at 120s	Max intensity within 120s	Notes
03/01/2022	15:38	133	27			
03/01/2022	15:41	133	27	277.11	2519	
03/01/2022	15:48	133	27	271.58	2455	
03/01/2022	15:54	133	27	283.33	2564	
03/01/2022	16:00	133	27	284.63	2581	
03/01/2022	16:08	133	27	282.41	2572	
04/01/2022	11:27	106	7	247.1	2450	Manually turned off at 11:37
04/01/2022	11:40	106	7	258.49	2460	
04/01/2022	11:57	106	7	263.73	2508	
04/01/2022	12:04	106	7	253.04	2486	
04/01/2022	12:11	106	7	261.84	2517	
04/01/2022	14:32	106	7	231.505	2443	Tried starting box before starting meter
04/01/2022	14:39	106	7	269.01	2562	
04/01/2022	14:45	106	7	253.775	2524	
04/01/2022	14:21	106	7	267.55	2571	
04/01/2022	14:26	106	7	290.325	2618	
04/01/2022	15:05	26	3	0	0	Actual zeros
04/01/2022	15:11	26	3	0	0	Actual zeros
04/01/2022	15:21	102	16	261.605	2680	Is this actually bulb 17?
04/01/2022	15:26	102	16	294.2	2741	
04/01/2022	15:33	102	16	290.2	2734	
04/01/2022	15:40	102	16	302.645	2750	Accidentally erased first point, substituted 1st point from next test
04/01/2022	16:09	102	16	NA	NA	Tape holding shutoff failed, test ended early
04/01/2022	16:11	102	16	292.16	2619	
04/01/2022	16:20	109	22	250.58	2606	
04/01/2022	16:27	109	22	280.91	2695	
04/01/2022	16:34	109	22	286.32	2707	
04/01/2022	16:45	109	22	235.17	2601	Tape holding shutoff failed, test ended early but still entered
04/01/2022	16:55	109	22	270.125	2650	
04/01/2022	17:22	109	22	279.12	2669	
11/01/2022	11:18	102	16	289.095	2745	Is this actually bulb 17?
11/01/2022	11:25	102	16	292.245	2729	
11/01/2022	11:32	102	16	301.73	2714	
11/01/2022	11:39	102	16	302.8	2728	
11/01/2022	11:46	102	16	306.97	2767	
11/01/2022	12:17	98	8	259.235	2643	

11/01/2022	12:25	98	8	299.985	2725	
11/01/2022	12:35	98	8	291.825	2723	
11/01/2022	12:41	98	8	300.625	2726	
11/01/2022	12:46	98	8	311.16	2732	
11/01/2022	13:33	107	12	274.79	2710	
11/01/2022	13:39	107	12	296.32	2756	
11/01/2022	13:46	107	12	310.07	2777	Test might have ended early because of shutoff, but still entered.
11/01/2022	13:58	107	12	288.585	2746	
11/01/2022	14:04	107	12	301.64	2752	
11/01/2022	14:15	128	2	294.165	2698	
11/01/2022	14:20	128	2	303.325	2774	
11/01/2022	14:26	128	2	306.04	2786	
11/01/2022	14:31	128	2	326.58	2823	
11/01/2022	14:38	128	2	316.025	2805	
11/01/2022	14:48	132	13	185.51	1836	Note: 13 is Sankyo Denki, not 1000bulbs
11/01/2022	14:53	132	13	NA	NA	Test ended early because tape holding shutoff failed; did not enter data
11/01/2022	14:56	132	13	NA	NA	Test ended early because tape holding shutoff failed; did not enter data
11/01/2022	14:58	132	13	217.13	1878	Note: 13 is Sankyo Denki, not 1000bulbs
11/01/2022	15:05	132	13	200.98	1861	Note: 13 is Sankyo Denki, not 1000bulbs
11/01/2022	15:12	132	13	202.25	1865	Note: 13 is Sankyo Denki, not 1000bulbs
11/01/2022	15:18	132	13	210.38	1867	Note: 13 is Sankyo Denki, not 1000bulbs
11/01/2022	15:39	93	6	182.57	1787	
11/01/2022	15:45	93	6	193.48	1834	
11/01/2022	15:51	93	6	192.18	1829	
11/01/2022	15:58	93	6	196	1841	
11/01/2022	18:11	93	6	184.43	1802	
11/01/2022	16:17	93	6	200.485	1854	
12/01/2022	09:15	114	14	266.395	2793	
12/01/2022	09:20	114	14	NA	NA	Shutoff tripped early; not entered
12/01/2022	09:30	114	14	265.185	2750	
12/01/2022	09:35	114	14	297.085	2830	
12/01/2022	10:02	114	14	274.005	2785	
12/01/2022	10:13	114	14	284.505	2828	
12/01/2022	10:21	92	11	NA	0	Tape holding shutoff failed, did not enter data.
12/01/2022	10:28	92	11	213.355	2201	
12/01/2022	10:36	92	11	223.74	2229	
12/01/2022	10:42	92	11	245.275	2285	
12/01/2022	10:49	92	11	235.87	2278	
12/01/2022	10:54	92	11	250.13	2308	
12/01/2022	11:03	99	10	277.165	2913	
12/01/2022	11:10	99	10	301.97	2963	

12/01/2022	11:14	99	10	325.935	2994	
12/01/2022	11:20	99	10	321.325	2995	
12/01/2022	11:30	99	10	319.185	2995	
12/01/2022	11:52	103	26	278.54	2810	Here might have been the point where the logger files become reliable; that is, that I can reliably keep the automatic shutoff disabled.
12/01/2022	11:57	103	26	308.235	2864	
12/01/2022	12:05	103	26	300.475	2852	
12/01/2022	12:14	103	26	300.435	2837	
12/01/2022	12:20	103	26	316.055	2857	
12/01/2022	12:27	108	17	298.545	3002	
12/01/2022	12:33	108	17	323.98	3050	
12/01/2022	12:40	108	17	335.645	3073	
12/01/2022	12:47	108	17	336.885	3078	
12/01/2022	12:52	108	17	347.45	3081	
12/01/2022	13:33	104	25	278.095	2808	
12/01/2022	13:37	104	25	312.035	2868	
12/01/2022	13:43	104	25	318.055	2878	
12/01/2022	13:49	104	25	315.435	2879	
12/01/2022	13:56	104	25	314.23	2878	
12/01/2022	14:02	112	23	5	48	Noticeably dim. Also, no logger board. Box had previously failed to turn on.
12/01/2022	14:09	112	23	4.31	37	Noticeably dim. Also, no logger board. Box had previously failed to turn on.
12/01/2022	18:07	105	6	264.555	2640	
12/01/2022	18:13	105	6	309.8	2753	Manually turned off at 18:33; electronics part of box is noticeably warm.
12/01/2022	18:33	105	6	315.075	2710	Manually turned off at 18:43
12/01/2022	18:43	105	6	305.825	2644	Manually turned off at 18:52
12/01/2022	18:52	105	6	297.59	2578	Manually turned off at 18:57
12/01/2022	19:02	97	9	294.185	2892	Seems too often (but not always) give a flash of light before settling into being on
12/01/2022	19:07	97	9	328.94	2914	
12/01/2022	19:14	97	9	334.83	2910	
12/01/2022	19:20	97	9	321.575	2902	
12/01/2022	19:25	97	9	335.99	2902	
13/01/2022	11:07	96	7	315.33	2997	
13/01/2022	11:12	96	7	338.345	3015	Accidentally erased first data point; used first point of next test instead.
13/01/2022	11:18	96	7	340.775	3017	
13/01/2022	11:25	96	7	335.09	3012	
13/01/2022	11:30	96	7	347.415	3015	
13/01/2022	16:17	93	KB18	215.585	1964	
13/01/2022	16:22	93	KB18	216.09	1978	
13/01/2022	16:32	93	KB18	205.09	1937	

13/01/2022	16:41	93	KB18	208.105	1948	
13/01/2022	16:46	93	KB18	218.435	1980	
14/01/2022	09:45	26	6	274.245	2811	
14/01/2022	10:07	26	6	276.565	2815	
14/01/2022	10:14	26	6	300.06	2881	
14/01/2022	10:32	26	6	289.545	2880	
14/01/2022	10:41	26	6	302.785	2900	
14/01/2022	15:29	93	KB18	224.45	2143	Tinfoil added behind bulb (though not very shiny)
14/01/2022	15:34	93	KB18	247.775	2239	Tinfoil added behind bulb (though not very shiny)
14/01/2022	15:37	93	KB18	261.005	2285	Tinfoil added behind bulb (though not very shiny)
14/01/2022	15:40	93	KB18	264.865	2296	Tinfoil added behind bulb (though not very shiny)
14/01/2022	15:43	93	KB18	266.495	2303	Tinfoil added behind bulb (though not very shiny)
17/01/2022	11:23	89	5	223.49	2512	
17/01/2022	11:29	89	5	244.03	2560	
17/01/2022	11:34	89	5	267.76	2666	
17/01/2022	11:38	89	5	279.085	2720	
17/01/2022	11:43	89	5	285.3	2740	
17/01/2022	11:51	110	24	221.415	2468	
17/01/2022	11:56	110	24	258.83	2667	
17/01/2022	12:02	110	24	275	2739	
17/01/2022	12:10	110	24	266.715	2822	
17/01/2022	12:17	110	24	270.31	2836	
17/01/2022	12:26	94	KB9	248.93	2692	
17/01/2022	12:31	94	KB9	289.865	2817	
17/01/2022	12:36	94	KB9	288.645	2818	
17/01/2022	12:42	94	KB9	285.52	2753	
17/01/2022	12:47	94	KB9	294.275	2762	
17/01/2022	13:34	91	15	289.9	3089	
17/01/2022	13:42	91	15	365.865	3413	
17/01/2022	13:48	91	15	327.345	3204	
17/01/2022	13:53	91	15	344.19	3248	
17/01/2022	13:57	91	15	352.4	3266	
17/01/2022	14:43	90	19	211.845	2389	
17/01/2022	14:48	90	19	250.405	2573	
17/01/2022	14:53	90	19	260.775	2619	
17/01/2022	14:58	90	19	271.69	2654	
17/01/2022	15:02	90	19	271.01	2628	
17/01/2022	15:09	101	20	272.905	2947	
17/01/2022	15:14	101	20	318.9	3080	
17/01/2022	15:19	101	20	332.005	3127	
17/01/2022	15:23	101	20	335.455	3127	
17/01/2022	15:28	101	20	333.965	3127	
18/01/2022	11:25	95	21	264.3	2917	

18/01/2022	11:33	95	21	284.18	2986	
18/01/2022	11:41	95	21	287.28	2996	
18/01/2022	11:47	95	21	308.425	3071	
18/01/2022	11:53	95	21	316.415	3102	
18/01/2022	11:59	111	18	274.29	2917	
18/01/2022	12:05	111	18	335.97	3048	
18/01/2022	12:11	111	18	341.775	3061	
18/01/2022	12:18	111	18	341.975	3068	
18/01/2022	12:24	111	18	353.125	3076	
18/01/2022	12:38	128	2	5.405	110	
18/01/2022	12:49	128	2	2.935	99	
18/01/2022	13:31	128	25	6.075	154	
18/01/2022	13:48	128	25	5.19	126	
18/01/2022	15:14	112	2	257.175	2742	
18/01/2022	15:20	112	2	284.525	2811	
18/01/2022	15:25	112	2	301.44	2856	Had to manually shut off; box was warm.
18/01/2022	???	112	2	349.78	3035	Might have forgotten to write this start time down. But it was obviously on for a while, as the box got hot. So, maybe started at 15:31 or so?
18/01/2022	15:47	112	2	287.05	2822	
18/01/2022	15:54	112	2	301.275	2865	
18/01/2022	16:04	100	KB16	293.025	3046	
18/01/2022	16:09	100	KB16	332.82	3131	
18/01/2022	16:14	100	KB16	339.355	3146	
18/01/2022	16:19	100	KB16	344.545	3154	
18/01/2022	16:23	100	KB16	352.32	3161	
20/01/2022	12:40	93	KB11	174.075	1732	
20/01/2022	12:45	93	KB11	191.325	1815	
20/01/2022	15:51	93	KB11	194.465	1862	
20/01/2022	15:56	93	KB11	197.035	1843	
20/01/2022	13:02	93	KB11	199.555	1886	
20/01/2022	16:52	132	KB18	332.19	3014	
20/01/2022	17:00	132	KB18	292.02	2804	
20/01/2022	17:07	132	KB18	303.255	2831	
20/01/2022	17:14	132	KB18	302.76	2834	
20/01/2022	17:21	132	KB18	308.505	2840	
21/01/2022	11:29	92	KB15	250.18	2673	
21/01/2022	11:34	92	KB15	291.805	2791	
21/01/2022	11:39	92	KB15	292.055	2795	
21/01/2022	11:47	92	KB15	267.625	2710	
21/01/2022	11:53	92	KB15	290.06	2797	Accidentally erased first data point; used first point of previous test instead.
03/02/2022	12:53	106	7	94.515	836	Full of borehole water, through quartz window on bottom. Sensor is some removed from bottom of

						box; should probably build a device to hold it close and in the proper position.
03/02/2022	13:31	106	7	NA	NA	Positioned the sensor closer to the window, and more accurately. Also forgot to record data; test data lost
03/02/2022	13:57	106	7	169.365	1740	
03/02/2022	14:02	106	7	191.58	1806	
03/02/2022	14:07	106	7	193.075	1805	
03/02/2022	14:20	106	7	177.365	1757	
03/02/2022	14:29	106	7	182.51	1778	
08/02/2021	17:45	106	7	148.415	1503	Through quartz window; box is empty
08/02/2021	17:51	106	7	164.64	1549	Through quartz window; box is empty
08/02/2021	18:02	106	7	169.445	1664	Moved sensor closer to window. Box is empty.
08/02/2021	18:07	106	7	191.47	1709	Through quartz window; box is empty
08/02/2021	18:15	106	7	185.19	1705	Through quartz window; box is empty
08/02/2021	18:20	106	7	188.275	1710	Through quartz window; box is empty
08/02/2021	18:27	106	7	187.925	1712	Through quartz window; box is empty
10/02/2021	09:53	106	7	171	1658	Through quartz window; box contains water from intern compound apartment 3. Needed to manually turn box off.
10/02/2021	09:58	106	7	172.035	1657	Through quartz window; box contains water from intern compound apartment 3.
10/02/2021	10:05	106	7	159.38	1611	Through quartz window; box contains water from intern compound apartment 3.
10/02/2021	10:15	106	7	154.855	1594	Through quartz window; box contains water from intern compound apartment 3.
10/02/2021	10:23	106	7	163.925	1632	Through quartz window; box contains water from intern compound apartment 3. Accidentally erased first data point, substituted first point from previous sequence.
10/02/2021	10:52	106	7	151.175	1576	Through quartz window; box is empty.
10/02/2021	15:58	106	7	167.975	1627	Through quartz window; box is empty.
10/02/2021	11:07	106	7	164.31	1626	Through quartz window; box is empty.
10/02/2021	11:16	106	7	169.7	1644	Through quartz window; box is empty.
10/02/2021	11:22	106	7	184.365	1683	Through quartz window; box is empty.
11/02/2022	12:27	106	7	151.125	1592	Through quartz window; box contains water from National Water tap on site.
11/02/2022	15:14	106	7	156.28	1602	Through quartz window; box contains water from National Water tap on site.
11/02/2022	15:21	106	7	168.125	1638	Through quartz window; box contains water from National Water tap on site.
11/02/2022	15:26	106	7	179.77	1672	Through quartz window; box contains water from National Water tap on site.
11/02/2022	15:32	106	7	177.285	1671	Through quartz window; box contains water from National Water tap on site.
11/02/2022	15:41	106	7	169.03	1655	Through quartz window; box contains water from National Water tap on site.

11/02/2022	15:52	106	7	163.69	1624	Through quartz window; box is empty.
11/02/2022	16:00	106	7	178.12	1666	Through quartz window; box is empty.
11/02/2022	16:06	106	7	177.635	1666	Through quartz window; box is empty.

APPENDIX C: RESULTS OF TIMING TESTS

Number of data points	timeStart	Duration (seconds)	Device
6	01/01/2000 00:00	11	98
4	22/11/2021 16:12	10	98
3	26/11/2021 11:02	4	98
3	26/11/2021 11:02	4	98
62	26/11/2021 15:32	124	98
59	26/11/2021 15:34	118	98
60	26/11/2021 15:36	120	98
63	29/11/2021 14:21	126	98
63	11/01/2022 12:19	126	98
62	11/01/2022 12:24	123	98
62	11/01/2022 12:33	124	98
61	11/01/2022 12:40	123	98
62	11/01/2022 12:45	124	98
63	13/01/2022 10:55	126	98
62	13/01/2022 11:03	123	98
61	13/01/2022 11:08	122	98
61	13/01/2022 11:13	121	98
61	13/01/2022 11:18	121	98
61	13/01/2022 11:22	121	98
61	13/01/2022 11:25	122	98
61	13/01/2022 11:30	122	98
61	13/01/2022 11:35	122	98
61	13/01/2022 11:38	121	98
61	13/01/2022 11:42	122	98
8	08/11/2021 15:50	18	96
1	17/11/2021 14:24	0	96
3	17/11/2021 14:25	4	96
7	01/01/2000 00:00	6.9E+08	96
36	01/01/2000 00:00	75	96
3	22/11/2021 12:06	4	96
7	22/11/2021 12:12	12	96
4	22/11/2021 12:12	7	96
1	24/11/2021 10:44	0	96
61	24/11/2021 10:46	121	96
59	24/11/2021 10:48	118	96
59	24/11/2021 10:50	118	96
59	24/11/2021 10:53	117	96
59	24/11/2021 10:55	118	96

62	26/11/2021 11:43	124	96
62	29/11/2021 14:17	123	96
63	13/01/2022 11:06	126	96
61	13/01/2022 11:12	121	96
61	13/01/2022 11:17	122	96
61	13/01/2022 11:24	121	96
61	13/01/2022 11:29	122	96
61	13/01/2022 11:40	122	96
61	13/01/2022 11:46	121	96
61	13/01/2022 11:50	122	96
61	13/01/2022 11:57	122	96
60	13/01/2022 12:01	120	96
1	18/11/2021 16:20	0	106
3	18/11/2021 16:21	4	106
7	22/11/2021 12:34	16	106
69	25/11/2021 10:39	138	106
67	25/11/2021 10:42	133	106
81	25/11/2021 10:45	162	106
61	25/11/2021 10:48	122	106
126	25/11/2021 10:51	253	106
110	25/11/2021 10:55	221	106
104	25/11/2021 10:59	209	106
93	25/11/2021 11:03	187	106
152	25/11/2021 11:06	306	106
98	25/11/2021 13:05	196	106
5	25/11/2021 13:09	8	106
215	25/11/2021 13:10	434	106
1	29/11/2021 11:50	0	106
2	29/11/2021 11:51	2	106
16	29/11/2021 11:53	30	106
26	29/11/2021 15:01	51	106
64	29/11/2021 15:02	128	106
46	29/11/2021 15:04	91	106
40	29/11/2021 15:08	80	106
32	29/11/2021 15:18	63	106
12	30/11/2021 14:18	22	106
65	01/12/2021 12:29	129	106
67	01/12/2021 12:32	133	106
2	01/12/2021 12:34	2	106
68	01/12/2021 12:34	136	106
61	01/12/2021 12:37	122	106
78	01/12/2021 12:39	156	106
69	01/12/2021 14:54	138	106

285	04/01/2022 11:27	577	106
60	04/01/2022 11:39	120	106
15	04/01/2022 11:55	28	106
63	04/01/2022 11:56	125	106
71	04/01/2022 12:03	142	106
83	04/01/2022 12:10	167	106
63	04/01/2022 14:31	126	106
1	04/01/2022 14:36	0	106
60	04/01/2022 14:36	120	106
63	04/01/2022 14:44	126	106
88	04/01/2022 14:50	176	106
62	04/01/2022 14:55	124	106
65	13/01/2022 11:03	130	106
68	13/01/2022 11:07	136	106
82	13/01/2022 11:10	165	106
88	13/01/2022 11:17	176	106
66	13/01/2022 11:22	132	106
86	13/01/2022 11:25	172	106
76	13/01/2022 11:30	152	106
68	13/01/2022 11:34	136	106
317	13/01/2022 11:37	642	106
798	13/01/2022 11:50	1618	106
2	01/01/2000 00:00	2	97
2	22/11/2021 15:13	2	97
6	22/11/2021 15:14	12	97
2	26/11/2021 11:13	2	97
4	26/11/2021 11:19	6	97
1	26/11/2021 11:19	0	97
1	26/11/2021 15:52	0	97
1	26/11/2021 15:53	0	97
1	26/11/2021 15:53	0	97
4	26/11/2021 15:53	6	97
59	26/11/2021 15:56	118	97
61	26/11/2021 15:59	122	97
61	26/11/2021 16:01	122	97
64	29/11/2021 13:48	128	97
64	12/01/2022 19:02	128	97
63	12/01/2022 19:06	125	97
1	12/01/2022 19:12	0	97
61	12/01/2022 19:12	121	97
63	12/01/2022 19:19	126	97
62	12/01/2022 19:24	125	97
64	13/01/2022 12:14	128	97

63	13/01/2022 12:22	126	97
63	13/01/2022 12:31	125	97
63	13/01/2022 12:36	126	97
63	13/01/2022 12:45	126	97
62	13/01/2022 12:49	124	97
25	01/01/2000 00:00	47	102
3	22/11/2021 12:10	4	102
5	22/11/2021 12:12	11	102
23	22/11/2021 12:15	47	102
1	26/11/2021 09:58	0	102
22	01/01/2000 00:00	6.91E+08	102
2	26/11/2021 10:00	2	102
2	26/11/2021 10:01	2	102
2	26/11/2021 10:01	2	102
18	26/11/2021 10:28	35	102
1	26/11/2021 10:30	0	102
2	26/11/2021 10:30	2	102
5	26/11/2021 10:59	10	102
66	30/11/2021 11:43	132	102
65	30/11/2021 11:46	129	102
65	30/11/2021 11:48	130	102
65	30/11/2021 11:50	130	102
67	30/11/2021 15:16	134	102
68	04/01/2022 15:21	136	102
65	04/01/2022 15:26	130	102
66	04/01/2022 15:33	132	102
66	04/01/2022 15:38	132	102
40	04/01/2022 16:08	79	102
62	04/01/2022 16:11	124	102
2	11/01/2022 11:17	2	102
64	11/01/2022 11:18	128	102
67	11/01/2022 11:25	134	102
67	11/01/2022 11:31	134	102
67	11/01/2022 11:38	134	102
66	11/01/2022 11:45	132	102
67	13/01/2022 11:36	133	102
67	13/01/2022 11:42	134	102
66	13/01/2022 11:46	132	102
66	13/01/2022 11:51	132	102
67	13/01/2022 11:58	134	102
65	13/01/2022 12:01	130	102
67	13/01/2022 12:11	134	102
67	13/01/2022 12:20	134	102

67	13/01/2022 12:32	134	102
66	13/01/2022 12:36	132	102
11	03/11/2021 18:54	22	103
6	03/11/2021 18:55	12	103
3	08/11/2021 15:51	4	103
14	08/11/2021 15:51	26	103
50	01/01/2000 00:00	6.9E+08	103
42	01/01/2000 00:00	45	103
3	01/01/2000 00:00	4	103
4	22/11/2021 12:12	6	103
3	22/11/2021 12:13	4	103
4	22/11/2021 12:18	6	103
5	22/11/2021 12:18	9	103
1	23/11/2021 13:46	0	103
1	23/11/2021 15:42	0	103
2	26/11/2021 09:58	2	103
4	26/11/2021 09:58	6	103
6	26/11/2021 10:20	10	103
1	26/11/2021 10:21	0	103
3	26/11/2021 10:58	4	103
3	26/11/2021 10:58	4	103
63	30/11/2021 11:18	125	103
63	30/11/2021 11:22	125	103
62	30/11/2021 11:25	123	103
14	30/11/2021 14:28	27	103
63	01/12/2021 14:57	126	103
64	02/12/2021 14:50	127	103
63	12/01/2022 11:52	125	103
63	12/01/2022 11:57	125	103
63	12/01/2022 12:05	125	103
63	12/01/2022 12:14	125	103
63	12/01/2022 12:20	126	103
64	13/01/2022 11:52	128	103
63	13/01/2022 11:58	126	103
62	13/01/2022 12:01	123	103
63	13/01/2022 12:12	125	103
63	13/01/2022 12:20	125	103
63	13/01/2022 12:32	125	103
63	13/01/2022 12:36	125	103
63	13/01/2022 12:45	126	103
63	13/01/2022 12:49	126	103
64	13/01/2022 13:28	128	103
1	18/11/2021 13:32	0	108

3	18/11/2021 13:32	4	108
17	22/11/2021 11:34	33	108
5	22/11/2021 11:34	8	108
122	24/11/2021 16:39	246	108
153	24/11/2021 16:43	308	108
97	24/11/2021 16:48	195	108
89	25/11/2021 10:36	179	108
266	25/11/2021 12:45	537	108
105	25/11/2021 12:54	211	108
21	25/11/2021 12:58	41	108
1	25/11/2021 12:59	0	108
173	25/11/2021 12:59	349	108
1	29/11/2021 12:00	0	108
156	29/11/2021 12:00	314	108
85	29/11/2021 12:19	170	108
67	29/11/2021 12:23	134	108
67	29/11/2021 12:27	134	108
23	29/11/2021 12:29	45	108
68	29/11/2021 12:39	136	108
66	29/11/2021 12:41	132	108
66	29/11/2021 12:44	132	108
69	01/12/2021 14:11	138	108
67	01/12/2021 14:14	134	108
67	01/12/2021 14:18	135	108
66	01/12/2021 14:20	132	108
66	01/12/2021 14:23	132	108
68	01/12/2021 14:47	136	108
69	02/12/2021 14:47	138	108
69	12/01/2022 12:26	138	108
68	12/01/2022 12:33	136	108
68	12/01/2022 12:39	136	108
68	12/01/2022 12:46	136	108
68	12/01/2022 12:52	137	108
69	13/01/2022 11:47	138	108
68	13/01/2022 11:52	136	108
68	13/01/2022 11:58	136	108
67	13/01/2022 12:01	134	108
68	13/01/2022 12:11	136	108
68	13/01/2022 12:20	136	108
68	13/01/2022 12:31	136	108
67	13/01/2022 12:36	134	108
68	13/01/2022 12:45	136	108
67	13/01/2022 12:49	134	108

6	22/11/2021 12:03	11	107
10	22/11/2021 12:04	22	107
64	25/11/2021 11:11	127	107
105	25/11/2021 11:13	210	107
125	25/11/2021 11:18	251	107
96	25/11/2021 11:25	192	107
125	25/11/2021 11:29	250	107
27	25/11/2021 12:33	53	107
84	25/11/2021 15:54	168	107
111	25/11/2021 15:57	223	107
65	25/11/2021 16:01	129	107
79	25/11/2021 16:04	158	107
76	25/11/2021 16:08	151	107
63	26/11/2021 12:20	125	107
64	11/01/2022 13:31	128	107
109	11/01/2022 13:38	218	107
61	11/01/2022 13:45	121	107
62	11/01/2022 13:56	123	107
104	11/01/2022 14:03	208	107
92	13/01/2022 10:53	184	107
67	13/01/2022 10:58	134	107
76	13/01/2022 11:03	151	107
175	13/01/2022 11:06	353	107
76	13/01/2022 11:17	152	107
67	13/01/2022 11:21	134	107
238	13/01/2022 11:24	480	107
182	13/01/2022 11:33	366	107
77	13/01/2022 11:40	154	107
61	13/01/2022 11:45	121	107
1	22/11/2021 16:05	0	132
1	22/11/2021 16:05	0	132
5	22/11/2021 16:05	11	132
3	26/11/2021 11:08	4	132
3	26/11/2021 11:08	4	132
1	26/11/2021 13:14	0	132
64	11/01/2022 14:47	128	132
27	11/01/2022 14:52	52	132
39	11/01/2022 14:55	77	132
62	11/01/2022 14:58	124	132
73	11/01/2022 15:05	146	132
83	11/01/2022 15:11	166	132
62	11/01/2022 15:18	123	132
68	13/01/2022 12:34	135	132

67	13/01/2022 12:45	134	132
71	13/01/2022 12:49	142	132
77	13/01/2022 13:27	153	132
62	13/01/2022 13:35	123	132
67	13/01/2022 14:05	134	132
67	13/01/2022 14:09	133	132
71	13/01/2022 14:12	142	132
81	13/01/2022 14:17	162	132
72	13/01/2022 14:34	144	132
11	24/11/2021 14:17	22	93
2	26/11/2021 11:04	3	93
2	26/11/2021 11:04	2	93
63	26/11/2021 14:53	125	93
61	26/11/2021 14:55	121	93
61	26/11/2021 14:57	121	93
62	30/11/2021 15:05	124	93
64	01/12/2021 14:59	127	93
64	02/12/2021 14:53	128	93
64	11/01/2022 15:38	128	93
63	11/01/2022 15:44	125	93
63	11/01/2022 15:50	126	93
63	11/01/2022 15:56	125	93
64	11/01/2022 18:09	128	93
63	11/01/2022 18:15	125	93
64	13/01/2022 16:16	127	93
63	13/01/2022 16:21	126	93
63	13/01/2022 16:31	126	93
63	13/01/2022 16:40	125	93
63	13/01/2022 16:45	126	93
64	14/01/2022 09:04	127	93
62	14/01/2022 09:08	123	93
62	14/01/2022 09:11	124	93
62	14/01/2022 09:14	123	93
62	14/01/2022 09:17	123	93
36	28/09/2021 13:36	71	99
35	28/09/2021 13:37	69	99
6	28/09/2021 13:40	10	99
16	28/09/2021 13:40	30	99
15	28/09/2021 13:42	29	99
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110	18/01/2022 12:18	221	111
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211	02/12/2021 12:31	429	133
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61	19/01/2022 12:07	121	92
6	01/01/2000 00:00	6.92E+08	100
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2	01/12/2021 12:29	2	100
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63	19/01/2022 12:07	125	100
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62	26/11/2021 14:17	123	94
59	26/11/2021 14:19	120	94
61	26/11/2021 14:22	121	94

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62	20/01/2022 16:14	124	112.2
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118	21/01/2022 00:18	238	106.2
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72	21/01/2022 03:36	144	106.2
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62	03/02/2022 08:50	124	90
63	03/02/2022 09:43	126	90
63	03/02/2022 10:21	126	90
63	03/02/2022 10:49	126	90
63	03/02/2022 14:47	126	90

62	03/02/2022 14:52	124	90
63	03/02/2022 15:26	126	90
63	03/02/2022 16:46	126	90
63	07/02/2022 10:01	126	90
62	07/02/2022 10:09	124	90
63	07/02/2022 11:48	126	90
63	07/02/2022 12:41	125	90
63	07/02/2022 16:35	126	90
63	07/02/2022 17:50	126	90
62	07/02/2022 18:20	124	90
62	07/02/2022 18:54	124	90
63	08/02/2022 11:29	126	90
63	08/02/2022 12:09	126	90
62	08/02/2022 12:16	124	90
63	08/02/2022 14:36	125	90
63	08/02/2022 15:58	126	90
63	08/02/2022 16:09	125	90
63	08/02/2022 16:33	126	90
63	08/02/2022 16:58	126	90
63	09/02/2022 10:38	126	90
62	09/02/2022 10:55	124	90
63	09/02/2022 13:26	126	90
63	09/02/2022 13:57	126	90
63	09/02/2022 15:11	126	90
63	09/02/2022 15:26	126	90
63	09/02/2022 16:36	127	90
63	10/02/2022 08:09	126	90
62	10/02/2022 08:29	124	90
63	10/02/2022 09:10	126	90
63	10/02/2022 14:57	126	90
63	10/02/2022 15:19	125	90
63	10/02/2022 15:31	126	90
63	10/02/2022 16:19	126	90
79	24/01/2022 12:43	158	114
68	24/01/2022 13:18	136	114
80	24/01/2022 14:45	160	114
89	24/01/2022 15:23	178	114
62	24/01/2022 16:36	123	114
62	25/01/2022 08:40	124	114
68	25/01/2022 08:51	136	114
71	25/01/2022 09:18	142	114
67	25/01/2022 09:26	134	114
62	25/01/2022 09:40	124	114

84	25/01/2022 09:47	168	114
62	25/01/2022 10:08	124	114
62	25/01/2022 13:45	123	114
68	25/01/2022 13:52	136	114
645	25/01/2022 14:06	1307	114
63	27/01/2022 12:35	126	114
68	27/01/2022 14:57	136	114
84	27/01/2022 15:31	168	114
74	27/01/2022 16:22	148	114
63	28/01/2022 13:28	126	114
69	28/01/2022 13:38	138	114
62	28/01/2022 13:58	124	114
62	28/01/2022 14:38	124	114
63	28/01/2022 15:34	126	114
68	28/01/2022 16:18	136	114
84	31/01/2022 11:18	168	114
62	31/01/2022 11:30	124	114
62	31/01/2022 11:37	124	114
82	31/01/2022 11:41	164	114
84	31/01/2022 11:49	169	114
68	31/01/2022 12:42	136	114
62	31/01/2022 13:32	124	114
62	31/01/2022 15:19	124	114
62	31/01/2022 16:08	124	114
62	31/01/2022 16:32	124	114
68	01/02/2022 08:58	136	114
62	01/02/2022 10:14	124	114
62	01/02/2022 10:52	124	114
62	01/02/2022 11:32	124	114
62	01/02/2022 12:55	123	114
68	01/02/2022 13:36	136	114
67	01/02/2022 13:44	134	114
62	01/02/2022 14:07	123	114
79	03/02/2022 08:45	158	114
61	03/02/2022 08:51	122	114
62	03/02/2022 09:44	123	114
62	03/02/2022 10:21	124	114
62	03/02/2022 10:49	124	114
63	07/02/2022 10:03	126	114
67	07/02/2022 10:09	134	114
62	07/02/2022 11:49	123	114
68	07/02/2022 12:41	136	114
62	07/02/2022 16:35	124	114

66	07/02/2022 17:50	132	114
62	07/02/2022 18:21	124	114
62	07/02/2022 18:55	124	114
68	08/02/2022 11:30	136	114
62	08/02/2022 12:10	124	114
62	08/02/2022 12:16	124	114
79	08/02/2022 14:36	158	114
95	08/02/2022 15:59	191	114
61	08/02/2022 16:10	123	114
68	08/02/2022 16:33	135	114
88	08/02/2022 16:59	177	114
62	09/02/2022 10:38	124	114
62	09/02/2022 10:56	124	114
68	09/02/2022 13:26	136	114
89	09/02/2022 13:58	179	114
73	09/02/2022 15:12	146	114
179	09/02/2022 15:27	361	114
62	09/02/2022 16:37	123	114
62	10/02/2022 08:09	124	114
67	10/02/2022 08:29	134	114
62	10/02/2022 09:10	124	114
82	10/02/2022 09:19	165	114
68	10/02/2022 14:58	136	114
62	10/02/2022 15:20	124	114
62	10/02/2022 15:31	124	114
62	10/02/2022 16:20	123	114
62	10/02/2022 16:51	123	114
1367	11/02/2022 08:21	2772	114
41	11/02/2022 15:18	155	114
143	06/04/2022 15:01	288	96
139	06/04/2022 15:11	280	96
139	06/04/2022 15:25	279	96
139	06/04/2022 15:49	280	96
139	06/04/2022 16:18	280	96
139	06/04/2022 16:53	280	96
140	11/04/2022 08:32	282	96
139	11/04/2022 09:06	280	96
138	11/04/2022 09:47	278	96
88	11/04/2022 10:33	177	96
151	09/04/2022 18:17	303	101
147	09/04/2022 18:27	295	101
146	09/04/2022 18:39	293	101
147	09/04/2022 19:03	295	101

146	09/04/2022 19:17	293	101
146	09/04/2022 19:37	293	101
146	09/04/2022 20:05	293	101
146	09/04/2022 20:27	294	101
146	09/04/2022 20:51	294	101
144	09/04/2022 21:02	290	101
146	09/04/2022 17:42	295	91
144	09/04/2022 18:14	290	91
142	09/04/2022 18:27	286	91
141	09/04/2022 18:38	284	91
142	09/04/2022 19:02	286	91
141	09/04/2022 19:16	284	91
142	09/04/2022 19:37	286	91
142	09/04/2022 20:04	286	91
142	09/04/2022 20:27	286	91
142	09/04/2022 20:50	286	91
147	07/04/2022 14:53	297	95
144	07/04/2022 15:05	290	95
144	07/04/2022 15:33	290	95
144	07/04/2022 15:49	290	95
144	07/04/2022 16:43	290	95
145	08/04/2022 09:18	292	95
143	08/04/2022 09:31	288	95
144	08/04/2022 10:58	290	95
143	08/04/2022 11:16	287	95
144	08/04/2022 11:40	290	95
142	09/04/2022 20:52	288	94
141	09/04/2022 21:02	283	94
142	11/04/2022 08:28	286	94
140	11/04/2022 09:06	282	94
141	11/04/2022 10:33	284	94
141	11/04/2022 11:24	284	94
141	11/04/2022 12:24	284	94
140	11/04/2022 12:44	282	94
140	11/04/2022 12:57	282	94
140	11/04/2022 13:36	281	94
147	07/04/2022 15:50	296	110
168	07/04/2022 15:58	338	110
193	07/04/2022 16:42	389	110
144	08/04/2022 09:17	290	110
177	08/04/2022 09:30	356	110
155	08/04/2022 10:57	313	110
198	08/04/2022 11:15	399	110

203	08/04/2022 11:39	410	110
178	09/04/2022 16:34	359	110
143	09/04/2022 16:57	288	110
236	07/04/2022 11:30	477	133
326	07/04/2022 11:42	660	133
156	07/04/2022 12:23	315	133
487	07/04/2022 12:32	987	133
145	07/04/2022 13:49	292	133
170	07/04/2022 13:56	343	133
880	07/04/2022 14:17	1785	133
389	09/04/2022 16:34	787	133
264	09/04/2022 16:57	534	133
168	09/04/2022 17:42	339	133
145	07/04/2022 11:30	292	112
142	07/04/2022 11:43	286	112
142	07/04/2022 12:24	287	112
140	07/04/2022 12:33	282	112
142	07/04/2022 13:50	286	112
140	07/04/2022 13:57	282	112
141	07/04/2022 14:18	284	112
141	07/04/2022 14:52	284	112
140	07/04/2022 15:04	282	112
141	07/04/2022 15:33	284	112
148	11/04/2022 11:25	299	103
147	11/04/2022 12:24	296	103
146	11/04/2022 12:45	294	103
145	11/04/2022 12:57	292	103
145	11/04/2022 13:36	292	103
145	11/04/2022 13:52	292	103
145	11/04/2022 14:15	292	103
145	11/04/2022 14:38	292	103
145	11/04/2022 15:08	292	103
145	11/04/2022 15:56	292	103
144	06/04/2022 17:29	292	99
141	06/04/2022 17:43	285	99
140	06/04/2022 17:51	282	99
142	06/04/2022 18:19	286	99
142	06/04/2022 18:56	286	99
142	07/04/2022 08:34	286	99
142	07/04/2022 10:10	286	99
141	07/04/2022 10:40	284	99
141	07/04/2022 11:05	284	99
140	07/04/2022 11:14	282	99

143	08/04/2022 16:12	288	99
141	08/04/2022 16:29	284	99
142	08/04/2022 17:04	286	99
144	09/04/2022 16:23	291	99
141	09/04/2022 16:33	285	99
141	09/04/2022 16:57	284	99
142	09/04/2022 19:13	286	99
141	09/04/2022 19:36	284	99
141	09/04/2022 20:04	284	99
141	09/04/2022 20:26	284	99
146	09/04/2022 16:23	295	89
132	06/04/2022 13:49	265	97
142	06/04/2022 13:59	286	97
141	06/04/2022 14:06	284	97
143	06/04/2022 14:27	288	97
142	06/04/2022 14:38	287	97
143	06/04/2022 14:50	288	97
146	11/04/2022 14:01	295	97
144	11/04/2022 14:24	290	97
143	11/04/2022 14:44	288	97
143	11/04/2022 15:08	288	97
143	11/04/2022 15:55	288	97
143	11/04/2022 16:17	288	97
144	12/04/2022 10:26	290	97
143	12/04/2022 10:54	288	97
143	12/04/2022 11:41	288	97
143	12/04/2022 12:16	288	97
154	06/04/2022 14:27	311	102
151	06/04/2022 14:38	305	102
151	06/04/2022 14:50	305	102
153	12/04/2022 10:40	309	102
151	12/04/2022 10:54	304	102
151	12/04/2022 11:14	305	102
149	12/04/2022 11:41	301	102
151	12/04/2022 12:16	305	102
150	12/04/2022 12:43	303	102
144	06/04/2022 17:30	290	92
141	06/04/2022 17:44	284	92
139	06/04/2022 17:53	280	92
141	06/04/2022 18:20	284	92
141	06/04/2022 18:57	284	92
142	07/04/2022 08:35	287	92
141	07/04/2022 10:11	284	92

141	07/04/2022 10:41	284	92
140	07/04/2022 11:06	282	92
140	07/04/2022 11:16	283	92
143	11/04/2022 12:55	288	98
143	11/04/2022 13:36	288	98
142	11/04/2022 13:52	286	98
142	11/04/2022 14:15	287	98
143	11/04/2022 14:37	288	98
143	11/04/2022 15:08	288	98
143	11/04/2022 15:56	289	98
143	11/04/2022 16:17	289	98
144	12/04/2022 10:26	290	98
141	12/04/2022 10:35	284	98
142	12/04/2022 12:15	286	100
142	12/04/2022 12:28	285	100
143	12/04/2022 12:43	288	100
144	12/04/2022 13:53	289	100
143	12/04/2022 14:23	288	100
143	12/04/2022 14:40	288	100
143	12/04/2022 15:16	287	100
144	12/04/2022 17:46	289	100
143	12/04/2022 18:17	288	100
144	13/04/2022 09:11	289	100
141	13/04/2022 09:19	284	100
145	12/04/2022 12:46	292	89
144	12/04/2022 13:56	290	89
143	12/04/2022 14:23	288	89
143	12/04/2022 15:15	288	89
144	12/04/2022 17:45	290	89
143	12/04/2022 18:16	288	89
144	13/04/2022 09:10	290	89
141	13/04/2022 09:18	284	89
142	13/04/2022 09:36	286	89

APPENDIX D: RESULTS FROM PRE-DEPLOYMENT AND FROM FIELD BACTERIA TESTS

Sample Collection			Test Procedure				Test Results (MPN is colonies per 100 mL)												WHO Risk Category	Turbidity (NTU)							
Source	Date	Time	Date	Time	Dilution	Incubation Temp (C)	Date	Time	E. Coli Compartments (+ or -)					Total Coliform Compartments (+ or -)				Log Removal									
									1	2	3	4	5	MPN	MPN upper confidence	1	2				3	4	5	MPN	Log Removal		
Office 1:100	25-04-22	16:30	25-04-22	16:30	1:100	35	26-04-22	14:17							0.0	2.87	NA						0.0	NA	Safe		
Office 1:10	25-04-22	16:30	25-04-22	16:30	1:10	35	26-04-22	14:17	mis-test: tap is blue					bottom is not clear		NA								>100	NA	Unsafe	
101	25-04-22	16:30	25-04-22	16:30		35	26-04-22	14:23							0.0	2.87	NA							0.0	>2	Safe	
91	25-04-22	16:30	25-04-22	16:30		35	26-04-22	14:26							0.0	2.87	NA							>100	0	Unsafe	
97	25-04-22	16:30	25-04-22	16:30		35	26-04-22	14:31							0.0	2.87	NA							3.2	>2	Possibly Safe	
96	27-04-22	14:20	27-04-22	15:00		35	28-04-22	15:30							0.0	2.87	NA							48.3	>1	High Risk	
92	27-04-22	14:20	27-04-22	15:00		35	28-04-22	15:30							0.0	2.87	NA							3.2	>2	Possibly Safe	
98	27-04-22	14:20	27-04-22	15:00		35	28-04-22	15:30							0.0	2.87	NA							1.2	>2	Possibly Safe	
102	27-04-22	14:20	27-04-22	15:00		35	28-04-22	15:30							0.0	2.87	NA							4.7	>2	Possibly Safe	
94	27-04-22	14:20	27-04-22	15:00		35	28-04-22	15:30							0.0	2.87	NA							0.0	3	Safe	

103	27-04-22	14:20	27-04-22	15:00		35	28-04-22	15:30						0.0	2.87	NA				0.0	3	Safe	
Office no dilution	27-04-22	14:20	27-04-22	15:00		35	28-04-22	15:30						13.6	83.06	NA				>100	NA	Unsafe	
Office 1:10	27-04-22	14:20	27-04-22	15:00		35	28-04-22	15:30						47.0	22.75	NA				483	NA	Probably unsafe	
Office 1:100	27-04-22	14:20	27-04-22	15:00		35	28-04-22	15:30						1.2	5.64	NA				4830	NA	Unsafe	
96	29-04-22	10:20	29-04-22	11:00		35	30-04-22	13:00						0.0	2.8	2				4.7	>3	Possibly Safe	
1:10 Office	29-04-22	10:20	29-04-22	11:00		35	30-04-22	13:00						47.0	227.5	NA				>1000	NA	Unsafe	
95	29-04-22	10:20	29-04-22	11:00		35	30-04-22	13:00						4.7	22.75	1				48.3	>2	Possibly Safe	
1:100 Office	29-04-22	10:20	29-04-22	11:00		35	30-04-22	13:00						340.0	1253	NA				>10000	NA	Unsafe	
112	29-04-22	10:20	29-04-22	11:00		35	30-04-22	13:00						0.0	2.87	2				>100	Unknown	Probably unsafe	
89	29-04-22	10:20	29-04-22	11:00		35	30-04-22	13:00						0.0	2.87	2				48.3	>2	Unsafe	
99	29-04-22	10:20	29-04-22	11:00		35	30-04-22	13:00						0.0	2.87	2				9.6	>2	Unsafe	
100	29-04-22	10:20	29-04-22	11:00		35	30-04-22	13:00						0.0	2.87	2				13.6	>2	Probably unsafe	
91	28-04-22	16:25	28-04-22	17:05		35	29-04-22	13:31						0.0	2.87	2				>100	Unknown	Possibly Unsafe	
101	28-04-22	16:25	28-04-22	17:05		35	29-04-22	13:31						0.0	2.87	2				1.2	3	Probably Safe	

97	28-04-22	16:25	28-04-22	17:05		35	29-04-22	13:31						0.0	2.87	2					2.1	3	Probably Safe	
96	28-04-22	16:25	28-04-22	17:05		35	29-04-22	13:31						0.0	2.87	2					0.0	4	Safe	
94	28-04-22	16:25	28-04-22	17:05		35	29-04-22	13:31						0.0	2.87	2					13.6	2	Possibly Unsafe	
Office 1:100	28-04-22	16:25	28-04-22	17:05		35	29-04-22	13:31						15.0	781	NA					1360	NA	Unsafe	
office 1:10	28-04-22	16:25	28-04-22	17:05		35	29-04-22	13:31						34.0	125.3	NA					>1000	NA	Unsafe	
89	05/02/2022	14:30	05/02/2022	14:58		35	05/03/2022	11:30						0.0	2.87	2					1.5	3	Probably Safe	
103	05/02/2022	14:30	05/02/2022	14:58		35	05/03/2022	11:30						0.0	2.87	2					0.0	4	Safe	
100	05/02/2022	14:30	05/02/2022	14:58		35	05/03/2022	11:30						0.0	2.87	2					3.9	3	Possibly Safe	
112	05/02/2022	14:30	05/02/2022	14:58		35	05/03/2022	11:30						0.0	2.87	2					48.3	2	High risk	
99	05/02/2022	14:30	05/02/2022	14:58		35	05/03/2022	11:30						0.0	2.87	2					4.7	3	Possibly Safe	
Office 1:100	05/02/2022	14:30	05/02/2022	14:58	1:100	35	05/03/2022	11:30						0.0	2.87	NA					4830.0	NA	Unsafe	
Office 1:10	05/02/2022	14:30	05/02/2022	14:58	1:10	35	05/03/2022	11:30						47.0	227.5	NA					>1000	NA	Unsafe	
94 Tap	05/03/2022	13:00	05/03/2022	13:30		35	05/04/2022	12:15						0.0	2.87	NA					1.2	NA	Probably Safe	
94 Treated	05/03/2022	13:00	05/03/2022	13:30		35	05/04/2022	12:15						0.0	2.87	NA					13.6	-1	High Risk	

094 Boiled	05/03/2022	13:00	05/03/2022	13:30		35	05/04/2022	12:15						0.0	2.87	NA				2.6	0	Probably Safe	
101 Source	05/03/2022	13:00	05/03/2022	13:30		35	05/04/2022	12:15						0.0	2.87	NA				>100	NA	Unsafe	
101 Treated	05/03/2022	13:00	05/03/2022	13:30		35	05/04/2022	12:15						0.0	2.87	NA				13.6	>1	High risk	
096 Source	05/03/2022	13:00	05/03/2022	13:30		35	05/04/2022	12:15						0.0	2.87	NA				13.6	NA	High risk	
096 Treated	05/03/2022	13:00	05/03/2022	13:30		35	05/04/2022	12:15						0.0	2.87	NA				1.5	1	Probably Safe	
Office 1:10	05/04/2022	15:00	05/04/2022	16:38	1:10	35	05/05/2022	11:58						136.0	830.6	NA				>1000	NA	Unsafe	
Office 1:100	05/04/2022	15:00	05/04/2022	16:38	1:100	35	05/05/2022	11:58						240.0	781	NA				>10000	NA	Unsafe	
95	05/04/2022	15:00	05/04/2022	16:38		35	05/05/2022	11:58						0.0	NA	3				13.6	>2	Probably unsafe	
98	05/04/2022	15:00	05/04/2022	16:38		35	05/05/2022	11:58						0.0	2.87	3				0.0	>3	Safe	
102	05/04/2022	15:00	05/04/2022	16:38		35	05/05/2022	11:58						0.0	2.87	3				0.0	>3	Safe	
97	05/04/2022	15:00	05/04/2022	16:38		35	05/05/2022	11:58						0.0	2.87	3				0.0	>3	Safe	
92	05/04/2022	15:00	05/04/2022	16:38		35	05/05/2022	11:58						0.0	2.87	3				0.0	>3	Safe	
103(S)	05/05/2022	12:20	05/05/2022	15:23		35	05/06/2022							1.5	7.81	NA				>100	NA	Unsafe	2.81
103(T)	05/05/2022	13:24	05/05/2022	15:23		35	05/06/2022							0.0	2.87	>1				13.6	>1	Possibly unsafe	

089(S)	05/05/2022	12:40	05/05/2022	15:23		35	05/06/2022						1.2	5.64	NA					>100	NA	Unsafe	2.28
089(T)	05/05/2022	13:44	05/05/2022	15:23		35	05/06/2022						1.5	7.81	0					48.3	>1	Possibly unsafe	
099(S)	05/05/2022	12:00	05/05/2022	15:23		35	05/06/2022						>100	9435	NA					>100	NA	Unsafe	4.37
099(T)	05/05/2022	13:04	05/05/2022	15:23		35	05/06/2022						48.3	351.91	>1					>100	Unknown	Unsafe	
100(S)	05/05/2022	13:20	05/05/2022	15:23		35	05/06/2022						0.0	2.87	NA					>100	NA	Unsafe	1.11
100(T)	05/05/2022	13:24	05/05/2022	15:23		35	05/06/2022						9.6	37.68	-2					9.6	>1	Possibly Safe	
Office 1:10	05/06/2022	15:04	05/06/2022	15:23	1:10	Ambient	05/07/2022	10:00					136.0	830.6	NA					>1000	NA	Unsafe	
Office 1:100	05/06/2022	15:24	05/06/2022	15:23	1:100	35	05/07/2022	10:00					>10000	9435.1	NA					>10000	NA	Unsafe	
92	05/06/2022	15:44	05/06/2022	15:23		35	05/07/2022	10:00					5.8	16.87	2					48.3	>1	Probably Unsafe	
95	05/06/2022	16:04	05/06/2022	15:23		35	05/07/2022	10:00					1.0	5.14	2					>100	Unknown	Unsafe	
Office	05/08/2022	12:30	05/08/2022	12:45		35	10/09/2022	10:50					48.3	351.91	NA					>100	NA	Unsafe	
92	05/08/2022	12:30	05/08/2022	12:45		35	10/09/2022	10:50					0.0	2.87	2					13.6	>1	>1	
95	05/08/2022	12:30	05/08/2022	12:45		35	10/09/2022	10:50					0.0	2.87	2					0.0	3	>2	
092(S)	05/10/2022	11:10	05/10/2022	12:09		35	05/11/2022	11:00					1.2	5.64	NA					48.3	NA	Probably Unsafe	

092(T)	05/10/2022	11:10	05/10/2022	12:09		35	05/11/2022	11:00					0.0	2.87	>1				1.5	2	Probably Safe	
095(S)	05/10/2022	11:10	05/10/2022	12:09		35	05/11/2022	11:00					>100	9435.1	NA				>100	NA	Unsafe	
095(T)	05/10/2022	11:10	05/10/2022	12:09		35	05/11/2022	11:00					0.0	2.87	>2				>100	Unknown	Unsafe	
112(S)	05/11/2022	10:55	05/11/2022	10:55		35	05/12/2022	12:00					0.0	2.87	NA				>100	NA	Unsafe	
112(T)	05/11/2022	10:55	05/11/2022	10:55		35	05/12/2022	12:00					0.0	2.87	NA				13.6	>1	Probably Unsafe	
099(S)	05/11/2022	10:55	05/11/2022	10:55		35	05/12/2022	12:00					0.0	2.87	NA				13.6	NA	Probably Unsafe	1.96
098(S)	05/12/2022	15:30	05/12/2022	16:30		35	13/05/2022	13:48					13.6	83.06	NA				>100	NA	Unsafe	5.3
098(T)	05/12/2022	15:30	05/12/2022	16:30		35	13/05/2022	13:48					0.0	2.87	2				48.3	>1	Probably Unsafe	
102(S)	05/12/2022	15:30	05/12/2022	16:30		35	13/05/2022	13:48					48.3	351.91	NA				>100	NA	Unsafe	3.3
102(T)	05/12/2022	15:30	05/12/2022	16:30		35	13/05/2022	13:48					0.0	2.87	2				>100	Unknown	Unsafe	
097(S)	17/5/2022	17:47	17/5/2022	18:30		35	18/5/2022	17:30					13.6	83.06	NA				>100	NA	Unsafe	
097(T)	17/5/2022	17:47	17/5/2022	18:30		35	18/5/2022	17:30					0.0	2.87	2				0.0	3	Safe	
094(S)	31/05/2022		31/05/2022	11:00		35	06/01/2022	10:15					0.0	2.87	NA				>100	NA	Unsafe	2.16
094(T)	31/05/2022		31/05/2022	11:00		35	06/01/2022	10:15					0.0	2.87	NA				8.4	>2	Possibly Safe	

099(S)	06/01/2022	10:00	06/01/2022	13:30		35	06/02/2022	09:56						0.0	2.87	NA					>100	NA	Unsafe	
099(T)	06/01/2022	10:00	06/01/2022	13:30		35	06/02/2022	09:56						0.0	2.87	NA					4.83	>2	Possibly Unsafe	2.61
099(boiled)	06/01/2022	10:00	06/01/2022	13:30		35	06/02/2022	09:56						0.0	2.87	NA					13.6	>1	Possibly Unsafe	

APPENDIX E: USE DATA FROM LOGGERS DURING FIELD TRIALS

Number of data points	Start Time	Duration (Seconds)	Device
146	10/05/2022 09:50	294	95
146	11/05/2022 20:00	295	95
143	11/05/2022 20:10	288	95
146	13/05/2022 14:44	294	95
144	13/05/2022 21:40	290	95
61	14/05/2022 17:01	122	95
52	14/05/2022 17:03	104	95
10	14/05/2022 20:31	19	95
143	14/05/2022 20:36	288	95
145	14/05/2022 22:58	292	95
145	15/05/2022 15:15	292	95
145	15/05/2022 21:09	292	95
146	16/05/2022 17:24	294	95
146	19/05/2022 18:48	294	95
147	21/05/2022 15:03	297	95
144	21/05/2022 15:10	290	95
143	21/05/2022 15:17	288	95
147	23/05/2022 14:03	296	95
146	23/05/2022 16:11	294	95
149	03/05/2022 10:59	299	101
148	03/05/2022 19:02	297	101
149	06/05/2022 10:14	300	101
149	17/05/2022 23:35	300	101
145	05/05/2022 11:54	291	89
145	05/05/2022 12:08	292	89
145	07/05/2022 17:58	291	89
142	07/05/2022 18:10	286	89
145	11/05/2022 19:00	292	89
141	11/05/2022 19:09	283	89
140	11/05/2022 19:17	282	89
140	11/05/2022 19:22	281	89
145	16/05/2022 19:23	292	89
141	16/05/2022 19:29	283	89
141	16/05/2022 19:37	284	89
142	16/05/2022 19:45	286	89
145	22/05/2022 15:04	292	89
142	22/05/2022 15:14	286	89
143	22/05/2022 15:25	288	89
145	25/05/2022 14:19	292	89
140	25/05/2022 14:24	282	89
141	25/05/2022 14:33	284	89

144	28/05/2022 19:10	291	89
141	28/05/2022 19:17	285	89
142	28/05/2022 19:28	286	89
140	28/05/2022 19:34	282	89
145	01/06/2022 12:25	292	89
140	01/06/2022 12:31	282	89
141	01/06/2022 12:38	284	89
142	01/06/2022 12:48	286	89
147	05/05/2022 11:26	295	103
1	10/05/2022 10:21	0	103
213	10/05/2022 10:21	440	103
147	14/05/2022 19:31	296	103
147	20/05/2022 12:28	296	103
140	03/05/2022 10:07	282	96
143	06/05/2022 08:20	288	112
142	06/05/2022 21:34	286	112
142	06/05/2022 22:01	286	112
143	11/05/2022 08:46	288	112
143	23/05/2022 07:54	288	112
144	05/05/2022 09:55	290	99
145	01/06/2022 11:18	292	99
7	03/05/2022 15:14	17	100
142	06/05/2022 14:24	286	92
140	08/05/2022 12:24	282	92
60	10/05/2022 09:40	119	92
125	10/05/2022 09:42	252	92
6	06/05/2022 10:05	13	102
148	12/05/2022 14:45	298	98
146	16/05/2022 20:40	294	97
1	17/05/2022 17:19	0	97
145	17/05/2022 17:23	292	97
143	02/05/2022 19:01	287	94
142	04/05/2022 13:52	286	94
142	05/05/2022 15:49	286	94
142	15/05/2022 10:02	286	94
142	18/05/2022 15:20	286	94
142	19/05/2022 18:19	286	94
143	22/05/2022 17:47	287	94
141	25/05/2022 20:28	283	94
140	25/05/2022 21:07	281	94
141	27/05/2022 10:48	284	94
140	29/05/2022 17:11	281	94

APPENDIX F: NOTES FROM FIRST FOLLOW-UP VISIT

Participant Number	Water Box Number	Observations
89	89	It is okay They have no problem They seem to have grasped how to use the box since we found a kid operating the box and he did so efficiently
97	97	They raised a complaint about the water smelling like tap water since for boiled water doesn't have a smell The other issue was, they wish the electric compartment was enclosed within the box rather than being on top
103	103	They did not have any issue with the box and said it works perfectly well
5	94	The box is being used and kept well. It is very encouraging that the people in this household are actually drinking water from the water box. No complaints were made about the box as yet. We will get more feedback as we conduct more visits
13	98	From the initial visit, it was mentioned that the power supply in this homestead was usually interrupted. Given the renting system in the area, power is only supplied in the night. This would not favour our teaching system and also ensuring that the box was being used correctly. We therefore decided that retrieving the box was best in this case. And thus recommend that the earlier generator idea be improved as reinstated in the boxes
2	112	The box is being used according to the recipient The concern on the box was that it leaves the water with a certain smell. We attributed the smell to the fact that these boxes are new and like any new plastics. There's a smell attached to it.
6	100	According to the box recipient, the box is being used It is also still in good shape and they have not had any issues in using it
102	102	Box was retrieved from them since she seemed not to be getting power anytime soon
98	98	Box was retrieved since the participant lacked power
101	101	The box works perfectly well Everyone in the household knows how to operate the box
99	99	She prefers the water box to the electric kettle since it takes a lesser time and does not require her to wait for the water to cool
100	100	The box was well They have two requests 1) If the plastic is made transparent so they tell the water level and know if it's at capacity 2) The control box be adjusted to a safer place as it tempts them a lot
101	101	The box works perfectly well but they wish the shape be adjusted to a cylindrical shape like a flask for purposes of storage
2	112	The box is being used alongside boiling of water using a charcoal stove. They are able to operate the box
5	94	The household could properly use the water box as per their demonstration. They have been using the water box for drinking water
89	89	They have not raised any complaint I found them drinking water from the box
103	103	They did not report any issue
92	92	When he pours water upon treating it, he finds sediment at the bottom He has an issue with the design

98	98	They simply love the product They do not use it so often
102	102	Says have no problem

APPENDIX G: NOTES FROM SECOND FOLLOW-UP VISIT

Participant Number	Water Box Number	Observations
96	96	Wish the water had a different smell rather than that of tap water
89	89	Found them operating or using the water box
92	92	Wish the electric box was placed elsewhere rather than being on top
98	98	Simply love the product
102	102	They said they have no problem with the box and use it alternatively with the percolator
101	101	Wish the box was transparent so they can tell when it's full without it over flowing Wish the box was cylindrical in shape like the water purifyaa
100	100	They love the water box however also still use the purifyaa, solar treatment and boiling
99	99	Prefers using the water box to using the electric kettle since it is energy saving
103	103	They simply told us; they have no problem with the water box
97	97	They love the product since they begged to retain it. They suggested that they would like the box to be transparent Also, they wish the electric tool box be adjusted to a place their kids can hardly access
15	95	The participants are able to use the box well from the demonstrations They would rather it was a bigger box
2	112	The box is used one a week according to the participant. The participant is able to use the box well
5	94	The participant is very happy with the box. She is even will to retain it if there is a way to manage it. Has resorted to using it entirely.

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APPENDIX H: NOTES FROM EXIT INTERVIEWS (LAST VISIT)

Water Box number	Consent form number	How many times per day did you use the Water Box?	Date of Interview		How did you use the water you treated with the Water Box?	Please describe how you feel about this product
99	7	1	01.06.2022		Drinking	Still curious about the box and its functionality Once a week
102	17	2	02.06.2022		Drinking 2 times a week	It would be a good product to have
100	6	4	31.05.2022		Drinking. 4 times a week	The product is good
89	9	1	31.05.2022		Drinking purposes and making medication for the baby	No problems
101	3	1	30.05.2022		Drinking	It is good
97	12	3	02.06.2022		Drinking	It is good because it is user friendly and consumes less power
95	15	2	02.06.2022		Drinking	It's not bad besides the size
103	8	2	30.05.2022		3 times a week Drinking and making juice	Some members of the family don't trust the water while others feel it remains the same. Some had no problem consuming the water
112	2	1	01.06.2022		Once a week Drinking	It is convenient to use though one needs to understand it
94	5	4	31.05.2022		4 times a week Drinking	It is a good product
92	14	3	02.06.2022		Drinking 3 times a week	Not bad besides the size

96	1	1	30.05.2022		Drinking and making juice to drink	The product is not bad just that adjustments on the box like the elect position on the box. Also, if the box produced water with a smell diffe that before treatment
98	13	1	06.06.2022		Drinking	The product is very easy to use and doesn't take a lot of time for the be treated. It also keeps water safely for more than a day since it covered while water in a kettle cannot be kept safely.

Do you think water treated by this device is safe to drink?	What did visitors think about this product?	Did having this product in your house solve any of your problems? If so, which ones?	Did you use other methods of water treatment (other than the Water Box) over the past month?	How many times per day did you use other methods of water treatment?	What part of this product was easy to use?	What about this product made it difficult to use?
Yes	They had doubts about the treatment	Drinking water was faster to make	Yes	3	Its general operation is easy. Few steps	Still concerned about the power it uses
Yes	The visitors were curious about the box generally and had questions about how it treats water	Yes, because it gives instant cool water to drink	No		Its general operation is easy. U switch on and off.	None
Yes	Curious about how it works and questions on why the water remains cold	It did because it takes lesser time thus its easier and faster to get water to drink without waiting for it to cool	No		Its on and off operation provided no difficulties	None
Yes	The visitors were curious about how to works and wondered why the water remained cold	It reduced on charcoal expenses in the home	No		The entire box since it treats water for	None

					a short time	
Yes	They didn't think the water was treated	Yes. It used less power and took less time	Yes	1	It is generally easy to use	Keeping it was hard
Yes	The visitors were also able to operate it because the steps were easy and few steps. The visitors wanted to know if it operated on solar energy too so that they could take it to remote areas without power	It did since the children could get themselves water too though they had to be extra careful	No		Everything	The tap on the box was loose thus leaked from its edges
Yes	They asked about it but didn't understand how it treats the water	It saved a lot of time taken in boiling	Yes	2	The operation . It takes less time	When there's no power. It needs an emergency battery
Yes	No visitors	It saves time and because the water stays cool, it is easy to use	Yes	2	Takes less time to use and treat water	None
Yes	One had to explain it but there was still curiosity on if it truly works	Yes. Short time in treating water	Yes	1	Its general operations and steps of using it	None
Yes	They liked it	Very much. Saved time used in boiling water	No		The water is treated quickly	None
Yes	They didn't understand it but drunk the water from it	No need to boil water	Yes	2	It doesn't take long	Dirt is able to get into the box
Yes	The visitors had doubts on the treatment since the smell of the water didn't change	Yes, it did. It is economical and time saving	No		The box in general is easy to use	The electronics box on the water box could easily be damaged if the

						user is not careful
Yes	It doesn't take a lot of time	It helped us keep our drinking water safe and incase more treated water was required it was quick	No		Everything about it was easy to use	The tap

Would you recommend buying this product to your family, or to your neighbors?	Please rank the following water treatment options, from best to worst.	1st	2nd	3rd	4th	5th
If they understood it yes		Boiling	Water Box	Chlorine Tablet	Filter	Liquid Chlorine
Yes, if it is affordable		Water Box	Boiling	Chlorine Tablet	Filter	Liquid Chlorine
Yes. It is a good product		Filter	Water Box	Boiling	Chlorine Tablet	Liquid Chlorine
It would be hard since even visitors were skeptical about its operation		Water Box	Boiling	Chlorine Tablet	Filter	Liquid Chlorine
Yes		Water Box	Boiling	Filter	Chlorine Tablet	Liquid Chlorine
Yes. The box is nice		Liquid Chlorine	Boiling	Chlorine Tablet	Water Box	Filter
Yes		Water Box	Boiling	Chlorine Tablet	Filter	Liquid Chlorine
Yes, I would		Water Box	Boiling	Filter	Chlorine Tablet	Liquid Chlorine
Yes		Boiling	Water Box	Chlorine Tablet	Filter	Liquid Chlorine
Yes		Water Box	Boiling	Chlorine Tablet	Filter	Liquid Chlorine

Yes, if they understood it		Boiling	Water Box	Filter	Chlorine Tablet	Liquid Chlorine
Yes, I would. It is a good product		Water Box	Boiling	Filter	Chlorine Tablet	Liquid Chlorine
Yes		Water Box	Boiling	Chlorine Tablet	Filter	Liquid Chlorine

How would you compare using this product to using your current or previous method of water treatment?	Would the introduction of this product have a positive or a negative impact on your community? In what ways?	If this product were sold in a local market, how much money would people be willing to spend to buy it?
If there was confirmation on treating water. The box would be the better option	Very positive since its providing people with an easier method to make water	100000
The water box saves time compared to other methods	It would be good since it saves time	50000
For example, using the purifier (locally made purifaya) you can heat the water The purifier is also bigger	It would reduce situations of people drinking un treated water	700000
It is a better option	It is economical in terms of power	100000
It takes lesser time than the rest	It would help save power in the community	250000
The water box is a better product	It would be positive because even my neighbors wanted to get water from my place	150000
This method is easy and takes a short time to cool water	Yes. In providing people with safe drinking water	100000
It takes longer to boil water while this is just 4 minutes	It would be good in providing people with safe drinking water if the people were taught about the mode of operation	50000
This takes a shorter time	It understood. This product would provide safe drinking water and curb diarrheal diseases	70000
This is better because of the less time needed to treat water	It would enable people in the communities get drinking water faster	100000

It doesn't take a lot of power	Not bad. It would bring growth in the society in terms of assets	80000
Given how long it takes to treat water, the water box is better than boiling	It would have a positive impact given the less time needed in treating water	150000
This method is better because it is quick	Yes, it is. Because it saves time in providing people with safe water	100000

If you could change one thing about this product, what would you change?	What features would you like to see added to this product?	What was your favourite part about using this product?
The design, handling and storage. It's difficult with the current design to safely handle the box and store it	If it were bigger in size for larger water quantities	It takes a short time to treat water
The size	Nothing	It is simple to use regardless of whether someone is educated or not
The electronics box would be on the side	The size to provide a larger capacity for water	It is quick in using
If the water from the box were to be hot so as to make tea	The box being bigger for larger amounts of water	It takes less time
The switch mechanism on the box isn't automatic Its shape preferably a cylindrical shape	If the box was sealed A sieve (mesh like) instead of a funnel	Takes short time to treat water
The tap	Making the box much bigger	The funnel
The tap needs to be secured	The size. This one treats little amounts of water	When there's power it is easy to use
The size should be bigger	If the box cold also cool the water further	The short time it takes to treat water
The size given that the large size of family needs larger amounts of water	A cooler so that there's no need to put it in a freezer	The time it takes to treat water
None	If it would be bigger in size	The short time needed to treat water

It allows a less amount of water The position of the electronics box	The tap below with a jerry can shape The electronics box on top of the jerry can 'Bigger in size	Takes less time to treat water
The location of the electronics box	I would prefer if it had a stand so that there's no need to carry it to a table	Time saving and economical
The tap to easily empty the water	A water heating section	It takes a small amount of time to treat water

What would make this product more attractive or desirable if you saw it in the market?	Do you think men or women would be more likely to buy this product in the market?	What appeals to you about this product?	What does not appeal to you about this product?
If it were larger	Both men and women	How it operates	The electronics box and its position
If the electronics box was better designed and positioned elsewhere	Both men and women	Its operation	The water outlets let insects in which dirties the water
If it were bigger and the control box in a different design	Both men and women	Its operation is easy	Size
If there was a description on of the water was to come out cold or hot	Women	The current design is okay	Nothing

If it were bigger	Women	The short time in treating Water	The shape
If it operated on both hydro power and solar	Women	It is automatic so it switches itself off even if one is away It provides water to drink in the shortest time	The tap kept dripping
A better manual or instructions on the box	Men	Takes less power It is quick	It doesn't have sieves for the water being put in. Some of the water from the taps has particles and someone needs to be sure that at least the water they put in the box is at least clear
Its appearance would make people curious	Men	The short time in operation	None
A larger container	Men	The ease in operation	There is a stay in smell from the water in the box
It looks like a tap	Women	The time in operation	None
In a jerry can shape	Women	The time it takes to treat water	The size The position of the control box
Having a stand for positioning	Men	It is quick in its operation	It has no support thus placing it is difficult. The taste of water treated by the box is similar to the tap water The tap position is also difficult to use since it requires bending to empty the box
If the electronics box was enclosed with in	Men	Takes a short time to treat water	The tap

Are there other products that you would rather own, instead of the Water Box?	What changes to this product would make it more desirable to people in your community?	How much money would you be willing to pay for this product?
Kettle for hot water	If it were bigger	100000
The electric kettle for making tea	The size and if the holes could be better designed	50000
Electric kettle	Price of the product The size The general appearance	700000
Still prefer the water box. The rest consume a lot of energy	It having a provision for hot water	6000
None	If it were exotically made since people trust exotic manufacturers more How it operates	250000
Electric kettle	The size for more water Quantities	50000

Filter	A sieve	100000
Electric kettle	If people understood the product and how it works they would want it	50000
Kettle for hot water	If people understood it	70000
Electric kettle	Size	100000
Electric kettle	If they understood its operation Shorter time	80000
For drinking water the water box is a better choice. But for hot water and electric kettle	A support for the box Change in taste	150000
No	The tap design and a bigger size	250000