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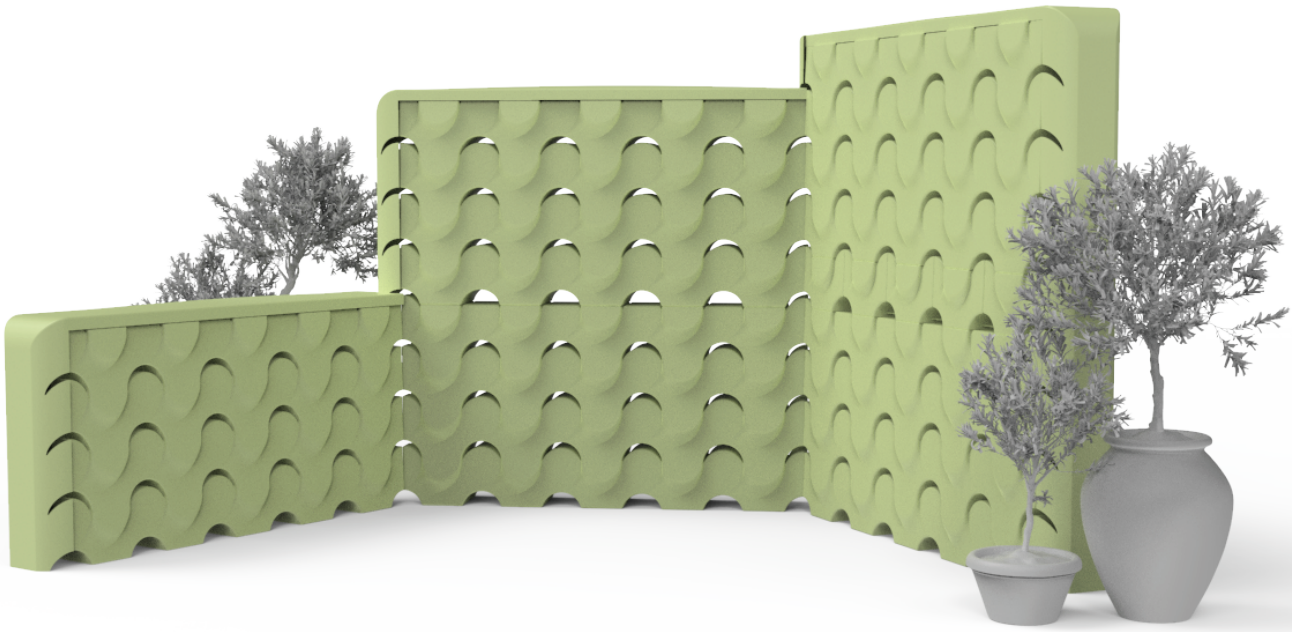
Modular Tank System for Water Scarcity

Adriane Spence - 2021



How May We Mitigate Water Scarcity in Barbados?

by

Adriane Spence

Submitted in partial fulfillment of the requirements for the degree of

Bachelor of Industrial Design

Faculty of Applied Sciences &Technology
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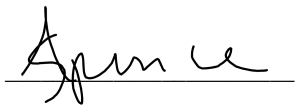
Student Signature : 

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Abstract

The Caribbean is more immediately susceptible to climate change related outcomes than most other regions. One which is already taking shape is the shorter rainy seasons and longer, harsher dry seasons which reduce the yearly rainfall significantly, and result in water scarcity. The island of Barbados in particular, is considered by the World Resources Institute as water scarce. Groundwater is Barbados' primary water source, however, with annual rainfall totals projected to decrease by up to 30%, this alone is not sustainable. A better solution must be provided to allow households to become more independent from public water systems. Research will begin with interviews with field professionals in order to understand the user on a broad, statistical basis. User samples will then be interviewed, surveyed and observed, which will help to inform design decisions and the subsequent solution. A one-to-one scale model will be developed in order to better understand the ergonomics, human factors, and viability involved in the final solution. Said solution will either generate and/ or save water to allow the islands to meet, and hopefully surpass their demands. This is necessary to enable continued economic growth and infrastructural development in the region.

Acknowledgements

I would first like to thank my parents, Elena and Malcolm, for their unending support and belief in my abilities.

I want to thank my classmates and my roommate for providing me with both moral and design support throughout this thesis project. My classmates inspired me and encouraged me to continue when the COVID-19 pandemic made being physically apart from them and everything else a necessity and a major challenge.

Thank you to my professors, Catherine and Sandro, for always reminding me of the line between realism and idealism, and to their TA, Reece, for steering me in the right direction.

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CHAPTER 1
Problem Definition

In this chapter the problem of water scarcity in the Caribbean shall be investigated. Context will be given and the problem will be defined further therein. The research methods will be disclosed, as will the historical and social context of the target users.

1.1 Problem Definition

Groundwater is Barbados' primary water source; however, this alone is not sustainable, especially considering the projected population increase and rainfall decrease. Barbados is in need of a water saving solution, a water generation solution, or both. This solution would need to address the basic physical need of access to potable water, and security thereof. There is a need for the solution to become one with the identity of the nation, in order to percolate the society and engrain the value of water within it.

1.2 Rationale and Significance

1.2.1 Key Information to be Determined

The quantity and nature of water use in the households of water scarce Caribbean islands must be determined in order to understand how water use can be reduced, and how the eventual solution will need to operate. Research into rainfall patterns in each island will be conducted in order to determine whether the solution can be reliant on rainwater catchment. The quantity of rain will be compared to the quantity of water used per household. Research into existing methods of water conservation and water reuse around the world, especially in other water scarce nations, will be conducted. The perception of locals to a domestic water solution will be investigated.

1.2.2 Key Questions to Be Answered

Professionals in the field of water management have been gathered in each nation, as well as others from regional organisations, and one who has expertise in water quality in general. They vary

between the private and public sectors and in their specific fields, however they are all relevant and willing to help. Some of the questions they will be asked are: What potable water generation methods are currently in place in each country? How do households access potable water? In what ways is water used in the average household? How much water is used in the average household? How do you think the average household might perceive a potential solution to this? Would incentives to be self-sufficient would need to be provided? What water conservation methods are currently in place in each country? What more reduction methods could be implemented? What water reuse methods are currently being used? Would citizens would feel comfortable with the concept of water reuse?

1.3 Background/ History/ Social Context

1.3.1 Demographic and Lifestyle Trends

The growing convenience of water has led to a decrease in society's value of it. In developed countries one can simply turn on a tap in their home and have an endless supply of perfectly potable water. But this convenience has been hundreds of years in the making; the length of the journey that led us here has allowed us to forget how valuable a resource water really is. This is an even more pressing issue in countries who face water scarcity, like the islands of the Caribbean.

These Caribbean islands also face an increase in population which will only exacerbate the issue of water scarcity.

1.3.2 Product Trends

In the Caribbean specifically, several products exist within the realm of the eventual design solution. One example being the white stepped roofs of Bermuda, a mandatory rain harvesting system integrated into local homes. Another example is the solar powered water heaters of Barbados. Through government run incentives, the majority of homes in the island can afford to operate them, and they do.

CHAPTER 2
Research

This chapter will discuss both user and product research, disclosing the methods through which this research was done, and the results of it.

2.1 User Research

Figure 1. Gladding, J. (2019). From left: 'Standpipe 1', 'Avon at Standpipe 1', 'Glo'

2.1.1 User Profile – Persona

2.1.1.1 Primary, Secondary, Tertiary Users

In focusing on water scarcity in the Barbados household, the primary user is presumed to be the homeowner, especially due to their managerial position in the household. Cultural customs in the Caribbean dictate that children must always be fully respectful and obedient to their parents. This would lend itself to the secondary user being the children of the homeowner. The tertiary user would then include the rest of the household, which in Caribbean cultural context means elders, who often live with their families rather than going to nursing homes. The elders of the household would only be forced into action when the rest of the household is not around to assist them.

2.1.1.2 Demographics

Overall, most working Caribbean adults seem to fit into the criteria of Afro-Caribbean tertiary education graduates earning approximately USD $17,690. Because of the almost even split between male and female, both genders will be considered. Being that gender roles in the Caribbean are fairly traditional, it can be expected that the male of a household would be the primary manager of a potable water generation and management system. See the table below for a summary of information.

Demographics of Barbadian Adults	
Age	25 – 65
Gender	More Female (~51%)
Ethnicity	Predominantly Black
Income	USD $17,690 avg.
Education	Tertiary Education

Table 1. User Demographic

2.1.1.3 User Behaviour

Online data relating to Caribbean water use in households was limited, however an extensive report of water use in Barbados specifically was found. Findings have been summarized below according to the relevant categories: Number of People per Household, Water Shortage Coping Strategies, and Water Use by Task.

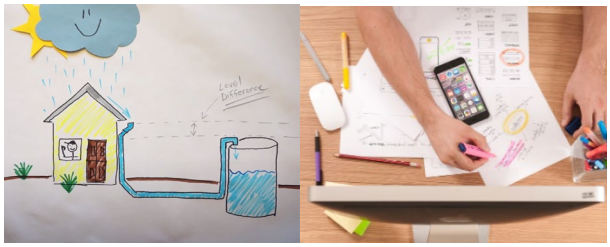
Number of People per Household. The number of people per household affects the amount and types of water use. The average of number of people per household in Barbados is 3.31 people.

Water Shortage Coping Strategies. Water scarcity in Barbados does not mean that water supply infrastructure is not in place, or that water quality is not up to standard, but rather that supply itself is unreliable. Information was gathered on how different parishes cope with water interruptions, and the most common coping strategy was preparing for such events by collecting and storing water.

Water Use by Task. In addressing water shortage in the household, how the household uses that water is vital information to assist in understanding how that use can be reduced. In Barbados bathing contributes most heavily to weekly household water use, by a significant margin. Washing dishes and clothes are the next most significant contributors.

2.1.2 User Observation – Current User Practice

In order to discover current user practice of at home water generation systems, one particular type of water generation system was selected: rainwater harvesting, and then further investigated. Videos were selected from the internet which gave as much information and detail as possible about the at home rainwater catchment process. Those videos were studied and the process was broken down into steps which are listed below.

Stage	Description
Planning 	- Researching existing systems and adapting them to suit their home - Calculating materials
Installation 	- Installing pipes, tanks, gutters, filters, etc. - Connect to house water system

Tank Maintenance 	- Empty the tank - Climb in from above - Collect sediment
Gutter Maintenance 	- Vacuum gutters from below
Pipe Maintenance 	- Disconnect pipes from tanks - Open outlets - Let a rainfall flow through, or flush out with water from hose
Filtration 	- Transfer rainwater from faucets to filtration device in smaller quantities, specifically for drinking or cooking

Table 2. User Observation: Homesteadonomics (2015)

2.2 Product Research

Existing Atmospheric Water Generation (AWG) tools were investigated via internet searches. Certain products were selected and compared through benchmarking. The selections were made to provide a variation of approaches to AWG. Selected products are primarily to provide water for a household, and half of them are electrically powered, while the other half use renewable energy. The major features examined are the water generation rate, in liters per day, the power source, the filtration system, and the reservoir capacity.

2.2.1 Benchmarking – Benefits and Features

Product Comparison

Product	Thumbnail	Litres per day	Power Source	Filter	Reservoir Capacity	Context
Portable Residential Atmospheric Water Generator HR-77L		30	Plug-in	12 stage	12.5 litres	Household
GENNY		30	Plug-in	UV treatment, mineralization and carbon filter	27 litres	Household
GenQ Stratus		50	Plug-in	Yes	Not available	Household

NUBE		30	Plug-in	Carbon + osmosis, UV	12.5 litres	Household
AWN Nanotech Product		20	Solar/ naturally occurring	UV and filter	Not available	Residential
Warka Tower		40-80	Passive	Yes	(Separate) 5000 gallons	Community
AirDrop Irrigation		Not available	Wind and Solar	N/A	4-5 litres	Agriculture
WaterSeer		37	Wind	No	~20 litres	Community

Table 3. Existing Product Comparison

Most of the products researched filter the water, whether or not the method is specified. Many of those filtration processes are multi-stage, including UV, carbon and mineralisation. Most of the household AWGs produce 30 liters of water per day and are electrically powered. The products which are powered with renewable energy are much less consistent in their filtration processes, water generation rate and reservoir capacity.

Features and Benefits

Features	Filtration	Generation Capacity	Sustainability	Water Storage	Technology
Benefits	Water Quality	Energy efficient	Cost efficient	Ecological	Easy Installation

Table 4. Features and Benefits

The features and benefits were identified through an analysis of the promotional material and specifications of the products. Water quality and filtration were always the major focus of the material, followed by functionality and efficiency.

2.2.2 Benchmarking – Functionality

Despite the fact that all of the benchmarked products perform the same function, generating water from the air, they vary in their approach thereof and in the way they are used. These two aspects of functionality will be explored in this section: the way that these products produce water, and the way that that water is accessed by the user.

The projected outcomes from investigating this are determining ideal usability of an AWG, and identifying the necessary functions of an AWG.

Product	Functionality	Usability
Residential AWGs	Most common technology. Condensation on an electrically cooled copper coil.	Access points resemble water cooler. Simple spout and trigger, plus access to filters for maintenance.
AirDrop	Condensation on copper coil, cooled by subterranean temps.	Channeled back into soil as drip irrigation.

WaterSeer	Wind powered fan channels air underground to the coil and tank.	User pumps water out of underground tank to faucet.
AWN Nanotech	Claims to have developed a naturally moisture wicking fabric.	Little information available.
Warka Tower	Captures fog and dew from the air with large nets.	Collection with personal container from community access point.

Table 5. Functionality and Usability Comparison

Summary

For residential applications, the most suitable access point would be that of the household AWGs. In terms of the water generation functionality, the most suitable for the environment of Barbados is also the household option.

2.2.3 Benchmarking – Aesthetics and Semantics Profile

Aesthetics

The majority of the products were relatively similar in terms of aesthetics with the exception of three of the conceptual products. The majority will be referred to as Group A and the minority Group B.

Group A was particularly rectilinear in form, with very similar dimensions. The scale of each component was also relatively consistent within this group. They tended to be white and grey without much other colour. The overall appearance is that of industrial and commercial equipment.

Group B was far less consistent in terms of appearance. The WaterSeer has a modern, streamlined appearance with its simple forms and consistently matte white finish. Being that it is designed for low-income communities, this appearance would not be cohesive with its environment.

The AirDrop Irrigation product resembles industrial equipment more closely than the other products in Group B. Being that this product is intended to exist in agricultural fields with little human interaction, the aesthetics are less vital.

The Warka Tower is the most contrasting in terms of aesthetics. Scale-wise, it is far larger than any of the other products. It is very organic in terms of form, and more vibrant in colour.

Semantics

The scale and schematic layout of the residential products closely resemble that of a water cooler. NUBE has far more personality than the rest of the products in its rounded edges and flowing design language, reminiscent of water. The residential products seem to be designed like appliances that you might want to forget are there.

2.2.4 Benchmarking – Materials and Manufacturing

In this section, a selection of existing products that address the issue of water scarcity are analysed and compared in order to better inform the design. This section was completed using a different product comparison table, which can be found in appendix F.

Materials

The primary material currently used for domestic water storage solutions is food-grade polyethylene. This is because of its durability and food-safety compared to its cost. Other materials that are used are galvanised steel, wood and concrete, however all three of these are typically lined with a polyethylene or geotextile made from polypropylene or polyester. Polyethylene is a highly recyclable and versatile material and given that it is involved no matter which material is primary, should be considered for the design. It is also very lightweight which is important considering that the design should be easily moved.

Galvanized, corrugated steel also has reason to be considered because of a cultural custom in the island of Barbados to use the material as a privacy screen between front and backyards. The

familiarity the community already has established could make corrugated steel favourable. It should also be noted that steel is 100% recyclable.

Manufacturing

Blow-moulding, rotational moulding and injection moulding are the three major manufacturing processes when considering polyethylene as the primary material. Rotational moulding is used for larger products that require complex details, where blow moulding is used for simpler large parts. Both of those methods are moulded with only an external mould and in one piece, which results in fewer stress points. Injection moulding on the other hand, is used for smaller parts and usually makes two parts which are then attached because the mould interacts both externally and internally. Injection moulding is significantly cheaper than the others, and rotational moulding is significantly more expensive.

When considering steel as the primary material, there are very limited manufacturing process options. The one viable option is bending, bolting and welding.

2.2.5 Benchmarking – Sustainability

Water storage solutions are typically only one or two materials, and do not have many complex details, therefore comparing the sustainability of the benchmarked products comes down to comparing their materiality.

2.3 Summary

This research section gleaned very informative insights on the user and their current practices, as well as the existing products on the market for them. User water use trends were exposed, and the demographic, was identified to be predominantly black, with a tertiary level of education. The at-home water generation solution of rainwater harvesting was observed and shown to be particularly arduous in terms of maintenance.

Researching existing products led to the discovery that for residential applications, the most suitable access point would be that of the household AWGs. In terms of aesthetics and semantics, the

majority of the products compared shared many qualities, leading to the understanding that a product which varies from those qualities would be perceived well.

CHAPTER 3
Analysis

The research disclosed in Chapter 2 will be analysed in this chapter. This will help to uncover the areas of opportunity for the eventual design solution.

3.1 Needs

3.1.1 Needs and Benefits Not Met by Current Products

The products which will be used for comparison in this section are ones which currently serve the specific target user, rather than other potential solutions. This means the systems through which Barbadians currently receive their water. Some systems which are currently used in other Caribbean islands will also be included. These systems are: ground water, desalination, rain water harvesting, atmospheric water generation (AWG), and surface water.

These will be shown comparing their sustainability, cost efficiency, and how suitable they are for Barbados' climate.

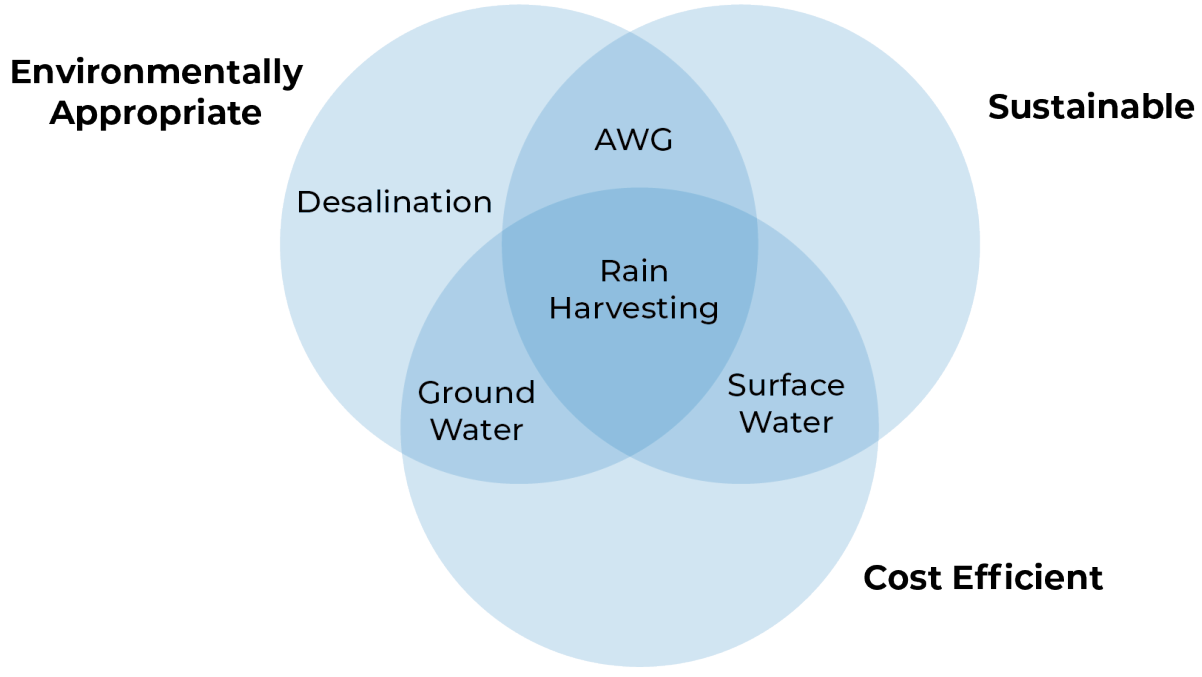


Figure 2. Venn Diagram comparing water generation solutions

3.1.2 Latent Needs

The customer needs to be reminded of how valuable water is in order to reduce water use.

3.1.3 Categorisation of Needs

Wishes	Wants	Latent Needs	Immediate Needs
To pay less for water	Consistent access to water	To be reminded to of the value of water	Access to potable water for drinking/ cooking
	To trust the water that they receive	To be less reliant on the local water system	

Table 6. User Needs

3.1.4 Needs Analysis Diagram

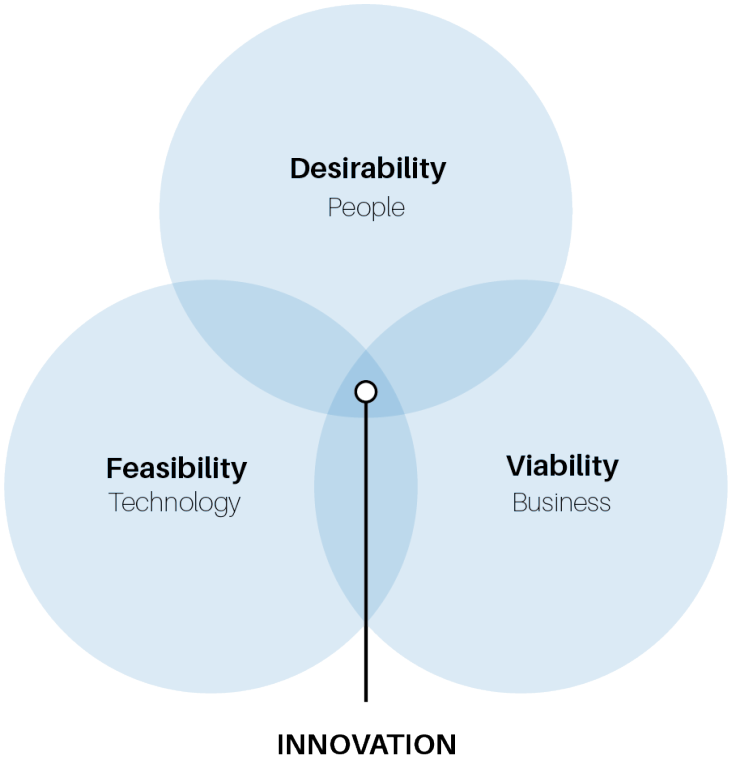


Figure 3. Needs Analysis Diagram

Desirability

Barbadians currently have inconsistent and unreliable access to water which they pay a lot for, and yet they also have difficulty trusting water from sources other than the municipal system. A product which is able to gain the trust of the user, and provide the user with consistent water access in an affordable manner would be desirable to the user.

Viability

Reliable access to clean water is a necessity for human life, and is therefore a market which will never cease to exist, and is relevant to all user demographics. As water security destabilises around the world due to climate change, the need for innovation and investment is even more vital.

Feasibility

Feasibility in terms of materials and manufacturing of the design solution will be achievable due to the expansive array of proven options. Rainwater catchment systems are generally affordable, low-end technology because they are comprised of components for the movement and storage of water, an industry which has existed for centuries. Where feasibility comes into questions is if Atmospheric Water Generation technology is incorporated in the final design, as this technology is very new and is still improving in terms of efficiency.

3.2 Usability

3.2.1 Workflow Mapping

The user observation from section 2.1.2 was analysed in order to locate areas of potential improvement. The major observations are listed below.

Process	Observations
Planning and Installation	A painstaking process for those who are not used to such DIY projects.
Tank Maintenance	Climbing into tank poses a problem. Generally laborious activity.

Gutter Maintenance	Special attachment for vacuum was constructed. Strain on neck. Can't see inside of gutter to be sure sediment is gone.
Pipe Maintenance	Potentially wastes fresh water.
Filtration	The "transfer" step could be avoided if the filtration system was linked to the home plumbing.

Table 7. Workflow Mapping

3.2.2 Experience Mapping

The user observation from section 2.1.2 and the workflow mapping from section 3.2.1 were mapped in relation to user experience and layered upon one another. The 'y' axis represents user experience, where the 'x' axis displays each process.

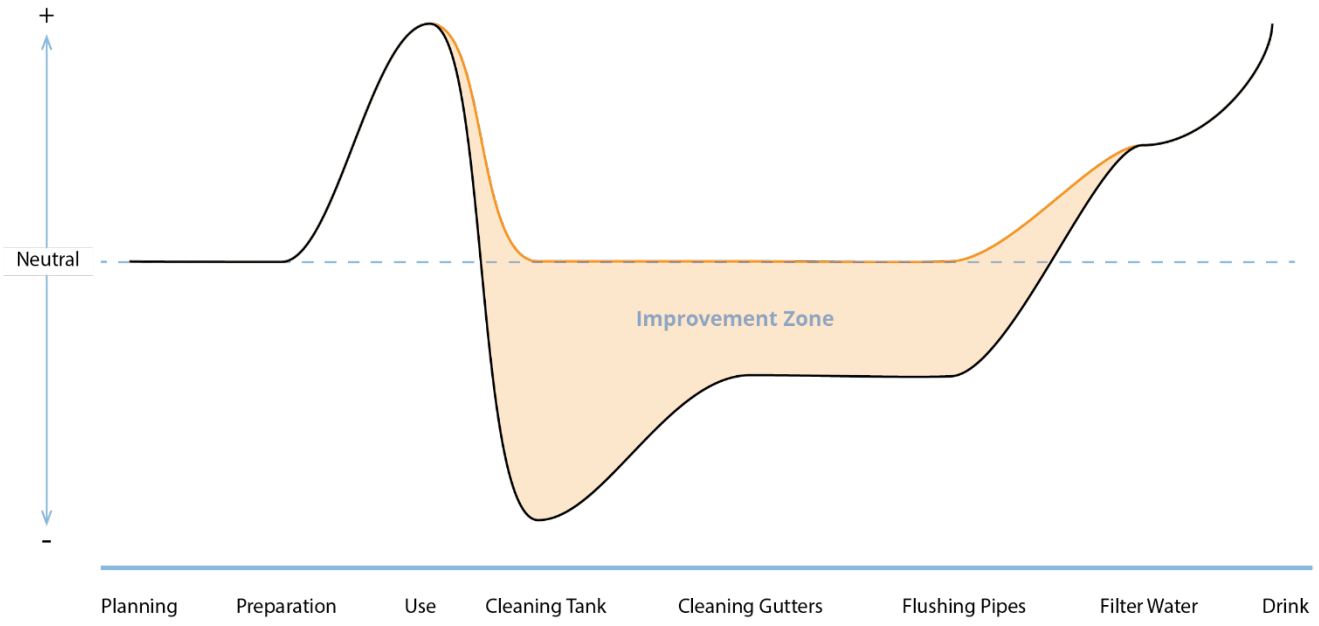


Figure 4. User Experience Map

3.3 Human Factors

3.3.1 Method

Objective

This investigation seeks to evaluate the human interaction, ergonomics, usability and functionality of a residential water tank. This includes the evaluation of "full-bodied human interaction design" which, for the purposes of this thesis, indicates the use of three major body parts. The evaluation shall result in the identification of areas of ergonomic challenges to pave the way for improvement.

Decisions to be Made

Typical residential water tanks provide only one feature: the storage of water, but in water scarce countries much more needs to be provided. Existing water tanks have very few human interaction touch points which are used very scarcely, resulting in various ergonomic challenges when use is increased and especially when new touch points need to be considered. Those touch points include:

1. Accessing water directly from the tank (Hand and arms)
2. Reading an information display (Head, neck and shoulders)
3. Lifting, removing, refilling, and reconnecting an upper section of the tank (Head, neck and shoulders, hand and arms, and legs)

Description of Users Targeted by Product

The primary user that has been identified is the head of the low-income household. Research indicated that this includes both females and males, between the ages of 25 - 65, with an income of about USD $15,000. These persons were also chosen for their location in rural Barbados, where the effects of water scarcity are most prevalent.

Evaluation Process

The evaluation was completed by first constructing a digital full-scale model and locating an existing

water tank of the same height, and similar overall scale. Comparing these models to 2.5th and 97.5th percentile human figures, the following was observed:

- How the user reaches the upper section of the tank.
- Whether the user can safely lift at the previous level of arm extension.
- Whether the user can easily see the information display.
- How the user interacts with the water outlet.

Description of User Observation Environment Used in this Study

Two primary user observation environments were used for this study. The first being a YouTube video tour of a residential rainwater harvesting system in Arizona. The second observation environment is the backyard of a private home in Barbados, next to a residential water tank suitable for comparison. (Homesteadonomics, 2015)

Location and Timeframe

Date of Observations: 05/11/2020 (Observation 1)

17/01/2021 (Observation 2)

Location of Observations: Private home, Arizona, USA (Observation 1)

Private home, Barbados (Observation 2)

3.3.2 Results

Results were developed using the relevant dimensions for a 2.5th percentile female and 97.5th percentile male. Ergonomic diagrams and photographs of subjects interacting with models are presented below.

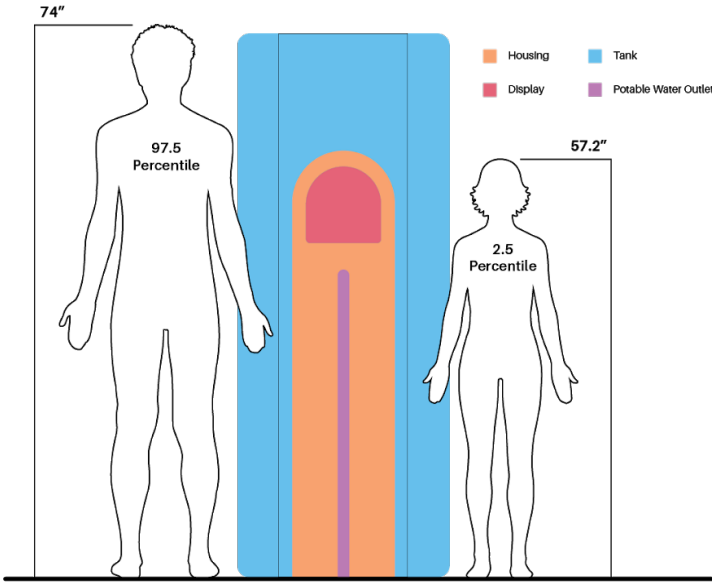


Figure 5. Accessing water directly from tank and reading information display

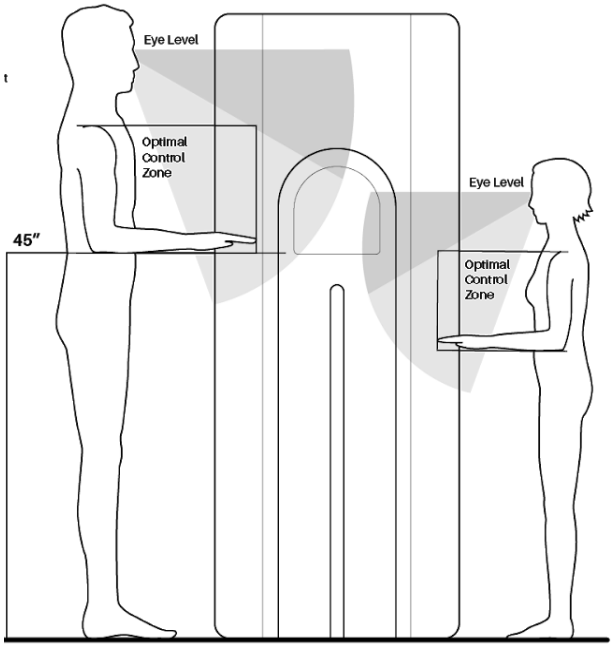


Figure 6. Accessing water directly from tank and reading information display

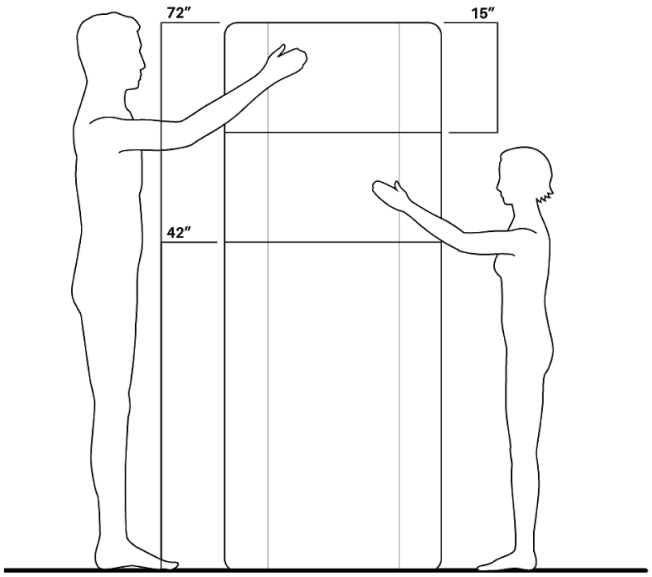


Figure 7. Lifting, removing, refilling and reconnecting upper section of the tank

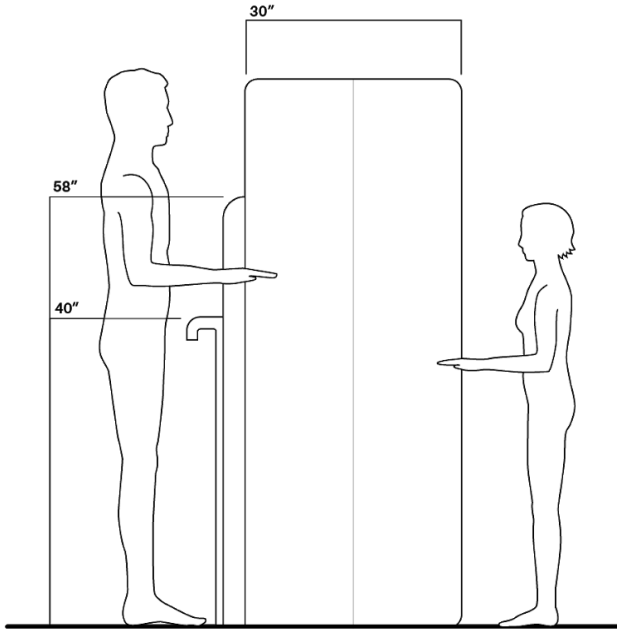


Figure 8. Accessing water directly from tank and reading information display

97.5th Percentile Male

Figure 9. Subject accessing water from tank, and lifting the top of the tank

2.5th Percentile Female

Figure 10. Digital scale model interacting with water outlet

Figure 11. Digital scale model reaching for upper tank

Figure 12. Digital scale model reaching for upper tank (Rear view)

3.3.3 Analysis

The analysis was completed using the above diagrams and photographs.

Observation 1 - Hands/Arms

In figures 4, 5, and 7, as well as figures 8 and 9, it is displayed that both user groups are able to operate the water outlet comfortably. Figure 8 shows that a 97.5th percentile male may crouch slightly to achieve better control.

Observation 2 - Head/Neck/Shoulders

The information display shown in figures 4 and 5 can be read by both user groups according to dimensions from Dreyfuss (1966). However, in figure 7 it can be seen that the screen is in the more casual field of view for the 97.5th percentile male. The information which is to be displayed is intended to be very evident to the user in order to subconsciously affect behaviours. Therefore, it would be more appropriate for the display to lie more directly within the 97.5th percentile male's field of view.

Observation 3 - Head/Neck/Shoulders/Hands/Arms/Legs

In figures 6 and 10 it is evident that the 2.5th percentile female is unable to comfortably reach the upper section of the tank. Figure 11 displays that they are also not able to comfortably span the tank section. They would be able to reach it when stretching, but given that the upper section is meant to be lifted, this is not ergonomically viable. The 97.5th percentile male is able to comfortably reach the upper tank section and would be able to lift, remove, and carry it comfortably.

3.3.4 Limitations and Conclusion

Major Findings

1. The information display does not suit the 97.5th percentile male and must be adjusted to lie within the more urgent field of view for both user groups.

2. The 2.5th percentile female is unable to reach the upper tank section and would therefore be unable to lift and remove it.

3. The 2.5th percentile female is unable to comfortably span the upper tank section in order to grip and lift it.

Takeaways to Inform Future Designs

1. The 97.5th percentile man can benefit from the screen angling upwards slightly. This would allow the 2.5th percentile female to see the display because of its height, and it would present itself more clearly to the male.

2. The upper tank section dimensions need to be revaluated in order to include those of the 2.5th percentile female.

3. The upper tank section might also benefit from handles of some sort to provide grip for the 2.5th percentile female.

Summary

This study revealed some major ergonomic challenges in relation to the range of motion and convenience of use of the proposed 'smart tank'. The study also helped to focus on the human factors and interaction of the three major body parts, and how they each relate to the concept. With these issues addressed, future iterations will be more ergonomically sound.

3.4 Aesthetics and Semantics

Most products in this category either have a particularly industrial appearance, seemingly having disregarded aesthetics, or are mimetic of similar products.

Some of the products lightly imitate the flowing nature of water in their language, however this could be explored further. The culture of Barbados could be further investigated in order to identify a design language which would be seamless in a Barbadian home.

3.5 Sustainability

Other than materials, the sustainability of the design speaks to the method used to move water throughout the system. Water can be moved from a water storage device to the household through gravity if the device is at a high enough elevation. Unfortunately, rainwater should be the primary source of water, and it should be harvested from the roof of the household. This means that the storage device which collects that rainwater should be lower than the roof of the house. Therefore, this water would have to be pumped to a second elevated storage device which would supply the house through gravity. It is this pumping step in the process where electricity is necessary, however the source of that electricity is a variable. Renewable energy harvested through solar panels or wind turbines could be used to ensure the system is passive in terms of energy, and that it has no operational costs.

Health and Safety

The major health considerations with this design are in regard to water quality. There are various ways the water can be contaminated: by an unsafe tank material, by an improperly sealed tank, or through foreign contaminants from the roof's surface or the gutters. The first two can easily be addressed through the design of the product, however the third requires closer interaction with the user about proper system maintenance and use of the different water types. The mobile application which accompanies the system should be able to educate the user, and provide information and reminders which would significantly reduce the likelihood of health risks.

3.6 Feasibility and Viability

The material selection has to take the existing market, health and safety, the user needs, and sustainability into consideration. The market for water storage solutions primarily consists of food-grade polyethylene (PE), which informs the typical cost of those products and considers health and safety. In terms of user needs, it is important for this product to be as affordable as possible to allow for accessibility to the public. Without this taking priority in decision making, the systematic effect of

reducing demand on municipal water that the product must have will be at risk. With all of these factors in mind, rotationally moulded food-grade PE is the most appropriate.

3.7 Design Brief

The eventual design solution should be able to:

1. Provide access to potable water.
2. Instil an awareness of the value of water.
3. Be easily maintained by non-professionals.
4. Not need regular maintenance.
5. Provide enough water to last the majority of the year.
6. Store enough water to last the majority of the year.
7. Reuse grey water.
8. Reduce water consumption.
9. Reduce demand on public water system.
10. Be relatively easy to install.

CHAPTER 4
Design Development

In this chapter, ideas on how to mitigate water scarcity will be developed from many vague concepts into a single design. A very wide range of solutions was explored, meaning that the final design varies greatly in terms of both appearance and purpose. A total of two direction changes occurred during this process and each is shown and explained in this chapter.

4.1 Idea Generation

4.1.1 Aesthetic Approach

As the product is designed for Barbadian households, the cultural context of the island of Barbados was of high priority for aesthetic influence. The local vernacular architecture was studied in order to inform the appearance of the final design. Two particular elements were identified as points of inspiration for the aesthetics of the product: the use of corrugated galvanised steel, known colloquially as 'galvanise', as a fence or space separator, and the use of breezeblocks for visual interest and ventilation. Examples of both can be seen in figure 12 and more detailed images are shown in figures 13 and 14.

Figure 13. Traditional Barbadian Vernacular Architecture

Figure 14. Traditional Barbadian vernacular architecture showing the use of 'galvanise' as a fence or wall

Figure 15. Breezeblocks used to create outdoor space

4.1.2 Mind Mapping

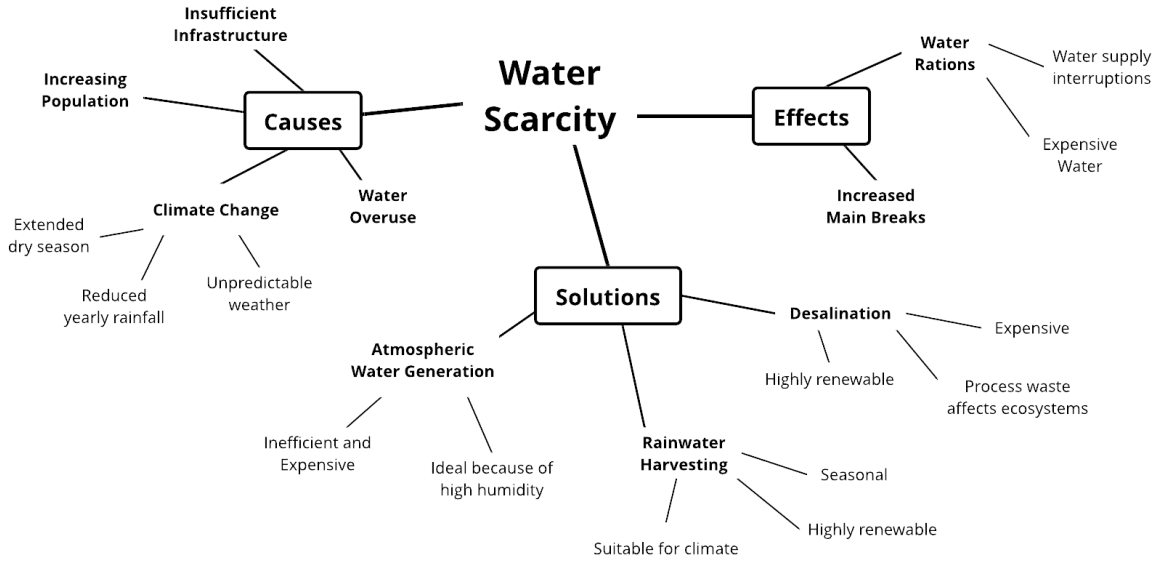


Figure 16. Mind map outlining the causes and effects of and solutions to water scarcity in Barbados

4.1.3 Ideation Sketches

Initial ideation sketches were blue-sky; each meant to represent a concept or technology.

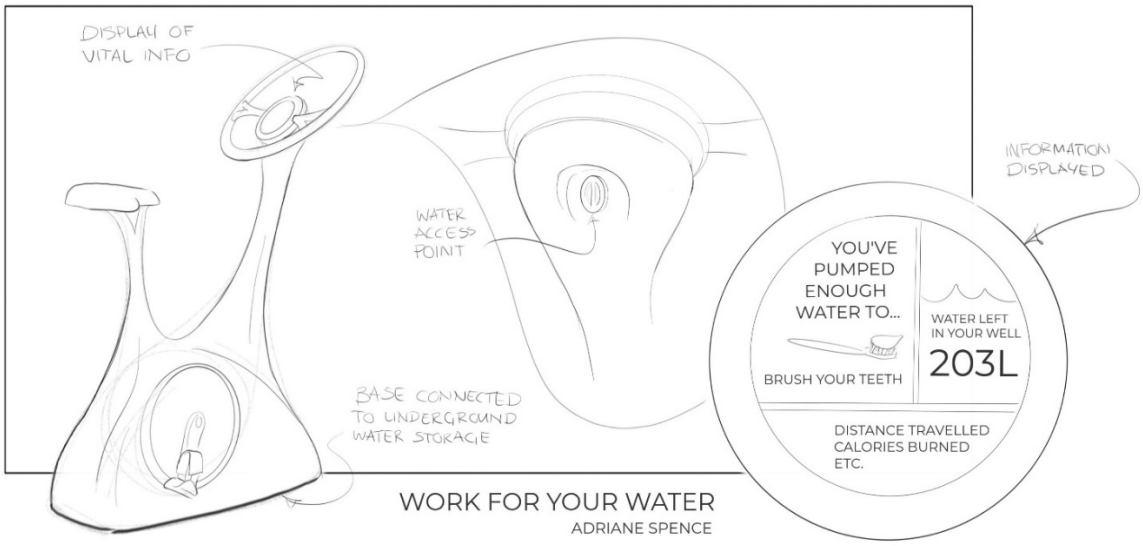


Figure 17. Ideation 1: Exercise Bike Water Pump; to instilling the value of water

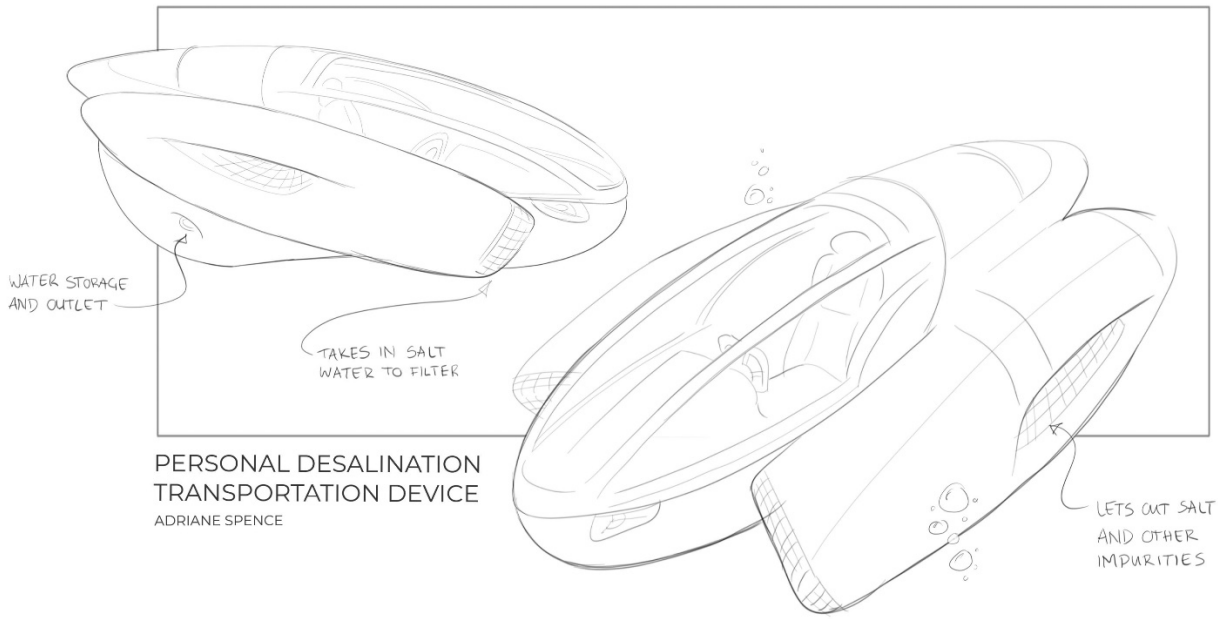


Figure 18. Ideation 2: Desalination Submarine; desalination that's more efficient and less damaging to ecosystems

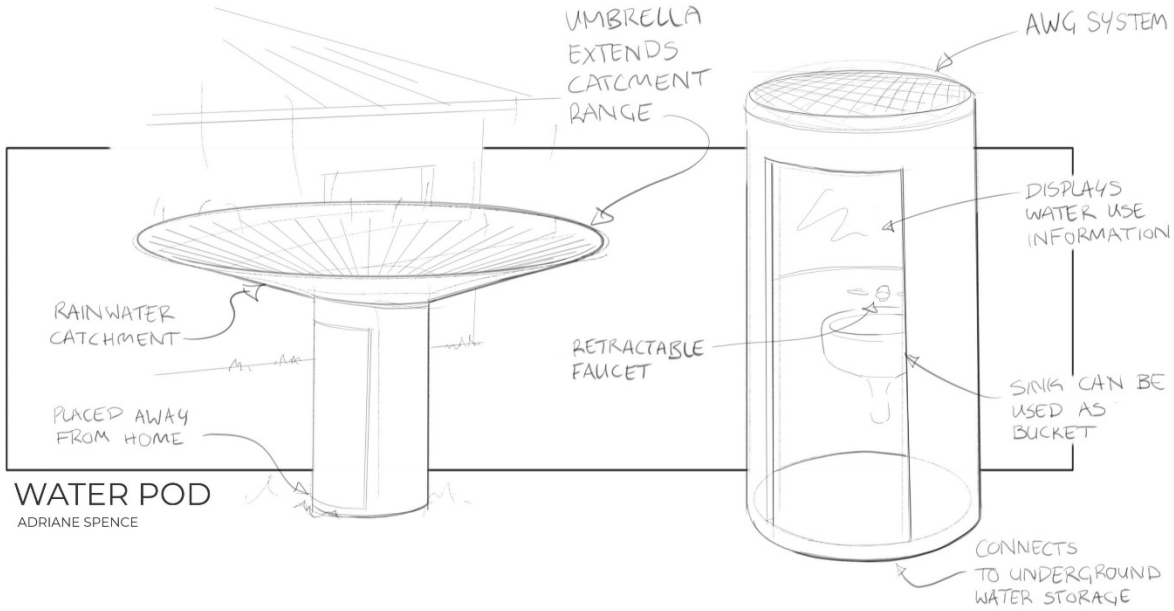


Figure 19. Ideation 3: Rainwater Harvesting and Atmospheric Water Generation Station

4.2 Preliminary Concept Explorations

At this stage in the design process, previous ideations were brought to more realistic standards.

4.2.1 First Concept

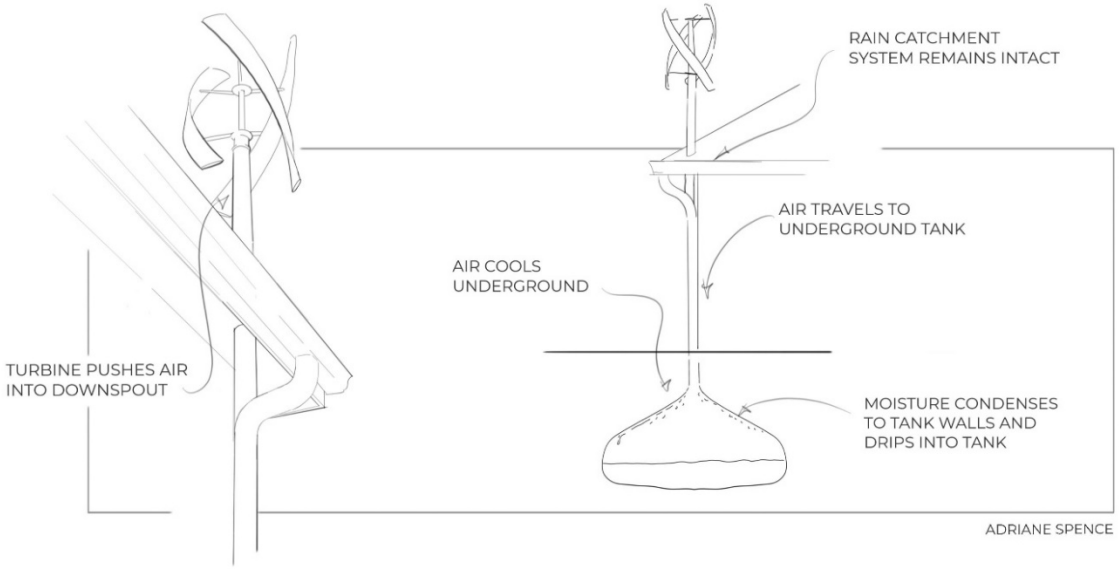


Figure 20. Wind and thermally powered atmospheric water generator

4.2.2 Second Concept

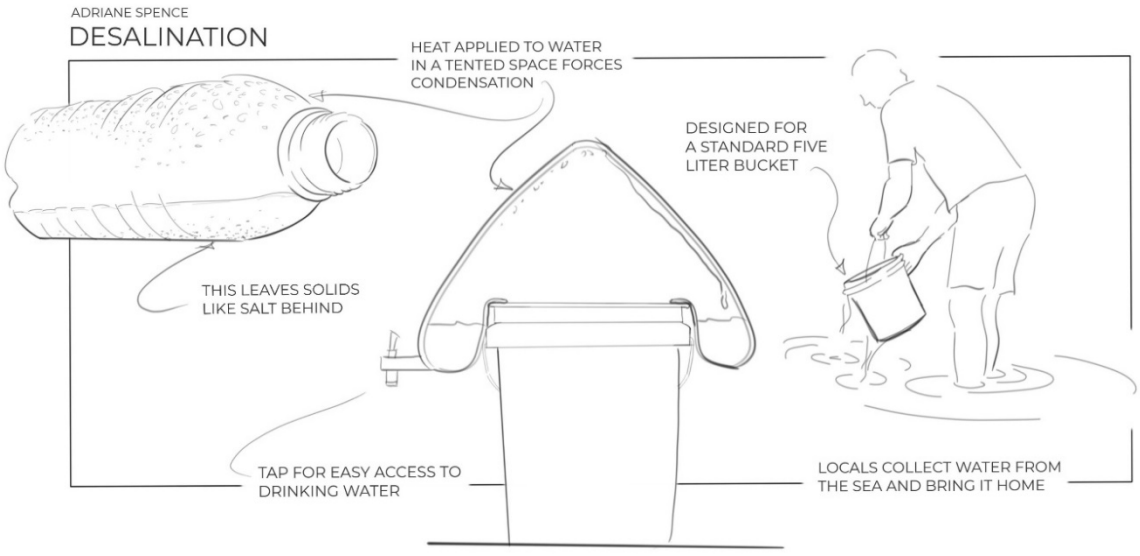


Figure 21. Low-tech desalination device

4.2.3 Third Concept

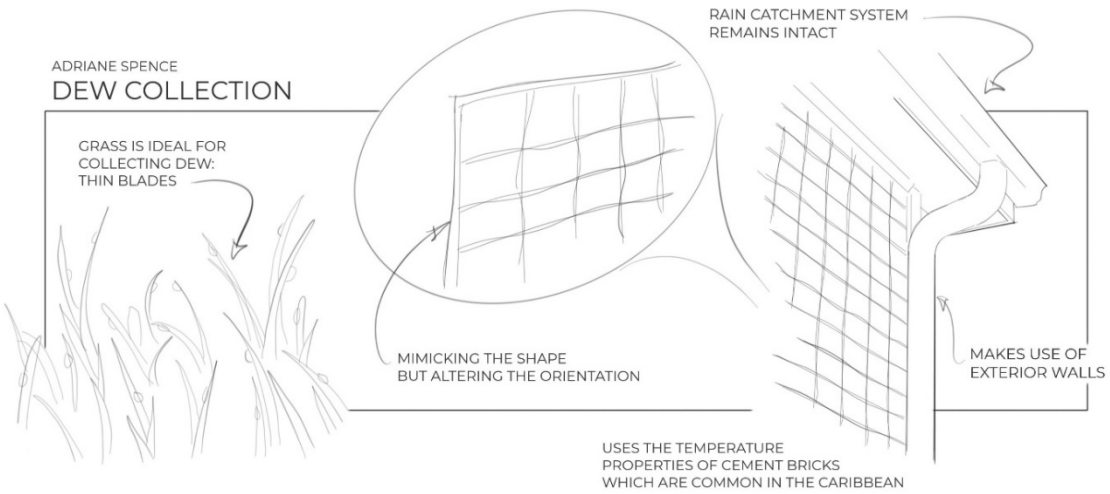


Figure 22. Dew collection wall covering

4.3 Concept Strategy

The following concept is an access point for potable water, designed to encourage the installation of rainwater harvesting systems in Barbadian homes and to bring awareness to the value of water through a direct household water management and monitoring system.

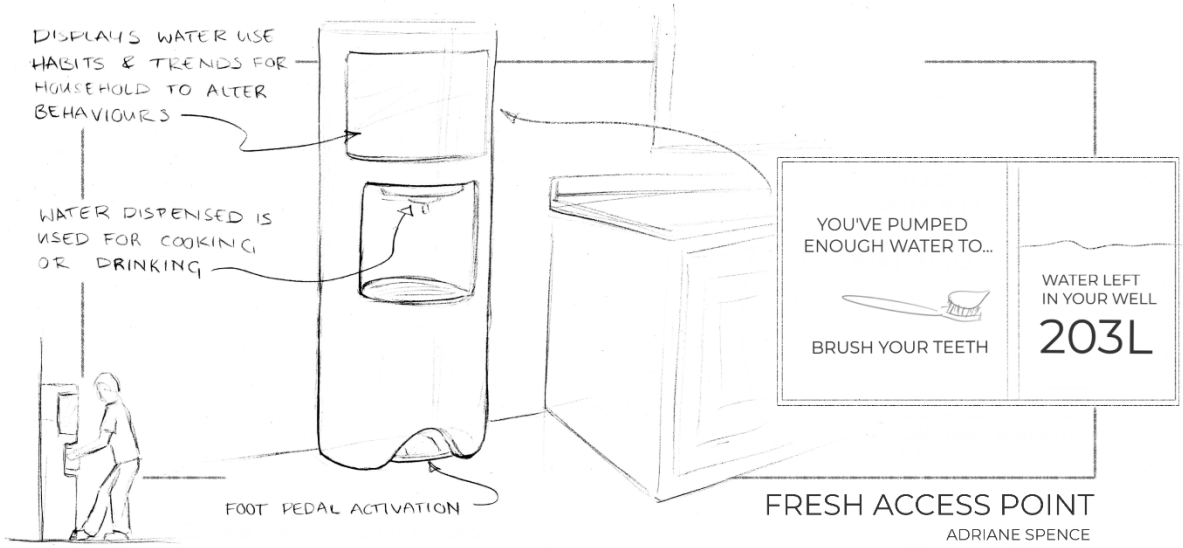


Figure 23. Access point for filtered water

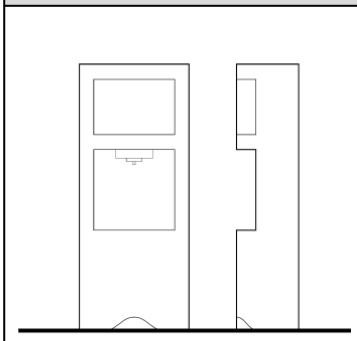
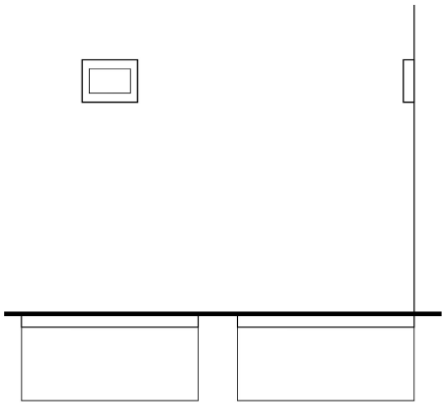
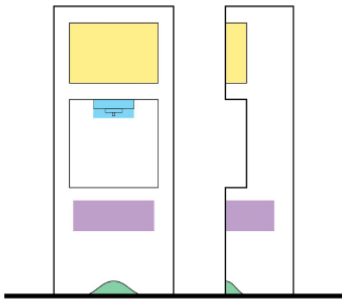
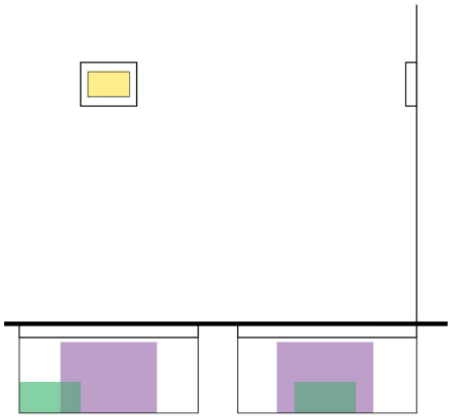
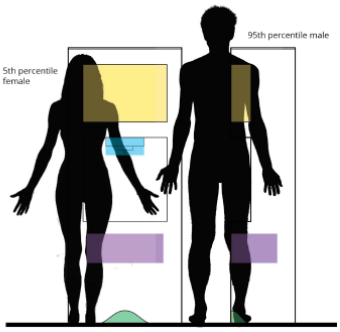
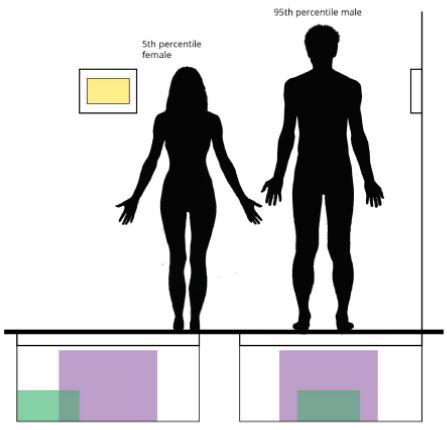
CONFIGURATION 1 **Access Point**	**CONFIGURATION 2** **Maintenance Hatch**	**EXPLANATION**
		**List of components:** - Filters - Pump - Water Outlet - Indicator **Locations affect:** - Interaction - Ergonomics - Functionality - Aesthetics
		Configuration 1 is far more self-contained. In configuration 2 elements of the design are scattered. For eg. the water outlet would be an existing faucet.
		Configuration 2 is more engaging to the entire body, and allows the system to be more discreet in the context of a home. Configuration 1 is less demanding to the user, allowing them to access all components more easily. Configuration 1 is more intrusive to the home.

Figure 24. Configuration diagram concepts

4.4 Concept Refinement

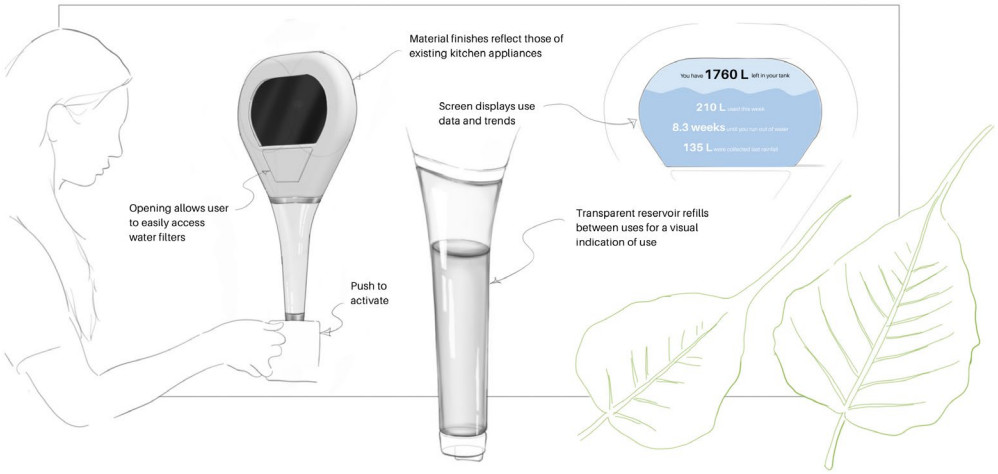


Figure 25. The access point concept was further refined, using a leaf which collects water from the air as form inspiration

4.5 Design Realisation

At this stage in the design process, a change of design direction took place. Instead of focussing on the potable water access point of a complicated plumbing system, the concept was centralised in a modular "smart tank" where water could be stored, monitored and accessed.

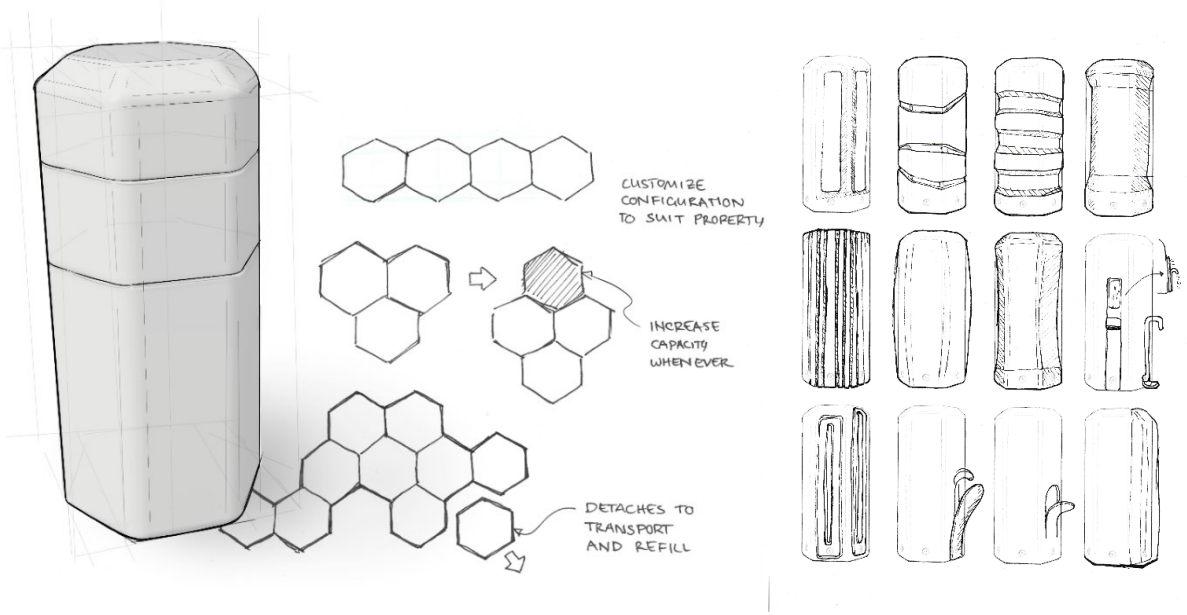


Figure 26. New direction concept

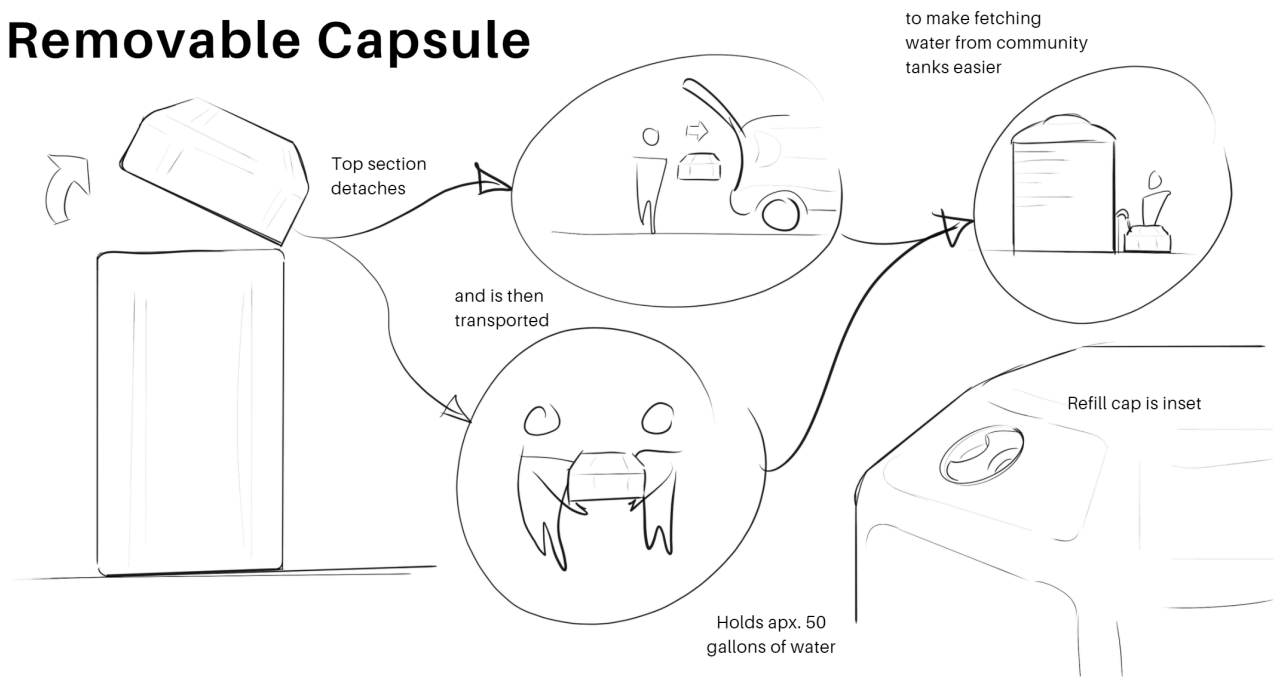


Figure 27. New direction concept

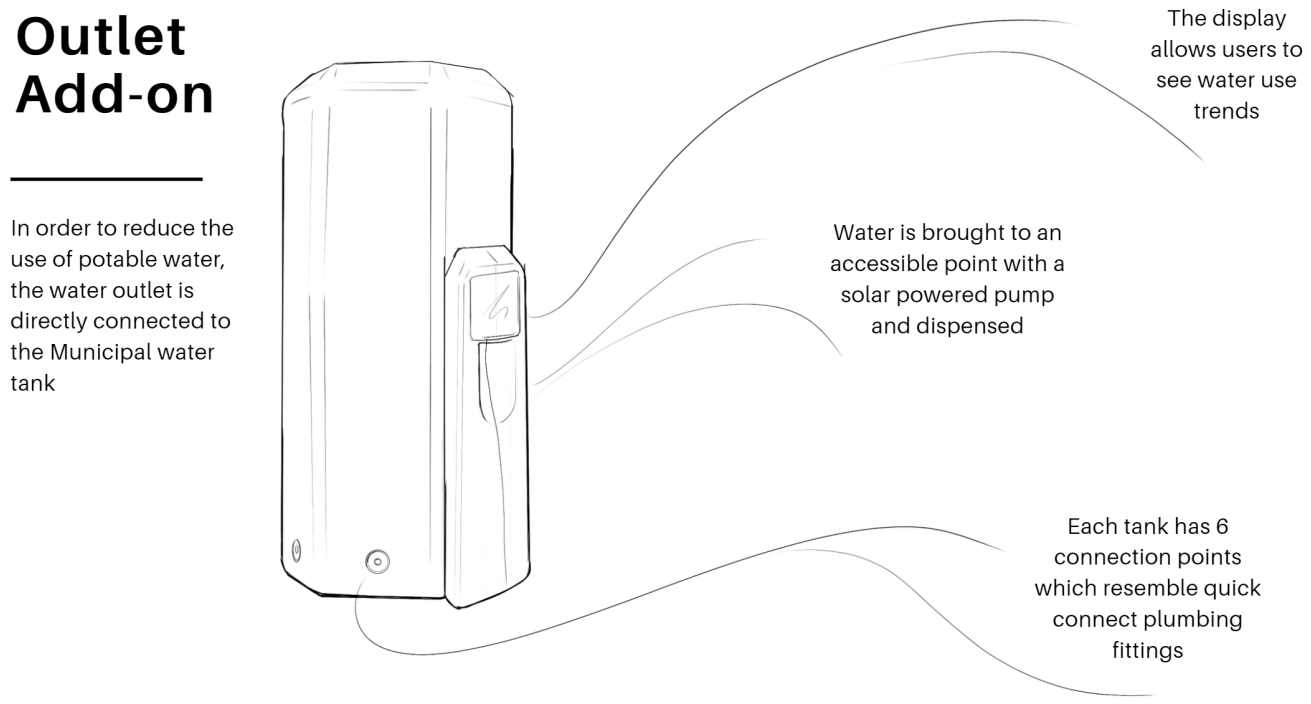
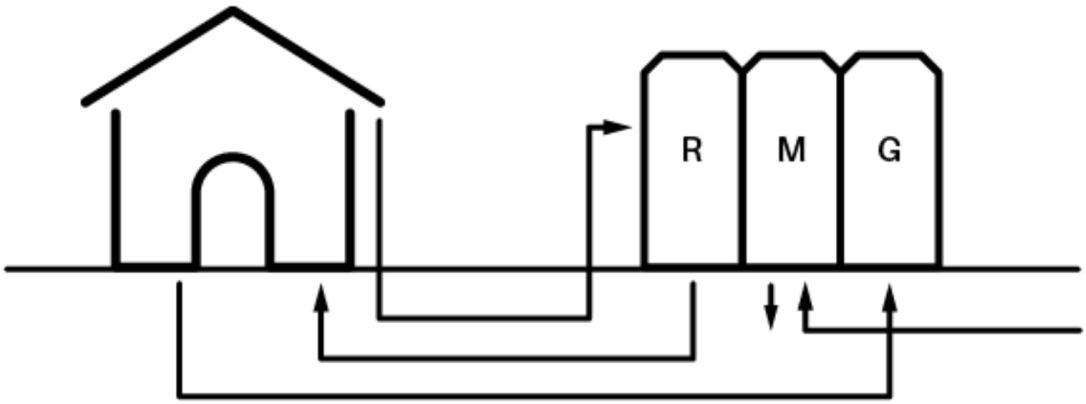


Figure 28. New direction concept



Rainwater

- Primary water source
- For all indoor outlets, ie. sinks, showers
- Not for consumption

Municipal

- Secondary source
- Potable water for cooking and drinking

Grey Water

- Tertiary source
- For outdoor use
- Can be connected to toilets for flushing

Figure 29. System functionality of new direction

4.5.1 Physical Study Models

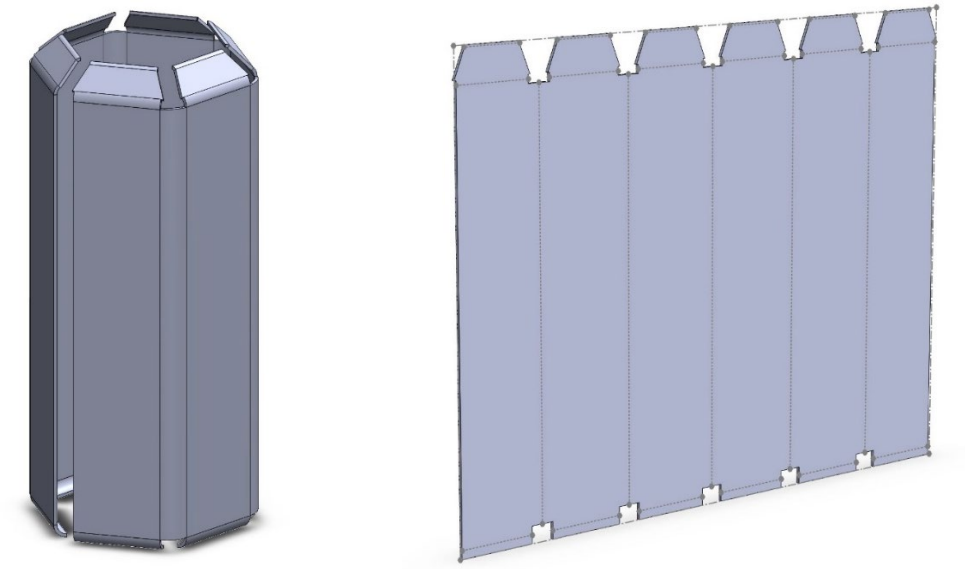


Figure 30. SolidWorks was used to create the basic form and the 'Sheet Metal' feature was used to create a flat pattern

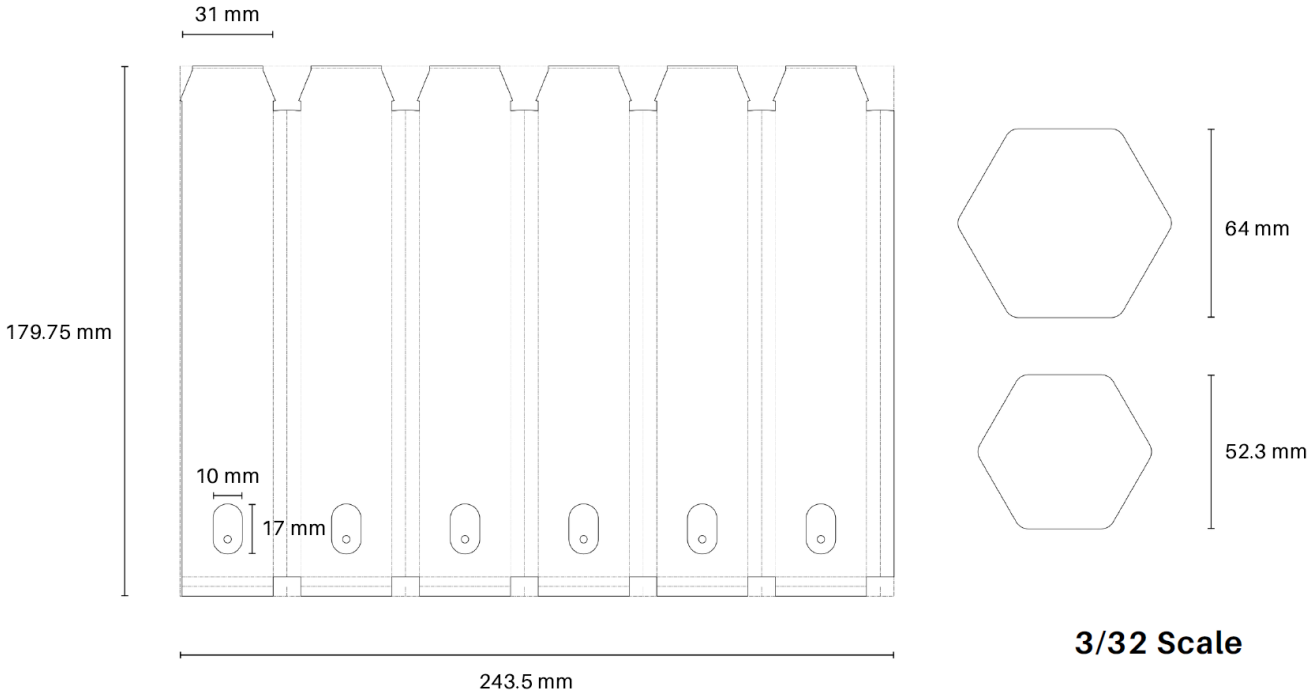


Figure 31. The flat pattern was printed and cut out of illustration board

Figure 32. Sketch Model Images

4.5.2 Product Schematic

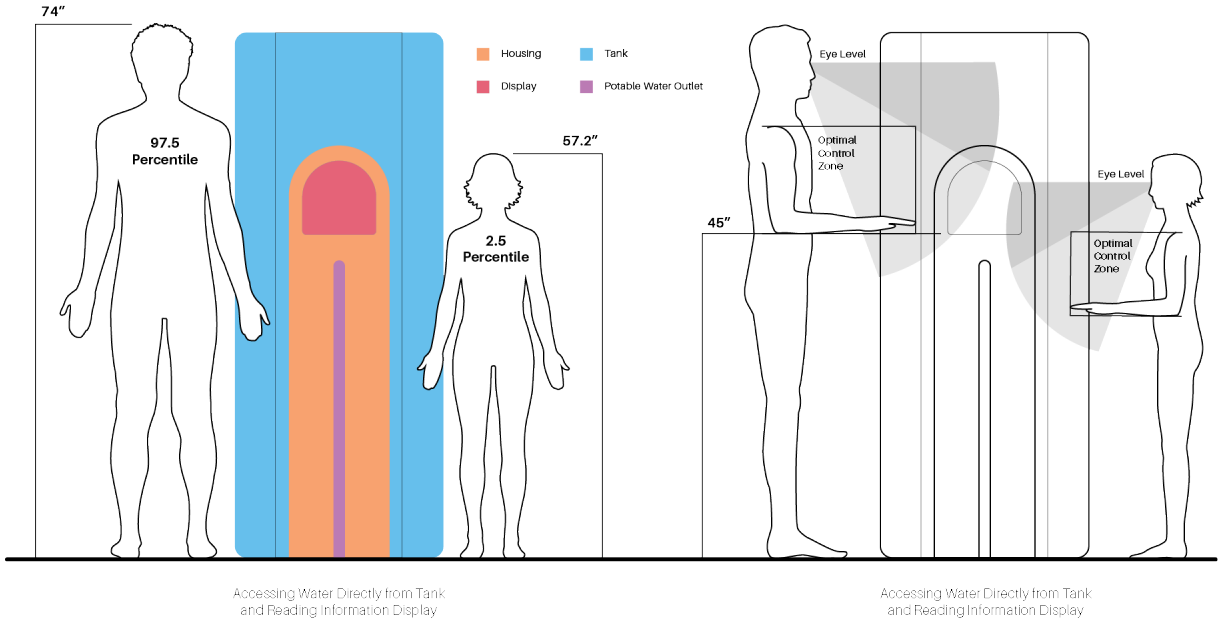


Figure 33. Revised Configuration Diagram and key ergonomic dimensions; 2.5th and 97.5th percentile for full-bodied interaction

4.6 Design Resolution

For one final time in this product's design process, the design direction was changed. Maintaining the concept of a modular tank and water management system, the form was developed greatly in order to satisfy the findings of the ergonomic research. The removable capsule was reduced to a more manageable scale for lifting and carrying, and lowered to a more accessible location in the design.

This direction allowed for much more resolution in regards to semantics, moving away from the traditional form of water storage devices, and delving deeper into designing for the product's intended physical environment. This aesthetic and semantic exploration can be seen in figure 34.

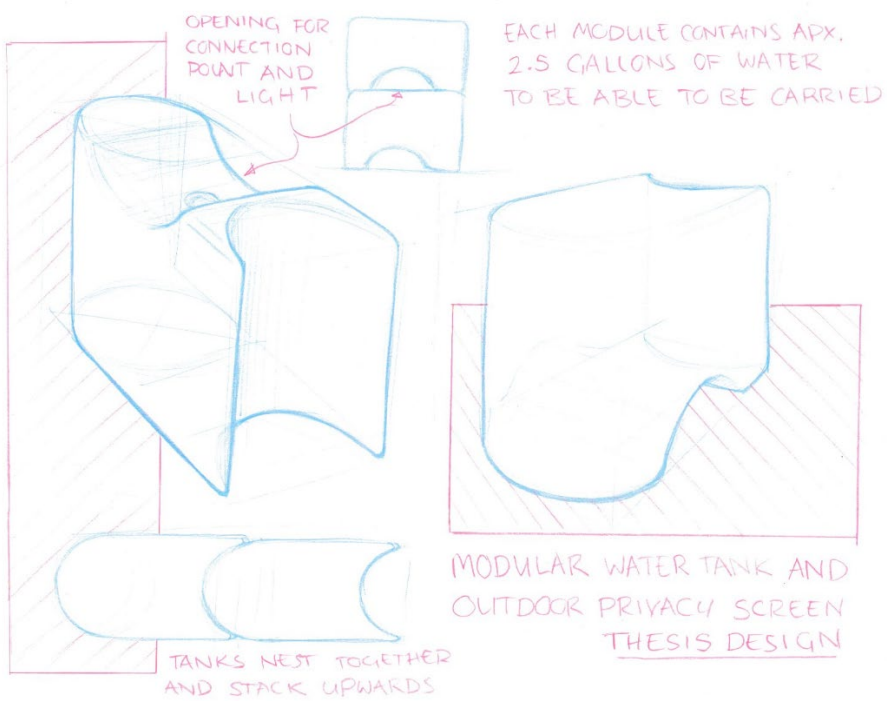


Figure 34. Sketches of the third direction change, developed shortly before beginning CAD work

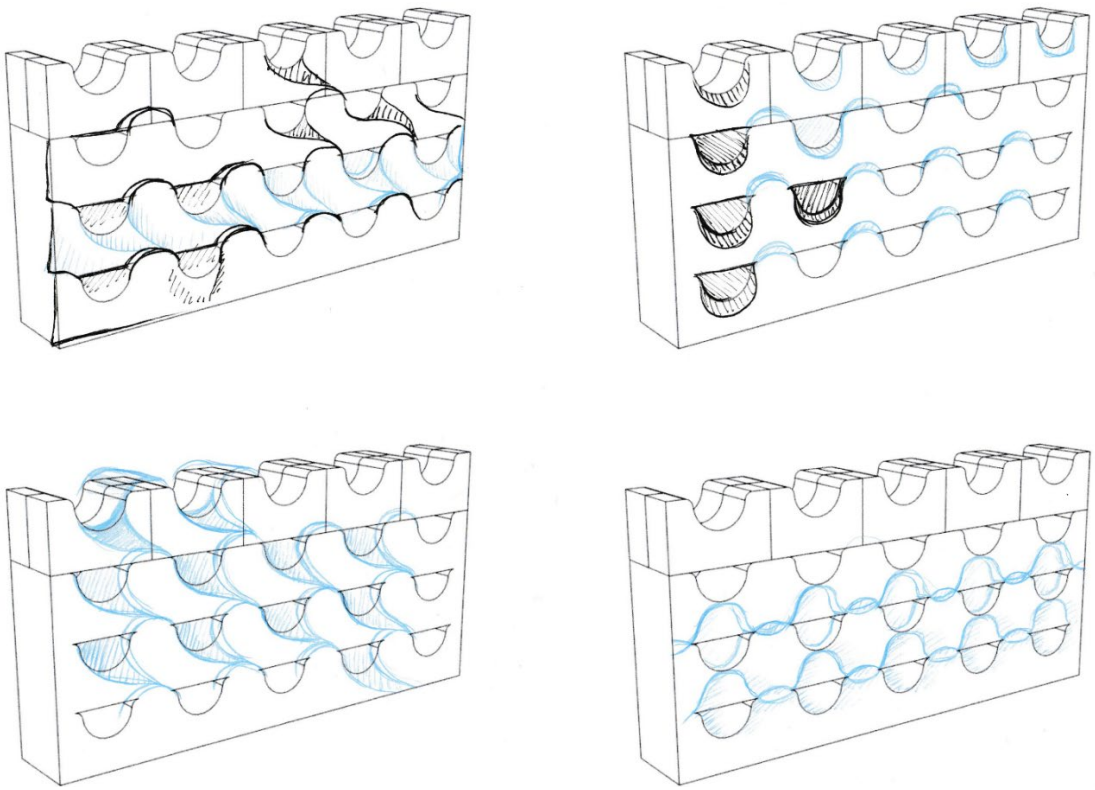


Figure 35. Further developing the physical design to suit Barbadian vernacular

4.7 CAD Development

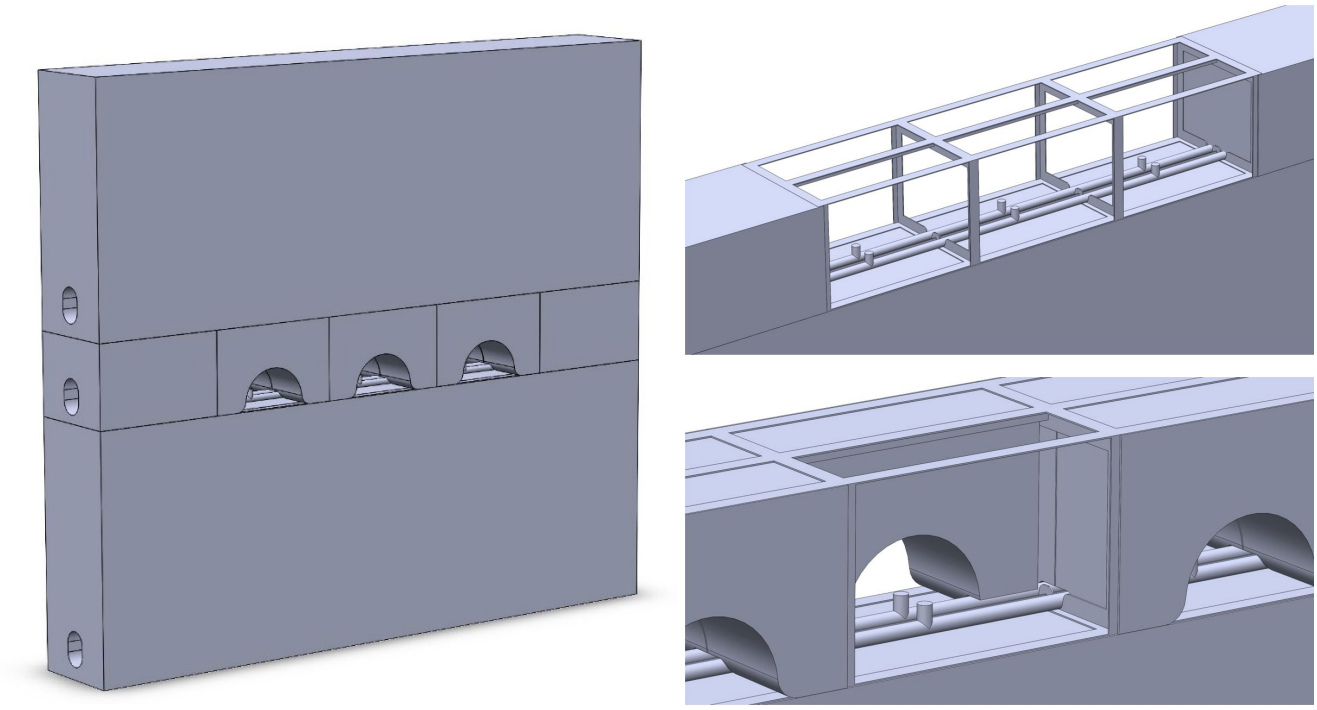


Figure 36. Initial CAD development exploring the structure and movement of water throughout

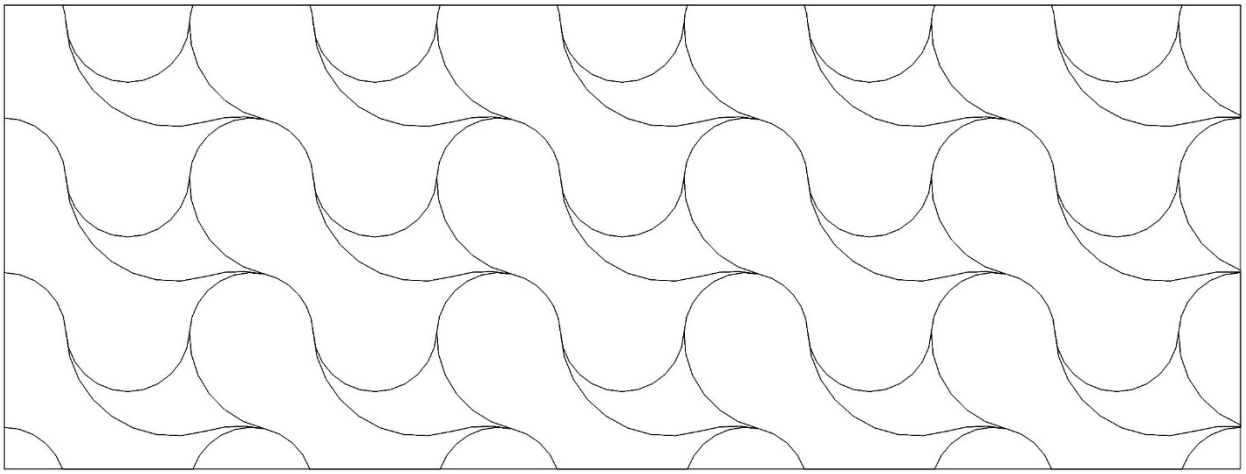


Figure 37. The exterior pattern for the tank system, designed to empathise with the culture of Barbados

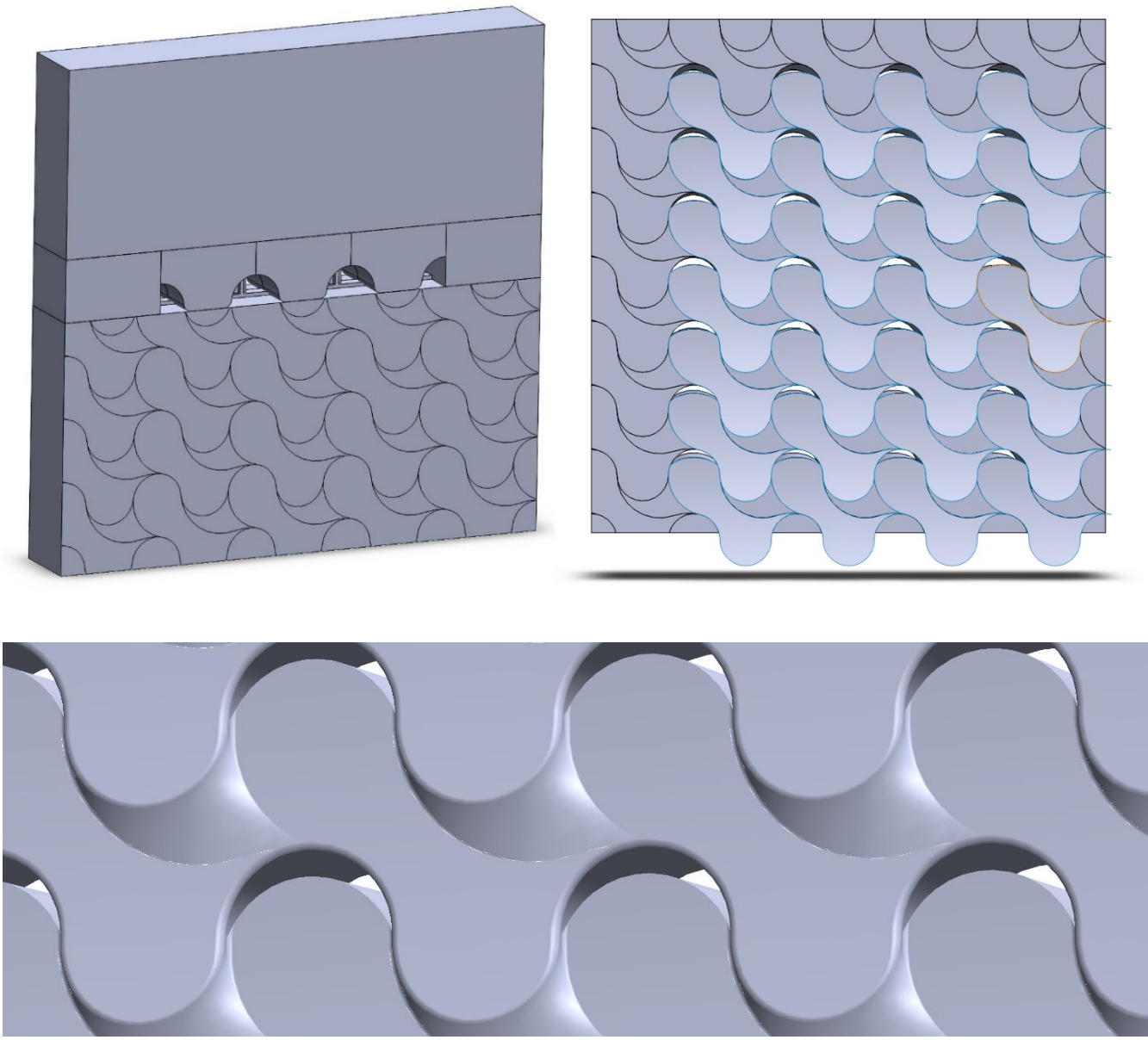


Figure 38. The build process of the three-dimensional pattern on the tanks

4.8 Physical Model Fabrication

As a novice, using a personal 3D printer for model fabrication led to many potentially avoidable issues in the printing process. The optimal print orientation was that of the product because it would result in the textured surface being of highest quality, however issues such as layer shifting, melting, and miscalibration of the printer occurred unless the model was very scaled down. Orienting the

model so that the textured surface was facing up meant more post-printing model making effort, but was the only way to achieve have a full print of a reasonable scale.

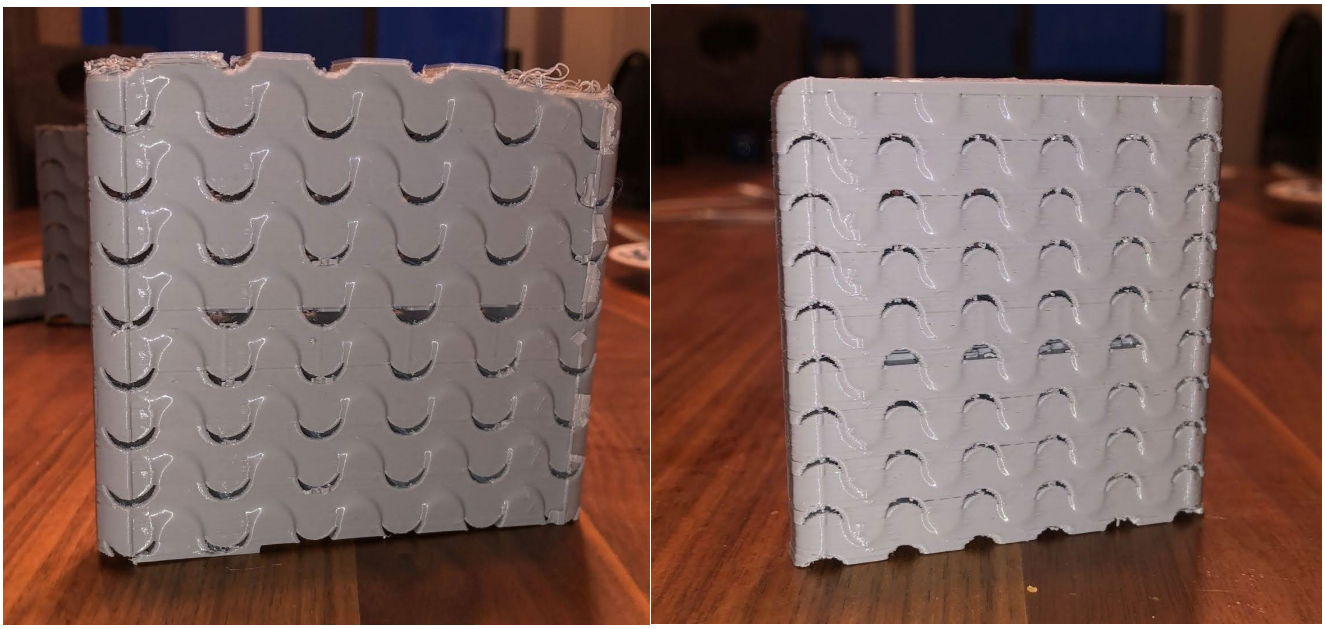


Figure 39. The first print failed when it was knocked off the bed towards the end of the print; a later version was a very small test to see if the geometry was inherently flawed, it printed without failure

Figure 40. An example of the layer shifting which occurred on many of the print attempts

CHAPTER 5
Final Design

5.1 Summary

Description

Wāv is a modular household tank and water management system designed to encourage the people of Barbados to use harvested rainwater as their primary water source, in order to reduce demand on the public water system and restore water security in the country.

Explanation

Barbados' issue of water scarcity exists on the basis that the entire population is almost entirely reliant on a single source of water. *Wāv* mitigates this by providing an easy and visually appealing way for users to take control of their own water acquisition via an alternative water source: rainwater harvesting. Currently, Barbados' municipal water is very high quality, completely potable, but it is used for tasks like washing cars and watering plants. Having the user manage their own water will allow Barbadians to gain a better understanding of the intrinsic value of water. Rural regions of the island experience the worst effects of water scarcity, frequent and unpredictable water outages. The Barbados Water Authority has installed large water tanks in these communities which are filled via truck during outages, for locals to access water in these times. The physical product consists of three kinds of tanks. Two of those comprise a subsystem which allows small 3.75-gallon tanks to be taken in and out, while the other, 7.5 gallons in capacity, acts as a stationary frame. This portability allows rural community members to easily detach, refill, and reconnect tank capsules to their *Wāv* system. The third and largest kind of tank is also stationary, and has a capacity of approximately 150 gallons. These tanks can be arranged in many configurations, allowing the user to adjust the system to suit their property.

Benefit Statement

Wāv is a modular tank and water management system which provides an easy and visually appealing

way for Barbadians to adopt rainwater harvesting as their primary water source, in turn reducing demand on the municipal water system and mitigating water scarcity in Barbados.

5.2 Design Criteria Met

5.2.1 Full Bodied Interaction Design

Wāv has one area of focussed full-bodied human interaction, the removable capsules. In this section, various aspects of those capsules will be discussed and their satisfaction of the ergonomic requirements of this thesis will be revealed.

The interactions that the user has with the removable capsules include lifting, carrying, and the fine motor interactions of disconnecting and reconnecting the capsules to and from the system.

Wāv's portable capsule has a capacity of 3.5 gallons, weighing approximately 29 pounds. This falls under the amount that the average adult in Barbados can carry, being that their average weight is approximately 150 pounds, and that the average adult can carry more or less half their weight. This particular interaction is full-bodied, involving the user's head, neck and shoulders, as well as their hands and arms, and their legs.

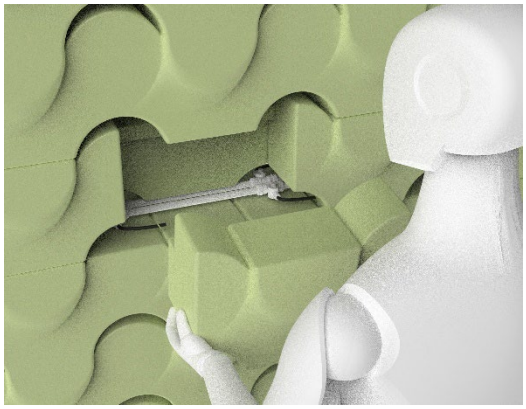


Figure 41. 50th percentile male lifting product

This portable capsule is also at an accessible height for removal and lifting for both 2.5th percentile female and 97.5th percentile male, 1 meter from the ground. Lifting the capsule affects the head, neck, shoulders region, as well as the hands and arms region.

Wāv's portable capsule has also been designed in a way which makes it easy and comfortable to carry. The form includes two indents in the bottom where the user's arms and hands can comfortably grip the product.

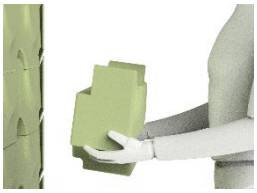


Figure 42. Product grip

In terms of the disconnection and reconnection of the capsule from the system, the hose is positioned in an accessible location. The quick-connect bulkhead on the capsule allows the user to use one simple pulling and pushing movement to complete this process, making the interaction easy on the hands and arms.

5.2.2 Materials, Processes, and Technology

The important factors when choosing *Wāv*'s materials and manufacturing processes, and technology will be discussed in this section. The decision-making process will be explained and the final decisions revealed.

When choosing a material for a water storage solution, one must consider the health and safety in regards to the contamination of the water. It is important to take chemical leeching, and effective sealing to prevent the growth of bacteria into account.

The purpose of *Wāv* is to have the general public of Barbados use the water storage and management system, therefore keeping it as low-cost as possible is a priority, so that it is financially accessible. This means that taking cost into account when evaluating materials was important.

In terms of manufacturing, the purpose and form of the product demand various attributes such as effective sealing, and thick, rigid walls. The form of the product is also quite complex, requiring certain manufacturing capabilities such as closed holes through hollow forms.

One last consideration when it comes to manufacturing is whether the island of Barbados has the capability to manufacture locally for environmental sustainability considering transportation of the product, as well as support of the local economy.

Regarding technology, all water movement and monitoring products must be affordable, effective and efficient.

Wāv's tanks are made of rotationally moulded food-grade polyethylene, with existing water movement and monitoring technology. Barbados has a rotational moulding facility which currently makes products of similar complexity to *Wāv,* using the selected material.

5.2.3 Implementation – Feasibility and Viability

Part	Material	Manufacturing	Estimated Cost
A-Class Items			
Large Tanks	Food-grade PE	Rotational moulding	$400
Medium Tanks	Food-grade PE	Rotational moulding	$150
Small Tanks	Food-grade PE	Rotational moulding	$70
B-Class Items			
End Caps	PE and sheet metal	Injection moulding and stamping and bending	$60
Top Caps	PE	Injection moulding	$50
T-valves	PVC	Injection moulding	$20
C-Class Items			
Structure	Steel beams	Extrusion	$12
Non-return valves	Brass	Cast	$10.50
Bulkheads	PP	Injection moulding	$10
Pipes	PVC	Extrusion	$9
Quick-connect	PP	Injection moulding	$6

Table 8. Bill of Material and ABC analysis

5.3 Final CAD Rendering

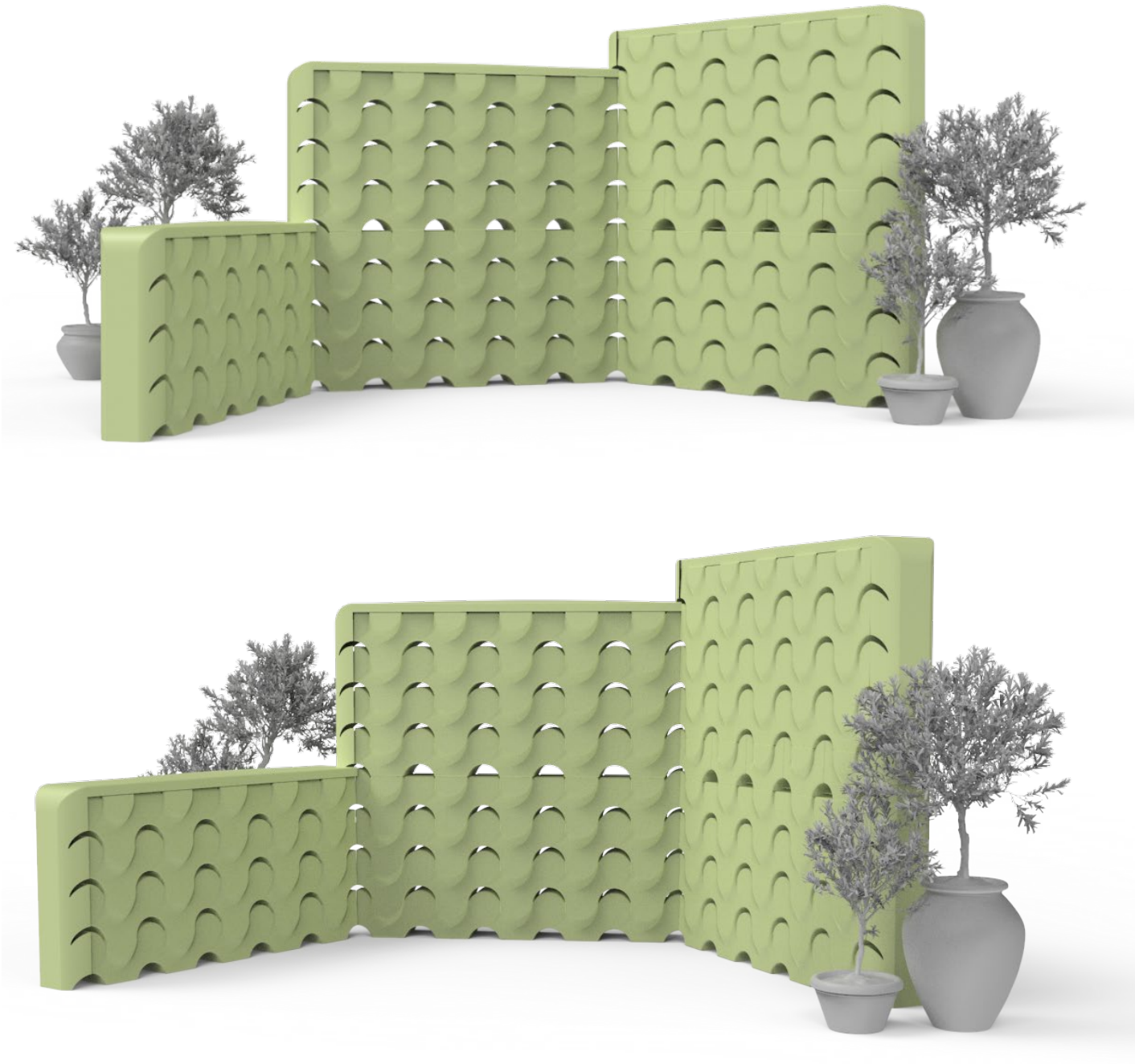


Figure 43. Hero Shots

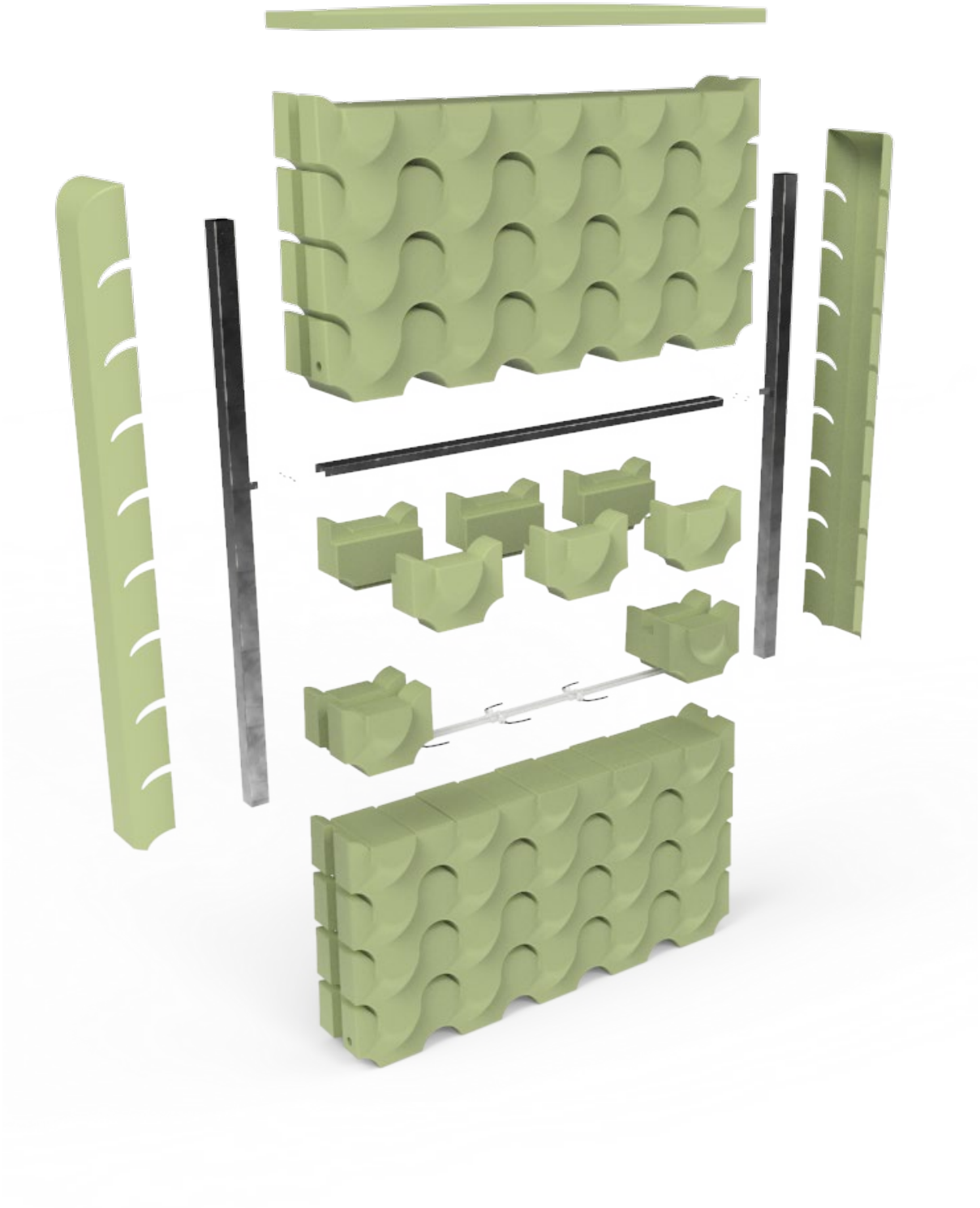


Figure 44. Exploded view

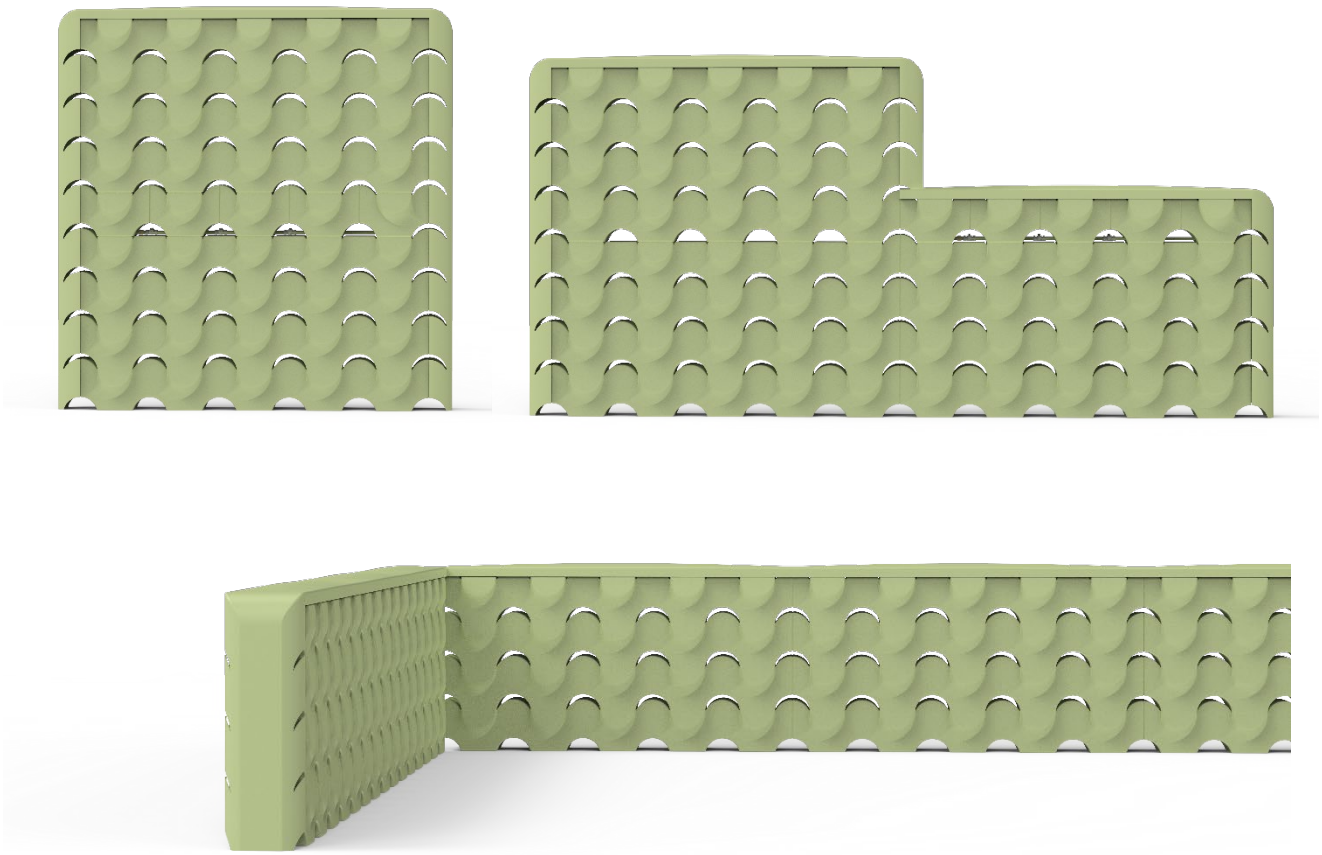


Figure 45. Product configuration examples

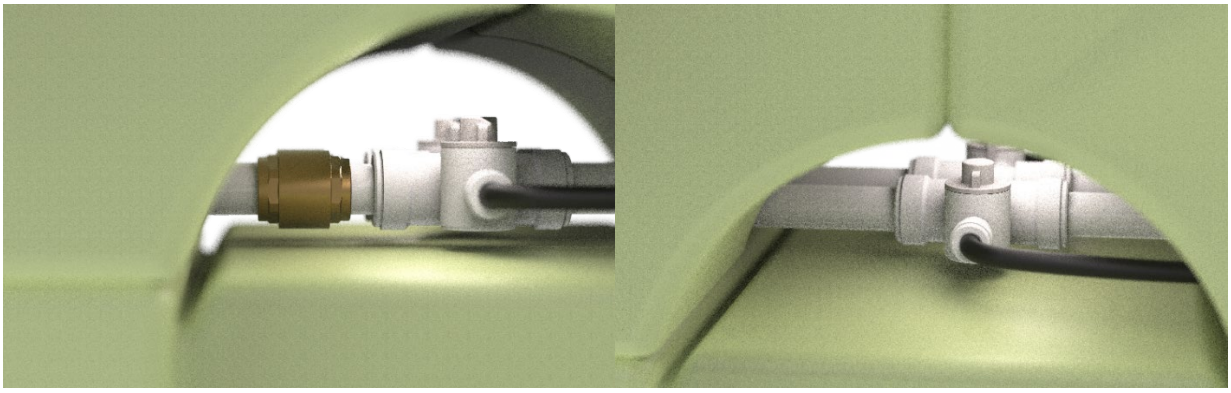


Figure 46. Plumbing close-ups

Figure 47. In-use rendering

5.4 Physical Model

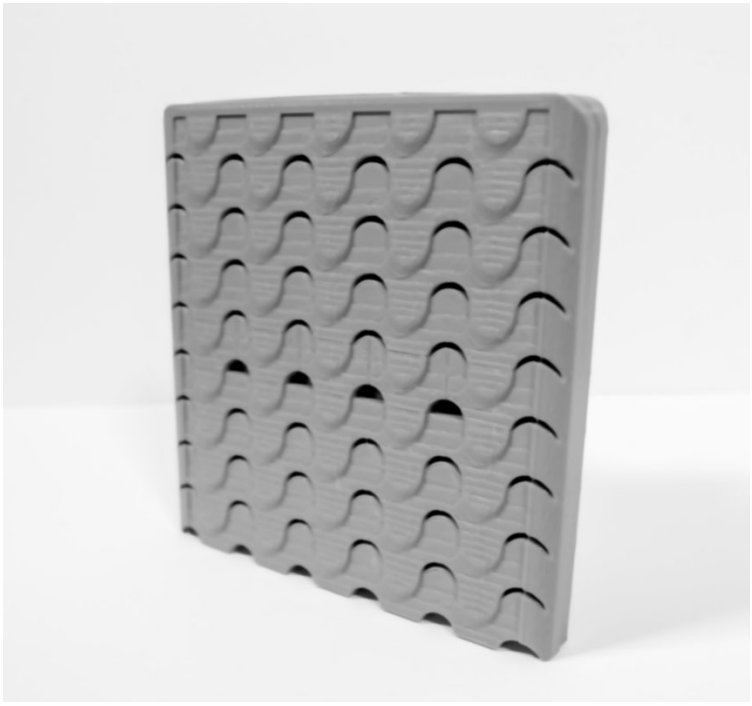


Figure 48. Image of final physical model

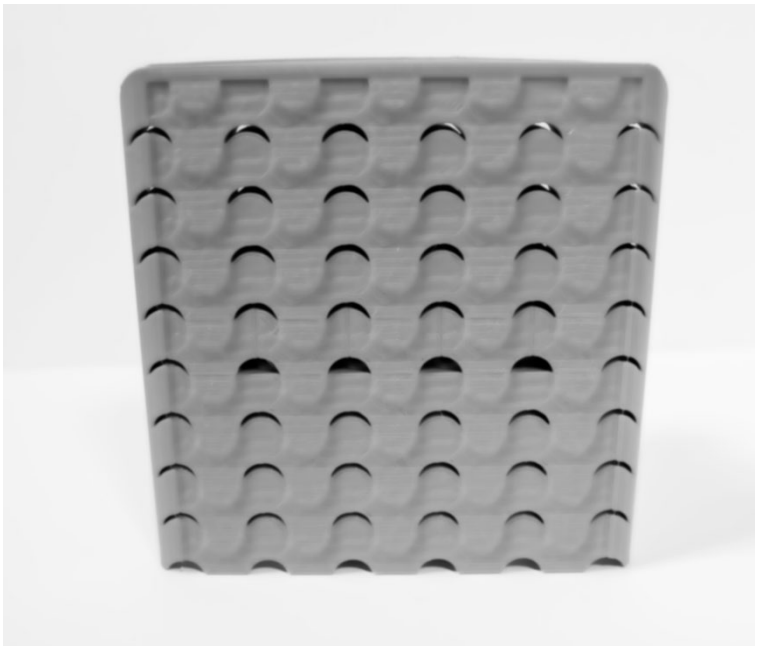


Figure 49. Image of final physical model

5.5 Technical Drawings

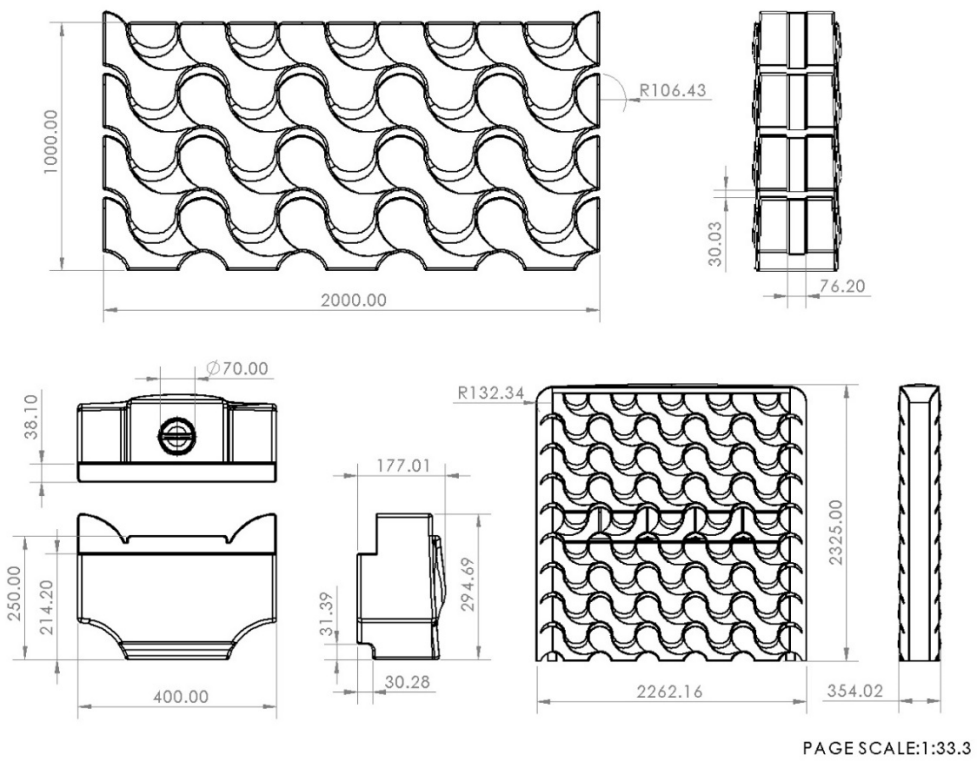


Figure 50. Technical drawings displaying essential dimension

5.6 Sustainability

Wāv considers sustainability in regards to its materiality, manufacturing process, energy source, and business model. Polyethylene is used for the materiality of the tank because it is lightweight, recyclable, affordable for the target user, and can be manipulated in its finish in order to simulate the cultural familiarity of the corrugated steel. Rotational moulding is used for its detail capabilities and one-piece manufacturing. Renewable energy sources will be communicated as preferred for the pump; however, it will be optional given that the system is completely customizable. The business model proposes that the product be manufactured at a local facility, using pre-existing materials and processes. It also facilitates sustainable water generation by encouraging rainwater harvesting.

CHAPTER 6
Conclusion

Wāv is a modular water storage and management system whose purpose is to foster the adoption of rainwater harvesting as a primary water source for households, and subsequently to help to achieve water security in the island nation of Barbados. Through customisability, affordability, and the integration of culturally empathetic physical design, *Wāv* has strong potential to be integrated into Barbadian society as a part of everyday life.

Figure 51. In-situ rendering

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Appendices

A – Discovery

Expert Interview

Adriane Spence 0:00
I think it's on. Yep. So, the four questions that I'm going to ask. In my little survey. The first one is, What's your relationship with water, which you've already kind of told me. But,

Mike Dejak 0:23
yeah, that's, I could go on for hours but,

Adriane Spence 0:27
well you know, that's a semi concise answer, maybe.

Mike Dejak 0:31
Yeah, well, it's unnecessary interruption refreshing when taken internally. It's a desirable and refreshing when taken externally. And, well, being close to water and being able to interact with it is, is very relaxing and soothing for the, for the mind and the soul. That's why people like to go near lakes and oceans and water. Most most people's idea of someplace recreational is where there's water and that's for for part of that reason. Yeah,

Adriane Spence 1:14
I would agree.

Mike Dejak 1:17
I mean it's part. Yeah, Part Part of it is, it's it's a it's associated with life like as my wife has mentioned it's necessary for life so you you intuitively and inherently know that so when there's plenty of water you feel very full of labor, because you feel very safe but there's lots of water.

Adriane Spence 1:35
Yeah. I mean, there's a reason why all you know major settlements are around water. We need it. Um, So the next question is, what do you think, the most vital issue is in terms of water scarcity in the Caribbean, just from your basic understanding.

Mike Dejak 2:03
Um, yeah well it's basically freshwater is delivered to the Caribbean at certain times of the year and other times it's not. And then it depends on the, on the geography of where you're located whether whether that freshwater that felons going to be stored will be available to you. And so there's that there's that fundamental question and then there's the question was related to global warming with ocean, rising ocean levels and warmer weather. You know, will that affect the availability of water in the future compared to what it is now, I suspect that all the trends indicate they'll be less water available in the future when it

Adriane Spence 2:57
seems that way. Okay, great. So, the third question is, what do you think having heard about my context. What do you think I should focus on, like what issue I should address.

Mike Dejak 3:21
Um, well, I think that, you know, what we, what we just talked about the last area that we talked about, which is a way of means of residential water management of collecting collecting rainwater for primary use, and then storing grey water first and for secondary use, and having a simple cost effective feedback for the user. So that they can be engaged in the process of of conserving their water, reducing it reusing it, and adjusting their behavior according to the feedback that they get. No.

Adriane Spence 4:14
Yeah. Okay. Um, and then the last question was, what resources do you think that you can point me towards that might help me in my further research.

Mike Dejak 4:33
Well, general information about water, you know, residential water consumption. I mean, other than what you know you can find things on Google I'm sure you know assistance in that regard. geo information about non geographic climatic climatic conditions like how much rainfall falls and when in the areas that you're talking about, and then going to the individual locations the countries and finding out what is their water management plan like but most of them have got, they know what the situation is they have some kind of a plan, understanding what that is. And then, and then it comes down to the, to the direct application for individuals, knowing what what's individual water consumption. And what are the use patterns, what are the, what's it used for and how do how does the information that you've that you've gathered in terms of how much rainwater is available. And how much do people need. How do you then develop a product that will will work effectively to meet everybody's needs. Mm hmm.

Adriane Spence 5:46
Yes. Okay. Um, I have one question that is not on this list, but I just remembered I ran into some research about atmospheric water generation. So I just wanted to know what you think about that i i know like very super surface level information about it so maybe you can give me some insight into the process in general, and its efficiency, and maybe its effectiveness, or like a general guess on its effectiveness in terms of the Caribbean.

Mike Dejak 6:35
Yeah, well, I guess the way I look at it in simplistic terms is generating your own dupe. So, when it's humid and you get, and then you have cool weather cool nights you get juice. And, you know, it so that it's possible. I don't know. And I think that there's some systems of doing something like that even on boats, to be able to generate enough water just by causing water to water to condense from the, from the human error. But, yeah. Well, I would say, it's a possibility worth investigating. My concern would be I don't I my concern would be if you don't have the natural climatic conditions which would be big temperature swings. Okay, like for example, in a lot of desert areas that's favorable because it's hot during the day when it's cooler at night so you can you can you can create conditions to form do with just some smart, you know, apparatus. But if you don't have the big variations from from day to night which is a case in the Caribbean, then you'd have to put energy into it, to make that happen. That makes it less attractive. Yeah.

Adriane Spence 7:55
Yes. That is very true. Um. Okay. Thank you.

Mike Dejak 8:04
The thing I'll say is, he also has a very good friend, a couple in Antigua that. If you don't have any other contacts there they would be very useful in terms of these. I mean, they have a house there, what do they do for water. They built the house there so I'm curious what they did, What, what did the neighbors do. And, and, you know what's what's the situation and thinking that they, they'll be 30 No, they also run a restaurant, very knowledgeable about different aspects of water use in Antigua and Barbuda.

Adriane Spence 8:35
Yeah, I would, that would be great. I would love to get in contact with them.

Mike Dejak 8:42
Okay. I'll get, add to, to contact to contact her, fake, fake kershner, and give you give her some background and introduce you and then share the contact with you and you can get in touch with her.

Adriane Spence 8:57
Great. Yeah, that would be. That's amazing. Thank you so much.

Mike Dejak 9:02
And adverts benefit.

B – User Research

User Interviews

Six interviews were conducted with Barbadians who experienced water scarcity related issues in their households. Three of those were on site and were therefore unable to be transcribed. The other three were digital due to the COVID-19 pandemic; those have been transcribed and are available below.

Interview 1: Gail Ramsay

Gail Ramsay
All basic things that I have experienced. Alright so we live in Asheville st john. Okay, which is very near Bowmanston. Back around the corner from Bowmanston actually.

Adriane Spence
Yeah, yeah, I think it's right now to Kathy, where she used to live right

Gail Ramsay
yes yes that actually Yes, right. So she wouldn't have told herself, her walls when she lived there. It's gotten better in the last two months and I guess because it's raining or whatever. But I would say most of the summer. Last year, September, October, November, we, we would get, we had a lot. I mean, which was unusual for us because normally if anything, we will have, we would have a low water pressure but he will still have water, but there were days when, after 11 o'clock. We would have water at all. And so it's. And that was consistent for about two months. I received these, I can't remember exactly but maybe September, October mostly last year. I think that's when they didn't have much rain, I believe. Right, so they were so they were obviously having water shortages and stuff like that. I don't have to, because they are now putting down, new pipes. Okay. By cynjohn as well, that I would have created the issue. But again, the literally the water would be turned off from maybe five o'clock, and not turned on until the next morning. Yeah. You know, so, and what we always find too is that it has a lot of rain, that the water is sometimes very cloudy or muddy. Brown. Yes. Brown. Yeah, for a while. So those are the real issues that we we deal with. I must say, as I said since from, maybe, November, maybe in December so on. And God we haven't had any of those things, but I really was because of the because we have more water, we want more rain. You know,

Adriane Spence
yeah,

Gail Ramsay
those are the only things I was worse last year than ever before. Because you know, as I said some months, we would just have a lot of pressure. So, you know, that much turn on your washing machine because you can't do a full load of clothes. I mean, literally, you learn to to wash up dishes with a little trickle of water. Yeah. And you learned and make sure you have water saved and stored, all the time.

Adriane Spence
Yeah, I was going to ask, sort of, what, what are the major things that you do to deal with those problems so you're saying that you you store water is that in, sort of like a tank or is it just containers that you have. And you put them in the fridge.

Gail Ramsay
well we, we have containers. We have been trying to set up a wardrobe that we haven't gotten there yet but yeah but mostly containers. You know, so my house has a whole set of containers that I have more historian, and you literally learn then the whole method of, you know, a what, what do I start. Where do I start for washing What do I store for drinking, you know, and that kind of thing. And literally learn every little trickle of water, what you can wash what you can't wash. So you learn to adapt, you know, you learn to go and have showers with to to PET bottles you know I mean yeah, it's not convenient because it's the thing is, you still have to be paying your water bill.

Adriane Spence

Yeah. Yeah, even though you're saying,

Gail Ramsay
Yeah, right. You can see what I'm not gonna pay this month, because I may cut you off when you don't have water at all. So it's a catch 22 type of thing. But I think the main problem would be that made me to investigate. Places like foreman stern golden Grove, and see how are they pumping any water, maybe, a lot of times to the water is being wasted. Because if you have a breakage It'll take a while before they can fix it.

Adriane Spence
Right.

Gail Ramsay
Yeah, and I think to maybe because they have different zombies your pipes that may be a lot better than brick be able to absorb the water, and also to, how are they catching your rainwater, you know, are they, do they, you know, are they making it better means in which they can store this water, you know,

Adriane Spence
so I was gonna ask you as well like do you catch any rainwater yourself, is there, you know, do you catch any

Gail Ramsay
no water, no

Adriane Spence
I didn't do that,

Gail Ramsay
unfortunately we don't do that. But, yeah, you know, I think, I think that's something that you could probably think that, you know, people who are, in fact, doing new buildings and stuff like that. They should have not just water tanks for storing water as they get it from the tap, but also a means of catching rainwater. Yeah. You know, then they can utilize that maybe to plant, maybe toilets, you know, that type of thing. Well, another way in which they, they could be doing water.

Adriane Spence
Yeah, because I was just I was also going to ask if you do any sort of water reuse yourself and you know like if you when you wash dishes or when you wash your hands in the sink or anything Do you catch any of that water to water your plants with or anything like that.

Gail Ramsay
Sometimes I do what I would do is that, you know, if I'm washing, I make sure then that that I have enough that I'm washing. You know, the you know the the dishes, so I'm not wasting the water that. Yeah, I got the soapy water, and I really use the same type of water to you know to do as much as I can, rather than a wasted. Yeah, so, so you learn, you learn, one of the things that that this is one of the positives. Is that is that you will learn how to utilize the water that you do have. Yeah, on your loan to realize that a bad boy has to go along with having.

Adriane Spence
Yeah. And just to value water for how precious it really is you know it's so important for us.

Gail Ramsay
Yes, that's so a lot of things. I mean, a lot of ways, I think, in which we can improve, which we are not improving. I mean, I mean, I think other households are doing it but but I think generally to re educate people, how to use their water right now. Again the rainbow. You know, because I remember many many years ago we were in St Lucia. And what they did was that they had their rainwater going to attacks right they would use that bat to flush their toilets and, and, and do their plants and stuff like that, which most people don't do here. Yeah. If they have a tank, it's, it's been showed up from a from a tap.

Adriane Spence
Mm hmm. And St Lucia is not, you know, Barbados is a water scarce country we have less freshwater than they do there it's, and we have more people, you know, it's, I think it's I didn't I've lived here since I was four years old and I didn't realize that, Barbados was as water scarce as it is just because I happen to live in St. Michael and, you know, I've always lived in town I've always had, you know, every now and then the water would go off or move at low pressure but it's still, it's consistent that I just turn on the top and then I have water. But, that's right. Yeah, you don't realize,

Gail Ramsay
people like in the country. The st john area is in an area the St Joseph's area where they like they tell me Well, I don't have a choice. So, obviously, the doors, and of course a much more populated. Michael area is the area. All the cash outflows. And so of course they are going to make sure you, they are more water than we do. Yeah, which is not fair. Rarely and to say that that those country areas are less populated that's not necessarily true and,

Adriane Spence
yeah, it isn't. You know, it isn't that it's

Gail Ramsay
a place like bash or casual wash. Most people are living down there.

Adriane Spence
Yeah. Yeah, I think it's a. They claim that it's, you know, a matter of how many people live where but it's really more about, you know, it's the hotels, that, that are on the coasts and it's the, the wealth I guess that they're kind of chasing to serve but that doesn't make any sense.

Gail Ramsay
Yeah. But, but, more, more of more of your. I think produce grown in new fields, I believe, more centric areas and john here to Joseph area, and it would be. I guess to see how they are utilizing their water as well.

Adriane Spence
Yeah. Yeah, so you live near the dairy farm that's out there right.

Gail Ramsay
Yes, yes. Yeah, so they are I'm sure they have struggled with water as well. But I guess they would have their own tanks and stuff like that. So, you know i mean but as I said they you know it's I don't exactly know how they how they will be doing it but they will be having the, I'm sure they weren't towns and stuff. But as I say it must, it must be a struggle for them. Because I remember when I used to live there. It used to be a struggle for water for them for the show only dairy farm. Yeah, I'm sure she would have told you that. Yeah, you know,

Adriane Spence
yeah. She mentioned that they were sorry. Go ahead. Yeah,

Gail Ramsay
I guess, as time progressed. We saw it was more of a problem they may have implemented certain things, you know.

Adriane Spence
Yeah, I think that's what she was, she was telling me you know they have lots of different backup backup backup things that. Yes, yes. So, whenever one thing goes out at least they have another one, and she because of their location was they were able to access, you know. All right.

Gail Ramsay
Yeah. So, what why do you think I think one of the things that you learn is that because you are aware of the shortages, because you are aware that Oh gosh, I better wash and I make sure I cook before 11 o'clock. Yeah, because I'm not gonna have water, you, you learn to improvise, you see.

Adriane Spence
Yeah, yeah, that

Gail Ramsay
gave you a solid course. And, you know, water goes off, you're, you're more. You're more prepared.

Adriane Spence
Yeah. Yeah, we don't really know what to do when that happens. I mean, I don't. Yeah.

Gail Ramsay

Yeah. Yeah. Um, but, but you would find now that most schools are so they will have water tanks and stuff like that because people began to realize Look, there's a water shortage. You know, but I think the whole thing of maybe becoming. So, in, you know, insisting that people now begin to collect rainwater and stuff like that. Yeah. and and how to utilize it, you know.

Adriane Spence
Yeah, I think so, a lot in an education thing. But unfortunately I'm Yes, come up with a project, a product. Yeah, so I do have a few more questions. Do. Sorry, just I'm just looking at my notes. So what would you say are the activities that use the most water in your household.

Gail Ramsay
My house. Yeah. Okay, so it's like, I would say the washing of clothes. Washing clothes mostly cooking but I mean that that's not as much as maybe just in Washington, close actually because that would take, you know, depends on a whole load of. Yeah, so you, in other words that like unless you have throwing water you really can't use your washing machine out Wow, yeah. So it's really the washing of clothes. Yeah, because everything else you're learning to improvise.

Adriane Spence
Like you can you can sort of solve those problems yourself with with

Gail Ramsay
bike. But I mean, right if I want to have a lot of clothes I can't put too bad bottles in there. Yeah, I mean, the water flowing in, plus the water flowing in and water flowing out so that that really I think is important, of what you use water on.

Adriane Spence
Yeah, you know. Yeah. Okay, interesting. Um, okay so, um, how do you feel about becoming more self sufficient with your in terms of your water. You know, like maybe catching rainwater being your primary source, and kind of having water as a secondary.

Gail Ramsay
I think in the future, it has to be like that, because. Unless Unless we have other ways of getting the water. I mean, because if, if I mean, we were lucky that we had some rain. But if they predicting with climate change or whatever that has been the last rain, whatever, then we have to have different ways we salvation and all that, you know more of those things have to come into play, you know. Yeah. You know, and I guess, you know, having a whole different education, of, of, of how to teach kids about water, you know. Yeah. and, you know, so it's.

Adriane Spence
So,

Gail Ramsay
you know, because it's one of the more. Well, we can live without it really

Adriane Spence
yeah yeah it's vital.

Gail Ramsay
Yeah, I guess teaching kids from Yeah, because I'm a teacher so teaching kids from y'all. The importance of the water and how to use it, and you know, not knowing to squander it not, you know,

Adriane Spence
yeah take advantage of it, really.

Gail Ramsay
So, yeah, yeah, you know, I guess, still, you know, wanting things that that because we feel you have it. I mean, simple things like brushing your teeth. Simple things like even being in the shower and the water running on, you know, you know, you're going to wash something and the waters running. Even simple things like being aware of how much you're wasting at, you know, I'm not aware, I mean just say oh I'm just brushing my teeth, you know, yeah.

Adriane Spence
But just like, you know, imagine if, as you are brushing your teeth or anytime you turn on a top there's a little meter, next to it, just ticking away.

Gail Ramsay
Yeah, no, no. But, But, but if we had to really pay for all the water that we use I think people will get it, they will they will respect it more yeah i agree i mean you pay for it anyway. But you will respect it more, because you think oh god well. It's like when you have to pay for long distance call. Yeah, you know, you don't talk as long. Yeah. So it's becomes a really is a mindset, I think. And I think what do you have to is more of a reeducation yeah you know to re educate them of the importance of it, and how you're wasting it, and met you know, many things too, that we take for granted, and how we use it. Yeah, you know, because it's all around you understand so we never had we've never yet yes, I may not have it for a couple hours, but I hope, and when I get up at five o'clock tomorrow to go and have a shower, I have water, you know, and to me degree literacy, I think, is it's not just the thing is is you flushing the toilet is the whole hygiene thing. Yeah, that's the most important thing is the whole app like a gene thing you know, and maybe having, you know, f4 is not like not around, than to have, you know, things of how we could survive without it, you know. Yeah.

Adriane Spence
Yeah. I. So I think I have only, only like three more questions. So the first one is about the kind of. If you know what the approximate square footage of your house is.

Gail Ramsay
No, I don't.

Adriane Spence
I figure I know. I also have no idea what mine is. So I'm asking that kind of in regards to storage of water on a tank, and I know you mentioned that you're kind of looking to put one in, and sometime in the future. But is it, you know, do you have sufficient space for something like that on your property or yes

Gail Ramsay
yes yes yes. Yeah, because we had what ours was actually nine, acres of land. It was subdivided so we have, of course it's being utilized. and, you know, yeah. Yeah, so I wouldn't know the square footage at all, but he asked me, we have enough attack, you know, yeah. Anything and one, one thing that I would suggest is that you know, when you buy a taqueria. It's a big one. This big tank. Why, why is it available that you can buy smaller tanks.

Adriane Spence
Yeah.

Gail Ramsay
So the same way that you could go and buy like the the garage the gas cylinders.

Adriane Spence
Yeah, different.

Gail Ramsay
So maybe a house can have a smaller gas, maybe that's something that thinking the future that one, what you can buy see when you go and you buy a gas cylinder. Why don't you can go and buy something that is for your house that could be attached to something that you can use as water, so it becomes like a constant thing, you know. Yeah. Yeah, you know.

Adriane Spence
Yeah, I think that's a.

Gail Ramsay
So, so, so it doesn't have to be this big big big tank that most people may, you know, may not be able to afford. And most people then don't have the space for. Yeah, but you may have a space for a little gas cylinder, and you may be able to have a space for water that you probably will use sparingly, but at least something that is if you don't have water at all.

Adriane Spence
Something consistent.

Gail Ramsay
Yeah, right. I'm the same way that the water tanks come in and fill up big tanks, they can come and fill it up in smaller tanks.

Adriane Spence
Yeah. Yeah, because they do yeah they already do that for people so why not why wouldn't it be available for something in a smaller size as well. Yeah, exactly.

Gail Ramsay
That because when the gas cylinder, you have to have aware. Like, it comes into the house. Same thing, that that's something that you could have with a water. Yeah, I'm just throwing that idea or just like like it just came to me Oh no, yeah,

Adriane Spence
no, no. That's. This is the kind of thing that I do want to hear I mean as well as everything else that we've been talking about but those thoughts are

Gail Ramsay
always one guy that just came to me I thought wow. Yeah, yeah. So, it could be something that that instead of having like a big truck come, you know, at least with some households, it could be something where the truck comes it has several motors. We don't have to be carrying your water bottles and so on to fill up. Yeah. It's, you know.

Adriane Spence
Yeah. So,

Gail Ramsay
yeah, no, it's, it probably could be more convenient. Yeah, for sure. Yeah, you know.

Adriane Spence
Okay. Um, so just two more questions. The first is, How many showers and toilets, do you have in your house, just to get an idea of the kind of the wiring so I have

Gail Ramsay
two showers and toilets.

Adriane Spence
Two showers and three toilets,

Gail Ramsay
to not to work in my. Well, what happened is I have a split level house so I love when downstairs upstairs I have two showers and two toilets and downstairs is one. One toilet one shower. So in all three showers, three, three toilets. Right.

Adriane Spence
Okay, thank you. And then the. The last question is just about if you know anybody else who experiences similar water issues who would be willing to to express them to me and help me out somewhere. I don't know if you know anybody. Yeah, I was gonna say, you may not be able to think of anybody offhand right now but if you do after we got off the phone if you It occurs to you.

Gail Ramsay
Right.

Adriane Spence
Yeah, it'd be very helpful if you could put me on to them I.

Gail Ramsay
Pam has maybe been. Let me see if a Pam Laurie is willing to talk to you because she lives families enjoy the ride. She lives. When I found the messenger was if I think.

Adriane Spence
Yeah, well, you know,

Gail Ramsay
okay i would i would ask her if she's willing to speak to you. Yeah,

Adriane Spence
it's no worries that's not I know everybody's busy and everything but it's always really, the more people I can talk to the more you know, the better it is so. All right.

Gail Ramsay
Thanks a lot.

Adriane Spence
Okay. Thank you.

Gail Ramsay
No problem.

Adriane Spence
Have a nice day. Bye. Bye bye.

Interview 2: Meta Reifer

Adriane Spence
Okay, go ahead.

Meta Reifer
Alright, so I would say definitely 2020, and I cannot recall when it started in 2019, but will be a pad. I will have to call it water rationing up here, where I live in Saint George, three days a week, Monday Wednesday Friday we have no water from about nine o'clock in the morning for just up to four it's just come back on. And sometimes it goes off in the night as well. I can't tell you. If it goes off on the same night, that it goes up in a day but it's often a night as well sometimes from 930. That night off. Should what used to happen. Prior to the three day. no water that's in that's happening now that used to happen before. And then after that on top of that came the three-day water three days off. And that's what's been going on for some months. I understand that, old pipes or not to dip the pipes in the ground need replaced saying, there are a lot of challenges which are, which exist. And you have to get accustomed but I don't like it. Obviously, I did not like it for example on Christmas day I went I even posted something on Facebook I was so furious because Christmas Day was a Friday and I couldn't understand why they couldn't just do it on a Saturday, like I didn't understand why it was set it had to be set in stone they had to be that Friday. I just was totally crazy. Because if and if it has to happen okay like if it has to happen, it has to happen. But Tom Christmas Day for heaven's sake. Yeah. Anyway, that happened on Christmas Day via no water after name 10 came back on evening so you had to, you know, it was not convenient. I thought would make you really hard for people who. Yeah, who did not have a tank, I mean people so all you need to get tank, but you cannot just say to a poor person, you have to have a tank, I mean you know how does that work for a person who doesn't has running water but cannot afford it. It's not fair. I don't have one, I would like to have one I suppose I will have to get one installed eventually. My neighbour has won and when I was sharing with him about the problem he didn't. Obviously feel the same inconvenience, or annoyance that I felt, because he has a tank. So, he, he can get through, you know I'm saying Yeah. But yeah, that's how it is here.

Adriane Spence
Yeah, so that's kind of the. What I'm looking to solve is for those people who can't afford a tank. How can we kind of work around that problem, and allow them to have a more convenient, more convenient access but also. Yeah,

Meta Reifer
I don't know, it just occurred to me that people who, for example, in a community where to hoses are, if you could share certain things, you know like, share the tank and others have instead of having every host with a tank which is might not be affordable. Yeah, maybe it could be subsidized. And also, you know, people pay into it, but it's subsidized by a government or somebody and you know you share it, like if you have three, three. If you have a house, because some in like a territory or houses might be closed and it might be close enough that could work. Yeah, no, the usage and all of that, but those things have to be worked out. I don't have that's an option I don't have I never heard I know that the. I remember hearing a few some time ago that he bought it. The Water Authority was like Bob it is worth I was like, offering some kind of scheme. Higher purchase, I don't know something whereby you could get the tank. And it would not be so expensive upfront. I don't know that he has a bad. Yeah, I think that existed so you might want to look at that, that's still in existence. In fact, I was, my husband works actually in doing for the BBs for authority but he's working for the CDB on a water authority project so I kind of like can be sympathetic to all the problems that exist but it's just so somebody said to me, Hey, you know, on the south coast I never have. But it's happening up here to me is that you know like is it because our because we're not on the tour section. Is it because or pumping thing in search for repair like what's the real reason?

Adriane Spence
Yeah, I mean, I. So, you're saying that they, they let you know do they let you know about when the water to go off.

Meta Reifer
Yeah, well the three-day thing was, is a stat was announced, and it was, it was announced from. It was enough, stratis just did that way they don't announce it every week. It's just, that's how it is. And then three days, sorry, go ahead you ask them the same three days monday wednesday Fridays, and they got pretty whole of 2020, I think, yeah. Last year I've been holed up. Yeah, ultimately, I think that's how it's been, and I think to me I thought people were talking about hope universal hygiene during this time of COVID and all problems and it's a real, it's something I mean, I've learned you have to get up early, you have to shower early on those days. You have to have some water there, you know your cook ever is affected your cooking. But you have to have tap things by the by the by each sink of guardian of water. But what I'm saying is you have to manage it because what you're going to do. But I would like it to be remedied because I have never. I live in Barbados. And I have never experienced anything like that.

Adriane Spence
Yeah. Yeah, I think. I was just speaking to somebody else about all of this and they're we're bringing up a similar point about how you know I'm here on the south coast, just with water pouring every day so with this rationing thing. If it's a really a ration Then why are you only on this island.

Meta Reifer
How do you manage, you know, I mean the place is worse than me, places and apparently and St. Andrew and St. Joseph I think know what to do to places where they haven't had proper water for months. I mean, not just like me. I don't know if the truck goes about to put special tanks in certain areas so people can go but of course it's Can you imagine, but you have live like that with little children and hygiene and all that kind of thing. It's really something. So I hope it is i mean i they say that the pipes are faulty and they weren't replaced for years and years and years and this corrosion of course that led into the water is no joke with the Alzheimer's. So, I mean, there are a lot that they have to get it fixed. Yeah. So, what so many other things have come up that require money I don't know how it's all going to be solved.

Adriane Spence
Yeah, pretty serious, a lot of infrastructural problems. So my sort of idea of how to address this is, or at least how I can address it from my, you know, with my skill set would be to sort of help people to become less dependent on the system itself, and maybe try to have a reliable or at least somewhat reliable rainwater catchment system or something along those lines so that you can be more responsible for your own water catchment.

Unknown
Yeah.

Adriane Spence
Yeah. And that way you know it won't be 100% reliable but then at least you can

Meta Reifer
buy that is another problem that could happen know when it's raining. Yeah, we had a terrible drought too. Yeah. And then the other problem that that has that that the success of that, you know, can be, you know, affected negatively by by the drought, because if you have no rain like, okay, scuzzy possible How come it's raining so much and we still have these problems. Yeah, but I mean any water you're done, you have to look at sterilization you have to do what would the purpose of this water be yeah you know you can't you have to, how you're going to store it was a factor as I guess you would have to look at it. Yeah. Is it, is it for bathing is it for, you know, what is it for, because that's another problem if you tell you rainwater you have it stored in something that isn't you know you know it could get stale or bad bacteria or something like that so that's another factor that you have to really look at carefully. I mean people I know somebody for example I went to they had a plant nursery. Like, when the rain fell they would they would come off the roof on the gutter and they had the gutter thing going straight into like a reservoir, a big big tank and then this is the time that they would use to water their plants. Yeah, you know, the anthurium certified I guess that they're, you know, three. But, that in itself requires expenditure. You have

Adriane Spence
to know what you are all about.

Meta Reifer
Yeah, something that you would have to put all those factors in in your, what you call the quality constraints in other words, when you say this is it, I have to say away, certain things have to be. If not, it shows you would have to appear research because if not it will show that if

you see them at least that showing that you recognize them if you don't see them. Yeah, we assume that you haven't taken them into content consideration. Yeah, so you have to remember to put all those things in your rotation because it's a good, you might have a great idea. When you can see how it works, the constraints as you mentioned the constraints that it shows that you're thinking, you know about. And if you can't find a solution the constraints that's even better. Yeah, at least you have to mention them because then they always act like that drug, I mean that is like we had months and months where the ground was cracked up. Yeah, you know you could walk out your door. It was the grass was not green it was brown, red. So, when that happens, you just know what the hub. I don't have desalination is an answer, but it has something has to be done because it's not good.

Unknown
Yeah.

Meta Reifer
I hope I've helped you.

Adriane Spence
Yeah, well I have a, I have a few more questions, because it really just been chatting so far but. So yeah, go ahead. What would you say are the biggest challenges when it comes to your access to water like how, what are the biggest ways that your lack of access affect your, your life.

Meta Reifer
It affects me in terms of have to readjust my personal hygiene, I have to say, I have to. It affects food preparation. Cooking eating, I mean you have to reschedule. Have you do things, laundry, the client does still care but I do the laundry, you have to know on what particular day so you'll be your housekeeping. Your house is has to be rescheduled on weekends, you know recovery thought because what you would have assumed that you could do and anybody on a date on those days can no longer be done. Once it requires water, cooking, laundry cleaning toilet, you know, hygiene matters. That's how I would say, yeah, I mean even bathing anymore You have to get my bed before a certain time otherwise you think you turn on the show and there's nothing. Yeah. So, yeah, things like that you have to learn to manage those things.

Adriane Spence
So, I'm

Meta Reifer
sorry, go ahead. Go ahead, you're asking that question. Go ahead.

Adriane Spence
Um, so I was just gonna ask about other than just, you know, getting up earlier to, you know, rescheduling a time and things like that. Do you do anything else to address those those problems like your food preparation, do you start.

Meta Reifer
I collect water in bottles and have them in the kitchen. In the bathroom. I have a seven minute poster. You know I have containers that can dispense water near the hotel room you know so there's always water there if you have to wash your hands right. I kept my sterilizer sanitized alcohol or something nearby. So, I do try to prepare by by collecting water in plastic bottles. Yeah, when it so I wouldn't do it tomorrow. For example, during the day but I would, I try to you if I don't use it I throw it over I use standard bands. And then I fit it back up again.

Adriane Spence
Right, so you'll, you'll basically store up you know since you know Wednesday is going to be off you'll store up on a Tuesday. So do you have on Wednesday. Yes. Okay.

Meta Reifer
I don't have a store it because I mean I know people who put it in the washing machine and happy, but I don't have big containers of it because I figure out what am I going to do with it afterwards and it might go, I can't, you know, I use, I don't have like huge containers of water. Yeah.

Adriane Spence
Yeah. Cuz I'm going back because

Meta Reifer
I just yeah we'll go to work without what and it was it comes up my tap I have to pay for it. So I just made the bottles and put them there it's just my husband and I, we just we just tried to manage it.

Adriane Spence
No. So, what would you say are the activities that you all do, in the household. They use the most water

Meta Reifer
laundry. And then, after laundry would be, I guess, washing down areas and watering plants that might take a bit of sec Nicole's garden, garden and, you know, washing up around the house a bit, you know, I would say probably washing machines is the most. Yeah, I think. But that's not used every day. But if it is, you know, I think that we use quite a bit. Yeah. Beeping so I don't think that you paid me, but it's not like I mean I love start letting the water, even when I'm washing dishes I don't have the water running as background music, I, I just turn. I call it. Background Music turned it off, I saw, I bet these things, they turn it off and they stopped the dishes. And then I turn it back on, wash them and then that's it I don't have it like running running around all day. I changed I used to be like that before but, you know, in an effort to conserve water and also to say about my bill. Yeah, I bedding. If I'm soaping I have the water off because I don't need it on that. Yeah, I just, that's how I tried to change my way of the water, the last few years because it once it comes I realized that once it comes out that it is.

Adriane Spence
Yeah. Yeah, I was listed. My next question was just going to be Do you think that having, you know, having experienced all of this sort of these water shortages and cut offs and rationing and all of that has made you to be more conscious of water conservation.

Meta Reifer
I guess it has but I think my conscious about it started a little before the actual rationing because it was, and I began to consider the cost of things. Yeah, and it was a valuable resource because, for example, I used to even at one point I don't have it No but you have a title kit you suggest, leave it in the shower. And when you show it rip down, it will strip anybody and I will put down the plans, because I figured when does what is coming out once in Venice coming out attack this entire bill. So I would just leave it bucket there and let it fill up and then it would throw the water on the plants any splash of water from me wherever I would just let it go in and then it was right on the glass after because you waste. You really do not realize how much is, I guess, not used by you consciously, and just ran down the tap. Yeah,

Adriane Spence
I was just gonna think sorry. That's another, another question of mine is. Do you think that. Like what what do you think about water reuse so if there's a way for you to get the water, you know, even after

Meta Reifer
I know my buddy was telling me about that to a weird a recycle the water that she she says that when they use water they actually up to, like, how much is like paying twice 1000 what sounded like to me like they want is like treated and comes back to them. Yeah. Um, I mean, many would have I don't know what do you use it for drinker is it portable, when you when it's ridden like that I would have to know all those things to make, if it's just for like, I don't even know bathing, because you never know what's in state.

Adriane Spence
Well, I mean, my thoughts. After, or even. Yeah. My thoughts are even just a more basic level where, you know, maybe you use the water from your sinks, or from washing dishes or maybe even from the shower to flush the toilets, which, you know, the toilet water right now is perfectly clean for no reason. Perfect. Yeah, or to water the plants,

Meta Reifer
not use it to water plants or to flush toilet or to, you know, on a pipe to a special area where the whole zone is on. I think those options are good ones because good reason, we say we use that water I guess you would have to call it in a different way, but then you'd have to store it or something. Yeah, I even saw was a strange thing which, which was like a sink attached to a toilet. I thought that rather interesting but rather, ugly, you had you wash your hand sort of over the toilet off to the side, and then the water from your hands went straight in the toilet, to lead straight in the tank or whatever. I didn't love it. I thought myself this is fishy. I mean, is it hygienic cloth, I wasn't sure about it by I find it interesting, because that's what they're essentially doing, making sure that the water that you use to wash your hands just went straight there used to be that toilet which I thought about. I didn't like the setup. I wasn't sure about the setup. Yeah,

Adriane Spence
I mean, ideally what you would want is to have just like you said somewhere that's that stores all of your you know shower whatever water, and then pumps it back, right to the toilet specifically just the toilet specifically the

Meta Reifer
priority would not be such a priority. Yeah, because it's not potable water. Yeah, no water for that type of thing. Yeah, lots of chemicals yeah once it's not gonna cause any, you know, because the chemical whatever soaps are using or detergent or whatever I mean, you'd have to be sure that, you know, causing a problem and these things mixed together. Yeah, fumes all come up to our, you know, you'd have to know what you're using it yeah because you know you never know dreadful marks that emerges from it. But you know what I mean you have to know. You have to be useful you'd have to say, Well, if you're going to do this I have this system you use these types of detergents or, it would be types of soap so that you can cause problems again.

Adriane Spence
Yeah, from what I've seen online that's it, but you're completely right like they say that you have to use eco products basically just organic or organic but things that are not harsh chemicals, it's just, you know, you know, Orange

Meta Reifer
is the best thing in the world. Everything is, you don't even know why you put it in. Yeah, it's mixed in with something else, then that's been cropped causes some problem insulting dddd, or something. Yeah, yeah. So right now I'm using I bought this little boy that was a rather fancy little device. But nano Mississippi pleased to spray on your hands. And it gives a fine mist and all that. Very cute and all that but I noticed that had said setup not using something exciting that had a poor my alcohol and it worked for a while and now I charged up an SPI press and nothing happened is wondering No, it's the alcohol. Tap Add thing and it's no use because, I mean, alcohol and things like that. Yeah, everybody's using alcohol No. Yeah, so how would you know all those fat all those things have to be considered. But that is a good idea. I think that would be your idea that that's what you're doing forward.

Adriane Spence
Well I'm, I'm thinking about it this is something I thought about over the past semesters one of my sort of directions I wanted to go in, but obviously speaking to everybody and hearing different perspectives on the challenges that everyone faces I think I'm probably, you know, I may still go in that direction but I wanted to, you know, feel, get a better feeling of what's happening

Unknown
yeah

Unknown
of what's happening

Meta Reifer
and what me personally I think the reuse of the, I think the we use of the wastewater let's call it that is a great idea in what way called the salt water the water from Washington. I think that's great but he wasn't in toilet for, like, outside and things like that. Yeah, so if you could get plumbing, to make sure that the pipes for that went in the storage and wait. He might have to be a lot I guess storage would be a good option too but you know like the plumbing will be important. Yeah, and getting it to that point. But I think that's a good idea I prefer that idea to water being Ambien suppose

Unknown
yeah

Meta Reifer
well I'm not convinced about that I'm not I'm not comfortable with it. Yeah, I can understand that for other purposes, representing that's a great idea. I don't know how you would manage to give people water for in these, you know it is a scarcity that would hardly people not thinking of that first thing out of cocoa how to bathe and how to drink water and all that kind of thing.

Adriane Spence
Yeah, and I'm, I think one of the reasons I was leaning away from that idea as well is because, you know, the people who are most affected by water scarcity and Barbados right now are people with low income and in those rural areas. So, you know, can I really say to them, to install a whole complicated plumbing system. I don't think so.

Meta Reifer
Exactly, exactly. I mean, I don't know if they're, you know, I guess, then I'm sure that there are places, which have thought of these things before us that you know like countries where it's worse. I guess you have to explore that. But I mean these. The other thing is that there are people doing agriculture. And I even asked that question as when they add the rationing because you know they have pools that are split bands and so on here is about, right where to tell you must not use your hose hose to wash or wash the car anything. We've had I

forgot to mention that we had that as well. But what happens is people can live in growing a few plants or few vegetables or whatever to sell or we, you know, how can I tell them not to use the hose. I mean like they have to water the plants, if not the one make a living. I even have no class and a balcony I used to sneak hotel, they don't wash. I mean like people were doing it so real, that's their source of income for their lives. Continue. Yeah, I can not have water. So I went out all those people managed because they are the people. You know that.

Unknown
Yeah,

Adriane Spence
well maybe they were reusing

Meta Reifer
their water I mean they will think of reusing, you see maybe that is something. Even if, even if it's, you know, rather crude fashion we don't set up piping you know they're happy to come in on sale, because people do that and always. I know that you plant certain things, near that needs to have water near near Washington things really gotta runs down, people line trees and things, say deliberately. You could also carried out a step up and say okay let's just have this one. Pipe coming, any water coming out to me can store it in a tank, and this is what we're gonna use to work the plants. You know, so, on a simple level, those persons that you're thinking about who might be able to do that.

Adriane Spence
Yeah, yeah, just as the waste water

Meta Reifer
use it for a second purpose in a in a very well get not crude if not primitive fashion, we put it in a very simple way, let the water come down and then you can put on it. Yeah, that's it and it would not be staying there stagnant for a long time, you just use a tape all the time. No So, something like that we're use simple

Adriane Spence
things,

Meta Reifer
you know, tying kind of pipe and low thing, you don't have to have a complicated sophisticated system thing that allows you to, you know, you pay for him as well use it

Adriane Spence
for sure. Yeah. Okay, well I have a few more questions, there's. Um, yes sorry to to just get an idea of, of, kind of your context of your, of your household. And then the last one is just going to be, well I'll get to it. So the first one. Do you have any idea of the approximate square footage of your house or.

Unknown
This kind of question yeah

Adriane Spence
okay I know

Meta Reifer
he's not here. But no, it's, I would say. It's pretty. Be like, what he did on your house that you live in. Later, and they asked us more than one level, right. So, there will be yours is this double the busy I don't know I don't sure I'm not sure I may not sure. Yeah. I don't know that I don't,

Adriane Spence
I mean I don't know mine either so. Okay. So, this might might help more, just for both of us to kind of get a better idea but how many showers and toilets, do you have in your house.

Meta Reifer
Okay. Well, I should say that there is another my sister lives downstairs with me and that is like, so she. That's like another house. This her alone but this is one show there right No, and there are one, two. There are four showers in this house. But I would sit there. That usually,

it will be two of them that are used more, because that would be my husband and I, and then my sister downstairs. It might churner in Barbados like how we all are here, then another one would be used. Right. But normally it's

Adriane Spence
okay. So you have one. One shower downstairs on one toilet.

Meta Reifer
Yes. And then one that's in her section but my section I have three numbers, three showers. And one to four toilets.

Adriane Spence
Okay. Nice. Okay, that is helpful, Thank you. All right. And then the last one is just. Do you know anyone else I know you were talking earlier about St. Andrew and some of these other parishes St. Joseph that struggle more than, even you do there. So do you know anybody in those places that would be willing to just chat with me for a bit.

Unknown
Really. Yeah.

Meta Reifer
Anybody, I don't know, I can't think of anybody right No.

Adriane Spence
Yeah, I mean, you can doesn't have to be in the

Meta Reifer
chat I will let you know i i will talk to. There's a guy comes and does some work here and he is from St. Andrew and I know if he has such problems. Yeah, and he does garden and he is so you may be interested to have another perspective from a different person you know percent different socioeconomic group. So that might be interesting but I will have to ask him if he's affected because I don't know if he is as may not be everywhere. Yeah. But I will ask him, and if he is I will find out how, how, you know what, hollywood how he if he'd be willing to him I will ask me he's supposed to come in on Wednesday. Okay.

Adriane Spence
Okay. Yeah, that would be great. That's yeah that's exactly what I want just to Yeah, if he faces those challenges then just to have a chat with him about it and

Meta Reifer
yeah, if he had because he can do it from here you could do it from the other phone to phone whatever. Yeah, I would have to find out your duty days here or even to me time to call him it's up to him. Yeah, I will ask him on. Just remind me when it's the morning me

Adriane Spence
yeah I'll do that.

Interview 3: Caroline Roberson

Adriane Spence
Great. So, yeah, if there's just any of the first things that come to mind in terms of the issues that you face. Maybe you talk about that.

Caroline Roberson
We moved to St john parish. Five years ago, five years ago. So when we, when we moved to St john from Christ Church. We didn't realize st john had a water issue. But when we moved into our home. We initially thought that we had no water, because we were already we owned the house but we had no water supply at all to the house and say us can say, I just thought, wow. Yeah. So, um, so we called the water authority and repeatedly, and they said that there are issues with the golden Ridge reservoir. And that's the pump is not reaching the water is so low in the reservoir that the pump is not reaching the water level, and we are supplied by a golden Ridge reservoir. So, we later found out that that although that was true. And the reason we weren't getting any water at all, rather than it being period periodical was because there was a mains. Break. A few 100 meters from our house, so we. So it took some time to sort that out but that that was then fixed, and we then started to get water every day but not only just for a couple of hours, so we would have water. A couple of hours a day. And on occasion we would have no water at all. So we then decided to put in a water tank, which we have, which we then did. And then we were, we know we didn't go without water after that, so we we have a tank so when it came on for a few hours a tank would fill up and then we'd have water for when we didn't get water. But, up to, up till now, and five years later, we still have water outages. Most days, maybe not

for long whereas before we were having water out for maybe 18 to 20 hours a day. Now we would have now we only have water out for a couple of hours a day. Again we don't really, we don't really touch base anymore because we have a tank, we just suffer from reduced pressure because we have a gravity fed tank tank. So we don't we don't we, we notice it because we then have low pressure on our taps and the hot water tap suffers because that's affected by the water pressure. Anyway, so that's what I can tell you we also the water is turned off. Even if there's lots of water. Because golden Ridge, I understand, is fed by bonused in reservoir and Boma Stan has an underground river which becomes very turbid, when you have high water, when you have high rain. So then they turn it off to reduce to stop the water that we do get being really dirty, but when it does come back on it's usually turbid as well, not, not as turbid as it would be obviously if they left it. Perhaps, but we, we then have a day or so. Afterwards of murky water

Adriane Spence
right so that that's murky water is something that happens every time it rains, or every time it rains really have any.

Caroline Roberson
If every time, every time. It's got heavy rain. Yes, we, we then I understand the reason is because Burnaston reservoir is fed by an underground river, and that gets very murky with with with heavy rains and because golden Ridge where we get our water from is fed by. Anyways, I don't understand obviously all of it this is just information that I'm picking up from from reading. Reading and trying to find out, time to understand, having an inquisitive mind. Yeah, you

Adriane Spence
understand a lot more than most people, I think so. Okay yeah that was all really helpful. Um, so, I think that that's really the biggest thing for most people, but to install a time seems to be, you know, the smartest move just because it's,

Caroline Roberson
yeah. So, and if you can, if you can have a graduate gravity fed tank obviously that reduces you don't have any costs associated afterwards, it's not electricity and pump outages and, and if you have no power, which also happens periodically. Then, you can't get water if you're relying on the pump.

Adriane Spence
Yeah. Yeah. So, um, okay so I just have a few more questions I think you answered a lot of those with that but. So, what would you say are. I mean, in the time that you didn't have the time or maybe even sometimes now but what would you say are the biggest challenges that you face regarding water and your water issues.

Caroline Roberson
I came home from work and I worked in a kitchen. And the kitchen I worked in was maybe 100 degrees. 100 degrees. So, when I got home from work, I was really hot and sticky, and I'd come home and there would be no water, so I couldn't leave.

Adriane Spence
Yeah, that sounds terrible.

Caroline Roberson
Did you it was disgusting, hence having a tank quite quickly. Yeah. And when but fortunately we are financially in a position to put in a tank. Yeah, so many people would not be.

Adriane Spence
Yeah, and you also were able to put in a gravity fed one is that just a matter of the land, going up or did you have to

Caroline Roberson
we have, we had a roof, we have a roof that we could put the tank on. So we put the tank on the roof.

Adriane Spence
Nice. Okay. Yeah, that sounds so horrible. So, did you ever you know before you got to install the tank and after you would experience this not being able to shower did you start to collect.

Caroline Roberson
Yes throughout the day yes yes we ended up, collecting water in in containers and storing it. At least we could bathe, and we started keeping bottled water so we can brush our teeth and stuff like that.

Adriane Spence
Um,

Caroline Roberson
you adapt very quickly.

Adriane Spence
Yeah, so it seems. A lot of people don't seem as bothered as they could be. By this, at this point, why we

Caroline Roberson
live in a third world country so you have to expect that things are not as sophisticated. Yeah,

Adriane Spence
yeah and you just, it seems, it seems like such a major challenge and then you just adapt so quickly.

Caroline Roberson
But I think things have improved. I mean, I would say that things have improved significantly over the last few years over the last couple of years. I don't know if it's if it's relevant but it would appear that the, the government change made a significant improvement.

Adriane Spence
Yeah, yeah. that does seem to be a theme. Yeah. So, what other than storing water was there anything else that you would do to address, you know,

Caroline Roberson
those challenges that you face filtration waste that we tried to put on a filtration unit on the house. Yeah. In order to reduce the turbidity of the water. Because when the water authority turn off the water because a lot of the mains pipes around the island are very old. Yeah. When the water came back on. It will be very very rusty. Yeah, so not just turbid, but also rusty. So we, we put on a large water filter onto the house, but that proved to be pointless because it was so dirty every day from being turned on. It was costing us a fortune in changing filters because they got locked up after, you know, two days.

Adriane Spence
Oh my god.

Caroline Roberson
So it became useless so if we ditch the filter and get onto the house because it's just where we are. It's just too too dirty to, to think you can filter your water so we we now. Although the water is perfectly safe to drink from the tap we filter our drinking water and water for our for cooking, not, not so much cooking I mean you cooked regular regular food. I wouldn't filter it, but, but if I make the tea, tea, the kettle. You know, if you're going to

Unknown
just drink it basically filter,

Caroline Roberson
we put affordable system. In order for that. That's what we use, but no father otherwise it's safe to drink. It's just not always pretty. Yeah,

Adriane Spence
so do you. You are yeah so I guess the water that you use to shower and to wash your hands and all of that is still filtered not filtered so when it's not we tried, we

Caroline Roberson
tried to but as I say that the filter got locked up in the water was going off.

Adriane Spence
So when it just kind of let it run out, or.

Caroline Roberson
So when, when we made it, we made were metered so you're paying for the dirty water.

Adriane Spence
Yeah. Wow, so you actually you you know you turn on the top. When you go to shower, and the water is dirty Do you just let it run out or do you maybe shower in that I

Caroline Roberson
don't know how you shower it now you're showering it because I can't tell you right now, because obviously we have a foot we have a tank now so it's probably for build up on the bottom with a sludge, perhaps. But, but I would say as a general rule, you don't. We're metered so you can't just just waste all of your heart really just wasted. Yeah,

Adriane Spence
yeah, yeah I think your tank from what I've read about tanks and all that it seems like they do tend to fill up on the bottom with the sludge, just like a kind of a filter system. Um,

Caroline Roberson
I just I'm not that you can really find out, other than other than watch.

Adriane Spence
Is there any way that you can clean the tank.

Caroline Roberson
No, not really. I mean, as the roof. So I suppose you could pump it out, perhaps.

Adriane Spence
Right. Yeah. Interesting. Okay, so, I suppose. What would you say are the activities in your household that use most water garden.

Caroline Roberson
When it's dry, when when we're watering the garden, the vegetables and so on. Oh, watering. Yeah.

Adriane Spence
And do you ever consider water reuse so like would that be something you would consider to use maybe the water from your shower or from washing dishes maybe

Caroline Roberson
or washing your hands yes when we, when we have when we have dry weather, although it hasn't been relevant. Recently, because it's been so wet. But um, yes we were, we were using our dishwashing water to water our, our plants in the garden. Yes. Yeah.

Unknown
Okay, yeah.

Adriane Spence
So, I guess that kind of addresses my or in a way. A lot of this has addressed. My next question which is about

Caroline Roberson
storing water rainwater tank is a really good idea, but the issues we have are mosquitoes. And that's another, another problem in the Caribbean. So, storing water, you've got to be very careful that you're not also breeding mosquitoes which carry all sorts of diseases which are very unpleasant like dengue and chikungunya and all that. So yes, we're very, although we would like to use more store more water and use it utilize it is a tricky one because you don't want to be breathing. Okay, so

Adriane Spence
what would you say is the major thing that motivates you, because like, it seems to me like you make a conscious effort now to conserve water probably more than, where you lived before. And what would you say is the main motivator for that. Just kind of becoming

Caroline Roberson
a well being in a planet which which you need to be not wasteful of anything so I'd say our general demeanor is not wasting. Regardless, So we've, we've always taken short showers and and turn lights off and we leave a room and, you know, not, not left the tap money when

you're brushing your teeth. So we've always been that way inclined anyway. So, from the personal point of view, I would say we're not motivated to save more water, because we've always been motivated to save water.

Adriane Spence
Right. Yeah. Okay. So how would you feel about becoming more self sufficient, in terms of your water.

Caroline Roberson
I mean, you talked about collecting collecting and putting in a filtration system. Yeah. So, I've looked into doing so. I've looked into water catch rainwater catchment. And, yeah, so at the moment it would be relevant because it's it's wet. Yeah. But then in the dry season. In the dry season, it comes becomes rather redundant. So, yeah, so at the moment we just we haven't done anything about it, we have considered it, we'll keep looking at cones and all sorts of things other things like we're using the moldy stuff to capture water where they have no water supply, other than from clouds.

Adriane Spence
Yeah and like Barbuda i think is the another island that does the same. Yeah, no. Um, okay, yeah. So, we already talked about that. So now just to get a bit of an idea because obviously I can't see your house. Do you maybe know the approximate square footage or the size

Caroline Roberson
of a house or that a property.

Adriane Spence
Either would work with your house is what I was asking.

Caroline Roberson
Three. Three and a half 1000 square feet. Right.

Adriane Spence
And how many showers and toilets Do you have.

Caroline Roberson
We have three showers and three toilets.

Adriane Spence
Okay, so my last question is to do with full showers

Caroline Roberson
for showers because there's one out by the

Adriane Spence
pool. The pool. Do you fill that with water from the tank and then chlorinated.

Caroline Roberson
No we don't use chlorine we have a saltwater pool. We don't add salt water so it's just, just as a matter of staying there. So yes, the initial usage would be filling it in the first place. But after that, the consumption is minimal. Because it evaporates and then refills with rain, but rarely have we had to add water to it usually where we've ended up with too much water in Nepal. Yeah, I

Adriane Spence
don't think think about that are the backyard, in my house floods all the time here. I guess I wouldn't have thought that the pool would slide but that makes perfect sense.

Caroline Roberson
Yeah, so unless you've got unless you've got a drain overflow, then you're adding. If you have an inch of rain overnight or two inches then obviously you've added it, but because it's hot, so it tends to be fill up evaporate. What regarding the pool for us, because we have a saltwater pool. I mean, differences that we have to add salt if we end up with a different dilution.

Adriane Spence

Okay. Yeah, so my last question is, do you know of anybody else who experiences, similar water challenges. Maybe upside down and maybe it's going to add here or somewhere else. That would be willing to speak with me about this.

Caroline Roberson
I know somebody just moved to St. Andrew. And so, I can all speak, I'll be seeing her soon I could speak to her soon and I will pass on your details. Okay, yeah, without help.

Adriane Spence
Yeah, that would be amazing. That'd be great. Yeah. Um,

Caroline Roberson
she just moved to St. Andrew.

Adriane Spence
Okay, yeah, it would be nice also to have kind of a new perspective as well. Awesome. Yeah, thank you so much by the way you've been very, very helpful. And I appreciate that. Yeah, thank you.

Caroline Roberson
Okay. You're welcome, and good luck with your thesis.

Adriane Spence
Thanks. Have a nice day.

Caroline Roberson
Thank you. Bye bye.

C – Product Research

Benchmarking of Water Storage Solutions

Product and Link	Thumbnail	Material	Manufacturing	Capacity
Tuff Tank Water Tanks https://rotoplastics.com.bb/product_tanks.html		PE Food grade	Roto-moulded	200, 450, 600, 800, 1,000, 2,000 Gallons

IBC Tote https://www.ibctanks.com/275gallon-new		HDPE Tank, Galvanized Steel Cage Food grade	Blow moulded	275 Gallons
Std Water Brick Blue https://www.waterbrick.org/product/10-pack-waterbrick-standard-3-5-gallon-blue/		HDPE Food grade	Blow moulded	3.5 gallons
Osculati Freshwater Rigid Tank https://www.osculati.com/en/11525-m-017477/fresh-water-rigid-tanks		PE	Injection moulded?	14 gallons
Thintanks Super Slimline Tank http://www.tightspottanks.com.au/polyslimlinetanks/thintanks/		PE Food grade	Blow moulded	260 gallons
Kingspan Ultra Skinny https://ecosustainablehouse.com.au/products/ultra-skinny-slimline-tank?variant=20704382058585		Galvanized steel with food grade polymer lining	Bent, bolted, welded	800 gallons

Slimline Poly Rainwater Tank http://www.tightspottanks.com.au/polyslimlinetanks/enviro-poly-slimline-tank-1000-litre/		PE Food grade	Roto-moulded/ Blow moulded	260 gallons

D – Analysis

Initial Needs Assessment

Description

An example product which provides some mitigation to the issue of water insecurity in the Caribbean is the "White Roofs" of Bermuda. These white stepped roofs harvest and purify rainwater, after which it is collected and stored in underground tanks. This is a potable water generation solution which, through daily contact, brings the user's attention to the value of water, and therefore becomes a water saving solution as well.

Initial Audit

Who. Many islands in the Caribbean experience water insecurity, worsened by climate change, but only three nations are considered water scarce: Antigua & Barbuda, St. Kitts and Nevis, and Barbados. In each of these countries there are many contributors to water scarcity and therefore many areas where the problem can be addressed. However, domestic users in these three nations were considered the most direct-to-consumer approach and therefore selected.

What. The assessment focuses on a product which provides some relief to the issue of water scarcity in the islands of Antigua & Barbuda, St. Kitts and Nevis, and Barbados.

When. From 2020 onwards, as the effects of climate change intensify and become more readily apparent, the same will happen in the Caribbean. The sooner solutions are found, the more effective they will be.

Why. Surface water, groundwater, and rain catchment systems are the Caribbean's oldest existing water sources. These alone are not sustainable, especially considering the projected population increase and rainfall decrease. Existing water generation solutions include

Desalination and Atmospheric Water Generation (AWG). Water saving solutions include at home water catchment systems. These each have their limitations; a better solution must be provided.

Motivation

Personal motivation for a Caribbean household would be a reduction in the cost of water. With the current water supply situation, for the most part the islands have good quality water, but often have outages and low water pressure therefore increased reliability would be another source of motivation.

Summary

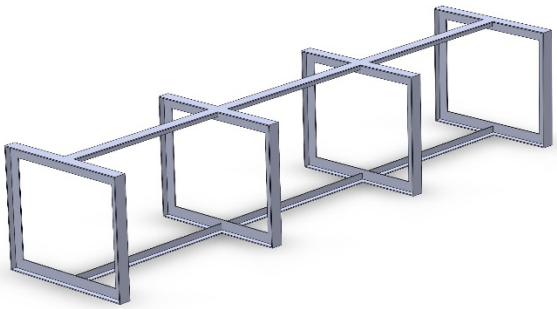
Introduction

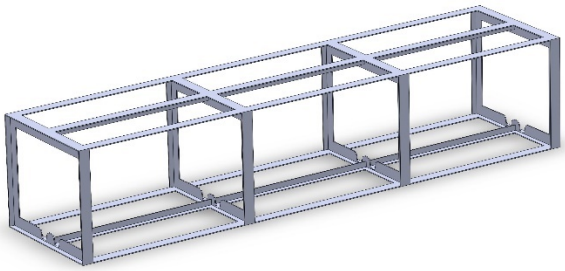
Sources were limited online when it came to precise experiences of the product. Some speculations were made outside of the available information. Networking to contact a user has begun in order to get a more accurate understanding of the experience of the product.

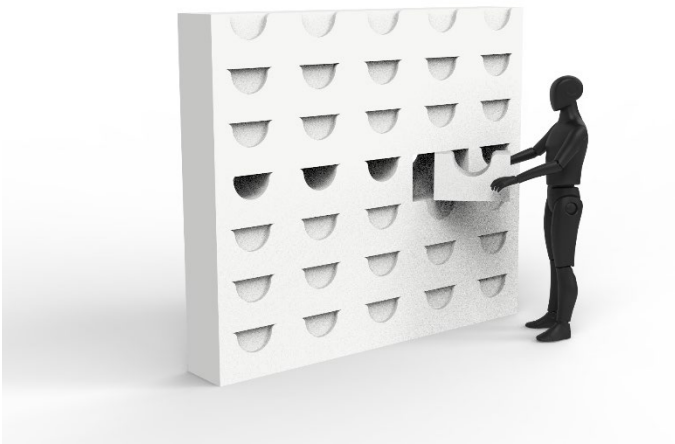
Needs Statement

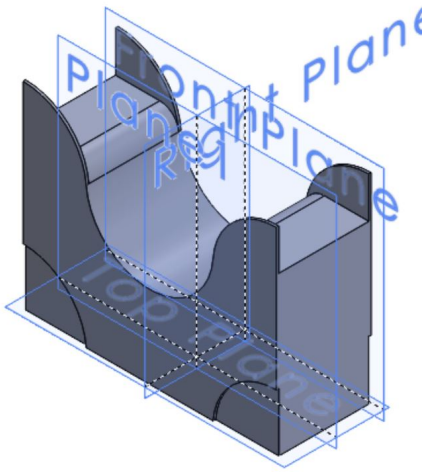
Surface water (rivers, lakes etc.), groundwater accessed by wells, and rain catchment systems are the Caribbean's oldest water sources. However, these alone are not sustainable, especially considering the projected population increase and rainfall decrease. The Caribbean needs a water saving solution, a water generation solution, or both.

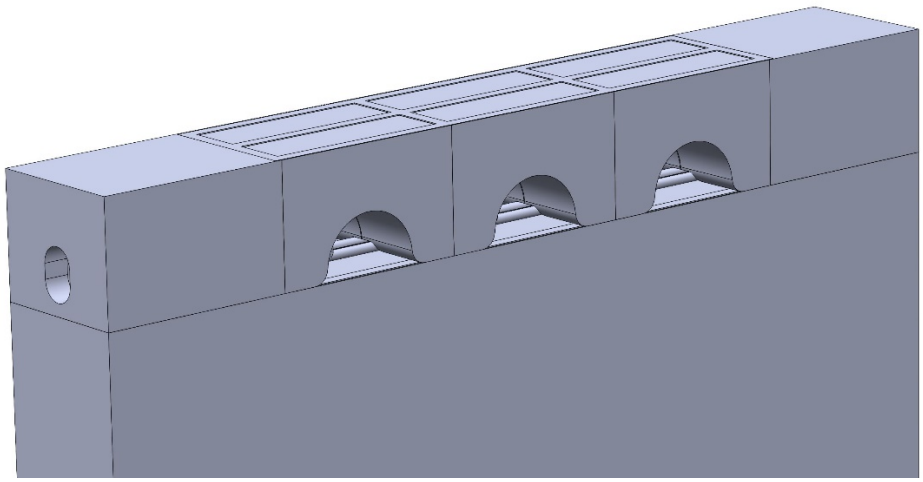
E – CAD Development

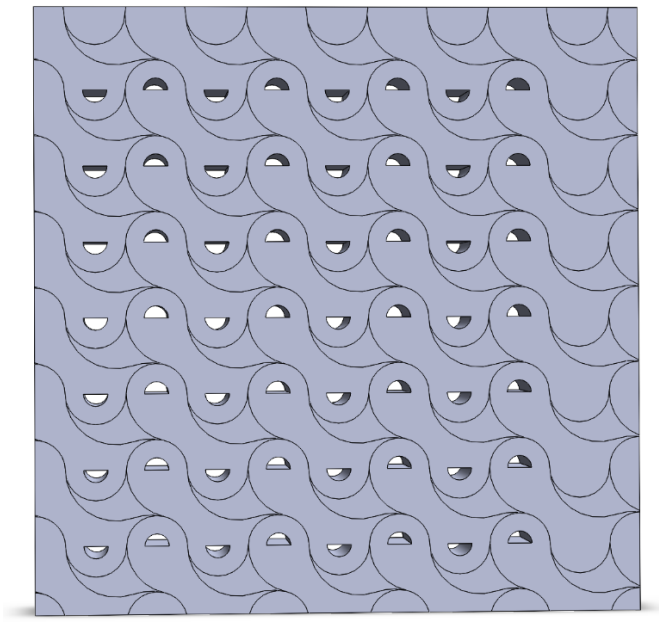


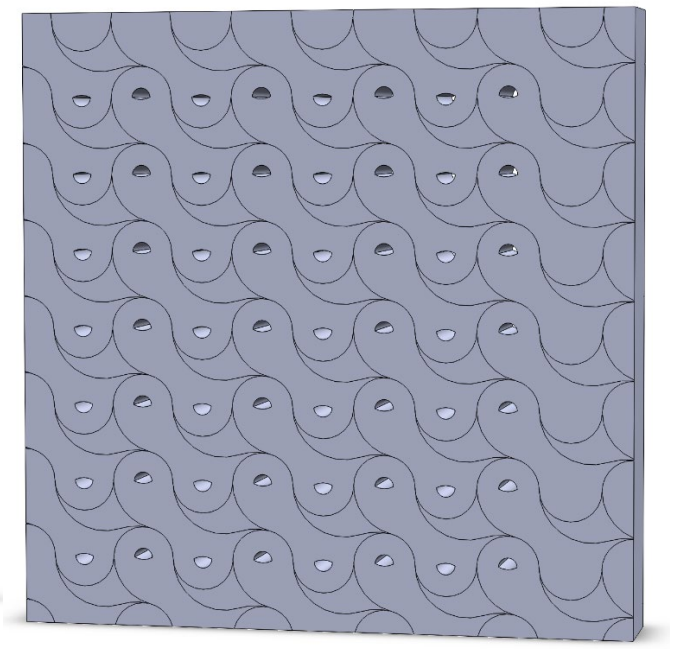


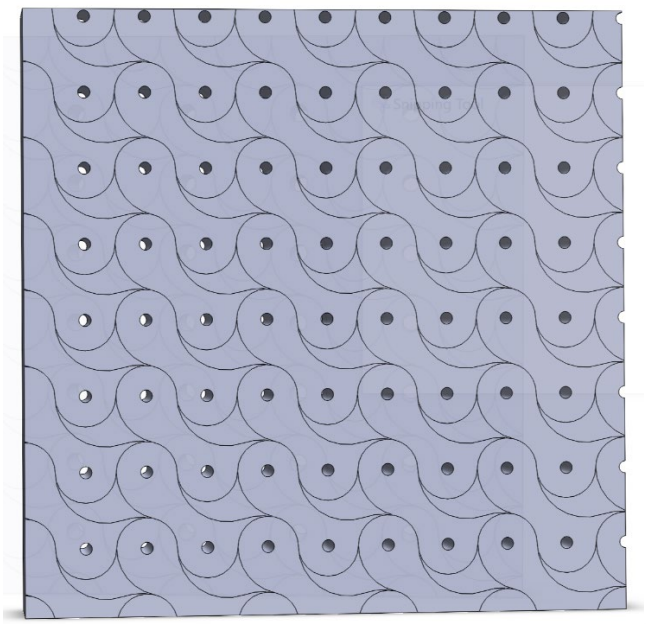


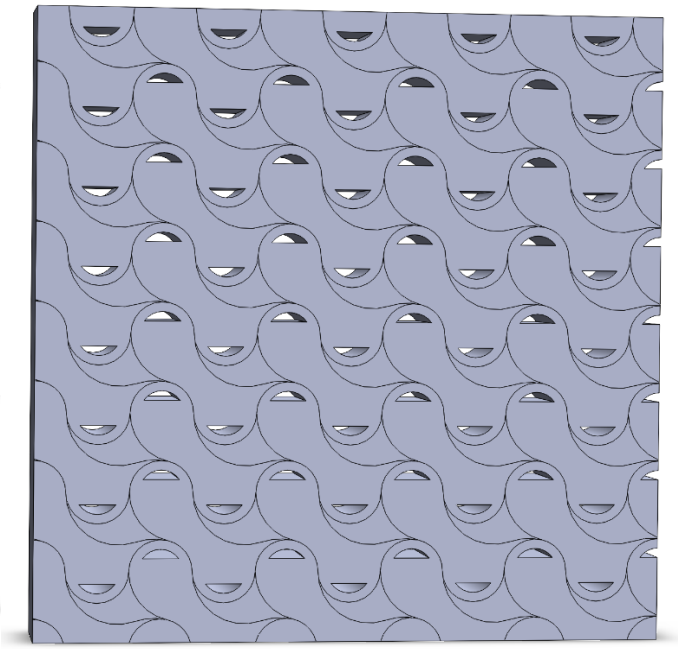


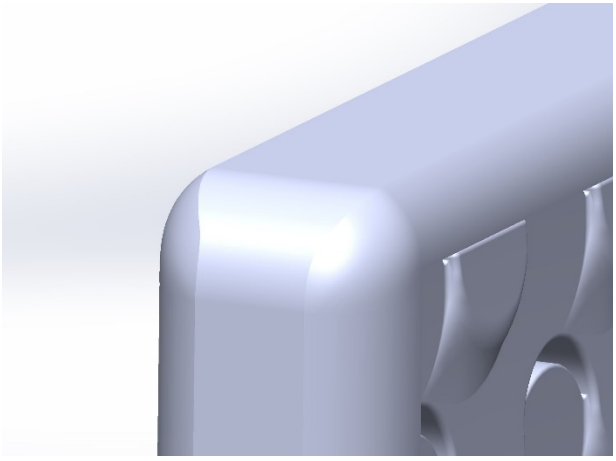


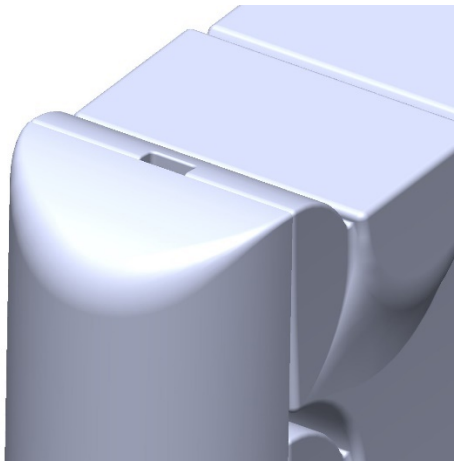


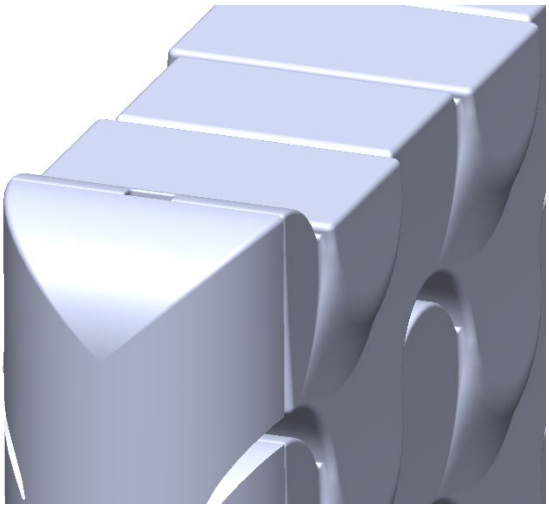


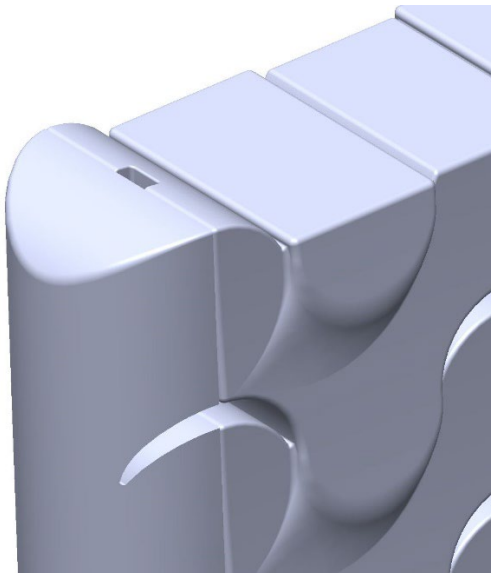


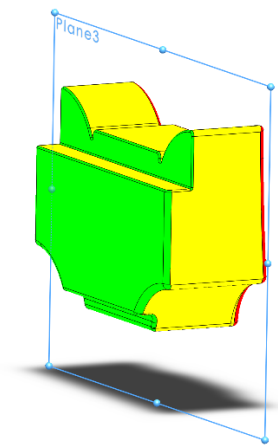


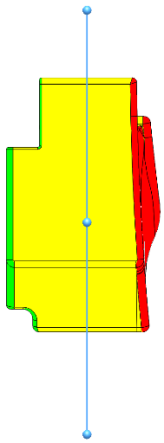


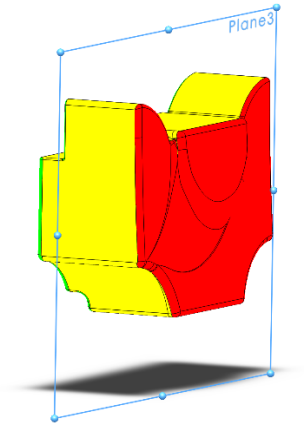







Plane3




Plane3

F – Manufacturing Cost Info/Data

Product and Link	Thumbnail	Price
Tuff Tank Water Tanks https://rotoplastics.com.bb/product_tanks.html		BDS $1 per gallon
IBC Tote https://www.ibctanks.com/275gallon-new		USD $383.10
Std Water Brick Blue https://www.waterbrick.org/product/10-pack-waterbrick-standard-3-5-gallon-blue/		USD $180
Osculati Freshwater Rigid Tank https://www.osculati.com/en/11525-m-017477/fresh-water-rigid-tanks		USD $77.40 - $174.74

Thintanks Super Slimline Tank http://www.tightspottanks.com.au/polyslimlinetanks/thintanks/		USD $998.85 – $1122.74
Kingspan Ultra Skinny https://ecosustainablehouse.com.au/products/ultra-skinny-slimline-tank?variant=20704382058585		USD $1410.69 - $1671.53
Slimline Poly Rainwater Tank http://www.tightspottanks.com.au/polyslimlinetanks/enviro-poly-slimline-tank-1000-litre/		USD $588.47

G – Sustainability Info/Data

Business Model Example: Solar Dynamics Limited

An organisation in Barbados known as 'Solar Dynamics Limited' is used as an example of how sustainable and energy efficient products can be introduced to the local society to eventually become ubiquitous.

They install photovoltaic water heating systems in homes, subsidised by the government of the island nation. This system has led to Barbados becoming a world leader "for cumulated glazed and unglazed water collector capacity in operation in 2018 per 1,000 inhabitants was Barbados (565 kWth / 1,000 inhabitants)." (slcoward, 2020)

H – Approval Forms

IDSN 4502
SENIOR LEVEL THESIS TWO

Humber ITAL / Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / WINTER 2021
Catherine Chong / Sandro Zaccolo

CRITICAL MILESTONES: APPROVAL FOR CAD DEVELOPMENT & MODEL FABRICATION

Student Name:	**Adriane Spence**
Topic / Thesis Title:	**Modular Tank System for Water Scarcity**

THESIS DESIGN APPROVAL FORM

Thesis design is approved to proceed for the following:	[X]	**CAD Design and Development Phase**
Comment: Initial CAD progress well as of reading week/March 10th, continue with detailing and refinement.		

Thesis design is approved to proceed for the following:	[X]	**Model Fabrication Including Rapid Prototyping and Model Building Phase**
Comment: Design development progress well as of reading week/March 10th, once CAD is completed, can move forward to model fabrication from week #9 onward.		

Instructor Signature(s):

Catherine Chong Sandro Zaccolo

Date:	10th March 2021

1

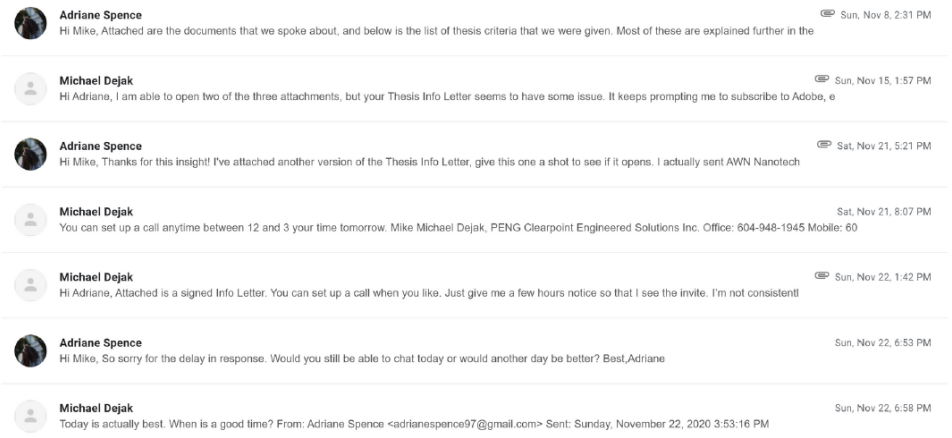
Chong, Kappen, Thomson, Zaccolo

I – Advisor Meetings and Agreement Forms

Advisor Reporting

Michael Dejak

Former President & Chief Executive Officer of Eco-Tec Inc.
Water quality and treatment expert.



Adriane Spence Sun, Nov 8, 2:31 PM
Hi Mike, Attached are the documents that we spoke about, and below is the list of thesis criteria that we were given. Most of these are explained further in the

Michael Dejak Sun, Nov 15, 1:57 PM
Hi Adriane, I am able to open two of the three attachments, but your Thesis Info Letter seems to have some issue. It keeps prompting me to subscribe to Adobe, e

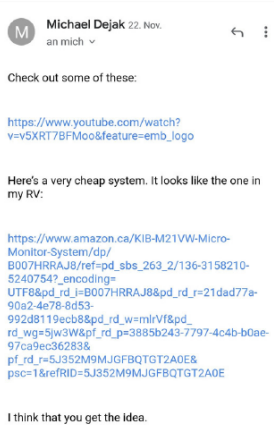
Adriane Spence Sat, Nov 21, 5:21 PM
Hi Mike, Thanks for this insight! I've attached another version of the Thesis Info Letter, give this one a shot to see if it opens. I actually sent AWN Nanotech

Michael Dejak Sat, Nov 21, 8:07 PM
You can set up a call anytime between 12 and 3 your time tomorrow. Mike Michael Dejak, PENG Clearpoint Engineered Solutions Inc. Office: 604-948-1945 Mobile: 60

Michael Dejak Sun, Nov 22, 1:42 PM
Hi Adriane, Attached is a signed Info Letter. You can set up a call when you like. Just give me a few hours notice so that I see the invite. I'm not consistentl

Adriane Spence Sun, Nov 22, 6:53 PM
Hi Mike, So sorry for the delay in response. Would you still be able to chat today or would another day be better? Best,Adriane

Michael Dejak Sun, Nov 22, 6:58 PM
Today is actually best. When is a good time? From: Adriane Spence <adrianespence97@gmail.com> Sent: Sunday, November 22, 2020 3:53:16 PM



Michael Dejak 22. Nov.
an mich

Check out some of these:

https://www.youtube.com/watch?v=v5XRT7BFMoo&feature=emb_logo

Here's a very cheap system. It looks like the one in my RV:

https://www.amazon.ca/KIB-M21VW-Micro-Monitor-System/dp/B007HRRAJ8/ref=pd_sbs_263_2/136-3158210-5240754?_encoding=UTF8&pd_rd_i=B007HRRAJ8&pd_rd_r=21dad77a-90a2-4e78-8d53-992d8119ecb8&pd_rd_w=mlrVf&pd_rd_wg=5jw3W&pf_rd_p=3885b243-7797-4c4b-b0ae-97ca9ec36283&pf_rd_r=5J352M9MJGFBQTGT2A0E&psc=1&refRID=5J352M9MJGFBQTGT2A0E

I think that you get the idea.

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2020 & WINTER 2021

INFORMATION LETTER

Research Study Topic: How may we mitigate water scarcity in the Caribbean?
Investigator: Adriane Spence/ adrianespence97@gmail.com/ 647-395-2662
Sponsor: Humber ITAL, Faculty of Applied Sciences & Technology (IDSN 4002 & IDSN 4502)

Introduction
My name is Adriane Spence. I am an industrial design student at Humber ITAL, and I am inviting your participation in a research study on various water scarcity problems that citizens of Barbados, Antigua and Barbuda, and St. Kitts and Nevis deal with. These problems include inconsistent access to potable water and the waste of water. The results will be contributed to my Senior Level Thesis project.

Purpose of the Study
This study is being conducted as an aid in designing a water generation and management system that is capable of generating potable water using renewable resources of both the water, and the energy required to collect it. The product will also encourage user behaviour to reduce water waste. This study is primarily based on understanding ergonomics, human interaction design activities, and user experience aspects of the research area.

Procedures
If you volunteer to participate in this study, you will be asked to discuss the design throughout the process, in order to provide a more informed and experienced perspective.

Confidentiality
Every effort will be made to ensure confidentiality of any identifying information that is obtained during the study. In the case of being recorded visually, your face will be masked /blurred or hidden. The information and documentations (photographs) gathered are all subject to being used in the final presentation of the study.

Participation and Withdrawal
Your participation in this study is completely voluntary and you may interrupt or end the study and the session at any time without giving a reason or fear of being penalized.

If at any point during the session, you feel uncomfortable and wish to end your participation, please let the moderator know and they will end your participation immediately.

Humber Research Ethics Board
This research project /course has been approved by the Humber Research Ethics Board. If you have any questions about your rights as a research participant, please contact Dr. Lydia Boyko, REB Chair, 416-675-6622 ext. 79322, **Lydia.Boyko@humber.ca**

1

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2020 & WINTER 2021

INFORMATION LETTER

Conditions of Participation

- ✓ I understand that I am free to withdraw from the study at any time without any consequences.
- ✓ I understand that my participation in this study is confidential. (i.e. the researcher will know but will not disclose my identity)
- ✓ My identity will be masked.
- ✓ I understand that the data from this study may be published.

☑ **I have read the information presented above and I understand this agreement. I voluntarily agree to take part in this study.**

Michael Dejak		Nov 20, 2020
Participant's Name	Participant's Signature	Date

Project Information

Thank you very much for your time and help in making this study possible. If you have any queries or wish to know more about this Senior Level Thesis project, please contact me at the followings:

Phone: **647-395-2662**
Email: **adrianespence97@gmail.com**

My supervisors are:

Prof. Catherine Chong, **catherine.chong@humber.ca**
Prof. Sandro Zaccolo, **sandro.zaccolo@humber.ca**

2

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2020 & WINTER 2021

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

PARTICIPANT INFORMED CONSENT FORM

Research Study Topic: How may we mitigate water scarcity in the Caribbean?
Investigator: Adriane Spence/ adrianespence97@gmail.com/ 647-395-2662
Courses: IDSN 4002 & IDSN 4502

I, Michael Dejak *(First Name/Last Name)*, have carefully read the Information Letter for the project ;How may we mitigate water scarcity in the Caribbean?', led by Adriane Spence. A member of the research team has explained the project to me and has answered all of my questions about it. I understand that if I have additional questions about the project, I can contact Adriane Spence at any time during the project.

I understand that my participation is voluntary and give my consent freely in voice recording, photography and/or videotaping; with the proviso that my identity will be blurred in reports and publications.

Consent for Publication: Add a (X) mark in one of the columns for each activity

ACTIVITY		YES	NO
Publication	I give consent for publication in the Humber Library Digital Repository which is an open access portal available to the public	☒	☐
Review	I give consent for review by the Professor	☒	☐

Privacy
All data gathered is stored anonymously and kept confidential. Only the principle investigator /researcher, Adriane Spence and Prof. Catherine Chong or Prof. Sandro Zaccolo may access and analyze the data. All published data will be coded, so that visual data is not identifiable. Pseudonyms will be used to quote a participant (subject) and data would be aggregated.

I also understand that I may decline or withdraw from participation at any time, without negative consequences.

I understand that I can verify the ethical approval of this study, or raise any concerns I may have by contacting the Humber Research Ethics Board, Dr. Lydia Boyko, REB Chair, 416-675-6622 ext. 79322, **Lydia.Boyko@humber.ca** or Adriane Spence/ adrianespence97@gmail.com/ 647-395-2662.

Verification of having read the Informed Consent Form:

☒ I have read the Informed Consent Form.

My signature below verifies that I have read this document and give consent to the use of the data from questionnaires and interviews in research report, publications (if any) and presentations with the proviso that my identity will not be disclosed. I have received a copy of the Information Letter, and that I agree to participate in the research project as it has been described in the Information Letter.

Michael Dejak — Participant's Name
Participant's Signature
Nov 20, 2020 — Date

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J – Topic Specific Data, Papers Publications

The following paper holds strong relation to the topic, in support of household rainwater harvesting in Barbados and is cited in the References section. The abstract is shown here because the full paper has not been posted online, and was sourced directly from the author.

Rainwater harvesting for domestic purposes: an adaptation management strategy for low freshwater availability in Barbados

Kwame Emmanuel

Department of Geography and Geology

Abstract

Harvesting rainwater at the domestic level is presented as a component of a sustainable water management strategy for Barbados where there is low freshwater availability, and water outages primarily in the northern and eastern sections of the country. Rainwater can be used at the domestic level for primary uses, however in Barbados it is mainly used and accepted for secondary uses such as irrigation. The objective of the paper is to motivate a change in attitude and policy towards rainwater harvesting in Barbados. The paper examines case studies of domestic rain harvesters in south-eastern St. Ann, Jamaica; and presents findings from a survey of households and semi-structured interviews of policy makers in Barbados. The analysis frames the practice of rainwater harvesting at the domestic level in rural Jamaica, and dissects issues and lessons learnt for transfer to Barbados, including recommendations for possible improvements to Jamaican designs and practices.

Key Words: Rainwater harvesting, sustainable water resource management, adaptive capacity, climate change