Final Report
Shed 3: Water

By: Milan Vashisht, Khalid Sayeed, Bryce Llewellyn
Eric Palamar and Enioluwa Ajetomobi

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Abstract

This design project was created within the GNG1103 section B class, led by M.A.Majeed. The purpose of such design project was to assist Barriere Lake Algonquin Reservation with their harsh day to day living conditions. Shed 3 Water group was responsible for the collection, storage and distribution of water to the user that is living within the small zero emission home. Utilizing the design process and other lessons learnt within the class, a rainwater harvesting system was created. This system collects rainwater that lands on the roof of the home, filters the water, stores it within a tank for use later inside the home. The water system pump is automated for maximum efficiency of electricity usage.

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Introduction

“So What?” The focus of this project was to design and build a water system for a house that is self sufficient and runs as efficiently as possible. This proved quite difficult to do as there were many factors working against us in this project.

“Who Cares?” This design was being done for our client, Monique Manatch, who is a representative of the Barriere Lake Algonquin Reservation. The reserve came to us because of the harsh living conditions that those living on the reserve are enduring. There was 3 main criteria to base our design around. First of all and most importantly, the shed itself, as well as the water system had to be able to function completely off the grid. Second, the water must be filtered of harmful substances. Finally, The shed must have some sort of running water.

“Why You?” Our shed collects rainwater which is the safest source of water on the Reservation. What separates our shed from the other sheds is where we store our water. To avoid our water freezing during the cold winters we decided to store the water about 10 feet underground where the temperature is relatively constant. This will ensure that there will be no lack of water during the winter.

Main Body

Empathize

The first step in the design process. This is the stage where getting a grasp for the situation and ultimately defining what clients needs are is the primary focus. In the first meeting with the client Monique Manatch, conditions surrounding the design were outlined, the client mentioned some needs that they would like to be fulfilled in the shed. First of all, they need a clean source of water and somewhere to store this water as well as some source of power generation and somewhere to store this power. If the water needs to be treated or filtered, that needs to be arranged as well.

Define

the second step in the design process. This is the stage where the main goal is to take the previous gathered information, analyze it and identify what are the primary needs

and what can be realistically completed with the given time and budget. This is when a problem statement is created and a plan is put into action.

> Problem Statement: The client needs a home which can fit a bed and sink The home must be able to collect, heat and store a clean source of water. The home must be able to collect and store power. Finally, the home must be modular, therefore, it must be easy to set up and take apart.

With the needs sorted and identified, design criteria is created. (This is associated with the ideation phase)

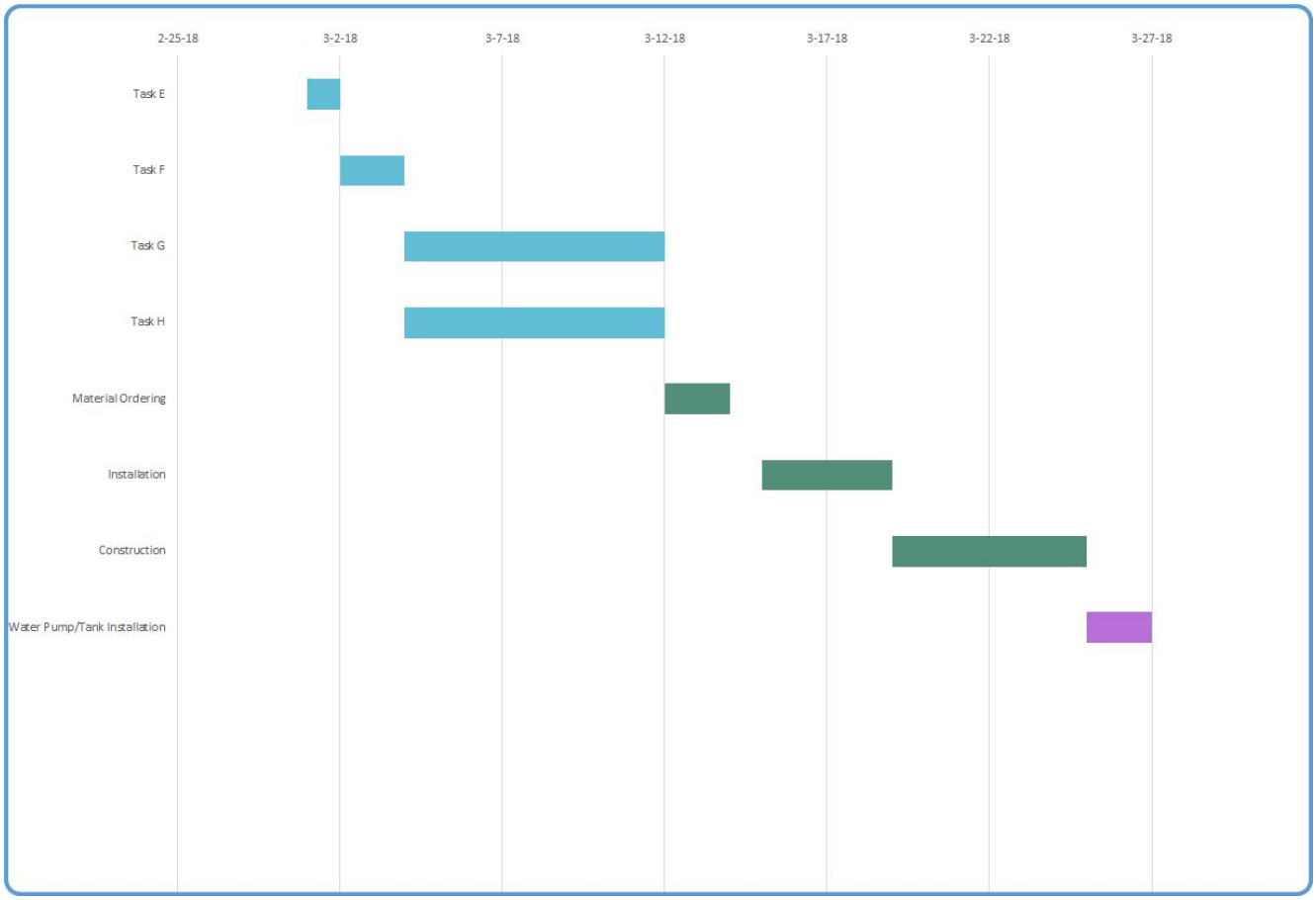
#	Need	Design Criteria
1	The house can collect, store, heat and purify its own source of water	Litres per month (L/month) Litres in storage Turbidity of water Temperature (C)
2	The house can collect and store its own power	Energy stored (Whrs)
3	The house is modular and easily disassembled	Take down and Setup time (hrs)
4	Materials are low cost	Cost ($)
5	The house is able to be towed and moved easily	Weight (lbs)

We have arranged these needs into 3 different sections which are further separated into their relative importance (1-5) .

Water

(5) Collection of water (enough for 3 people)
(5) Filtration
(4) Plumbing
(3) Heating of water

A Gantt Chart is planned out and created with the purpose of organising and managing time in this phase too.



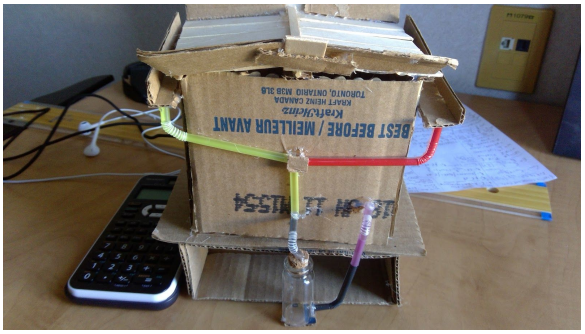
Ideate

In this step, we collectively brainstormed ideas on how we were going to create an effective approach to collect, conserve, and distribute water. Initially, we opted to incorporate a spring water system for out shed. A spring water system is a method to retrieve water from springs, as well as extracting water that subsides in soil. We eventually rejected this idea because the area was polluted, we would have to design and engineer an intricate water collection system, and we would have to develop a filtration system that would extract any bacteria that exists in the water. The cons had outweighed the pros of incorporating a spring water system, and we had brainstorm another type of water collection system. We then utilized the Rain Water Harvesting case study and developed a similar system pertaining to our shed. We incorporated a corrugated tin roof because it would easily guide the water down the shed without it straying away from the shed. We then opted to include eavestroughs (or gutters) because it would increase the efficiency of collecting water for our shed. Then we decided to cut holes at an end of our eavestroughs and attached funnels because it

would collect more water. As for the filtration system, we had used a four-stage filtration system, consisting of coarse gravel, fine gravel, sand, and mesh surfaces. We thought this would be a proficient filter because it would extract large objects that may appear in the first two layers, and any bacteria would be filtered out in the last two layers. Here is a diagram of the filter:

Then, we decided to incorporate a tank that would incorporate two Home Depot buckets with one end attached to another. The tank was 10 L in total. We believe this would be enough for inhabitants of the shed. We wanted our tank to be located underground because the temperature of the tank would mediate itself in cold or warm weather. After that, we wanted to include a pump that would distribute the water throughout the shed. At first we wanted to build a pump, but decided against it because we received one from Brunsfield at Lees Campus. Next, we decided to connect our water system using PEX piping because it is flexible and durable through extreme weather.

Prototype



We designed three prototypes during the entire design process. The first of these was a smaller version of the shed with the water system attached. Here you can see the different parts of the water system. The straws show the piping systems, the cork is the filter and the glass container is the tank. There wasn't any testing done on this

prototype as it was more of a small scale mockup of the final prototype.

Our second prototype was the filter that would be used on our final prototype. For this prototype we used a Home Depot Bucket with seven holes cut in the bottom of it to allow water to pass through. We used a layer of scouring pads, then layers of aggregate in increasing size to act as our filter. This filter is a cheap alternative to more expensive filters, while still being effective.

The final prototype was our final design presented on Design Day. This final prototype consisted of gutters attached to pipes which connected to the filter. The filter, would then drain into the tank. We then had a pump attached to the tank which would send the water up to the sink.

Test

We did not perform any tests on our first prototype as we felt there was no relevant tests to be done or any relevant data to be collected.

For our second prototype we decided to test the effectiveness and efficiency of our filter. We did this by running water through our filter and timing how fast the water would filter through, as well as how clean the water was when it was filtered through. The water took 30s to filter through the filter and came out clear passing both of our tests for this prototype the next step was to test the final prototype.

We never actually got to testing our final prototype because of time constraints. Also the other two water groups tested their water and ended up causing many issues in their sheds (flooding and short circuiting of wires and sensors). Had we decided to test the shed we would have tested the following; Response time between sensor and pump starting, amount of time required for water to reach sink after pump turns on and the efficiency of our roof and gutter system (amount of water captured relative to amount sprayed onto shed). The first and second test would be relatively simple ones requiring only a timer and some water already in the tank. The final test mentioned would have been more complicated and would require a set amount of water being placed on the roof of the shed and then measuring how much water actually made its way to the tank.

Conclusion

During this design project we learned the importance of communication within the group and within the entire team. Furthermore, we realized that we need to be much better at budgeting our time, tasks seemed to take much longer than we had expected and this put us behind quite a lot during the project. If we were to continue this project we would probably add some sort of a countertop around the sink to provide more support and give some room for the client to store items. We would also try to add some sort of tarp system to increase the surface area of the shed. Despite these advancements we would make, we are still quite pleased with the work we have done and hope the client is as well.