The Blue Water Purification

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Summary

Water is a limited commodity in many parts of the world. One small step towards solving that issue starts out in our showers. According to the Home Water Works, in America, the average person uses 17.2 gallons of water while showering (Showers, 2011). At first glance may not seem much to people who live in cities near water like New York; however, for places suffering drought such as California, it could make a huge difference. With sustainable water, harsh climate change becomes less of a problem and there becomes a less of a dependence if showers reused their water through filtering used water and having a reserve. Through the technical innovation of a recycling shower, water used during a shower could be captured, filtered and stored in a reservoir for safe reuse. We propose the installation of a water recycle system in existing showers in homes in San Diego. We would require approximately three weeks for construction at a cost of $10,619.89 per home. Our lead engineers are all undergraduate students at City College with 1-2 years of completed engineering coursework. If this proposal is authorised, we would begin construction designs and permit applications immediately.

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Introduction

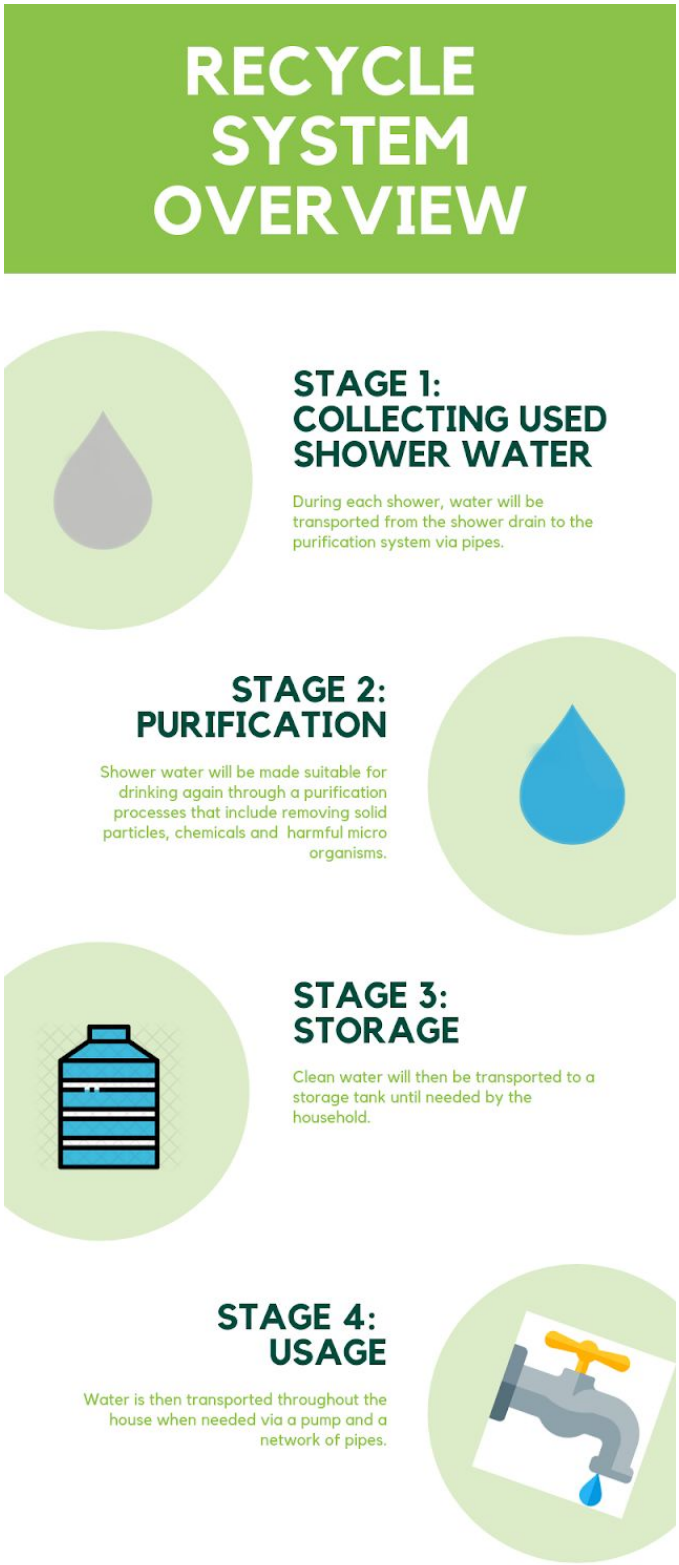
The Issue

On average, a person uses approximately 80-100 gallons of with 5 gallons of water being used per minute while showering. If the shower water could be collected and recycled, the use of additional water from other means could be mitigated. This proposal is meant to bring into light an innovation that could significantly reduce water usage by households in California. Systems are in place to catch rainwater or recycle water to many forms but there lacks access to a storage system of clean water which can be used for any domestic purpose. Our innovation approaches this issue directly.

The Recycling Shower

The scope of the proposal is to reuse shower water or grey water. The process of using grey water already exists on earth. For example, in New Mexico and Arizona, people used grey water to flush their toilets. We plan to reuse the shower water for domestic works such as drinking, cooking, washing dishes, etc. The purpose of using grey water is to avoid water scarcity because it is a huge global issue. According to the Home Water Works, in America, the average person uses 17.2 gallons of water while showering (Showers, 2011). Thus, 17.2 gallons is a lot of water for per person. In the future, water scarcity might be an essential crisis in California. According to the National Geography, “California (and much of the West) relies heavily on snowpack each winter to resupply surface water streams and lakes” (Dimick, 2017). California relies on snowfall to fulfill people needs for water; however, it declines significantly in recent years because of global warming and other environmental factors. There is a chance of

water scarcity in California upcoming years because less snow indicates there will be less water for the streams since there is not enough snow to fill it. Therefore, we plan to introduce the Blue Water Purification system in California so that the state can be less dependent on the weather to fulfill people water demands. In order for us to achieve our goal, we plan to design a storage and purification system in the basement so that the shower water can be reused again.



Proposed Program

Overview

The purpose of the innovation is to retrieve the grey water that would usually go down a drain, purify it and reuse it for domestic purposes e.g. drinking, washing, watering the yard, etc. The innovation consists of materials and parts that are easily accessible from any home improvement supplies retailing company such as Home Depot. The system transports the grey water through various systems which rely on a UV lamp, sand/granular, activated carbon, geotextile and screen filter to remove particulates, bacteria, organic and inorganic compounds that may contaminated the water and store it in a sterilized non-biodegradable tank which can be accessed for various purposes.

These filters were tested using specified contaminants of varying concentrations and resulted in 98% efficiency (Selvarajan, Holland, 2013). The UV lamp was tested using two different flow rates and the disinfection system performed effectively (K.C, Khadka). The purification will be located in the basement of the apartment complex with a pump that will transport the drinkable water through pipes leading towards the storage tank.

According to Water Filter Data, 211 billion gallons of water are used every year for showering in California. This innovation lowers water consumption by 80% to 95% and save approximately $780 to $831 on the water bill a year (Kanellos, 2015). The installments of this innovation will cost more than the average shower but save more money in the long run. This innovation will be certified under the Leadership in Energy and Environmental Design (LEED). LEED is a recognized symbol of sustainability achievement, hence, enhancing our brand.

Technical Description

The recycling system will be composed of three main units: the purification system, storage system, and pump. Each of these components will be connected to each other by pipework that will transport wastewater from the shower to the purification system, the storage tank and finally to the pump which will redistribute the newly purified water.

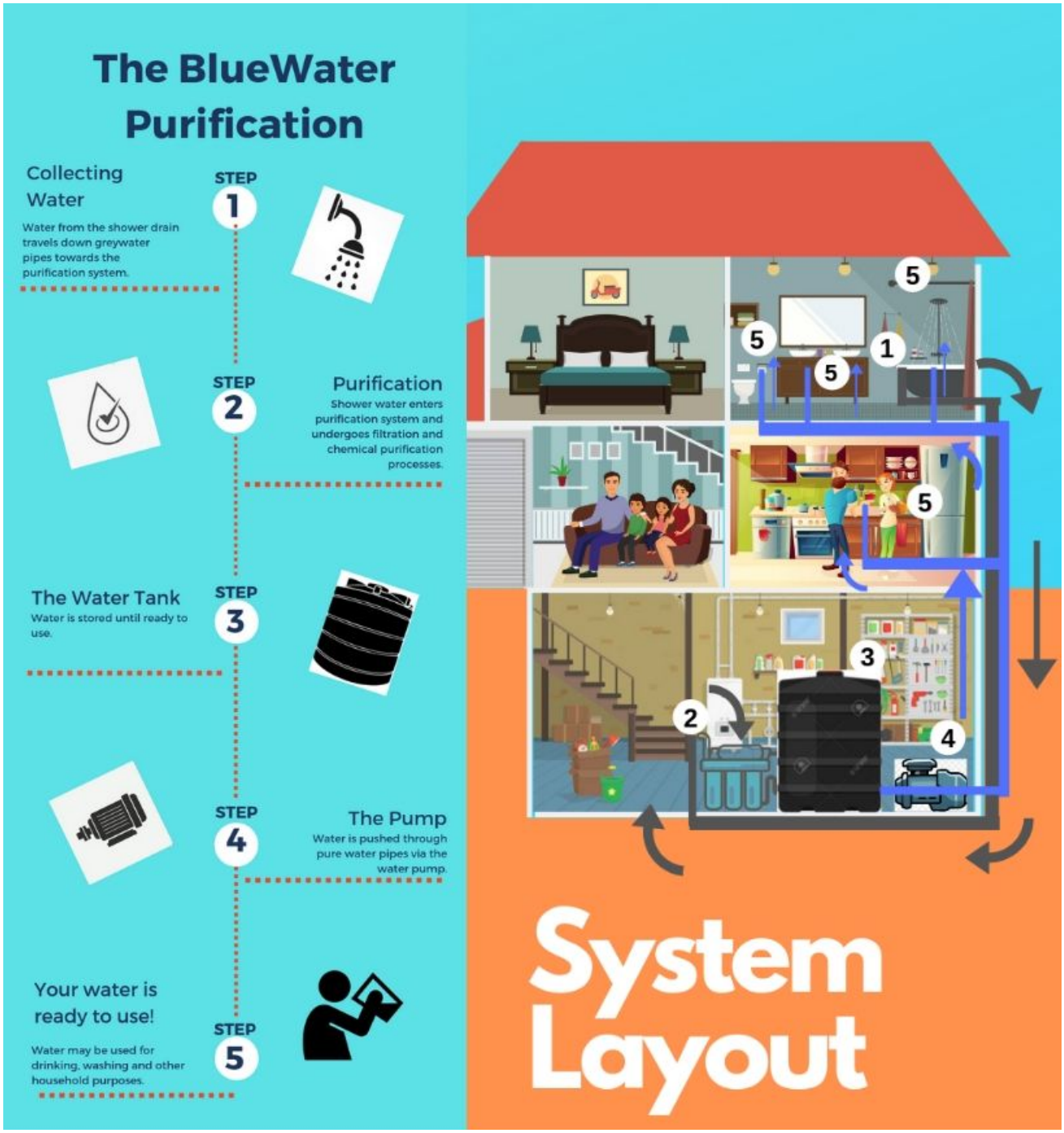


Figure 1: Overview of the recycling system

The Purification System

The filtration or purification system is responsible for the removal of solid particles, chemicals and harmful microorganisms in the water. The filtration system is divided into exterior and interior parts. The exterior parts include the acrylic tube, lid, silicone gasket, UV lamp and threaded rods. The interior parts consist of compression disks, a screen filter, an activated carbon filter, geotextiles and a sand filter.

The acrylic tube is used to contain the materials used for the filtration process. The lid and silicone gasket prevent the materials from leaking through the bottom or top of the acrylic tube. The threaded rods resemble screws and act as pins to connect materials together. The threaded rods also stabilize the filtration structure.

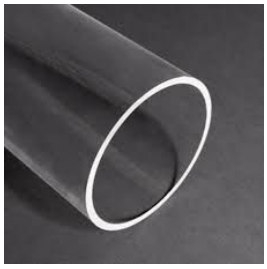


Figure1: acrylic tube

Figure 2: Threaded rods

Figure 3: Silicone gasket

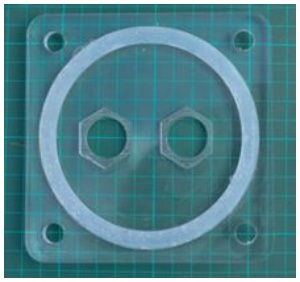


Figure 4: Lid

The UV lamp emits UV rays at a frequency that kills the bacteria by destroying the DNA of the microorganisms meaning, it can no longer duplicate. This process is effective against viruses such as E. coli. It is also good for killing harmful microorganisms that are resistant to chlorine.

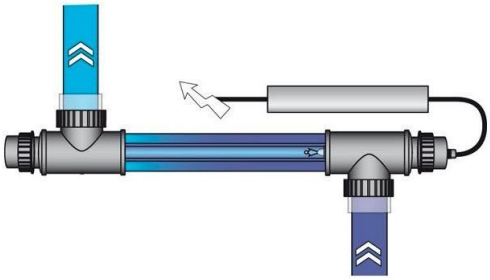


Figure 5: UV lamp

Compression disks are used to apply low pressure gas onto a filter screen, this compressed gas creates the pressure differential (pressure measured relative to the pressure of the atmosphere around it) needed to accomplish filtration. It is also used to separate the materials used in the filtration process.

Figure 6: Compression disk

A screen filter is a flexible mesh-membrane that is used to filter sand and other fine organic and inorganic particles in the water.

Figure 7: Screen filter

An activated carbon filter removes organic elements and residual disinfectants in the water. Activated carbon removes contaminants from water through two ways i.e. adsorption (atoms sticking to a surface) and catalytic reduction. Organics are removed by adsorption and residual disinfectants are removed by catalytic reduction.

Figure 8: Activated carbon

A sand filter uses sand or gravel to filter particles and particle-bound constituents found in water. Sand filters accomplish much of their treatment through biological processes. The sand filter has an ecosystem called the biomat which contains bacteria which consume particles in the water.

Figure 9: sand

Figure 10: Gravel

Geotextile is a permeable textile material that serves as a membrane to filter small particles.

Figure 11: Geotextiles

The Water Storage System

The water storage system is responsible for the storage of the filtered water passing through the purification system. The storage system consists of a total of 8 parts: the tank, base or plinth, pump, pipes, elbows, gate valves, non-return valves, and a float valve.

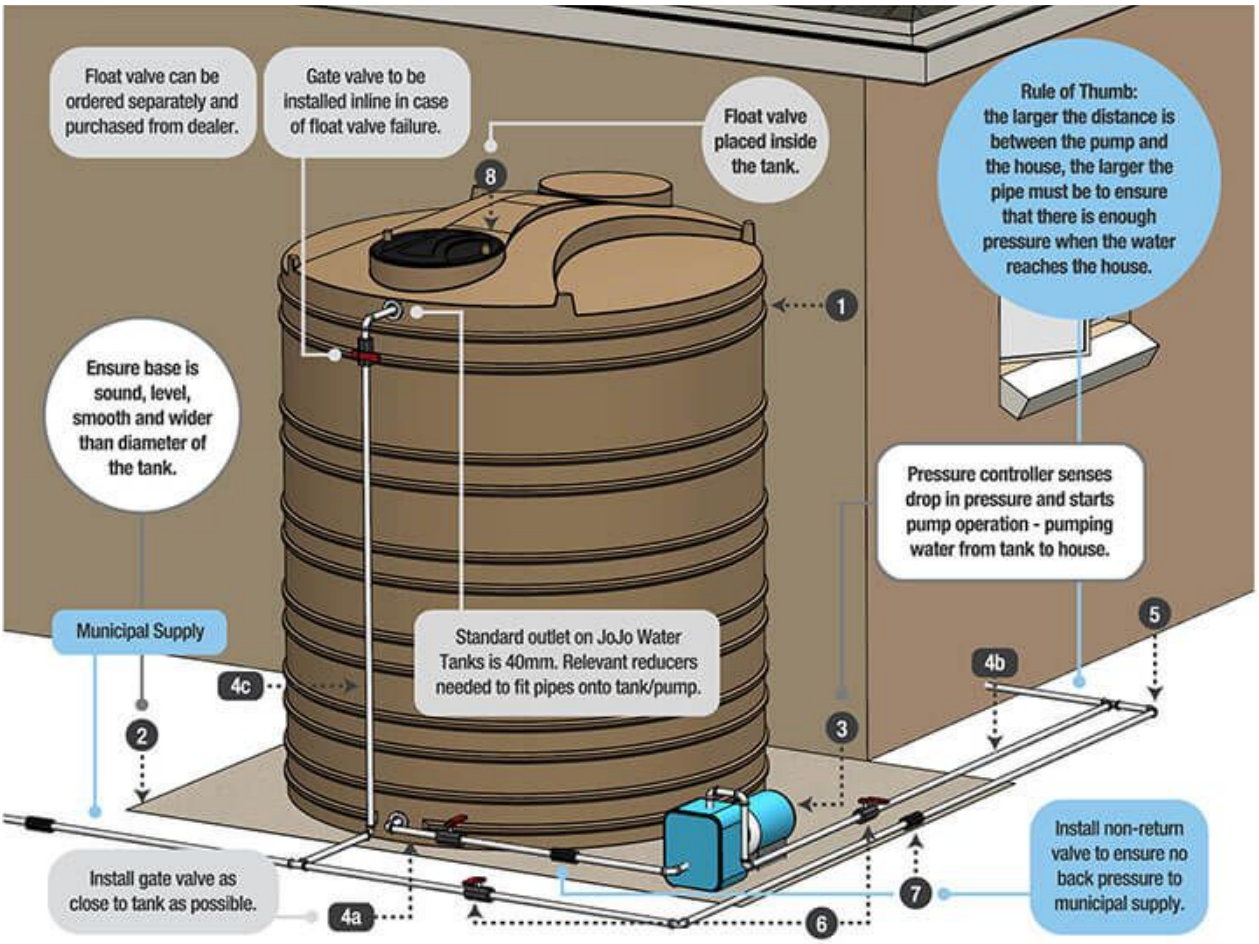


Figure 12: This image displays the storage unit and its main components labeled

Tank

Figure 13: The exterior of the tank component of storage of which where the water will stay

The tank consists primarily of plastic with a 10 year guarantee. The size and shape of the tank can be changed to best fit users and can store food-grade water. Furthermore the tank is

equipped with a black inner lining that prevents algae growth and keeps water fresher for longer periods of time.

Base or Plinth

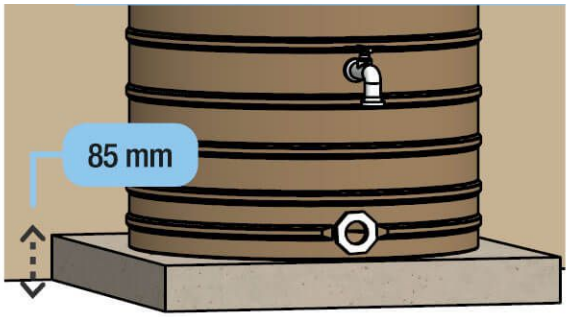


Figure 14: This image displays the placement of the base or plinth component

As displayed in figure 14, the base or plinth section of the tank is responsible for supporting the weight of the tank and for keeping the water and system level. The base or plinth is typically 85 mm in height and is composed of concrete. The bottom slab ensures that the ground has been 100% compacted. The base will prevent the weight of the tank from exerting too much pressure on floor by increasing the surface area of the pressure applied onto the ground.

Pipes

There are three main pipes connecting to the tank, each ¾ inch steel pipes that have been dipped in a protective zinc coating to prevent corrosion and rust. The first pipe labelled 4a in Figure 12, is a pipe 25mm minimum in diameter whose main function is to transport the purified water from the tank to the gate and to the pump. The second pipe labeled 4b is 20mm minimum in diameter and tansports the water from the pump to the house if the tank is placed outside, but

will be replaced with a faucet for direct use as shown in figure 14. The last pipe 4c attached to the tank is the pipe that transports the purified water into the tank. Together, these three pipes regulate the water flow within the storage system.

Gate Valves

The gate valves are there to regulate the flow of water within the pipes entering and leaving the storage unit physically. By turning the knob, the water flow could be blocked to stop water from entering or leaving certain parts of the system.

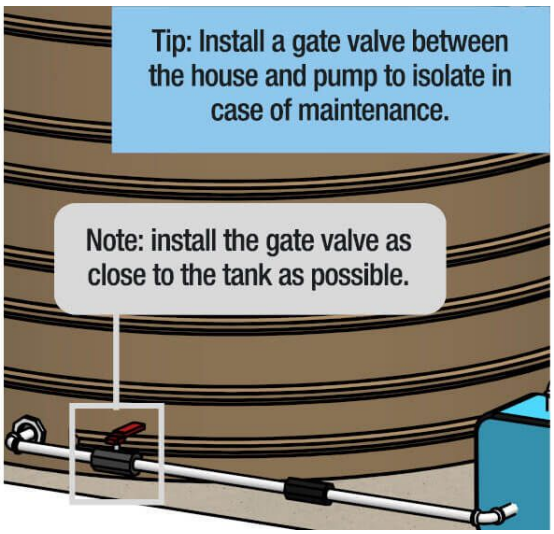


Figure 15: This image shows the control valves in reference to the tank

Non-return Valves

As shown in figure 15, the non-return valve is a pipe in the system that prevents backflow of water to prevent any form of clogging in the system. Fluid is allowed to flow through non-return valves in only one direction, leading to having two openings in the body, one for the

fluid to enter and the other for it to leave. This mechanism does not require electricity or any harmful greenhouse gas to operate and is environment friendly.

Float Valve

Figure 16: This image displays the mechanism within the tank that regulates flow

As depicted in figure 16, a float valve is used to regulate the water level from inside the tank. This mechanism is placed within the tank and will close water flow inside the tank to prevent flooding from inside. This works with the ball part floating to the level of the pillar as water flows into the tank to close the valve and prevent flooding. This is an efficient way to prevent flooding as it is green and does not need any electricity to function.

These components come together to form what we see as the storage component of the recycling part of water. The tank is an essential part and has several minor components as observed that ensure the safety and portability of the fluids used.

Furthermore, greywater is store in the water tank then they need to go to the plumbing system again otherwise users cannot access to it. The water pump makes the process easier and

they will play an essential role to generate forces to move tank water through the plumbing system so that the users can easily access to it for the domestic works.

The Rio Plus Aqua Pump 1700

We propose using the Rio Plus Aqua Pump/Powerhead 1700 to pump water back to the household. This pump is one of the most efficient water pumps in the market because it pumps 642 gallons per hour (Rio Taam Plus Water Pumps). Also, the pump uses less energy; as a result, it reduces the electricity bills. The Water Pump has two main components: motor housing and main housing strainer.

Figure 17: Rio Plus Aqua Pump/Powerhead 1700 (Rio Taam Plus Water Pumps)

Motor Housing

Motor Housing consists of 3 components: impeller, suction cups, and suction cups bracket.

Impeller

Figure 18: Impeller (Rio Impeller Assembly Kit).

The impeller is a significant component of the motor because it continuously spins to convert electrical energy into mechanical energy. The impeller has a permanent magnet on top of it. As a result, when the current transfer to the permanent magnets then they produce magnetic fields surrounding it. Then the permanent and field magnets begin to interact with each other to

spin the impeller to creates mechanical energy pressure to move the water through the plumbing system so the users can access it.

Suction Cups

Figure 19: Suction Cups (Rio Taam Plus Water Pumps)

Suction cups play the role of a vacuum in the water pump. They remove the air inside to create high pressure in the outside.

Suction Cups Brackets

Figure 20: Suction Cups Bracket (Rio Taam Plus Water Pumps)

Suctions cups are placed into the bracket so that it can create high pressure surrounding the tank surface to move the water closer to the impeller. The suction cups bracket is made from the metal; as a result, they are environmentally friendly, and it can be reused again.

Main Housing Strainer

The main housing strainer consists of 4 parts: under gravel filter adapter, under gravel filter strainer, o-ring, and housing end cap.

Under Gravel Filter Adapter

Figure 21: Under Gravel Filter Adapter (Rio Taam Plus Water Pumps).

The function of the component is to filter the unclean water. The process is essential because without filtering the water people cannot drink clean water. The filtration is completed before the water moves to the plumbing system.

Under Gravel Filter Strainer

Figure 22: Under Gravel Filter Strainer (Rio Taam Plus Water Pumps).

The purpose of the under gravel filter strainer is to break down dangerous chemicals to make it less harmful for the human body. Therefore, it makes the water drinkable for the people.

O-ring

Figure 23: O-ring (Rio Taam Plus Water Pumps).

The O- ring connects with the housing end cap to seal the component so that the water cannot leak.

Housing End Cap

Figure 24: Housing End Cap ((Rio Taam Plus Water Pumps).

The Housing end cap prevents the other components from interfering with the impeller because they are interacting with the impeller prevent it from spin freely. Therefore, the component allows the impeller to function freely so that the motor can perform it task.

Outer Parts of Rio Plus Aqua Pump 1700

The outer part consists of 6 components: flow control, intake and output Pipe adapters, air tubing and silencer, pump hanger, duck bill, and elbow.

Flow Control

Figure 25: Flow Control (Rio Taam Plus Water Pumps).

The flow control serves as a switch on the water pump. The users can use the flow control to change the speed of water flowing. Also, the benefit of Rio water pump is users can attach the silencer tube with it so that the pump make less noise.

Intake and Output Pipe

Figure 26: Intake and Output Pipe Adapters (Rio Taam Plus Water Pumps).

The pump has two ports intake and output. The input intakes water horizontally from water tank and then the output moves the water to the plumbing system vertically so the users can access it.

Air Tubing and Silencer

Figure 27: Air Tubing and Silencer (Rio Taam Plus Water Pumps).

The purpose of the air tubing and silencer is to prevent noise pollution by changing the speed of the air expelling into the atmosphere. The silencer can change the speed of the air because it provides extra space for the air to expand. As a result, the speed of the air declines significantly to make less noises.

Pump Hanger

Figure 28: Pump Hanger (Rio Taam Plus Water Pumps).

The purpose of the component is to protect the pump from getting damage because if the pump is placed on the ground then it will get wet if any of the pipes leak. Therefore, the hanger gives the users flexibility to place their water pump on it so the pump can stay safe.

Duck Bill

Figure 29: Duck Bill (RF-DBF Flanged Duckbill Check Valve).

The Duck Bill removes extra water pressure from the pump when the water goes through the plumbing system. The ends of the duck bill open up so that the water pressure can move out from the pump. Then, the duck bill releases the water pressure and it returns to their normal position so the water direction does not get reverse because without the high-pressure it cannot move forward.

Elbow

Figure 30: Elbow (Rio Taam Plus Water Pumps).

The Elbow functions as a bridge between the water pump and housing plumbing system because it connects them together.

How Does The Water Pump Work?

The water pump functions when the impeller starts to spin because then the suction cups will release air from the inside. As a result, the inside will be low pressure and the outside of the suction cups will be high pressure. Then the water will starts to flow through the intake pipe from the tank because the pressure around the tank is high. Also, the impeller rotates to generate more pressures to move the water forward. After the water pass the impeller, then they go to the main housing strainer for the purification. Finally, the water goes through the output pipe and the water pressures continue to move the water so that users can have access to it.

Innovation Process

Budget

In San Diego there are constantly moments of drought. Therefore, to solve the problem of drought and save water, the water purification showering system will be the solution. The showering system will reuse shower water and return it back into the house. This way water will be saved and stored for future and important occasions. With the recycling shower water, water isn't the only thing that can be saved but money too. At first glance the cost of recycling shower water may appear expensive. However, at the end money will be saved. Our future goal is to have the water purification free and accessible for all to save water and money. Until that goal is met, trials will be tested to make sure the shower system is safe to use. Compared to

non-recycling showers, people will pay more for water compared to not having the recycling shower water. According to Voice of San Diego, the average household in San Diego pays $80 per month for water. In a year that is $960 spent on paying water bills. The recycling shower water saves money by cutting down on the water bill by 15%. The household will use purified water that is stored from the shower instead of using more water from municipal well water.

There are a few organizations supporting the plan for a recyclable shower system. Both the University of California San Diego and the company Purple Pipes are going to support funds and trial runs for the project. Purple Pipes is an organization that focuses on purifying water around the country and we will work together to make that goal accomplish in San Diego's showers. The equipment used to build the water purification showering system will be bought and funded by Purple Pipes. They're helping to install the materials. The University of California San Diego, however, will also give funds and work together towards the shower purification system with indirect costs and having volunteers testing the shower in a house. The indirect costs are utilities such as water and electricity bill and maintenance of the equipment making sure it is clean and up to date.

The indirect and direct costs are based on a trial that will be set up in a one-story house with a basement in San Diego. The University will interview their own college students willing to volunteer their home for the experiment. After passing housing qualifications and student qualifications, a house will be chosen to do the project in. These same students living in the house will stay living there and test the shower for one year. In return for volunteering their

home, the University of California San Diego will pay for the housing expenses such as the utilities.

STARTUP EXPENSES

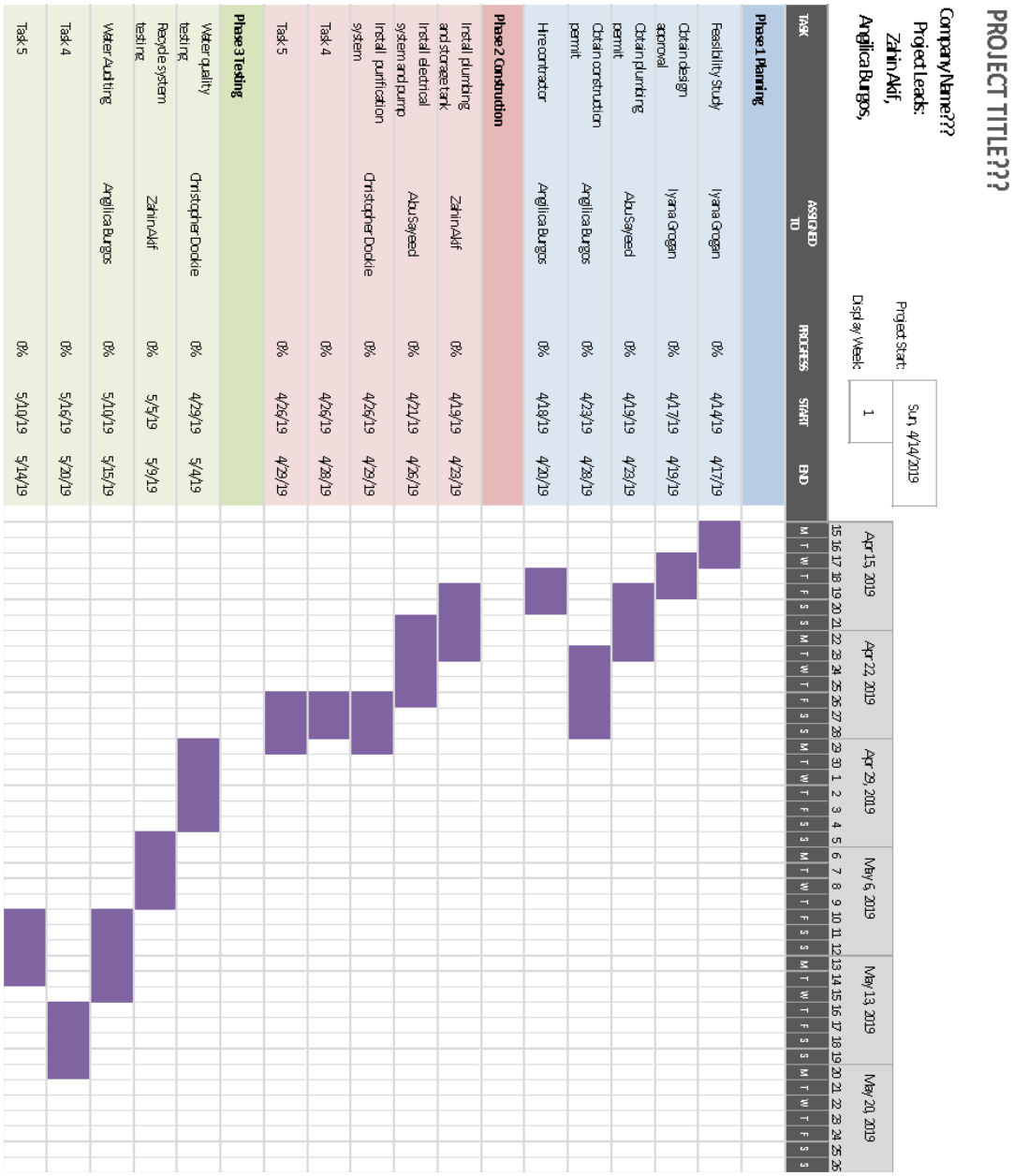
MATERIALS	AMOUNT
Tank	$603.89
Purification System	$1,932.00
Pump	$2,000.00
Total	**$4535.89**

LABOR	AMOUNT
Tank Installation	$889.00
Pump installation	$1,152.00
Purification System installation	$1,875.00
Other	$2,000.00
Total	**$5,916.00**

INDIRECT EXPENSES	AMOUNT
Water Bill	$68.00
Electricity Bill	$100.00
Total	**$168.00**

Appendix

Task Schedule



Evaluation Techniques

Status Reports

A status report will be conveyed to investors at the halfway mark of the pilot program. This report will include details on the progress of the system construction.

Water Quality Monitoring

Water will be tested once per month during the first year of installation to ensure it is suitable for potable use. Water quality testing will be conducted by the California Environmental Protection Agency.

Water Audit

Annual audits will be conducted to ensure recycle and purification systems continue to perform efficiently. This includes ensuring that the system consistently replaces 100 gallons of water per day and that there are no leaks in the system. These audits will be conducted by a private firm.

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