

Divide and Conquer
Water Saver



Group 13

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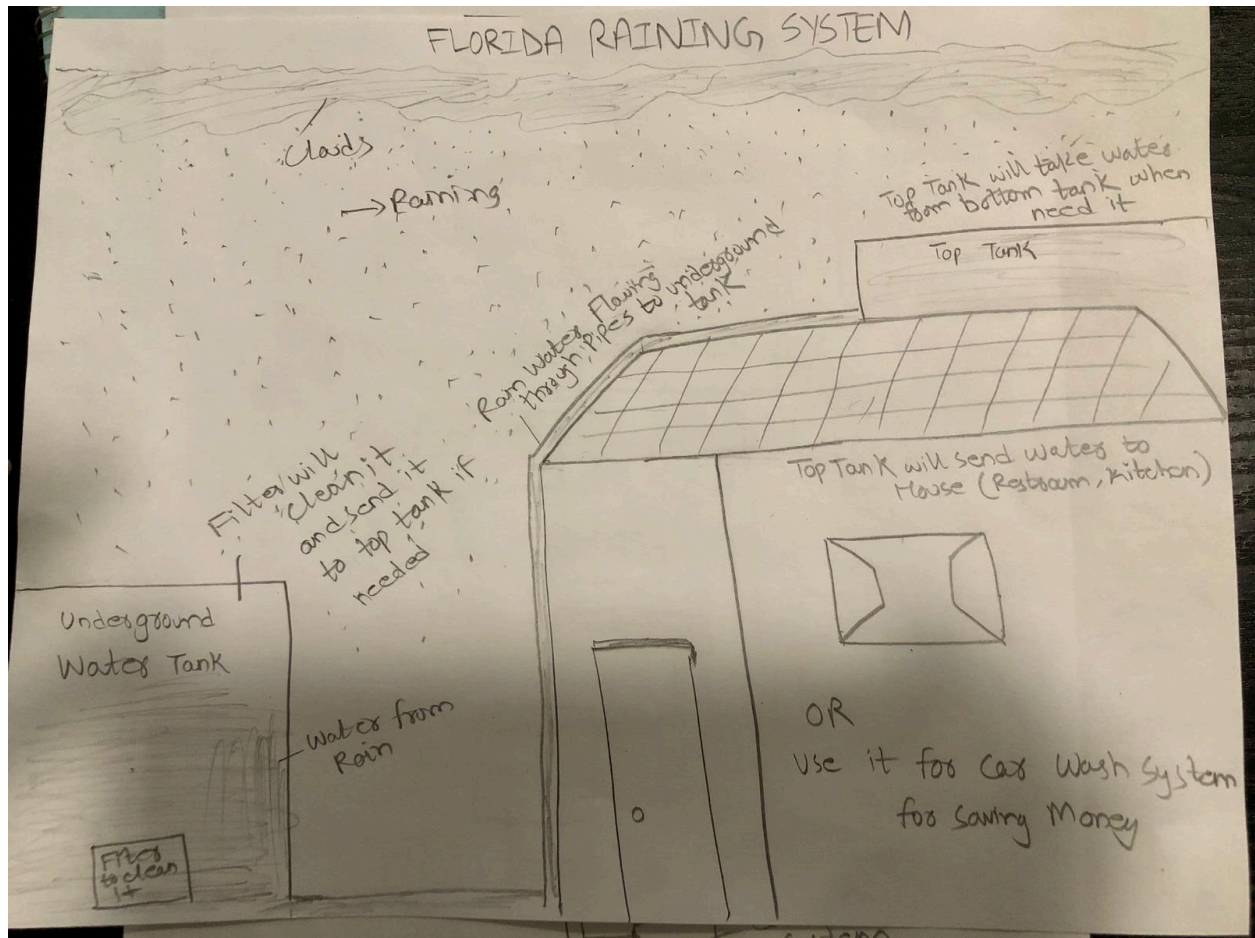
Mohammed Bazrbachi (EE)

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EEL 4914 - Spring 2024

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Project Motivation:

We want to conserve the rainwater by storing it in tanks for subsequent reuse. The recycled water will be utilized in various applications such as car wash systems, bathrooms, kitchens, and for irrigating lawns. The primary objective is to reduce the overall water consumption, lower water costs, and preserve high-quality water for more essential purposes. This initiative is particularly inspired by the prevalent rainfall in Florida throughout the year, presenting an opportunity to harness this abundant resource for practical and sustainable uses.

Project Narrative:

This approach not only helps in reducing overall water consumption but also serves to lower water costs, making it an economically viable and environmentally responsible strategy. The emphasis on preserving high-quality water for essential purposes aligns with the principles of efficient resource management. Harnessing the abundant rainfall for practical uses underscores the importance of sustainable practices, reflecting a commitment to both environmental conservation and responsible water management. This initiative sets a positive example for others to follow in promoting

water efficiency and resilience in the face of changing environmental conditions.

Project Function:

Our project is designed to activate when the rainwater sensor detects rainfall. Upon activation, the system checks the water level in the tank. If the tank is full, no action is taken; however, if it's not full, the system opens the valve to allow water to fill the tank. The valve closes automatically when the water tank sensor detects that the tank is full. To power the system, we integrate a small solar panel for sunlight-derived electricity, supported by a battery for charge storage. In case of insufficient sunlight or a depleted battery, the system seamlessly switches to power from the wall plug. The system incorporates a digital screen to display real-time information on battery and water tank levels. Additionally, we've integrated mobile connectivity, enabling users to control the system remotely via a mobile phone app, or manually through dedicated buttons.

Project Usage:

Our project is user-friendly, although not portable; however, it can be effortlessly reinstalled in various locations as required. While it may entail a significant initial investment, the cost is justified by substantial long-term savings. The system is designed to conserve both water and electricity, making it a financially prudent and environmentally responsible choice in the extended timeframe.

Project Requirements:

We will need the following requirement to build this project:

Water Collection System:

- Gutters: Install gutters on the roof to collect rainwater efficiently.
- Downspouts: Direct water from the gutters towards the storage tanks.
- First Flush Diverter: A device that diverts the initial, potentially contaminated rainwater away from the storage tanks, ensuring cleaner water enters the system.

Storage Tanks:

- Dedicated Water Tanks: Select suitable storage tanks based on the anticipated water demand. Tanks should be durable, non-toxic, and resistant to corrosion.

Filtration System:

- Pre-filtration: Use mesh screens or filters to remove large debris from the collected rainwater before it enters the storage tanks.
- Filtration Unit: Implement a more advanced filtration system to ensure the water is safe and suitable for various applications. This may include sand filters, cartridge filters, or other filtration technologies.

Pump System:

- Water Pump: Install a pump to distribute rainwater to different applications. The pump should be appropriately sized for the system's water flow requirements.

Distribution System:

- Pipes: Use pipes to distribute rainwater to different areas, such as irrigation systems, kitchens, bathrooms, and car wash systems.
- Control Valves: Incorporate valves to control the flow of water to different applications.

Solar Power Integration:

- Solar Panels: If integrating with a solar power system, install solar panels to generate electricity for powering the pump and other components.
- Charge Controller: Use a charge controller to regulate the power generated by the solar panels and prevent overcharging of batteries.

Monitoring and Control System:

- Sensors: Implement sensors to monitor water levels in the storage tanks, ensuring efficient use of available rainwater.
- Control Unit: Use a microcontroller or programmable logic controller (PLC) to automate the system and optimize water distribution.

Overflow and Drainage System:

- Overflow Pipes: Include pipes to divert excess rainwater away when storage tanks are full.
- Drainage System: Ensure proper drainage to prevent waterlogging in the surrounding area.

Maintenance and Access Points:

- Access Hatches: Provide access hatches for maintenance and inspection of the storage tanks.
- Cleaning Mechanism: Consider a mechanism for periodic cleaning of the filtration system.

Regulatory Compliance:

- Check local regulations and obtain necessary permits for rainwater harvesting systems.

Requirements

In this project we can show the need of dirty water in the world because usually the water from rain throw in the gutter which won't help anyone but we need to use that water in our purpose so we basically trying to make a tank which will store the water from rain through the pipes from the houses roofs or either the side ways of the road we will store that water in tank then we will add filter on it to clean the water then we can use those store that water in other tank to use it in homes or either Car wash so we can safe lot of money on it and we can add this system in the poor countries because they have water problems in the earth so we can safe that water and they can use it.

- System must be able to collect water from rain
- System must be able to filter rainwater for repurposing for other uses (IE: Car Wash).
- System must have sensor device to balance water tank
- System must have sensor light to show tank state
- System must be able to send sensor data to database
- System must be able to connect or adapt to home/unit gutter system
- System should have architected design to automated pipeline
- System should run automated pipeline upon level indicator detection
- System should be able to view database design of events from water tank sensors.
- User should be able to select screen on water tank to view options
- User should be able to select WIFI Icon
- User should be able to configure WIFI on water tank
- User should be able to view water tank level state
- User should be able to turn off screen
- User should be able to view battery level
- User should be able to view temperature level
- User must be able to login to front-end portal
- User must be able to view water tank dashboard of reports
- User must be able to view water tank level indicator
- User must be able to understand the ROI for tank
- IoT device should send results every 30 seconds to database per event driven architecture

Basically in a 3rd world country there is a system of water motors and there are two tanks in the houses, one underground and one at the top of the building. The a water motor sucks the water from the earth surface and fills the underground water. Then other motor transfer that water to top tank and

from top tank it goes in the house like in kitchen or restrooms but in order to transfer the water from bottom tank to top tank someone have to open the motor but as we all know that in third world countries there is no electricity and sometime we forget to turn on the motor to transfer the water from bottom tank to top so we want to make a water filtering system which doesn't require anyone to open the motor we will use the sensors on the top tank and when the level of the water goes down the motor start by itself and the water will be transferred from the bottom tank to top. And in this system we will try to save the water from rain put it in one tank clean it with filter and then transfer it from bottom tank to tank and then will use it for home or business purpose.

Structure of the house

Dimensions: size TBD

WEIGHT: TBD

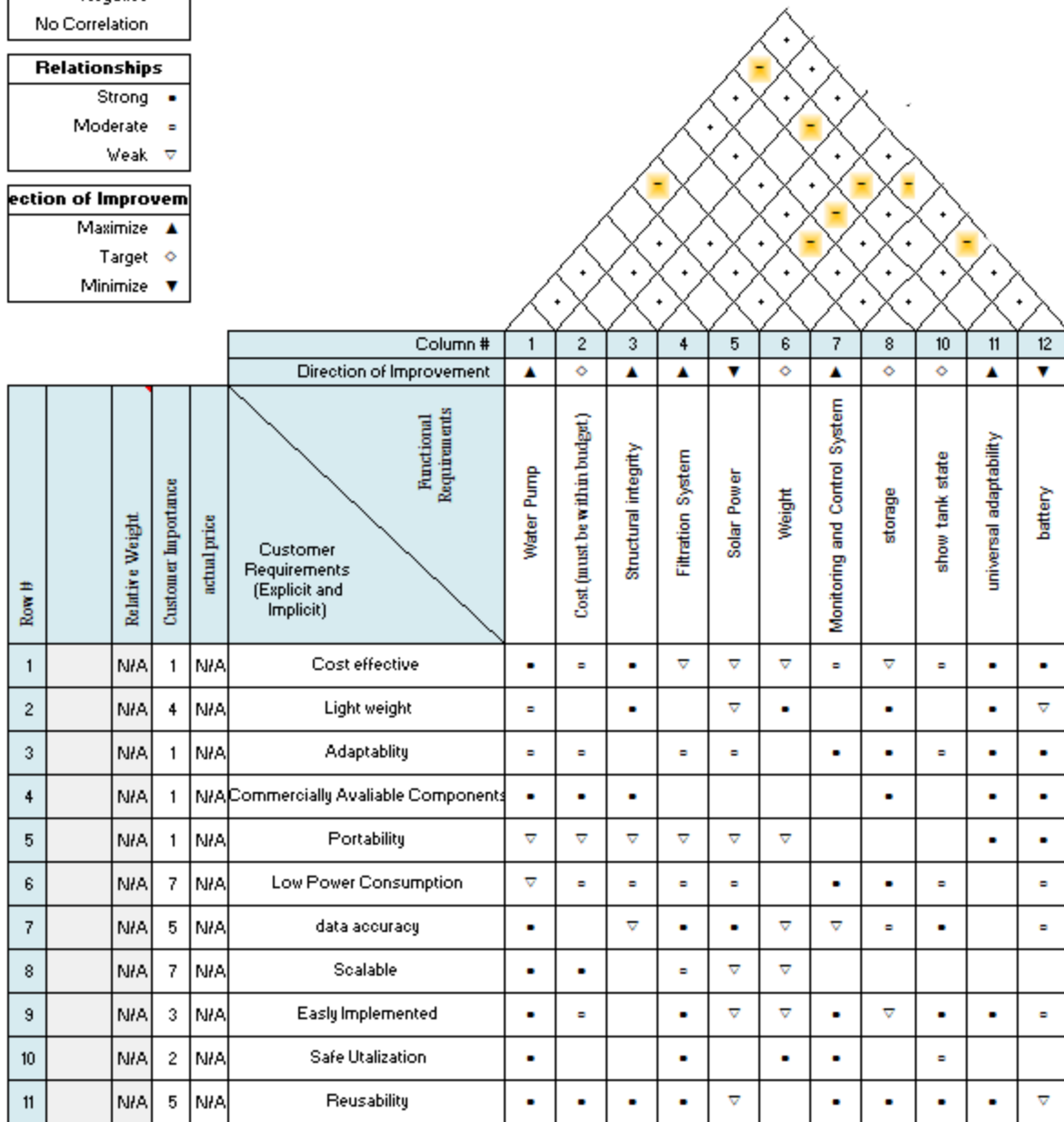
The metaphorical "house" is constructed with different matrices, each representing a stage in the product development process. The roof of the house outlines the correlation between customer needs and engineering characteristics, emphasizing the importance of aligning design elements with customer expectations.

<https://app.smartdraw.com/editor.aspx?templateId=3290965f-3c2d-42b7-a96e-7bc4ed294ebf&flags=128>

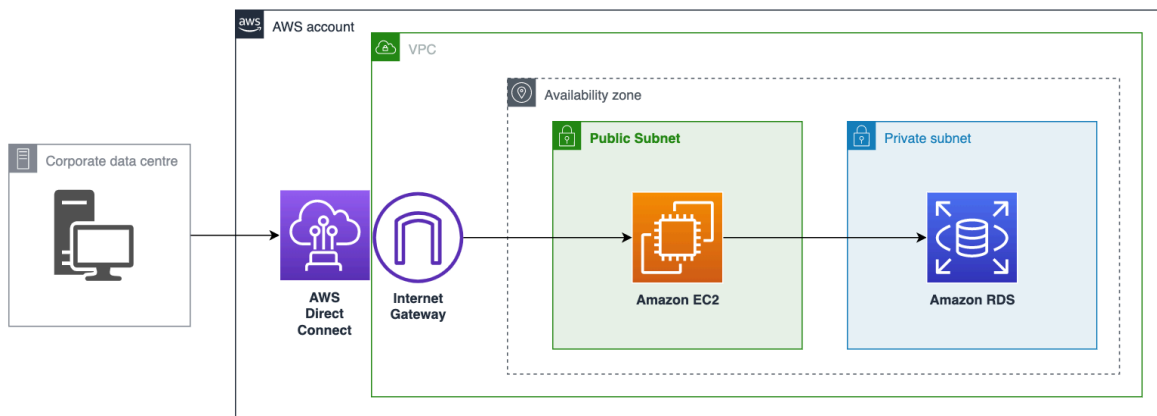
Correlations	
Positive	+
Negative	-
No Correlation	

Relationships	
Strong	■
Moderate	=
Weak	▽

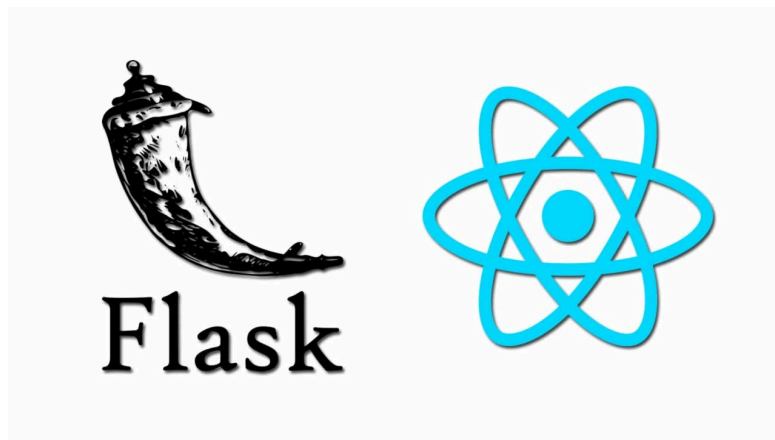
Direction of Improvement	
Maximize	▲
Target	◇
Minimize	▼



AWS Infrastructure



Code Stack -Flask API (Backend) and React UI (Frontend)



6. Estimated project budget and financing:

The anticipated cost of our project falls within the range of \$300 to \$400, based on estimates provided in the attached links. To optimize expenses, we plan to source our components from AliExpress due to its cost-effectiveness. Upon project approval, we intend to promptly procure all necessary parts, ensuring their availability well before SD2, considering the approximate one-month lead time for shipment from China. Our team will initiate the project's construction as soon as we have acquired all the required components.

Item	Unit Cost	Budget Cost	Total Cost
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AWS EC2 m5.large Instance	\$0.096 per hour	\$0 - Free Tier	\$0
AWS RDS (DB, S3)	\$0.096 per hour	\$0 - Free Tier	\$0
Domain, SSL	\$10	\$20	\$10
IoT Devices	\$50	\$100	\$50
IoT Sensors			
Home module			\$50
PCB Board			\$30
Water tank			\$8.51
Water filter			\$7.15
Water sensor			\$29.78
Light sensor			
Water tube			\$12
Digital screen			
Sun solar power panel			\$4.50
Battery			\$26.53
Charge Controller			\$7.01

7. Initial project milestone for both semesters.

Milestone Tasks

Task	Priority	Expected Completion	Milestone
Project Idea	High	01/11/24	SD1 (Spring)
Initial Project document	High	02/02/24	SD1 (Spring)
Professor meeting	High	02/07/24	SD1 (Spring)

Discovery Kit Form		02/09/24	SD1 (Spring)
All Quizzes	High	02/20/24	SD1 (Spring)
New assignment on standards		02/23/24	SD1 (Spring)
Creating a website			
60 pages draft	High	03/29/24	SD1 (Spring)
Final document (120 pages)	High	04/23/24	SD1 (Spring)
Build data specifications to the devices data management	High	5/1/2024	Semester 1
Team should decide on IoT devices and sensors			
Design Prototypes for IoT Device			
Design UX Prototype for Application			

Open Questions

Task	Priority	Date	Milestone
	High	5/1/2024	Semester 1

4. Name each input and each output associated with each block.

5. Diagram Legend. The legend should expand all acronyms and describe all named entities in the block diagram by giving brief definitions.

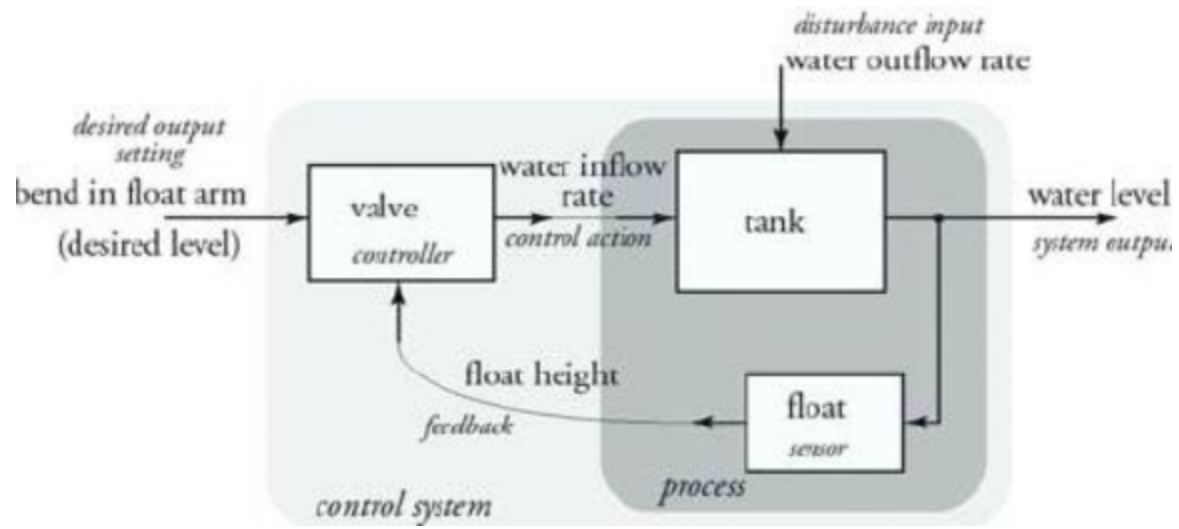
Include any additional information that would increase the understanding of the block diagram. The use of identifier grouping and color may be helpful. Example: All of member 1's blocks may be drawn with red rectangles, all of member 2's blocks may be drawn with blue rectangles, etc.

Project Identification Document - 5

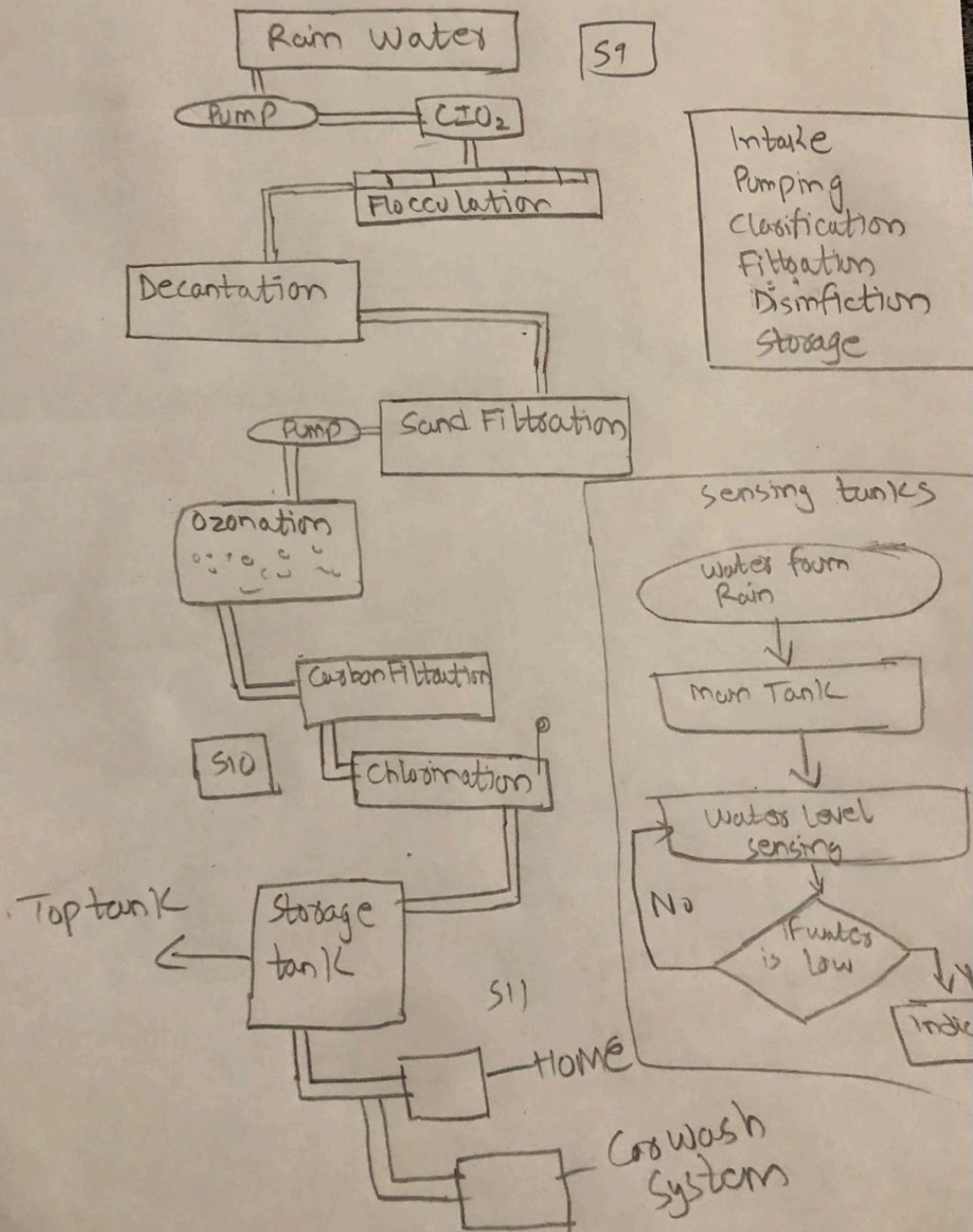
Decision Matrix:

- Projects Under Consideration:
 - Rainwater Harvesting for Car Wash Systems
 - Rainwater Harvesting for Bathrooms
 - Rainwater Harvesting for Kitchens
 - Rainwater Harvesting for Lawn Irrigation
- Parameters:
 - Cost
 - Sponsorship
 - Familiarity with Technology
 - Educational Goals
 - Motivation

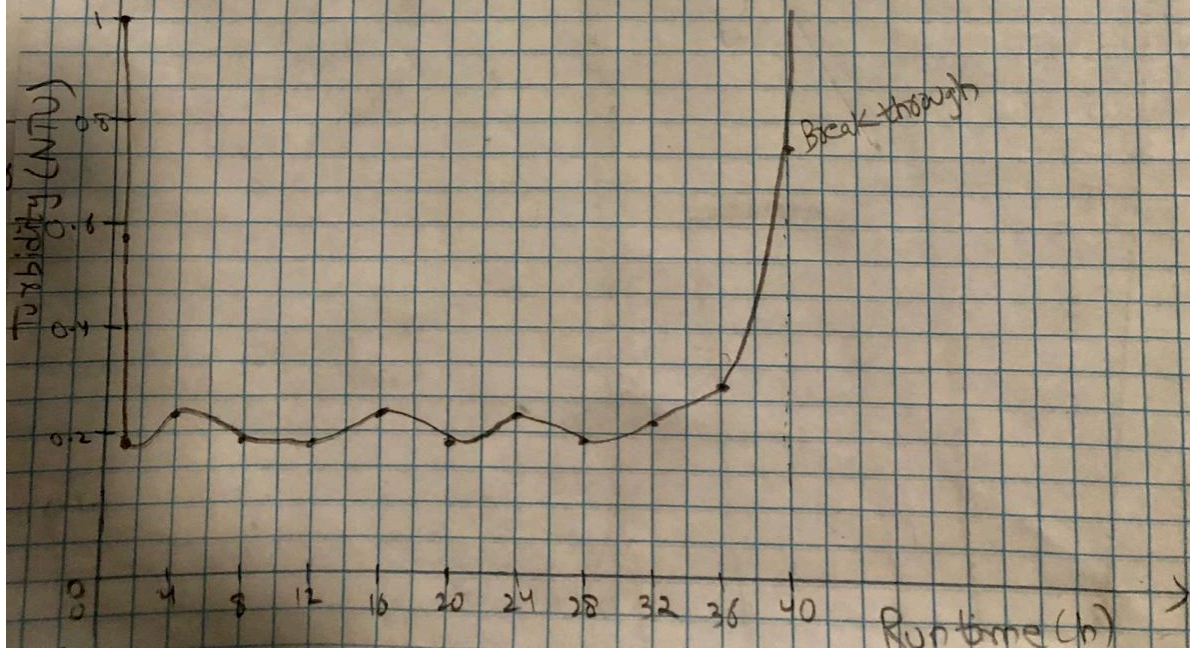
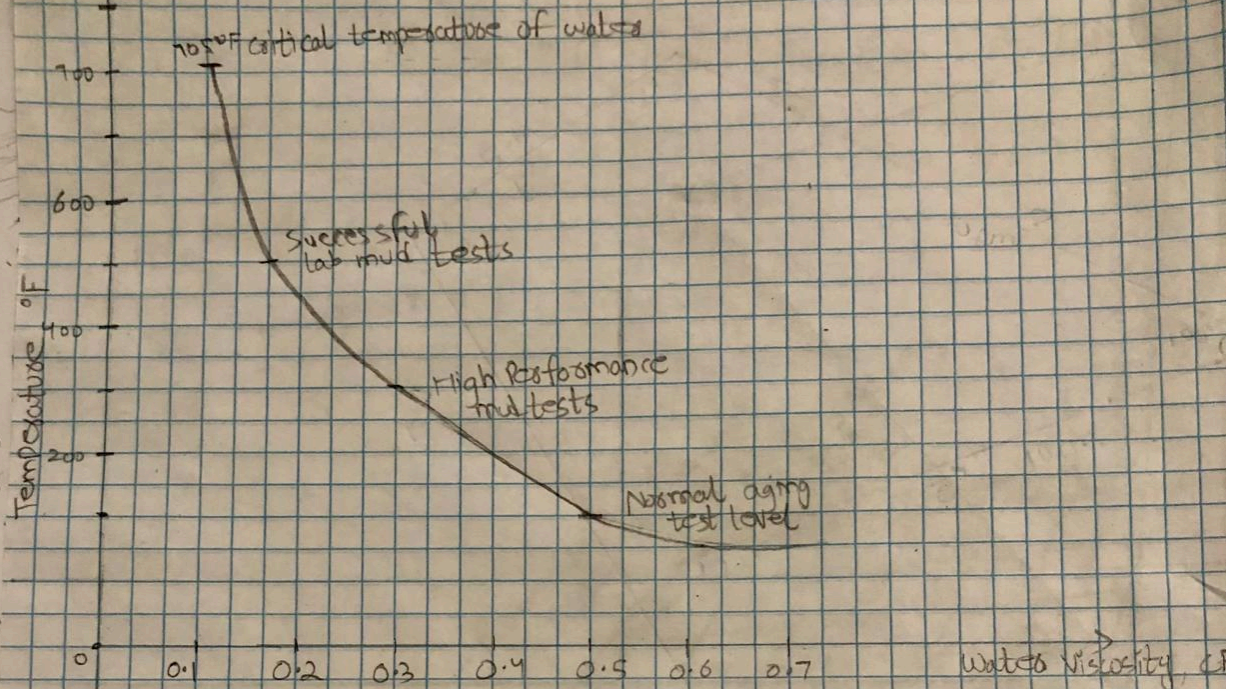
Block Diagram (Overview):



FILTRATION FLOW CHART



WATER FILTRATION



- Group Member: [Muhammad Siddiqui, Mina Samaan, Mohammad Bazrbachi, Evan Glazer]

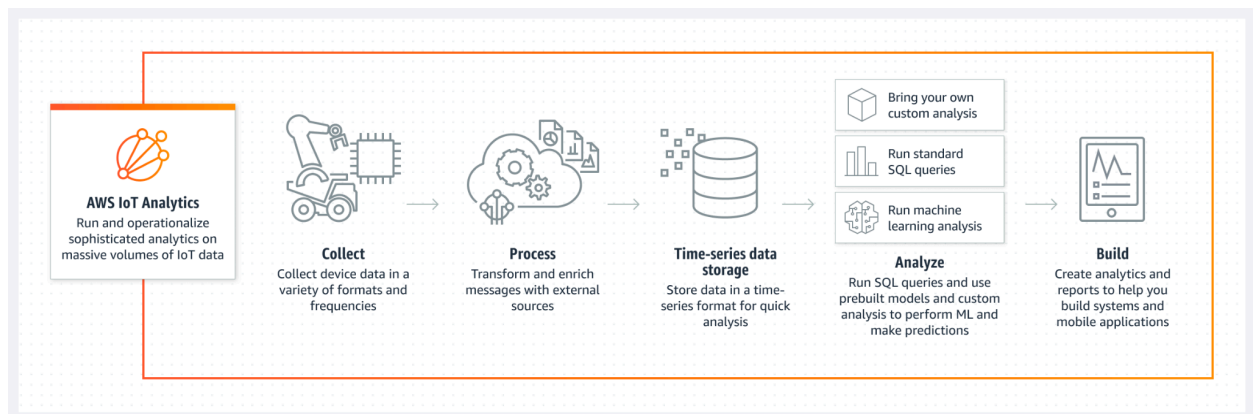
Project Software

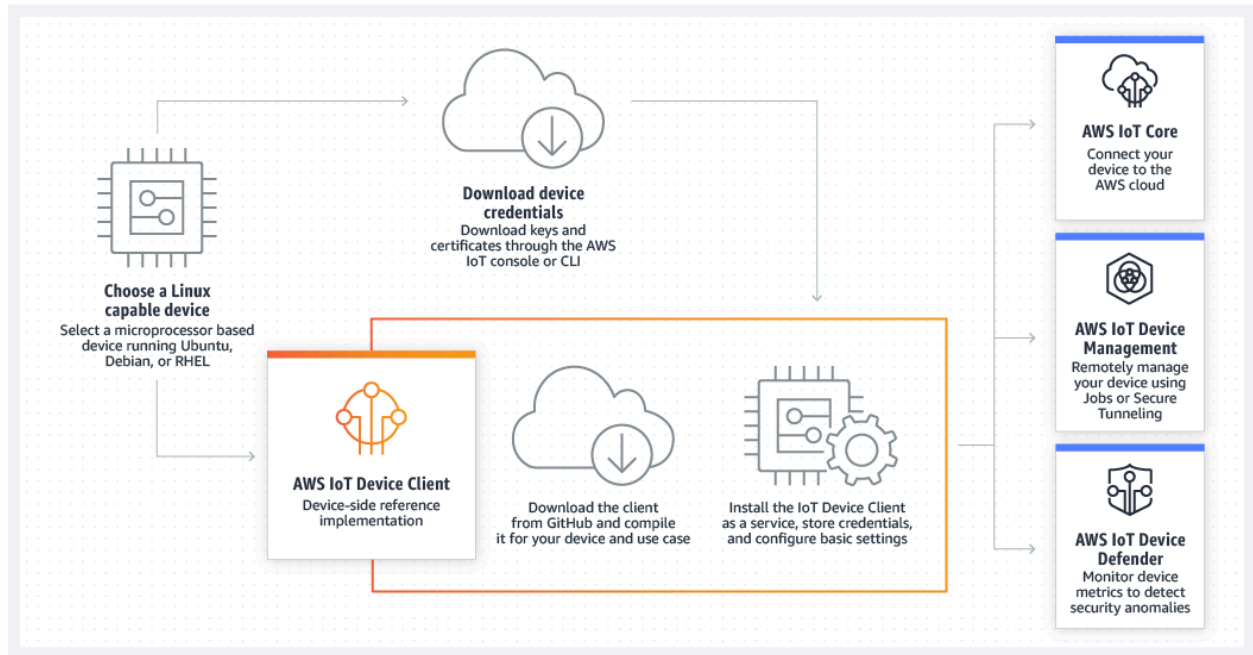
- Block Name: Rainwater Monitoring System
- Block Status: Design
- Inputs: Rainfall Data, Tank Levels
- Outputs: System Alerts, Water Consumption Reports

AWS IoT Device Client

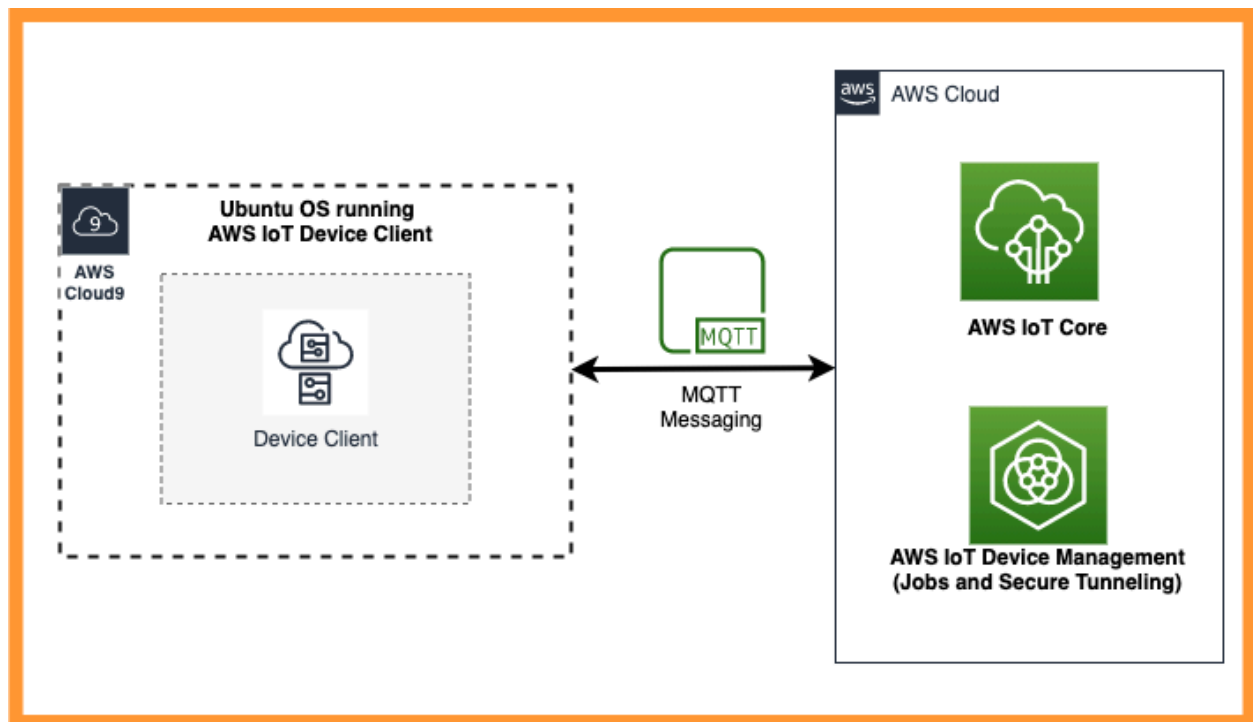
The AWS IoT Device Client is free, open-source, modular software written in C++ that you can compile and install on your Embedded Linux based IoT devices to access AWS IoT Core, AWS IoT Device Management, and AWS IoT Device Defender features by default. It serves as a reference implementation for your IoT devices to work with AWS IoT services, with operational best practices baked in – using it is the easiest way to create a proof-of-concept (PoC) for your IoT project. What's more, since it is open-source, you can modify it to fit your business needs, or optimize it when you wish to scale up from a PoC to production.

AWS IoT Architecture

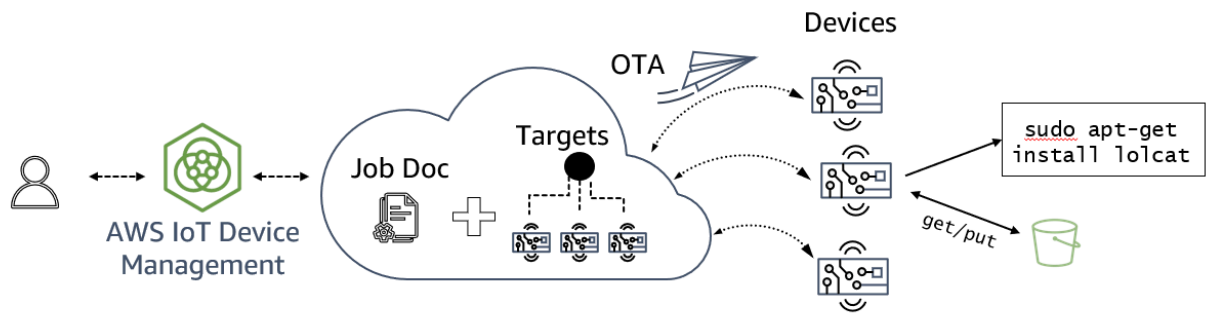




IoT Device Message Broker Architecture



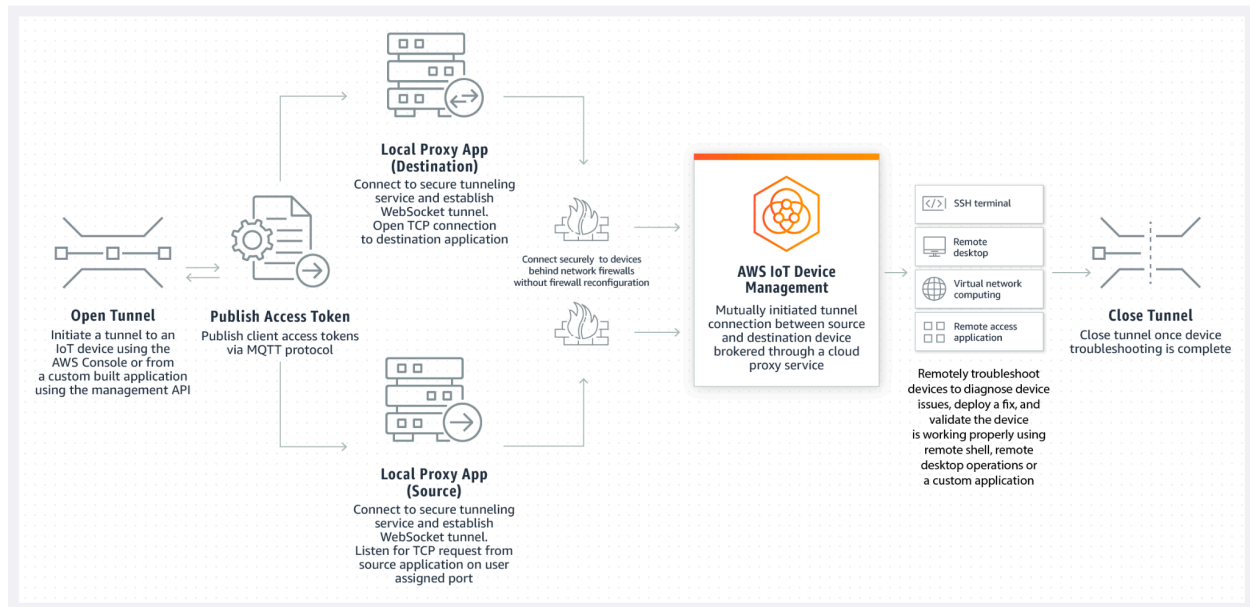
Over-The-Air (OTA) remote operation with AWS IoT Jobs



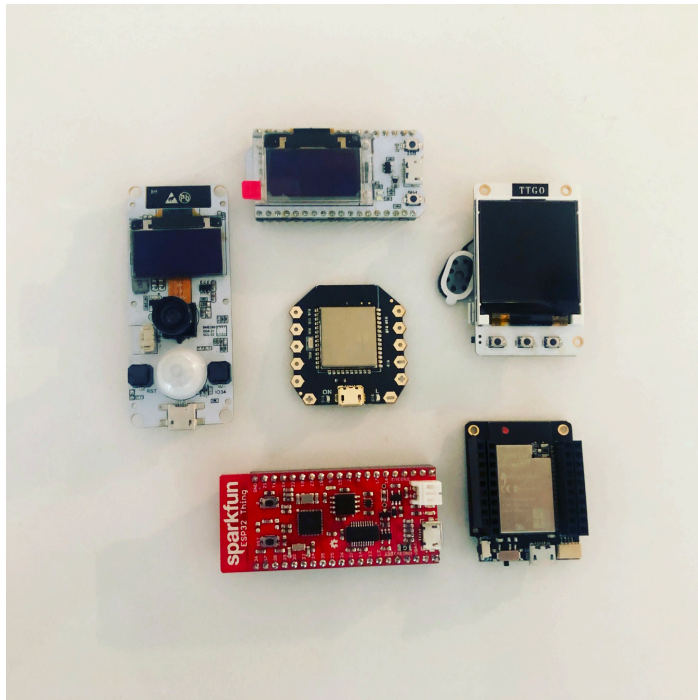
AWS IoT Device Defender



AWS IoT Secure Tunneling



A collection of various ESP32 development boards.



Cloud-side Metrics

Abnormal behavior on the AWS IoT network is detected by using cloud-side metrics such as the number of authorization failures, or the number or size of messages a device sends or receives through AWS IoT.

Device-side Metrics

Device-side metrics are metrics generated by device and sent to cloud),

Security Profile

A Security Profile defines anomalous behaviors for a group of devices (a thing group) or for all devices in your account, and enables you to specify what actions to take when an anomaly is detected.

Behavior

A behavior tells AWS IoT Device Defender Detect how to recognize when a device is doing something anomalous. Any device action that doesn't match a behavior triggers an alert.

Dimension

You can define a dimension to adjust the scope of monitoring to detect a behavior. For example, you can define a topic filter dimension that applies a behavior to MQTT topics that match a specific pattern.

Alarm

When an anomaly is detected, an alarm notification can be sent through a CloudWatch metric (see Using AWS IoT metrics) or an SNS notification. An alarm notification is also displayed in the AWS IoT console along with information about the alarm, and a history of alarms for the device.

Sensors

- 3 Water level sensors (Bottom empty, warning, full)
- Battery level
- Thermostat

Boards

- ESP32 IoT device.
- Arduino WiFi (Arduino MKR WiFi 1010)

Metrics

- Battery level
- Water level
- Temperature
- Water storage
- Calculates how much water is stored per year
- ROI

Filters

- Date time
- By Components

Event log

- Logs of send events from devices

Alerts

- Green - good
- Yellow - getting close
- Red - full

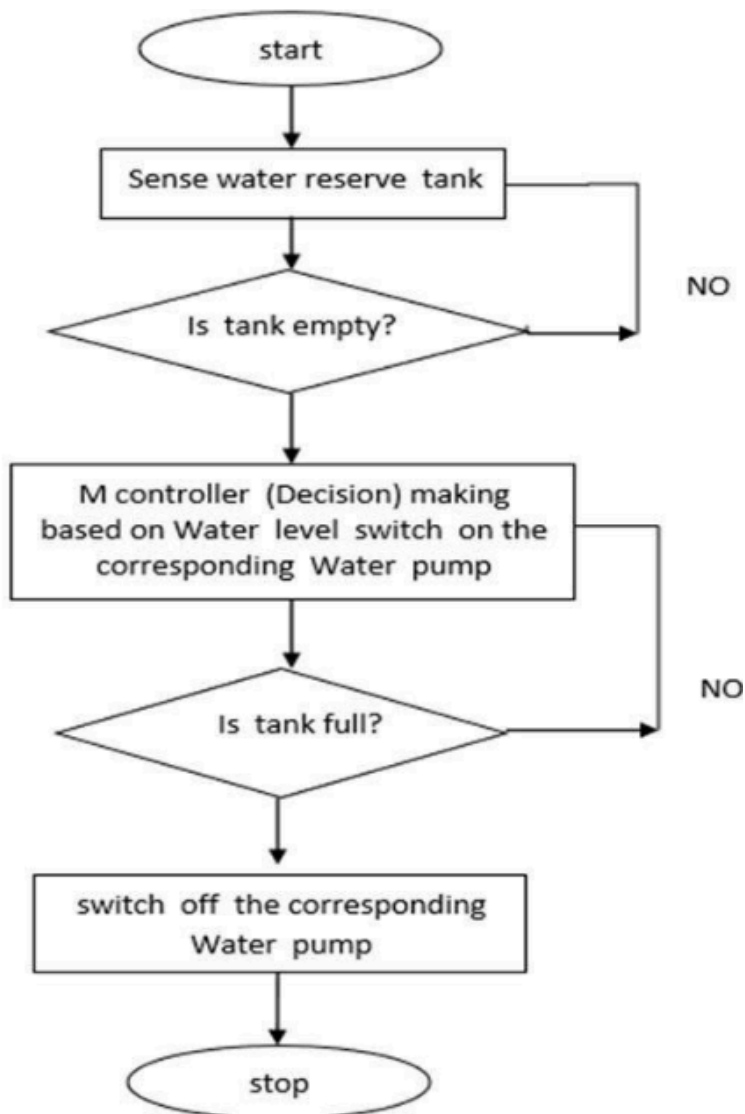
Project Hardware

- Block Name: Rainwater Collection System
 - Block Status: To be Acquired
 - Inputs: Rainwater
 - Outputs: Stored Rainwater
- Block Name: Water Distribution Unit
 - Block Status: Research
 - Inputs: Stored Rainwater
 - Outputs: Distributed Water to Applications

Diagram Legend:

- Acronyms:
 - RMS: Rainwater Monitoring System
 - RCS: Rainwater Collection System
 - WDU: Water Distribution Unit
- Named Entities:
 - Rainwater Monitoring System: Software responsible for monitoring and reporting rainwater data.
 - Rainwater Collection System: Hardware for collecting and storing rainwater.
 - Water Distribution Unit: System handling distribution of rainwater to various applications.

This is a simplified textual representation of the information you might include in a project identification document. You can expand on each block with more details and use visual aids when creating the actual document.



Problems - Criteria	Solutions	Neglecti on	Responsible	Required	Cost
Heavy Rain Water	Will be solve by Storage Method	More Water	Water Damage	Pipes and Clips	Not Very High
Tanks Maintenance	Buy the expensive tanks	Have more money	Tanks Cleanliness	Cements and Others	Moderate
Water Filtration	Take a good quality Filters	Have market experie	Filter Washing Liquid	Filtration Company	Above Average

		nce			
Water Moving Tanks	Motors should be from good companies	Motor Product ion cost	Motor Oil and Fuel	Water Sucking Motors	Expensive

**** Legend**

Products websites:

Water sensor:

<https://www.parallax.com/product/mini-liquid-level-sensor/> ⇒ \$4.99

Ultrasonic Sensor (HC-SR04) to get the values of the distance between the sensor and water surface:

https://www.amazon.com/Sensors-Ultrasonic-Distance-Measuring-Transducer/dp/B08D11S5ZJ/ref=asc_df_B08D11S5ZJ/?tag=hyprod-20&linkCode=df0&hvadid=680464708271&hvpos=&hvnetw=g&hvrand=2152862875881344160&hvpone=&hvptwo=&hvqmt=&hvdvcmdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9011805&hvtargid=pla-2247208156223&psc=1&mcid=3bf34edd0a5c3d3088bc709c255e18f1

Thermostat (NCIR hat)

<https://www.robotshop.com/products/m5stickc-infrared-temperature-sensor-ncir-hat-mlx90614>

Sun Solar power panel

<https://www.parallax.com/product/mini-liquid-level-sensor/> \$5.50 to \$99.00

https://www.aliexpress.us/item/3256802591317946.html?spm=a2g0o.productlist.main.1.51685b4b5MLfv3&algo_pvid=5d1c4f21-270e-4a27-8f96-5adace9d2f54&aem_p4p_detail=20240201090126146539554838880000330433&algo_exp_id=5d1c4f21-270e-4a27-8f96-5adace9d2f54-0&pdp_npi=4%40dis%21EUR%211.03%211.03%21%21%211.09%211.09%21%402101e63417068068867666783ece2d%2112000022139931388%21sea%21BE%210%21AB&curPageLogUid=L5H71FuyK8d0&utparam-url=scene%3Asearch%7Cquery_from%3A&search_p4p_id=20240201090126146539554838880000330433_1&gatewayAdapt=glo2usa ⇒ \$4.50 ali express

Bread Board

https://www.amazon.com/Breadboards-Solderless-Breadboard-Distribution-Connecting/dp/B07DL13RZH/ref=sr_1_1_sspa?crid=1NYDJUEDEY4HN&keywords=bread+board&

[qid=1706800218&srefix=bread+boar%2Caps%2C96&sr=8-1-spons&sp_csd=d2lkZ2V0TmFtZT1zcF9hdGY&psc=1](https://www.amazon.com/dp/B08JYPMCZY/ref=sr_1_4?crid=31M00G8657Y38&keywords=5v+power+supply+arduino&qid=1706800074&srefix=5v+power+supply+arduino%2Caps%2C95&sr=8-4)

Jumper Wires (F-F)

<https://www.sparkfun.com/products/12796>

5V Power Supply

https://www.amazon.com/ALAMSCN-Solderless-Breadboard-Battery-Arduino/dp/B08JYPMCZY/ref=sr_1_4?crid=31M00G8657Y38&keywords=5v+power+supply+arduino&qid=1706800074&srefix=5v+power+supply+arduino%2Caps%2C95&sr=8-4

https://www.amazon.com/SHNITPWR-100V-240V-Converter-Transformer-5-5x2-5mm/dp/B07S7Q9J8G/ref=sr_1_8?crid=31M00G8657Y38&keywords=5v%2Bpower%2Bsupply%2Barduino&qid=1706800074&srefix=5v%2Bpower%2Bsupply%2Barduino%2Caps%2C95&sr=8-8&th=1

Arduino ESP 32

<https://store.arduino.cc/collections/internet-of-things/products/nano-esp32-with-headers>
Raspberry Pi

https://www.amazon.com/GeeekPi-Raspberry-Starter-Active-Readers/dp/B0CQXJXG8F/ref=sr_1_4?crid=20YS90T6BCDAL&keywords=raspberry+pi+5+aws+iot&qid=1706800173&srefix=raspberry+pi+5+aws+iot%2Caps%2C99&sr=8-4

Infrastructure:

IoT Device Management

<https://aws.amazon.com/iot-device-management/>

EC2

<https://aws.amazon.com/pm/ec2>

Database (Options)

<https://aws.amazon.com/timestream/>

<https://www.snowflake.com/en/>

<https://aws.amazon.com/rds/postgresql/>

Frontend:

<https://react.dev/>

Backend:

<https://flask.palletsprojects.com/en/3.0.x/>

<https://www.arduino.cc/en/software>

Device Inspiration Tutorials:

<https://docs.arduino.cc/tutorials/mkr-wifi-1010/securely-connecting-an-arduino-mkr-wifi-1010-to-aws-iot-core/>

<https://www.youtube.com/watch?app=desktop&v=w1VjDBhL82k>

Charge controller:

https://www.aliexpress.us/item/3256805934923031.html?spm=a2g0o.productlist.main.7.21841e78xySeL0&algo_pvid=17824758-25fa-45ee-a9dd-c04377f1a781&aem_p4p_detail=202402010815268037166205137870000391014&algo_exp_id=17824758-25fa-45ee-a9dd-c04377f1a781-3&pdp_npi=4%40dis%21USD%2110.78%217.01%21%21%2177.13%2150.13%21%402101e5f117068041263934024ee08f%2112000035847416301%21sea%21US%210%21AB&curPageLogUid=YiTJkDVaE0T5&utparam-url=scene%3Asearch%7Cquery_from%3A&search_p4p_id=202402010815268037166205137870000391014_4 ⇒ \$7.01 ali express

Water tank:

https://www.amazon.com/gp/product/B0BX5QD5W3/ref=sw_img_1?smid=AY899Z1JN88IF&th=1 ⇒ \$29.9 amazon

https://www.aliexpress.us/item/3256805124164184.html?src=google&aff_fcid=cd8c64d46840493aaa64d3673c9e6264-1706805447496-08896-UneMJZVf&aff_fsk=UneMJZVf&aff_platform=aaf&sk=UneMJZVf&aff_trace_key=cd8c64d46840493aaa64d3673c9e6264-1706805447496-08896-UneMJZVf&terminal_id=df42e9dd920241b49262eba8957ff2d8&afSmartRedirect=y&gatewayAdapt=tur2usa4itemAdapt ⇒ \$8.51 ali express

Water filter:

https://www.aliexpress.us/item/1005003161532989.html?src=google&aff_fcid=345a13f4b8b142a19842df11733a1960-1706805950346-09512-UneMJZVf&aff_fsk=UneMJZVf&aff_platform=aaf&sk=UneMJZVf&aff_trace_key=345a13f4b8b142a19842df11733a1960-1706805950346-09512-UneMJZVf&terminal_id=df42e9dd920241b49262eba8957ff2d8&afSmartRedirect=y&gatewayAdapt=glo2usa ⇒ \$7.15 ali express

12V Battery:

https://www.aliexpress.us/item/3256806028775550.html?spm=a2g0o.productlist.main.37.144f681alqe3YO&algo_pvid=1a3b8692-10ae-49c9-a3b0-e080314eb725&aem_p4p_detail=2024020109073512736410180236800000322176&algo_exp_id=1a3b8692-10ae-49c9-a3b0-e080314eb725-18&pdp_npi=4%40dis%21USD%2145.74%2126.53%21%21%21327.15%21189.75%21%402101f01817068072556813845ede2c%2112000036315387208%21sea%21US%210%21AB&curPageLogUid=tTWOMevrni1K&utparam-url=scene%3Asearch%7Cquery_from%3A&search_p4p_id=2024020109073512736410180236800000322176_19 ⇒ \$26.53 ali express

Liquid sensor:

https://www.aliexpress.us/item/3256806165431886.html?spm=a2g0o.productlist.main.1.1e096a96nMwr1U&algo_pvid=d397c025-6477-491b-a40f-9edfbd7aa265&aem_p4p_detail=20240201171447390997648797100000723146&algo_exp_id=d397c025-6477-491b-a40f-9edfbd7aa265-0&pdp_npi=4%40dis%21USD%2129.78%2129.78%21%21%21213.00%21213.00%21%402101e56617068364878322695ed85c%2112000036860118077%21sea%21US%210%21AB&curPageLogUid=gJYX2pxtQCU3&utparam-url=scene%3Asearch%7Cquery_from%3A&search_p4p_id=20240201171447390997648797100000723146_1 ⇒ \$29.78 ali express

Water tube:

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