# EC 6020

# PROJECT PROPOSAL

# AUTOMATED WATER QUALITY TESTING SYSTEM

## GROUP NUMBER 20



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## CONTENT

## TITLE

Automated Water Quality Testing System

## INTRODUCTION

Due to the impact of Cyclone Ditwah, Sri Lanka had to face severe weather conditions from 23 November to 30 November 2025. Around 230,000 people were displaced from their homes and sought shelter in government-run safety centers. Major water treatment plants in Kandy, Gampaha, and Madampe were shut down due to flooding. Nearly all open dug wells in the flood zones (Gampaha and the Kelani River basin) were contaminated with sewage and flood runoff, making them totally unsafe. On December 1, 2025, the Public Health Inspectors' Union (PHIU) issued a strict advisory urging all residents in flood-affected areas to consume only boiled water. The public in critical areas was also instructed not to use well water for several weeks without inspection by the Sri Lanka Water Board.

However, most officers in the responsible departments were busy handling the emergency situation. The main problem with the current system is that water testing by government services is carried out manually by collecting samples and testing them under laboratory conditions. This process takes a considerable amount of time to obtain results.

In this project, a portable water quality testing system is developed that can be handled by a single user. It provides a more convenient and faster method for authorities responsible for monitoring and certifying public health in such situations.

The Water Quality Index (WQI) is one of the most widely used parameters for testing potable water. The index provides a score from 0 to 100 for a water sample, and these scores are classified from poor to excellent. WQI compares water parameters with WHO standards. The most commonly used parameters are temperature, biological oxygen demand, total suspended solids, dissolved oxygen, and conductivity. Some of these parameters must be calculated under laboratory conditions. In the proposed embedded system, temperature, conductivity, pH, and turbidity are used. Suitable values are derived from the measured data. Furthermore, the project uses its own parameters for index calculation. Therefore, it is possible to develop a low-cost portable embedded system to measure household water potability.

## DESIGN OVERVIEW

### 1. SYSTEM ARCHITECTURE

The core of the system was the ATmega328P microcontroller, which functioned as the central processing unit for all sensing, control, and communication tasks. A crystal oscillator was connected to the microcontroller in accordance with the manufacturer's datasheet to provide a stable and accurate system clock.

Four sensing modules were interfaced with the system to measure water temperature, turbidity, pH, and electrical conductivity. The temperature sensor provided a digital output, while the turbidity, pH, and conductivity sensors generated analog signals proportional to the measured parameters. The internal ADC peripheral of the ATmega328P was used to convert these analog signals into digital values for processing. Communication with external modules was supported using the UART interface.

Two external interrupts were configured using GPIO pins to manage system operation. One interrupt was used to initiate the measurement process, while the other prepared the system for the next measurement cycle. In addition, a system reset function was implemented as a separate input to allow manual reinitialization of the microcontroller when required.

A 128×64 graphical display was used to present the measured water quality parameters to the user. Due to the limited number of available communication lines on the microcontroller, the I²C protocol was employed to establish a master–slave communication architecture between the ATmega328P and the display controller.

The entire system was powered using a 12 V battery as the primary power source. A 7805 linear voltage regulator was used to step down the voltage to 5 V, which was required for the operation of the microcontroller and associated peripherals.

In summary, the system was designed with the ATmega328P microcontroller and an external crystal oscillator as the central unit. It acquired inputs from four water quality sensors, utilized two interrupt-driven user controls, and displayed processed results on a graphical display via I²C communication. All components were powered from a 12 V battery supply regulated to 5 V using a simple step-down regulator.

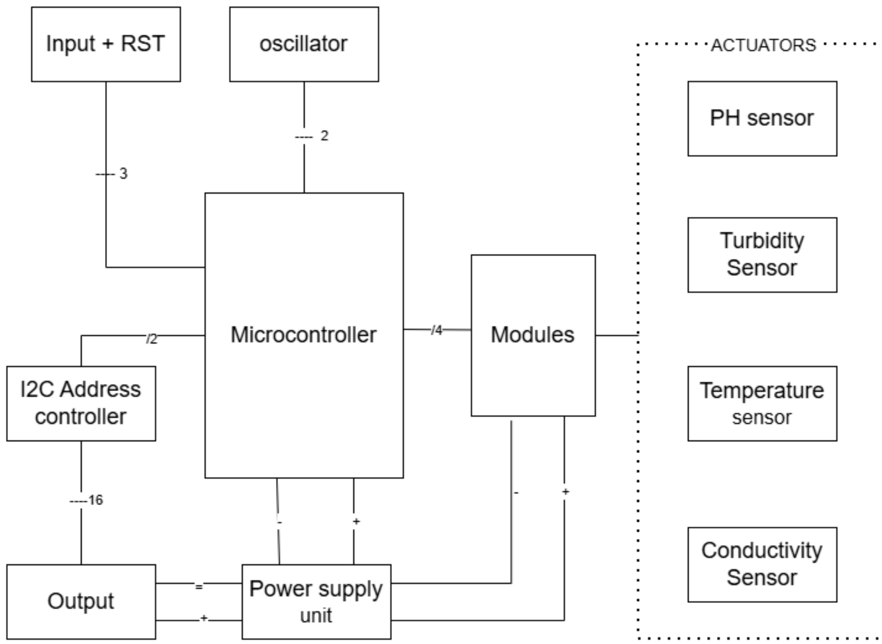


Figure 1 : High Level system architecture diagram

## 2. PROTOCOLS AND LIBRARIES

Table 1 : Intended protocols to be used

| Protocol | Use Case | Justification |
|---|---|---|
| I2C | Display | Simplify complex wiring with multiplexer. Library support for programming. |
| GPIO | Input switches | Easy control using microcontroller pins |
| UART | Sensor to Microcontroller | Module compatibility |

3. **CIRCUIT DESIGN**

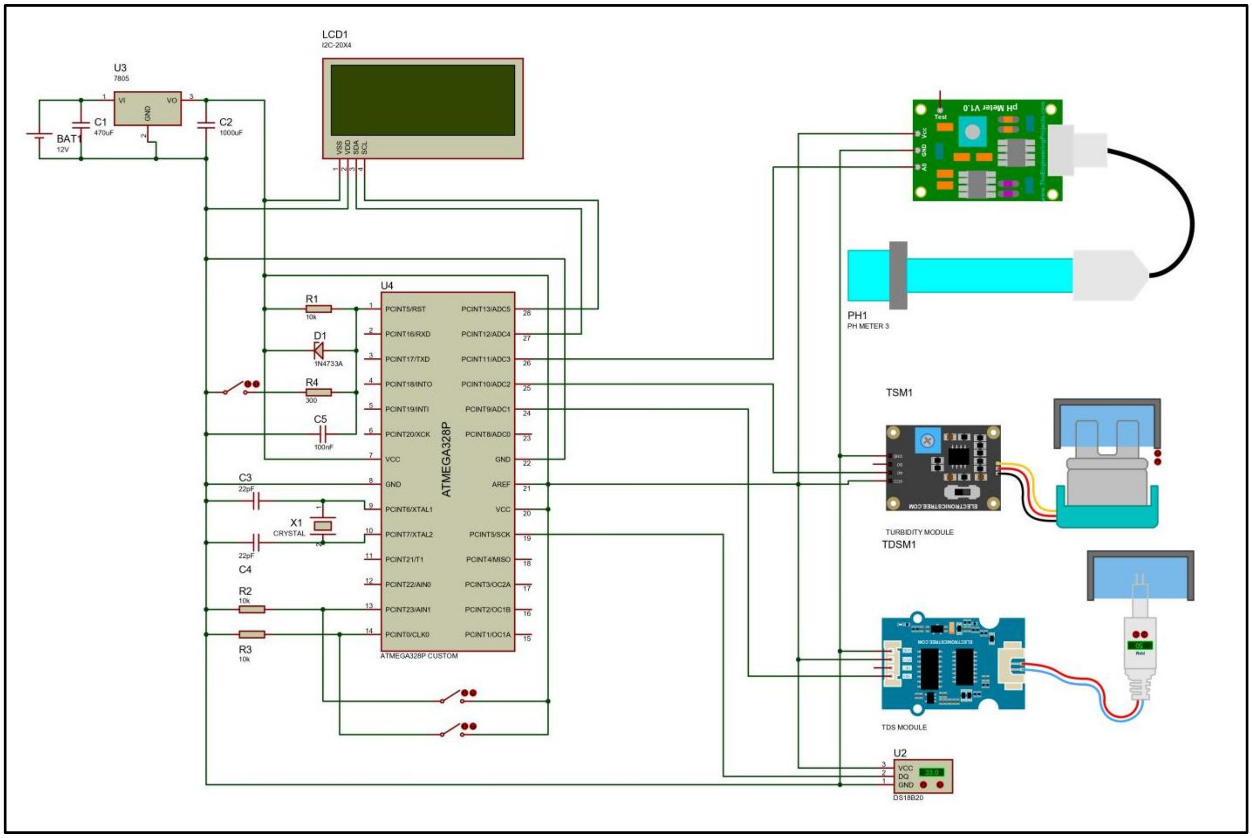


Figure 2 : Preliminary Circuit Diagram

## TECHNOLOGIES

### 1. METHODS

Water quality index is used :

$$WQI = \frac{\sum QnWn}{\sum Wn}$$

Where: Qn = Quality Rating; Wn = Unit Weight

The quality rating was determined using the formular:

$$Qn = \frac{100(Vn - Vio)}{(Sn - Vio)}$$

Vn – Estimated value for nth water quality parameters of collected samples

Sn – Standard permissible value of the nth water quality parameters

Table 2 : WQI classes

| WQI | General criteria |
|---|---|
| 85 - 100 | Uncontaminated |
| 70 - 84 | Acceptable |
| 50 - 69 | Little contaminated |
| 30 - 49 | Contaminated |
| 0 - 29 | Highly contaminated |

### 2. SOFTWARE TECHNOLOGIES

- Programming Language: C
- IDE/Compiler: Atmel Studio or AVR-GCC,AVRDUDE
- Frameworks/Libraries for Sensors in C:
    - DS18B20: OneWire library for C
    - I2C Display: Wire library (for I2C communication)
    - ADC Sensors (Turbidity, pH, Conductivity): Use AVR ADC module libraries

## 3. HARDWARE COMPONENTS

Table 3 : Components and quantity

| Component | Quantity |
|---|---|
| ATmega328P Microcontroller | 1 |
| Temperature Sensor (DS18B20) | 1 |
| Turbidity Sensor | 1 |
| Conductivity Sensor | 1 |
| pH Sensor | 1 |
| LED Display (I2C) | 1 |
| Push Buttons | 2 |
| 12V Battery | 1 |
| LM7805 Voltage Regulator | 1 |
| Crystal Oscillator (16 MHz) | 1 |
| Capacitors 22pF | 2 |
| Decoupling Capacitors 100nF | 2–3 |
| Resistors 10kΩ | 3 |
| Miscellaneous (wires, PCB) | - |

## UNIQUENESS OF THE PROJECT

1. Portable, Single-User Operation and Real-Time Water Quality Index (WQI) Calculation : Sample testing in the laboratories is sped up by the portable design.

2. Inexpensive design with sufficient accuracy compared to devices available in the market.

Table 4 : Comparison table

| Criteria | Current Methods(Through water board)/Technology | Project Design |
|---|---|---|
| Cost | Expensive devices in the market | Relatively low |
| Portability | Need Laboratory Conditions | Portable |
| Time for Results | Takes Longer Time | Real Time |

## BUDGET

Table 5 : Intended Budget for the system

| Component | Quantity | Price (Rs.) |
|---|---|---|
| Development Board | 1 | 350.00 |
| ATmega328P Microcontroller | 1 | 1050.00 |
| Temperature Sensor(DS18B20) | 1 | 900.00 |
| Turbidity Sensor | 1 | 2410.00 |
| Conductivity Sensor | 1 | 2650.00 |
| pH Sensor | 1 | 4500.00 |
| LED Display (I2C) | 1 | 650.00 |
| Push Buttons | 2 | 300.00 |
| 12V Battery | 1 | 1800.00 |
| LM7805 Voltage Regulator | 1 | 50.00 |
| Crystal Oscillator (16 MHz) | 1 | 20.00 |
| Capacitors 22pF,100nF,470uF,1000uF | 2 | 120.00 |
| Decoupling Capacitors 100nF | 3 | 360.00 |
| Resistors (10k,330) | 4 | 16.00 |
| Miscellaneous (wires, PCB) | - | 500.00 |
| **TOTAL** | | 15676.00 |

**TIMELINE**

Table 6 : Timeline of the project

| **Work** | W 1 | W 2 | W 3 | W 4 | W 5 | W 6 | W 7 | W 9 | W 10 | W 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| Component collecting | | | | | | | | | | |
| Testing the components with programming tools. | | | | | | | | | | |
| Simulation for Temp and conductivity | | | | | | | | | | |
| Calibrating and programming Temp and conductivity to get input. | | | | | | | | | | |
| Programming for ion concentration detection by values | | | | | | | | | | |
| Simulation and for Turbidity and pH separately | | | | | | | | | | |
| Calibration and Programming Turbidity and pH sensors separately | | | | | | | | | | |
| Combine two simulations and testing | | | | | | | | | | |
| Connecting all sensors to the system with the Input switches | | | | | | | | | | |
| Simulation and Progress prototype for mid exam. | | | | | | | | | | |
| WQI calculation added to the program | | | | | | | | | | |
| I2C Display simulating and testing separately | | | | | | | | | | |
| I2C Display connect to mcu and programming | | | | | | | | | | |
| Connect the Display to the project system | | | | | | | | | | |
| Testing the system and Debugging | | | | | | | | | | |
| Enhance the functionality with expert opinions. Testing modifications | | | | | | | | | | |
| Compacting the System With Development kit or PCB Design | | | | | | | | | | |
| Finalized product demonstration | | | | | | | | | | |