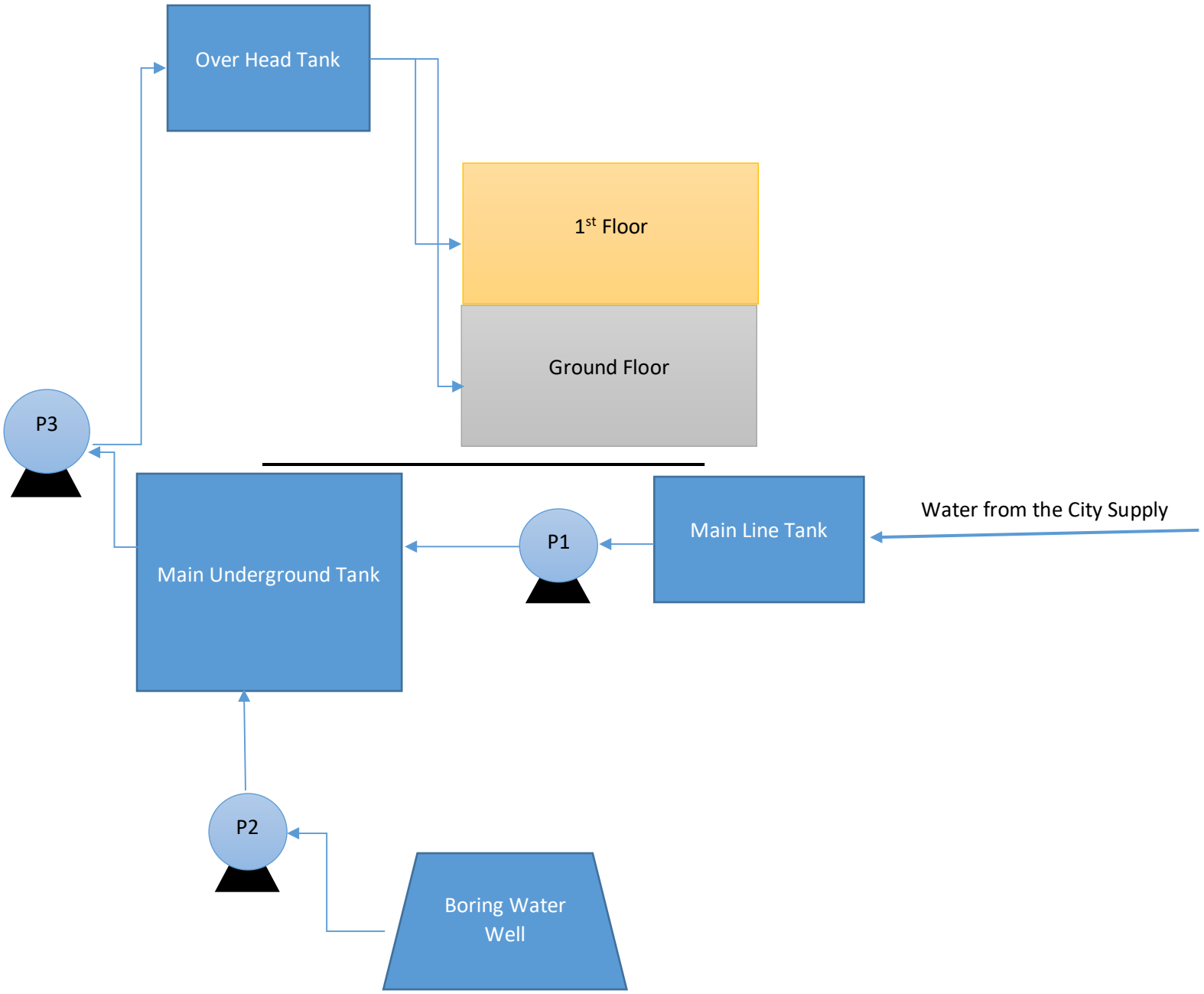
Over Head Tank
1st Floor
Ground Floor
P3
Main Underground Tank
P1
Main Line Tank
Water from the City Supply
P2
Boring Water Well

Water Pump Automation System Design

System Overview

The diagram provided illustrates the water system of a two-story house, consisting of a ground floor and a first floor. The house primarily relies on water supplied by the city's main line, which is available between 10:00 AM and 3:00 PM daily. The water flow rate from the city supply is variable but sufficient to meet the household's daily needs. The water is first stored in the **Main Line Tank** and then pumped to the **Main Underground Tank** using **Pump P1**.

Additionally, the house has a backup system—a **boring water well**—that extracts underground water and fills the **Main Underground Tank** using **Pump P2**. This backup system operates only when the primary city water supply is unavailable.

Pump P3 is responsible for transferring water from the **Main Underground Tank** to the **Overhead Tank**, which then supplies water to both floors of the house.

The electrical system for operating these pumps is designed with a **selector switch** that allows the load to be transferred between the ground floor's electricity meter and the first floor's meter based on the following schedule:

- **1st to 15th of each month**: Ground floor meter.
- **16th to the end of each month**: First floor meter.

This schedule ensures that electricity costs are evenly distributed between the two occupants.

Furthermore, the system is designed to avoid operating the pumps during **peak hours** (6:30 PM to 10:30 PM), when electricity rates are 1.5 times higher.

Problem Statement

Your task is to **automate the operation of the water pumps** based on the following requirements:

1. **Pump P1 Operation**:
    - Pump P1 will operate only if:
        - The water level in the **Main Line Tank** is **above 15%**.
        - The water level in the **Main Underground Tank** falls **below 10%**.
    - If the water level in the **Main Line Tank** drops **below 15%**, Pump P1 should automatically shut off.
    - A **manual bypass** option should be available to override the automatic shutoff if the **Main Underground Tank** level falls below 5%. However, the bypass will not work if the **Main Line Tank** level is below 5% to prevent cavitation.
2. **Pump P2 Operation**:

- Pump P2 will operate automatically only if:
  - The water level in the **Main Line Tank** is **below 5%**.
  - The water levels in both the **Main Underground Tank** and the **Overhead Tank** are **below 5%**.
- Pump P2 will fill the **Main Underground Tank** to at least **30% capacity** before shutting down automatically.
- A **manual bypass** option should also be available for Pump P2, allowing the user to operate it manually if needed.

3. **Pump P3 Operation**:

- Pump P3 will operate when:
  - The water level in the **Overhead Tank** falls **below 10%**.
  - The water level in the **Main Underground Tank** is **at least 10%**.
- If the **Main Underground Tank** level is **below 10%**, Pump P3 will first signal Pump P1 to fill the **Main Underground Tank** to at least **30%** before resuming operation.
- Pump P3 will also operate with warnings if:
  - The **Overhead Tank** level is **below 5%**.
  - The **Main Underground Tank** level is **between 5% and 10%**.
- If the **Main Underground Tank** level falls **below 5%**, Pump P3 will stop and signal either Pump P1 or Pump P2 to fill the **Main Underground Tank** to at least **30%** before resuming operation.

Additional Requirements

1. **Pressure Sensors**:

- All pumps must be equipped with **pressure sensors** at their inlets and outlets. If the sensors detect zero pressure, the pump should shut down as a safety measure, and the user should be notified of the error.

2. **Logging System**:

- Every pump operation must be logged with the following details:
  - Which pump was operated.
  - Start and end times (with date).
  - Reason for starting the pump (e.g., water level at 4% in the Overhead Tank).
  - Condition at the time of shutdown.
  - Error conditions (e.g., unexpected shutdown due to zero pressure).
  - Any other important log messages.

3. **Electricity Meter Selection**:

- The system must automatically select the appropriate electricity meter (ground floor or first floor) based on the day of the month.

4. **Avoiding Peak Hours**:
    - The system must ensure that no pumps operate during peak hours (6:30 PM to 10:30 PM) to avoid higher electricity costs.
5. **Routine Schedule**:
    - The system should have a **routine schedule** for pump operations, which can be set and adjusted as needed.

Design Details

You are required to design and implement this system using **Python**. The system should incorporate the following:

- **Object-Oriented Programming (OOP) principles**.
- **Modular programming** with well-defined functions.
- **Type hints** for better code readability and maintainability.
- A **database** to store and manage operation logs.
- A **Graphical User Interface (GUI)** to allow users to interact with the system, set schedules, and monitor pump operations.

Objective

The primary objective of this system is to **automate and streamline** the water pump operations while ensuring that:

- The pumps operate efficiently and without issues.
- The system avoids running during peak hours to minimize electricity costs.
- The household's water supply remains uninterrupted at all times.