# METHODOLOGICAL FRAMEWORK FOR CONVERSION OF INTERMITTENT WATER SUPPLY SYSTEM TO CONTINUOUS (24×7) SUPPLY USING HYDRAULIC MODELING

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**Abstract -** *Intermittent water supply systems are commonly used in developing regions, but they suffer from major operational challenges such as pressure fluctuations, uneven water distribution, and higher risks of contamination. This study develops a systematic methodology for converting an existing intermittent water supply network into a continuous (24×7) system using hydraulic modeling. A distribution network with a total pipeline length of 26 km and 533 junctions was analyzed using Water GEMS. The proposed methodology includes modifying demand patterns, optimizing pump operation, and balancing storage through Extended Period Simulation (EPS). Results indicate that a continuous supply can be achieved primarily through operational improvements, without requiring major infrastructure upgrades.*

***Key Words***: **Continuous Water Supply, Intermittent Supply, Hydraulic Modelling, Water GEMS, Pump Control, EPS**

## 1. INTRODUCTION

Water supply systems in many urban areas continue to operate under intermittent conditions due to historical infrastructure limitations and constraints related to available resources. Although such systems are able to meet basic water demand, they experience several technical shortcomings, including wide pressure variations, unreliable delivery during peak periods, and overall operational inefficiencies. Continuous water supply offers a more efficient and reliable alternative by maintaining steady pressure and promoting equitable distribution across the network. However, converting an intermittent system into a continuous one requires careful planning and hydraulic assessment to avoid system imbalance or unintended pressure impacts. This study focuses on developing a structured and practical methodology for transitioning from intermittent supply to continuous (24×7) operation using simulation-based hydraulic modeling. The proposed approach aims to improve system performance while minimizing major physical infrastructure modifications.

## 2. NEED FOR THE STUDY

Many urban areas still rely on intermittent water supply because of old infrastructure and limited resources. Although this system provides water for basic needs, it causes several issues such as pressure drops, uneven distribution, and operational inefficiencies. Continuous water supply (24×7) offers better pressure stability, improved reliability, and safer water quality.

However, shifting an existing intermittent system to continuous supply requires proper planning, hydraulic analysis, and performance checks to avoid over pressure, shortages, or network imbalance. A structured and model-based approach is therefore needed to guide utilities in evaluating their current system and designing the required operational improvements. This study focuses on developing such a methodology using hydraulic modeling to support a smooth and efficient transition from intermittent to continuous water supply.

## 3. Methodology

This study follows a structured, simulation-based approach for developing a workable methodology to convert an Intermittent Water Supply (IWS) system into a Continuous Water Supply (CWS) system. The methodology combines field data, hydraulic modeling, demand adjustments, and operational optimization. To make the process easier to understand, important screenshots and charts generated from Water GEMS are included throughout this chapter.

### 3.1. Network Data Collection and Assessment

The first step involves collecting all available information on the existing distribution system:

- Pipe diameters, lengths, and materials
- Junction elevations and consumer demand
- Pump characteristics and current operating schedule
- ESR geometry and storage levels
- Present 8-hour supply pattern used in the IWS system

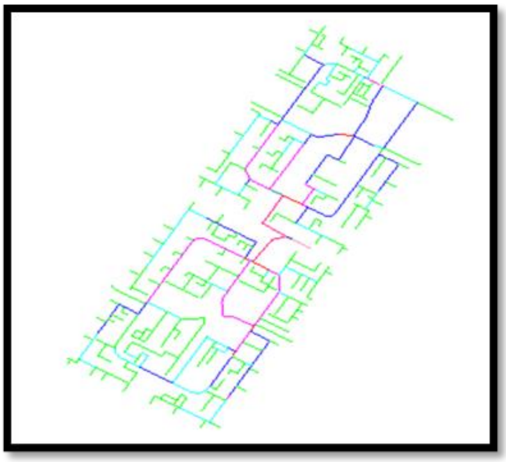


**Figure 1** Water GEMS network layout showing pipes, nodes, ESR, and pump.

### 3.2. Development of the IWS Hydraulic Model

Once the data is compiled, the existing IWS system is modelled in Bentley Water GEMS.
Key configurations:

- Intermittent 8-hour supply is represented using a **Three-peak demand multiplier pattern**.
- During off-hours, demand drops near zero to simulate no supply.
- Pump operations are aligned with the supply windows.
- A 24-hour Extended Period Simulation (EPS) is executed.

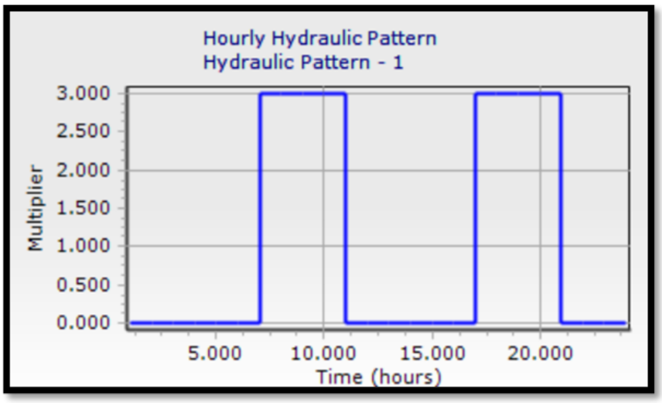



**Figure 2** IWS 8 hrs supply pattern

### 3.3. Development of the IWS Hydraulic Model

To simulate continuous (24×7) supply, a second scenario was created using the same network. In this scenario, the intermittent 8-hour demand pattern was replaced with a 24-hour diurnal demand curve, representing typical daily water consumption behavior in Indian urban areas. This includes a morning peak (07:00–09:00), a moderate mid-day period, an evening peak (18:00–20:00), and low night-time demand.

It is important to note that CPHEEO does not prescribe any standard 24-hour demand pattern. Therefore, the diurnal curve used in this study follows general practice commonly adopted in hydraulic modeling, based on typical household usage trends rather than regulatory guidelines.

Since the network distributes water through an Elevated Service Reservoir (ESR), basic ESR-based pump controls were applied to maintain stable operation under continuous supply. These controls ensure that the reservoir neither overflows nor empties during the 24-hour cycle. For modeling purposes:

- The Pump ON level was set when the ESR water level drops to approximately 95.5 m,
- The Pump OFF level was set when the ESR level reaches approximately 99.5 m.

These ON/OFF levels maintain the storage between realistic working limits and allow the CWS system to operate smoothly without short-cycling. When combined with the 24-hour demand pattern, this setup helps evaluate whether the existing infrastructure can support continuous flow using mostly operational adjustments rather than major upgrades.

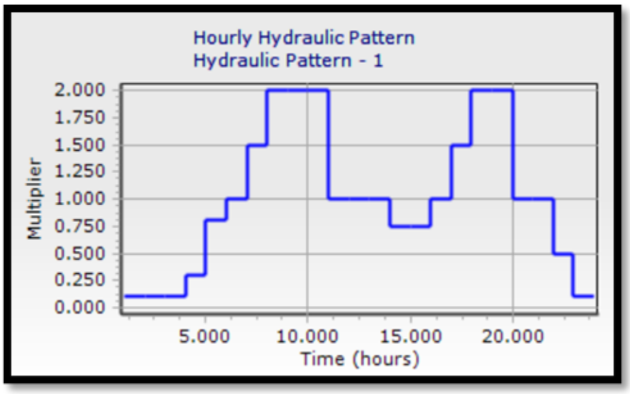



**Figure 3 Diurnal demand pattern for 24×7 operation (general practice — not as per CPHEEO).**

### 3.4. Extended Period Simulation (EPS) Setup

To compare the performance of the system under both intermittent (IWS) and continuous (CWS) supply, a 24-hour Extended Period Simulation (EPS) was carried out for each scenario using the same modelling settings. Keeping the simulation conditions identical ensures that any differences in results come only from the change in supply pattern, not from model configuration.

**In both scenarios, the EPS was run with:**

- Simulation Duration: 24 hours
- Hydraulic Time Step: 1 Hour
- Reporting Time Step: 1 Hour
- Demand Application:
- IWS uses on/off supply pattern
- CWS uses a smooth diurnal pattern (general practice)
- Solver Settings: Same numerical tolerances and convergence criteria, ensuring fair comparison

These settings allow the model to capture time varying changes in pressure, flow, and tank levels throughout the day, which are essential for assessing whether the system can maintain stability during continuous operation.

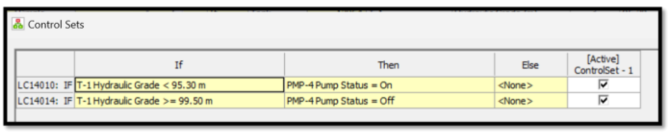
### 3.5. ESR Operation and Pump Control Logic

To maintain stable water levels under continuous supply, the Elevated Service Reservoir (ESR) must operate within a defined working range. In the hydraulic model, ESR behaviour is controlled using level-based pump ON/OFF conditions. These controls ensure that the reservoir neither runs empty nor overflows during 24-hour operation.

Since CPHEEO does not define any mandatory ESR control settings for continuous supply, the following operational limits were adopted based on common engineering practice and system safety:

- **Pump ON level:** The pump starts when the ESR water level (hydraulic grade) drops to approximately **95.5 m.**
- **Pump OFF level:** The pump stops when the ESR water level reaches approximately **99.5 m.**

These limits provide sufficient storage buffer, allow smooth refill cycles, and prevent short-cycling of the pump. The control logic ensures that the ESR supports the system during demand peaks and refills during low-demand hours, which is essential for achieving stable 24×7 supply.


Control Sets

| | If | Then | Else | [Active] ControlSet - 1 |
| --- | --- | --- | --- | --- |
| LC14010: IF | T-1 Hydraulic Grade < 95.30 m | PMP-4 Pump Status = On | <None> | ☑ |
| LC14014: IF | T-1 Hydraulic Grade >= 99.50 m | PMP-4 Pump Status = Off | <None> | ☑ |

**Figure 4** Pump control setup showing ON/OFF triggers linked to ESR levels.

### 3.6. Verification of Network Components for Continuous Operation

The following checks must be performed:

✔ **Pipe Velocities -** Ensure velocities stay within recommended range (0.3–2.0 m/s).

✔ **Pressure Availability -** Check if continuous supply reduces low-pressure areas.

✔ **ESR Cycling -**Verify the ESR level cycles smoothly under the new pump controls.

This step ensures the model is stable and operational in CWS mode.

## 4. CONCLUSION

This study presents a clear and practical methodology for converting an existing Intermittent Water Supply (IWS) model into a Continuous Water Supply (CWS) model using Water GEMS. The framework focuses on the operational and modelling changes required to support 24×7 supply rather than on major infrastructure expansion.
The methodology efficiently demonstrates that the transition to continuous supply primarily requires modifications such as:

- Replacement of the intermittent ON/OFF demand pattern with a continuous 24-hour diurnal curve
- Introduction of ESR based automatic pump controls
- Correction of base demands for realistic 24 hour distribution
- Continuous availability of hydraulic sources
- Verification of hydraulic stability through Extended Period Simulation

By applying these structured adjustments, the Water GEMS model can successfully represent continuous flow behaviour, stable pressures, and balanced storage operation. The approach serves as a practical guide for engineers and utilities planning to shift from intermittent to continuous supply using simulation-based analysis. The methodology ensures that system performance is evaluated and optimized while minimizing the need for costly physical upgrades.

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