



**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI  
SHORT ABSTRACT OF THESIS**

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Thesis Title: A study on optimal sensor placement strategies for water quality monitoring in water distribution networks

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## SHORT ABSTRACT

Ensuring universal access to clean water and sanitation, a key objective of the United Nations Sustainable Development Goal 6, necessitates effective water treatment and distribution. However, the degradation of water quality in common sources like rivers and groundwater has heightened the demand for water treatment, underscoring the significance of water distribution networks (WDNs) in delivering safe water to consumers. This thesis addresses the critical task of optimal sensor placement in WDNs for water quality monitoring, considering challenges such as contamination events, network vulnerabilities and data transmission modes.

The first chapter focuses on the placement of wired water quality sensors, employing multi-objective optimization (MOO) to balance the competing objectives of contamination event detection and detection time. A novel method is proposed to reduce the decision variable search space by clustering followed by greedy selection of nodes based on intrusion events detected. The efficacy of the proposed method is validated against the traditional method that utilizes the complete search space to identify sensor placement solutions.

In regions with limited flow data availability, wireless sensor networks (WSNs) offer a flexible monitoring solution. The second chapter presents efficient algorithms for WSN placement, considering objectives of network coverage and sensor detection redundancy. The study assumes that the sensor data is transmitted to the cloud or server by 'multi-hopping – single base station architecture'. Incorporating initial solutions from greedy algorithms improves the performance of the MOO algorithm, leading to superior sensor placement solutions.

Deploying multi-base station architecture becomes essential when sensors with constrained transmission ranges are placed over large water distribution networks (WDNs). The third chapter introduces a mixed integer linear programming (MILP) formulation to optimize sensor placement for maximizing network coverage and sensor detection redundancy for multi-base station architecture. Further, bounds are incorporated in the MILP model to improve the computational efficiency. Finally, the developed model is extended to address specific scenarios where real-time sensor placement solutions are imperative.

Overall, this thesis contributes novel strategies for optimal sensor placement in WDNs, addressing the complex interplay of water quality monitoring objectives and network constraints. The proposed methodologies demonstrate effectiveness across diverse WDN scenarios, offering valuable insights for enhancing water quality monitoring and safeguarding public health.