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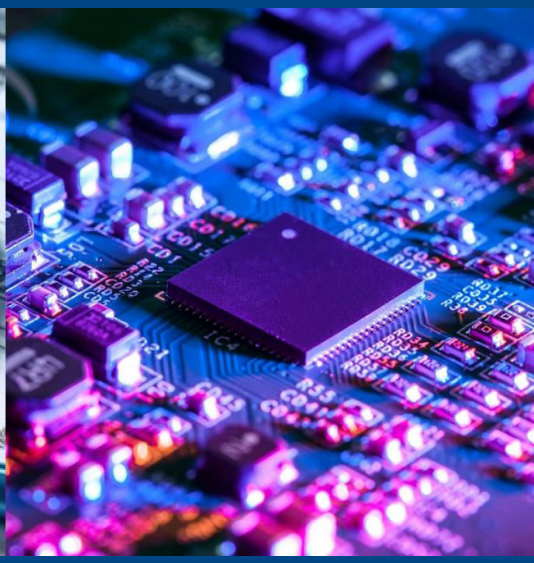

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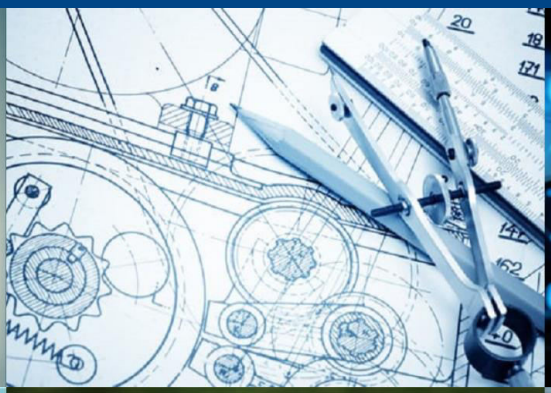

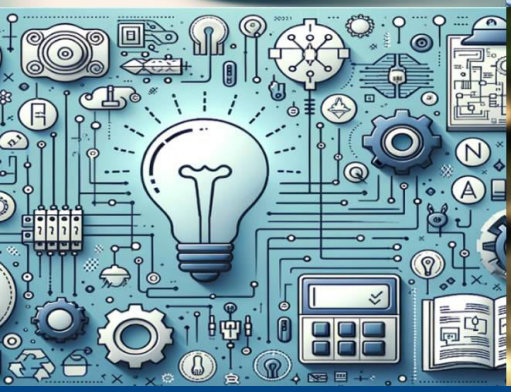

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A Study on Noble Method of Hydraulic Modelling for Urban Sewerage Projects in Chhatrapati Sambhaji Nagar District, Maharashtra

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ABSTRACT: Rapid urbanization in small and medium towns of India has led to increased stress on existing sanitation infrastructure, often resulting in inadequate wastewater collection and treatment. a developing town in Chhatrapati Sambhaji Nagar District Maharashtra, currently faces challenges such as unplanned wastewater discharge, open drains, and limited sewerage coverage. To address these issues, this study focuses on the Integrated Planning and Hydraulic Modelling of the Sewerage System for sustainable urban sanitation.

The research involves a comprehensive assessment of the town's existing infrastructure, land use, topography, population growth trends, and wastewater generation patterns. Geographic Information System (GIS) tools are integrated with hydraulic modelling software (such as SewerGEMS) to simulate and optimize the proposed sewer network. The model aims to ensure efficient conveyance, minimize energy consumption, and reduce operational costs, while considering future population projections and climate resilience.

The study emphasizes sustainable design principles, including decentralized treatment options, reuse of treated wastewater, and environmentally sound disposal methods. The integrated approach is expected to provide a technically robust and economically feasible sewerage plan that aligns with national urban sanitation policies and supports long-term environmental sustainability for town.

KEYWORDS: SewerGEMS, Sewer Network Design, Hydraulic Modelling, GIS, Wastewater Management, Sustainable Urban Infrastructure.

I. INTRODUCTION

Urban sanitation infrastructure plays a critical role in protecting public health and environmental quality. Rapid urbanization in India, particularly in small and medium towns, has placed significant pressure on existing wastewater management systems. Many towns lack properly planned sewer networks and rely on septic tanks, open drains, or unregulated wastewater disposal practices.

These conditions lead to groundwater contamination, surface water pollution, and increased risk of waterborne diseases. Traditional sewerage planning methods often rely on manual calculations and empirical design approaches that do not adequately consider spatial variability, future population growth, or hydraulic performance. Recent advances in digital technologies such as Geographic Information Systems (GIS), Computer-Aided Design (CAD), and hydraulic modelling software have transformed the way sewer systems are designed. Hydraulic modelling tools such as SewerGEMS allow engineers to simulate network behaviour, evaluate flow conditions, and optimize pipe sizes and slopes under various operational scenarios. This study aims to develop an integrated methodology for planning and hydraulic modelling of sewerage systems in small towns using GIS and SewerGEMS. The approach focuses on optimizing sewer network performance while promoting sustainable and environmentally responsible sanitation solutions.

The study also aims to estimate present and future wastewater generation, prepare a geo-referenced base map of the study area, and simulate the hydraulic performance of the sewer network under different flow conditions. By optimizing pipe diameters, slopes, and flow velocities, the proposed system ensures efficient wastewater conveyance through gravity flow while minimizing operational and maintenance costs.

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II. LITERATURE REVIEW

Urban wastewater management has become a major concern due to rapid urbanization and increasing population in many cities and towns. Efficient sewer network planning is essential to ensure proper wastewater collection, transportation, and treatment. Several researchers have studied the application of hydraulic modelling tools and GIS techniques for improving sewer system design and management.

Kulkarni (2021) studied the design and analysis of sewer networks using hydraulic modelling software and emphasized that computer-based modelling provides more accurate results compared to conventional manual design methods. The study demonstrated that hydraulic simulation helps engineers evaluate flow characteristics and optimize pipe sizes effectively.

Pawar et al. (2019) conducted research on urban sewer network design using GIS and hydraulic modelling tools. The study showed that integration of spatial data with hydraulic analysis improves the efficiency of sewer planning and helps identify suitable alignments and catchment areas for wastewater collection.

Bhagat et al. (2024) analysed the application of SewerGEMS software for sewer network design in urban areas. Their study highlighted that hydraulic modelling software allows engineers to simulate different flow conditions, evaluate pipe capacity, and identify potential problems such as surcharging or low flow velocity in pipelines.

S. No.	Author(s) & Year	Title / Source	Key Findings / Relevance
1	Bhagat, P., Pawade, D., Ghodmare, S., & Khan, A. (2025)	A Comprehensive Review of Sewer Network Design by SewerGEMS. Springer, Cham.	Comprehensive analysis of SewerGEMS applications for sewer network design. Integration of GIS data, population forecasting, and hydraulic simulation enhances design efficiency and sustainability. Validates model-based planning for sustainable urban sanitation.
2	Bhagat, P., et al. (2024)	Optimizing Urban Infrastructure: Design and Analysis of Sewer Networks with SewerGEMS. International Journal of Engineering Trends and Technology (IJETT).	Presents a systematic workflow for sewer design from data collection to model calibration using SewerGEMS. Demonstrates how model-based optimization reduces costs, improves flow efficiency, and ensures network sustainability under varying loads.
3	Virde, R., & Dohare, D. (2022)	Design of Sewerage Scheme and Evaluation of Proposed Treatment Plant for Saatvik Vihar Phase-II, Indore (M.P.).	Reviews sewer network design methods using GIS and SewerGEMS. Highlights key parameters: population forecasting, dry/wet weather flows, land use, and topography. Stresses coupling of network design with treatment capacity.
4	Kulkarni, A. (2021)	Design of Sewer System for Holkarwadi Village by Using SewerGEMS-Software. IJRASET, 9(6), 2119–2123.	Demonstrates the use of SewerGEMS integrated with GIS/CAD for pipe sizing, slopes, manholes, and network analysis. Shows benefits of software-aided design over manual methods for accuracy, speed, and future scalability.
5	Khan, M. & Regulwar, D. (2021)	Design of Sanitary-Storm Network using SewerGEMS: A Case Study (Navi Mumbai).	Explores combined sanitary and storm sewer modelling using SewerGEMS CONNECT. Emphasizes simulation under various return periods and compliance with hydraulic standards. Relevant for mixed flow (sanitary + stormwater) conditions.

Table 1: Key Findings/ Relevance

III. METHODOLOGY

The research methodology adopted in this study involves a systematic approach for planning and hydraulic modelling of the sewer network using GIS, AutoCAD, and SewerGEMS software. The methodology includes several stages such as data collection, base map preparation, population forecasting, sewer network design, hydraulic analysis, and model optimization.

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2.1 Data Collection

The initial stage of the study involved the collection of primary and secondary data related to the study area. Primary data such as ground elevations, road layouts, and drainage patterns were obtained through field observations and available survey data. Secondary data including population statistics, land use information, and topographic maps were collected from government records and planning authorities.

2.2 Base Map Preparation

A detailed base map of the study area was prepared using AutoCAD software. The map included important features such as roads, buildings, drainage channels, and contours. The AutoCAD drawing was further integrated into GIS software to create a geo-referenced digital map. This helped in identifying suitable sewer alignments and catchment areas for wastewater collection.

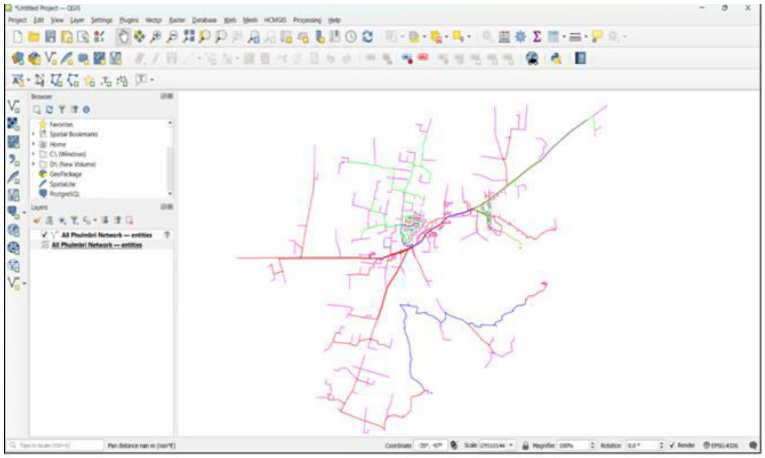

Figure 1: Network referencing using Q-Gis

2.3 Population Forecasting and Wastewater Estimation

Future population of the study area was estimated using standard population forecasting methods for the selected design period. Based on the projected population and per capita water supply norms, wastewater generation was calculated according to CPHEEO guidelines. This estimation provided the basis for determining the design flow for the sewer network.

2.4 Sewer Network Design

The sewer network layout was developed in SewerGEMS hydraulic modelling software by defining nodes (manholes), links (pipes), and catchment areas. Design parameters such as pipe diameter, pipe slope, invert levels, and roughness coefficient were assigned according to standard sewer design guidelines.

2.5 Hydraulic Simulation

The designed sewer network was simulated using SewerGEMS to analyse hydraulic parameters such as flow velocity, discharge, and hydraulic grade line. The simulation was carried out under dry weather flow and peak flow conditions to evaluate the performance of the sewer system.

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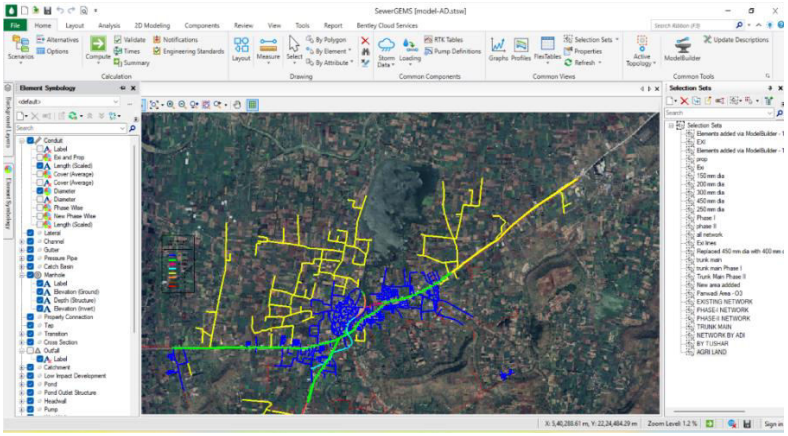

Figure 2: Network built using SewerGems

2.6 Model Optimization

The sewer network model was further optimized to maintain self-cleansing velocity and ensure efficient gravity flow. Necessary adjustments were made in pipe diameter, slope, and alignment to achieve a balanced and cost-effective sewer network design.

IV. CONCLUSION AND FUTURE WORK

All The study demonstrates the application of GIS and hydraulic modelling tools for planning and designing an efficient sewerage network. The integration of spatial data analysis with SewerGEMS modelling enables accurate evaluation of sewer system performance under different flow conditions.

The optimized sewer network ensures proper wastewater conveyance through gravity flow while maintaining self-cleansing velocity and reducing operational costs. The proposed methodology provides a sustainable and cost-effective approach for sewerage planning in small and medium towns.

The results of this study can support municipal authorities and planners in developing improved wastewater management infrastructure for growing urban areas.

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