Published by :
https://www.ijert.org/
An International Peer-Reviewed Journal

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

Storm Water Management Plan for Urban Neighbourhood: Case of Lucknow using Runoff Co-effiecient Method

Saurabh Srivastava
Faculty of Architecture And Planning Lucknow.

Varun singh
Faculty of Architecture And Planning Lucknow.

Dr. Prabhat Kumar Rao
Assistant Prof- Faculty of Architecture And Planning, Lucknow.

Ar. Tabish Ahmed Abdullah
Assistant Prof- Faculty of Architecture And Planning, Lucknow

Abstract: **This study develops an integrated storm water management plan for Lucknow's Zone-4 urban catchment to address increasing runoff, flooding, and drainage failures caused by rapid urbanization and impervious surface growth. The research evaluates hydrological changes, drainage infrastructure, and Sponge City strategies to formulate sustainable, resilient, and environmentally responsive stormwater management solutions.**

Keywords - Stormwater Management, Urban Flooding, Sponge City, Runoff Coefficient, Urban Drainage, Lucknow, Impervious Surface, Sustainable Infrastructure.

1.INTRODUCTION

Stormwater is water that originates from precipitation events - rain, snowmelt, or other forms of runoff — that flows over land surfaces rather than being absorbed into the ground.

Why It Matters

In natural landscapes, rainfall is largely absorbed by soil, filtered through vegetation, and slowly released into groundwater or streams. However, **urbanization dramatically changes this balance**. Roads, rooftops, parking lots, and other impervious surfaces prevent infiltration, causing:

- Higher runoff volumes and faster flow rates.
- Increased flooding risk in downstream areas.
- Erosion of stream channels and riverbanks.
- Transport of pollutants (oils, heavy metals, fertilizers, sediments) into water bodies.

The Indian Context

India receives about **1,170 mm of rainfall annually on average**, but this is unevenly distributed — both geographically and seasonally. Nearly **70–90% of annual rainfall occurs within just 3–4 months** of the monsoon. This seasonal intensity, combined with rapid and largely unplanned urbanization, makes stormwater management one of the most pressing urban challenges in the country.

Key issues in the Indian urban scenario include:

- **Encroachment of natural drains and water bodies**, reducing their capacity to absorb runoff
- **Mixing of stormwater and sewage** in the same drainage network, worsening water quality
- **Lack of separate storm drainage systems** in most cities and towns
- **Poor solid waste management**, leading to choked drains during rains
- **Increasing impervious surfaces** due to unplanned construction and urban sprawl

About Lucknow

- Lucknow, the **state capital of Uttar Pradesh**, is one of India's fastest-growing metropolitan cities with a population exceeding **35 lakh (3.5 million)** as per recent estimates, and a larger urban agglomeration of nearly **50 lakh**. It is the political, administrative, and cultural hub of UP, and has witnessed massive urban expansion over the past two decades — making stormwater management an increasingly critical concern.

Hydrological Setting of Lucknow

Lucknow's geography plays a defining role in its drainage challenges:

- The city is situated on the **banks of the Gomti River**, which bisects it and serves as the primary receiving water body for all urban drainage.
- The terrain is essentially **flat alluvial plain**, part of the Indo-Gangetic basin, with very **low natural slopes** — making gravity-driven drainage inherently slow and inefficient.
- The city receives an average annual rainfall of approximately **900–1000 mm**, with nearly **85–90% concentrated in the monsoon months** (July–September).
- Intense rainfall events of **50–100 mm in a single day** are common during peak monsoon, easily overwhelming existing drainage infrastructure.

Urban Growth and Its Impact on Stormwater

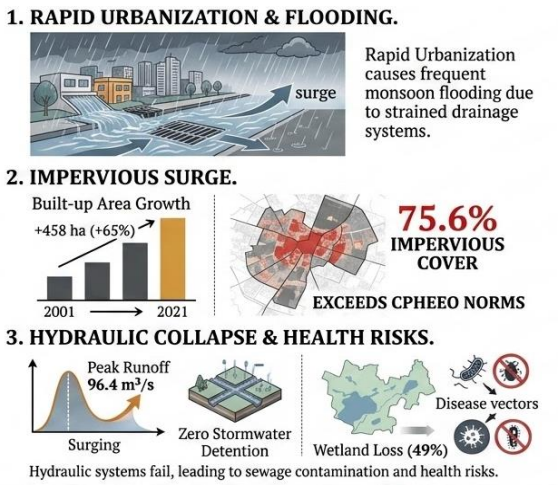
Lucknow has expanded rapidly through planned and unplanned development:

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

- **New urban extensions** such as Gomti Nagar, Aliganj, Indira Nagar, and Vrindavan Yojana were developed with some planned drainage, but **older, denser areas** like Chowk, Aminabad, Yahiyaganj, and Raja Bazar have severely inadequate and deteriorated drainage networks.
- **Peri-urban growth** in areas like Faizabad Road, Kanpur Road, and Sultanpur Road has outpaced drainage infrastructure entirely.
- Rapid conversion of **agricultural land, wetlands, and green open spaces** into built-up areas has dramatically increased impervious surface cover, generating far more runoff than existing drains can handle.
- Several historic **water bodies (taals) and natural nalas** that once absorbed and retained excess rainwater have been **encroached upon, filled, or built over**, destroying the city's natural stormwater buffering capacity.

Key Issues

- Rapid Indian urbanization causes frequent monsoon flooding due to strained drainage systems.
- Gomtinagar's planned growth and aging infrastructure severely reduced drainage efficiency.
- Built-up area grew 65%, pushing impervious cover to 75.6%, exceeding CPHEEO norms.
- Peak runoff surged to 96.4 m³/s due to zero detention and 49% wetland loss.
- Sewage-contaminated floodwater creates acute health risks in inundated neighborhoods.

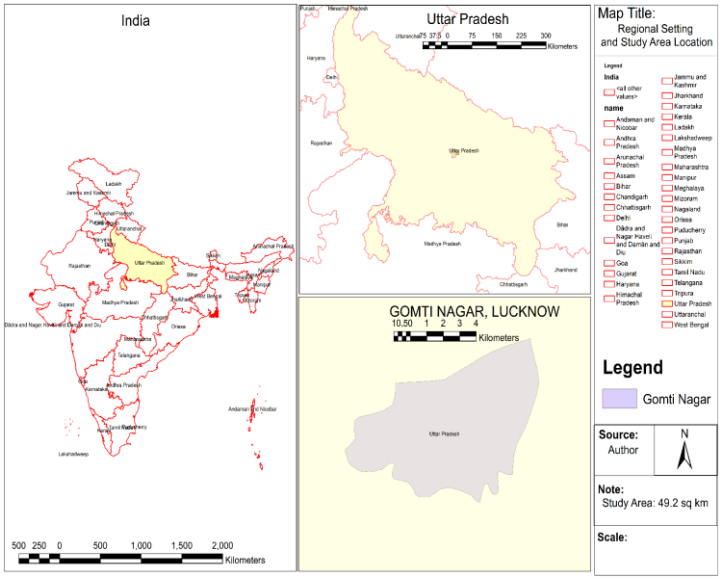


2.Background of the Study Area: Jal Kal Vibhag Zone 4

The focus of this study is **Zone 4** of the **Jal Kal Vibhag** in **Lucknow**, a critical administrative segment responsible for managing water supply and drainage infrastructure. This zone encompasses approximately **30.80 sq km** of the urban catchment area, primarily covering the rapidly developing regions of **Gomti Nagar** and its surroundings.
The administrative jurisdiction of Zone 4 includes the following key wards:

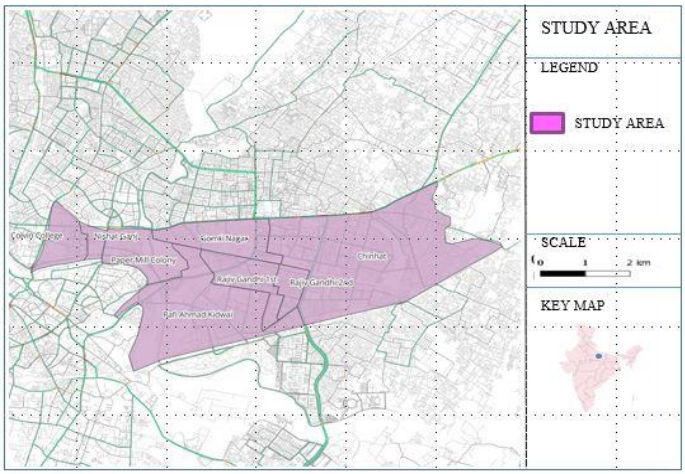
- **Chinhat Pratham** and **Chinhat Dwitiya** Wards.
- **Colvin College, Nishatganj** and **Papermill Colony** Wards.
- **Rajiv Gandhi Pratham** and **Rajiv Gandhi Dwitiya** Wards.
- **Gomti Nagar** and **Gomti Nagar Vistar** Wards.
- **Rafi Ahmed Kidwai** Ward.

As part of the broader **Lucknow Master Plan 2031**, this study area is currently undergoing significant hydraulic and urban planning analysis. This includes a **decadal drainage study** (tracking changes from 2006 to 2026) to assess the impact of land-use shifts on runoff coefficients and to integrate modern concepts like **Sponge City** infrastructure into the existing drainage and sewerage master plan.



Inferences

This study analyzes Lucknow's **Jal Kal Vibhag Zone 4, covering 30.80 sq. km**. It assesses **land-use shifts from 2006 to 2026 to update drainage master plans.** The goal is integrating **Sponge City concepts** framework.



International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

4. Aim

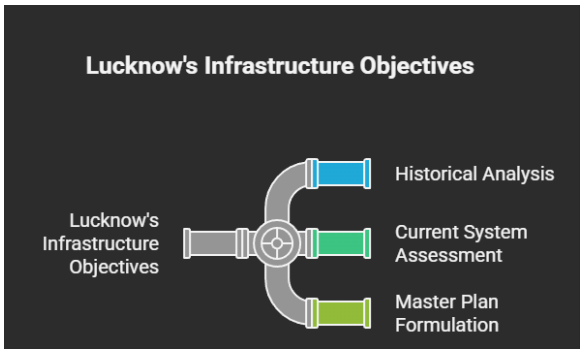
To Frame A Storm Water Management Plan For Urban Neighbourhood: Case of Lucknow

5. Objective

1. Historical Analysis: Examine the development and timeline of the existing sewerage and drainage infrastructure in Lucknow.

2. Current System Assessment: Conduct a detailed study and analysis of the current sewerage and drainage network to identify critical issues and challenges.

3. Master Plan Formulation: Develop the Integrated Drainage and Sewerage Master Plan (IDSMP) for Lucknow, focused on a 2040 planning horizon.



6. Need of the Study

The central planning problem that this study addresses is the structural absence of an inclusive planning and management framework for Gomtinagar's storm drainage ,hydraulically interdependent, and environmentally inseparable, yet are planned by different agencies, maintained under different contracts, and governed under different institutional frameworks. This planning fragmentation produces four mutually reinforcing infrastructure failures:

- **1. Recurrent Urban Flooding:**

Gomtinagar experiences widespread inundation in 4-5wards during monsoon peak events exceeding 25 mm/hour rainfall intensity, attributable to undersized drainage channels, blocked outfalls, sewer surcharge In India, the **CPHEEO Manual on Storm Water Drainage** recommends designing storm water systems while accounting for interactions with sewerage networks. Backflow, and encroachment of natural drainage corridors.

- **2. Sewage-Contaminated Floodwater:**

Cross-connections between sewer lines and drain channels mean that virtually all urban flood events in Lucknow involve co-conveyance of raw sewage, creating acute waterborne disease risk — cholera, typhoid, leptospirosis, and hepatitis A — in inundated areas.

- **3. Hydraulic System Failure:**

During monsoon peak flows, surcharging storm drains back-flood sewer lines, hydraulically overloading STPs and reducing treatment efficiency at precisely the time when pollutant loads are highest.

- **4. Environmental Degradation:**

Combined drainage-sewage overflow enters the River Gomti, the Kukrail Nallah, and groundwater recharge zones during every major flood event, driving chronic deterioration of receiving water quality in direct violation of CPCB/NGT standards

S.N.	Ward Name	Area (SqKm)
1	Chinhat	13.14
2	Rafi Ahmed Kidwai	7.73
3	Gomti Nagar	2.61
4	Rajiv Gandhi Pratham	2.02
5	Rajiv Gandhi Dwitiya	1.63
6	Papermill Colony	2.32
7	Colvin College, Nishatganj	1.35
	TOTAL (Zone 4 Catchment)	30.8

7. Scope and Limitations

6.1 Scope

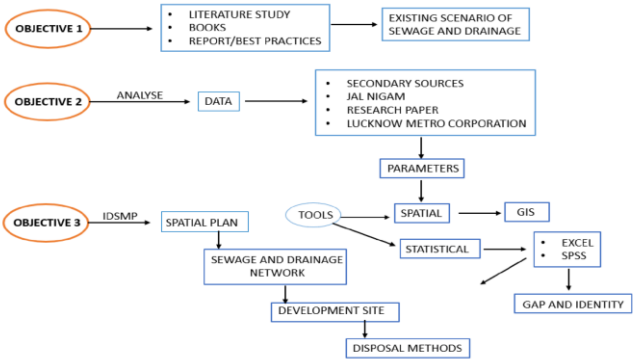
The geographic scope of the study encompasses all gomtinagar of the Lucknow Municipal Corporation (LMC) And Part of chinhutt including BBd and Uttardhawana, covering approximately 49.2 km² of urbanised area, extending to the natural drainage basin boundaries. The infrastructure scope encompasses the complete storm drainage network (primary, secondary, and tertiary channels); natural drainage corridors and water bodies within and adjacent to the Gomtinagar area. **The planning horizon extends from the base year 2026 to 2040, with structured investment milestones at 2030, 2035, and 2040**. Both engineered grey infrastructure and Blue-Green Infrastructure solutions are within scope.

6.2 Limitations

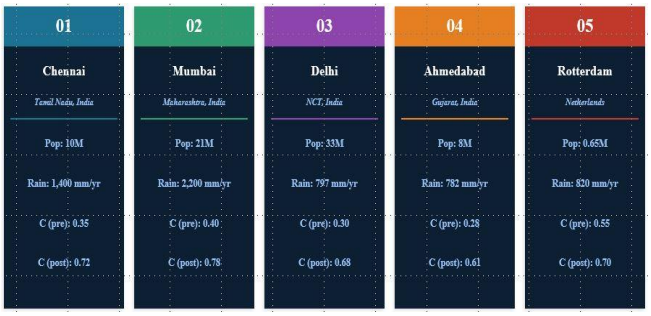
The study relies on Gomtinagar ,operational records, UPJN drainage channel data, and IMD gauge records for primary hydrological and infrastructure data, which may have gaps in spatial and temporal coverage. Storm drainage network condition assessment is based on available records and visual surveys without comprehensive CCTV or sonar survey of underground conduits. The study's hydrological modelling uses a semi-distributed rational method approach calibrated to available gauge data; 2D hydraulic inundation modelling is indicative and based on DEM analysis rather than site-specific bathymetric survey. Climate change projections are based on published IMD regional scenario data rather than city-specific dynamically downscaled models. Capital cost estimates are indicative, based on CPHEEO and MoHUA benchmark rates, subject to DPR-stage refinement.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

8. Methodology



8. Case Study



.9.CURRENT SITUATIION

Baseline Infrastructure & Hydrological Data: Zone 4 (Lucknow)

- Total Catchment Area: The study area encompasses a 30.8 sq km urban catchment within the Gomti Nagar region.
- Administrative Jurisdiction: Managed by Jal Kal Vibhag, the zone includes specific wards such as Chinhat (I & II), Gomti Nagar, Gomti Nagar Vistar, and Rafi Ahmed Kidwai, as detailed in image_19f103.png.
- Rainfall Data Framework: Analysis utilizes a decadal rainfall dataset covering the period from 2006 to 2026 to track shifting precipitation intensity.

Runoff Coefficient (C) Parameters:

- Baseline values are calculated to account for high impermeability in established wards like Nishatganj (Colvin College) and Papermill Colony.
- The coefficient accounts for rapid land-use transitions from permeable soil to concrete surfaces in Gomti Nagar Vistar.
- Hydraulic Modeling: Discharge calculations (Q) are based on the Rational Method (Q=CiA), where i represents peak rainfall intensity and A is the 50 sq km catchment.
- Infrastructure Monitoring: Site-specific data includes rebar preparation and foundation monitoring for structural work near critical nodes like the Bhootnath Market metro station.

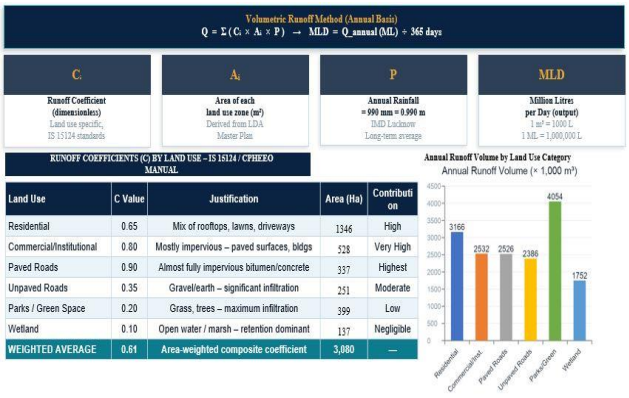
Strategic Planning Alignment: All baseline data is benchmarked against the Lucknow Master Plan 2031 to facilitate the transition toward Sponge City drainage infrastructure.

10. Population Analysis, ZONE-4, Lucknow

Parameter	1991	2001	2011
Total Population	1,22,000	1,90,500	3,17,463
Decadal Growth (%)	—	+56.15%	+66.65%
Population Density (per km²)	2,480	3,872	6,453
CAGR (%)	—	4.56%	5.24%

5. Weather and climate Data Gomti Nagar, Lucknow

- The variation in precipitation between the months with the lowest and highest levels of **rainfall is 308 mm | 12 inch**, as observed.
- The average temperatures vary during the year by 17.9 °C | 32.2 °F.
- The month with the highest relative humidity is August (81.82).
- The month with the lowest relative humidity is April (29.59).
- The month with the highest number of rainy days is July (24.17 days).
- The month with the lowest number of rainy days is November (0.63 days).



6.. PROPOSED STORM WATER MANAGEMENT PLAN

6.1 Integrated Drainage and Sewerage Master Plan (IDSMP)

The proposed IDSMP integrates:

- Stormwater drainage
- Sewerage systems
- Natural drainage corridors

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

- Blue-Green Infrastructure
- Urban flood management strategies

A. 6.2 Sponge City Interventions

The following interventions are proposed:

1) Bioswales

Vegetated channels to slow runoff and improve infiltration.

2) Rain Gardens

Landscape depressions designed to retain and infiltrate rainwater.

3) Permeable Pavements

Porous paving systems that allow infiltration.

4) Recharge Wells

Groundwater recharge systems for runoff infiltration.

5) Detention Basins

Temporary storage structures for peak runoff reduction.

6) Urban Wetland Restoration

Revival of natural retention areas and drainage corridors.

B. 6.3 Green Infrastructure Framework

The proposed framework includes:

- Green corridors
- Riparian buffers
- Urban parks
- Recharge landscapes

7. Results and Discussion

The analysis demonstrates that rapid urbanization significantly increased runoff coefficients and stormwater discharge within Zone-4.

C. Existing Condition

Parameter	Existing Condition
Impervious Surface	75.6%
Flooding Frequency	High
Groundwater Recharge	Low
Drainage Efficiency	Poor
Wetland Retention	Reduced

D. Proposed Condition

Parameter	Proposed Scenario
Runoff Coefficient	Reduced
Peak Runoff	Reduced
Flooding Frequency	Moderate
Groundwater Recharge	Increased
Ecological Quality	Improved

The proposed Sponge City interventions can reduce peak runoff and improve urban resilience significantly.

The study also highlights the importance of integrating ecological systems with engineered infrastructure for sustainable urban water management.

8. Policy Recommendations

1. Mandatory rainwater harvesting in all new developments.
2. Protection and restoration of urban wetlands.
3. Separate sewer and stormwater drainage systems.
4. GIS-based drainage monitoring systems.
5. Regular maintenance and desilting of drains.
6. Revision of urban drainage bylaws.
7. Integration of Blue-Green Infrastructure into master planning.

9. Future Scope

Future studies may include:

- Real-time flood forecasting systems
- IoT-based drainage monitoring
- AI-based rainfall prediction models
- Detailed hydraulic simulation
- Climate change adaptation modelling
- Smart urban water management systems

10. CONCLUSION

This study highlights the urgent need for an integrated storm water management framework in Lucknow's Jal Kal Vibhag Zone-4, where rapid urbanization, increasing impervious surfaces, and inadequate drainage infrastructure have significantly increased runoff generation and urban flooding risks.

The research demonstrates that uncontrolled land-use transformation between 2006 and 2026 has reduced natural infiltration capacity and increased hydraulic stress on the existing drainage network. Encroachment of natural drains, loss of wetlands, sewer-drain cross connections, and poor

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

maintenance practices have aggravated flooding and environmental degradation in the Gomti Nagar region.

Hydrological analysis using the Rational Method confirms that runoff coefficients and discharge values have increased substantially due to urban expansion and reduction of permeable surfaces. The existing drainage system is fragmented and hydraulically insufficient for handling peak monsoon runoff.

The proposed Integrated Drainage and Sewerage Master Plan (IDSMP) provides a sustainable planning framework by integrating conventional drainage systems with Sponge City and Blue-Green Infrastructure approaches. Interventions such as bioswales, detention ponds, recharge wells, permeable pavements, and restoration of natural drainage corridors can significantly reduce peak runoff and improve groundwater recharge.

The study concludes that future stormwater management in Lucknow must adopt climate-responsive, ecologically integrated, and decentralized infrastructure approaches. Effective institutional coordination, sustainable planning policies, and long-term infrastructure investment are essential for reducing flood vulnerability and ensuring resilient urban development by 2040.

11. REFERENCES

[1]. CPHEEO. *Manual on Storm Water Drainage Systems*. Ministry of Housing and Urban Affairs, Government of India, New Delhi, 2019.
[2]. Central Pollution Control Board (CPCB). *Urban Stormwater Management Guidelines*. Government of India, New Delhi, 2021.
[3]. Indian Meteorological Department (IMD). *Climatological Tables of Observatories in India (1981–2020)*. Ministry of Earth Sciences, Government of India.
[4]. Lucknow Development Authority (LDA). *Lucknow Master Plan 2031*. Lucknow, Uttar Pradesh, India.
[5]. Ministry of Housing and Urban Affairs (MoHUA). *Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines*, 2015.
[6]. United Nations Human Settlements Programme (UN-Habitat). *Urban Flood Risk Management: A Toolkit for Integrated Planning*. Nairobi, Kenya, 2017.
[7]. World Bank. *Integrated Urban Water Management for Sustainable Cities*. Washington D.C., USA, 2016.
[8]. Fletcher, T. D., Andrieu, H., and Hamel, P. "Understanding, Management and Modelling of Urban Hydrology and Its Consequences for Receiving Waters." *Urban Water Journal*, vol. 10, no. 5, 2013, pp. 261–274.
[9]. Ahiablame, L., Engel, B., and Chaubey, I. "Effectiveness of Low Impact Development Practices in Two Urbanized Watersheds." *Journal of Irrigation and Drainage Engineering*, vol. 139, no. 7, 2013, pp. 564–571.
[10]. Zhang, K., and Chui, T. F. M. "Evaluating the Effectiveness of Low Impact Development Stormwater Practices Using the SWMM Model." *Journal of Environmental Management*, vol. 100, 2012, pp. 44–52.
[11]. Ministry of Jal Shakti. *National Water Policy*. Government of India, New Delhi, 2012.
[12]. Census of India. *Primary Census Abstract – Uttar Pradesh*. Government of India, 2011.
[13]. Uttar Pradesh Jal Nigam (UPJN). *Drainage and Sewerage Records for Lucknow Region*, Technical Reports and Operational Data.
[14]. Environmental Protection Agency (EPA). *Storm Water Management Model (SWMM) Reference Manual*. United States EPA, 2015.
[15]. Rogers, P., de Silva, R., and Bhatia, R. "Water is an Economic Good: How to Use Prices to Promote Equity, Efficiency, and Sustainability." *Water Policy*, vol. 4, no. 1, 2002, pp. 1–17.