Database of Nature-based Solutions in Bhubaneswar

Global EbA Fund

BHUBANESWAR MUNICIPAL CORPORATION BMC

National Institute of Urban Affairs

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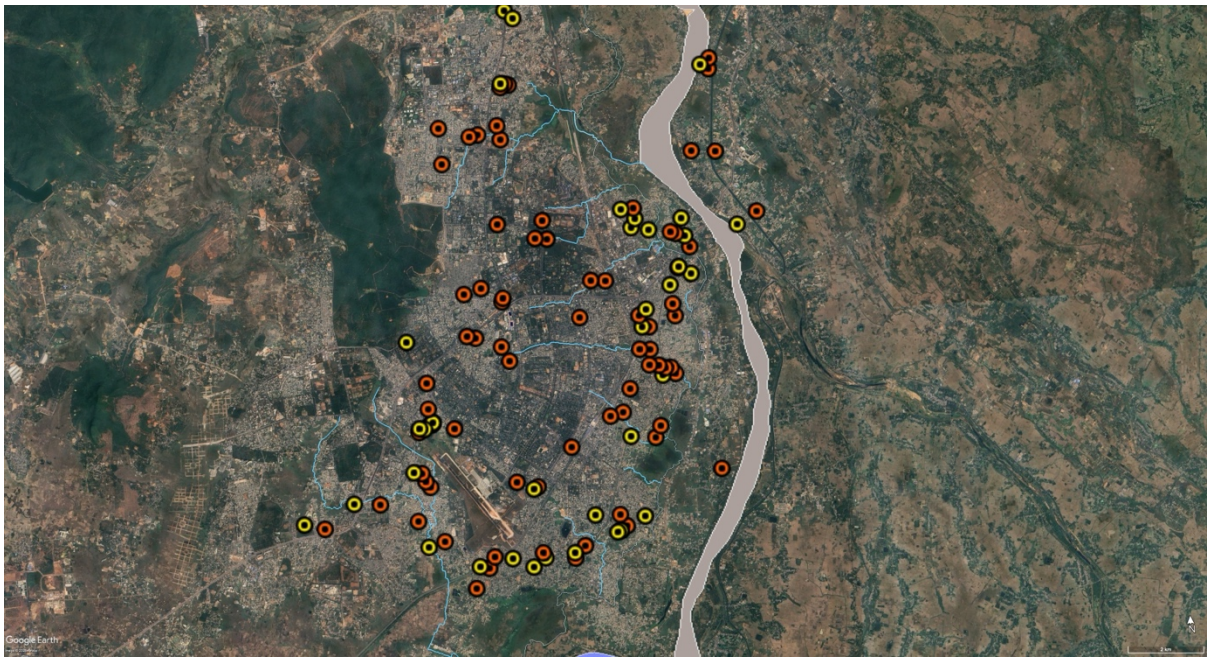
The Bhubaneswar Municipal Corporation (BMC), key stakeholder of the EPIC project had shared a long list of 80 locations within BMC boundary where heavy urban flooding was reported during the monsoons of 2022 and 2023. The BMC officials from the storm water drainage department also had to resort to dewatering through heavy-duty pumps, which were up to 1400 cumulative hours in a season at several sites. The flood locations shared by the BMC were also overlaid on the hazard and vulnerability maps, and composite risk map (on a scale of 1-5 where 1 indicates low risk and 5 indicates high risk) of the entire BMC area to verify the accuracy of maps prepared with ground reality.



Waterlogging locations in the Bhubaneswar city

From the long list, around 30 potential flooding points were selected to suggest EbA solutions.

The data collection at each flooding point covered the following.

- Extent of flooding
- Observed inundation depth
- Duration of inundation
- How often area get flooded
- Any Dewatering done by BMC (*If yes, for what duration)*

To recommend EbA solutions, Ecosystems nearby the flooding site were mapped and the following information was captured relevant to the potential site.

- Land use typology (Residential, Commercial, Open Space, slum etc.)
- Ownership of the potential site (Government, Private)
- Current use of the potential site (religious use, recreational use, for parking etc.)
- The existing condition of the potential NbS site

- Existing stormwater drainage system around the area
- Groundwater level

After the site visit of the 30 identified locations, a database was created compiling all the information on the flooding hot spots. The database comprises of the observations from the field and community perspective on aspects like inundation depth, frequency of flooding, damage caused to life and property etc. The detailed analysis of the compiled data helped in narrowing down to 3 major flooding hotspot locations where the EbA can be proposed.

Based on the analysis, four sites were selected for site visits to recommend the NbS to the Storm Water Drainage Department (SWD). Around 14 individual NbS are integrated for all sites selected, where prominent ecosystems can be leveraged to alleviate urban flooding.

The detailed assessment, along with potential solutions are given below.

Detailed Sites Assessment

1. Falcon Tattva (Site number 18)

This area comprises mixed land use like Residential, Commercial and open spaces. Natural drain number 9 flows through the area and merges with drain no. in downstream. Due to the encroachment along the drains and increased built-up along the drain the width of the drain has been reduced, causing the flooding in the nearby area during heavy rains. In the upstream of the drain, still a large portion of the area is green which helps in reducing the flow of the run-off from the surrounding high altitude area.

Map showing the location of flooding hot spot and nearby locations visited during the site visit

Pictures showing the existing condition of the flooding Hot spots

The SWOT analysis for the flooding hot spot around the Falcon Tattva is provided below for reference.

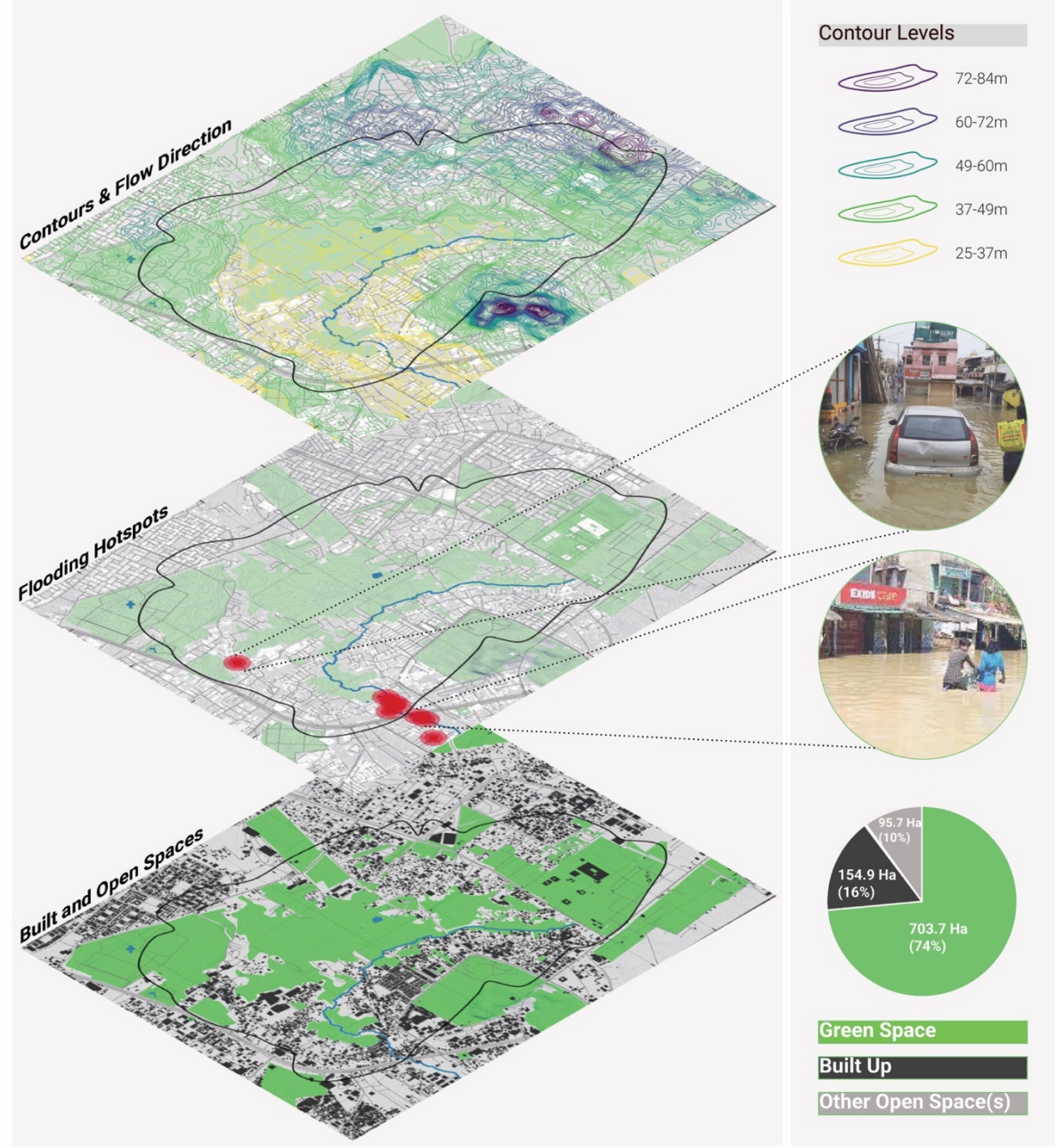
Strength	Weakness
The drain flows within the city can help manage the storm water and help in recharging the Groundwater	A lot of development along the drain has made on-site solution difficult

Opportunity	Threat
On the upstream of drain, a lot of green area can be leveraged for creating water sponges' spaces along with recreational space	New development in form of high-rise buildings are coming up along the drain which can further lead to new flooding spots

To understand the existing hydrological parameters at the flooding sites, following parameters were assessed;

- Land Use and Land Cover along the Hot Spot area
- Contour of the Area (5 m and 1 m)
- Run-off catchment area of the flooding hot spot
- Run-off generation
- Existing slope of the catchment area
- Water flow direction assessment
- Existing ground water condition

A brief exercise was done to understand the existing condition of the micro-catchment area of the flooding hot spot. More than 70% area under the micro-catchment is open space.



Proposed Interventions

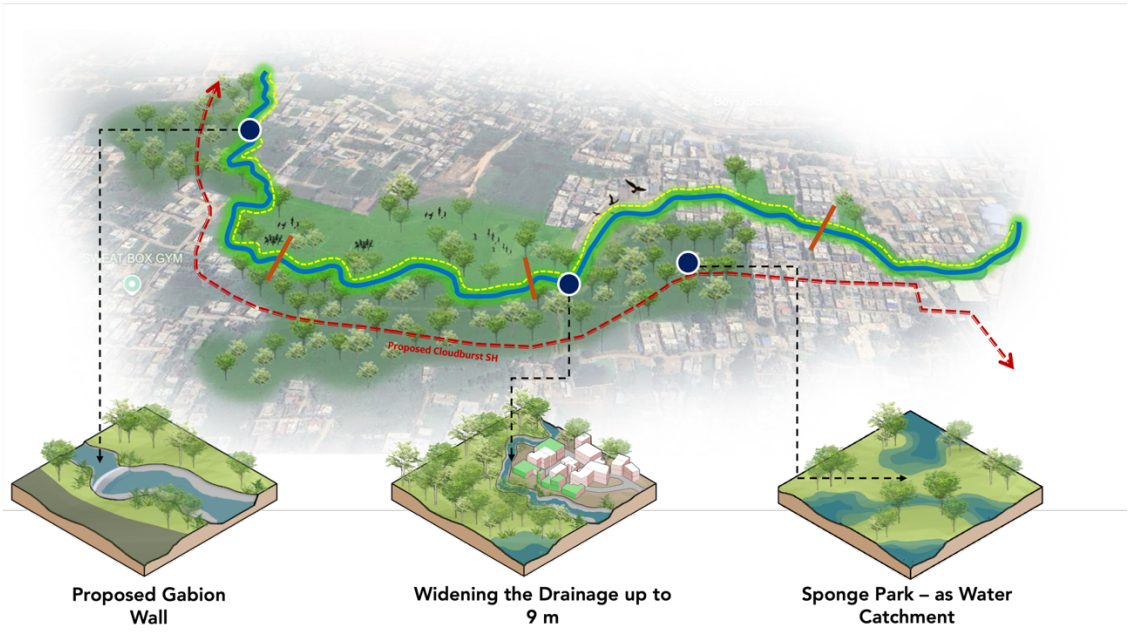
One of the intervention that is being explored for reducing the urban flooding is drain improvement by increasing the width and depth of the drain. The proposed drain width in the City Development Plan (CDP) is proposed 14 metres but the existing width of the drain is between 5-8 meters.

Following interventions are proposed at the site, for which further detailing and designing is in progress;

- **Drain Re-development**: Much of the area along the drain remains undeveloped, presenting an opportunity to widen the drain and establish a riparian buffer. This buffer will help reduce runoff velocity. We will provide cross-section plans for drains with widths of 10 meters and 14 meters.

- **Rain Park**: A low-lying area within the micro-catchment has been identified for the creation of a rain park. This park will help accommodate runoff during the rainy season, thereby reducing downstream water flow.

- **Gabion wall**: Stone check dams will be constructed upstream to decrease runoff velocity and enhance groundwater recharge



Conceptual design of the proposed NbS at the Falcon Tattva site

2. Kargil Basti

This area includes one of the largest informal settlements in Bhubaneswar, making it a highly vulnerable zone in terms of both socio-economic and environmental risks. A key contributing factor to urban flooding in the region is land subsidence, primarily caused by unregulated earth excavation and lack of soil stabilization measures. Despite these challenges, the presence of two large green open spaces offers a significant opportunity to implement nature-based flood mitigation solutions, such as retention ponds or urban wetlands. The land ownership pattern, comprising both slum dwellings and government-held plots, provides scope for collaborative, inclusive planning that integrates community needs with urban resilience strategies.

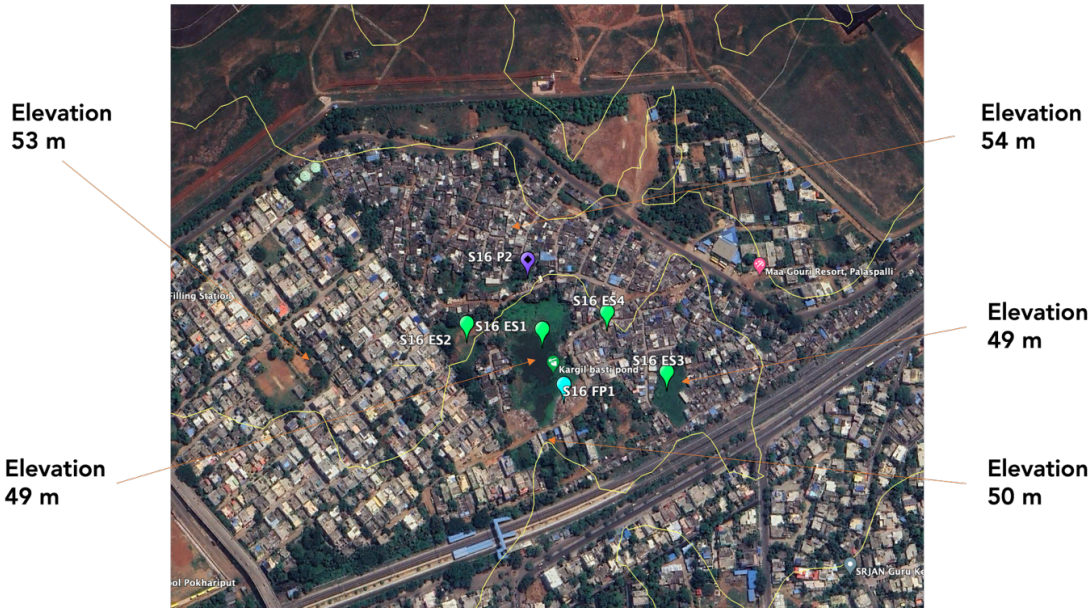
Additionally, an existing natural depression that serves as a stormwater catchment for the surrounding area is currently being degraded through indiscriminate dumping of construction debris and solid waste. This poses a serious threat to local drainage and may exacerbate flooding during peak rainfall events. Within the Kargil Nagar area, four to five such low-lying depressions exist, functioning as informal stormwater and wastewater collection basins. If protected and enhanced, these can form the backbone of a decentralized water management strategy. It is therefore crucial to preserve and rehabilitate these natural catchments, while simultaneously developing a network of internal drains to channel excess water effectively, ensuring both environmental sustainability and improved living conditions for residents.

Map showing the location of flooding hot spot and nearby locations visited during the site visit

Pictures showing the existing condition of the flooding Hot spots

The SWOT analysis for the Kargil Basti is provided below for reference.

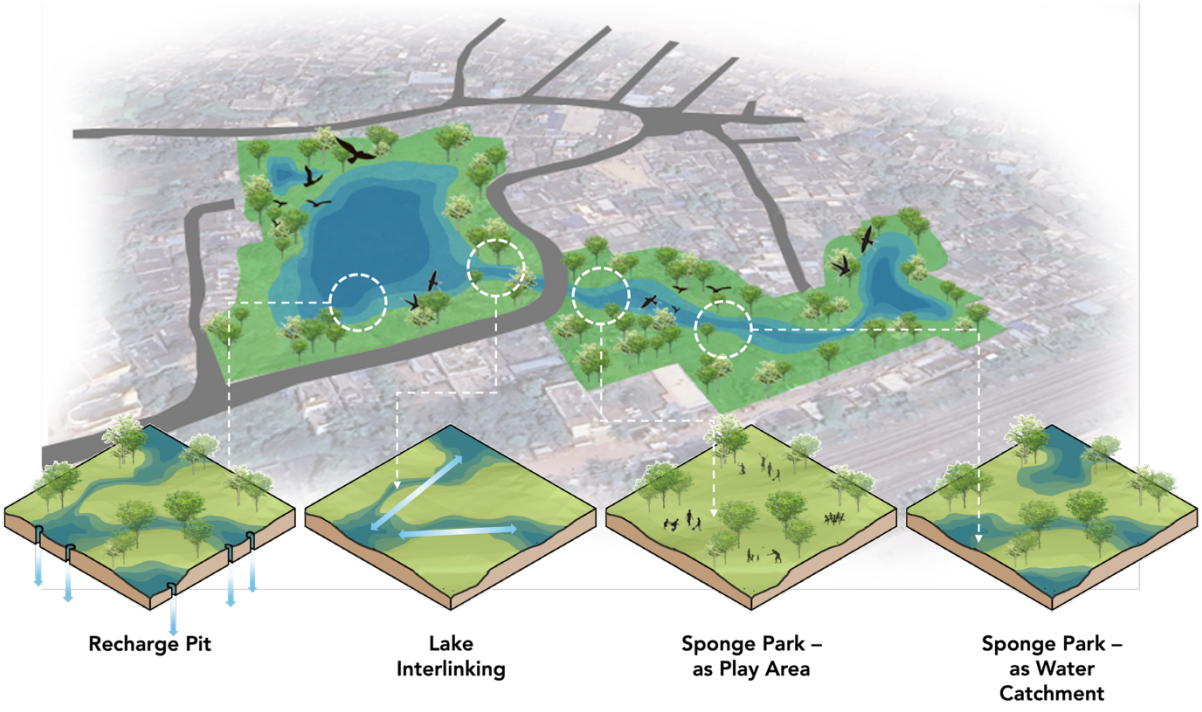
Strength Presence of natural depressions and green patches provides a strong ecological base for implementing water retention and flood mitigation NbS	**Weakness** Unplanned settlements and land subsidence due to informal earth excavation hinder effective infrastructure and ecosystem restoration
Opportunity Government-owned land and community interest create potential for co-developed green infrastructure and urban waterbody restoration	**Threat** Ongoing encroachments and dumping of solid waste in drainage depressions may worsen flood risks and block long-term NbS effectiveness



Proposed Interventions

The proposed intervention focuses on restoring two natural depressions within the urban landscape and transforming them into multi-functional waterbodies. These revitalized basins will serve as crucial stormwater retention zones, effectively absorbing surface runoff during heavy rains and reducing urban flooding risks.

Drawing from nature-based solutions, the design integrates blue-green infrastructure, enhancing infiltration, improving groundwater recharge, and supporting biodiversity. Beyond their ecological function, the waterbodies are envisioned as vibrant public spaces with landscaped edges and tree-lined pathways that can be used for recreation, community interaction, and environmental education.



Conceptual design of the proposed NbS at the Kargil Basti site

3. Drain no. 8

Drain No. 8, originating from the upstream region near the city's boundary, plays a critical role in channelling runoff from the adjacent Chandaka Forest, a key ecological zone. Designed as a natural drainage pathway, it once served to regulate seasonal flows and maintain hydrological balance. However, over time, the drain has come under significant stress due to encroachments by informal settlements along its length. These settlements not only obstruct the natural flow of water but also contribute to pollution, with untreated household wastewater being discharged directly into the drain.

During the monsoon season, the situation worsens considerably. The high volume of runoff from the forested catchment exceeds the drain's carrying capacity, leading to frequent inundation of surrounding low-lying areas. The continuous narrowing and encroachment of the drain corridor, both along its banks and within the drain itself, further restricts water flow, significantly escalating the risk of urban flooding. This degradation underscores the urgent need for restoration and protection of the drain's ecological and hydrological functions, not only to mitigate flood risks but also to enhance the urban environment and public health outcomes.

Image showing the location and existing surrounding of the drain 8

Image showing the existing condition of the drain 8

The SWOT analysis for the drain no. 8 location is provided below for reference.

Strength Natural alignment with upstream forest runoff (Chandaka) offers a strong hydrological flow that can support blue-green infrastructure like sponge parks and wetlands	**Weakness** Heavy encroachment by informal settlements and discharge of untreated household waste have degraded the drain's ecological function
Opportunity Planned interventions such as aeration zones, floating wetlands, and linear parks present a chance to transform the drain into a multifunctional urban green corridor	**Threat** Increasing urbanization, lack of enforcement, and continued solid waste dumping may obstruct flow restoration and reduce NbS effectiveness over time

Proposed Interventions

The proposed intervention for Drain No. 8 adopts an integrated and nature-based design approach to restore the ecological and functional integrity of the drainage corridor. The plan segments the drain into distinct functional zones, Pre-Treatment, Treatment, Settlement, Aeration, and Public Space zones, to sequentially manage pollution, improve water quality, and mitigate flood risks. A solid waste trap will be installed at the drain's entry point to intercept plastic and debris. Downstream, a treatment zone is planned using either in-situ dosing chambers or ex-situ geobags to biologically treat wastewater. Four strategically placed weirs in the Settlement Zone will further slow water flow and facilitate the settling of organic matter. A solar-powered aeration system will be installed over a 600-meter stretch, alternating with floating wetlands and fountains, to improve dissolved oxygen levels and suppress foul odours.

Beyond water treatment, the proposal reimagines the drain as a public green space that contributes to urban resilience and quality of life. A Sponge Park, acting as a retention pond, will help manage excess runoff during the monsoon, while a Linear Park with pedestrian walkways and cycle tracks will line both sides of the drain, transforming it into a community asset. Two pedestrian bridges will enhance connectivity across the corridor. In the lower stretch, dosing and aeration mechanisms are repeated to tackle additional wastewater inflows and sustain water quality throughout the length of the drain. Overall, this multi-zonal strategy combines ecological restoration, water-sensitive urban design, and public space creation, turning a degraded drain into a multifunctional urban blue-green infrastructure system.

Schematic showing the treatment zone created in the drain 8 for reducing the pollution load from the drain

Conceptual drawings of the proposed interventions in and along the drain 8

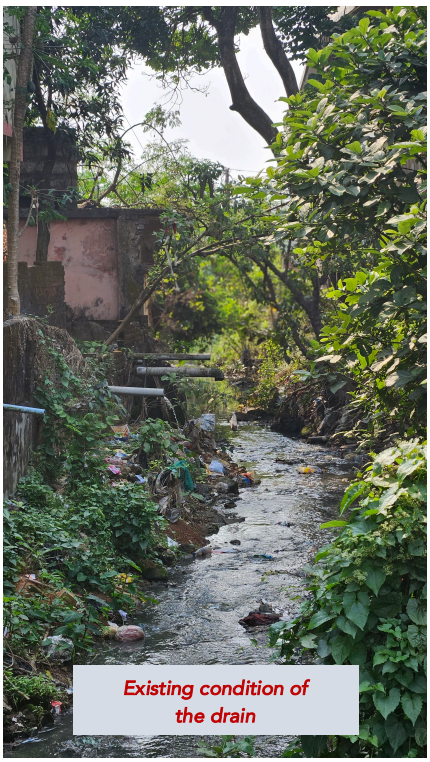
4. Paika Nagar

The Paika Nagar area is predominantly a residential zone, but over the years, it has witnessed extensive unplanned construction and encroachment, particularly along the natural drainage corridor. As a result, the width of the drain has significantly narrowed, reducing its capacity to carry runoff during heavy rains and contributing to frequent urban flooding. One of the critical issues is the backflow of drain water into the household stormwater systems, which poses serious risks to public health and sanitation, especially during monsoon peaks.

In response to severe flooding events, mechanical dewatering had to be carried out approximately two years ago to manually pump out stagnant water from the area. Additionally, the entire drain stretch has been fully concretised, eliminating any remaining natural buffers such as vegetated banks or infiltration zones. This has further compromised the drain's ecological function and its ability to absorb and regulate stormwater naturally. The absence of green cover and buffer zones also limits any scope for passive filtration or groundwater recharge, making the area increasingly vulnerable to climate-induced rainfall variability.

Site Context

- **No official data** on the drain passing through the area
- Small **tributary** of the Drain No. 8
- Length of drain before merging into storm water drain constructed on Highway – **1.48km**


Existing condition of the drain

The SWOT analysis for the location is provided below for reference.

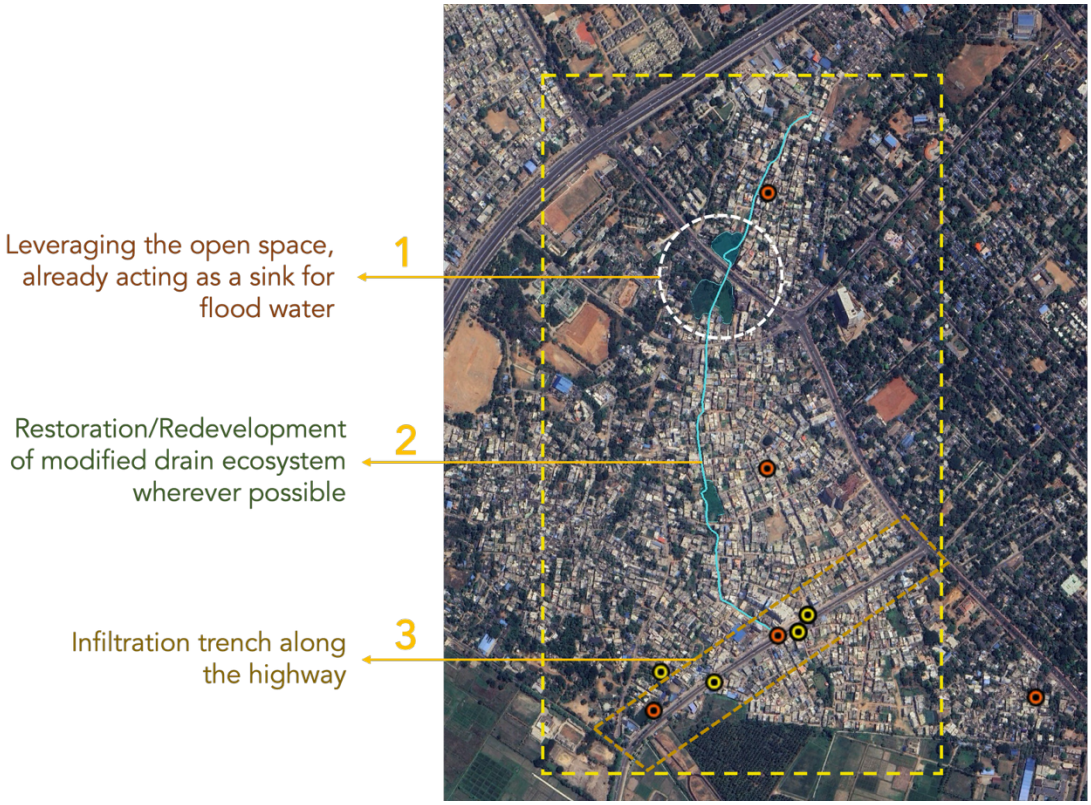
Strength	**Weakness**
Established drainage route already exists, providing a clear corridor for targeted restoration and intervention	Complete concretization and loss of natural buffers severely limit the drain's ecological and hydrological functionality

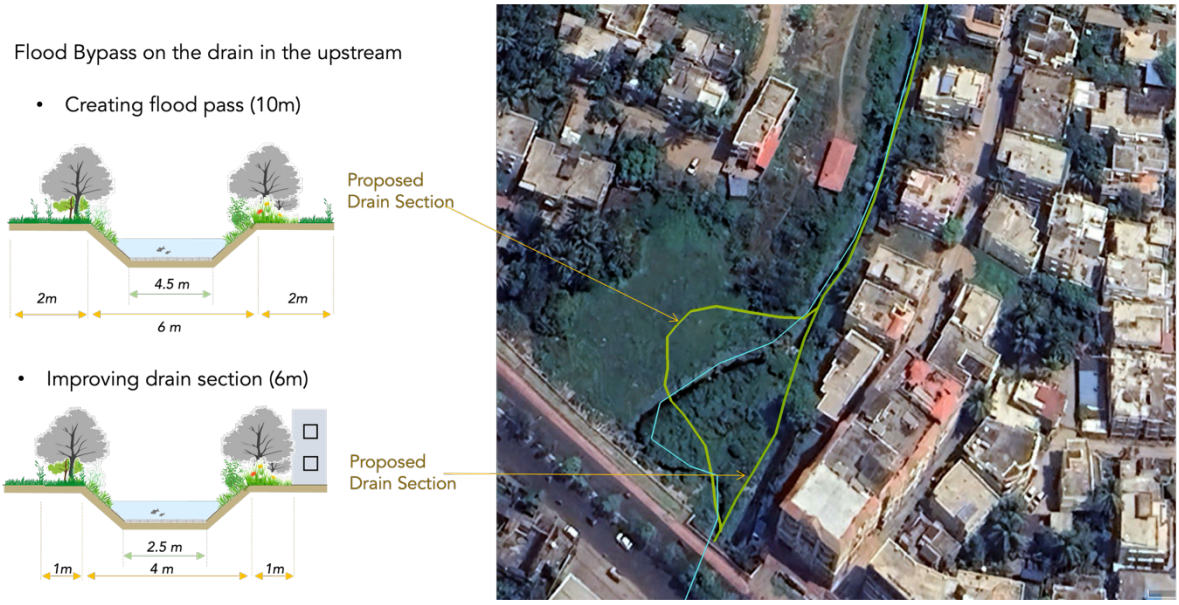
Opportunity	Threat
High residential density offers potential for community-led NbS, such as green buffers, sponge street, and stormwater planters	Continued encroachment and backflow into household systems increase health risks and undermine future resilience efforts

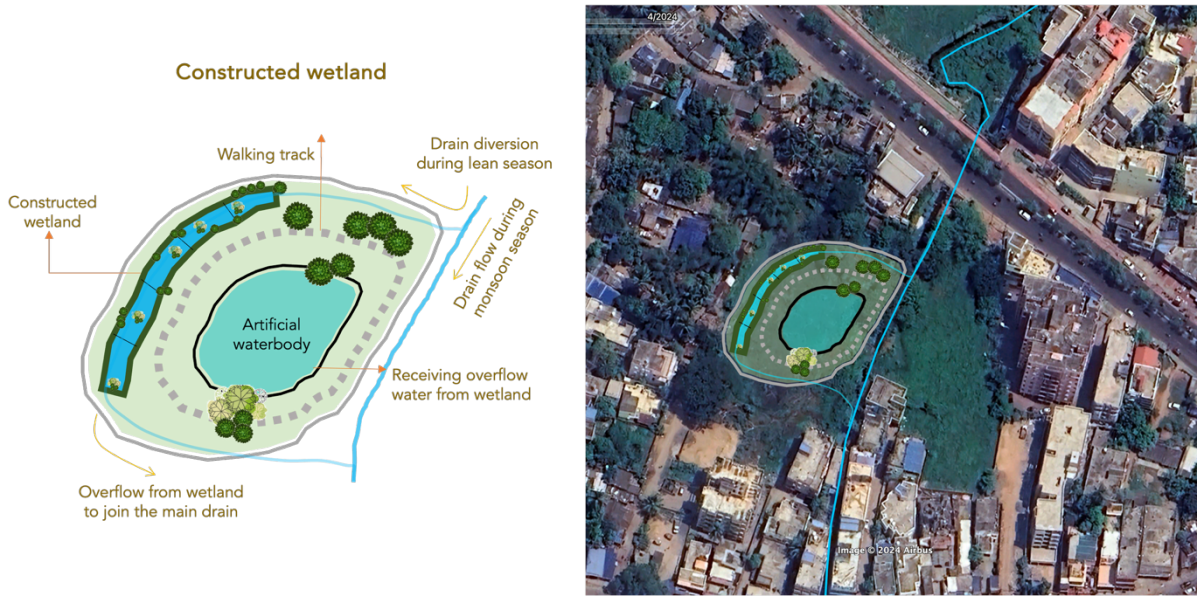
Proposed Interventions

The proposed interventions for the Paika Nagar site aim to reduce urban flooding through a multi-layered, nature-based approach that restores drainage functionality and integrates green infrastructure. The first key intervention is to leverage existing open spaces near the drain that currently act as informal flood sinks. These areas will be formalized as flood bypass channels and constructed wetlands, designed to receive overflow during heavy rains, reduce flow velocity, and improve water quality. Features like free water surface wetlands, artificial water bodies, and walking tracks will not only enhance flood resilience but also provide biodiversity and recreational benefits to the community.

The second and third interventions focus on revitalizing existing infrastructure to better manage stormwater. This includes restoration and desilting of the modified drain ecosystem, increasing its width and depth where feasible, and incorporating riparian buffers to allow natural infiltration and prevent erosion. The third intervention targets the redevelopment of the adjacent road sections by introducing permeable pavements along cycle tracks and creating patches of rain gardens. These decentralized infiltration zones will reduce surface runoff and allow stormwater to be absorbed naturally, thereby mitigating backflow and urban flooding during monsoons.







Schematic showing the interventions proposed for the paika nagar area