Lessons from planning and designing Nature-based Solutions in urban India: From Basins to Sponge Parks

National Institute of Urban Affairs

german cooperation

giz

sponge collaborative

Chennai | Bengaluru
Kolkata | Lyon

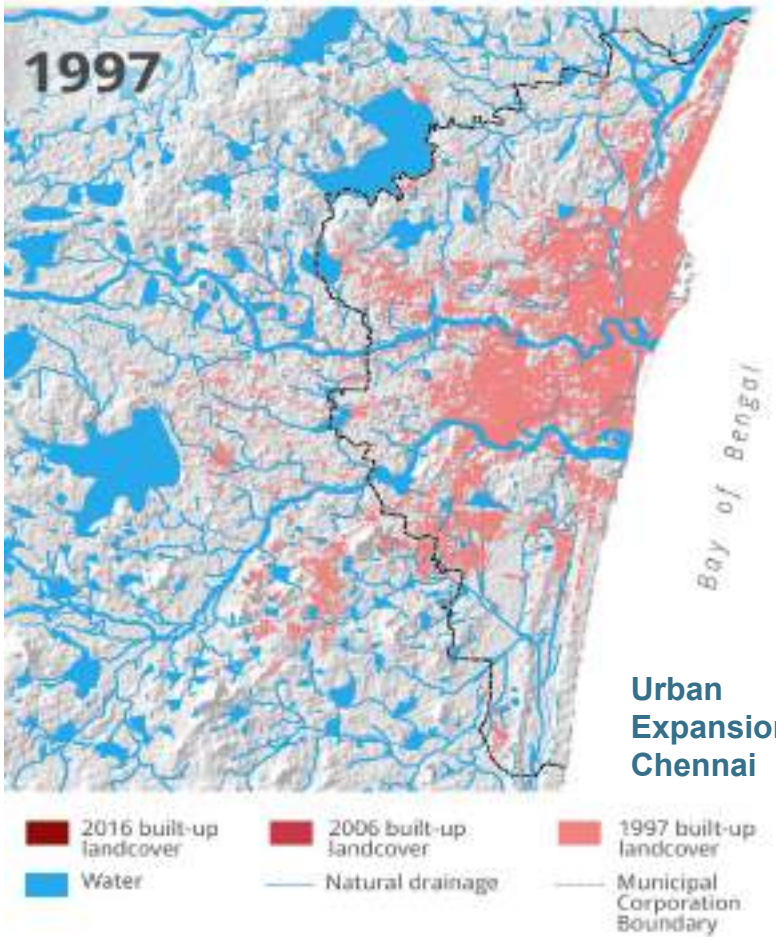
October 30, 2023

Climate change will be increasing the intensity and recurrence of hazards Indians are already facing

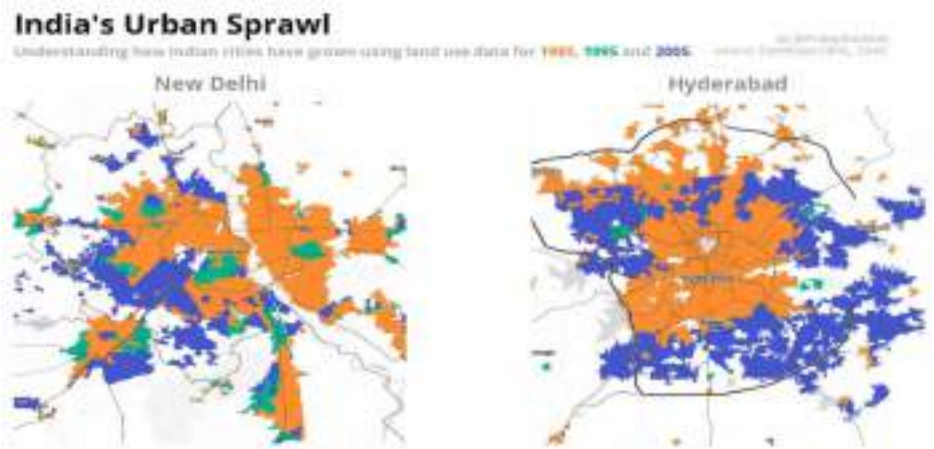
Chennai Water Crisis 2019

Delhi Heat Wave 2022

Land-use change and the nature of urbanization in India also create greater risk for people and assets



Urban Expansion in Chennai



Nature-based Solutions (NbS) leverage functioning ecosystems or restore landscapes to reduce risks from flooding to heat and provide multiple benefits

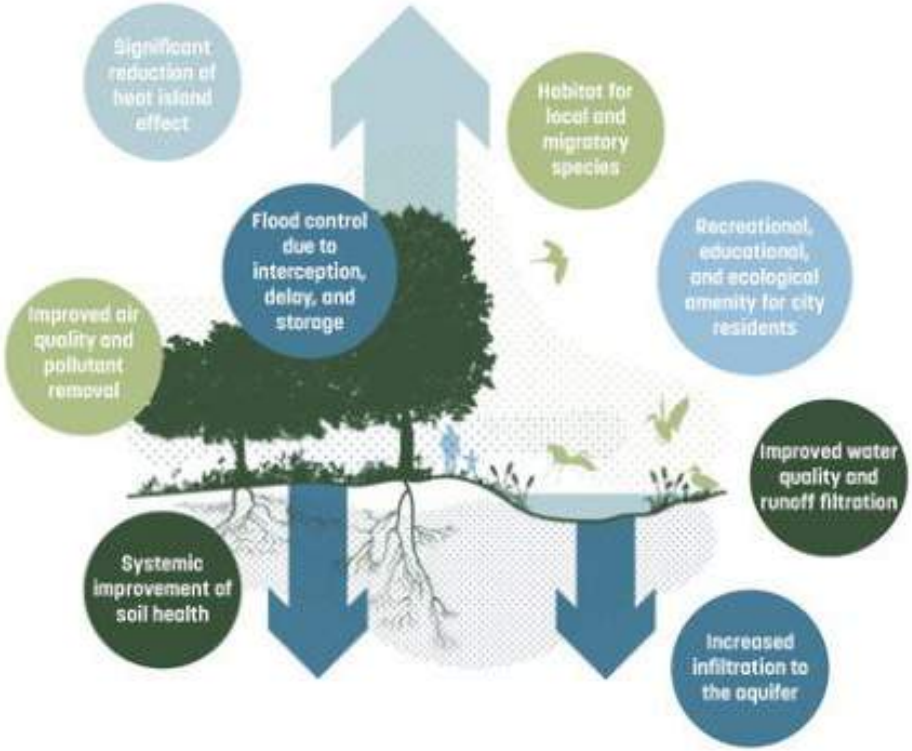
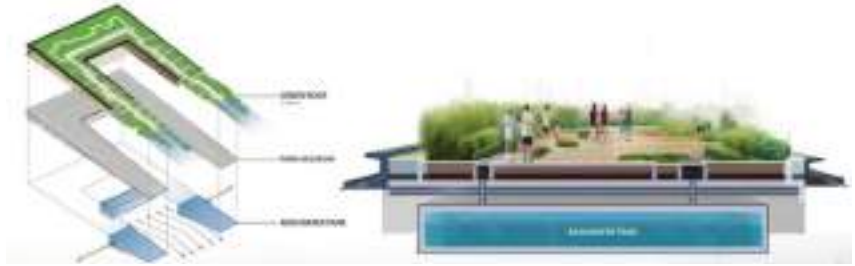


Image Credit : Sponge Collaborative

Sanya Dong'an Wetland Park, Hainan, China **Project Credit : Turenscape**



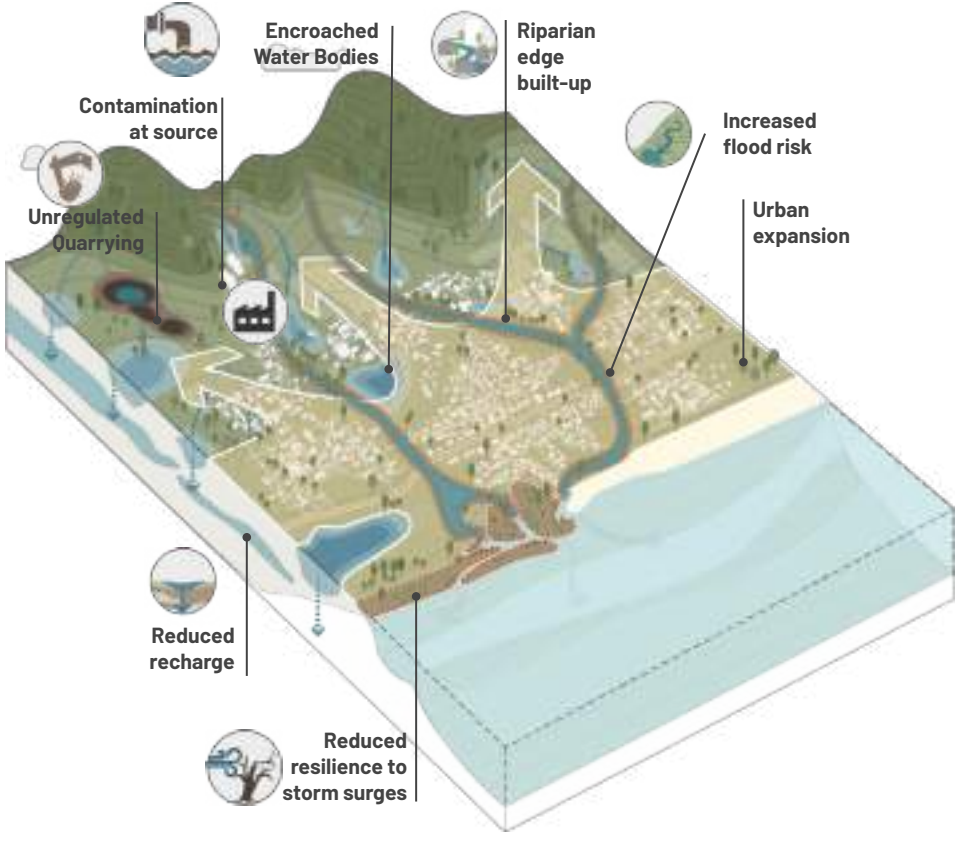
Project Credit : LANDPROCESS

12 acre Chulalongkorn University Centenary Park in Bangkok, Thailand

Urban pollution and unplanned development reduce or remove the potential of ecosystems to reduce risk

Pre-colonial Water Management by the Cholas

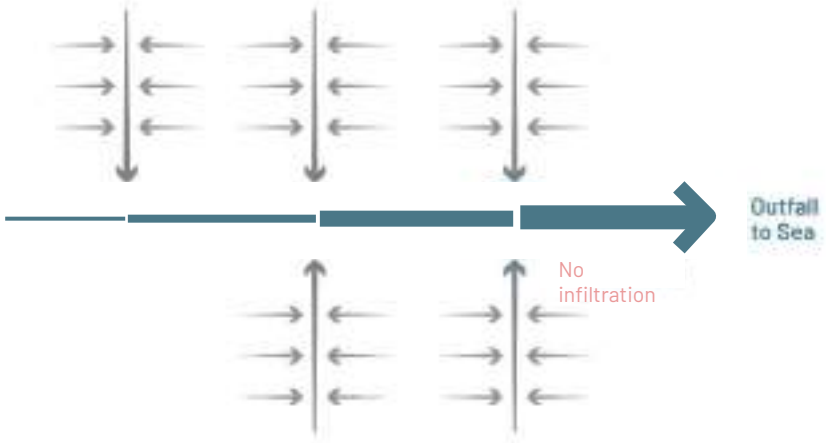
Modified Hydrological Cycles due to contemporary urbanization

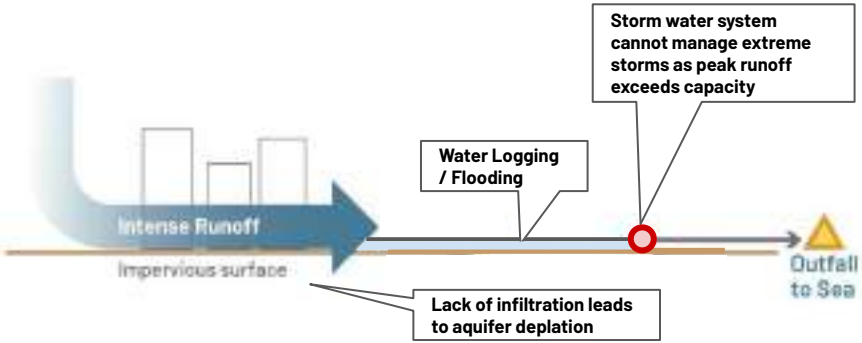


We promote NbS through the Sponge City approach by improving public spaces and ecosystems to reduce flood, drought, and extreme heat risks while providing social amenities to residents and a habitat for urban wildlife

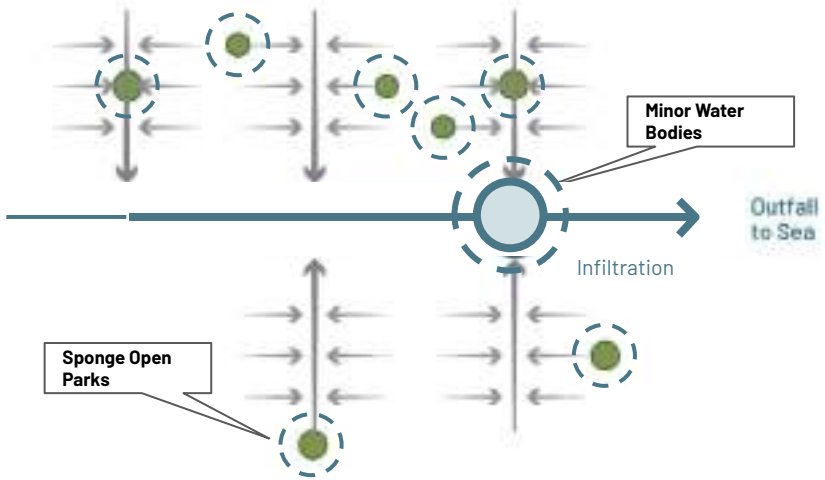
The Sponge City approach manages rainwater as an urban resource and equip cities to face climate change

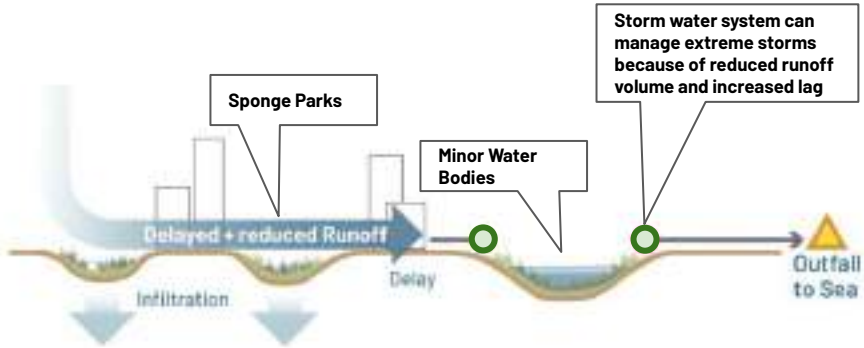
The Gray Infrastructure approach to flood mitigation





The Sponge City approach to flood and drought mitigation





PRINCIPLES OF NATURE-BASED SOLUTIONS (Based on UNEP and IUCN definitions)

1. Protect

Green Ecosystems and Water Bodies from Encroachment or Pollution

2. Restore

Ecological Functions of Degraded or Polluted Landscapes

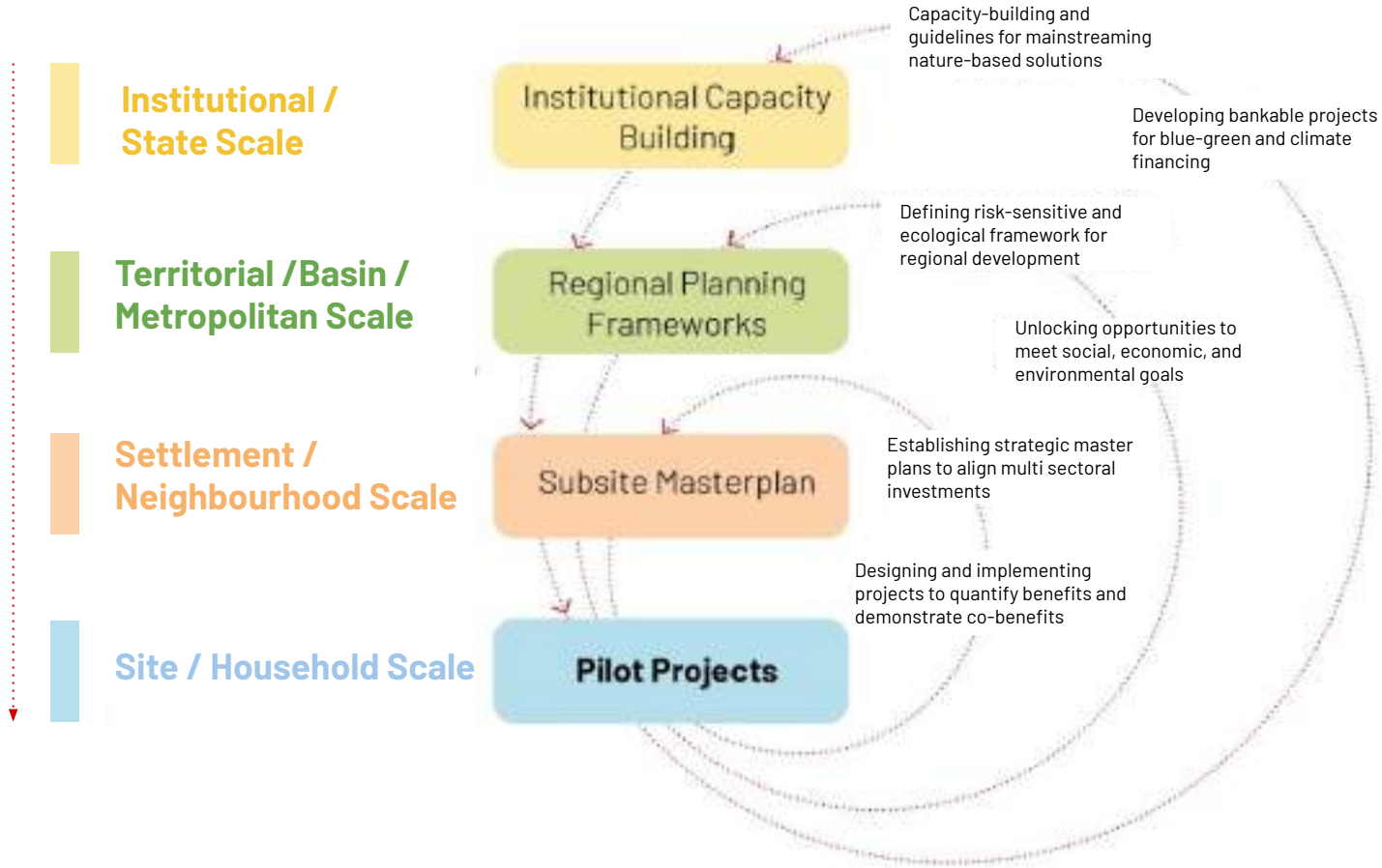
3.Enhance

Coastal, Riparian, Wetland Ecosystems with Hybrid Infrastructure

4. Construct

Blue-Green Infrastructure in open spaces, streets, and buildings

Nature-based Solutions require a multi-scalar approach where projects are strategically aligned because of a regional vision or neighbourhood framework and scalable because of capacity building or detailed guidelines



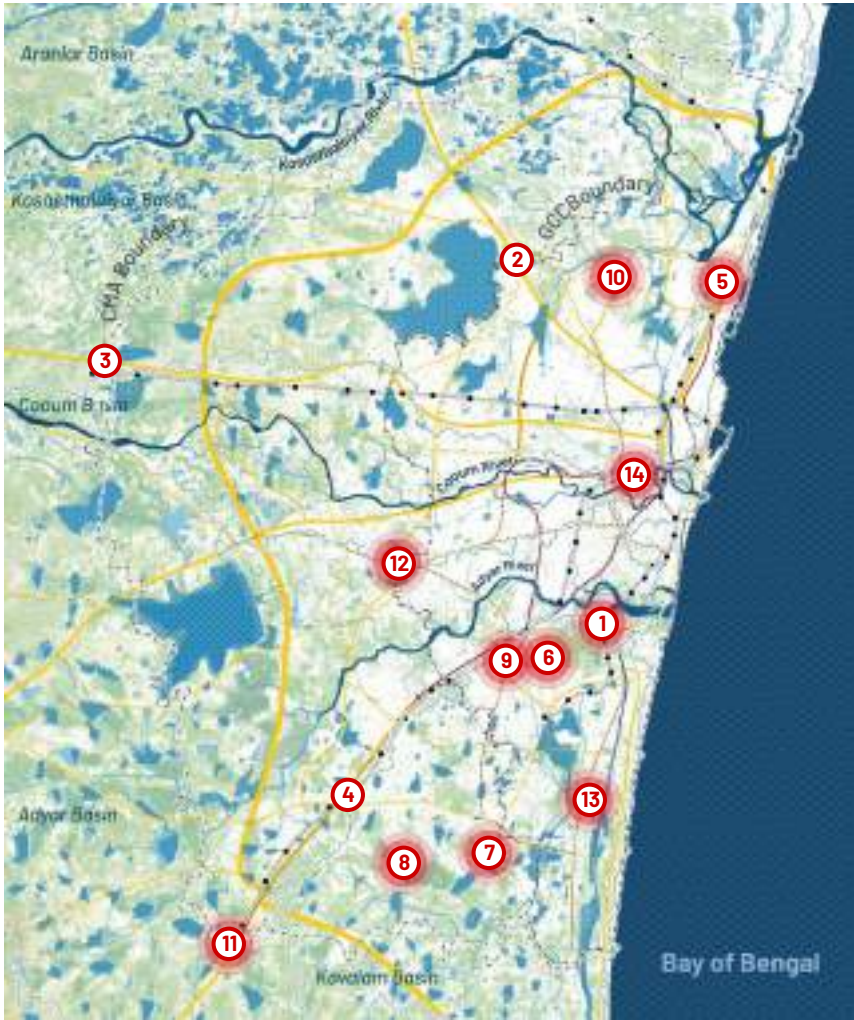
Learning from our experiences in transforming the Chennai Metropolitan Area into a Sponge City

1. Sponge Handbook: Chennai (Cities Fit for Climate Change)
2. Sponge Park Framework for Resilient Open Spaces in GCC

3. CMA Vision for Environment and Climate Resilience
4. Adyar River Vision for Ecological River-sensitive Development

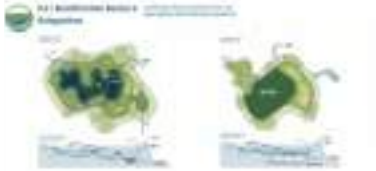
5. Detailed Feasibility Study for Blue-green Infrastructure in Kosasthalaiyar Basin (Thiruvottiyur and Mathur Colony)
6. Masterplan and DPR for Velachery Lakefront Rejuvenation
7. Masterplan and DPR for Perumbakkam Lake Restoration
8. Vision and Concept Plan for Madambakkam Lake
9. Vision and Concept Plan for Adambakkam Lake

10. Integrated Sponge Park in Mathur Colony Detailed Project Report
11. Kilambakkam Archaeological Center, Biodiversity and Climate Park (Under Construction)
12. Porur Wetland Park (Under Construction)
13. Kannagi Nagar Integrated Community Center and Market
14. FUSO Sponge Building Retrofit



Mainstreaming nature-based solutions among urban local bodies and government institutions to address flooding, water scarcity, and heat through publications, training, and lessons from pilot projects

2018 | SPONGE HANDBOOK, CHENNAI (Author. GIZ India, 2018)



Greater Chennai Corporation plans to set up 'sponge park'

HOW SUCH A PARK WORKS

- A sponge park is an urban space constructed to collect, filter and store the run-off during heavy rainfall
- A tank with several layers of filters using gravel, sand, and biofilters is set up at the centre of the park. It is an artificial wetland structure without any concrete flooring but water infiltration blocks
- Several layers of pond zones are created around it to store water
- Around these pond structures, a rain garden using native species of trees and a top layer of sand and compost is set up to allow faster water infiltration and percolation
- During dry months, the space can be used as a park or recreation area

Chennai Corporation to develop sponge parks at 10 locations

Corporation to convert Chennai into 'sponge city'

Corporation To Set Up Natural Infrastructure Instead Of Concrete Box Drains

ECR: City managers bet big on sustainable stormwater drains

Metropolitan Development Plans and Strategic Basin Planning

Applying Nature-based Solutions principles to develop a Sponge City Framework for ecological development

Spatial framework to prioritize where blue-green systems need to be protected from land-use conversion, restored from negative urban impacts, enhanced to face climate risks, and constructed to mitigate hazards

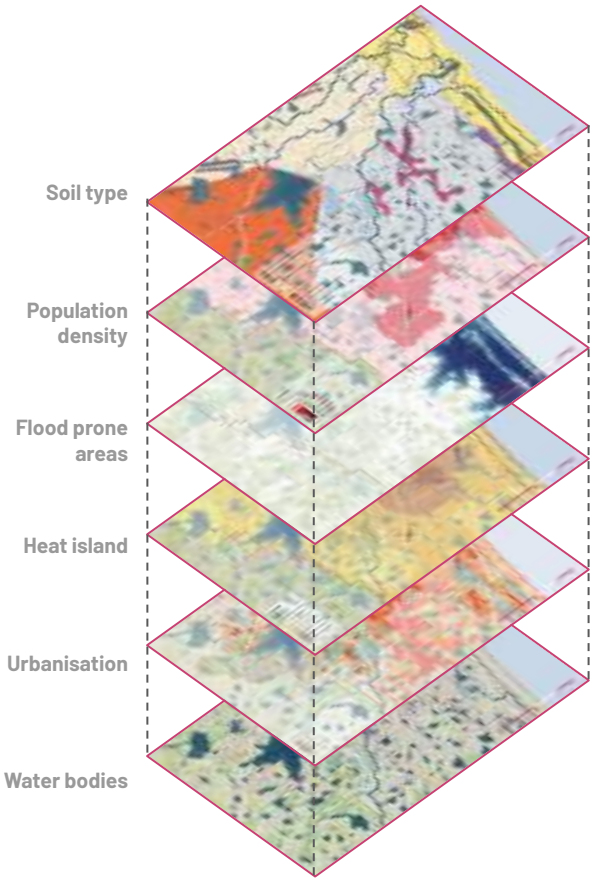
PROTECT Ecosystems and water bodies from encroachment or pollution **(P)**

RESTORE Ecological functions of degraded or polluted landscape **(R)**

ENHANCE Coastal, riparian, and wetland areas to withstand climate change **(E)**

CONSTRUCT Blue-green infrastructure in urban open spaces, streets, and buildings to replicate natural systems **(C)**

Developing a spatial framework for ecological development in CMA using data



PROTECT Peri-Urban Aquifer Recharge Areas from urban sprawl

PROTECT Peri-Urban Wetlands and Drinking Water Reservoirs

ENHANCE Riparian Areas and Buffers to limit riverine flooding

RESTORE Polluted Rivers and Estuaries

CONSTRUCT Blue-green Infrastructure in flood-prone areas

CONSTRUCT Aquifer recharge infrastructure in high yield zones

PROTECT Peri-Urban Wetlands and Drinking Water Reservoirs

ENHANCE Shoreline against sea level rise and erosion

RESTORE Polluted and encroached Water Bodies

Identifying opportunities within a basin for water-sensitive and multi-sectoral urban development strategies

ECOLOGY

The Adyar River as an ecological corridor for blue-green systems and biodiversity

RISK & RESILIENCE

The Adyar River as a nature-based solution for mitigating multihazards and climate risks

CULTURE & LIVELIHOODS

The Adyar River as a source of support and cultural identity for communities

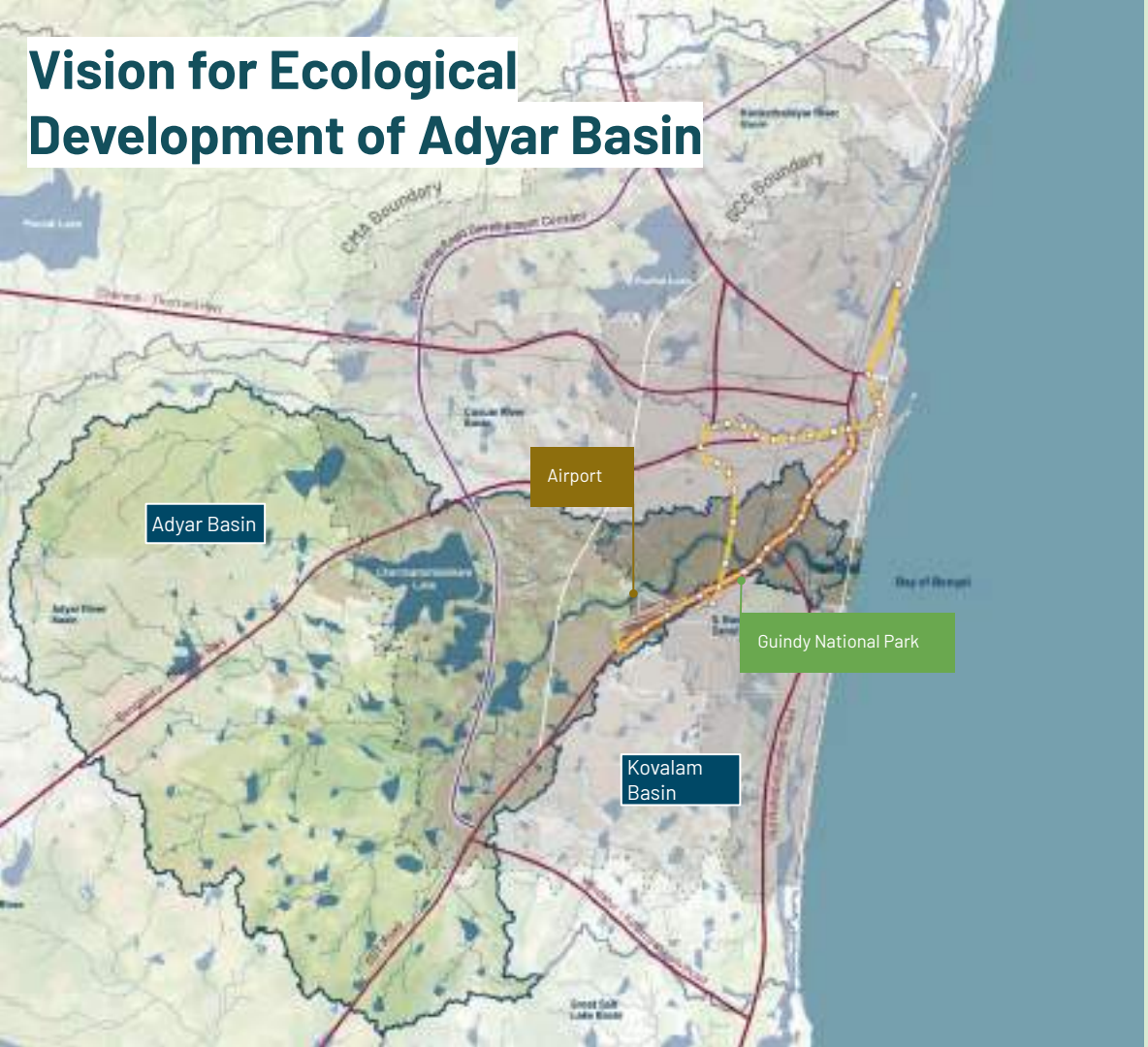
OPEN SPACE & ACCESS

The Adyar River as a spatial system of parks and trails for recreation and wellbeing

URBAN DEVELOPMENT & HOUSING

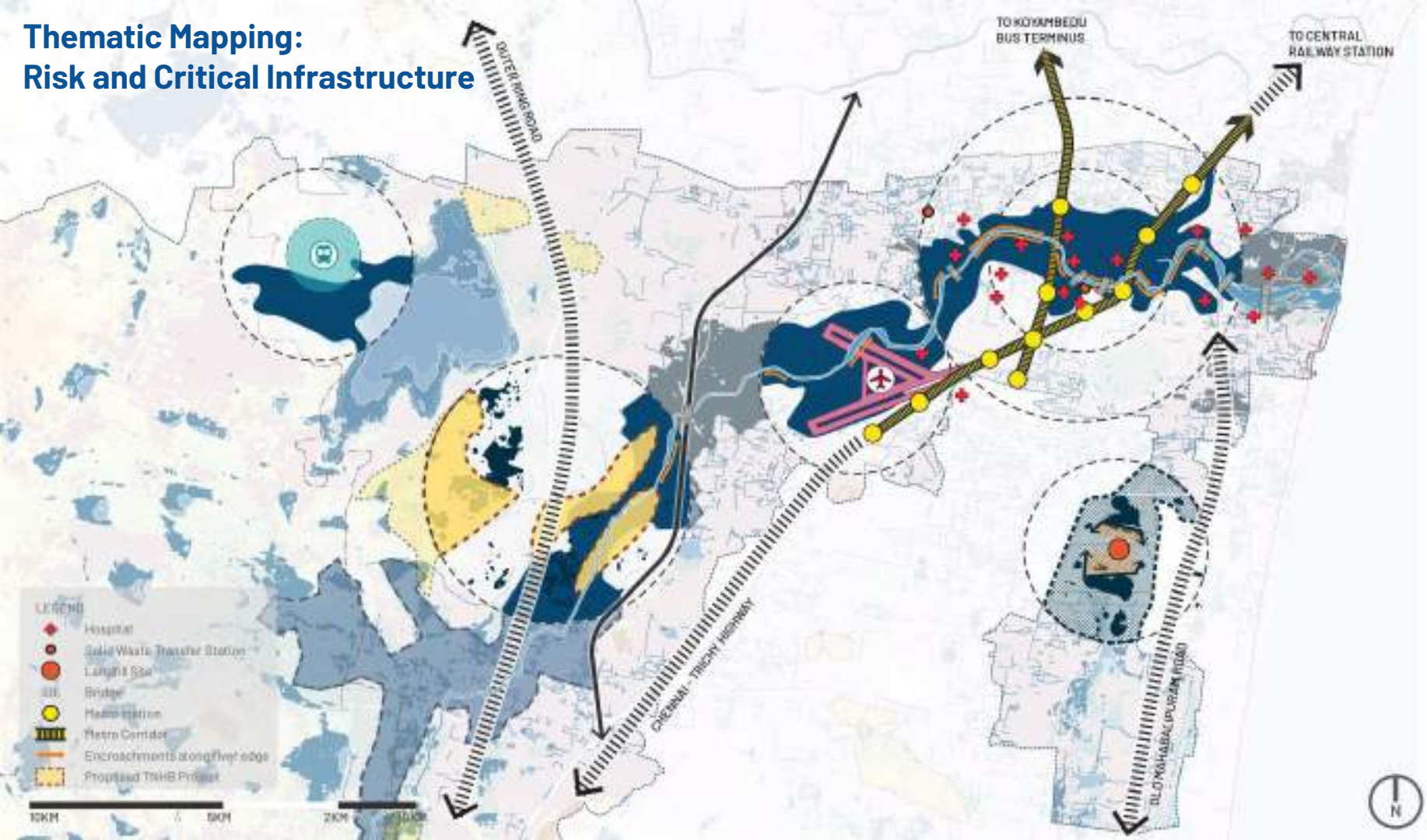
The Adyar River as armature guiding Chennai's sustainable development

Vision for Ecological Development of Adyar Basin

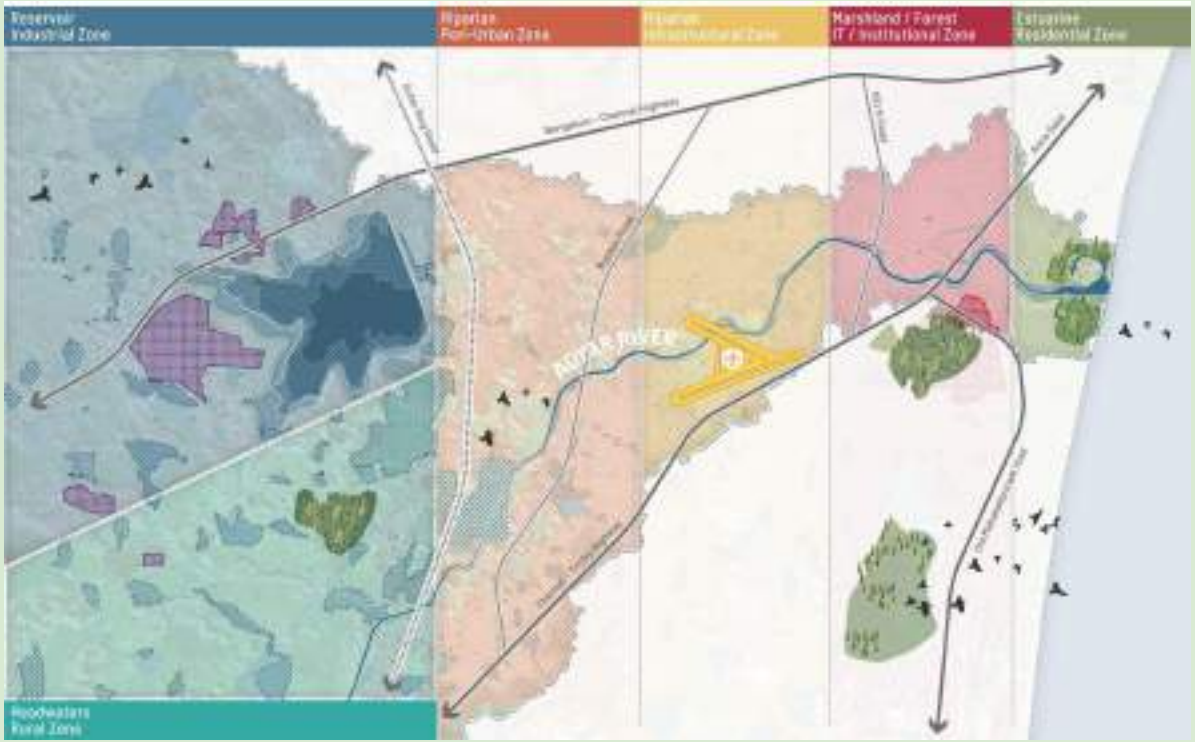


- Adyar basin is the southernmost of the three major river systems within Chennai city extents
- The riverine transect encompasses urban, peri-urban and rural contexts of the Chennai Metropolitan Area
- Basin approach considers the interconnectedness of the river to the aquifer and upstream areas that impact the quantity and quality of water entering Chennai's rivers

Thematic Mapping:
Risk and Critical Infrastructure



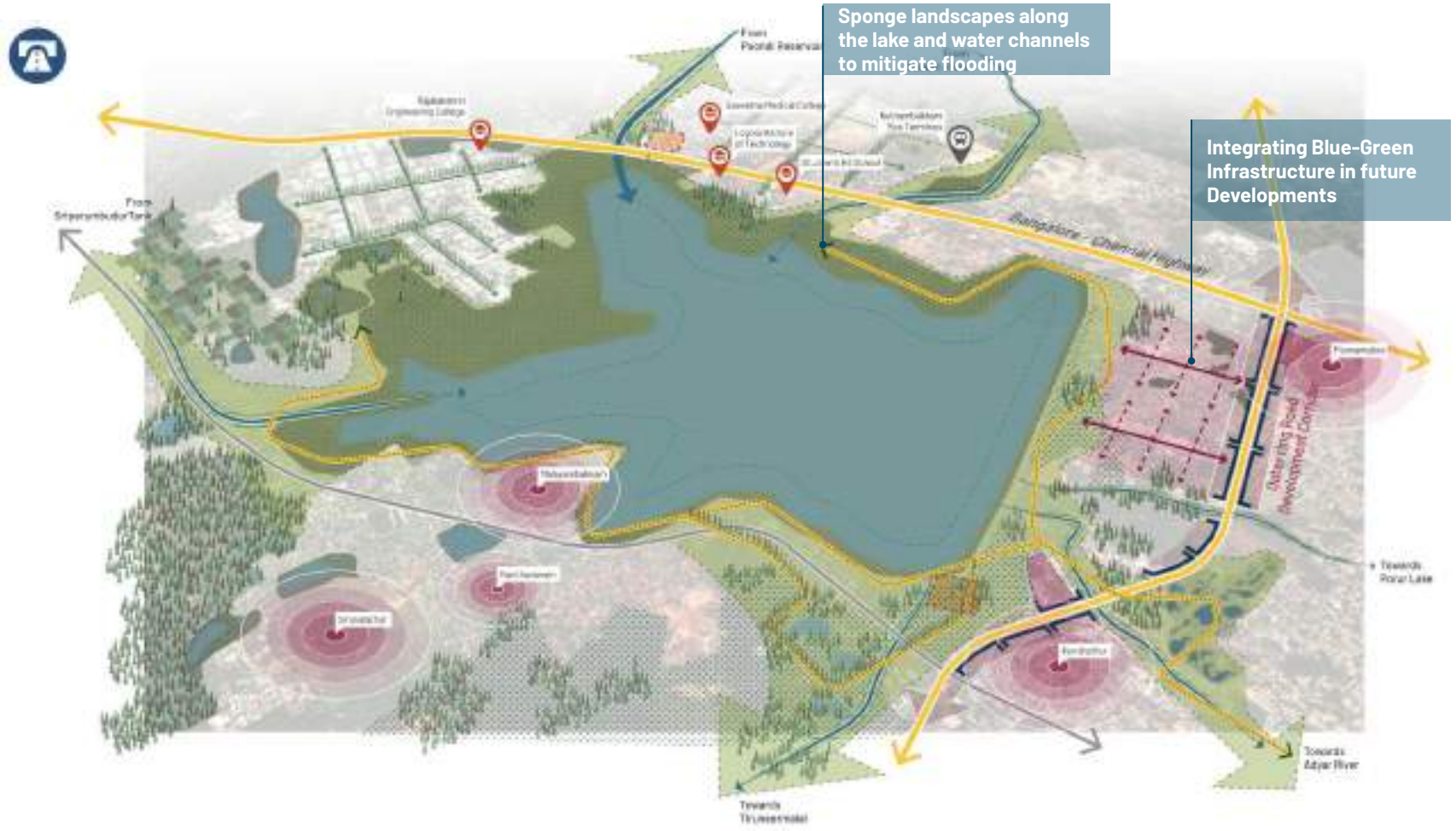
Engagement with Technical Stakeholders to identify priorities by Character Zone



[Left to Right]: 1) Estuarine Residential Zone, 2) Forested Institutional Zone, 3) Riparian Infrastructural Zone, 4) Riparian Peri-urban Zone, 5) Reservoir Industrial Zone, 6) Headwaters Rural Zone

Estuarine Zone: Ecological and cultural linkages between the river and sea

Industrial Zone: Eco-industrial Parks and Ecological Buffers with Recreation around Lakes



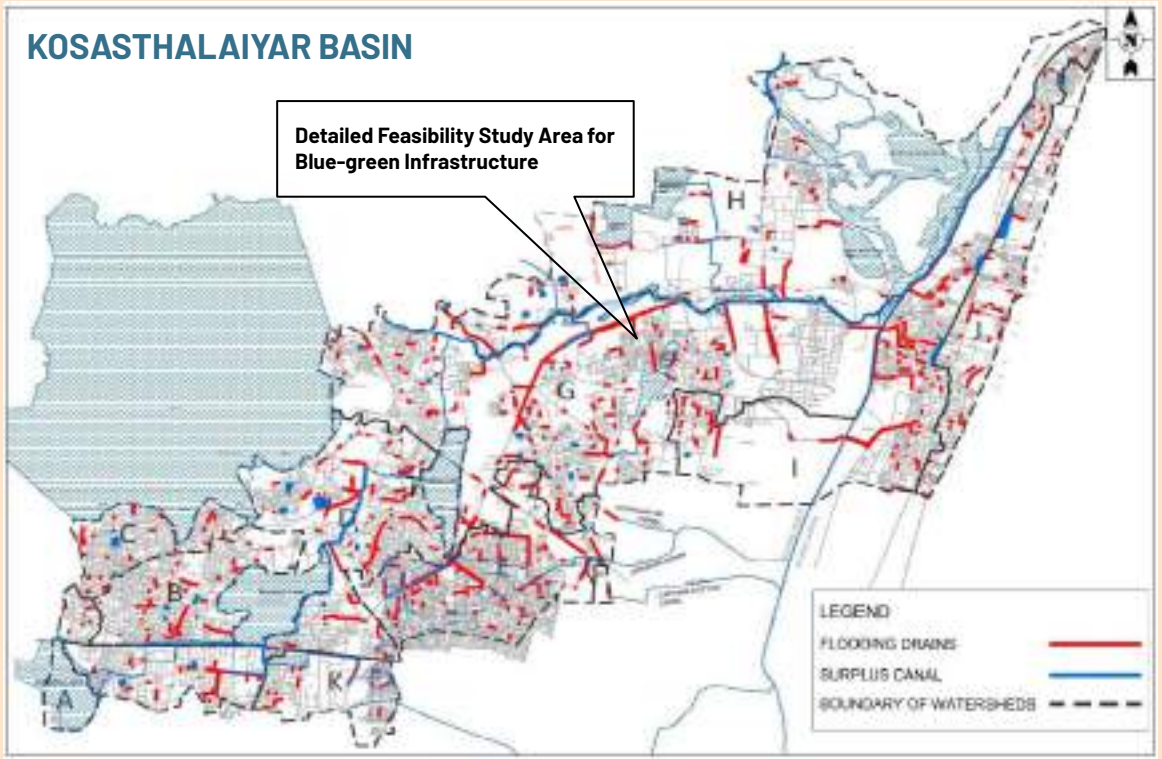
Peri-urban Zone: Proactive conservation of wetlands and streams for green growth

Water-sensitive Urban Design and Sponge City Framework

Detailed Feasibility Study for Blue-green Infrastructure

Stormwater drains are designed to manage runoff from 2 and 5 year return period storms. In a changing climate, this will not be sufficient. Can blue-green infrastructure handle extreme storms more cost-effectively than gray infrastructure?

Likelihood of Experiencing 2-year return period storms	
In any given year	50%
Over 2 years	75%
Over 5 years	97%
Likelihood of Experiencing 5-year return period storms	
In any given year	20%
Over 2 years	36%
Over 5 years	67%
Likelihood of Experiencing 25-year return period storms	
In any given year	4%
Over 2 years	8%
Over 5 years	18%



Stormwater drains in Kosasthalaiyar Basin where capacities would exceed during a 5 year return period storm

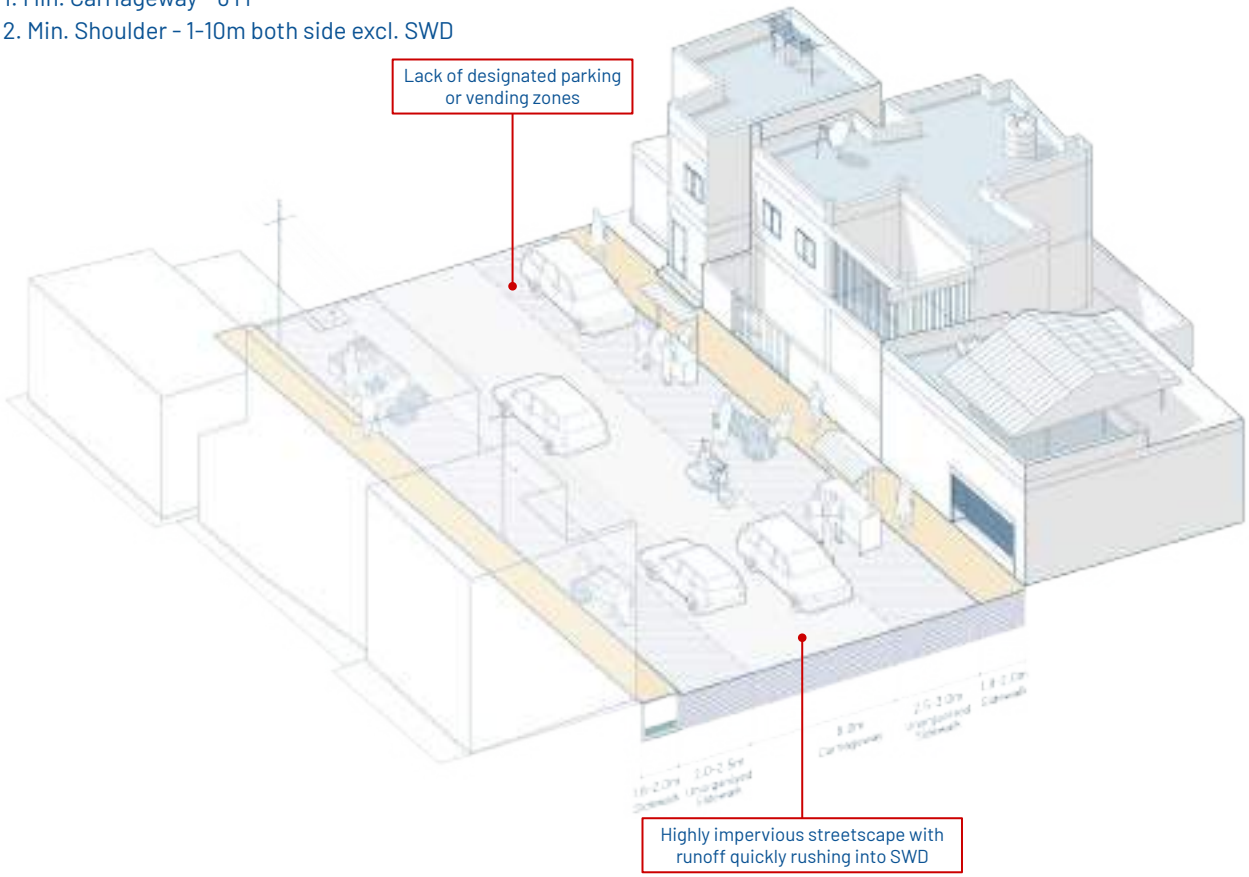
We determined the spatial feasibility of BGI within the urban fabric and tested their hydrological impact

From detailed land cover mapping to Sponge City framework

Sponge Street Potential | Primary Street

Criteria:

1. Min. Carriageway - 6 M
2. Min. Shoulder - 1-10m both side excl. SWD



Site Photo of Identified Primary Street

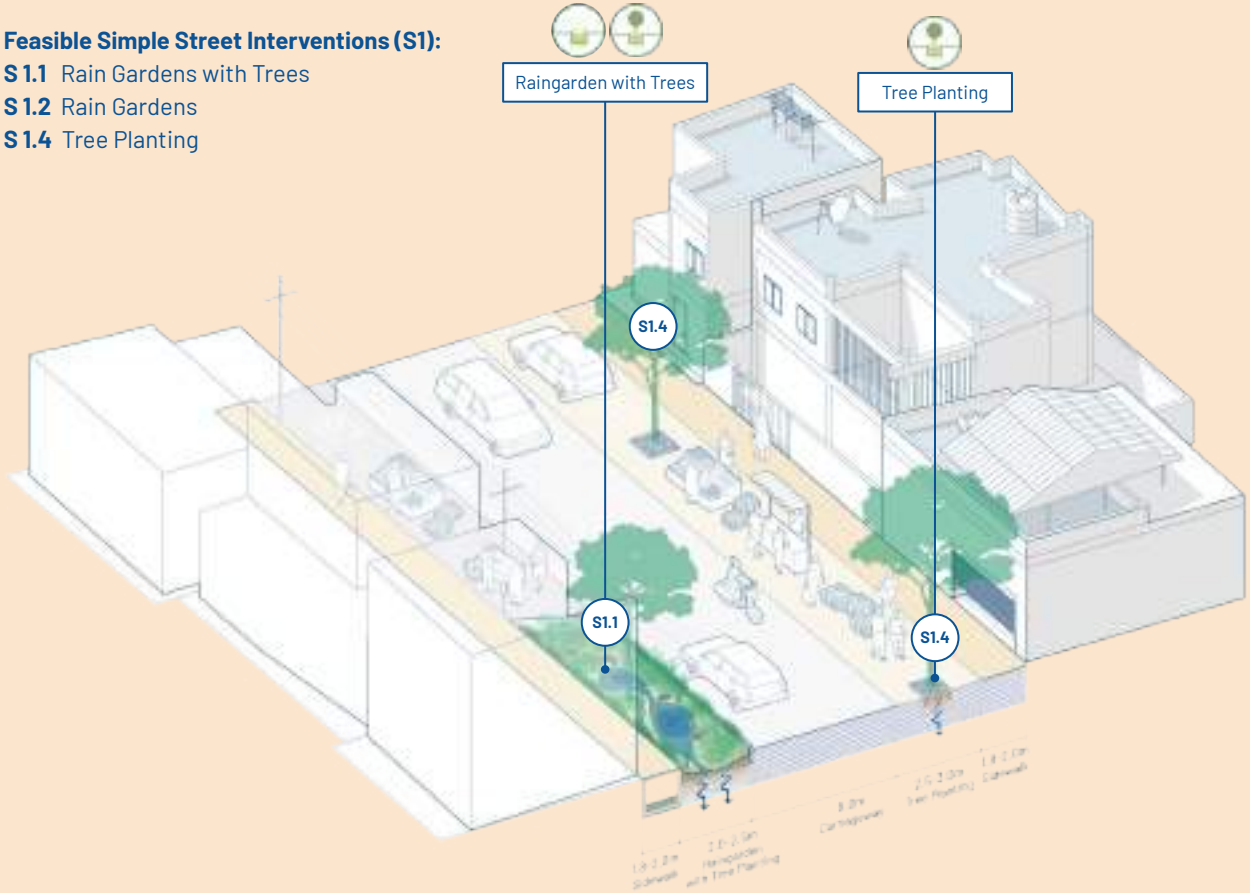
Identified Primary Streets

DETAILED FEASIBILITY: MATHUR-PERIYATHOPPUR CATCHMENT | Primary Streets

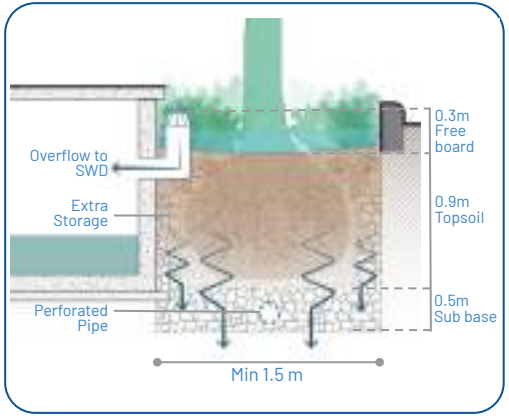
Sponge Street Potential | Primary Street

Feasible Simple Street Interventions (S1):

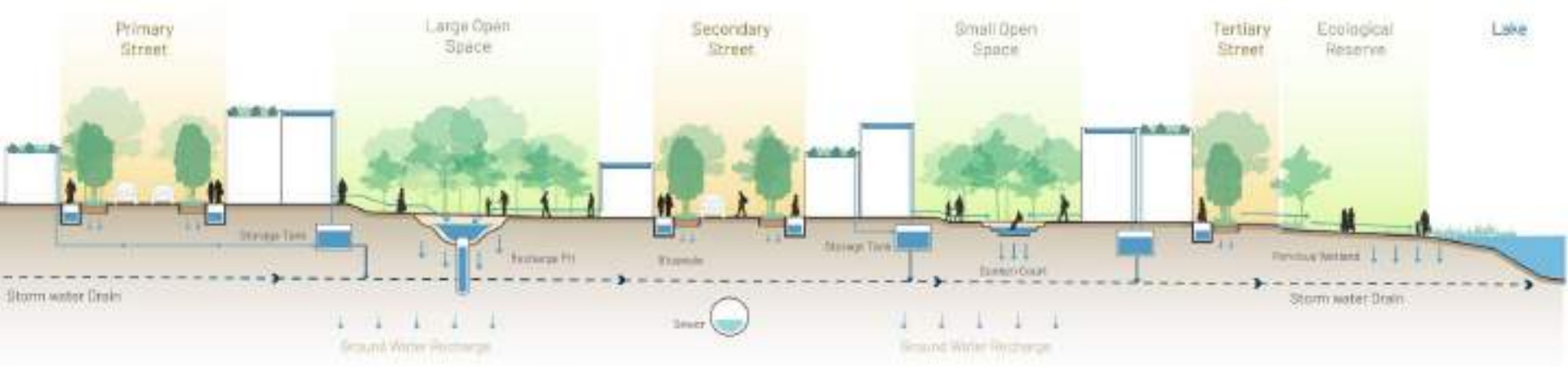
S 1.1 Rain Gardens with Trees
S 1.2 Rain Gardens
S 1.4 Tree Planting

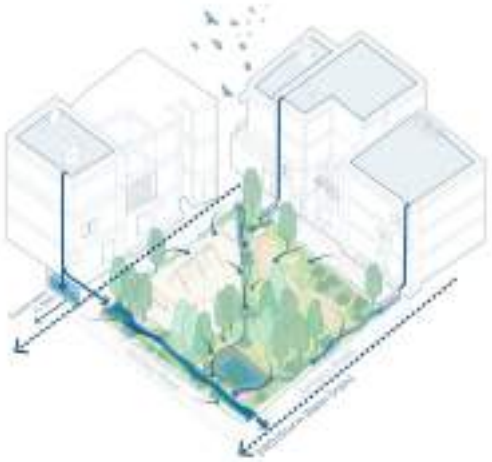


S 2.1 Rain Garden with Storage

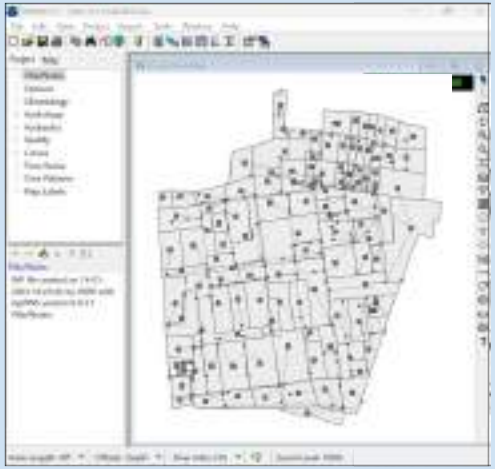


Reference Images

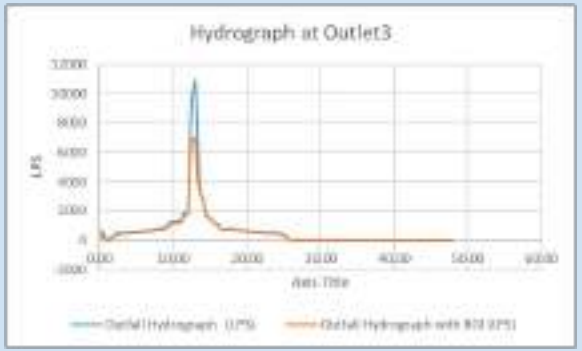

Primary Street
Large Open Space
Secondary Street
Small Open Space
Tertiary Street
Ecological Reserve
Lake
Storage Tank
Recharge Pit
Bioswale
Storage Tank
Swales / Check Dam
Storm water Drain
Sewer
Storm water Drain

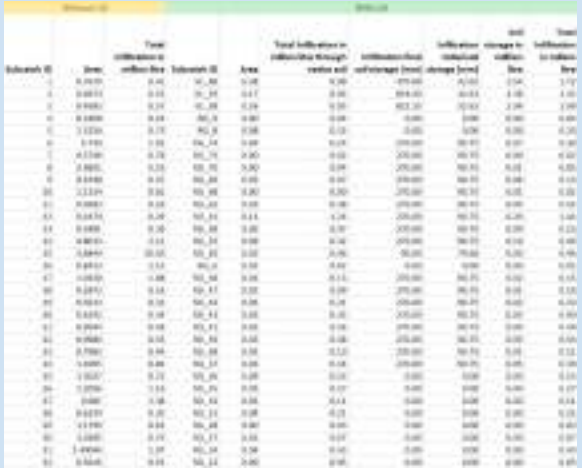


Field Visit & Soil Conductivity Testing

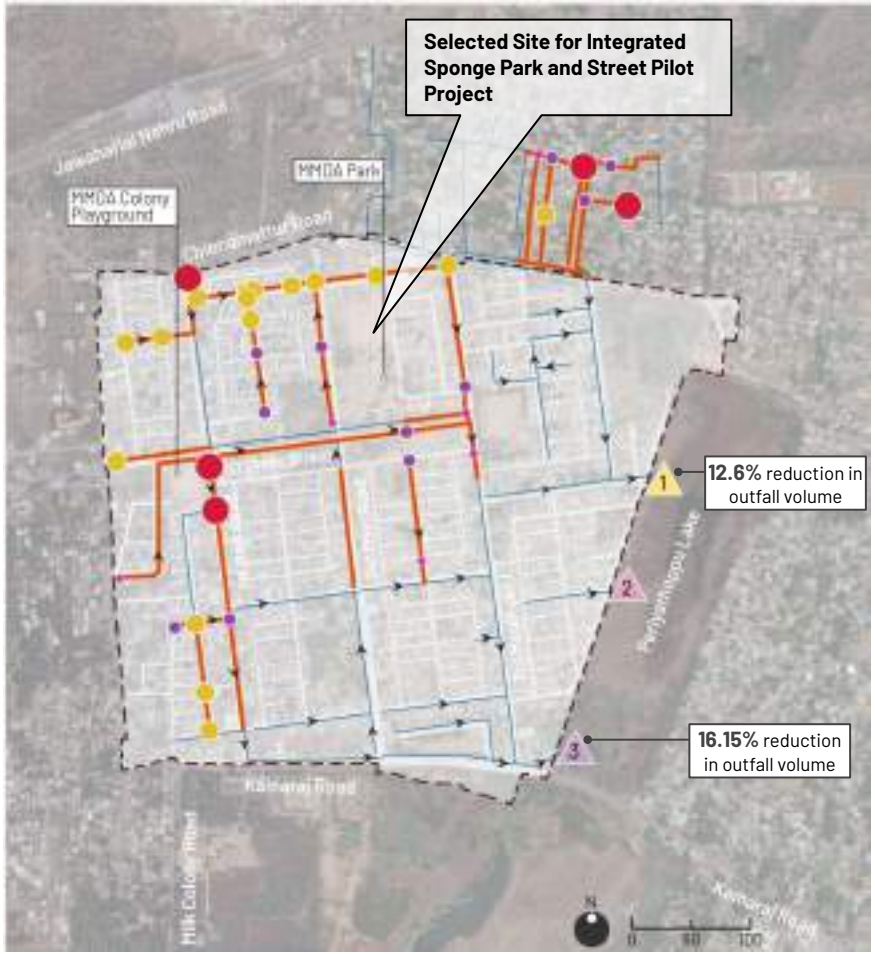


Dynamic Hydrological Modeling





Simulation results from 5, 10, 25 year R.P storms with and without blue-green infrastructure



Proposed BGI network can prevent flooding in a 25-year R.P. storm for an investment of

₹ 7.98 Crores

How much would it cost to upgrade stormwater conduits to prevent flooding from a 25-year storm?

₹ 17.3 Crores

BGI investment results in a ₹ 9.32 Cr savings on top of offsetting losses from more extreme storm events and provides the following benefits:

	Baseline (Without BGI)	Interventions (With BGI)
Runoff (in million L)	122.61	111.88 (-8.75%)
Infiltration (in million L)	68.40	74.12 (+8.3%)

Duration of Flooding in Junction during 5 yr. R.P. storm

- Less than 15 minutes
- 15 - 30 minutes
- 30 - 45 minutes
- 45 - 60 minutes
- More than 1 hour

Flooding in Conduits during 25 yr. R.P. storm

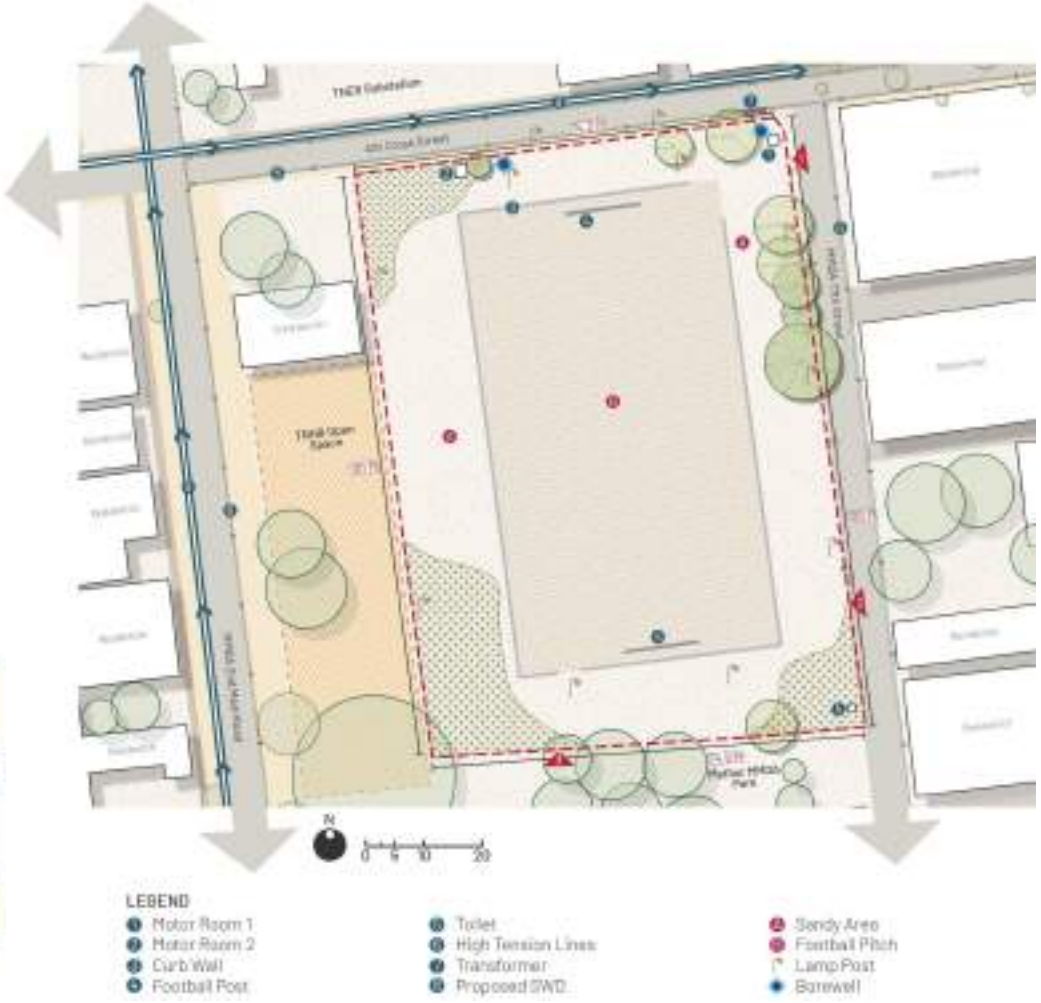
- Peak runoff exceeds designed capacity without BGI interventions
- Peak runoff does not exceed designed capacity in any scenario

Integrated Sponge Parks and Sponge Streets

MMDA Playground - Football Pitch

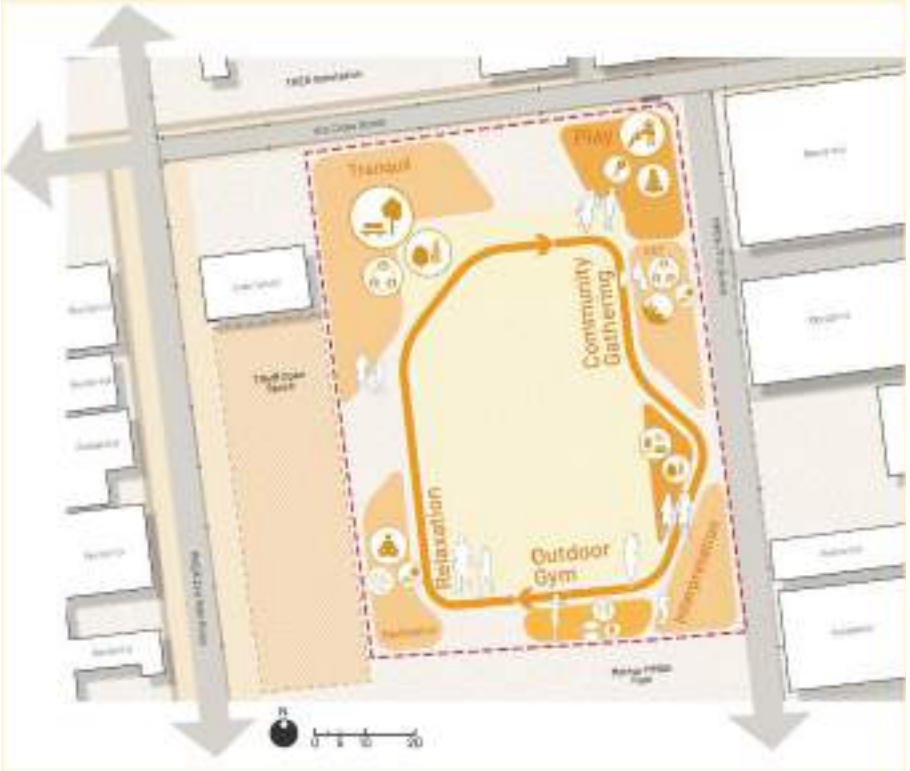
North Side Compound Wall

Adjacent TNHB Open Space

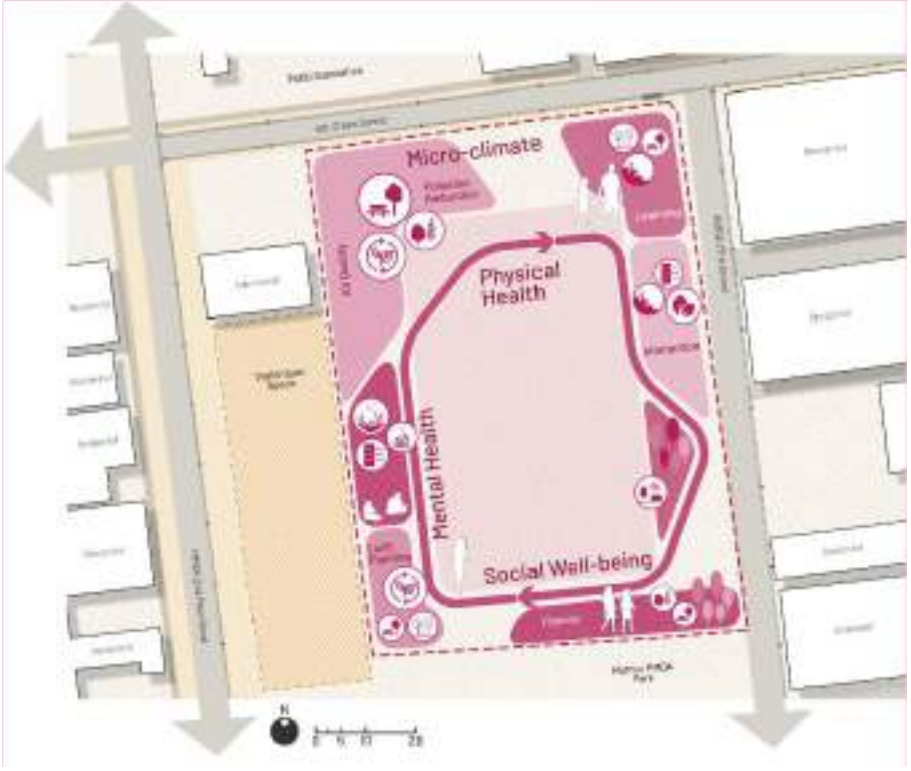


Pilot project will integrate social amenities with blue-green infrastructure

Neighbourhood Commons for Vibrant Social Life

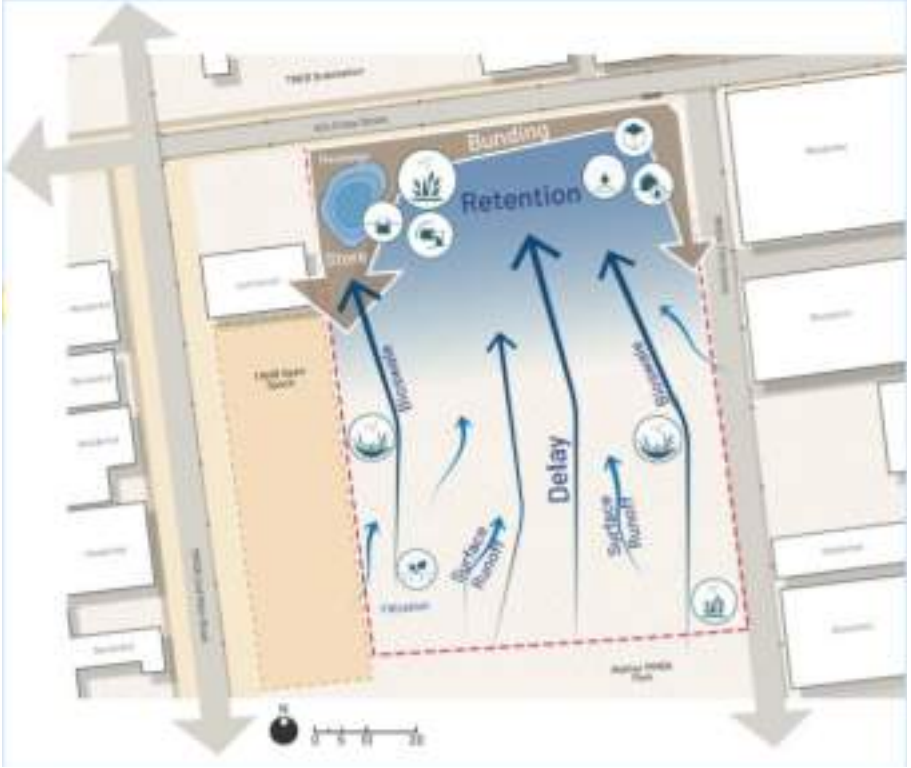


Green Park for Healthy Living



Habitat for Local Flora and Fauna

Infrastructure to Reduce Flooding and Raise Aquifers



> **Happy to see a park like this in our community which has no breathing space for old people and women like us**

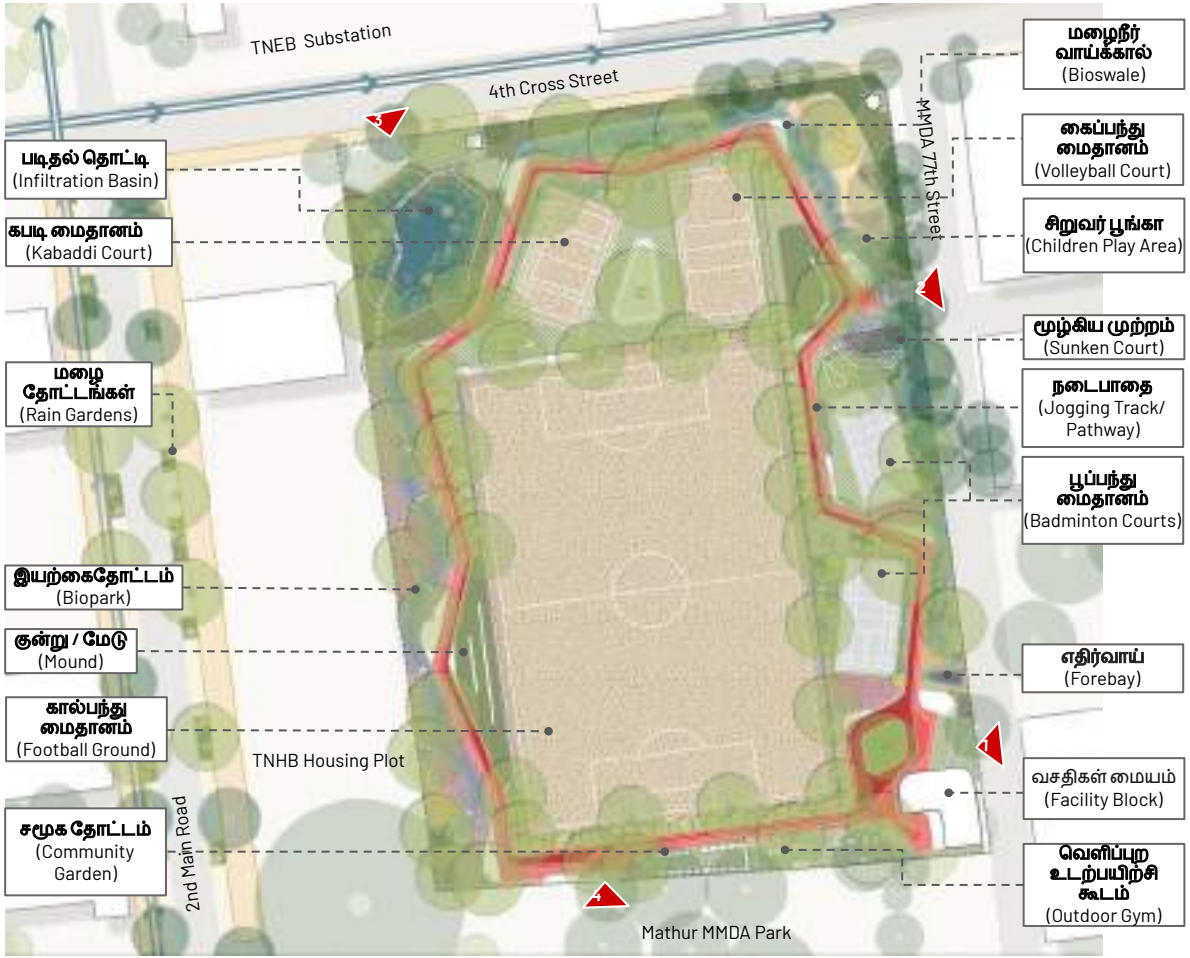
-Elderly man & Woman from the RWA

Neighbourhood Commons for Vibrant Social Life

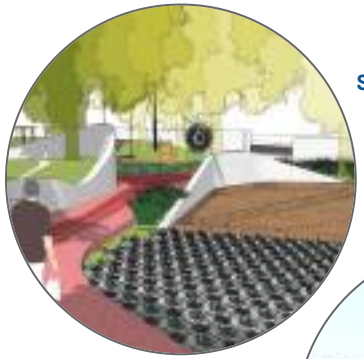
Green Park for Healthy Living

Habitat for Flora and Fauna

Infrastructure to Reduce Flooding and Raise Aquifers



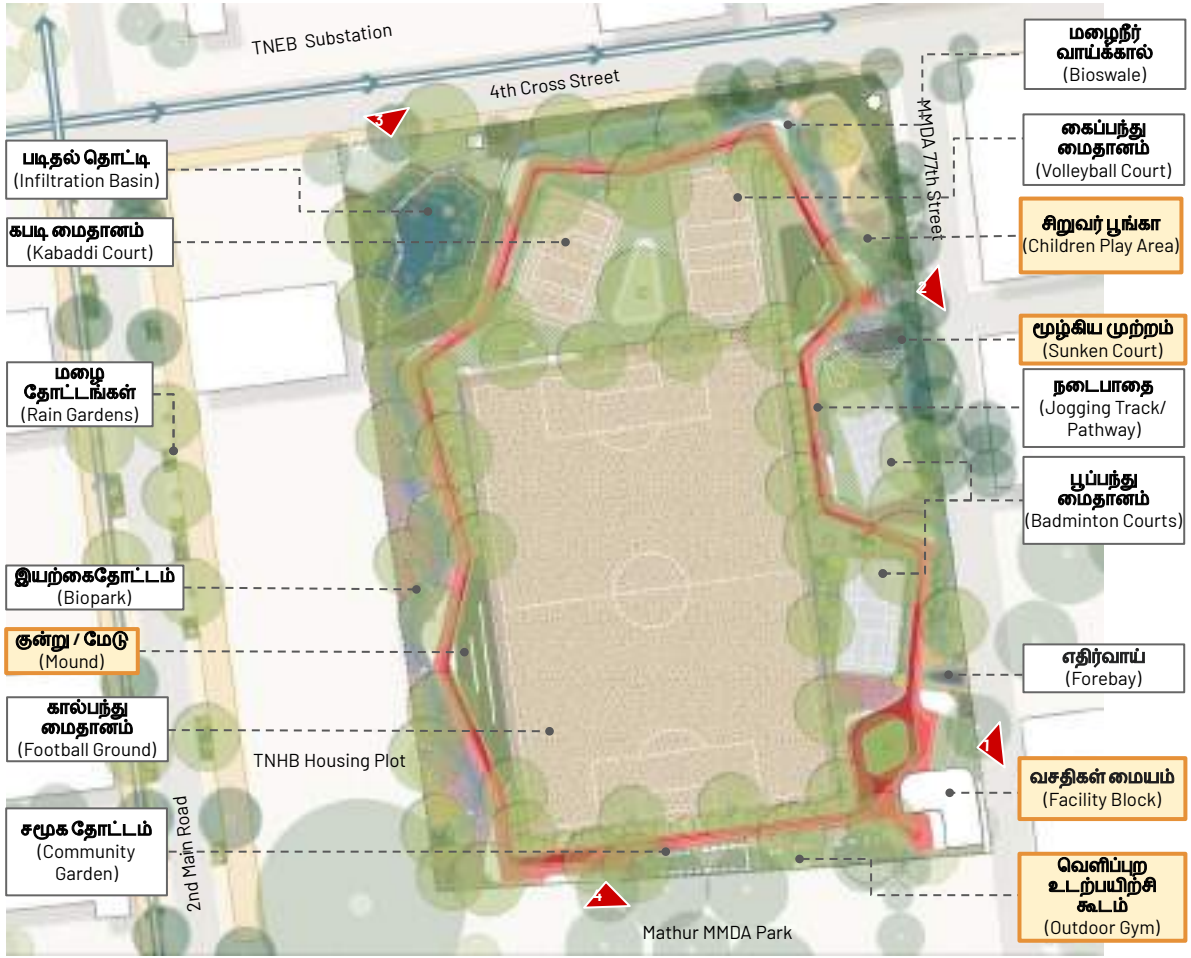
Neighbourhood Commons for Vibrant Social Life



Sunken Court

Childrens Play Area

Facility Block & Entrance



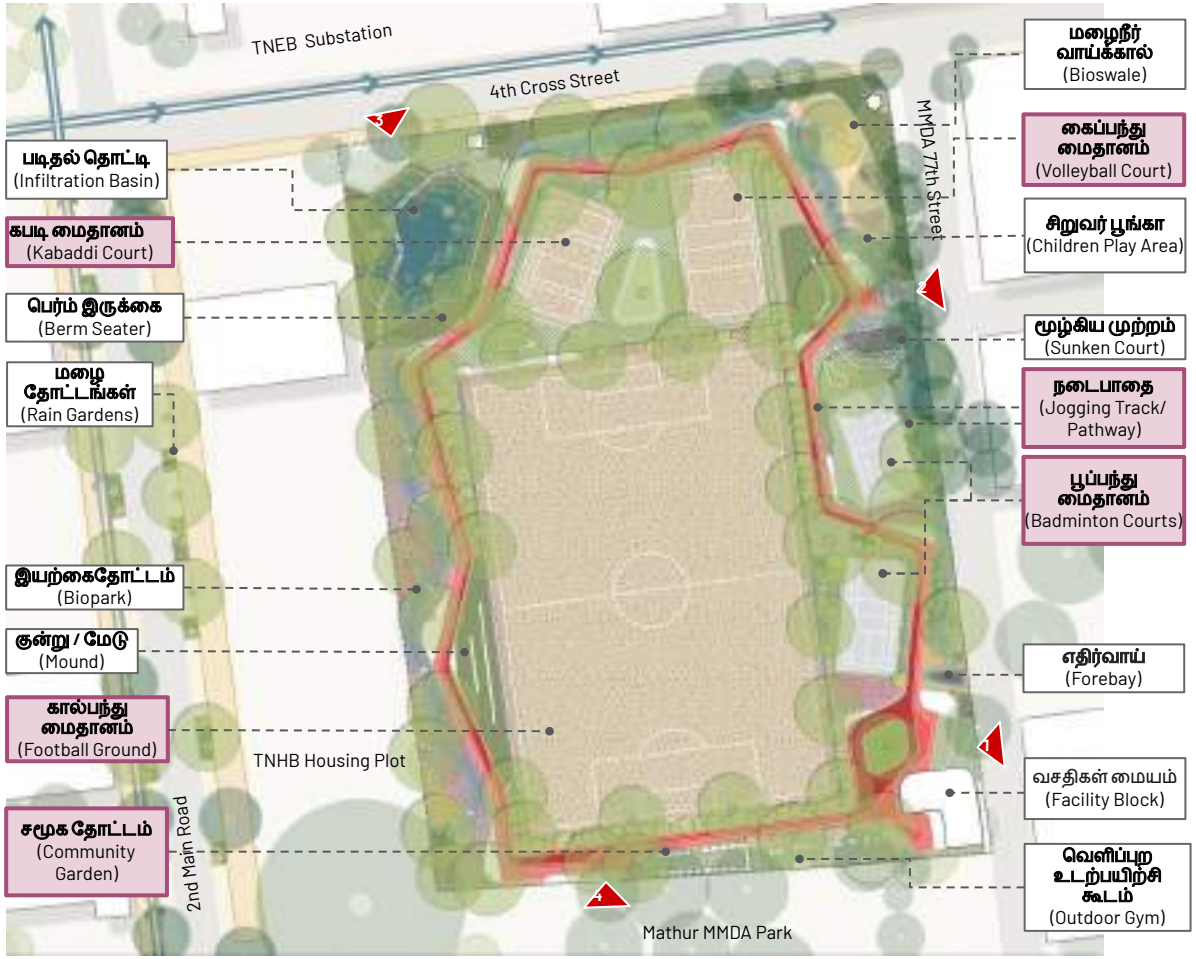
PILOT PROJECT | **Sponge Park as Social Amenity and Gathering Space**

Green Park for Healthy Living

7-a-side Football Ground

Current football ground during monsoons

Kabaddi Court



PILOT PROJECT | **Sponge Park as Recreational and Wellness Hub**

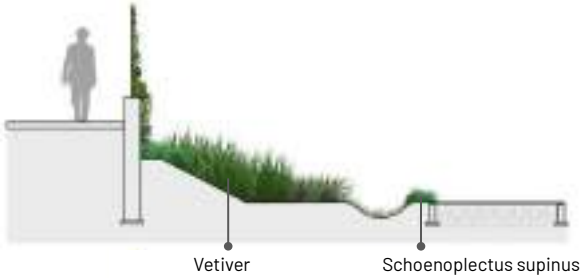
Habitat for Flora and Fauna

Biopark

Wetland park

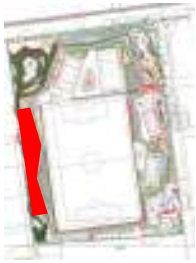
Herbal garden

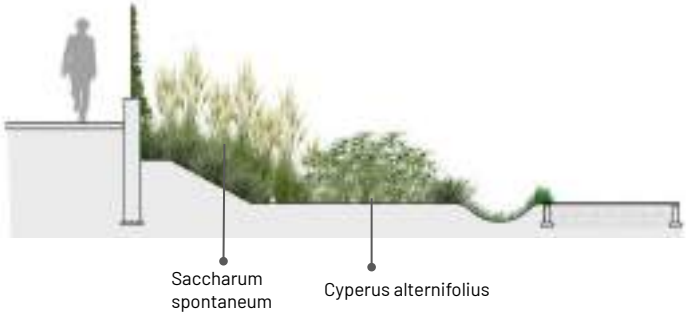

எல்லை சுவர்
(Compound Wall)
எதிர்வாய்
(Forebay)
யோகா பகுதி
(Yoga Deck)
இரண்டாம் நிலை நுழைவு
(Secondary) Pathway
மழைநீர் வாய்க்கால்
(Bioswale)
நடைபாதை
(Jogging Track/ Pathway)
குன்று / மேடு
(Mound)
Key Plan

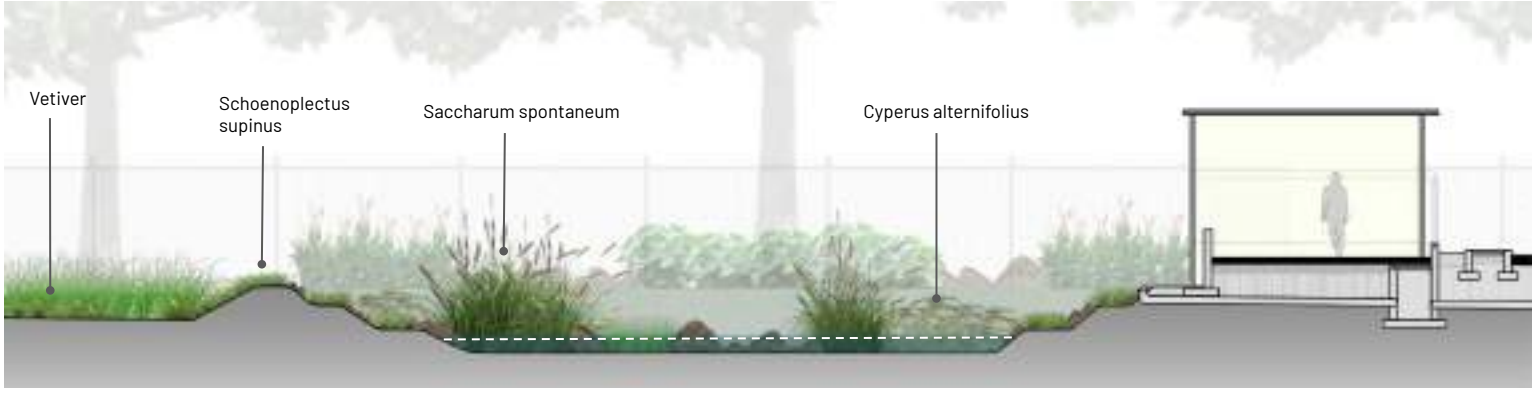


Wetland Zone

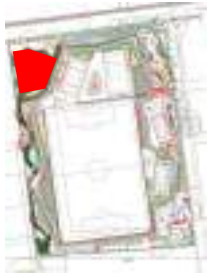
Biopark

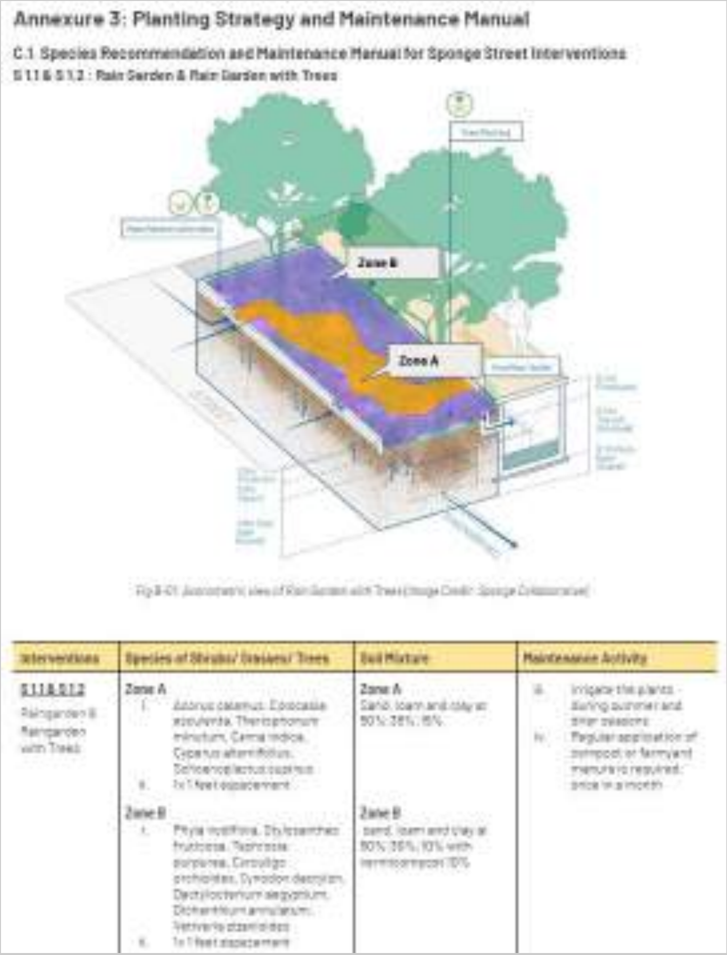






Bioinfilitration Basin





Trees	
Bauhinia purpurea	Purple orchid
Cassia fistula	Golden shower
Mimusops elengi	Purple orchid
Pongamia pinnata	Pungam
Shrubs	
Alpinia pulpurata	Ginger
Canna indica	Indian shot
Colocasia esculenta	Yam
Hygrophila auriculata	Neermulli
Ocimum tenuiflorum	Tulsi
Plumbago auriculata	Forget me not
Tabernaemontana	Crape jasmine
Grasses	
Cynodon dactylon	Arugampul
Cyperus alternifolius	Umbrella palm
Chlorophytum comosum	Spider plant
Eclipta prostrata	Karisalan kanni
Saccharum spontaneum	Kans
Schoenoplectus supinus	Scirpus
Vetiveria zizanioides	Vetiver
Cynodon dactylon	Arugampul
Climbers	
Passiflora incarnata	Krishna kamal

BGI are dynamic systems that depend on healthy vegetation to delay, infiltrate, store and cleanse the stormwater runoff.

A dedicated maintenance program is important to sustain them to be effective and aesthetic.

Maintenance Manual offers set of guidelines to maintain urban vegetation, for:

- Rain Garden
- Bioswale
- Tree Planting
- Soil Amendment
- Infiltration basin.

Infrastructure to Reduce Flooding and Raise Aquifers

Infiltration Basin

Bioswale

Forebay

Infrastructure to Reduce Flooding and Raise Aquifers

The Proposed "Sponge Park" receives water inflow from majorly through two inlets respectively **I1** and **I2**.

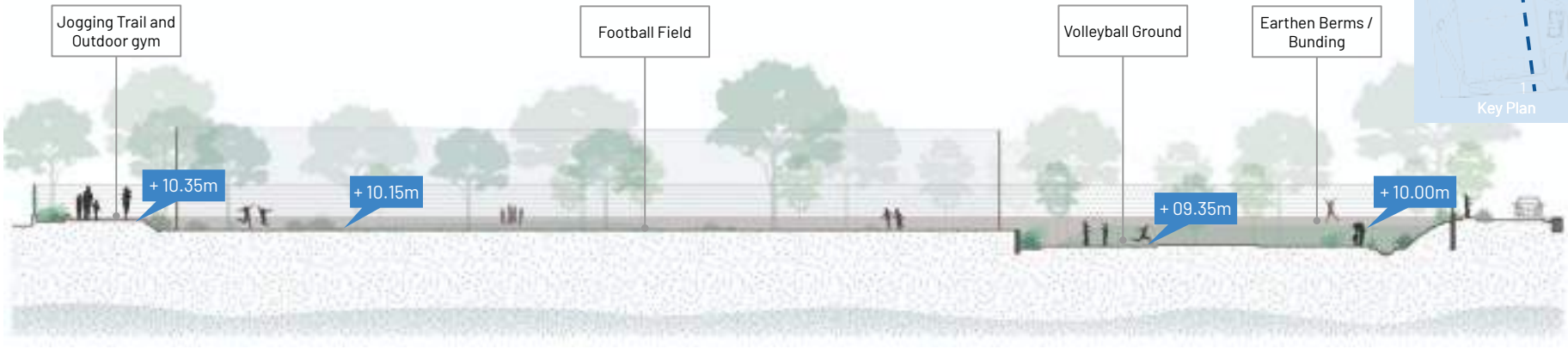
During moderate storms, the inflow through **I1** and **I2** will be stored in lower sections of the park and allowed to infiltrate through soil and bore wells.
During heavy storms, the park and the infiltration basins with recharge wells fill up.

Overflow from storm events in exceedance of 25 year R.P. are directed to stormwater drains with significant lag time.

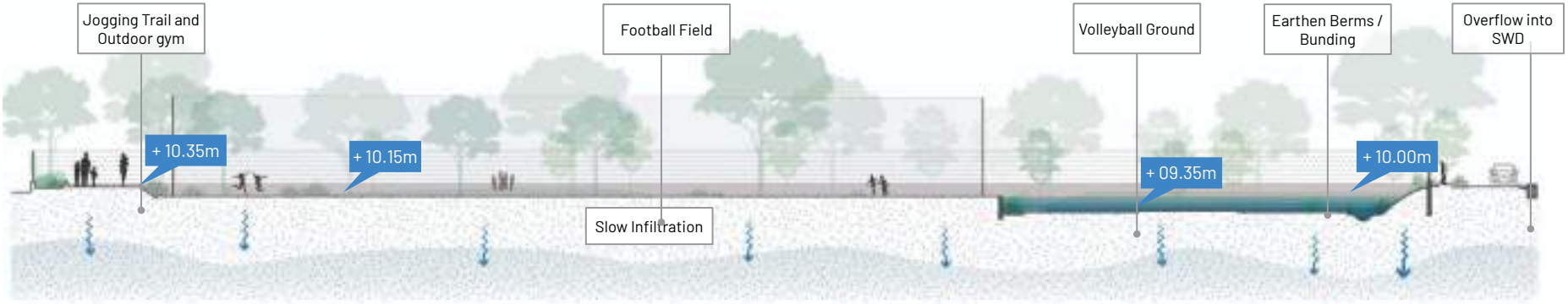
STORAGE	Area (m^2)	Volume (m^3)
Raingardens (R.G) on Street	84 m^2	100 m^3
Sunken Court (Red Hatch)	56 m^2	12 m^3
Infiltration Basin (Green Hatch)	255m^2	355 m^3
Shallow Park Grading	1190 m^2	328 m^3
Deep Park Grading	1567 m^2	862 m^3
TOTAL	**3152 m^2**	**1,657 m^3**

PILOT PROJECT | **Sponge Park section to illustrate stormwater retention**

During Dry Periods



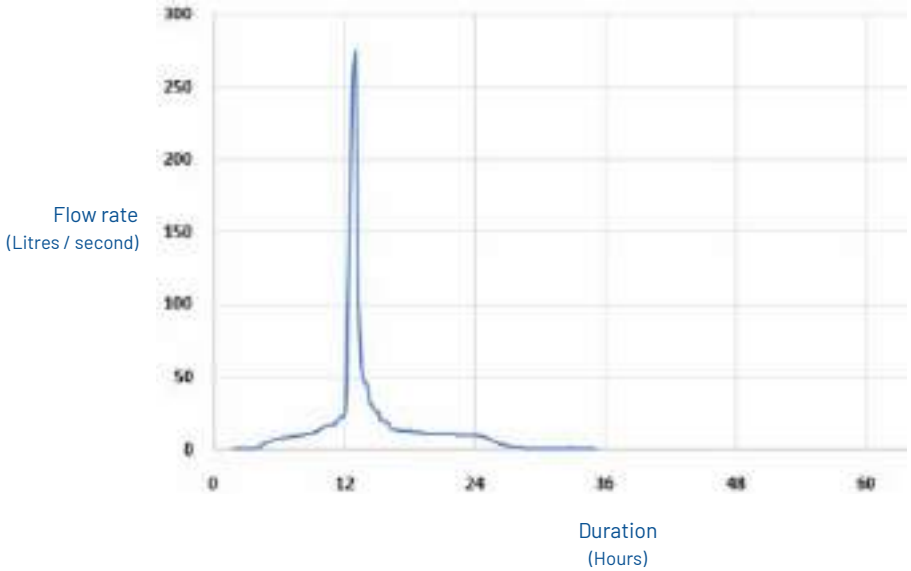
During Storms



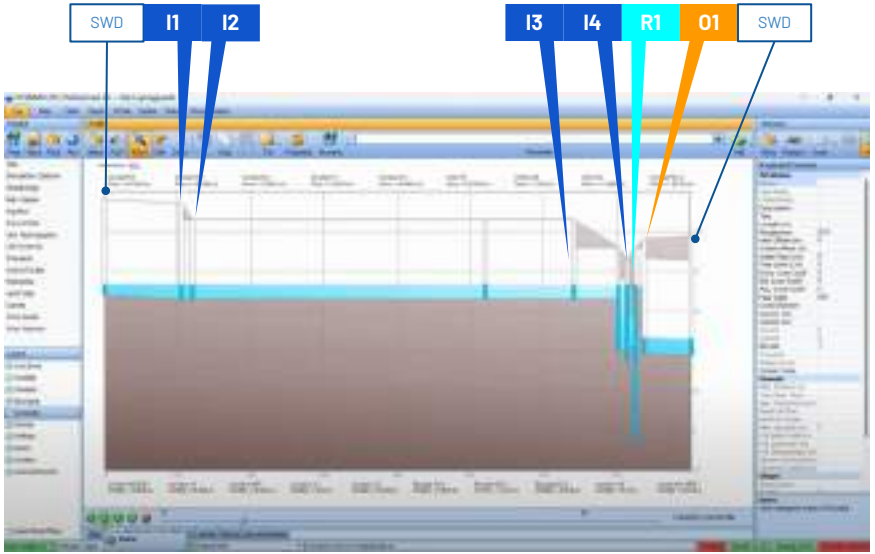
Section 1-1

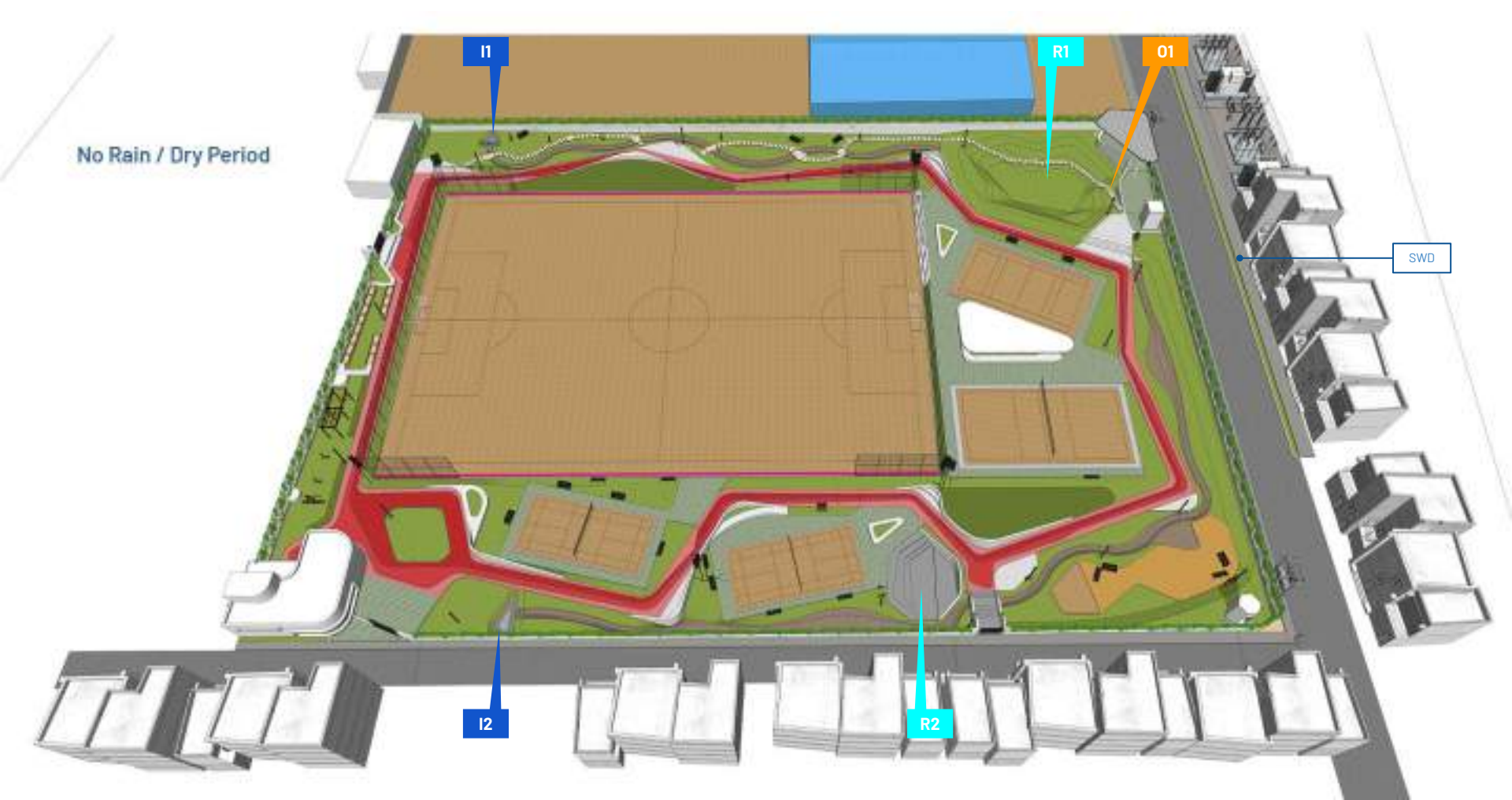
- The Proposed Sponge Park receives water inflow through two inlets.
- The total inflow over 24 hours during a 25 year return period storm through inlet I1 is **1,992 m^3**, which is contributed from west of sponge park.
- The total inflow through inlet I2 is **545 m^3**, which is contributed from east.
- The sponge park is able to store and infiltrate **3,797 m^3** of runoff volume.

Total Inflow Volume into Sponge Park through I1 during 25 year R.P. storms



Dynamic Simulation of 25 year R.P. storm over 24 hour period




No Rain / Dry Period
I1
R1
O1
SWD
I2
R2

What we have learnt

- **Strategic Planning:** Undervalued but critical for rapidly growing urban areas exposed to multi-hazards. Without planning small projects will be negated by unplanned regional development
- **Prioritization:** No clear guidelines or basis for prioritization of DRM projects esp. Lack of multi-sectoral projects in the pipeline because of underemphasis on strategic planning
- **Project Planning and Design:** Siloed approach for mono-functional projects even within "integrated" projects. Aquifer recharge potential of flood mitigation infrastructure not considered
- **Procurement:** Prohibitive requirements and lowest-cost model inhibits innovation and involvement of qualified consultants in public sector projects

What we have learnt

- **Detailed Design:** Prevailing standards and capacities lead to traditional gray solutions. Lack of design guidelines on NbS
- **Finance:** Lack of consideration of co-benefits, O&M costs over time, and resilience to climate change
- **Construction:** Lack of qualified vendors and consultants due to tendering practices and absence of products not mandated by regulations
- **Operation & Maintenance:** Requires capacity building at urban local body levels and considerations during design and financing of project
- **Repurposing:** Lot of opportunities for retrofitting streets and open spaces but require design expertise and consortium of consultants / departments to implement

Points for Discussion

- **Institutional Reform:** Design Manuals and Standards at National Level (CPHEEO), Regulations and Bylaws at Local Level (Risk-sensitive Land-use Planning, Stormwater management Guidelines)

- **Capacity Building:** Updating Engineering Curriculum at National Level, Training for Municipal Engineers and Maintenance Personnel at Local Level

- **Inter-governmental and multi-scalar Coordination:** Coordination of blue-green infrastructure strategies and investments at metropolitan, municipal, and ward levels

- **Inter-departmental Coordination:** Coordination for the integration of multiple systems for implementation and maintenance of blue-green infrastructure (Public Works Department with Department of Roads, Stormwater, and Park)

- **Procurement Reform:** Prohibitive qualifications for Municipal and Multilateral procurement for innovative firms in blue-green space competing against low-bidding firms with decades of gray infrastructure experience

- **Green-Blue / Climate Financing:** Unlocking new finance models including blended finance, public-private collaborations to finance the planning, design, implementation and maintenance of blue-green infrastructure

Contact Us

sourav@spongecollaborative.com
manushi@spongecollaborative.com
praveenraj@spongecollaborative.com