Sponge Park Framework for Resilient Open Spaces - Greater Chennai Corporation

Final Workshop | April 26, 2024

sponge collaborative
Chennai | Bengaluru
Kolkata | Lyon

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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Project Objective and Significance

- **Assess institutional gaps within GCC on understanding of Sponge City and evaluate current implementation practices of Sponge Parks**
- **Develop a spatial framework for prioritising Sponge Parks using pre-existing datasets and providing a Zone-wise summary of prioritised OSRs for Sponge Park upgrading**
- **Design toolkits and guidelines for planning, designing, finance, procure, implement, and maintain Sponge Parks for typological size and conditions**

Over the past 4 months, our team has developed a manual to help GCC transform OSRs into Sponge Parks

	OCT	DEC	JANUARY				FEBRUARY				MARCH					APRIL				MAY
STAGES AND ACTIVITIES	27/10	29/12	5/1	12/1	19/1	26/1	2/2	9/2	16/2	23/2	1/3	8/3	15/3	22/3	29/3	5/4	12/4	19/4	26/4	5/5
TASK 0. KICKOFF AND INCEPTION REPORT																				
Activity 0.1. Kickoff Meeting and Data Gathering Plan	M1																			
Complete data from GCC Received on 27/12																				
Deliverable D-01: Inception Report					D-01															
TASK 1. GAP ASSESSMENT AND SCENARIO MAPPING																				
Task 1.1. Scenario Mapping																				
Activity 1.1.1. Stakeholder Mapping and Policy Review																				
Activity 1.1.2. Open Space Mapping and Analysis																				
Activity 1.1.2. Surveys and Key Informant Interviews																				
Deliverable D-02: Baseline Assessment and Situation Analysis for Sponge Park in GCC									D-02											
Task 1.2. City-level Framework for Prioritising Sponge Park																				
Activity 1.2.1. Strategic Framework for Sponge Parks																				
Activity 1.2.2. Spatial Framework for Sponge Parks																				
Activity 1.2.3. Stakeholder Consultation Workshop									W1											
Activity 1.2.4. Environmental and Technical Toolkits for Sponge Parks																				
Activity 1.2.5. Social and Development Toolkits for Sponge Parks																				
Deliverable D-03: Roadmap for Sustainable Urban Development						M2a							D-03							
TASK 2. INSTITUTIONAL STRENGTHENING AND CAPACITY BUILDING																				
Task 2.1. Institutional Capacity Building																				
Activity 2.1.1. Gap Analysis of Institutional Arrangement and Capacities																				
Activity 2.1.2. Technical Training and Capacity Building																			T1	
Deliverable D-06: Institutional Gap Assessment and Capacity Building Materials																			D-06	D-06
TASK 3. DOCUMENT BEST PRACTICES ON IMPLEMENTING SPONGE PARKS																				
Task 3.1. Documentation of Best Practices																				
Activity 3.1.1. International and National Case Study																				
Deliverable D-04: Documentation of International and National Cases														M2b	D-04					
Task 3.2. Detailed Implementation Guidelines																				
Activity 3.2.1. Planning, Design, Procurement Guide																				
Activity 3.2.2. Construction, Maintenance and Monitoring Guide																				
Deliverable D-05: Detailed SOPs for Sponge Park Implementation																	D-05			M4

We are here

- Review of Sponge Park Implementation ***Complete***
- Open Space Analysis ***Complete***
- Capacity Interviews ***Complete***

- Strategic and Spatial Framework for Sponge Park prioritisation ***Complete***
- Preliminary results for Validation ***Complete***

- Presentation of Sponge Park Manual ***TODAY***
- Training Workshop on Using Manual ***TODAY***

- Draft Manual ***Complete***
- Final Manual with Annex and Workshop Proceedings To be *Complete after Workshop*

Agenda of Final Workshop

1. ## Project Significance and Framework
   - Why Chennai needs Sponge Parks
   - Sustainable Infrastructure Lifecycle
2. ## Gap Assessment and Sponge Park Manual Structure
   - Institutional Gap Assessment
   - Structure of the Manual
3. ## Spatial Framework for Prioritising Sponge Parks
   - The Potential of OSRs in Chennai
   - Priority Wards and OSRs for Sponge Parks
4. ## Overview of Sponge Park Manual
   - Strategic Planning for Sponge Parks
   - Designing Sponge Parks
   - Implementing Sponge Parks
   - Maintaining Sponge Parks
   - Improving Sponge Parks
5. ## Workshop

1

Project Significance and Framework

- Why Chennai needs Sponge Parks?
- Sustainable Infrastructure Lifecycle

Why does Chennai need Sponge Parks?

Flooding and Water Logging

Water Scarcity

Heat Wave

Water Pollution

Climate change is increasing the intensity and recurrence of extreme flooding, drought, and heat in Chennai

Catalysts for Integrated Storm Water Drainage Projects in Kosasthalaiyar, Cooum, Adyar and Kovalam Basins

Ongoing CMDA Stormwater Plan, Blue-green Infrastructure Study, and Third Master Plan

2004
Tsunami

2005
Cyclone Fanoos & Flooding

2008
Cyclone Nisha

Cyclone Nilam
2012

2015
Flooding
1.8 million people displaced and economic losses estimated at $7.43 billion – $14.67 billion
(Transforming Chennai, Okapi, 2016)

Cyclone Vardah
2016

2019
"Day Zero"
Four of the reservoirs ran dry

Cyclone Nivar
2020

Cyclone Mandous
2022

Cyclone Vardah
2023

2023
Heat
Hottest summer on record

2023 - 2046

Greater frequency of cyclones making landfall during 2002 and 2021 as compared to 1982-2001
(Hindustan Times, 2022)

Projected annual water deficit in the year 2050 is 4872 MCM
(Strengthening Climate Change Resilience in Urban India, ADB, 2019)

2.4°C - 2.5°C rise of temperature predicted by 2041-2070
(Challenges in Chennai City to Cope with Changing Climate,CCDM, 2020)

21.75 km² is under the threat of inundation to 0.5m sea-level rise
(Challenges in Chennai City to Cope with Changing Climate,CCDM, 2020)

The loss of green cover and water bodies to urban development reduces aquifer recharge in increases runoff

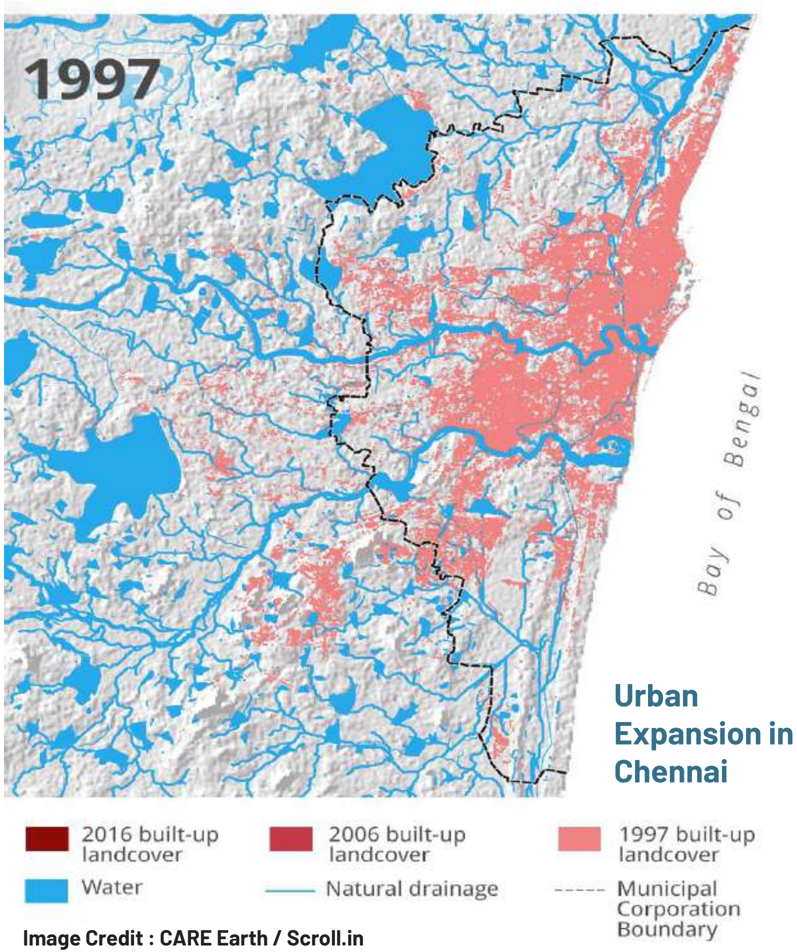


Image Credit : CARE Earth / Scroll.in

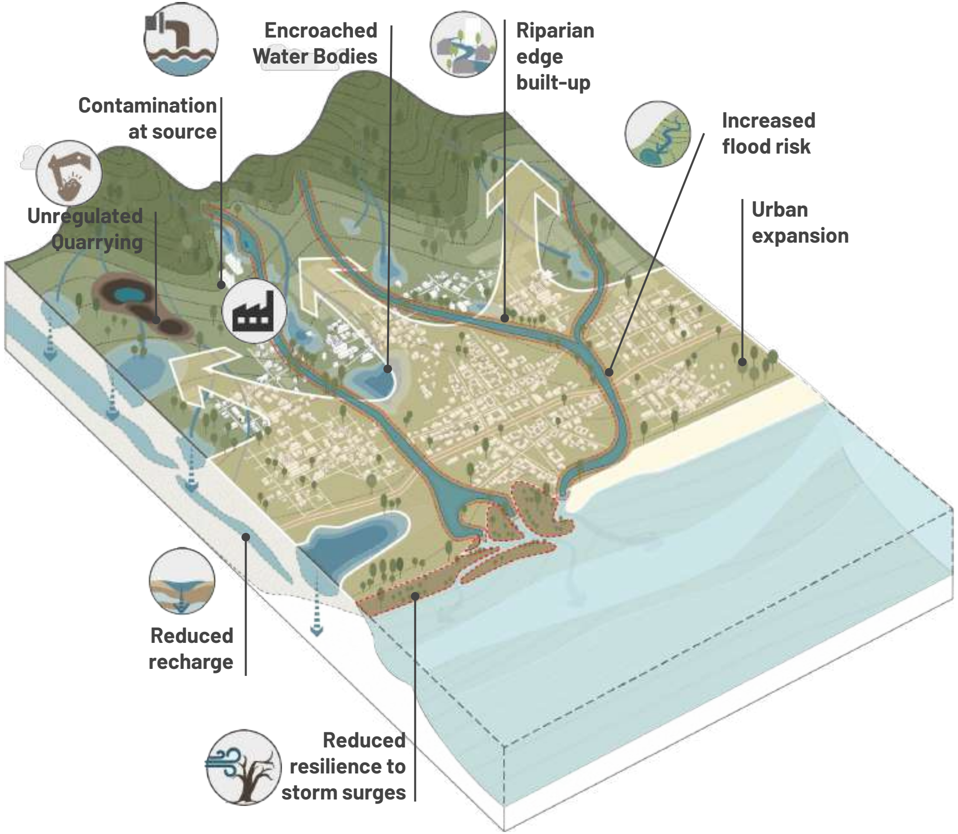
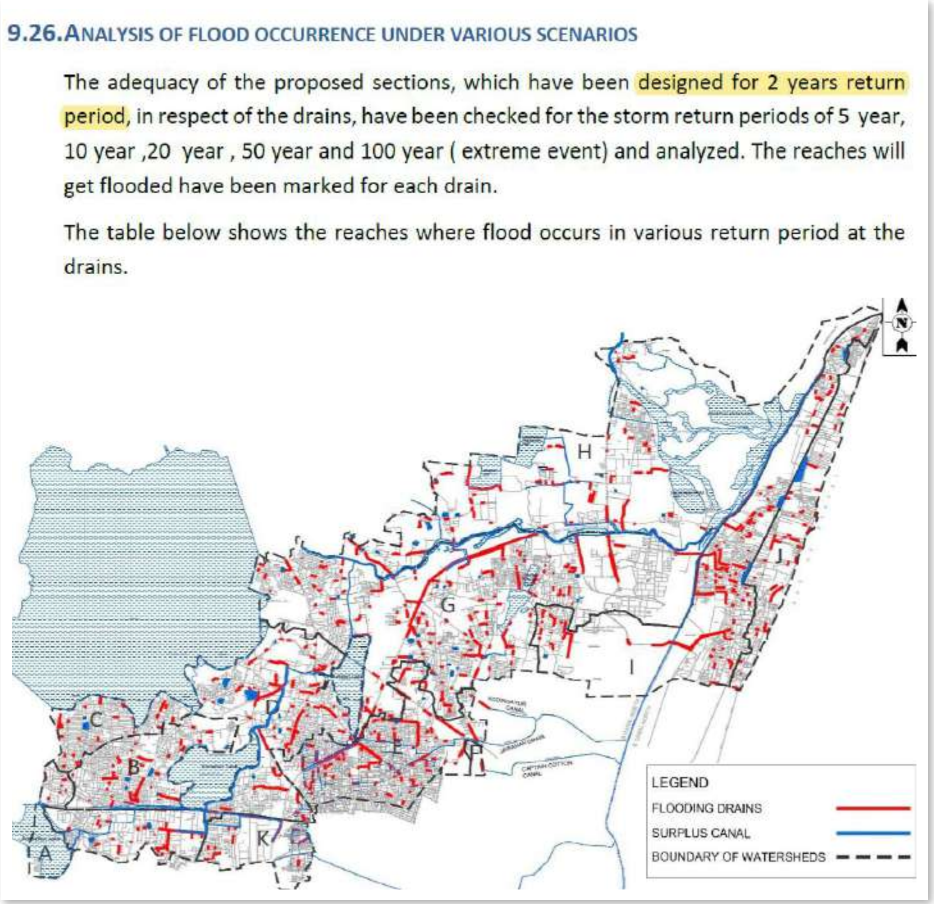


Image Credit : Sponge Collaborative

Stormwater drains in India are designed to handle 2 and 5 year storms. This degree of resilience will not be sufficient in a changing climate and increasingly urbanised catchments



9.26. ANALYSIS OF FLOOD OCCURRENCE UNDER VARIOUS SCENARIOS

The adequacy of the proposed sections, which have been designed for 2 years return period, in respect of the drains, have been checked for the storm return periods of 5 year, 10 year ,20 year , 50 year and 100 year (extreme event) and analyzed. The reaches will get flooded have been marked for each drain.

The table below shows the reaches where flood occurs in various return period at the drains.

Map from Kosasthalaiyar ISWD showing flood occurring sections during 5 year storm

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 10-year return period storms	
In any given year	**10%**
Over 2 years	**19%**
Over 5 years	**41%**

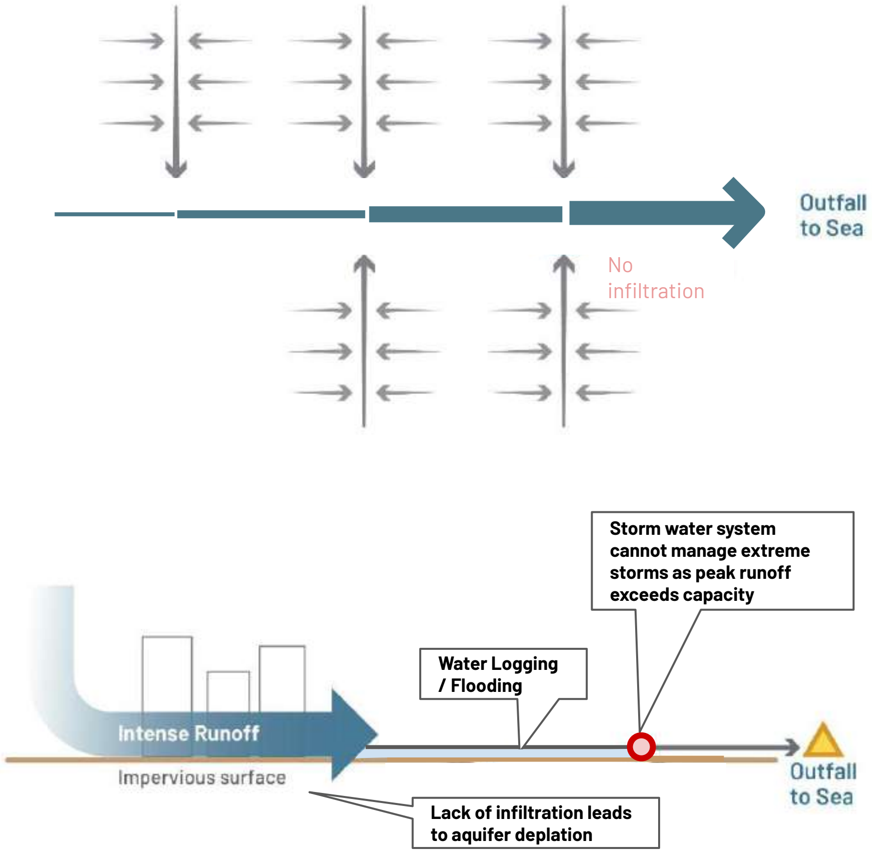
Likelihood of Experiencing 25-year return period storms	
In any given year	**4%**
Over 2 years	**8%**
Over 5 years	**18%**

Stormwater drains have a 20 - 50% chance of failing during a storm event in any given year

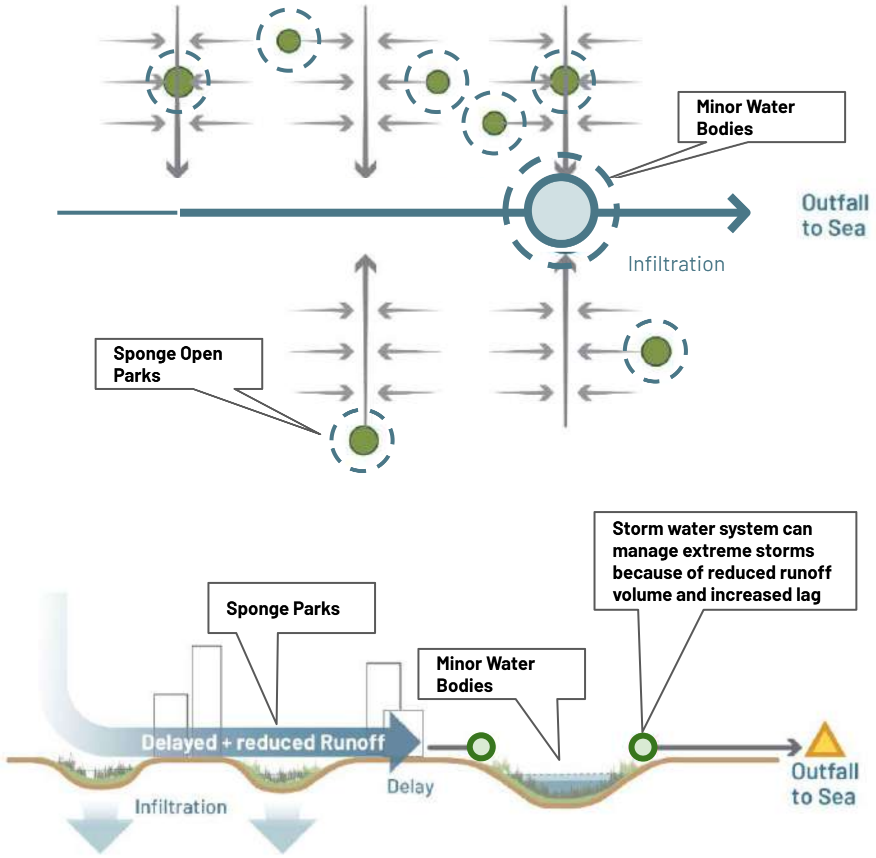
Blue-green infrastructure or Sponge Parks can cost effectively increase the capacity of gray infrastructure and make cities more resilient to extreme storms

Sponge Parks can help limit flooding and create opportunities for recharge as an urban blue-green network

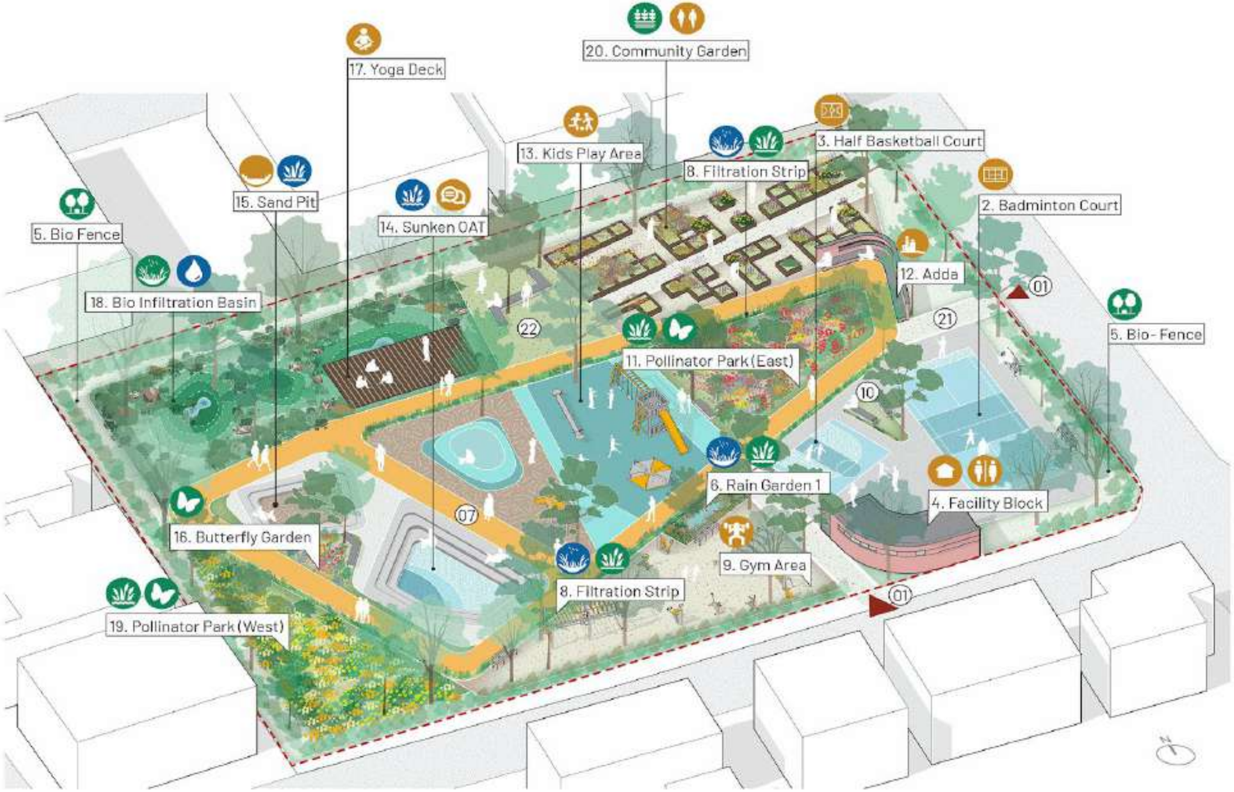
The Gray Infrastructure approach to flood mitigation



The Sponge City approach to flood and drought mitigation



Sponge Parks mitigate climate risks detain stormwater, recharge aquifers, and reduce ambient temperatures while providing social amenities to residents and a habitat for urban wildlife

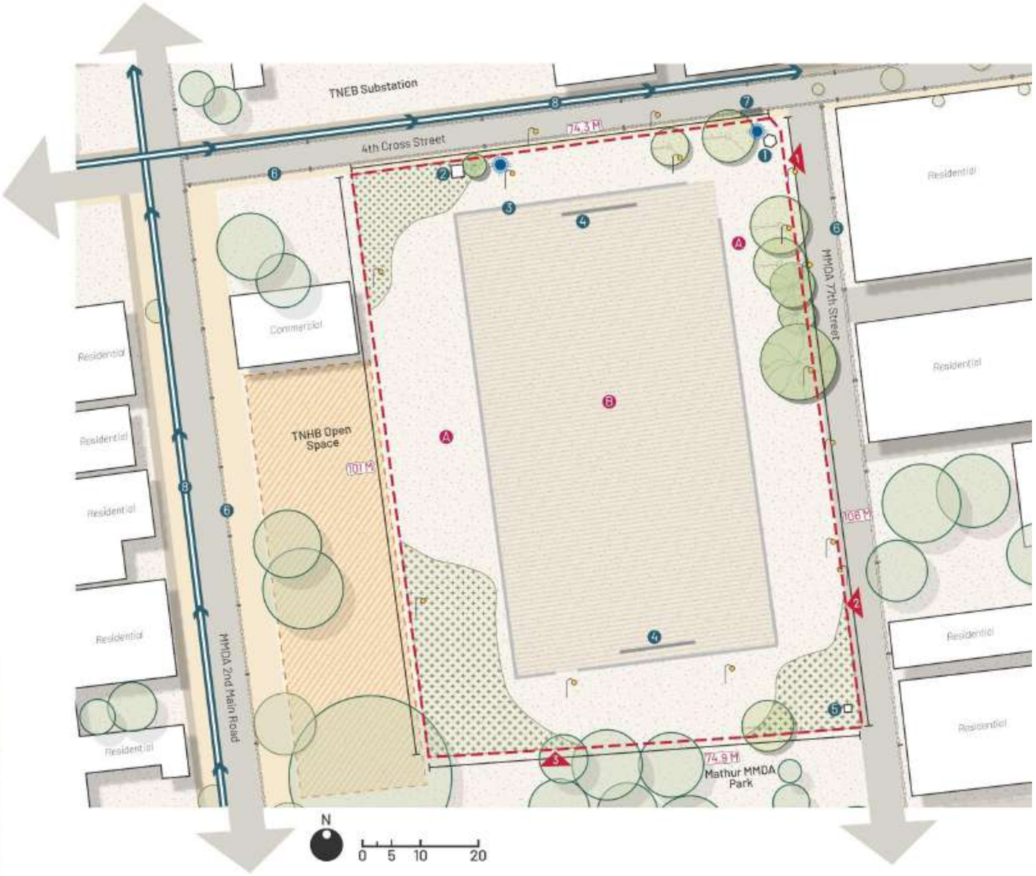


In Kosasthalaiyar Basin, we designed a Sponge Park pilot following a detailed feasibility study for the area

MMDA Playground - Football Pitch

North Side Compound Wall

Adjacent TNHB Open Space



LEGEND

1 Motor Room 1
2 Motor Room 2
3 Curb Wall
4 Football Post
5 Toilet
6 High Tension Lines
7 Transformer
8 Proposed SWD
A Sandy Area
B Football Pitch
Lamp Post
Borewell

Pilot project will improve open space by integrating more social amenities with blue-green infrastructure

We engaged the community of Mathur Colony so the Sponge Park is customised to meet local social and recreational needs

> **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

The design of the Integrated Sponge Park improves public spaces and biodiversity while mitigating multi-hazards

Neighbourhood Commons for Vibrant Social Life

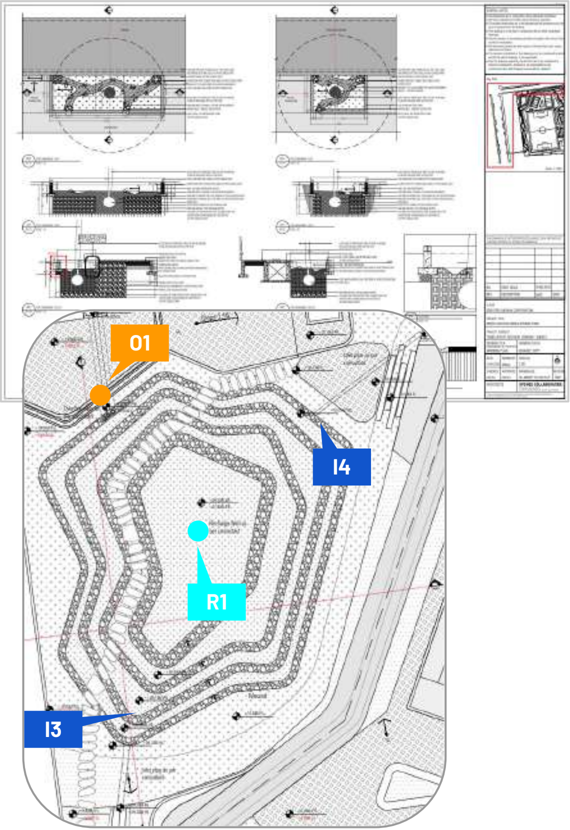
Green Park for Healthy Living

Habitat for Flora and Fauna

Infrastructure to Reduce Flooding and Raise Aquifers

Sponge Park is graded to temporarily detain runoff from extreme storm events while keeping streets and buildings safe

Infrastructure to Reduce Flooding and Raise Aquifers

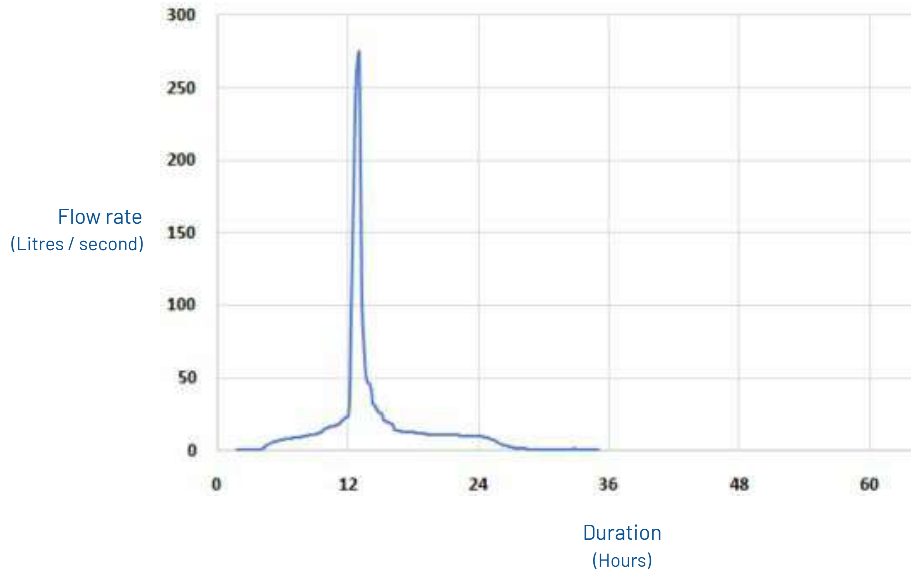


Hydrological modelling of the Sponge Park quantified runoff storage and infiltration volume achieved in extreme storms

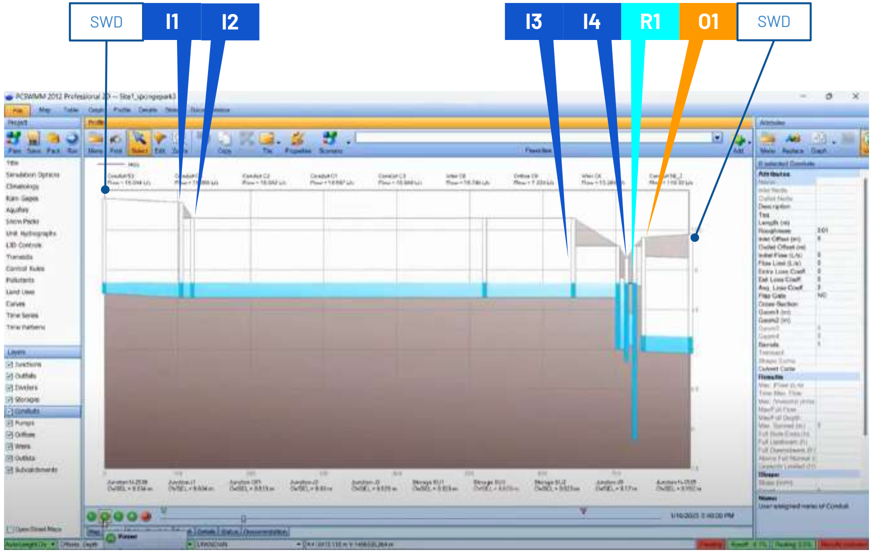
- The total inflow over 24 hours during a 25 year return period storm through inlet I1 is **1,992 m^3**, which is contributed from west of sponge park.
- The total inflow through inlet I2 is **545 m^3**, which is contributed from east.

Sponge City Park and Street Benefits	
Water Storage Volume (in m3)	1,657 m^3
Infiltration Volume (over a 24 hour period during a 25 year storm in m3)	3,797 m^3
Open space and Recreational Amenities	4,060 m^2

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



The Sponge Park helps the neighbourhood withstand flooding from 25 year storms and improves aquifer health

GCC has committed to the Sponge City approach by implementing Sponge Parks across various Zones and Wards

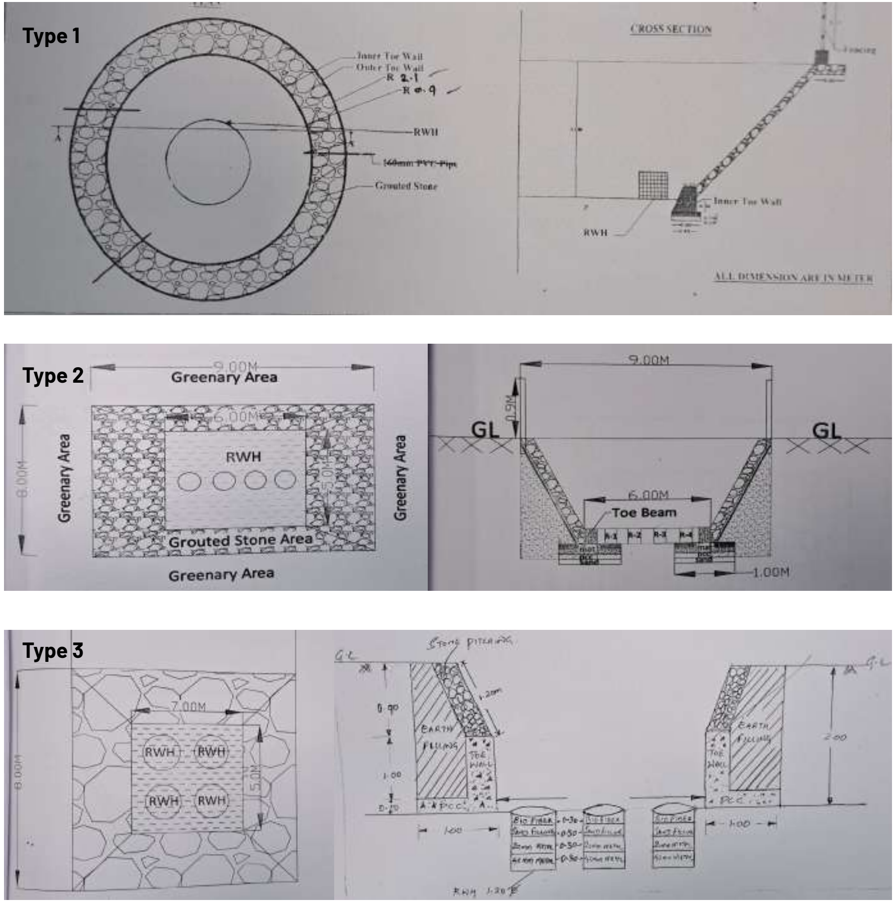
Sponge Parks by the GCC are created by the construction of pits of varying depths to store water draining into wells to recharge the aquifer

In Vartha park (sponge park 41 in zone 11), the recharge pit was constructed in a playground and then fenced, rendering the middle of the park inaccessible for social uses

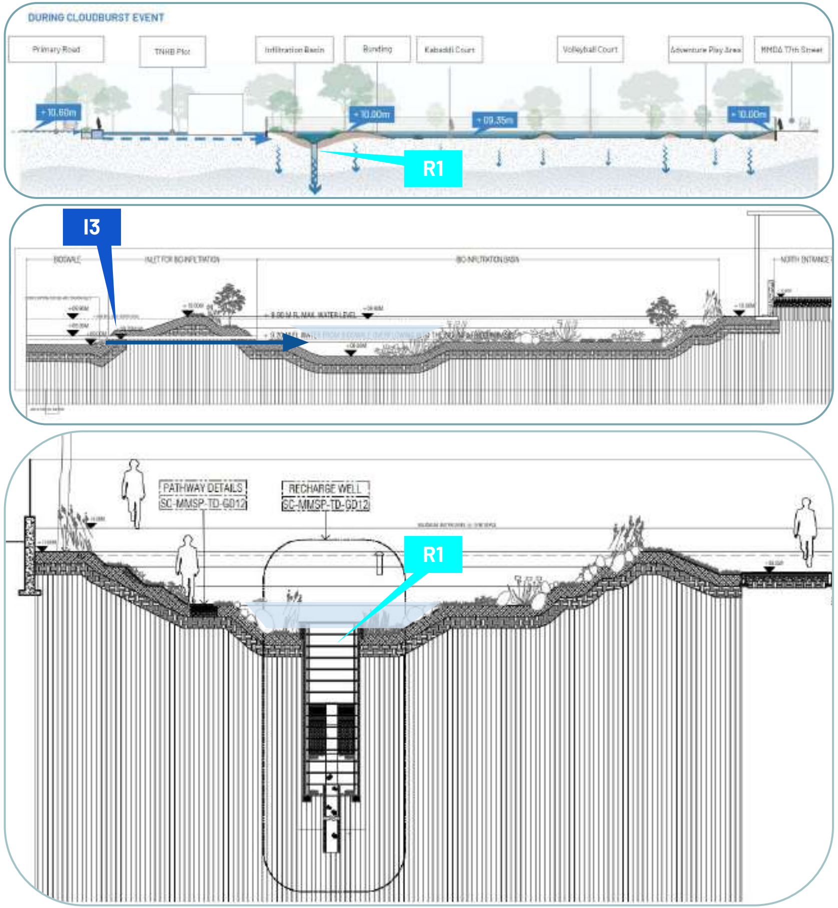
In Mayor sundar Rao park (sponge park 21 in Zone 5), the recharge pit did not drain the water after more than 10 days since the December floods. Leaf litter was seen collecting around recharge wells

In Vartha park (sponge park 41 in zone 11), the construction of the pit disrupted the jogging trail and led to an observed decline in users

We compared our technical drawings and spoke to engineers to understand how Sponge Parks could be improved



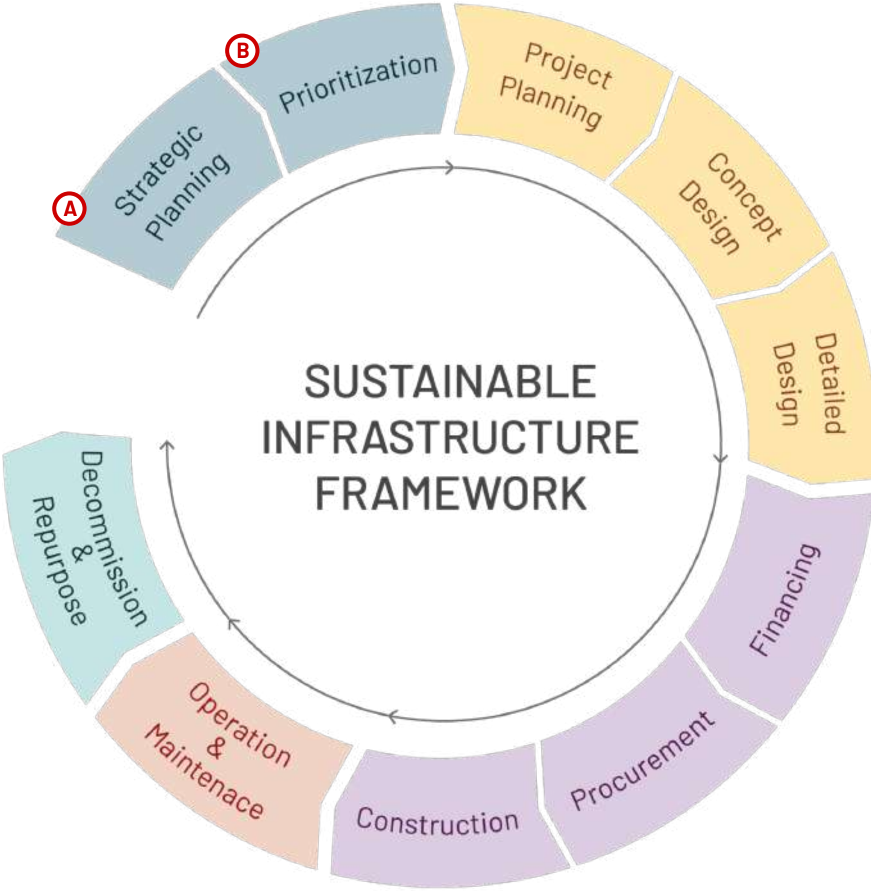
Sponge Park detail and schematic drawings from GCC



Integrated Sponge Park details by Sponge Collaborative

Sustainable Infrastructure Framework is used to assess capacity and structure the manual for Sponge Parks

"Sustainable Infrastructures are built or natural systems that provide services in a manner that ensures economic and financial, social (including gender), environmental (including climate resilience), and institutional sustainability in line with the Global Goals and over the entire infrastructure lifecycle, from strategic planning all the way to decommissioning." (GiZ, UNEP 2018)



A. Strategic Planning (Understanding Need)

- How does GCC identify the hydrological, infrastructural, and social need for Sponge Parks?
- Does the GCC make data-driven decisions or engage communities to determine the need for transforming open spaces?
- Is there a city-level, metropolitan, or basin scale framework for how Sponge Parks are planned as a network to mitigate disaster risks?

B. Prioritization (Prioritising Need)

- How does GCC prioritize which open spaces are upgraded into Sponge Parks?
- Does the GCC use social environmental pre-screening mechanisms, multi-criteria decision criteria, or geospatial tools to select open spaces?
- Is there adequate city-level, zonal level and ward level data to select priority open spaces for Sponge Park upgrading?

Sustainable Infrastructure Framework is used to assess capacity and structure the manual for Sponge Parks

C. Project Planning (Feasibility and Sizing)

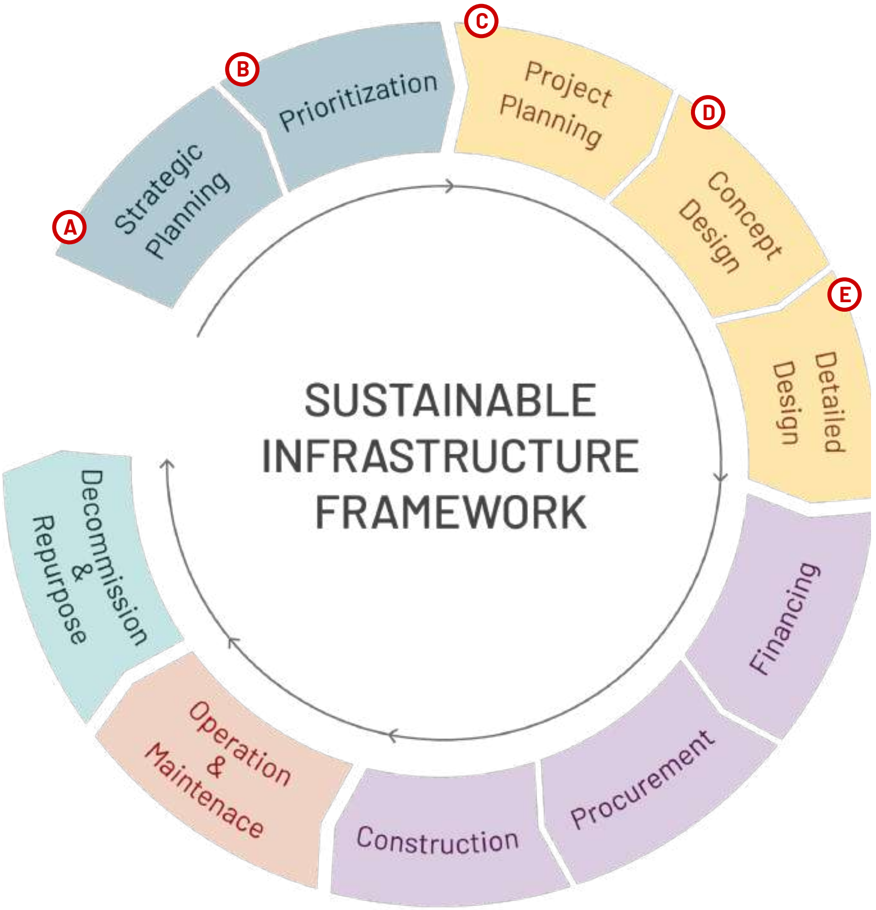
- How does GCC determine the feasibility, community need, social / environmental impact, and technical requirements of Sponge Parks?
- Does the GCC use flood modelling, soil and water testing, cost benefit analysis, and life cycle studies to determine infrastructural requirements from open spaces?
- Is there adequate technical and administrative capacity within GCC or academic/practitioner networks to determine the storage and recharge capacities required from Sponge Parks?

D. Concept Design (Programming and Siting)

- How does GCC design the layout, blue-green infrastructure components, and social amenities of Sponge Parks?
- Does the GCC use high performance landscape standards, best management practices, and placemaking principles towards improving open spaces?
- Is there adequate technical and administrative capacity within GCC or consultant networks and adequate information to design Sponge Parks?

E. Detailed Design (Hydrology and Specifications)

- How does GCC detail the grading, planting, blue-green infrastructure, social programs, and placemaking components of Sponge Parks?
- Does the GCC have design guidelines and specifications to ensure quality and implementable detailed design by consultant or contractor?
- Is there adequate administrative capacity within GCC and technically qualified providers for design and construction documentation towards tendering of Sponge Parks?



Sustainable Infrastructure Framework is used to assess capacity and structure the manual for Sponge Parks

F. Finance

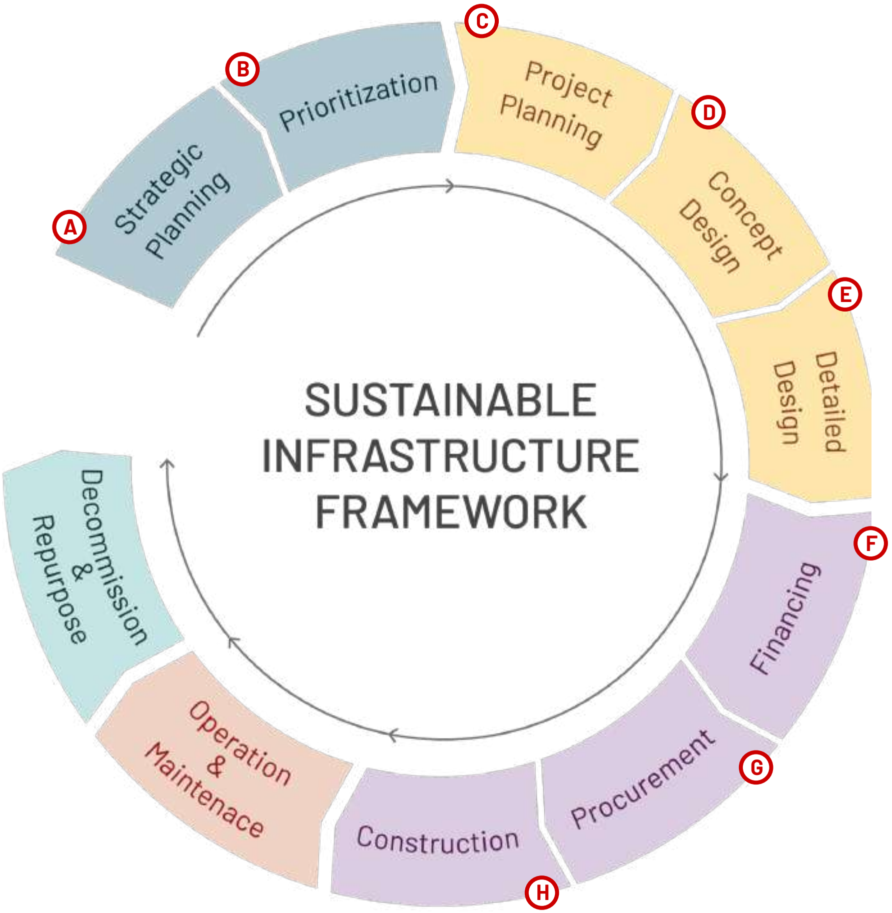
- How does GCC arrive at costing and identify sources for financing the construction and maintenance of Sponge Parks?
- Does the GCC utilise sectoral budgets, special state programs, intergovernmental grants, multilateral financing, PPP or CSR funding to finance projects?
- Is there adequate administrative capacity within GCC to make budgetary proposals, multilateral grant requests, or private sector partnerships to finance Sponge Parks?

G. Procurement

- How does GCC procure consulting services for design, contractors for construction, and vendors for products and operations to implement Sponge Parks?
- Does the GCC use quality-based criteria for the selection of goods and services or empanelment of consultants required to transform open spaces?
- Is there adequate administrative capacity within GCC and technically qualified providers to ensure timely and effective implementation of Sponge Parks?

H. Construction

- How does GCC ensure construction of Sponge Parks in line with design documentation, budget, and schedule?
- Does the GCC promote best practices in construction site management, use of sustainable materials, local sourcing of products, and native planting?
- Is there adequate technical and administrative capacity within GCC to ensure high quality construction of Sponge Parks within budget and schedule?



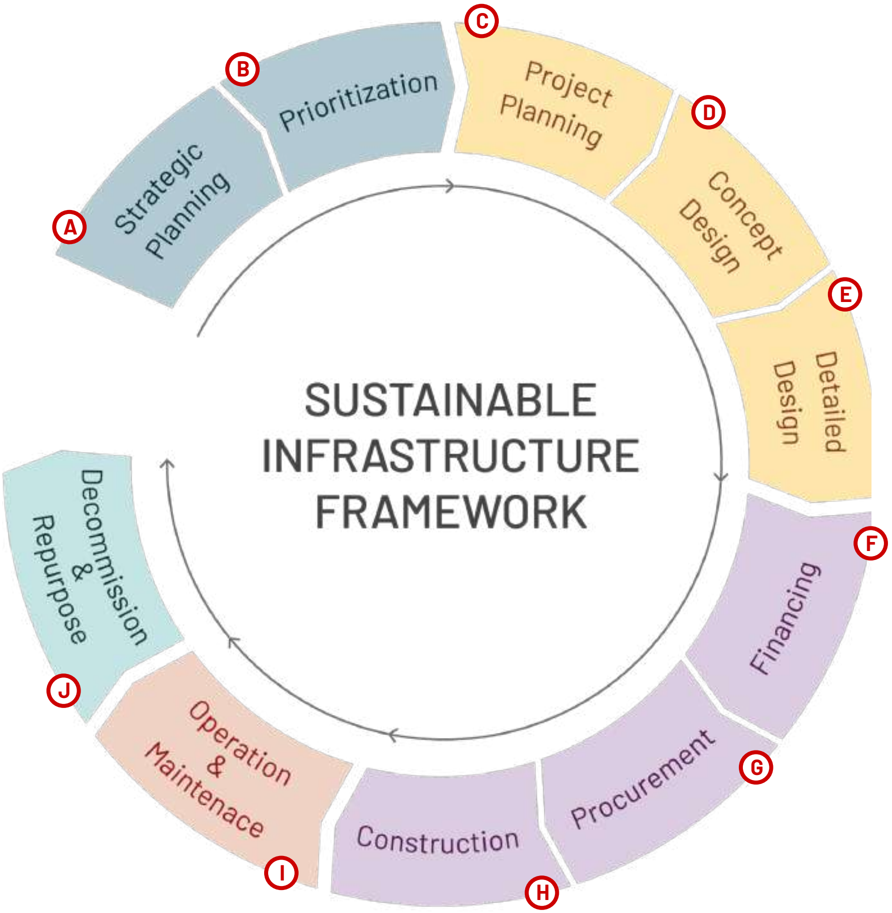
Sustainable Infrastructure Framework is used to assess capacity and structure the manual for Sponge Parks

I. Operation and Maintenance

- How does GCC ensure continued operation of Sponge Parks and specific maintenance of blue-green infrastructure and planting?
- Does the GCC have clear guidelines, allocated budgets, and trained staff for the continued maintenance of Sponge Parks over its lifecycle?
- Is there adequate technical and administrative capacity within GCC or trusted service providers to ensure efficient operation and maintenance of Sponge Parks?

J. Decommission and Repurpose

- How does GCC monitor the performance of Sponge Parks and determine the need for decommissioning, upgrading, and repurposing?
- Does the GCC have infrastructure lifecycle considerations for the continued maintenance and eventual decommissioning or repurposing of Sponge Parks?
- Is there adequate technical and administrative capacity within GCC to monitor aquifers, tree health, and climate risks to determine new infrastructure lifecycle for Sponge Parks?



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Gap Assessment and Sponge Park Manual Structure

- **Sustainable Infrastructure Lifecycle:**
  Strategic Planning > Prioritization > Project Planning > Concept Design > Detailed Design > Finance > Procurement > Construction > Operation and Maintenance > Decommissioning and Repurposing

- **Data Collection and Inception Report**

We conducted a validation workshop to present project approach and gather initial feedback on capacity gaps

Which infrastructure lifecycle of the Sponge Park has the highest need for capacity building?

(Respondents could select multiple options)

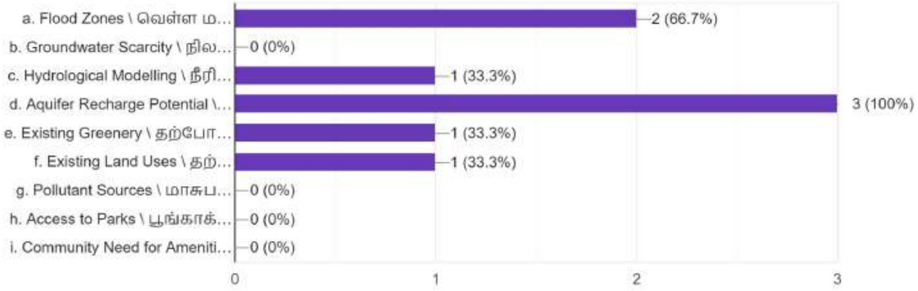
Strategic Planning (Understanding Need)	48%	**Financing**	33%
Prioritisation (Prioritising Need)	48%	**Procurement**	10%
Project Planning (Feasibility and Sizing)	57%	**Construction**	38%
Concept Design (Programming and Siting)	33%	**Operation and Maintenance**	62%
Detailed Design (Hydrology and Specifications)	62%	**Decommissioning and Repurposing**	19%

We interviewed Administrative Heads and Zonal Engineers to identify how GCC implements Sponge Parks

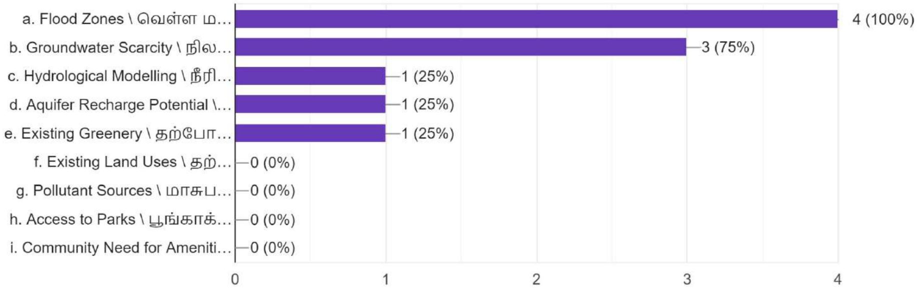
A. Strategic Planning (Understanding Need)

What factors did the GCC consider when planning for Sponge Parks? ஸ்பான்ஜ் பூங்கா திட்டமிடும்போது GCC என்ன காரணிகளைக் கருத்தில் கொண்டது?

Department Heads



Zonal Engineers



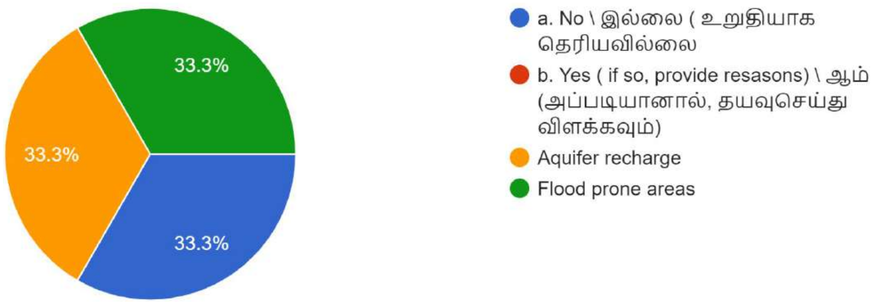
Flooding and **Aquifer Recharge Potential** are the two biggest factors considered in the planning of Sponge Parks

Lack of technical understanding within the department and **lack of data / information** were considered main gaps for why factors are not proper considered

B. Prioritisation

Do you know on what basis the location for 57 Sponge Parks were determined by the GCC? 57 ஸ்பான்ஜ் பூங்காக்கள் எந்த அடிப்படையில் GCC ஆல் தீர்மானிக்கப்பட்டது தெரியுமா?

Department Heads



Zonal Engineers

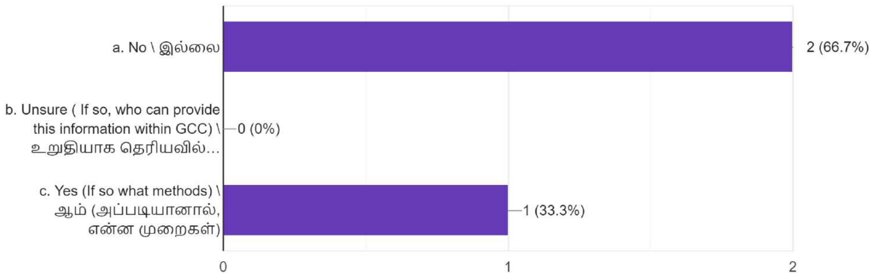
Aquifer recharge, flooding, and size are the some of the factors considered in the prioritisation of Sponge Parks

Lack of data / information, lack of technical understanding within the department and **lack of budgets** were considered main gaps for the lack of a clear prioritisation framework

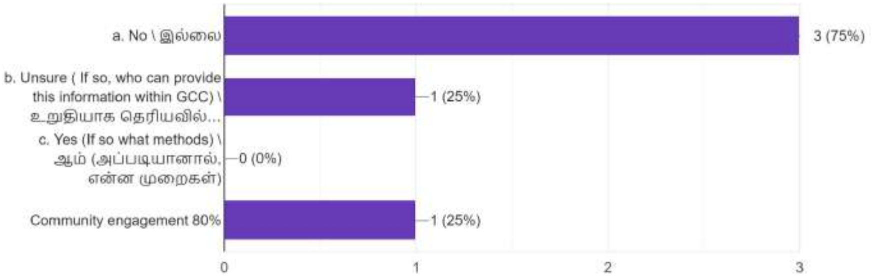
C. Project Planning

Did the GCC conduct any stakeholder engagements or social and environmental impact to determine the programming or amenities wi...்றும் சுற்றுச்சூழல் பாதிப்பை மேற்கொண்டதா?

Department Heads



Zonal Engineers



Stakeholder engagement or environmental assessments were not consider in a majority of Sponge Park planning process

Lack of technical understanding within the department and **lack of data / information** were considered main gaps for the lack of planning in programming or sizing Sponge Parks

D. Concept Design

Does the GCC follow any open space design guidelines, landscape standards, or best management practices to design Sponge Parks? G... மேலாண்மை நடைமுறைகளைப் பின்பற்றுகிறதா?

Department Heads

Zonal Engineers

Open Space design guidelines or standards are not followed in the majority of Sponge Park concept design process

Lack of technical understanding within the department and **lack of guidelines** were considered main gaps for the concept design of Sponge Parks

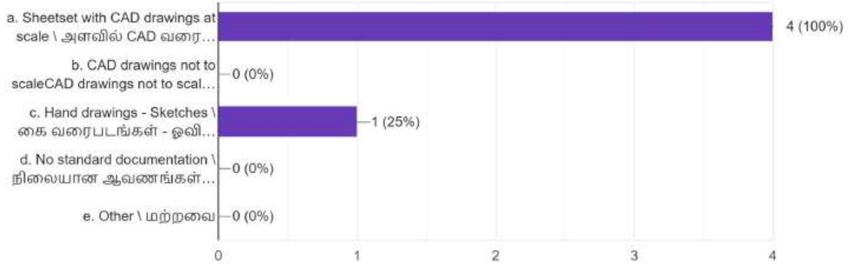
E. Detailed Design

Does the GCC follow design guidelines and standard specifications to size and detail blue-green infrastructure in Sponge Parks? ஸ்பான்...யான விவரக்குறிப்புகளை GCC பின்பற்றுகிறதா?

Zonal Engineers

How did the GCC produce the design documentation for costing and tendering for contractors? GCC எவ்வாறு ஒப்பந்தத...கான வடிவமைப்பு ஆவணங்களை தயாரித்தது?

Zonal Engineers

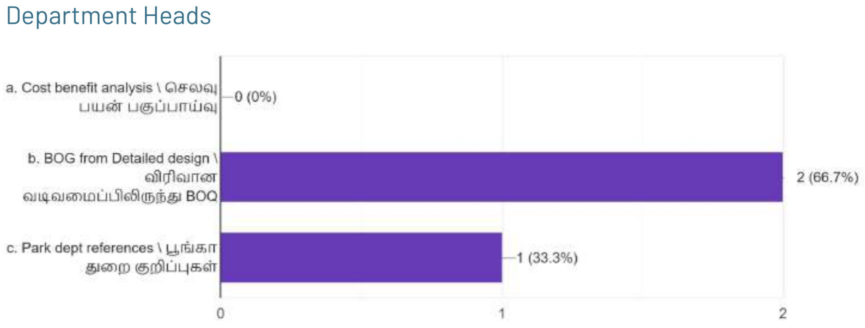


Design guidelines or standards are not followed in the detailed design of Sponge Park

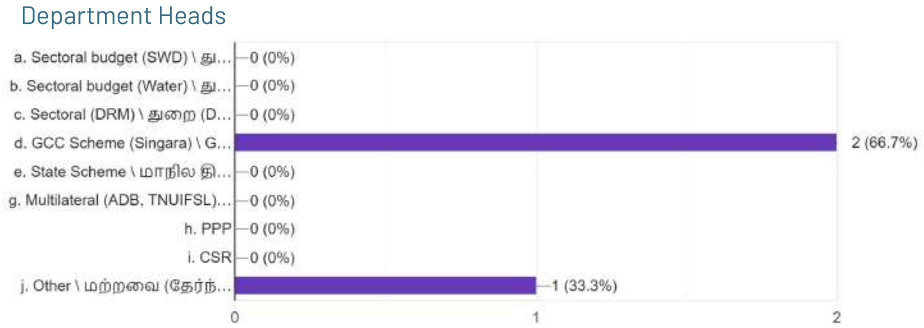
Lack of standards / guidelines and **lack of technical understanding within the department** were considered main gaps for why factors are not proper considered

F. Financing

How does GCC determine the cost of Sponge Parks in terms of initial capital investment and recurrent operation and maintenance expen...ங்கா விலையை GCC எவ்வாறு தீர்மானிக்கிறது?



What source of funding has been utilised by the GCC in the planning, design, and implementation of Sponge Park so far? இதுவரை ஸ்பாஞ்ச் ப...ந்த நிதி ஆதாரம் பயன்படுத்தப்பட்டுள்ளது?



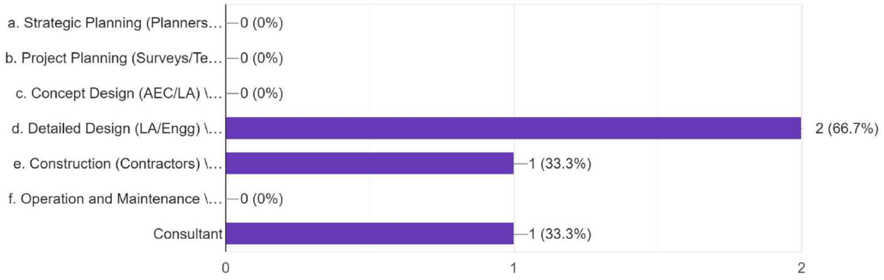
Cost benefit analysis is not conducted to evaluate Sponge Park investments. While GCC schemes have been utilised so far in the implementation of Sponge Parks, there is interest in exploring **Central / State schemes** and **Climate / green financing**

Sectoral funding from SWDs has not been utilised in the construction of Sponge Parks so far

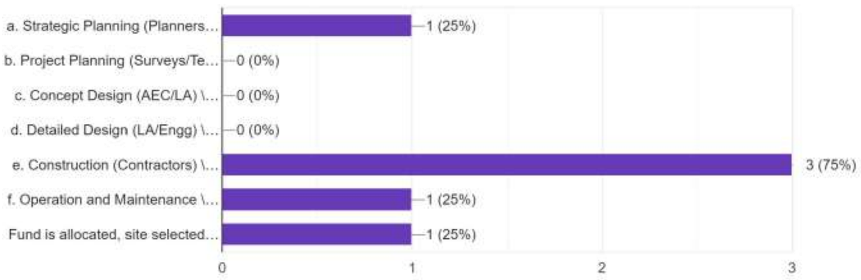
G. Procurement

At what stage of the Sponge Park infrastructure lifecycle does GCC procure external technical services ஸ்பான்ஜ் பூங்கா உள்கட்டமை...புற தொழில்நுட்ப சேவைகளை வாங்குகிறது

Department Heads



Zonal Engineers



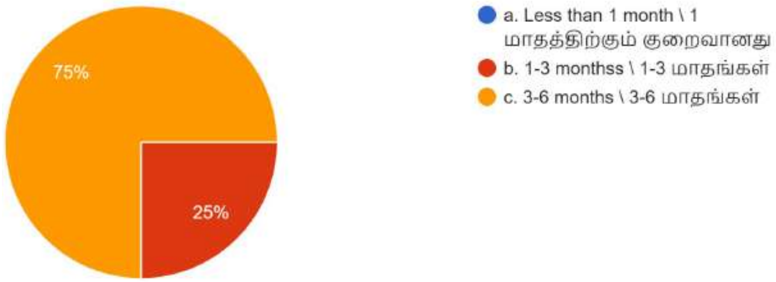
Construction, Maintenance and Detailed Design services were procured for Sponge Park implementation by GCC

Lowest Cost (Open Bid) was the most common method of selection followed by **Quality and Cost Basis (Open Bid).** GCC does not have empaneled consultants or contractors specialising in Sponge Parks

H. Construction

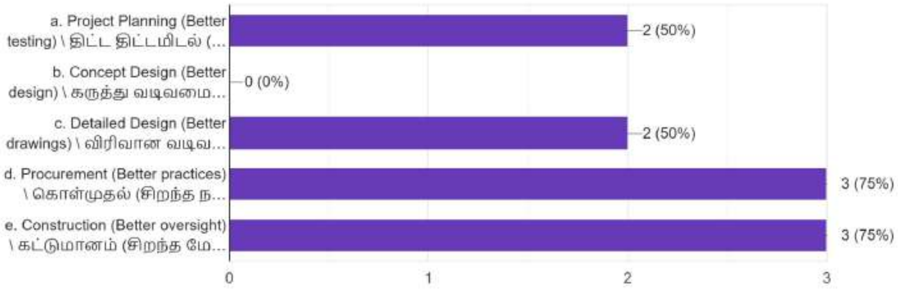
How long did it take to construct the Sponge Park - from the first equipment arriving on site to park opening? ஸ்பான்ஜ் பூங்கா கட்டுவதற்கு ... உபகரணத்திலிருந்து பூங்கா திறப்பு வரை?

Zonal Engineers



What stage of the Sponge Park infrastructure lifecycle should be the focus to improve construction quality and outcomes? select one or mor... களை மேம்படுத்த கவனம் செலுத்த வேண்டும்?

Zonal Engineers

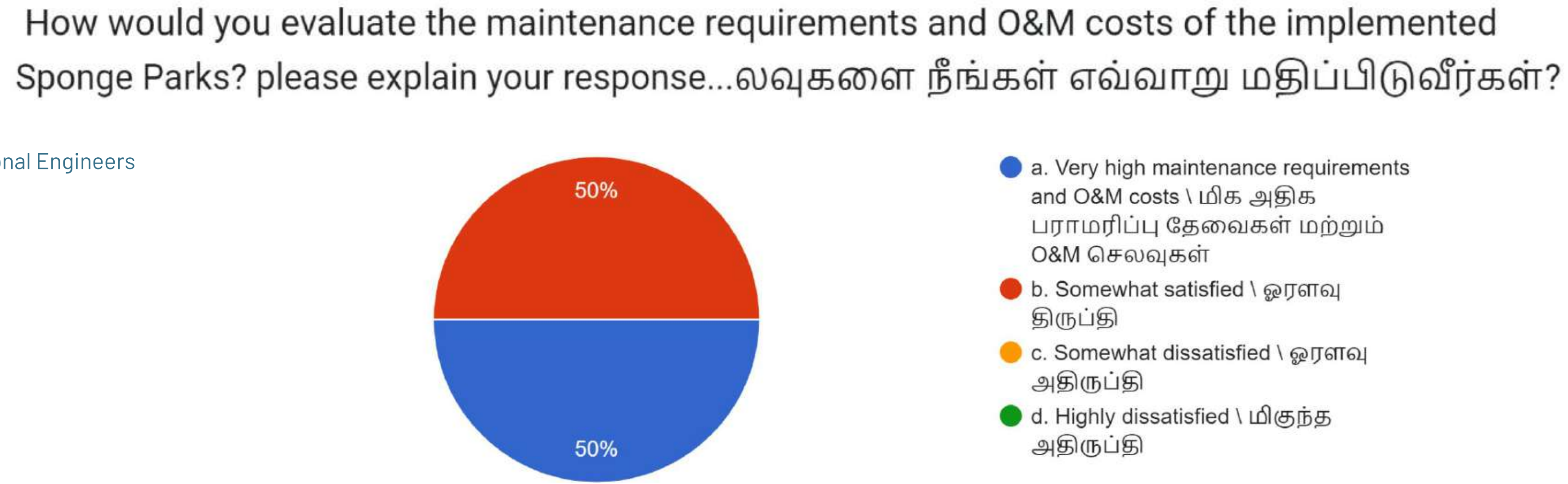


Construction of Sponge Parks mostly take between **3-6 months of site work**

Better oversight during construction and **better procurement practices** were considered important to improve construction quality and outcomes

I. Operations and Maintenance

Zonal Engineers

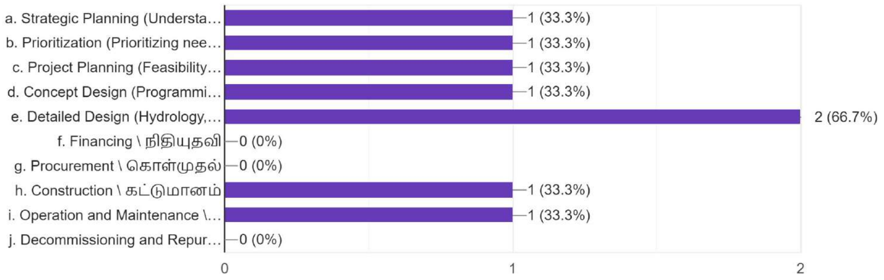


Maintenance of Sponge Parks is evaluated to be **very high O&M costs** or **satisfactory.**

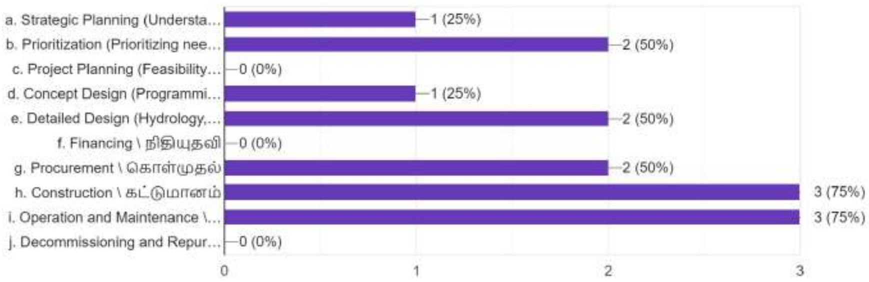
Removal of weeds and leaf litter are new maintenance practices in Sponge Parks which require **labour** and design decisions such as **leaf litter catchers** and **sedimentation ponds.**

For the training exercise with GCC Department Heads and Engineers, which infrastructure lifecycle of the Sponge Park has the highest need for...ல் திறன் மேம்பாட்டிற்கு அதிக தேவை உள்ளது?

Administrative Heads



Zonal Engineers



Detailed Design, Construction, Operation and Maintenance were considered areas with highest capacity building needs in realising Sponge Parks. **Prioritisation** was also considered a training need over other stages of the Sponge Park lifecycle

Structure of the Manual: Organised around the Sustainable Infrastructure framework

- ❑ Letters
- ❑ Executive Summary
- ❑ How to Read the Manual
- ❑ Project Background

INTRODUCTION

- ❑ Why Chennai needs to be a Sponge City
- ❑ Sponge Parks in Chennai
- ❑ Sustainable Infrastructure Framework

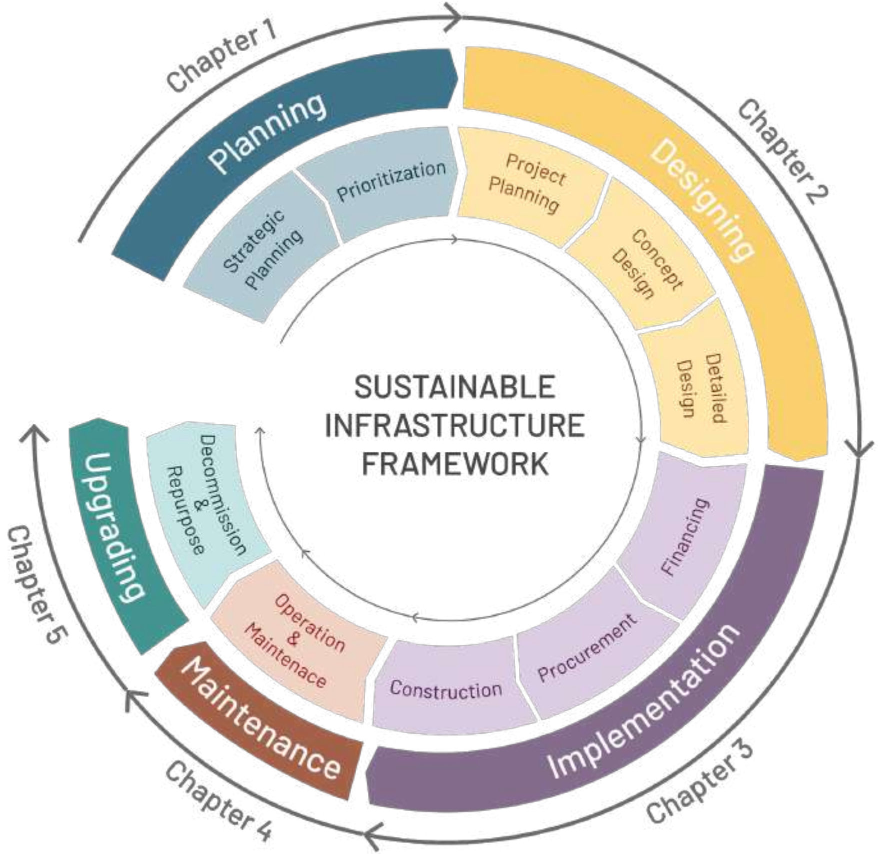
1. STRATEGIC PLANNING OF SPONGE PARKS

- ❑ Spatial Analysis for Strategic Planning of Sponge Parks
- ❑ Priority OSRs for Sponge Parks

2. DESIGNING SPONGE PARKS

- ❑ **Design Criteria: *Soil and Grading, Blue-green Infrastructure, Planting, Social Amenities***
- ❑ **Guidelines for S, M, L, XL Parks**

- ❑ *Detailed Guidelines and Toolkits:* ***Assessments***
- ❑ ***Blue-green Infrastructure***
- ❑ ***Planting***
- ❑ ***Social Amenities***



Structure of the Manual: Organised around the Sustainable Infrastructure framework

3. SPONGE PARK IMPLEMENTATION

- ❑ Financing Sponge Parks
- ❑ Procurement for Sponge Parks (S, M, L, X)
- ❑ Constructing Sponge Parks

4. MAINTAINING SPONGE PARKS

- ❑ Framework for Maintaining Sponge Parks
- ❑ Maintaining BGI
- ❑ Maintaining Planting

5. UPGRADING SPONGE PARKS

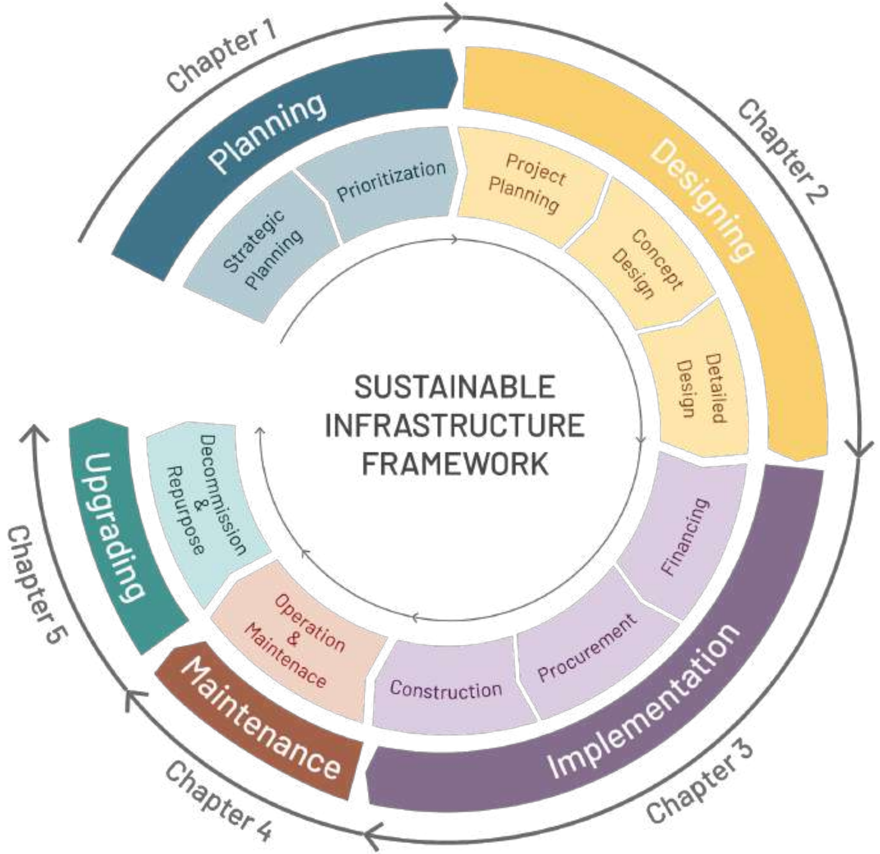
- ❑ Monitoring Sponge Park for Climate Change
- ❑ Repurposing Sponge Parks

- ❑ **Concluding Notes**

ANNEX

- ❑ A. Priority OSR by Zones
- ❑ **B. Detailed Guides**
- ❑ C. Interviews
- ❑ D. Workshop Proceedings

- ❑ *Hydrology for Sizing BGI*
- ❑ *Planting Guide*
- ❑ *Amenities Guide*
- ❑ *Detailed Maintenance Manual*

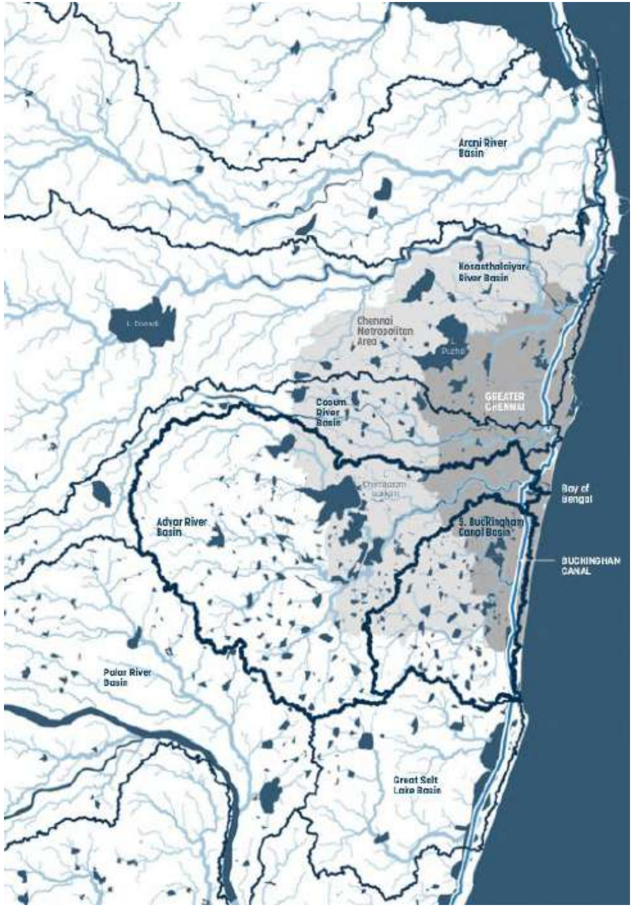


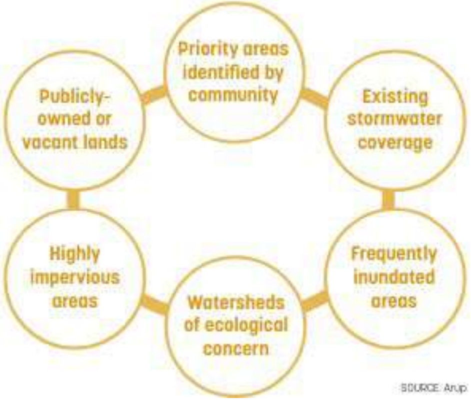
3

Spatial Framework for Prioritising Sponge Parks

- Prioritisation Methodology
- Priority OSRs for Sponge Park Upgrades

Spatial Framework guides Sponge Park investments towards building systemic resilience as sites are identified based on socio-ecological attributes. It also helps package Sponge Parks as a large investment





The extensive network of OSRs in Chennai has the potential to transform the open space access for residents and function as a resilient infrastructure system to mitigate flood, drought, and heat risks

There are **1,126 OSRs** in Chennai ranging in size from 0.003 acres to 17 acres.

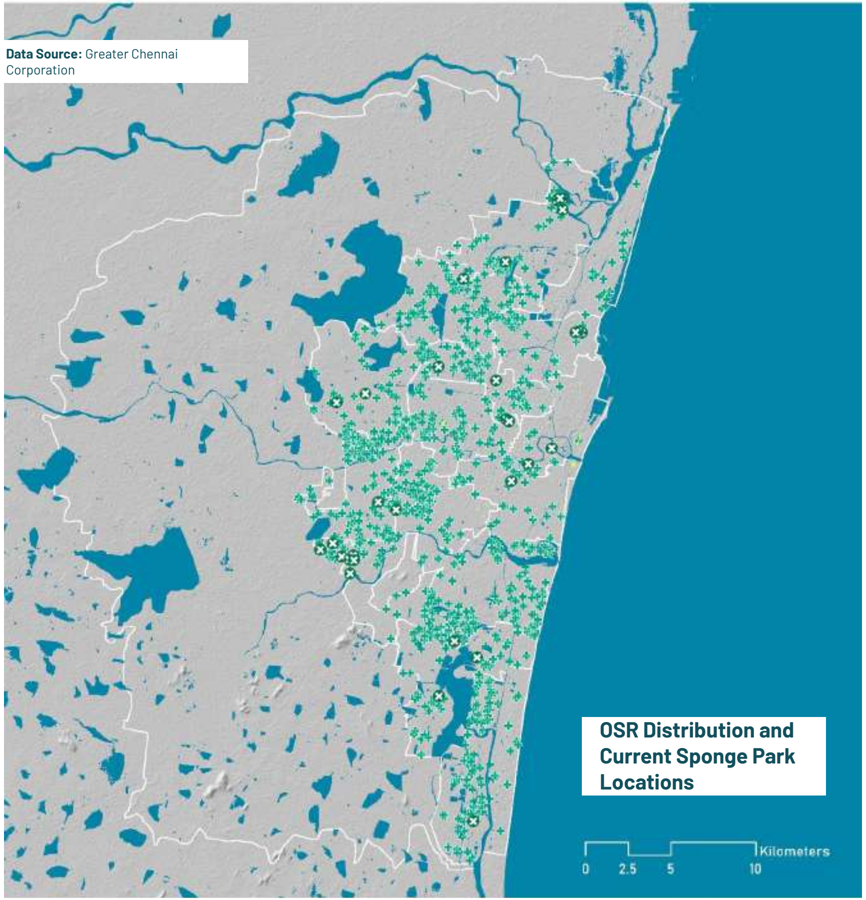
The manual will develop typological condition of OSRs based on the four size categories. The table below summarises how many OSRs fall within each category:

Category (Size Range)	# of OSRs
S (Less than 0.2 acres)	481
M (Between 0.2 - 1 acres)	538
L (Between 1 - 5 acres)	100
X (Above 5 acres)	7

In total, OSR's add up to **515 acres** or **2 km^2** of land

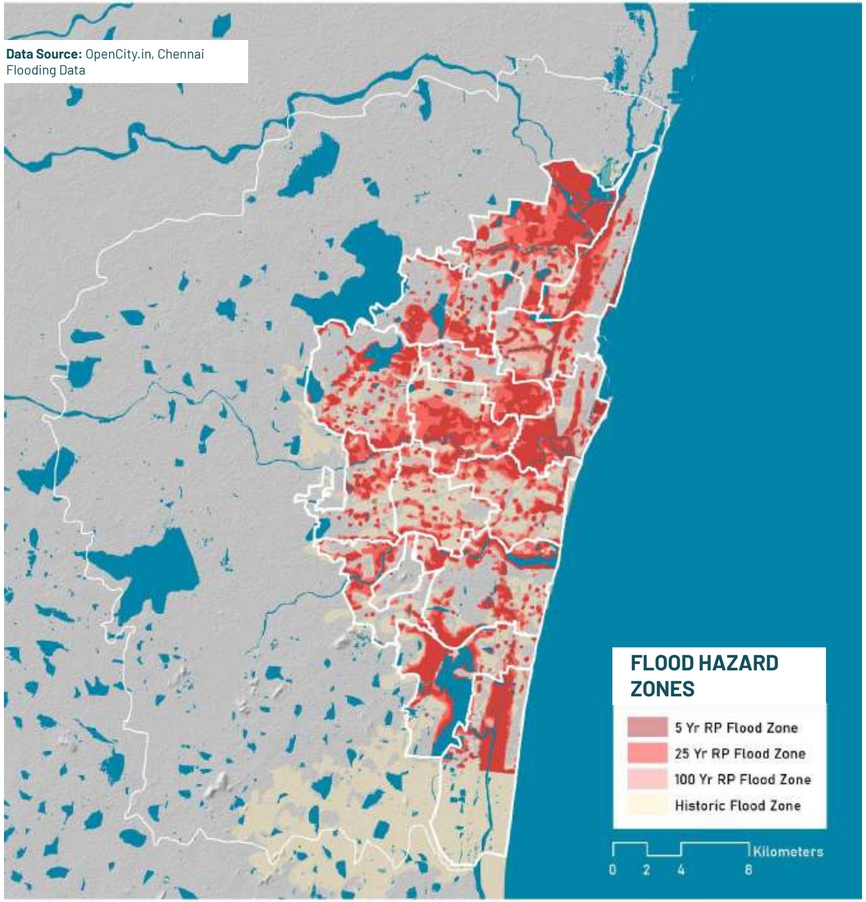
In comparison, *all* the parks within GCC add up to 400 acres. The transformation of all OSRs into Sponge Parks could more than double Chennai's inadequate park acreage per capita.

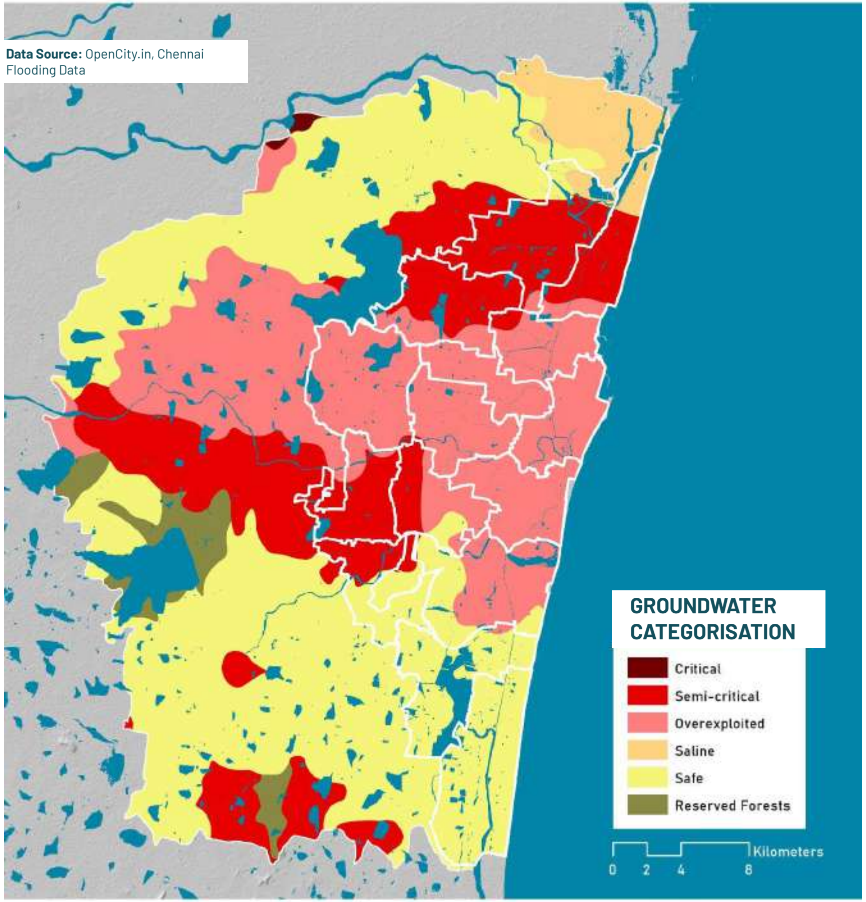
Thus, upgrading OSRs into Sponge Parks will fulfill social needs while building resilience to water risks.



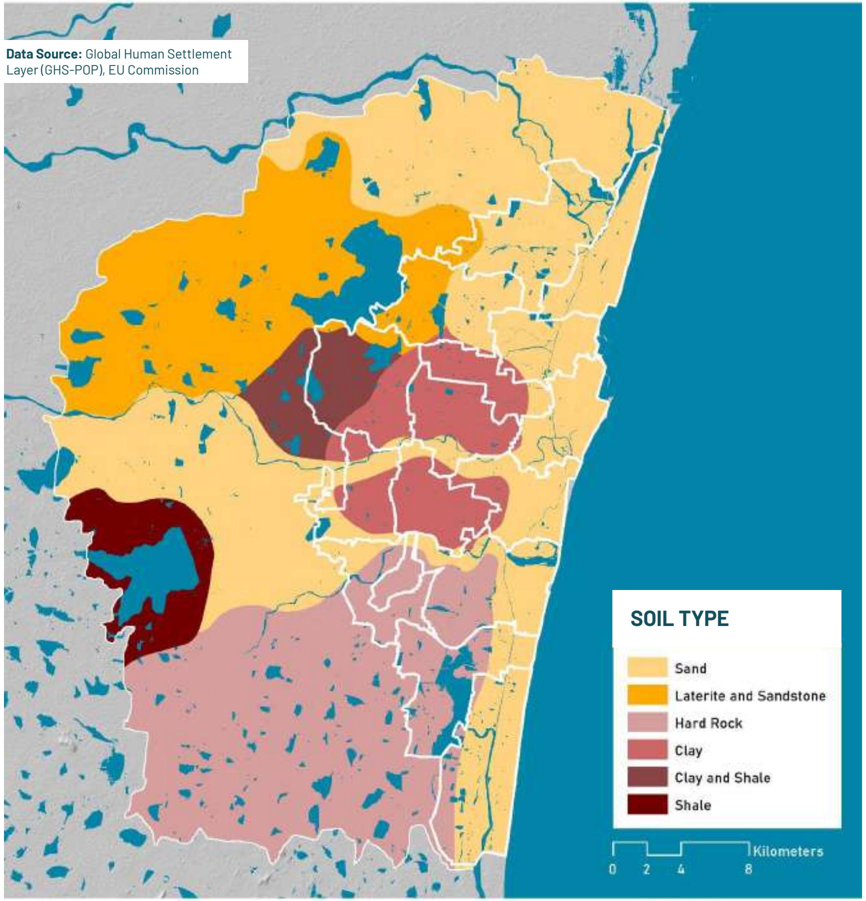
The loss of water bodies and green cover that can regulate stormwater and the increased recurrence of extreme events have increased flood risk in Chennai

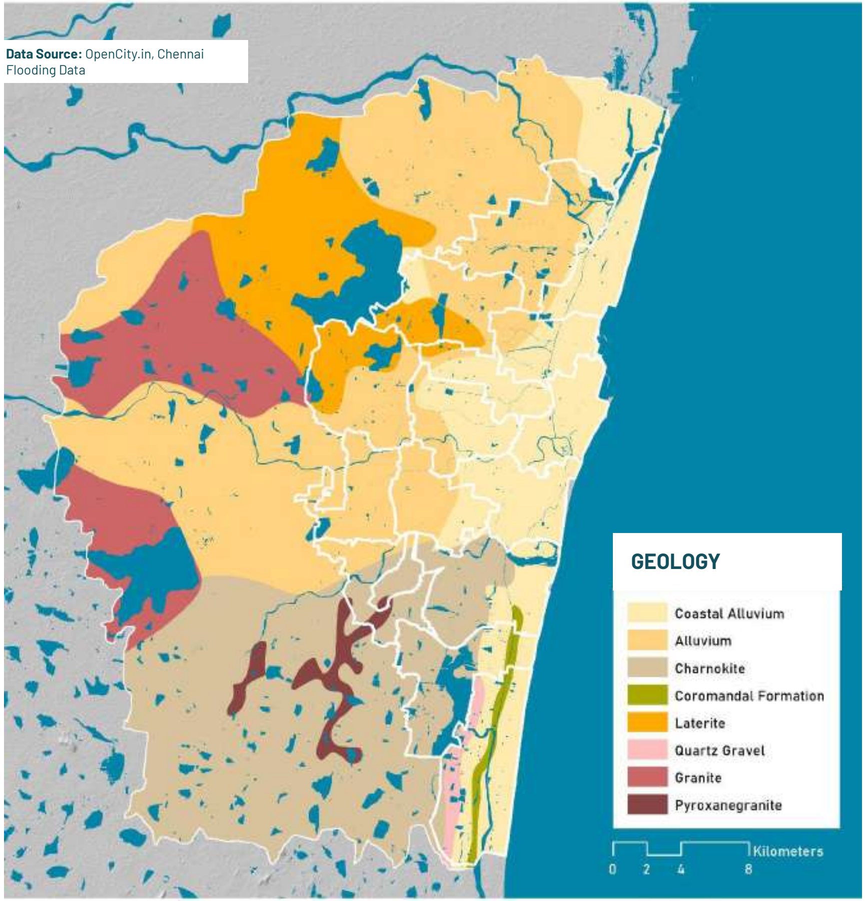
The prioritization framework uses spatial multi-criteria to identify OSRs are environmentally optimal for Sponge Parks. OSRs located in flood-prone areas and areas with semi-critical or overexploited aquifers are ranked high



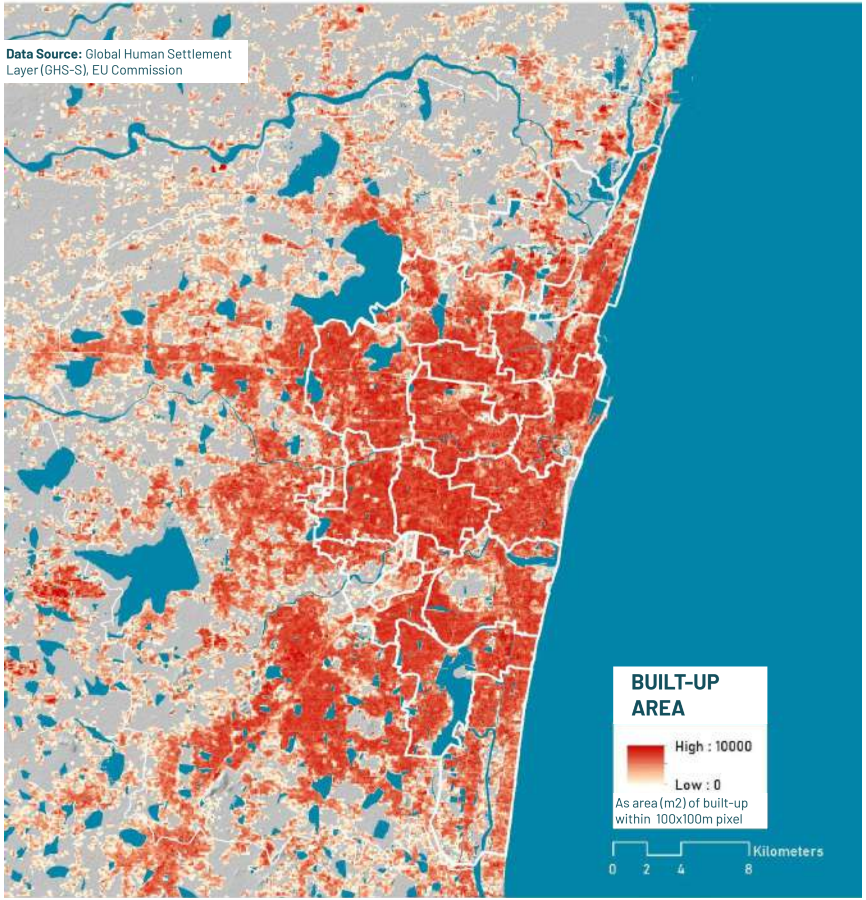


OSRs are further ranked based on their location over more porous soil and geology types. OSRs over sandy soil and alluvium geology are assigned the highest scores with lower scores for clay or shale over granite

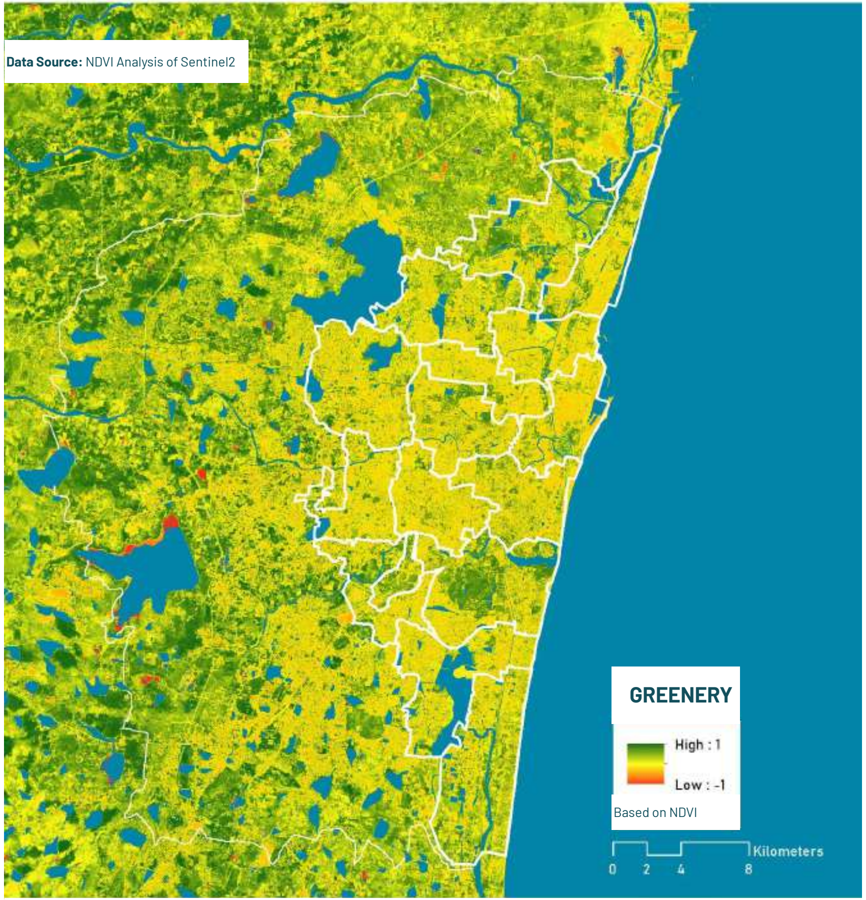




In parallel, Chennai's wards are scored on a multi-criteria assessment of parks need. Wards with high share of built-up and low greenery have higher risk of urban heat island effect and in greater need of open spaces

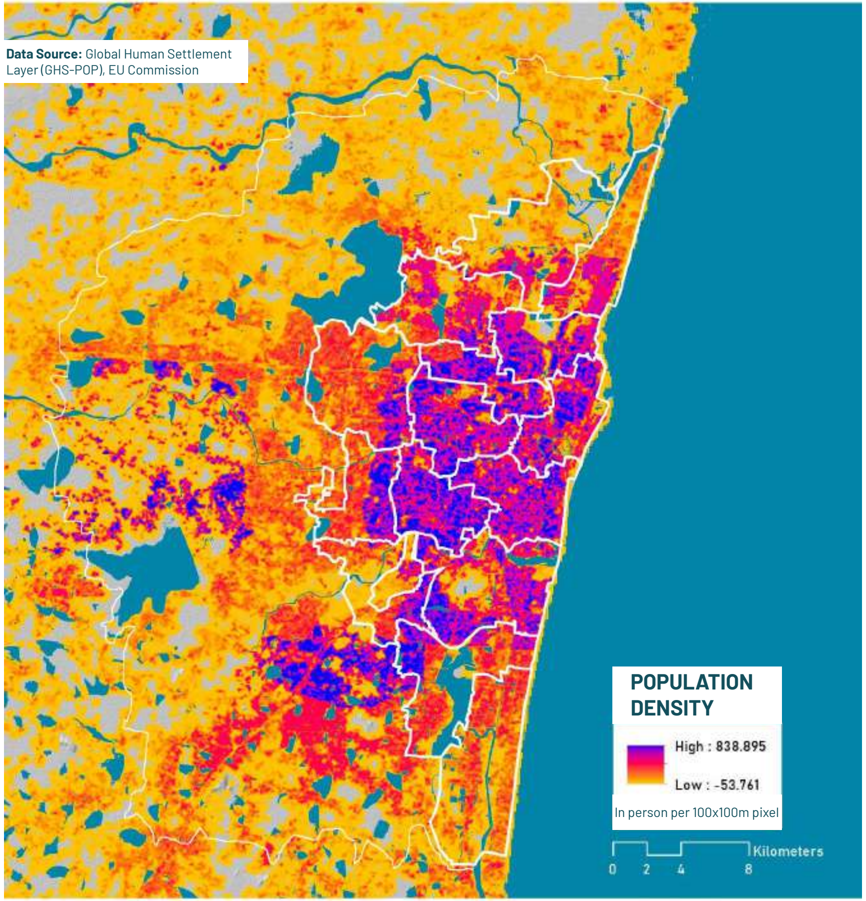


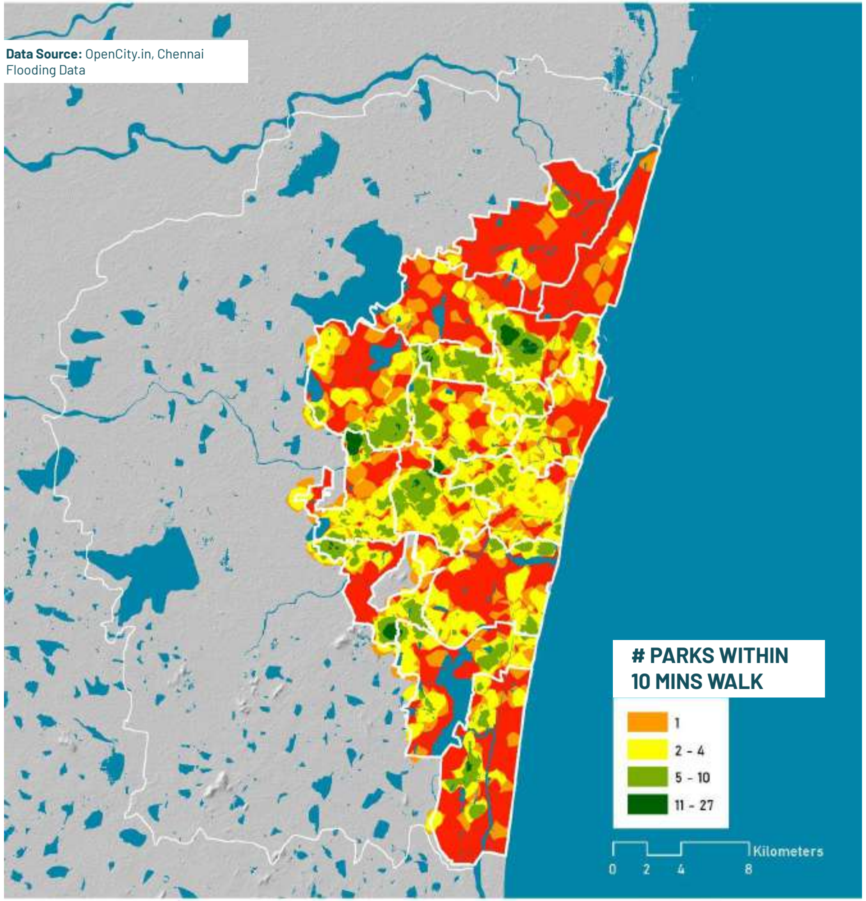
The built-up area of Chennai has rapidly expanded in the past decade with settlements growing beyond the peripheral wards of the GCC



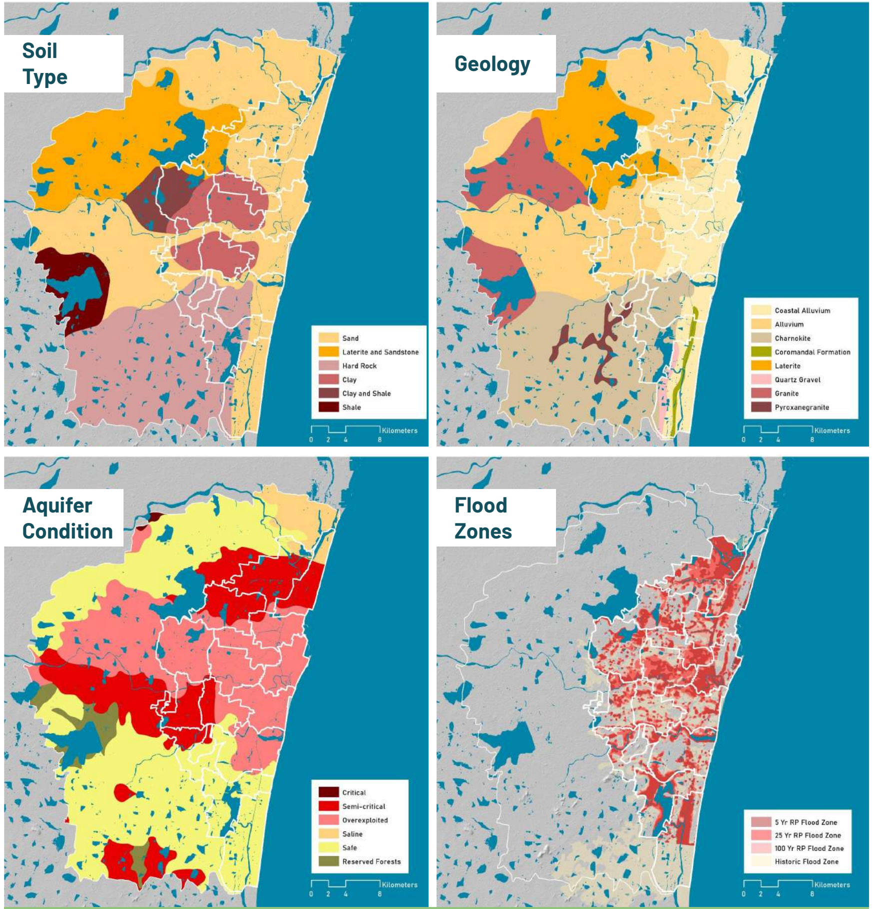
NDVI is an openly available proxy for "greenery" and reveals only pockets of Chennai city with lush vegetation that can intercept rainfall and help recharge

Densely populated areas with limited access to existing parks have higher need for Sponge Parks as open space. An isochrone analysis shows which parts of Chennai do not access to any parks within a 10 minutes walk

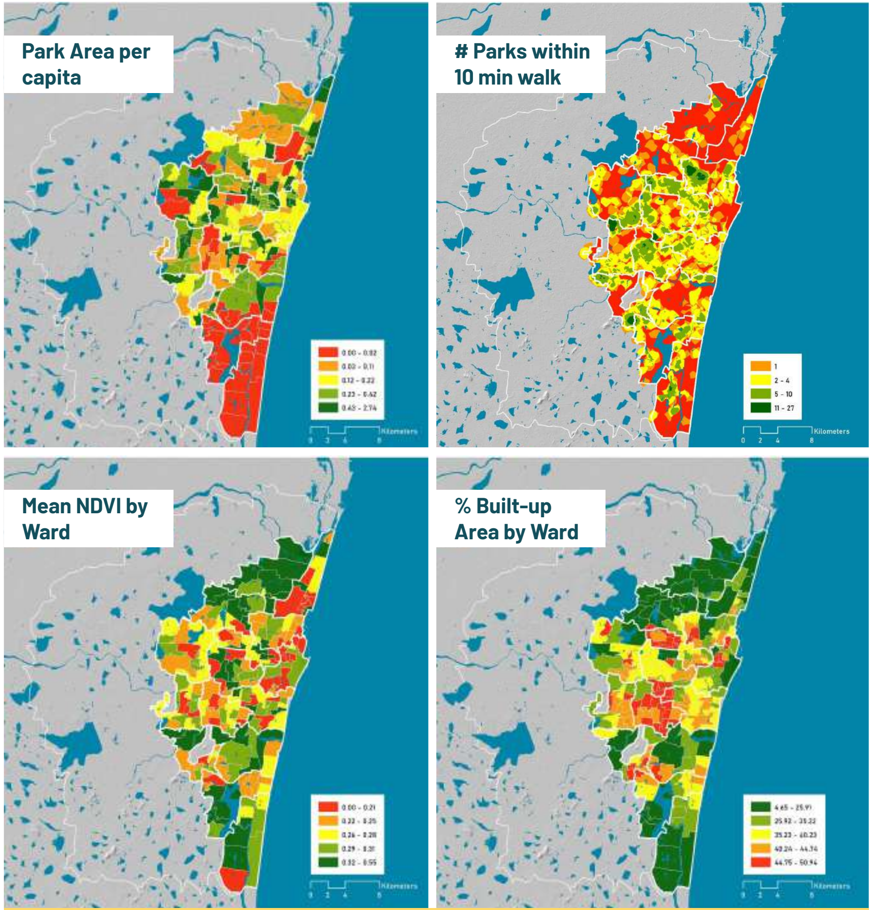




OSRs will be prioritized for upgrading into Sponge Park in wards that have the greatest social need for park and in places where the functions of groundwater recharge and flood mitigation are most feasible and required

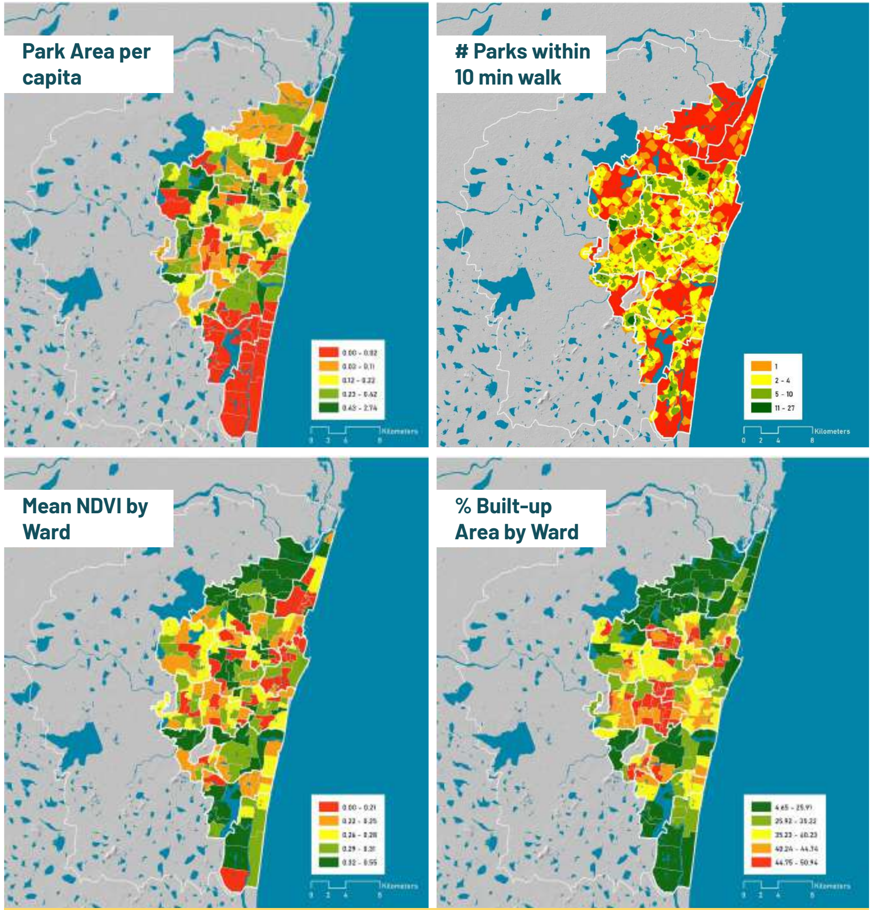


Geospatial variables for Environmental Suitability

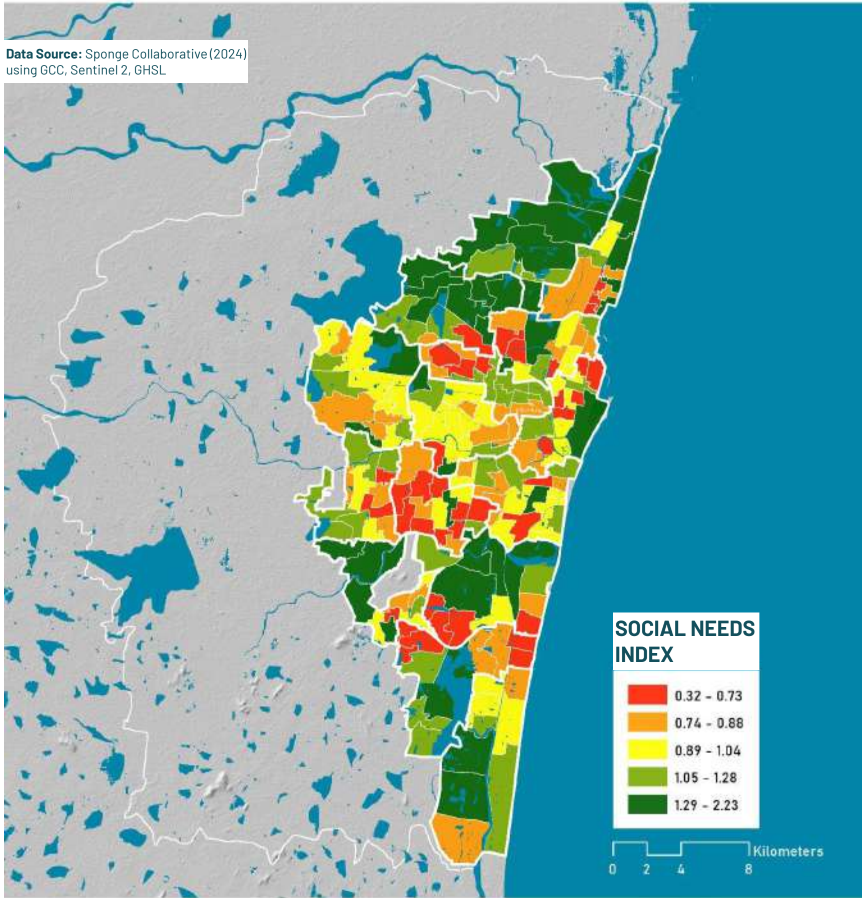


Geospatial variables for Social Need

A number of park need metrics are developed and summarised at ward level to generate a Social Needs Index per ward. This index is classified into quantiles to identify which ward's social needs are relatively unmet (in red)

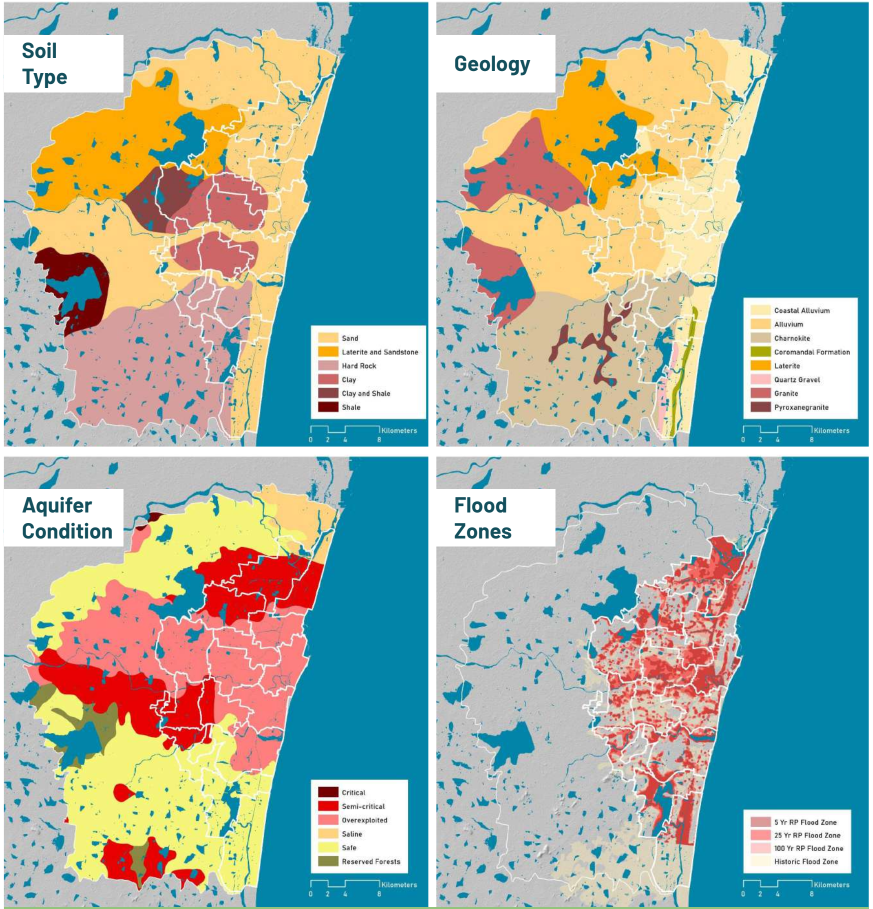


Geospatial variables for Social Need

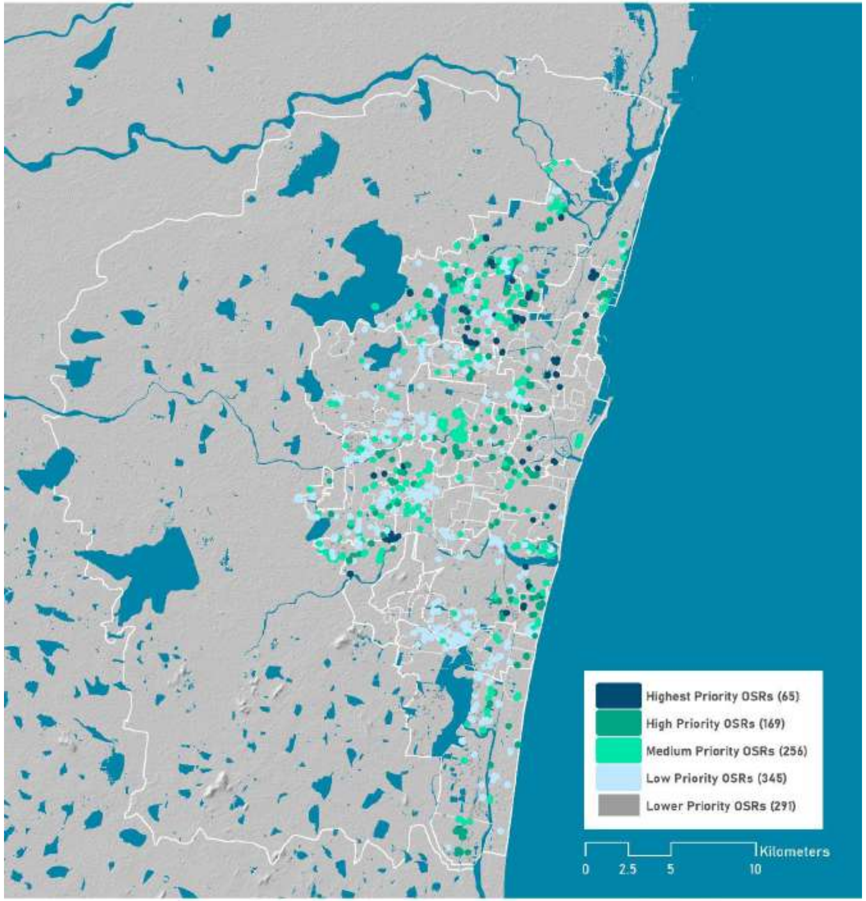


Densely populated wards with low greenery, high built-up, low acreage of parks per capita, and low access to parks show up as red and orange

OSRs will be prioritized for upgrading into Sponge Park in wards that have the greatest social need for park and in places where the functions of groundwater recharge and flood mitigation are most feasible and required



Geospatial variables for Environmental Suitability

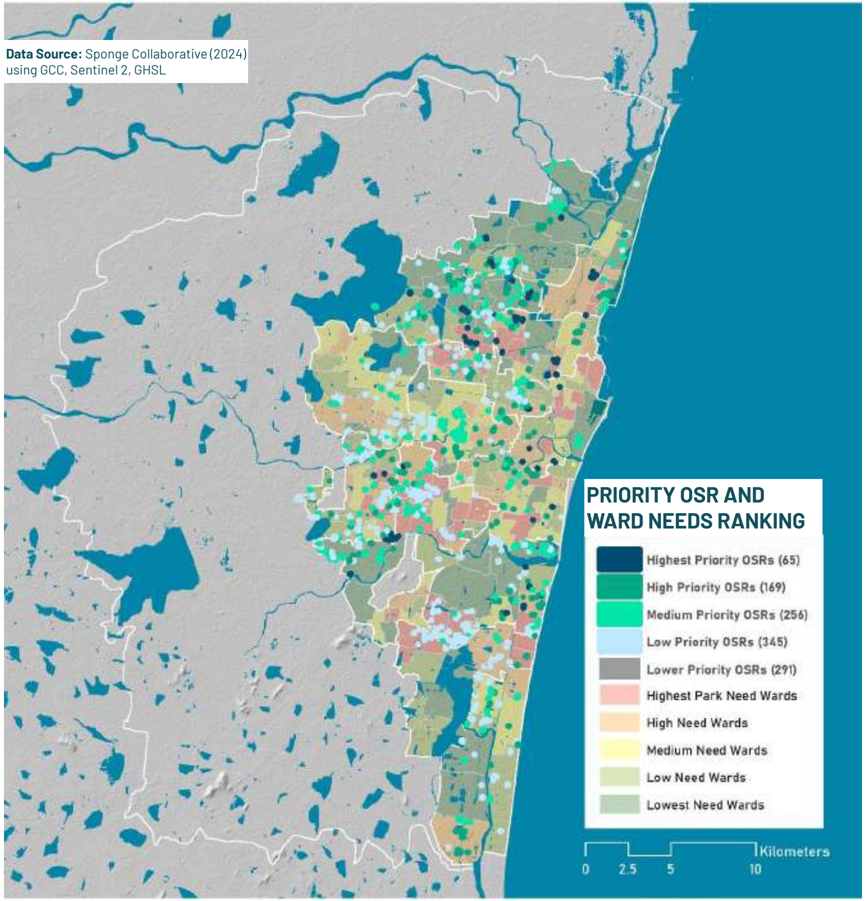


Using a non-weighted summation of normalized variables, all OSRs are given a score based on which they can be prioritized by Zones within Wards that demonstrate higher levels of need

Based on the scores assigned to **1,126 OSRs** using social and environmental variables, the table below summarises the priority levels and number of OSRs at each level:

Priority (Score Range)	# of OSRs
Highest (24 - 28)	65
High (22 - 23)	169
Medium (20-21)	256
Low (18-19)	345
Lower (9-17)	291

Each OSR has their individual score and they can be evaluated within each Zone based on the Social Needs Index of each Ward, their respective stormwater drainage network, and community inputs.



Highest and high priority OSRs within Wards of Highest and High park needs should be the top candidates for upgrading into Sponge Parks

Neighbourhood level feasibility studies need to be conducted to validate this framework developed using high-level datasets

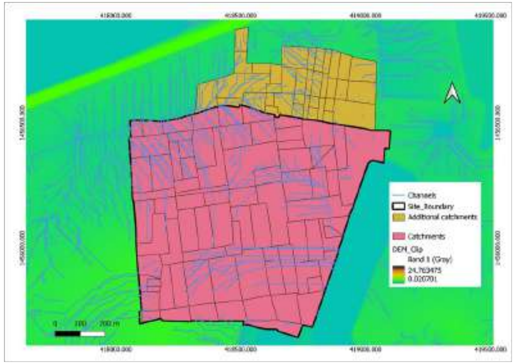
4

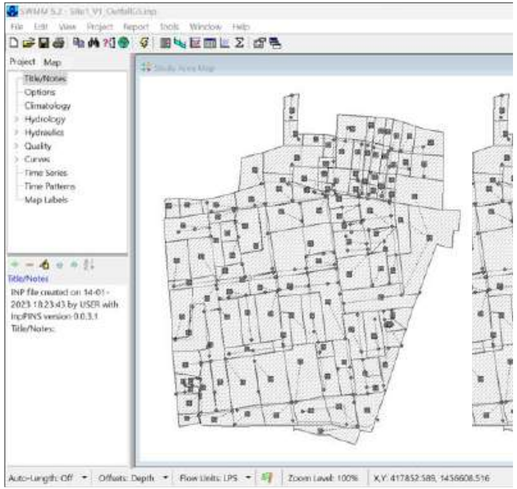
Overview of the Sponge Park Manual

- Strategic Planning for Sponge Parks
- Designing Sponge Parks
- Implementing Sponge Parks
- Maintaining Sponge Parks
- Improving Sponge Parks

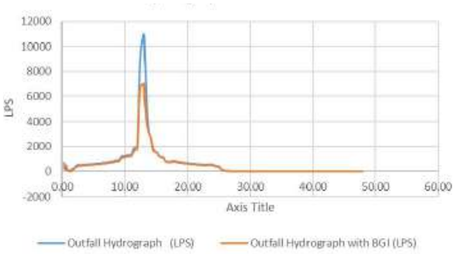
STRATEGIC PLANNING FOR SPONGE PARKS

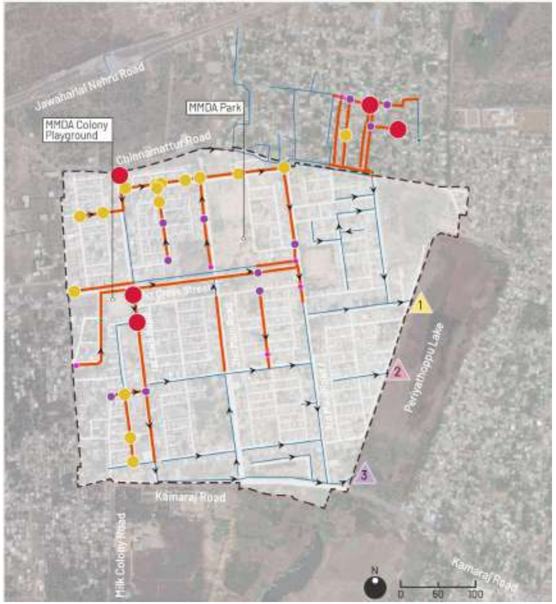
Delineate contributing catchments





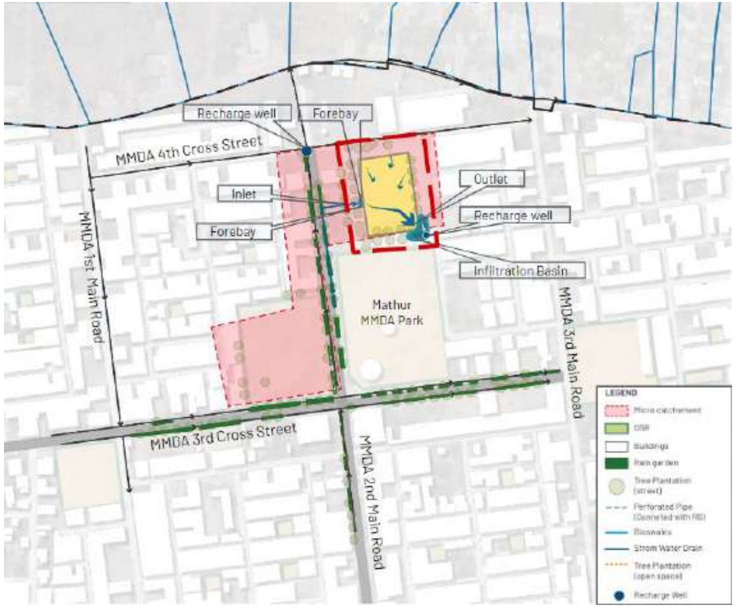
Calculate flood mitigation potential





Assess aquifer recharge potential and risks

Study adjacent land uses and social uses to identify project site within catchment area



Strategic Planning Checklist to ensure Sponge Park can fulfill multiple functions

சமூக வாழ்க்கைக்கான பூங்கா

ஆரோக்கியமான வாழ்க்கைக்கான பசுமை பூங்கா

வெள்ளத்தைக் குறைப்பதற்கும் நிலத்தடி நீர் உயர்த்துவதற்கும் உள்கட்டமைப்பு

தாவரங்கள் மற்றும் பல்லுயிர் வாழ்விடம்

Aquifer Recharge and Water Quality

- ❑ Assess soil infiltration rate and depth to groundwater table to estimate aquifer recharge benefits
- ❑ Ensure catchment area has no point pollution sources and Sponge Park has adequate filtration to prevent aquifer contamination

Flood Mitigation

- ❑ Calculate contributing catchment area and runoff volume for 5, 10, 25 year RP storms to size BGI components in Sponge Park

Community Needs

- ❑ Engage community to understand social and climate needs that can be fulfilled by Sponge Park programming or planting

Urban Ecology

- ❑ Study ecological corridor, habitat Potential, and heat island effect

DESIGNING SPONGE PARKS

Sponge Park Systems

S.1. SOIL & GRADING

This comprehensive checklist for site surveys can help engineers collect the vital data needed to direct the planning and execution of a park project.te direct ththth

- Grading
- Amendment
- Enhance
- Infiletration

Pg <?>

Strategies

- Grading
- Infiltration
- Survey
- Enhance
- Soil Amendment

Pg <?>

S.2.HYDROLOGY & BLUEGREEN

This comprehensive checklist for site surveys can help engineers collect the vital data needed to direct the planning and execution of a park project.te diret ththth

- Delay
- Store
- Filter
- Recharge

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Strategies (BGI Toolkits)

- T1. Bioswales
- T2. Recharge Pit
- T3. Raingarden (Building)
- T4. Raingarden (Streets)
- T5. Retention Pond
- T6. Infiltration Basin
- T7. Sunken Court
- T8. Water Plaza
- T9. Constructed Wetlands

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S.3.VEGETATION & PLANTING

This comprehensive checklist for site surveys can help engineers collect the vital data needed to direct the planning and execution of a park project.te direct ththth

- Biodiversity
- Maintainence
- Aesthetics
- Resilience

Pg <?>

Strategies

- Buffer Mix
- Grove Mix
- Pollinator Mix
- Pathway Mix
- Bioswale Mix
- Lawn Mix
- Wetland Mix

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S.4. AMENITIES & SOCIAL FACILITIES

This comprehensive checklist for site surveys can help engineers collect the vital data needed to direct the planning and execution of a park project.te direct ththth

- Inclusion
- Accessibility
- Safety
- Services

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Strategies

- Entrances
- Cycling
- Signage
- Kids Play Area
- Gym
- Seatings
- Lighting
- Jogging / Walking
- Toilets
- Play courts

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Typologies of Sponge Parks

SMALL SPONGE PARK

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MEDIUM SPONGE PARK

2.3.1

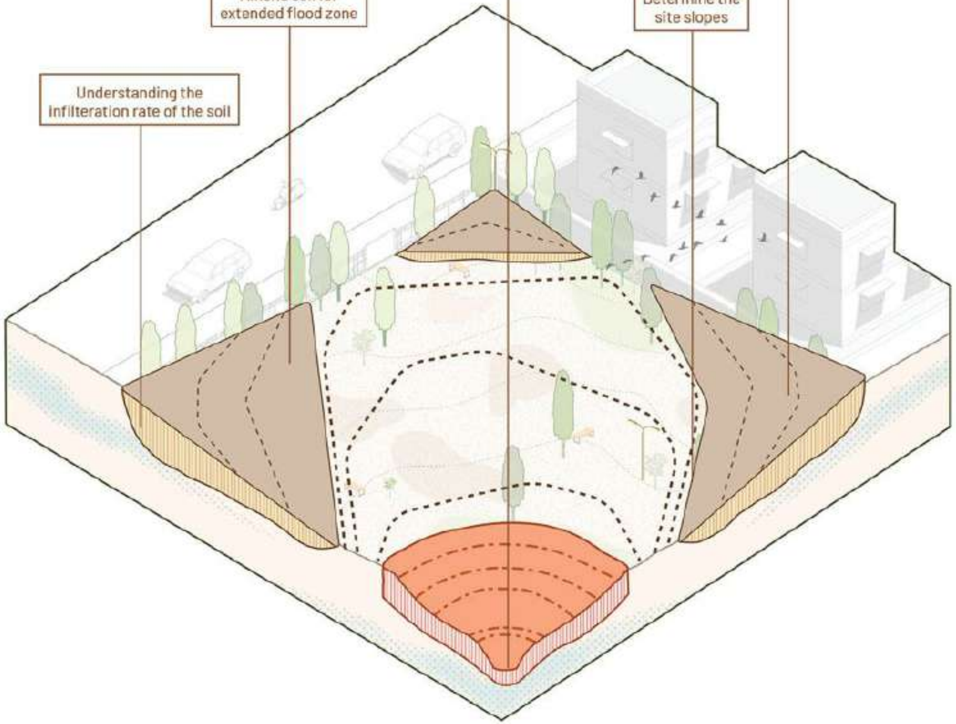
LARGE SPONGE PARK

2.3.1

X SPECIAL CASE

2.3.1

Soil and Grading



Grading

- Determine the site's elevation, slopes, and natural drainage patterns.
- Identify areas of high and low points that may influence stormwater management and landscaping.
- Evaluate surface water flow patterns and potential sources of stormwater runoff.

Amendment

- Conduct soil tests to assess soil type, texture, compaction, and permeability.
- Conduct soil profile test
- Amend the soil to create extended flood zone areas

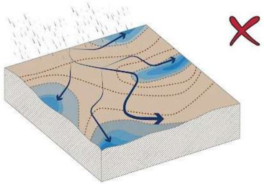
Enhance

- Ensure that filtering components are designed with safety in mind, such as avoiding steep slopes and providing adequate barriers or signage around water features

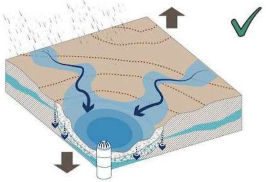
Infilteration

- Understand the infiltration rate of soil is critical for designing effective stormwater management
- Do water Aquifier and analyze depth of water table

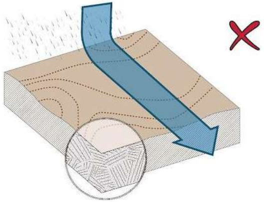
Do's and Don'ts



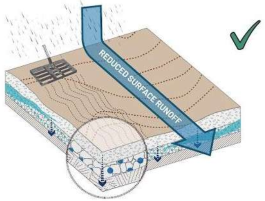
Don't incorporate sponge park in the existing topography which leads to water stagnation



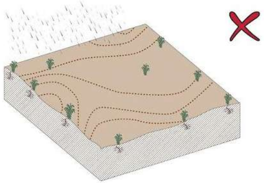
Do amend the soil and effectively place BGI components in the low points of the site



Don't use the existing soil condition as it has lower rate of absorption



Do grading of the soil to increase the rate of percolation



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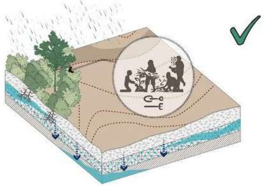
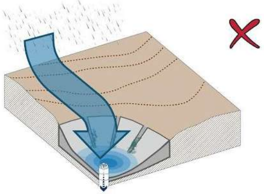
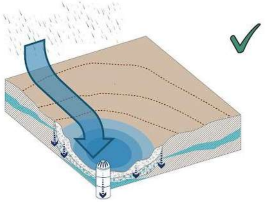


Do grading of the soil to increase the rate of percolation



Don't implement planting randomly in the selected site

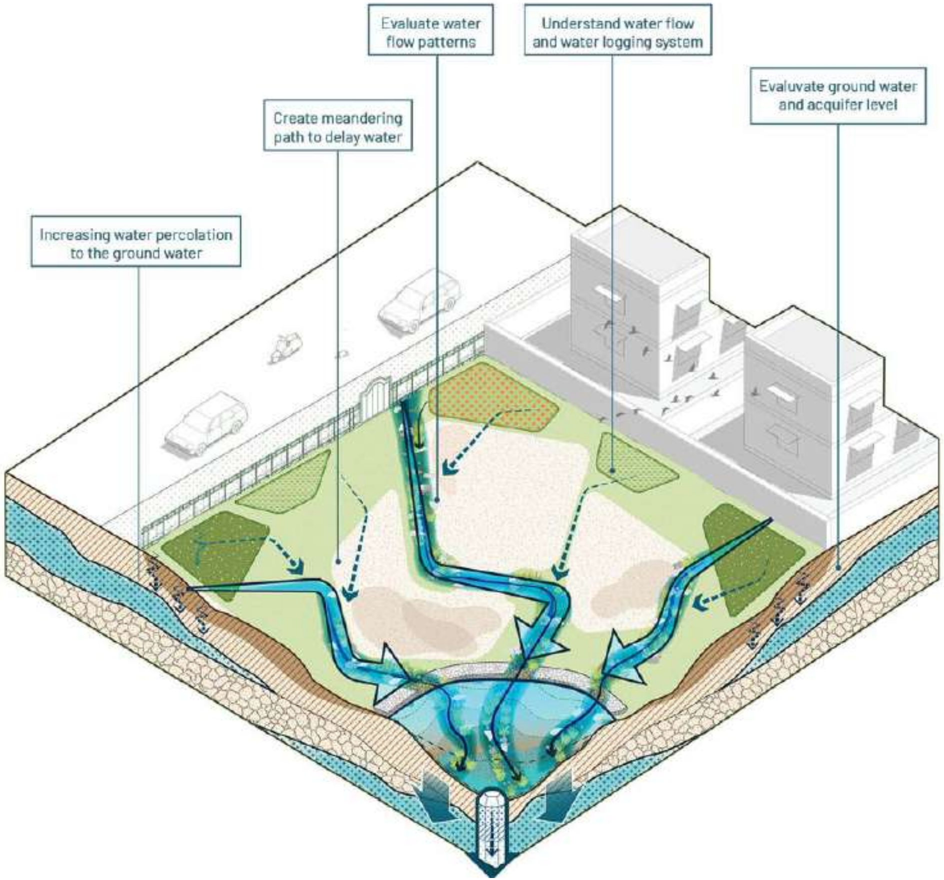


Do planting in the high points of site selected

S.1. SOIL & GRADING

- Soil amendment is done in the designated high planting zones
- Land is graded to create a extended flood zones
- Natural grading of the site is used to incorporate BGI (Sponge) toolkits to capture runoff from all zones

Hydrology and BGI



Delay

- Evaluate surface water flow patterns and potential sources of stormwater runoff.
- Place bioswals and raingarden in the direction of water flow

Store

- Understand hight points and low poitns to place the retension ponds in low points
- Take proper measures towards mosquito breeding if the retension pond has accumulated water for a certain period of time

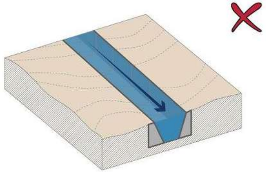
Filter

- Schedule periodic inspections and monitoring to assess performance and address any maintenance needs.
- Ensure that filtering components are designed with safety in mind, such as avoiding steep slopes and providing adequate barriers or signage around water features

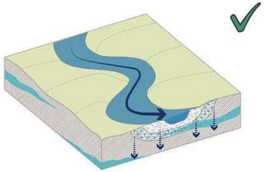
Recharge

- Conduct a comprehensive site assessment to identify suitable locations for recharge wells based on soil conditions, hydrology, and proximity to runoff sources.

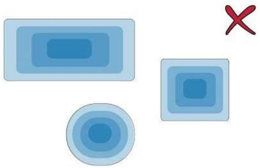
Do's and Don'ts



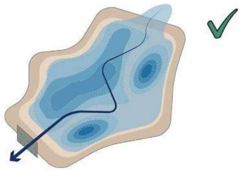
Don't implement sponge park without chanelling as it delay the water flow



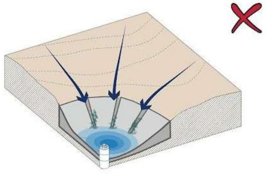
Do create chanelling of water to make advantage in the delay flow of water



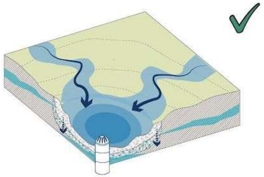
Don't execute BGI of sponge park with simple shapes



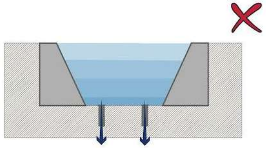
Do organic shaped BGI componets to attain maximum benefit



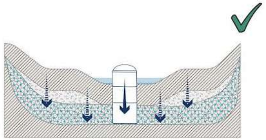
Don't make direct pit for the water to percolate into the groundwater



Do construct the retension basin with recharge well to reduce to filter leaf litter and percolate water soon



Don't execute sponge park with sharp slope of 1:1 or 1:2



Do slope of 1:3 with curved base for the BGI components

S.2. HYDROLOGY & BLUEGREEN

- Understanding water flow helps determine the capacity and design BGI to manage stormwater runoff.
- Designing BGI with appropriate water depths ensures that surfaces remain accessible and safe for maintenance activities.

Detailed Design Criteria (in Report Annex)

3.3.2 System Function

GSI system function can be categorized into the following types: infiltration, detention/slow-release, and disconnection.

Note: Some guidance presented in the infiltration section is relevant for systems that are not fully lined with an impermeable geomembrane liner, even those designed for detention/slow-release.

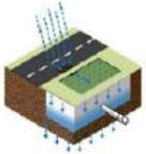


Figure 31: *Infiltration*

Infiltration

Infiltration systems are designed to infiltrate stormwater into the existing subgrade, as shown in **Figure 31**. The first priority for all projects is infiltration as it removes volume from the combined sewer system and provides the maximum water quality benefits. Systems should be designed to maximize opportunities for infiltration.

Figure 32: *Detention/slow-release*

Detention/slow-release

Detention/slow-release systems are designed to capture, detain, and treat stormwater and then slowly release it at a controlled rate to the sewer, as shown in **Figure 32**. If systems are not wrapped in an impermeable geomembrane liner, then some infiltration may still occur.

Figure 33: *Disconnection*

Disconnection

Disconnection is designed to divert impervious areas from the stormwater collection system, as shown in **Figure 33**. Depaving is the most typical form of disconnection in PWD GSI projects. Disconnection may also be used to categorize re-routing inlets to the separate or non-contributing sewer system.

Infiltration Systems

Guidelines

3.3.2.1 If measured infiltration rates are found to be greater than or equal to 0.25 inches per hour, then the system should be designed for infiltration.

a. Where measured infiltration rates are less than 0.25 inches per hour, but soil profiles show layers of greater permeability beneath the impermeable layer, infiltration columns or over-excavation and soil replacement should be considered to promote infiltration. The PWD project manager can provide guidance on a project-by-project basis.

b. Soils with highly variable infiltration rates or with infiltration rates in excess of 10 inches per hour may require over-excavation and soil replacement, amendment, reinforcement, or an impermeable geomembrane liner.

3.3.2.2 Where there is more than one infiltration test for a given system, the infiltration rate should be calculated using the geometric mean. See ***3.3.11 Geotechnical Testing Guidelines*** for more information on obtaining infiltration rates.

3.3.2.3 Infiltration loading ratios (contributing impervious drainage area to infiltration area) should be minimized as feasible.

Table 3: *Maximum Loading Ratio for Subsurface and Surface Systems*

SYSTEM TYPE	MAXIMUM LOADING RATIO
Subsurface Systems	10:1
Surface Systems	25:1

a. These loading ratio maximums are guidance for stabilized drainage areas. Designs should consider the amount of sediment loading expected, factoring in ground cover and land use.

b. Higher loading ratios may be evaluated on a case by case basis in consideration of the geotechnical conditions and at the approval of the PWD project manager. Additional pretreatment should be considered for systems with higher loading ratios.

c. Loading ratios for the total contributing drainage area, which includes pervious and impervious contributing areas, should be designed to consider overall site conditions.

d. Runoff that has been filtered through the surface should not be counted towards the subsurface loading ratio.

3.3.2.4 For surface features, it is recommended that ponding areas drain completely in less than 24 hours. Drain down time for infiltration systems should be calculated using the following equation. Model calculations, where available, may be used in lieu of the equation below.

$$t = \frac{\left(\frac{V}{A_i}\right)}{i} * 12$$

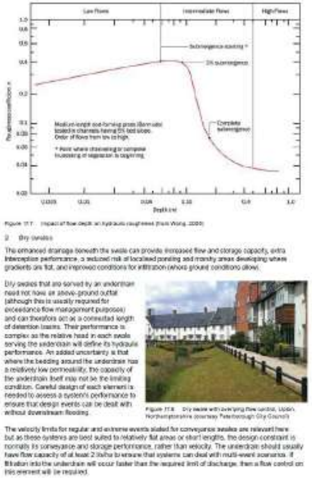
Where:

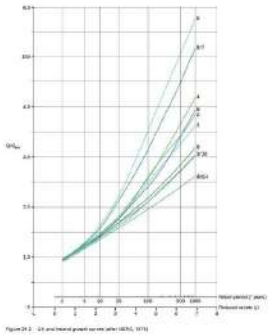
t = Time (hrs)

V = Storage Volume (cf)

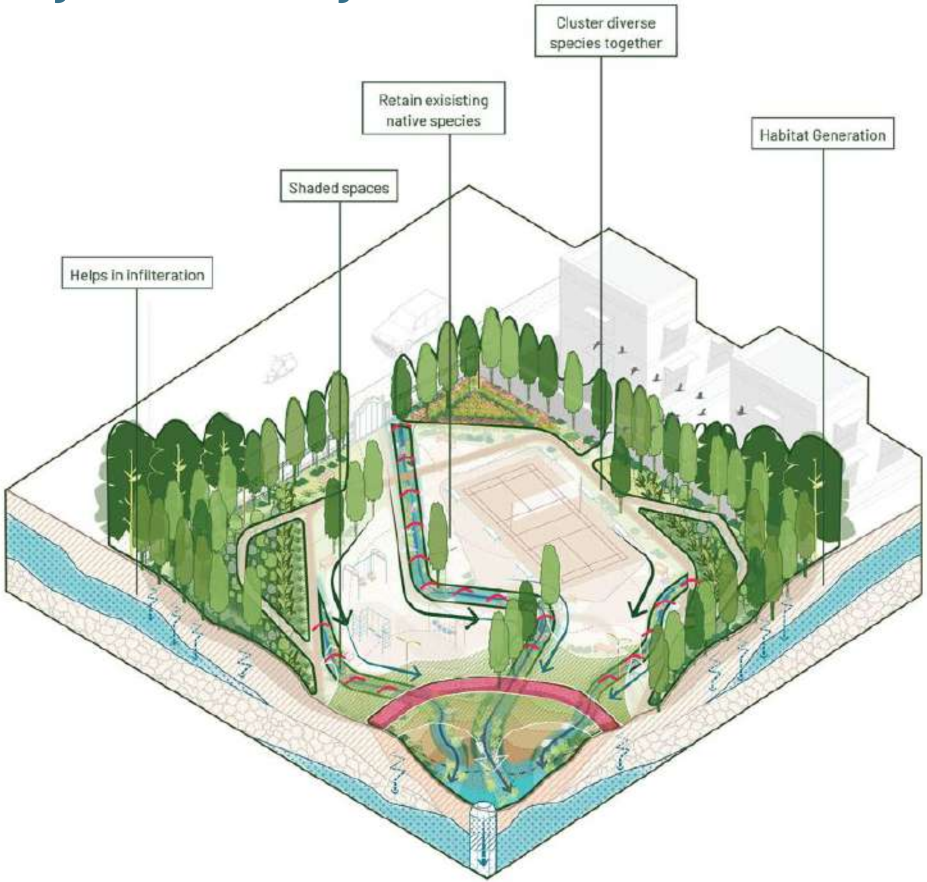
A_i = Infiltration Footprint (sf)

i = Infiltration Rate (in/hr)





Vegetation and Planting



Biodiversity

- Create diverse habitats within the park, including meadows, wetlands, and riparian areas creating home for many species.
- Use native plant species in park landscaping to support local wildlife and pollinators.

Resilience

- Use native plant species which are heat tolerent, drought tolerent and flood resistant
- Control and minimize spread of invasive species

Aesthetics

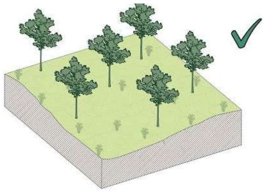
- Try to create visual attractiveness of the park by using a variety of textures, offering year-round interest, and establishing a plant hierarchy.

Maintainence

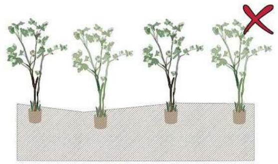
- Check in and proper maintainence should be done to the plants near BGI components
- Plants should be properly cut an dtrimmed
- Proper measures to be taken to control pests and diseases

Do’s and Don’ts

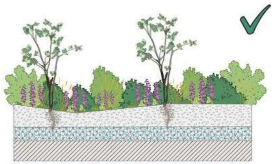
Don’t remove existing vegetation while upgrading the OSR with spong parks



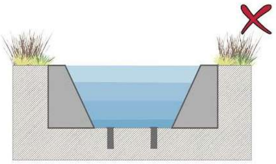
Do conserve the existing species and in some cases try to relocate the vegetation instead of removal



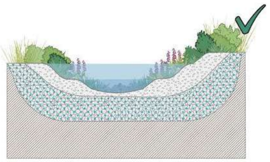
Don’t Incorporate of the single type sampling can be avoided



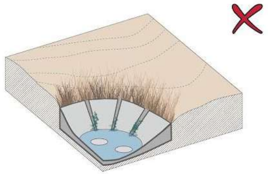
Do diverse of the species can be incorporated in the hierachy like trees, shrubs and ground cover



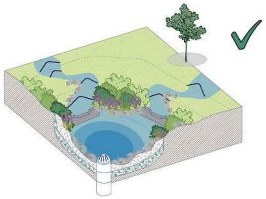
Don’t implement steep sponge park with more depth



Do hierachy of levels while implementing BGI components



Don’t construct sponge parks without filteration otherwise it leads to accumulation of leaf litter

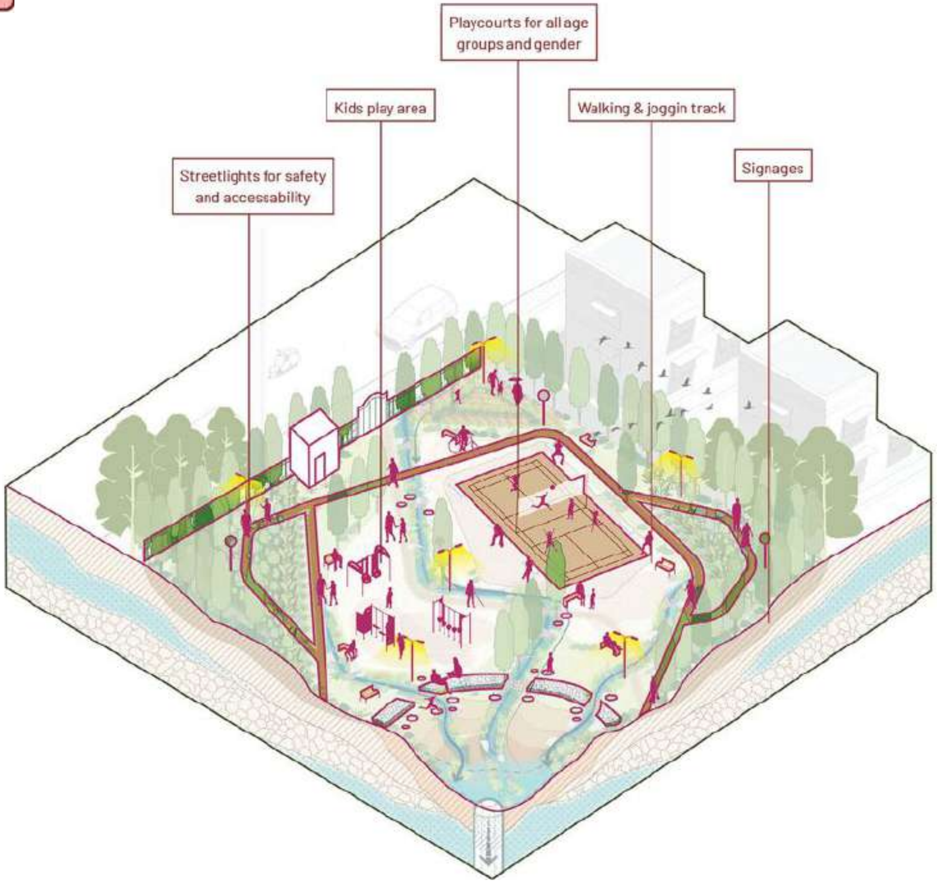


Do integrate filteration infrastructure which helps with easy conveyance of water through the site and filters the litter

S.3.VEGETATION & PLANTING

- Based on the audits conducted various zones like urban forest, pollinated garden & ground cover with native species are created
- Speed areas of greenary is created with native species
- 7 types of planting mixes were incorporated in the

Amenities and Social Facilities



Inclusion

- Include amenities and recreational features that cater to children with diverse abilities.
- Incorporate sensory-rich play elements and inclusive play surfaces to encourage interaction and engagement among children of all abilities

Safety

- Ensure clear sightlines, adequate lighting, and well-maintained pathways to promote a sense of security

Accessibility

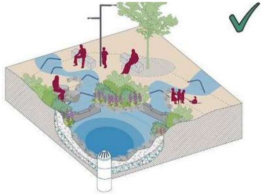
- Ensure that the park is accessible to everyone, including individuals with disabilities.
  Try to integrate features like wheelchair-friendly surfaces\ accessible seating, and signage with Braille elements.
  Provide accessible pathways, ramps, and entrances/exits

Services

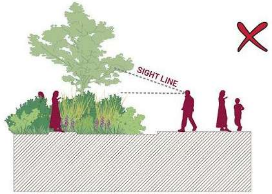
- Provide a variety of amenities to meet the needs of different park users
- Provide toilets and changing areas that are gender-neutral to
- accommodate people of all gender identities.

Do's and Don'ts

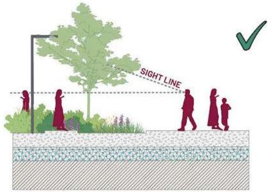
Don't randomly place seating and amenities in the park



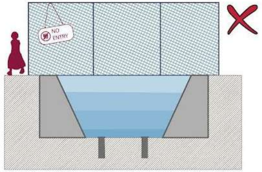
Do placement of amenities and relaxation spots near the BGI components



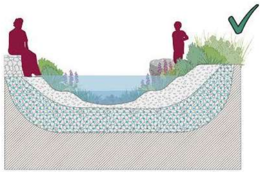
Don't do massing of the species without hierachy



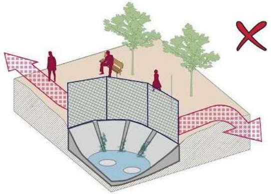
Do hierachy like trees, shrubs and ground cover around the p boundary to have proper sight lines



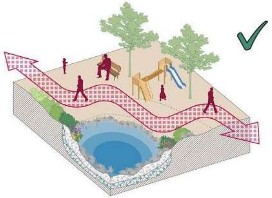
Don't implement steep sponge park with more depth



Do hierachy of levels while implementing BGI components



Don't plan social amenities and BGI components separetely

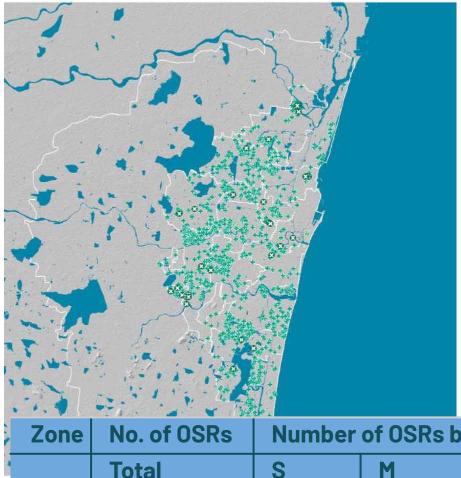
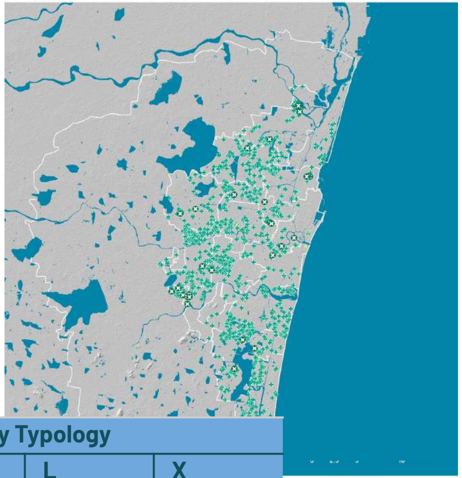
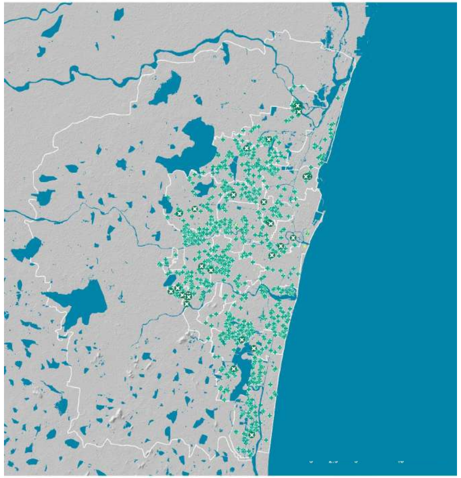
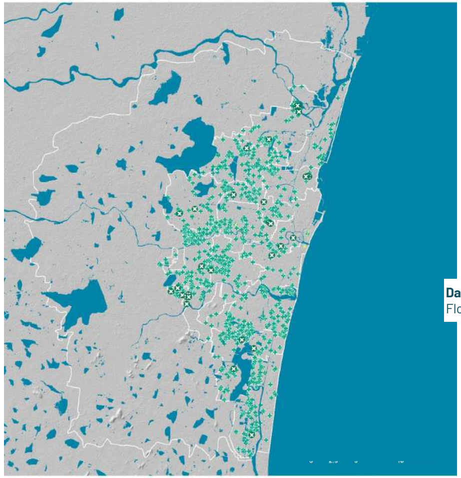


Do blend bgi components and social aminities coherently

S.4. AMENITIES & SOCIAL FACILITIES

- Continuous jogging and walking trail is incorporated compatible with BGI components
- Playgrounds were provided with different sizes and ground mix.
- Proper seatings, signages, sigthlines and lighting are provided to feel safe.

1,126 OSRs are categorised into 4 typologies based on size as a defining factor for design and implementation

Zone	No. of OSRs	Number of OSRs by Typology			
	Total	S	M	L	X
1	481				
2	538				
3	100				
4	7				
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

Data Sou
Flooding

2.3.1. Small Sponge Park

How to assess the site ?

Small sponge parks, usually under 0.2 acres in size, require careful attention to project objectives and site conditions during their design and implementation. Often, the existing conditions of these locations do not align with the park's goals of integrating community-focused activities and green-blue infrastructure. Conducting comprehensive site surveys becomes crucial to bridge this gap. These surveys encompass detailed topographical assessments, thorough soil analysis, hydrological evaluations, geotechnical investigations, catchment analyses to understand water flow patterns, and comprehensive assessments of the entire site.

Checklist For Site Assessments For Sponge Park Systems

SOIL

- ✓ Site survey to examine any depressions in the site.
- ✓ Identification of high and low points.
- ✓ Conduct a soil and geotechnical survey to analyse the soil type
- ✓ Also conduct chemical and granular profile test below ground level.

For more details "DC.1. Soil and Grading" - pg 50

HYDROLOGY

- ✓ After selecting the OSR land, understand the local catchmenet and hydrology model.
- ✓ Understand water flow and water logging system.
- ✓ Analysing the depth of water and quality of aquifer.

For more details "DC.2. Hydrology and Blue Green Infrastructure" - pg 52

VEGETATION

- ✓ Survey the number of trees in the site
- ✓ Audit to measure tree caliper (DBH) above 6" to 12" tree ground line level to maintain trees without relocating.
- ✓ Conduct species audit to remove the invasive species

For more details "S.3. Vegetation and Planting" - pg 54

AMENITIES

- ✓ Check for th entry and exit points
- ✓ Analyse onsite and offsite safety concerns

Conduct species audit to remove the invasive species.

- ✓ Research on the user desires and history of the site

For more details "DC.4. Social and Inclusive Amenities" - pg 56

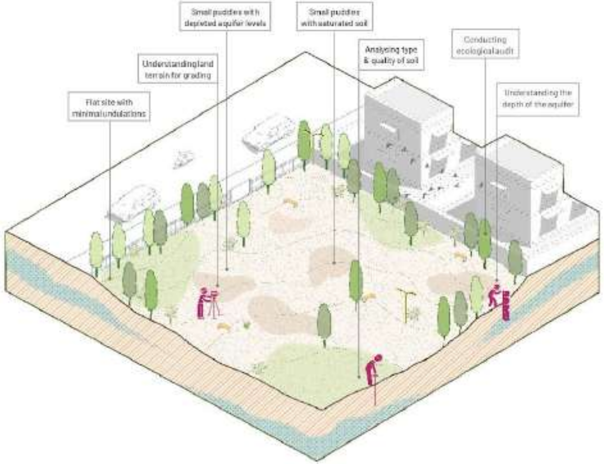


Fig. 2.9 Axon showing the Existing scenario of small osr lands

How design small sponge parks ?

Based on the findings of conducted surveys, sponge parks are strategically planned according to specific criteria, organized into various systems or components. These criteria typically involve understanding soil characteristics and optimizing grading, designing features to effectively manage stormwater (such as bioswales, recharge wells or retention basins), constructing components to improve water quality and minimize runoff, selecting suitable plant species that can thrive in diverse soil and moisture conditions to enhance biodiversity and ecosystem resilience, and incorporating recreational amenities that prioritize the safety and comfort of women and children.

Design Criteria For Sponge Park Systems

S.1. SOIL & GRADING

- Soil amendment is done in the designated high planting zones
- Land is graded to create a extended flood zones
- Natural grading of the site is used to incorporate BGI (Sponge) toolkits to capture runoff from all zones

S.2. HYDROLOGY & BLUEGREEN

- Understanding water flow helps determine the capacity and design BGI to manage stormwater runoff.
- Designing BGI with appropriate water depths ensures that surfaces remain accessible and safe for maintenance activities.
- For more "S.2. Bluegreen Infrastructure (Sponge) Toolkits" - pg 84

S.3. VEGETATION & PLANTING

- Based on the audits conducted various zones like urban forest, pollinated garden & ground cover with native species Pg 162 are created
- Speed areas of greenery is created with native species
- 7 types of planting mixes were incorporated in the site "S.3.3. Types Of Plant Mixes" - pg 106

S.4. AMENITIES & SOCIAL FACILITIES

- Continuous jogging and walking trail is incorporated compatible with BGI components
- Playgrounds were provided with different sizes and ground mix Pg 169
- Proper seatings, signages, sigthlines and lighting are provided to feel safe

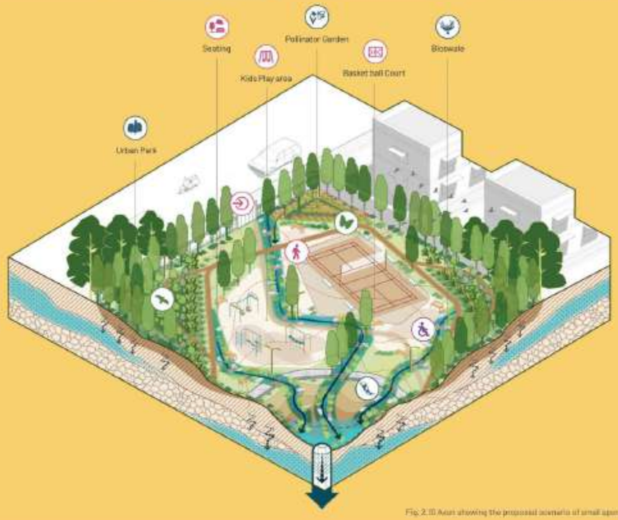


Fig. 2.10 Axon showing the proposed scenario of small sponge park

Functions of Small Sponge Park

The concept of sponge Parks offers a promising solution to Chennai's water challenges by incorporating four key principles: Delay, Store, Filter, and Recharge. These principles are essential for effectively managing stormwater and closing the water cycle in urban environments. Chennai's water issues are complex and exacerbated by rapid urbanization, which has drastically altered the natural hydrology of the region. Implementing Sponge Parks in Chennai's urban fabric requires strategic interventions that mimic natural ground cover conditions. This involves designing park landscapes with features that promote water absorption, infiltration, and retention. These interventions can include selecting appropriate vegetation, incorporating permeable paving materials, and integrating engineered systems for stormwater management.

Delay

By incorporating features like swales, permeable surfaces, and vegetation buffers, Sponge Parks can delay the flow of water, allowing more time for infiltration and reducing peak flows during heavy rainfall events.

Filter

Through natural filtration processes facilitated by vegetation, soil, and engineered media, pollutants and sediments are removed from stormwater runoff before it enters groundwater or surface water bodies.

Store

Sponge Parks are designed to temporarily store stormwater runoff. Features such as rain gardens, retention ponds, and infiltration basins capture excess water, reducing pressure on drainage systems and preventing flooding downstream.

Recharge

By promoting infiltration and allowing water to percolate through soil layers, these parks replenish recharge wells and contribute to sustainable water management.

Table 1. Performance Ability of BGI toolkits in Large Park

BGI Toolkits	Delay	Filter	Store	Recharge
T.2. Bioswales	High	High	Low	Moderate
T.2. Recharge Pit	Moderate	Low	Low	High
T.3. Raingardens - bulings	Moderate	Moderate	Low	Low
T.4. Raingardens - Street	N/A			
T.5. Retension pond	N/A			
T.6. Infilteration basin	N/A			
T.7. Sunken court	N/A			
T.8. Water plaza	N/A			
T.9. Constructed wetlands	N/A			

Performance ability of BGI Toolkits : ● High ◉ Moderate ○ Low

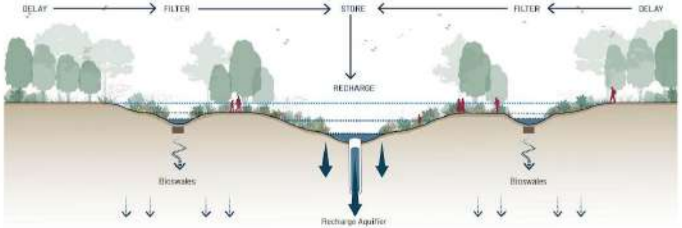


Fig. 2.11 Schematic section of small sponge park

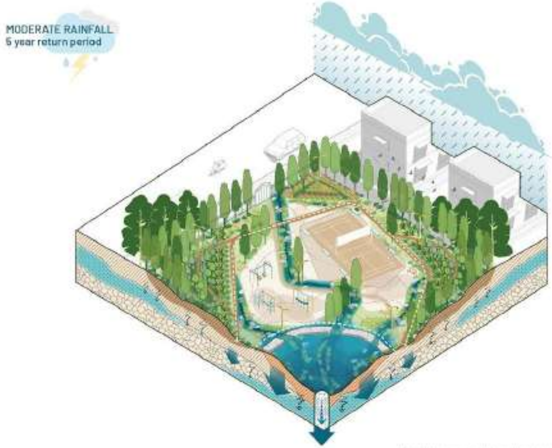


Fig. 2.12 Axon showing the small sponge park during moderate rainfall

Fig. 2.13 Axon showing the small sponge park during peak floods

Case Studies

1 - Sankt Kjelds Square and Bryggervangen

Sankt Kjelds Square and Bryggervangen are urban redevelopment projects showcasing innovative approaches to sustainable urban design, green infrastructure, and community-oriented development. These projects are part of Copenhagen's broader efforts to create vibrant, livable neighborhoods while addressing environmental challenges and enhancing quality of life for residents. Sustainable drainage features were integrated to capture and treat rainwater, reducing runoff and mitigating urban flooding.

Area - 34,900 sqm
Designed by - SLA

Highest temp month : 21.1°c in July
Lowest temp month : 13.3°c in July
Highest rainfall :

Fig. 2.14 Various sustainable drainage systems

KEY TAKEAWAYS

- Sankt Kjelds Square now features pedestrian-friendly pathways, seating areas, recreational spaces, and public art installations.
- The square features rain gardens, which are planted areas designed to capture and absorb rainwater runoff from paved surfaces.
- The square includes an abundance of vegetation, including trees, shrubs, and native plants selected for their ability to thrive in urban conditions.
- Sustainable drainage systems are integrated into the square's design to manage stormwater in an environmentally friendly manner.
- Sustainable draingage systems features may include bioswales, infiltration basins, and detention ponds that slow down and treat stormwater runoff before it enters the sewer system or local water bodies.

Fig. 2.15 overall view of Sankt Kjelds Square

2 - Gowanus Canal Sponge Park

The concept of the Gowanus Canal Sponge Park represents an innovative approach to storm water management and urban revitalization centered around the restoration and enhancement of the Gowanus Canal area. The park is designed to function as a "sponge," absorbing and filtering storm water runoff to mitigate flooding, improve water quality, and create valuable green space within the urban landscape. The park incorporates extensive green infrastructure elements, such as rain gardens, bioswales, vegetated areas, and permeable surfaces.

- Area - 167.2255 sqm
- Designed by - SASAKI

Fig. 2.16 Various sustainable drainage systems

KEY TAKEAWAYS

- The park acts as a "sponge" by absorbing and storing rainwater during storm events, reducing the volume and velocity of runoff entering the Gowanus Canal.
- This sponge effect helps prevent combined sewer overflow (CSO) events and alleviates pressure on the city's sewer system by retaining and slowly releasing stormwater.
- Stormwater captured by the park's green infrastructure features undergoes natural filtration processes as it percolates through soil and vegetation.
- Pollutants, sediments, and contaminants are removed or reduced, leading to improved water quality in the Gowanus Canal and nearby water bodies.
- In addition, Park supports ecological restoration and habitat creation.

Fig. 2.17 Overall view of Gowanus canal park

2.3.2. Medium Sponge Park

How to access the site ?

Medium-sized sponge parks, which typically range in size from 0.2 to 1 acres, necessitate close consideration of site characteristics and project objectives throughout the design and construction phases. The current state of these areas frequently conflicts with the park's objectives of combining community-focused programming with green-blue infrastructure. It becomes essential to perform site surveys. These surveys include in-depth examinations of the topography, soil, hydrology, geotechnical studies, catchment studies to comprehend patterns of water movement, and full evaluations of the entire site.

Site Assessment Criteria By System

SOIL

- ✓ Site survey to examine any depressions in the site.
- ✓ Identification of high and low points.
- ✓ Conduct a soil and geotechnical survey to analyse the soil type
- ✓ Also conduct chemical and granular profile test below ground level.

For more details "DC.1. Soil and Grading" - pg <?>

HYDROLOGY

- ✓ After selecting the OSR land, understand the local catchmenet and hydrology model.
- ✓ Understand water flow and water logging system.
- ✓ Analysing the depth of water and quality of aquifer.

For more details "DC.2. Hydrology and Blue Green Infrastructure" - pg <?>

VEGETATION

- ✓ Survey the number of trees in the site
- ✓ Audit to measure tree caliper (DBH) above 6" to 12" tree ground line level to maintain trees without relocating.
- ✓ Conduct species audit to remove the invasive species

For more details "S.3. Vegetation and Planting" - pg <?>

AMENITIES

- ✓ Check for th entry and exit points
- ✓ Analyse onsite and offsite safety concerns
  Conduct species audit to remove the invasive species.
- ✓ Research on the user desires and history of the site

For more details "DC.4. Social and Inclusive Amenities" - pg <?>

Fig. 2.18 Axon showing the Existing scenario of medium [illegible] lands

How design medium sponge parks ?

Sponge parks are arranged into several systems or components and strategically developed based on the results of surveys that are done. These requirements usually include knowing the properties of the soil and grading it effectively, designing stormwater management features like bioswales, raingardens recharge wells, or retention basins to enhance water quality and reduce runoff, choosing appropriate plant species that can perform well in a wide range of soil and moisture conditions to promote biodiversity and ecosystem resilience, and incorporating recreational amenities that put women's and children's safety and comfort first.

Design Criteria By System

S.1. SOIL & GRADING

- Soil amendment is done in the designated high planting zones
- Land is graded to create a extended flood zones
- Natural grading of the site is used to incorporate BGI (Sponge) toolkits to capture runoff from all zones

S.2. HYDROLOGY & BLUEGREEN

- Understanding water flow helps determine the capacity and design BGI to manage stormwater runoff.
- Designing BGI with appropriate water depths ensures that surfaces remain accessible and safe for maintenance activities.
- For more "S.2. Bluegreen Infrastructure (Sponge) Toolkits" - pg <?>

S.3.VEGETATION & PLANTING

- Based on the audits conducted various zones like urban forest, pollinated garden & ground cover with native species Pg 162 are created
- Speed areas of greenary is created with native species
- 7 types of planting mixes were incorporated in the site "S.3.3. Types Of Plant Mixes" - pg 104

S.4. AMENITIES & SOCIAL FACILITIES

- Continuous jogging and walking trail is incorporated compatible with BGI components
- Playgrounds were provided with different sizes and ground mix Pg 169
- Proper seatings, signages, sigthlines and lighting are provided to feel safe

Fig. 2.19 Axon showing the proposed scenario of Medium sponge park

Functions of Small Sponge Park

The concept of sponge Parks offers a promising solution to Chennai's water challenges by incorporating four key principles: Delay, Store, Filter, and Recharge. These principles are essential for effectively managing stormwater and closing the water cycle in urban environments. Chennai's water issues are complex and exacerbated by rapid urbanization, which has drastically altered the natural hydrology of the region. Implementing Sponge Parks in Chennai's urban fabric requires strategic interventions that mimic natural ground cover conditions. This involves designing park landscapes with features that promote water absorption, infiltration, and retention. These interventions can include selecting appropriate vegetation, incorporating permeable paving materials, and integrating engineered systems for stormwater management.

Delay

By incorporating features like swales, permeable surfaces, and vegetation buffers, Sponge Parks can delay the flow of water, allowing more time for infiltration and reducing peak flows during heavy rainfall events.

Filter

Through natural filtration processes facilitated by vegetation, soil, and engineered media, pollutants and sediments are removed from stormwater runoff before it enters groundwater or surface water bodies.

Store

Sponge Parks are designed to temporarily store stormwater runoff. Features such as rain gardens, retention ponds, and infiltration basins capture excess water, reducing pressure on drainage systems and preventing flooding downstream.

Recharge

By promoting infiltration and allowing water to percolate through soil layers, these parks replenish recharge wells and contribute to sustainable water management.

Table 2. Performance Ability of BGI toolkits in Large Park

BGI Toolkits	Delay	Filter	Store	Recharge
T.2. Bioswales	●	●	○	◉
T.2. Recharge Pit	◉	○	○	●
T.3. Raingardens - bullings	◉	◉	○	○
T.4. Raingardens - Street	◉	◉	◉	○
T.5. Retension pond	◉	◉	●	○
T.6. Infilteration basin	●	◉	◉	●
T.7. Sunken court	○	○	●	◉
T.8. Water plaza	N/A			
T.9. Constructed wetlands	N/A			

Performance ability of BGI Toolkits : ● High ◉ Moderate ○ Low

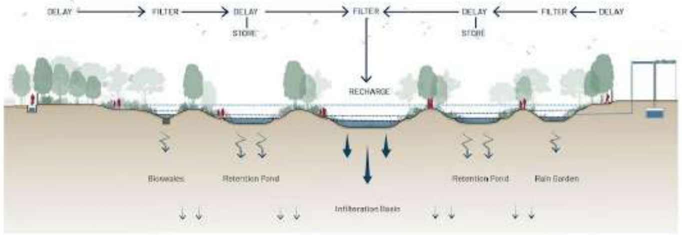


Fig. 2.20 Schematic section of Medium sponge park

Fig. 2.21 Axon showing the medium sponge park during Floods

Fig. 2.22 Axon showing the medium sponge park during moderate rainfall

Case Studies

1 - Tanners Springs Park

Nestled in Portland, Oregon's Pearl District is Tanner Springs Park, a singular urban green space. Tanner Springs Park is an excellent example of how urban planning, ecological restoration, and community involvement can come together to create dynamic, sustainable public spaces that benefit locals and tourists alike by raising awareness of environmental issues and improving quality of life. Tanner Springs Park incorporates a central wetland area which emphasizes the restoration of natural hydrological processes in an urban context, showcasing sustainable stormwater management techniques.

- Location - Pearl District, Portland
- Area - 0.92 acres
- Designed by - Atelier Dreiseitl

Fig. 2.23 includes permeable paving, raingarden and biofiltration swales

KEY TAKEAWAYS

- The wetland serves as a constructed ecosystem that captures and treats stormwater runoff from surrounding streets and buildings.
- Water is circulated through the park, mimicking natural processes of filtration and purification, before being discharged back into the city's stormwater system.
- Native plant species were carefully selected to enhance biodiversity and create a resilient urban ecosystem.
- The park showcases innovative stormwater management strategies, demonstrating how urban green spaces can contribute to water quality improvement and habitat conservation.
- The park reflects Portland's commitment to environmental stewardship, green infrastructure, and the integration of nature into the urban fabric.

Fig. 2.24 Image Of Central Wetland Area Surround By Bioswales

2 - Dr. Shivarama Karanth Park - Rainwater harvesting park

The park's design incorporates various rainwater harvesting structures, including rooftop harvesting, surface runoff collection, and groundwater recharge systems which were aimed at promoting rainwater harvesting techniques and raising awareness about sustainable water management practices among residents and visitors in Bangalore, India. The park serves as a demonstration site for various rainwater harvesting methods and technologies, showcasing how urban landscapes can integrate water conservation strategies while providing recreational and educational amenities.

- Location - Bangalore, India
- Area - 1 acres
- Designed by - Bangalore Water Supply and Sewerage Board (BWSSB) in collaboration with the Karnataka State Council for Science and Technology (KSCST).

Fig. 2.25 Various water filteration methods

KEY TAKEAWAYS

- The park features interactive exhibits and demonstrations that educate visitors about different rainwater harvesting methods and technologies
- The park showcases sustainable landscaping practices, such as native plantings, permeable surfaces, and biofiltration features.
- Vegetated swales, rain gardens, and water-efficient irrigation systems demonstrate how green infrastructure can enhance water infiltration and reduce runoff.
- The park serves as a hub for community engagement and environmental education, hosting workshops, seminars, and outreach programs on rainwater harvesting and water conservation.

Fig. 2.26 Overall view of Rainwater harvesting park

2.3.3. Large Sponge Parks

How to access the site ?

Large-scale sponge parks typically span an acre or more, and their design and implementation need close consideration of project goals and site conditions. Frequently, the locations' present condition breaks below of the park's objective of combining community-focused events and green-blue infrastructure. It becomes essential to carry out comprehensive site surveys to address this disparity. These surveys include full topographical assessments, in-depth soil analysis, hydrological evaluations, geotechnical investigations, catchment analyses to comprehend patterns of water flow, and comprehensive assessments of the entire site.

Site Assessment Criteria By System

SOIL

- ✓ Site survey to examine any depressions in the site.
- ✓ Identification of high and low points.
- ✓ Conduct a soil and geotechnical survey to analyse the soil type
- ✓ Also conduct chemical and granular profile test below ground level.

For more details **"DC.1. Soil and Grading" - pg <?>**

HYDROLOGY

- ✓ After selecting the OSR land, understand the local catchmenet and hydrology model.
- ✓ Understand water flow and water logging system.
- ✓ Analysing the depth of water and quality of aquifer.

For more details **"DC.2. Hydrology and Blue Green Infrastructure" - pg <?>**

VEGETATION

- ✓ Survey the number of trees in the site
- ✓ Audit to measure tree caliper (DBH) above 6" to 12" tree ground line level to maintain trees without relocating.
- ✓ Conduct species audit to remove the invasive species

For more details **"S.3. Vegetation and Planting" - pg <?>**

AMENITIES

- ✓ Check for th entry and exit points
- ✓ Analyse onsite and offsite safety concerns

  Conduct species audit to remove the invasive species.
- ✓ Research on the user desires and history of the site

For more details **"DC.4. Social and Inclusive Amenities" - pg <?>**

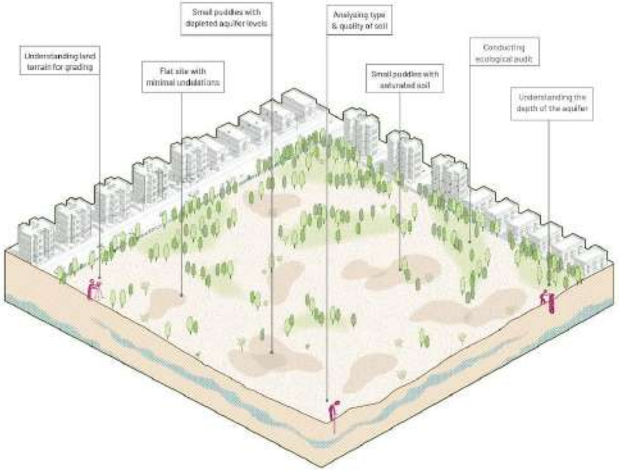


Fig. 2.27 Axon showing the Existing scenario of Large OSR

How design Large sponge parks ?

Based on the insights from conducted surveys, sponge parks are strategically designed according to specific criteria, organized into different systems or components. These criteria typically include Understanding soil characteristics and optimizing grading, Designing features that manage stormwater effectively, such as bioswales, rain gardens, or retention basins, constructed wetlands, sunken court, water plaza to enhance water quality and reduce runoff, selecting appropriate plant species can thrive in varying soil and moisture conditions, contributing to biodiversity and ecosystem resilience, incorporating recreational amenities where women and children feel safe. The process of designing sponge parks involves a holistic approach that integrates ecological, hydrological, and social considerations. This comprehensive approach ensures that sponge parks not only mitigate urban challenges like stormwater runoff but also provide valuable green spaces that benefit both people and the environment.

Design Criteria By System

S.1. SOIL & GRADING

- Soil amendment is done in the designated high planting zones
- Land is graded to create a extended flood zones
- Natural grading of the site is used to incorporate BGI (Sponge)toolkits to capture runoff from all zones

S.2. HYDROLOGY & BLUEGREEN

- Understanding water flow helps determine the capacity and design BGI to manage stormwater runoff.
- Designing BGI with appropriate water depths ensures that surfaces remain accessible and safe for maintenance activities.
- For more **"S.2. Bluegreen Infrastructure (Sponge) Toolkits" - pg <?>**

S.3.VEGETATION & PLANTING

- Based on the audits conducted various zones like urban forest, pollinated garden & ground cover with native species **Pg 162** are created
- Speed areas of greenery is created with native species
- 7 types of planting mixes were incorporated in the site **"S.3.3. Types Of Plant Mixes" - pg 104**

S.4. AMENITIES & SOCIAL FACILITIES

- Continuous jogging and walking trail is incorporated compatible with BGI components
- Playgrounds were provided with different sizes and ground mix **Pg 169**
- Proper seatings, signages, sigthlines and lighting are provided to feel safe

Fig. 2.28 Axon showing the proposed scenario of Large sponge space

Case Studies

1 - Qunli Stormwater Wetland Park

The Qunli Stormwater Wetland Park, is a innovative park serves as a model for integrating ecological restoration, stormwater management, and public recreation within an urban setting, represents a paradigm shift in urban design, demonstrating how landscape architecture can contribute to ecological restoration, stormwater management, and community well-being in rapidly growing cities. The primary objective of the Qunli Stormwater Wetland Park is to manage and treat stormwater runoff from the surrounding urban area.

- Location - Qunli New Town, Harbin, China
- Area - 84 acres
- Designed by - Turenscape

Fig. 2.32 Images of vegetated swales that capture and filter stormwater

KEY TAKEAWAYS

- The park incorporates a series of constructed wetlands, detention basins, and vegetated swales that capture and filter stormwater, reducing peak flows and improving water quality.
- Wetland ecosystems within the park support a variety of plant and animal species, contributing to the overall health of the urban environment
- The park is designed to retain and infiltrate stormwater through natural processes, reducing the burden on conventional drainage infrastructure.
- Permeable surfaces, such as wetland soils and vegetated areas, facilitate groundwater recharge and minimize surface runoff.
- The park's design promotes resource conservation, resilience to climate change, and integration with the natural landscape

Fig. 2.33 Aerial view of Qunli Stormwater Wetland Park

2 - Houtan Park

Houtan Park, is a renowned example of innovative urban design that integrates ecological principles, sustainable practices, and public amenities within a densely populated urban area. Houtan Park is characterized by its focus on ecological restoration, transforming a former industrial site into a vibrant urban green space. The park's design incorporates native vegetation, wetland habitats, and naturalistic landscapes that mimic the region's natural ecology and is designed to enhance the resilience of the urban environment to climate change and extreme weather events.

- Location - Shanghai, China
- Area - 14 hectares.
- Designed by - Turenscape

Fig. 2.34 Series of criteria of how water is filtered in the park

KEY TAKEAWAYS

- One of the central features of Houtan Park is its innovative stormwater management system, which utilizes ecological principles to capture, treat, and recycle rainwater.
- The park includes constructed wetlands, bioswales, and permeable surfaces that filter and purify stormwater runoff, reducing pollution and mitigating flooding
- The park's water features, such as ponds, channels, and waterfalls, help regulate local microclimates, improve air quality, and support biodiversity.
- Park provides a range of recreational and cultural amenities for visitors, including walking paths, viewing platforms, art installations, and outdoor gathering spaces.

Fig. 2.35 overall view of Minghu wetland park

1- Urban wetland park

The proposed park is intended to be an Integrated Public Space development that would restore an Urban Wetland that is in danger of disappearing and allow biodiversity to flourish in addition to serving as a community learning and enjoyment area. The general guidelines for landscape design includes natural biodiversity, nature-based recreation, low-impact development, and environmental education. The wetland's interpretation as an urban infrastructure, social amenity, and habitat for biodiversity is on display in the park.

- Location - Porur, Chennai, India
- Area - 19 acres
- Designed by - Sponge Collaborative

Fig. 2.38 Series of images of Entrance way, boardwalks on the wetlands

KEY TAKEAWAYS

- The Chettiyar Agaram Lake is preserved in the Wetland Zone, which also improves the waterbody's edge by adding wetland plant species to support biodiversity and build an ecosystem. The lake viewing platform offers a comprehensive perspective of the lake as well as information on plant and wildlife species.
- The Flowering Avenue features a lawn that people can use for play areas and seating as well as a rammed earth pathway that winds through a dense stand of red poinsettias and mature trees.
- The Boardwalk is a raised path that offers access to multiple activity zones, covered lounging areas, and a range of wetland vegetation, including grasses and flowering shrubs.

Fig. 2.39 Masterplan of urban wetland park

2. Kilambakkam climate interpretation park

One of the major public infrastructure projects that the Chennai Metropolitan Area's CMDA undertook is the Kilambakkam Climate Park and Archaeological Interpretation Centre. To cope up with climate change in Chennai, it will highlight the significance of regional landscapes and blue-green infrastructure. Critical regional landscapes, proving BGI for climate adaptation strategies, and raising community education and understanding about climate change are all taken into account in the proposed design. As a multipurpose infrastructure, the proposed park is meant to be a destination for culture, recreation, urban ecology, archeological interpretation, and community building in the surrounding area.

- Location - Kilambakkam, Chennai
- Area - 16.9 acres
- Designed by - Sponge Collaborative

Fig. 2.40 Series of images of Entrance way, boardwalks on the wetlands

KEY TAKEAWAYS

- The purpose of sponge park infrastructure, a sustainable approach to water management, is to generate an interpretation through the use of vegetation and natural solutions to store, filter, and recharge water.
- Parks are an excellent means of enhancing resilience, habitat, and wildlife surrounding the park.

Fig. 2.41 Masterplan of Kilabakkam climate interpreatation

Blue-green Infrastructure Toolkit

Table 4. Performance Ability of BGI toolkits across Sponge Parks

BGI (Sponge) Toolkits	Principles				Typologies			
	Delay	Store	Filter	Recharge	Small	Medium	Large	X - Special
T.1. Bioswales	●	○	●	◉	●	●	●	●
T.2. Recharge Pit	◉	○	○	●	●	●	●	●
T.3. Raingarden (Buildings)	◉	○	◉	○	●	●	●	●
T.4. Raingarden (Streets)	◉	◉	◉	○		●	●	●
T.5. Retention Pond	◉	●	◉	○		●	●	●
T.6. Infilteration Basin	●	◉	◉	●		●	●	●
T.7. Sunken Court	○	●	○	◉			●	●
T.8. Water Plaza	◉	●	○	◉			●	●
T.9.Constructed Wetlands	●	●	●	◉			●	●

Performance ability of BGI Toolkits : ● High ◉ Moderate ○ Low


Fig. 2.48 Reference - Bioswales


Fig. 2.49 Reference - Recharge Wells


Fig. 2.50 Reference - Rain Garden


Fig. 2.51 Reference - Retension Pond


Fig. 2.52 Reference - Infilteration basin


Fig. 2.53 Reference - Sunken Court


Fig. 2.54 Reference - Water plaza


Fig. 2.55 Reference - Constructed wetlands

T.1. Bioswales

The purpose of planted and managed swales, or bioswale channels, is to transmit stormwater at a low velocity and encourage natural treatment and infiltration. Stormwater from roads and other impervious surfaces can be efficiently conveyed and treated via bioswale channels. When the drainage area, terrain, soils, slope, and safety considerations allow for their implementation, they can be used on medians or beside roads. Most swales are kept as lawn areas and planted with turf grass.

Indicators To Consider

Suitability

- Water depth - 1.5 to 3m
- Slope - 0.5 % - 4%
- Infilteration Rate - 1"-6"/hr
- Soil mix - sand + loam + compost
- Planting mix - Bioswale mix **"Bioswale Mix" - pg 108**
- Maintainence lvl - Low
- Community engagement - Medium lvl of acceptance

Performance Ability

DELAY ●
STORE ●
FILTER ○
RECHARGE ◉

LEGEND
● Highly Effective in all conditions
◉ Moderately/ Conditionally Effective
○ Not Effective / Not Applicable

Limitations

- If slope of existing bioswale is higher than 3%, the slope must be decreased using check dams or a sequence of terraced bioswales.
- 6" should be the maximum amount of ponding in the swale.
- Typically, amended soil in the bioswale should be between 12"-18" thick.

Maintainence

- Removal of debris/litter from the system
- Clearing of inlets, culverts and outlets from debris and sediment.
- Check **"4.2.1. General Site Maintainence" - pg 130** for more details
- Check **"MAINTAINENCE OF" - pg 85** for more details

Table 5. Schedule Of Rates - 1M x 1M x 1M

Components	SOR number	Quantity	Units	UnitRate
Excavation		0.8	Cmt	Rs 230
curb		3	Rmt	Rs 750
Water inlet grating		0.5	Nos.	Rs 450
Water outlet grating		0.25	Nos.	Rs 450
Boulder		0.25	LS	Rs 150

Components	SOR number	Quantity	Units	UnitRate
Shrub		1	Sqm	Rs 1,600
Soil		0.3	Cmt	Rs 2,000
Gravel		0.1	Cmt	Rs 1,200
Perforated pipe		1	Rmt	Rs 600
overflow pipe		1	Rmt	Rs 200

Fig. 2.56 Reference Images of Bioswales

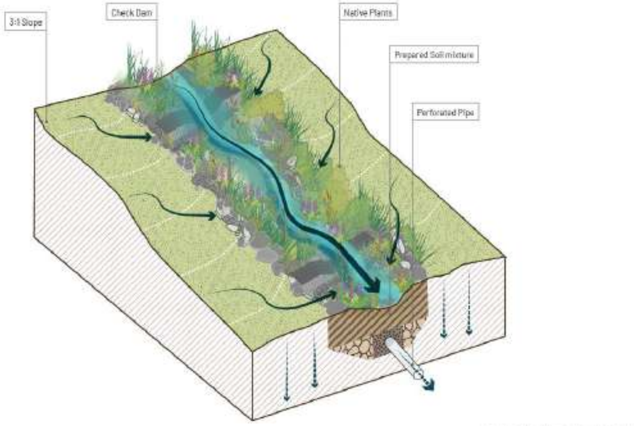


Fig. 2.57 Axon showing Bioswale Details

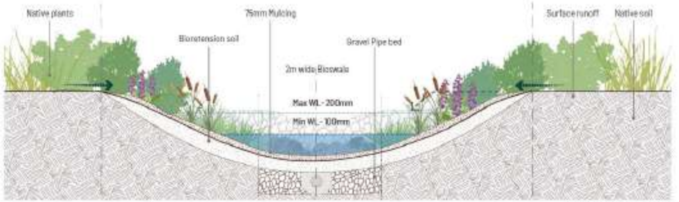


Fig. 2.58 Section of Bioswales

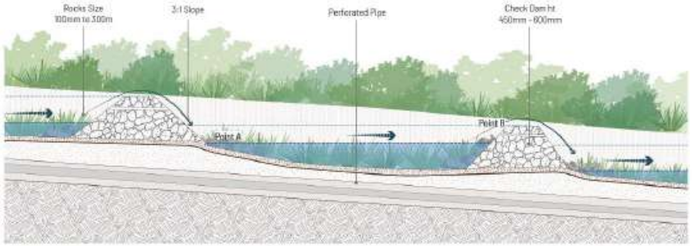


Fig. 2.59 Checkdam Details

T.2. Recharge Wells

Recharge wells are artificial groundwater recharge methods that release water directly into zones of deep water holding capacity. The aquifer-covering material can be used to casing recharge wells. A screen can be inserted into the well at the injection zone if this material is not well-consolidated. Since subsurface groundwater recharge requires wide regions for infiltration, they are also beneficial in places with limited land. This technique can achieve a comparatively high rate of recharge.

Indicators to consider

Suitability

- Water depth - 6m
- Infilteration Rate -
- Soil mix - sand + loam + soil textures
- Planting mix - Bioswale mix **"Bioswale Mix" - pg 108**
- **Maintainence lvl** - Medium
- Community engagement - Medium lvl of acceptance

Performance Ability

DELAY ◉
STORE ○
FILTER ○
RECHARGE ●

LEGEND
● Highly Effective in all conditions
◉ Moderately/ Conditionally Effective
○ Not Effective / Not Applicable

Limitations

- Description neededBa. Idici incta etus, tem autem ligendita cor moluptias autem quas si am ipid quibus eos et qui conse ex everferio odiciis ut quiatur sequia quodita tiorum quat.
- Rit. comnis alit, cupta eiciaec tioreca tenempo datestendae sin nostiunti commoditius as ex exere aliquid quid untium

Maintainence

- Removal of debris/litter from the system
- Clearing of inlets, culverts and outlets from debris and sediment.
- Check **"4.2.1. General Site Maintainence" - pg 130** for more details
- Check **"MAINTAINENCE OF" - pg 85** for more details

Table 6. Schedule Of Rates - 0.9m diameter

Components	SOR number	Quantity	Units	UnitRate
Recharge well		1	Nos.	Rs 70,000
Excavation		11.4453	Cmt	Rs 230
Rcc rings with perforation		2.4021	Sqm	
Perforated RCC cover slab		1	Nos.	
Gravel		2.5434	Cmt	Rs 1,200

Components	SOR number	Quantity	Units	UnitRate
overflow pipe		1	Rmt	Rs 1,200
Recharge Well provided in Open Spaces		15	Nos.	Rs 70,000

Fig. 2.60 Reference images of Recharge wells

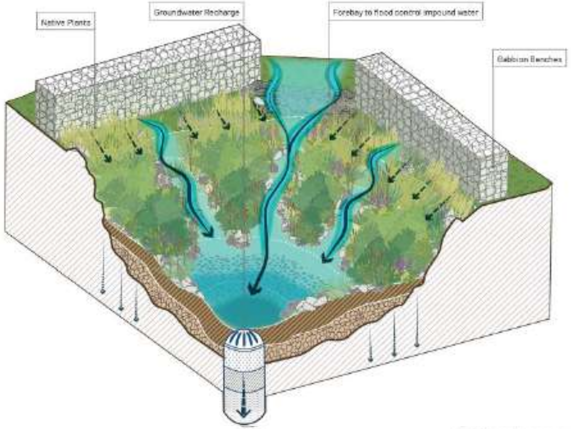


Fig. 2.61 Axon showing recharge wells Details

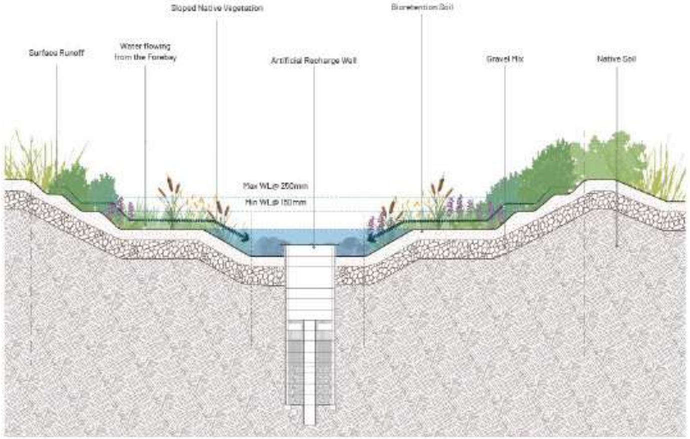


Fig. 2.62 Section of Recharge wells

T.3. Raingarden - Builings

Rain gardens are vegetated areas created to collect runoff from impermeable surfaces like parking lots, walkways, and roofs. In case of runoff from the roofs, water from the buildings are slowly released back into the existing sewer system via underdrain pipe conveyance through vegetation, and infiltrated into the ground. Rain gardens are small, often planted spaces that blend in with the surrounding landscape elements. They are typically filled with a range of native grasses and plants.

Indicators to consider

Suitability

- Water depth - 3" to 8"
- Slope - 4% to 12%
- Infilteration Rate - 5"/hr
- Soil mix - sand + topsoil + compost
- Planting mix - Bioswale mix **"Bioswale Mix" - pg 108**
- Maintainence lvl - Low
- Community engagement - Medium lvl of acceptance

Performance Ability

DELAY	Moderately/ Conditionally Effective
STORE	Moderately/ Conditionally Effective
FILTER	Not Effective / Not Applicable
RECHARGE	Not Effective / Not Applicable

LEGEND
- Highly Effective in all conditions
- Moderately/ Conditionally Effective
- Not Effective / Not Applicable

Limitations

- Use of rain gardens is not advised in the site with steep slopes or insufficient rainfall.
- Additionally, sites with high groundwater tables and polluted areas should not be used for rain gardens.
- Highly susceptible to clogging if the surrounding vegetation is neglected

Maintainence

- Removal of debris/litter from the system
- Clearing of inlets, culverts and outlets from debris and sediment.
- Immediately after the monsoon is over, take out the stagnant water in the settling chamber.
- Check **"MAINTAINENCE OF" - pg 85** for more details

Table 7. Schedule Of Rates - 1.5M x 1M x 1M

Components	SOR number	Quantity	Units	UnitRate
Excavation		1.50	Cmt	Rs 391
Kerb		3.50	M	Rs 2,948
Water Inlet Grating		0.75	Nos.	Rs 338
Water Outlet Grating		0.375	Nos.	Rs 169
Shrubs		1.50	Sqm	Rs 2,700
Soil		0.45	Cmt	Rs 2,838
Boulder (300-450mm)		0.38	LS	Rs 56
Gravel		0.90	Cmt	Rs 1,080
Perforated Pipe		1.50	M	Rs 900
Overflow Pipe		1	M	Rs 200
Trees		2	Nos.	Rs 12,000

Fig. 2.63 Reference images of Raingarden (Buildings)

Fig. 2.64 Axon showing Raingarden (Buildings)

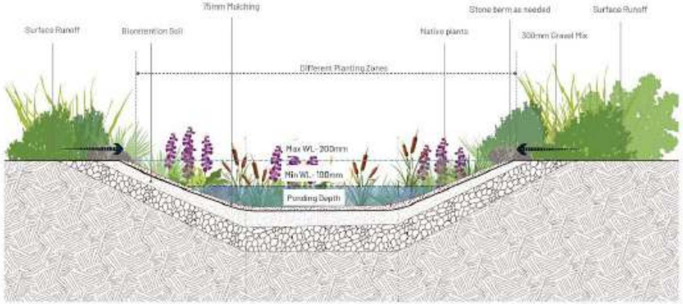


Fig. 2.65 Section showing Raingarden details

T.4. Raingarden - Streets

Rain gardens are vegetated areas created to collect runoff from impermeable surfaces like parking lots, walkways, and roofs. Surface Runoff is the overland flow of water resulting from rainfall before it reaches a water course. It is generated because impervious areas do not allow water to soak into the ground. Rain gardens are usually generated over various impervious surfaces of sponge parks. The runoff water from the streets are channelized in the raingarden and entered through the pipes and used as source water for artificial groundwater recharge.

Indicators to consider

Suitability

- Water depth - 3" to 8"
- Slope - 4% to 12 %
- Infilteration Rate - 5"/hr
- Soil mix - sand + topsoil + compost
- Planting mix - Bioswale mix **"Bioswale Mix" - pg 108**
- Maintainence lvl - Low
- Community engagement - Medium lvl of acceptance

Performance Ability

- DELAY – Moderately/ Conditionally Effective
- STORE – Moderately/ Conditionally Effective
- FILTER – Moderately/ Conditionally Effective
- RECHARGE – Not Effective / Not Applicable

LEGEND
- Highly Effective in all conditions
- Moderately/ Conditionally Effective
- Not Effective / Not Applicable

Limitations

- Use of rain gardens is not advised in the site with steep slopes or insufficient rainfall.
- Additionally, sites with high groundwater tables and polluted areas should not be used for rain gardens.
- Highly susceptible to clogging if the surrounding vegetation is neglected

Maintainence

- Removal of debris/litter from the system
- Clearing of inlets, culverts and outlets from debris and sediment.
- Manage the implemented vegetation.
- Check **"MAINTAINENCE OF" - pg 66** for more details

Table 8. Schedule Of Rates - 1.5M x 1M x 1M

Components	SOR number	Quantity	Units	UnitRate
Excavation		1.50	Cmt	Rs 381
Kerb		3.50	M	Rs 2,948
Water Inlet Grating		0.75	Nos.	Rs 338
Water Outlet Grating		0.375	Nos.	Rs 169
Shrubs		1.50	Sqm	Rs 2,700
Soil		0.45	Cmt	Rs 2,838
Boulder (300-450mm)		0.38	LS	Rs 56
Gravel		0.90	Cmt	Rs 1,080
Perforated Pipe		1.50	M	Rs 900
Overflow Pipe		1	M	Rs 200
Trees		2	Nos.	Rs 12,000

Fig. 2.88 Reference images of Raingarden (Streets)

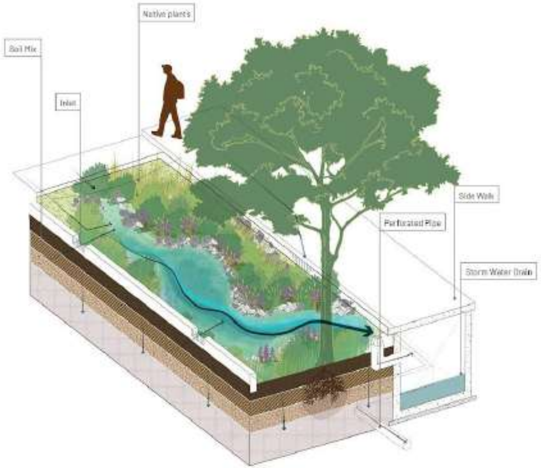


Fig. 2.87 Axon showing Raingarden (streets)

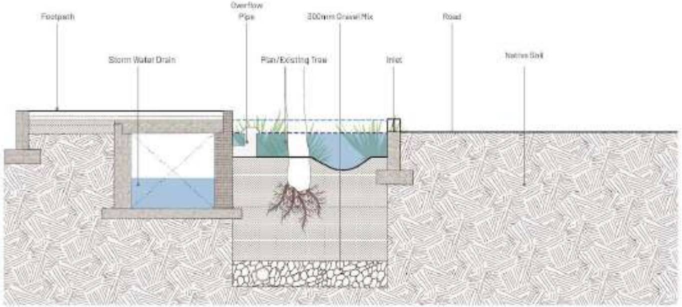


Fig. 2.88 Section showing Raingarden (Streets) details

T.5. Retention Pond

Even though retention ponds might seem like basically another water feature, it has far more benefits. Permanent components designed to contain water flow for a specific amount of time are called retention ponds. In response to a flood, the pond's water level fluctuates, reducing risk and protecting the neighborhood from flood damage and expensive repairs. By temporarily retaining water during strong storms, retention ponds help reduce peak stormwater runoff rates and enhance the quality of urban runoff.

Indicators to consider

Suitability

- **Water depth** - 1m to 2.5m
- **Slope** - >15%
- **Infilteration Rate** - 0.5 to 3"/hr
- **Soil mix** - Clayey + Loam
- **Planting mix** - Bioswale mix **"Bioswale Mix" - pg 109**
- **Maintainence lvl** - Medium
- **Community engagement** - Medium lvl of acceptance

Performance Ability

DELAY	Moderately/ Conditionally Effective
STORE	Moderately/ Conditionally Effective
FILTER	Highly Effective in all conditions
RECHARGE	Not Effective / Not Applicable

LEGEND
- Highly Effective in all conditions
- Moderately/ Conditionally Effective
- Not Effective / Not Applicable

Limitations

- Due to the need for high embankments, it might not be appropriate for steep sites.
- Land take could limit utilization in areas with high densities.
- No decrease in the amount of runoff

Maintainence

- Examine the vegetation in the pond and on the banks and slopes nearby.
- If decaying vegetation in the pond is clogging pipe openings, it should be removed in the spring.
- Eroded areas should be repaired Check **"MAINTAINENCE OF" - pg 85** for more details

Fig. 2.69 Reference Images of Retension pond

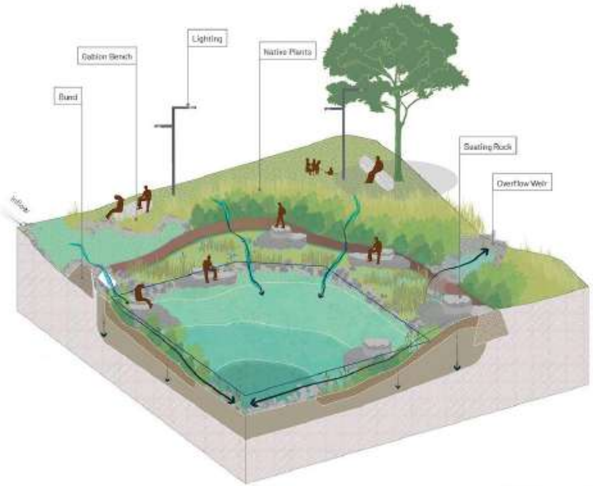


Fig. 2.70 Axon showing Retension pond

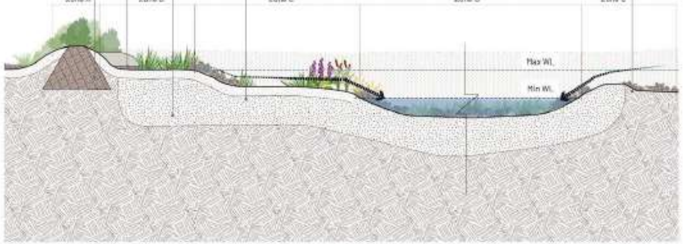


Fig. 2.71 Section showing Retension ponds details

T.6. Infilteration Basin

An infiltration basin is a type of shallow pond where rainfall penetrates through the ground. In addition to helping to remove pollutants from stormwater, this control is effective in boosting groundwater recharge, which in turn increases baseflow to neighboring flows. Certain underlying soil requirements of infiltration basins may make them impractical in certain places. To make sure they don't fail, pretreatment design and routine maintenance and inspection protocols are essential. Onsed que non cum quiaeratus.

Indicators to consider

Suitability

- Water depth - 1m to 2.5m
- Slope - >15%
- Infilteration Rate - 0.5" to 3"/hr
- Soil mix - Clayey + Loam
- Planting mix - Bioswale mix **"Bioswale Mix" - pg 109**
- Maintainence lvl - Medium
- Community engagement - Medium lvl of acceptance

Performance Ability

DELAY	●
STORE	◉
FILTER	◉
RECHARGE	●

LEGEND
- ● Highly Effective in all conditions
- ◉ Moderately/ Conditionally Effective
- ○ Not Effective / Not Applicable

Limitations

- Areas with compacted or poorly infiltrating soils are not suitable for infiltration basins.
- Sites with a high groundwater table should not use them.
- An infiltration basin may attract mosquitoes if it gets clogged and takes longer than three days to empty.

Maintainence

- When necessary, replace the topsoil or pea gravel.
- Make that all debris, including silt and oil/grease, is removed from the inlets.
- Patch up erosion-prone inflow & outflow structures be repaired
- Check **"MAINTAINENCE OF" - pg 85** for more details

Fig. 2.72

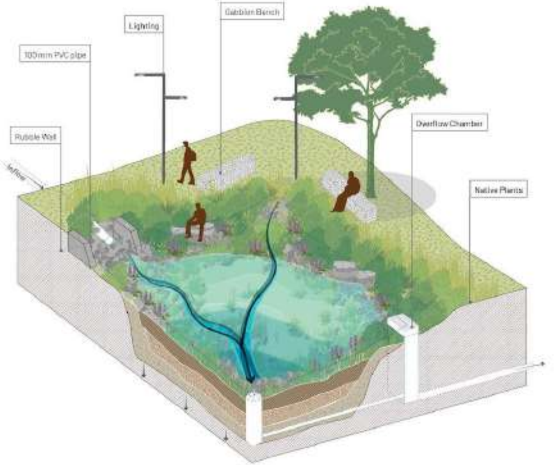


Fig. 2.73 Axon showing Infilteration Basin

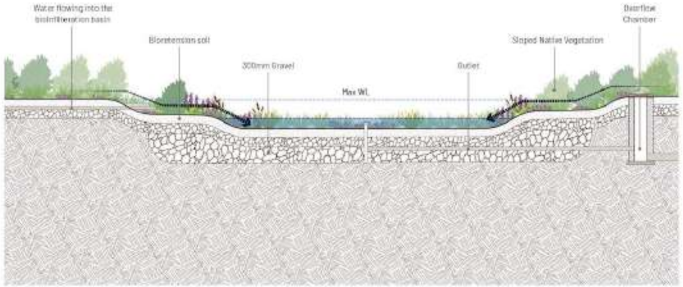


Fig. 2.74 Section showing infilteration basin details

T.7. Sunken Court

A sunken plaza, also known as a sunken courtyard or sunken square, is a unique architectural feature where a portion of the ground level is excavated or lowered to create a depressed area within an outdoor space. Sunken plazas offer distinctive design opportunities and functional benefits, often serving as gathering spaces, performance venues, or landscaped areas within urban environments.

Indicators to consider

Suitability

- **Water depth** - 1m to 2.5m
- **Slope** - >15%
- **Infilteration Rate** - 0.5" to 3"/hr
- **Soil mix** - Sand+gravel
- **Planting mix** - wetland mix
- **Maintainence lvl** - Medium
- **Community engagement** - Medium lvl of acceptance

Performance Ability

DELAY	Not Effective / Not Applicable
STORE	Not Effective / Not Applicable
FILTER	Highly Effective in all conditions
RECHARGE	Moderately/ Conditionally Effective

LEGEND
- ● Highly Effective in all conditions
- ◉ Moderately/ Conditionally Effective
- ○ Not Effective / Not Applicable

Limitations

- Areas with compacted or poorly infiltrating soils are not suitable for infiltration basins.
- Sites with a high groundwater table should not use them.
- constructed wetlands may attract mosquitoes if it gets clogged and takes longer than three days to empty.

Maintainence

- Make that all debris, including silt and oil/grease, is removed from the inlets.
- Patch up erosion-prone inflow & outflow structures be repaired
- Check "**MAINTAINENCE OF**" - **pg 85** for more details

Fig. 2.75 Reference images of Sunken plaza

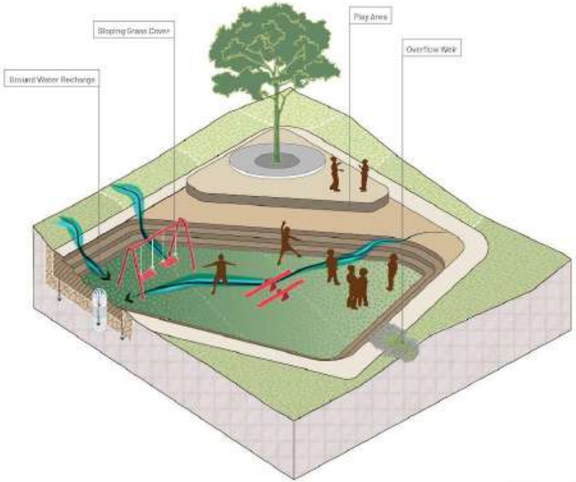


Fig. 2.76 Axon showing Sunken Plaza

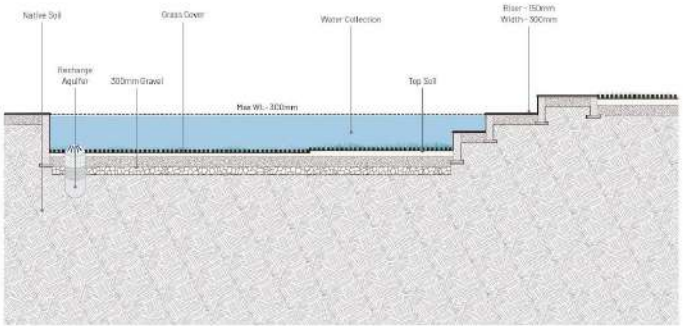


Fig. 2.77 Section showing Sunken Plaza Details

T.8. Water Plaza

Water plaza is a type of public space or urban feature that incorporates water elements as a central design element. It typically consists of an open area or plaza where water features such as fountains, pools, or interactive water installations are integrated into the landscape. Water plazas serve multiple purposes, including aesthetic enhancement, recreation, stormwater management, and ecological function.

Indicators to consider

Suitability

- Water depth - 1m to 2.5m
- Slope - >15%
- Infilteration Rate - 0.5" to 3"/hr
- Soil mix - Sand+gravel
- Planting mix -wetland mix
- Maintainence lvl - Medium
- Community engagement - Medium lvl of acceptance

Performance Ability

DELAY	Moderately/ Conditionally Effective
STORE	Not Effective / Not Applicable
FILTER	Highly Effective in all conditions
RECHARGE	Moderately/ Conditionally Effective

LEGEND

- ● Highly Effective in all conditions
- ◉ Moderately/ Conditionally Effective
- ○ Not Effective / Not Applicable

Limitations

- Areas with compacted or poorly infiltrating soils are not suitable for infiltration basins.
- Sites with a high groundwater table should not use them.
- constructed wetlands may attract mosquitoes if it gets clogged and takes longer than three days to empty.
- Requires longer treatment times .

Maintainence

- When necessary, replace the topsoil or pea gravel.
- Make that all debris, including silt and oil/grease, is removed from the inlets.
- Patch up erosion-prone inflow & outflow structures be repaired
- Check **"MAINTAINENCE OF"** **- pg 85** for more details

Fig. 2.78 Reference images of Water plaza

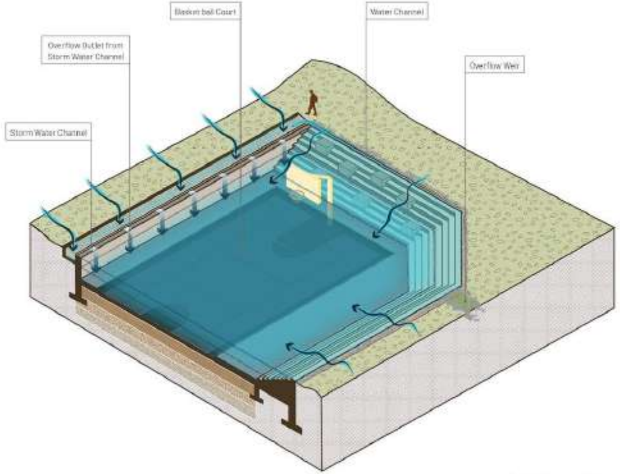


Fig. 2.79 Axon showing Water plaza details

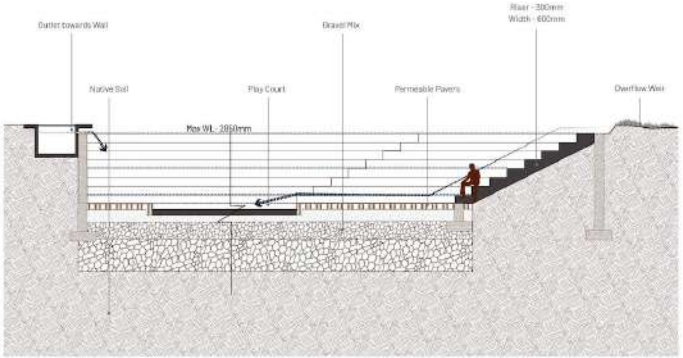


Fig. 2.80 Section showing water plaza details

T.9. Constructed Wetlands

Constructed wetlands are engineered systems designed to mimic the natural processes of wetlands for the purpose of wastewater treatment, stormwater management, and ecological restoration. These systems use a combination of vegetation, soil, and microbes to remove contaminants and improve water quality. Constructed wetlands typically include a substrate layer consisting of sand, gravel, or organic material where beneficial microbes can thrive

Indicators to consider

Suitability

- Water depth - 1m to 2.5m
- Slope - >15%
- Infilteration Rate - 0.5" to 3"/hr
- Soil mix - Sand+gravel
- Planting mix -wetland mix
- Maintainence lvl - Medium
- Community engagement - Medium lvl of acceptance

Performance Ability

DELAY	●
STORE	●
FILTER	●
RECHARGE	◉

LEGEND
- ● Highly Effective in all conditions
- ◉ Moderately/ Conditionally Effective
- ○ Not Effective / Not Applicable

Limitations

- Areas with compacted or poorly infiltrating soils are not suitable for infiltration basins.
- Sites with a high groundwater table should not use them.
- constructed wetlands may attract mosquitoes if it gets clogged and takes longer than three days to empty.
-

Maintainence

- When necessary, replace the topsoil or pea gravel.
- Make that all debris, including silt and oil/grease, is removed from the inlets.
- Patch up erosion-prone inflow & outflow structures be repaired
- Check **"MAINTAINENCE OF"** **- pg 85** for more details

Fig. 2.81 Reference images of constructed wetlands

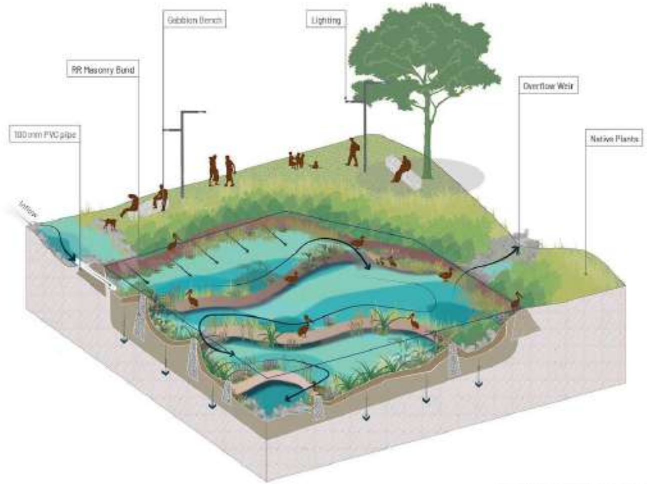


Fig. 2.82 Axon showing Constructed wetlands

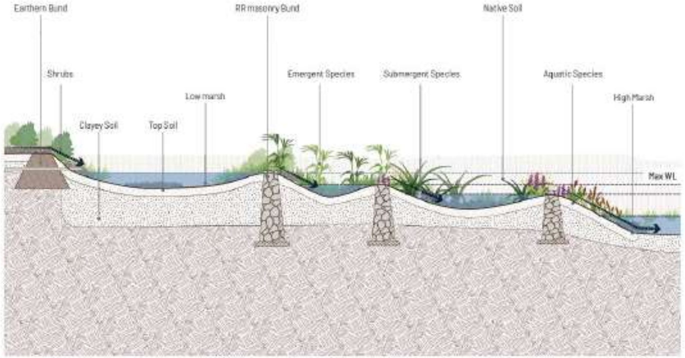


Fig. 2.83 section showing contructed wetlands details

Vegetation and Planting

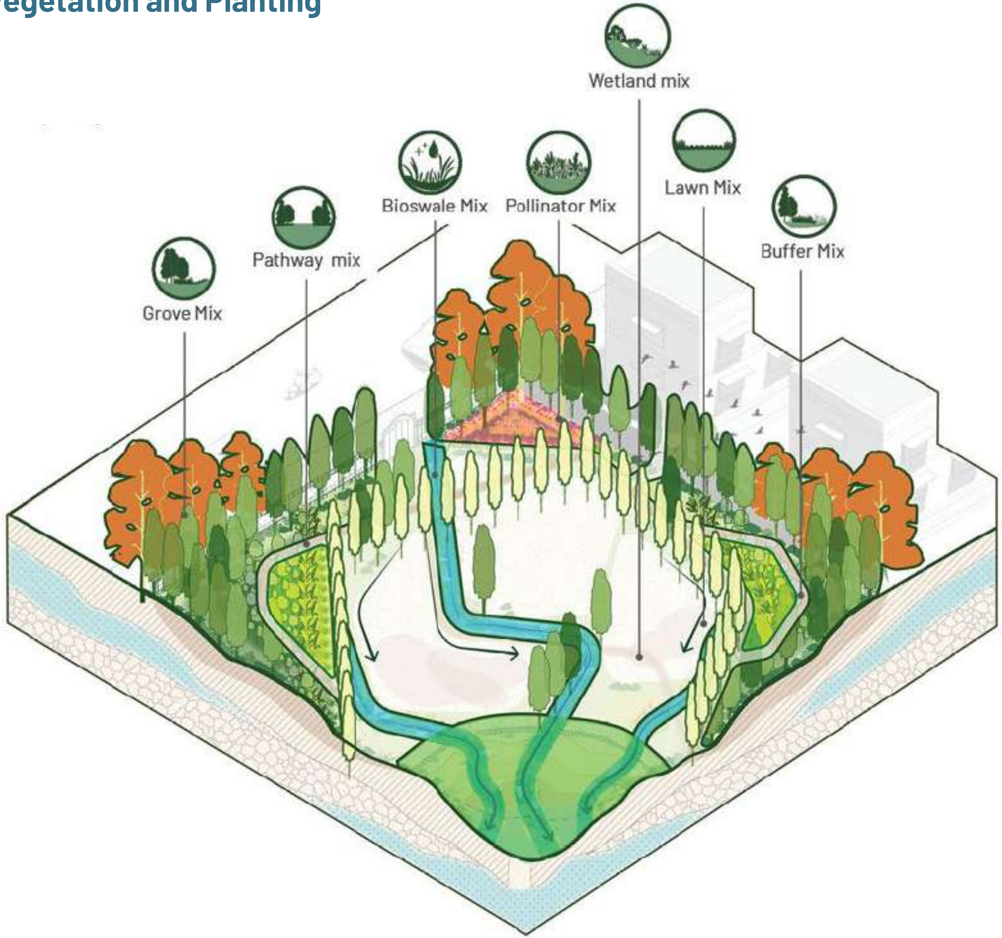


Table 6. Different Planting mixes

Planting Mix	Description
Buffer Mix	A robust, multi-layered, densely planted species in combination of trees, shrubs & creepers to buffer from the noise & air pollution.
Pathway Mix	A multi-layered combination of indigenous trees of different species helps establish a viable community through the trails
Grove Mix	A planting mix consisting of old growth climax stage species with different understoried species. The species present are distributed in two ways – they occupy different areas of ground (they are distributed horizontally), and their canopies occupy different levels above the ground (they are distributed vertically).
Pollinator Mix	An intense combination of diverse flowering plants creates one-of-a-kind sensory experiences in certain public spaces. This planting mix can have non-invasive exotic plants, which require supplementary maintenance.
Lawn Mix	Throughout the sponge park, a multilayered mixture containing multiple grass species is dispersed to facilitate easy water percolation towards groundwater during floods.
Bioswale Mix	A diverse array of moist soil-loving plants arranged in layers, chosen for their individual soil moisture tolerance levels
Wetland Mix	A diverse range of species that are tolerant to drought and love water, mostly marking the locations of seasonal water bodies.

Table 5. Planting Strategy

Strategy	Description
Massings	Plant grasses, perennials, and shrubs in groups or massings, with members of the same species, for easier maintenance and a powerful visual impression.
Edge Techniques	A traditional way to indicate the change in terrain for the users of the park to analyse the pedestrain and vehicular entry of the park.
Diveristy of species	A multi-layered combination of indigenous trees of different species helps establish a viable community and enhace habitats.
Sightlines	To preserve public safety and sight lines, the landscape plan should choose a variety of species while also keeping the park safe.
Microclimate	Within a system, a single plant or massing can influence nearby plants or massings and provide a small-scale microclimate.
Sunlight	The three light conditions that a plant prefers are full sun, moderate shade, and full shadow. It is typical to have full sun in an urban setting.
Hydrology	Different plants can tolerate different amounts of downpours; some can sustain prolonged periods of flooding, while other plants react negatively to prolonged flooding.

Fig. 2.84 Reference Images of Plantin

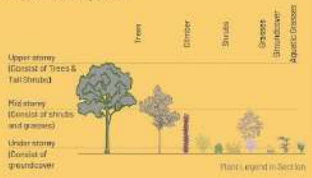
How to read Plant mixes ?

Name of the Plant Mix

- This section gives the clear description of the titled plant mix.
- This provides an in-depth explanation regarding how to plant the specified mix.
- This gives detailed instructions on where to plant the designated combination.
- Chapter to be read with maintenance chapter & annexure

ii. Typical Planting Plan

iii. Typical Planting section

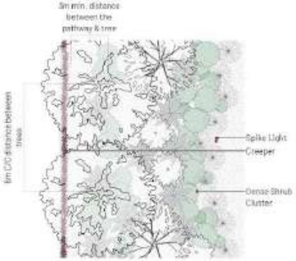


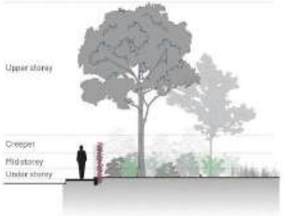
Composite of species	Percentage of various species combination % Trees + % Shrubs + % Lawn (Anneixure pg no.)
Maintainence level	Maintainence needed for plant mix (Maintainance pg no.)
Irrigation Demand	Amount of watering needed for the plant mix ●●●●○
Spacing & Massing	Plant spacing is dependends on a number of variables ●●●●●
Lighting	Lighting required that is adequate for humans & less harmful to the flora & fauna
Plant Species	Required species for the mix. To be refer with plant list (Annexure pg no.)

Types of Plant mixes

Buffer Mix

A robust, multi-layered, densely planted species is a combination of trees, shrubs & creepers. It is used exclusively along the periphery of the park to provide a climatic buffer (heat mitigation, noise & air pollution) that comes from the neighbourhood. Its width varies from 6 - 8 m. It provides visual connect with park but blocks physical accessibility for safety. It not a public amentiy but serves as an ecologically rich continuous green corridor. It has spike lights along the periphery for safety. This mix needs maintainencedue to dense shrub cluster.

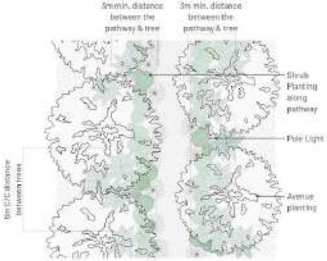


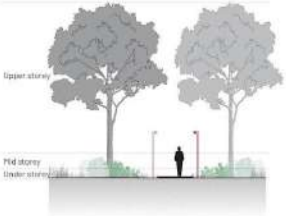


Composite of species	30% Trees + 50% Shrubs + 20% Creeper
Maintainence level	●●○○○
Irrigation Demand	●●○○○
Spacing & Massing	Trees at min. 6m C/C.
Lighting	Lighting the biofence edge for safety
Plant Species	*Pongamia pinnata, Murraya panniculata, Passiflora edulis*

Pathway Mix

A layered combination of indigenous trees of different species helps establish a viable community through the trails. Plantation of avenue trees with shrubs to shade the pathway & add to the aesthetic. This mix needs maximum maintainence and will have pole lights alternately placed between the trees. A minimum of 3m distance has to be left from the pathway so that the tree growth can spread without harming the pathway. This mix also has irrigation requirement.

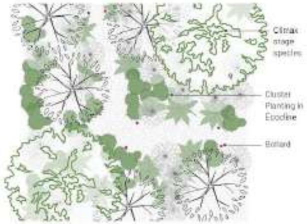


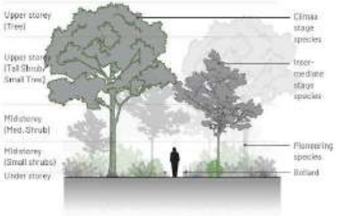


Composite of species	40% Trees + 30% Shrubs + 30% Grasses
Maintainence level	●●●○○
Irrigation Demand	●●●○○
Spacing & Massing	Trees to be planted at 6m C/C
Lighting	Pole light along the pathway
Plant Species	*Azadirachta indica, Alpinia purpurea*

Grove Mix

A planting mix representing the climax vegetation with different understoried species as a grove. The Ficus species forms the main species with native small tres and understories supporting its growth. It creates a community through ecoline planting where vertically & horizontally incremental layers form a dense core. Minimal lighting is suggested at the entrance & centre to lit the trail but also provide dark patches for the habitats to thrive. This mix needs minimal irrigation since the species choosen are native (requires less water) & the soil will retain moisture due to dense planting.



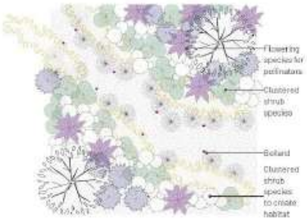


Composite of species	40% Trees + 40% Shrubs + 20% Grasses
Maintainence level	●●○○○
Irrigation Demand	●○○○○
Spacing & Massing	Plant spacing is dependends on a number of variables
Lighting	Bollard lighting at the entrances and centre
Plant Species	*Ficus hispida, Senna auriculata, Ocimum sanctum*

Types of Plant mixes

Pollinator Mix

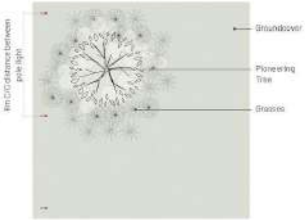
An intense combination of diverse flowering plants creates one-of-a-kind sensory experiences in certain public spaces. This planting mix can have non-invasive exotic plants, which require supplementary maintenance. This plant mix will attract a lot of pollinators due to thier colours & fragrance. This mix is dominant by various shrubs planted in different levels based on thier hieght & aesthetic. This mix might requires extensive irrigatation & maintainence. Lighting is suggested using bollards to lit the pathway but leave dense pockets as dark for habitats to thrive.



Composite of species	25% Trees + 50% Shrubs + 25% Grasses
Maintainence level	● ● ○ ○ ○
Irrigation Demand	● ● ● ○ ○
Spacing & Massing	Plant spacing is dependends on a number of variables
Lighting	Bollard light along the pathway
Plant Species	*Hibiscus tiliaceus, Barleria cristata*

Lawn Mix

Throughout the sponge park, a multilayered mixture containing multiple grass species is dispersed to facilitate easy water percolation towards groundwater during floods. This mix is the most useable area for the public. It would show a seasonal character where the grasses will become dry during summer & regenerate during monsoon. It will also need maintainence to avoid anhy successive species from growth so as to maintain its character. This mix also has intermediate clusters of small trees to provide shade.

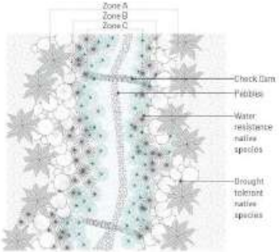


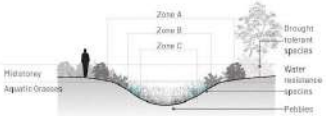
Typical planting Mix section

Composite of species	20% Trees + 20% Shrubs + 60% Lawn
Maintainence level	● ● ● ○ ○
Irrigation Demand	● ● ○ ○ ○
Spacing & Massing	Plant spacing is dependends on a number of variables
Lighting	Pole light on the periphery of the lawn area
Plant Species	*Cynodon dacylon*

Bioswale Mix

A diverse array of moist soil-loving plants arranged in layers, chosen for their individual soil moisture tolerance levels. It has 3 zone - Zone A has drought tolerant species that has minimal impact from water inundation. Zone B has water resistance species that can survive during flooding, while zone C are species that thrive in high moisture areas. This mix need high mainatinece especially during pre monsoon & post flooding (Refer Maintainnce manual).

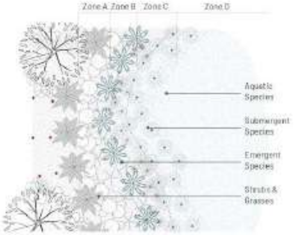


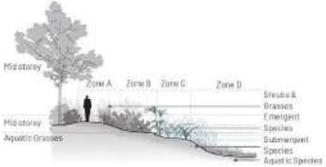


Composite of species	10% Trees + 40% Shrubs + 40% Grasses
Maintainence level	● ● ● ○ ○
Irrigation Demand	● ○ ○ ○ ○
Spacing & Massing	Plant spacing is dependends on a number of variables
Lighting	-
Plant Species	*Canna indica, Eclipta prostata*

Wetland Mix

A diverse range of species that are tolerant to drought and water inundation, mostly marking the locations of seasonal water bodies. This mix has 4 zones with shrubs & grasses on ground level, emergent, submergent & aquatic species in the water body. These species filters & stores the stormwater, creates habitats for aquatic species & a community amenity. It needs high maintainence pre monsoon & post flooding for efficent functioning.





Composite of species	15% Trees + 25% Shrubs + 60% Grasses
Maintainence level	● ● ● ○ ○
Irrigation Demand	● ○ ○ ○ ○
Spacing & Massing	Plant spacing is dependends on a number of variables
Lighting	Bollard light along the band edge
Plant Species	*Nymphoides ssp., Canna indica, Vetiver*

c. List of Native Plant Species

BUFFER MIX

HABIT	BOTANICAL NAME	COMMON NAME	HEIGHT	SPREAD	N	D	F	SOR	I	E	M
TREE	*Pongamia pinnata*	Pungam Tree	25	15	✓	✓	✓	✓	Low	Partial Sun	Low
	Polyalthia longifolia	False Asoka	10-25	2.4	✓	✓			Low	Sun	Low
SHRUB	*Lawsonia Inermis*	Henna	2-6	2-6	✓	✓			Low	Partial Sun	Low
	Murraya panniculata	Orange Jasmine	2-7	3	✓	✓		✓	Medium	Partial Sun	Medium
GROUNDCOVER	*Cuphea hyssopifolia*	Mexican heather	0.6	0.9		✓			Low	Partial Sun	Low
CLIMBER	*Passiflora edulis*	Passion Flower	8	-		✓	✓	✓	Medium	Sun	Medium

NOTES

The mix consist of trees, layers of shrubs & climber along the compound wall.

Soil - The top soil needs to be ploughed well and the cleared soil shall be treated suitably with farmyard manure or vermicompost.

LEGEND

N - Native
D - Drought Tolerant
F - Flood Resistance
SOR - Schedule of Rates
I - Irrigation
E - Exposure
M - Maintainence

Low Medium High
Shade Partial Sun Sun
Low Medium High


Pongamia pinnata


Polyalthia longifolia


Lawsonia inermis


Murraya panniculata


Cuphea hyssopifolia


Passiflora edulis

PATHWAY MIX

HABIT	BOTANICAL NAME	COMMON NAME	HEIGHT	SPREAD	N	D	F	SOR	I	E	M
TREE	*Azadirachta indica*	Neem Tree	30	20	✓	✓		✓	Low	Sun	Low
SHRUB	*Alpinia purpurata*	Red Ginger	2-4	1			✓		High	Sun	High
HERB	*Mimosa pudica*	Shame Plant	0.15-1	0.5-0.5		✓	✓	✓	Medium	Partial Sun	Medium

NOTES

The mix consist of shaded giving avenue trees with aesthtically pleasing shrubs and groundcover.

Soil - The top soil needs to be ploughed well and the cleared soil shall be treated suitably with farmyard manure or vermicompost.

LEGEND

N - Native
D - Drought Tolerant
F - Flood Resistance
SOR - Schedule of Rates
I - Irrigation
E - Exposure
M - Maintainence

Low Medium High
Shade Partial Sun Sun
Low Medium High


Azadirachta indica


Alpinia purpurata


Tradescantia spathacea

LAWN MIX

HABIT	BOTANICAL NAME	COMMON NAME	HEIGHT	SPREAD	N	D	F	SOR	I	E	M
TREE	*Butea monosperma*	Palash	5-15	9-12	✓	✓		✓	Low	Sun	Low
GRASS	*Bouteloua dactyloides*	Buffalo grass	0.15-0.3	0.15-0.45		✓	✓		Medium	Sun	Low
GROUNDCOVER	*Cynodon dactylon*	Durva	0.15	0.05-0.15	✓	✓	✓	✓	Medium	Sun	Medium

NOTES

The mix consist of grasses & herbs that are smaller than 300mm alongwith a deciduous tree that provides shade within the vast open space creating a habitat for perching birds.

Soil - The top soil needs to be ploughed well and the cleared soil shall be treated suitably with farmyard manure or vermicompost.

LEGEND

N - Native
D - Drought Tolerant
F - Flood Resistance
SOR - Schedule of Rates
I - Irrigation
E - Exposure
M - Maintainence

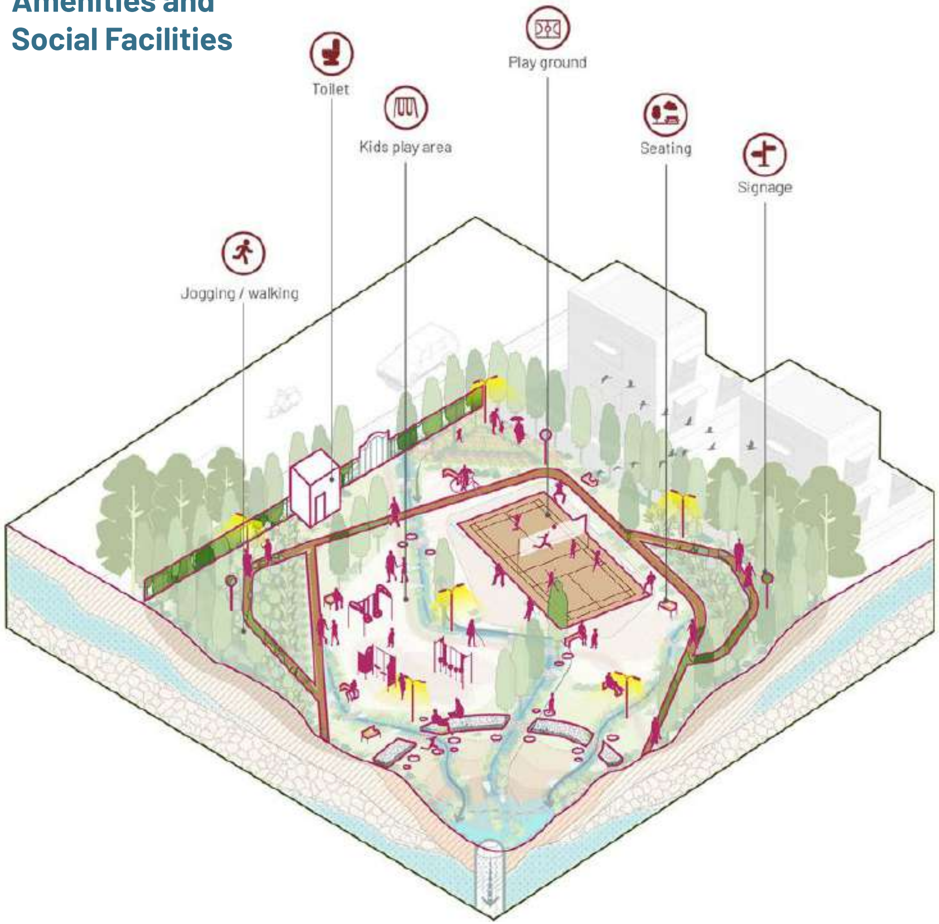
Low Medium High
Shade Partial Sun Sun
Low Medium High


Butea monosperma


Bouteloua dactyloides

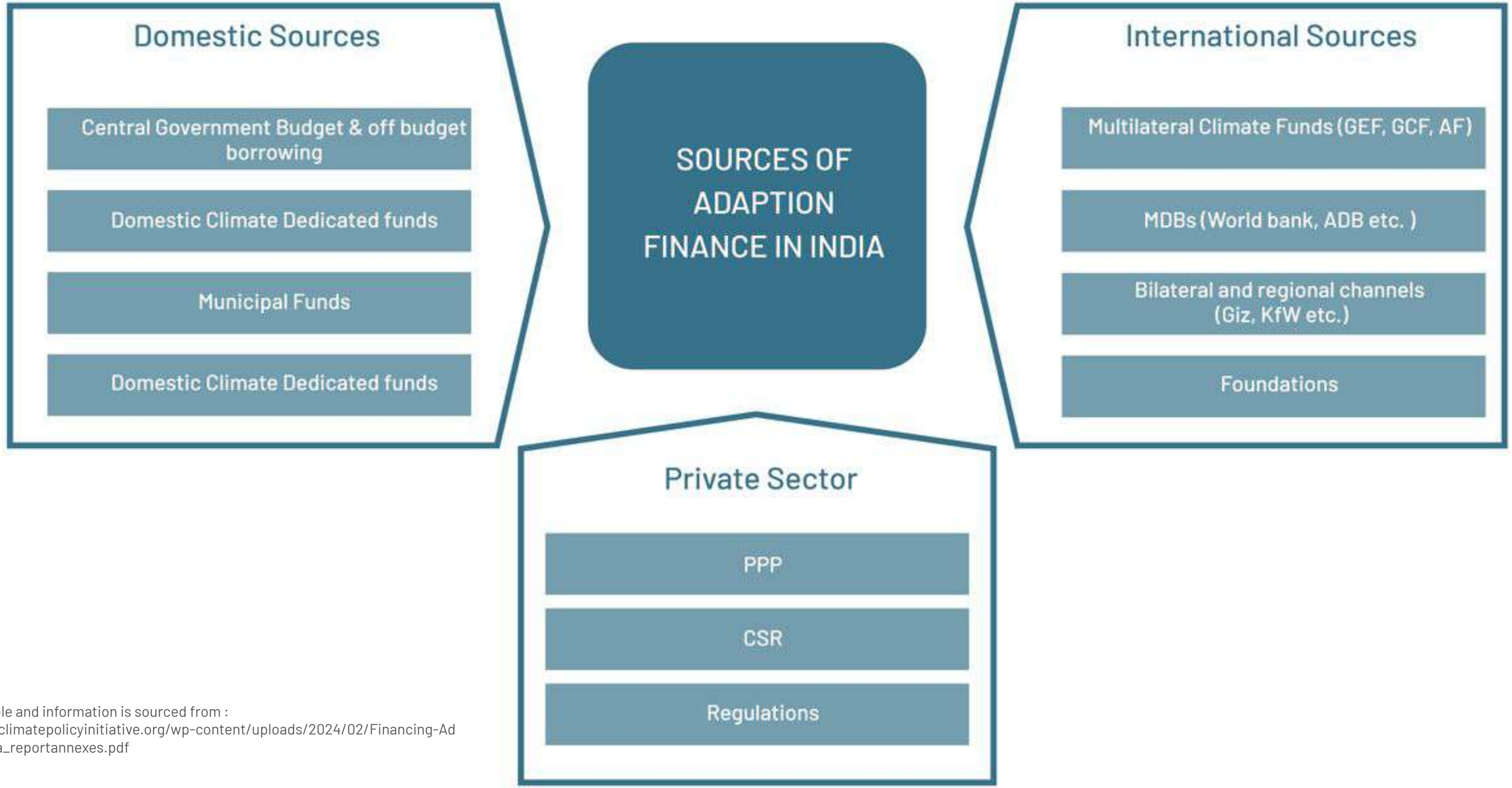

Cynodon dactylon

Amenities and Social Facilities



Amenities	Typology	Descriptions	Advantages
Entrances	S M L X	Entrances are the portals to nature play and learning, with naturalized entrance designs can convey positive messages to attract visitors and put them at ease.	• Creates sense of arrival and departure • Acts as transition zone • Serves as a gathering and socializing setting
Pathways	S M L X	Pathways function as a space's arteries, regulating human energy flow along primary, secondary, and tertiary scales navigating throughout the sponge park.	• Provide flat terrain that is easy to navigate and has an accessible surface. • Offer less direct, narrow routes • Slanted enough to retain a sense of exploration
Signage	S M L X	A key aspect of pathway settings can be signage. They facilitate a sense of inquiry and revelation by offering hints and data to improve the learning process.	• Provide communication system of information that can be easily read and understood by people • communicating clear directions inside the park.
Kids Play area	S M L X	A play area is a space created, usually outside, to give kids an environment that encourages play.	• Improves the physical, social and emotional wellbeing • Enhances and attracts more children to come to the sponge parks
Gym	S M L X	The gym is a free time where community members can use the gym to run laps, and engage in fitness stations, and other activities.	• Exercises in an open gym provide you greater flexibility and freedom during your workout, which can help you get fitter and feel better overall.
Seatings	S M L X	Seatings int he park draw people and activity while improving people's sense of social comfort.	• Seatings provide social comfort • It can aid in promoting impromptu social gatherings and activities.
Lighting	S M L X	Lighting in parks plays a crucial role in enhancing safety, accessibility, usability, and aesthetics, especially during evening hours	• Aids safety and security to the park • Brings in clear accessibility through the sponge park even during nights
Jogging Walking Trails	M L X	Pathways for recreational activities such as running, walking, jogging, and biking	• Brings in more intereaction among the people
Toilets	M L X	Seatings int he park draw people and activity while improving people's sense of social comfort.	• Seatings provide social comfort • It can aid in promoting impromptu social gatherings and activities.
Play grounds	M L X	Seatings int he park draw people and activity while improving people's sense of social comfort.	• Seatings provide social comfort • It can aid in promoting impromptu social gatherings and activities.

Financing Sponge Parks



The above table and information is sourced from : https://www.climatepolicyinitiative.org/wp-content/uploads/2024/02/Financing-Adaptation-India_reportannexes.pdf

Financing Sponge Parks

Summary of Benefits from Blue-green Infrastructure

Task	Description	Climate Resilience Benefits	Carbon Sequestration And Air Quality Benefits	Water Management Benefits
Bioswales	Vegetated linear depression or trench designed for the collection, conveyance, infiltration and filtration of stormwater runoff.	• Increased groundwater infiltration • Reduced heat island effects from grey infrastructure • Flood mitigation • Reduced pressure on existing water management infrastructure • Improved biodiversity and wildlife habitats	• Carbon sequestration from vegetation • Reduced energy needs for managing stormwater (e.g., pumping, treatment) • Removal of air pollutants such as ozone, nitrogen dioxide, sulfur dioxide and particulate matter • Water pollution abatement through filtration of stormwater runoff	• Reduced runoff fromprecipitation • Increased groundwater infiltration • Flood mitigation • Reduced erosion during storms • Reduced pressure on existing water management infrastructure • Reduced sedimentation of streams and rivers • Water pollution abatement through filtration of stormwater runoff
Bioretention areas	Stormwater treatment process for removing pollutants and sediment from stormwater using a system of ponding areas with vegetation, soil, sand gravel and organic materials.	• Increased groundwater infiltration • Reduced heat island effects from grey infrastructure • Flood mitigation • Reduced pressure on existing water management infrastructure • Improved biodiversity and wildlife habitats	• Carbon sequestration from vegetation • Reduced energy needs for managing stormwater (e.g., pumping, treatment) • Removal of air pollutants such as ozone, nitrogen dioxide, sulfur dioxide and particulate matter • Water pollution abatement through filtration of stormwater runoff	• Reduced runoff from precipitation • Increased groundwater infiltration • Flood mitigation • Reduced erosion during storms • Reduced pressure on existing water management infrastructure • Reduced sedimentation of streams and rivers • Water pollution abatement through filtration of stormwater runoff
Native Landscaping	Landscaping that uses native plants – including trees, shrubs, groundcover and grasses –indigenous to the geographic area being planted. Particularly important in dry or droughtprone areas (see: xeriscaping in key terms).	• Reduced heat island effects from paved areas • Increased groundwater infiltration • Flood mitigation • Reduced water demand for irrigation • Improved biodiversity and wildlife habitats	• Carbon sequestration from planted materials and vegetation • Reduced energy needs for managing stormwater (e.g., pumping, treatment) • Reduced energy needs for irrigation	• Increased groundwater infiltration • Flood mitigation • Reduced pressure on existing water management infrastructure • Reduced water demand for irrigation
Urban Wetland	Urban or periurban trasitional areas between terrestrial and aquatic ecosystems where the water table is usually at or near the surface or the land is covered by shallow water	• Improved watershed management • Increased groundwater infiltration • Flood mitigation • Reduced heat island effects from paved areas • Reduced pressure on existing water management infrastructure • Improved biodiversity and wildlife habitats	• Improved watershed management • Increased groundwater infiltration • Flood mitigation • Reduced heat island effects from paved areas • Reduced pressure on existing water management infrastructure • Improved biodiversity and wildlife habitats	• Reduced erosion during storms • Reduced flooding from storm surges • Improved watershed management • Increased groundwater infiltration • Reduced pressure on existing water management infrastructure • Water pollution abatement through filtration of stormwater runoff

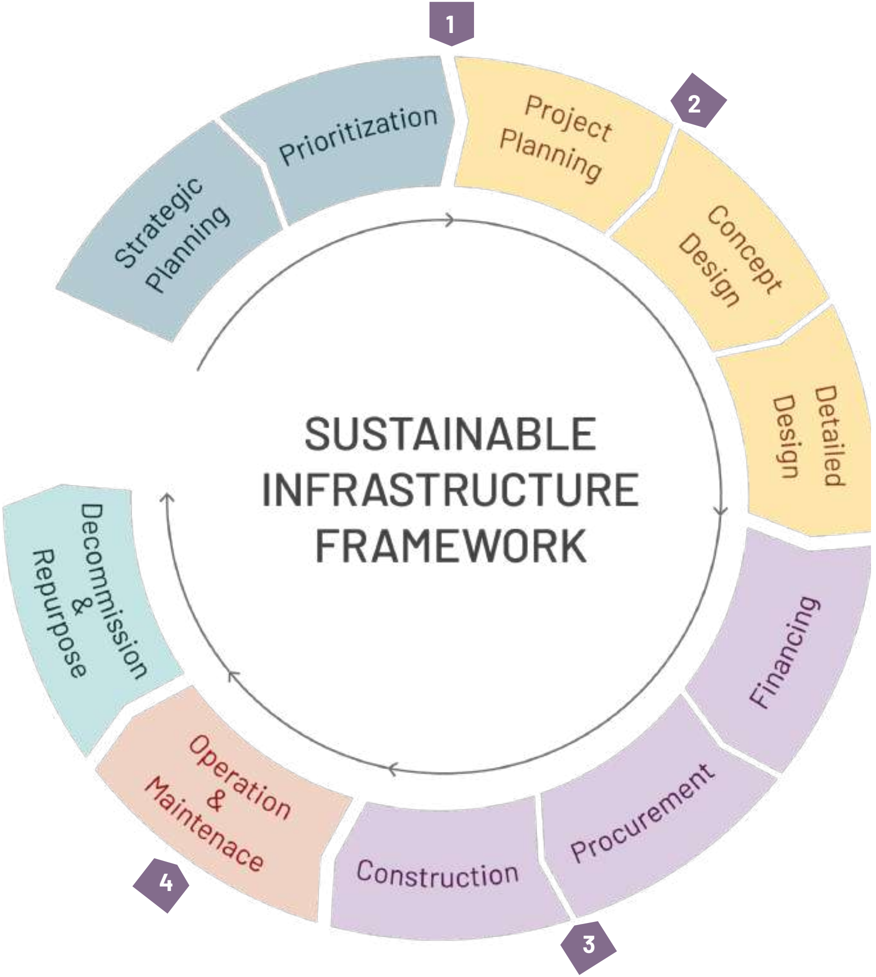
Evaluation of Creative Funding and Financing Models

Creative funding & financing models	Potential Generate Revenue and attract capital	Technical and Political Feasibility	Fairness and Efficiency	Equity
Multilateral Bonds	High	Medium	Low	Low
Municipal Bonds	High	Medium	High	Low
Central government Grants	Medium	Medium	Low	Medium
State grants	Medium	Medium	Low	Low
Green / Climate bonds	Medium	High	Low	Low
TIF	Medium	High	High	Low
P3s	High	Medium	High	Low
Regional Resilience trust funds	High	Medium	Medium	High
Impact development fees	High	Medium	High	Medium

The above table and information is sourced from
https://ash.harvard.edu/wp-content/uploads/2024/02/financing_climate_resilience_final_report.pdf

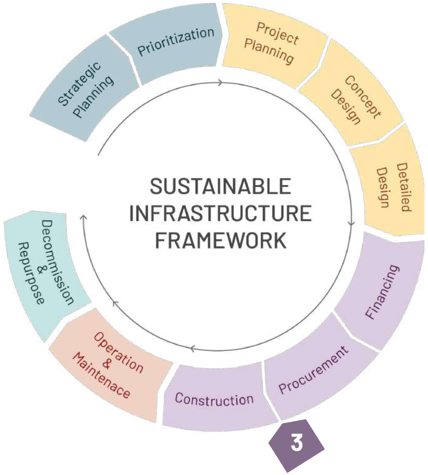
Procuring for Sponge Parks

		Open Tender		Empanelled / Invited	
Lifecycle	**Expertise**	**LCS**	**QCBS**	**LCS**	**QCBS**
1. Project Planning	Surveyors, Hydrologists, Geologists, Field Engineers, CAD Engineers	S, M	S, M, L, X		
2. Concept Design through Detailed Design	Landscape Architects, Architects, Urban Designers, Hydrologist, Civil, MEP, Drafting		L, X		M, L, X
3. Construction	Contractor, Field Engineers, Site Manager, Landscape Architect, Project Manager, Construction Workers	S	M, L, X	S	M, L, X
4. Operation and Maintenance	Contractor, Horticulturist, Field Engineers, Gardeners, Cleaners, Repair			M	M, L, X

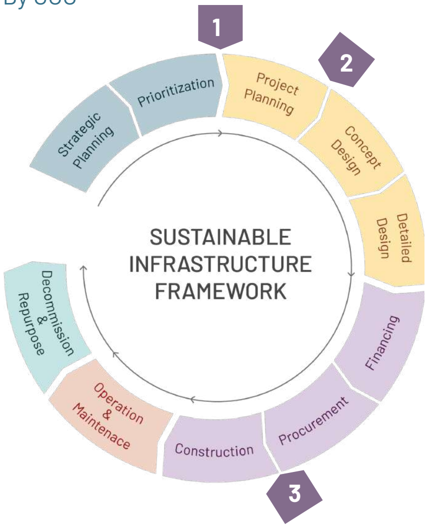


Procuring by Sponge Park Typology

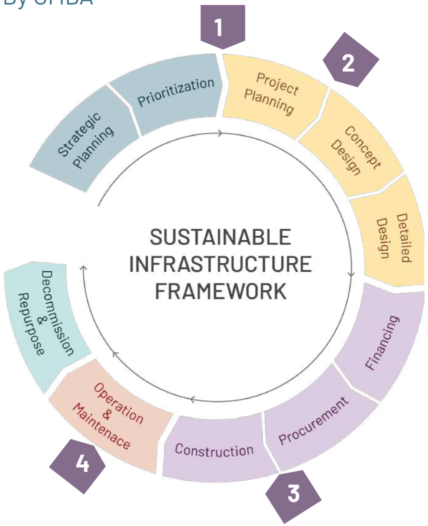
Small Sponge Parks (S)
By GCC



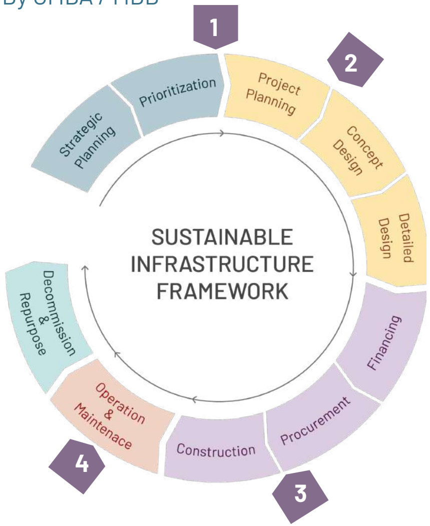
Medium Sponge Parks (M)
By GCC



Large Sponge Parks (L)
By CMDA



Special Sponge Parks (X)
By CMDA / MDB



Constructing Sponge Parks

4. Erosion Control

The importance of erosion control during construction activities, outlining factors influencing erosion, erosion control procedures, and specific erosion protection techniques to mitigate soil disturbance and maintain SuDS effectiveness.

a. Factors Influencing Erosion During Construction:

- Soil Disturbance: Any disturbance of natural soil and vegetation can increase erosion due to exposed loose soil.
- Erosion Factors: Soil type, geology, vegetative cover, topography, climate, and land use influence erosion potential.
- Role of Vegetation: Roots bind soil, leaves reduce raindrop impact, and ground cover traps rain, reducing runoff velocity.
- Water Erosion Factors: Runoff velocity, volume, soil type, vegetation cover, machinery, and de-watering outlets affect land erosion.

b. Erosion Control Procedures:

- Objectives: Limit erosion amount and rate on disturbed areas to maintain SuDS effectiveness.
- Surface Treatments: Stabilize exposed soil with temporary or permanent covers and water conveyance facilities.
- Key Activities: Conduct land disturbing activities to reduce soil erosion and sediment movement.
- Minimize total exposed soil and duration of accelerated soil erosion during construction.
- Establish cover on disturbed areas promptly after final grading.
- Design water conveyance facilities to limit flow to non-erosive velocities.
- Remove sediment from runoff water before leaving the site.
- Stabilize disturbed areas with vegetative cover quickly.
- Erosion Protection Techniques:

c. Erosion protection techniques

- Use vegetation to reinforce soil and reduce runoff velocity,
- Employ geotextiles, geocellular confinement, and erosion control fabrics,
- Implement reinforced grass systems to protect against erosion and traffic loading.
- Utilize gravel trenches to intercept runoff and infiltrate or divert it.
- Design flat sites or slack gradients to reduce runoff velocity.

5. Sediment Control

Sediment control techniques such as straw bale barriers, silt fences, and sediment basins are employed during construction to manage sediment runoff effectively, based on site characteristics like catchment area and slope.

a Principles of Sediment Control:

i) Runoff and Sediment:

- Sediment in runoff tends to settle as runoff rates decrease during rainfall events, but it can be resuspended and moved downstream with subsequent runoff.

ii) Erosion Control Impact:

- Effective erosion control can reduce sediment supply on-site, but sediment trapping and management are still necessary.

b. Sediment Control Techniques:

i) Common Controls:

- Include straw bale barriers, geotextile silt fences, and sediment basins during construction.
- Selection Criteria: The choice of control system depends on catchment area size and site slope.

ii) Straw Bale Barriers and Silt Fences:

- Used for smaller sites.
- For larger areas, runoff should be directed through diversion ditches to temporary sediment basins. Proper installation and maintenance are crucial for performance.

iii) Geotextile Silt Fences:

- Act as temporary barriers along contours at the base of disturbed areas. Durable if installed and maintained correctly. Not suitable for concentrated flow paths; consider more robust filters if concentrated flow conditions exist.

iv) Sediment Basins:

- Designed to trap sediment and facilitate easy removal.
- Proprietary systems or other facilities may also be used.
- Consideration should be given to sediment resuspension during storm events.

v) Maintenance and Rehabilitation:

- Sediment basins and treatment systems require complete clean-out and rehabilitation post-construction.
- Permanent features in BGI design need careful management to prevent sediment contamination and maintain effectiveness.

6. Pollution Control

a. Pollution Prevention:

- Detailed guidance from Masters-Williams et al (2001) and EA (2012) emphasizes controlling pollution loads from surface water runoff and managing materials and fuel spills with containment techniques.
- Pre-planning of construction site layout to minimize impacts on water bodies, including proper waste disposal, storage, and fueling areas. Environmental pollution protection plan outlining drainage routes, discharge systems, spillage kits, and incident response.

b. Construction Pollution Sources and Controls:

i) Sediment:

- Address sources like excavated or exposed ground with measures such as silt fences, runoff diversion, and interception devices.
- Manage stockpile erosion through protective coverings and proper location away from drainage systems.
- Control plant and wheel washing to prevent contaminated discharge into watercourses.
- Design haul roads to minimize runoff and manage dust through regular spraying and swooping.
- Limit excavation in riverbeds, employing diversion strategies and protective booms.
- Implement techniques like grass areas or gravel strips to reduce suspended solids in dewatering operations.

ii) Oils and Hydrocarbons:

- Mitigate hydrocarbon pollution through machinery maintenance, drip trays, and regular inspections for leaks.
- Use designated refueling areas with spill kits and proper storage facilities.
- Secure tanks and install booms along watercourses to prevent oil and hydrocarbon contamination.

Table 3.x. Maximum Allowable velocities based on soil type

Soil Type	Maximum allowable velocity m/s	
	Seeded	Turfed
Sand	0.6	0.9
Silt loam, sandy loam, loamy sand	0.6	0.9
Silty clay loam, sandy clay loam	0.75	1.2
Clay, clay loam, sandy clay, silty clay	0.9	1.5

Table 3.x. Sediment control system design criteria

Allowable Maximum Limits			
Sediment control facility	Drainage catchment area (hectares)	Drainage catchment slope length (m)	Drainage catchment slope gradient
Straw bale barrier or silt fence	0.6–1.2 per 100 linear metres	50	1:2 (50%)

Table 3.x. Maximum Allowable velocities based on soil type

Sources	Potential Problem Indicators
Storage tanks	leaking valves, leaking pipe work corrosion, Monsoon damage, vandalism, leaking bund
General operation and maintenance	removal of waste, refuelling leaking pumps, browsers, generators, plants, machinery disposal of waste oil
Accidents/incidents	spillages (greatest risk at refuelling) overturning (drums and buckets) mechanical failure eg rupture of pipes, inadequate bunded area, vandalism

Erosion Control

- ❑ Assess soil infiltration rate and depth to groundwater table to estimate aquifer recharge benefits
- ❑ Ensure catchment area has no point pollution sources and Sponge Park has adequate filtration to prevent aquifer contamination

Sediment Control

- ❑ Calculate contributing catchment area and runoff volume for 5, 10, 25 year RP storms to size BGI components in Sponge Park

Community Needs

- ❑ Engage community to understand social and climate needs that can be fulfilled by Sponge Park programming or planting

Pollution Control

- ❑ Study ecological corridor, habitat Potential, and heat island effect

MAINTAINING SPONGE PARKS

Maintenance Activity Schedule

REGULAR

- Remove trash and sediments from GBI surfaces.
- Remove organic debris.
- Wipe the signage daily.
- remove sediment form basin and forebay areas.
- Clean the park regularly.

For more information pg <?>

PRE - MONSOON

- To determine the most suitable workers, equipment, and machinery, go over all route and site access limitations, site features, and maintenance maps.

For more information pg <?>

MONSOON

- Application of permitted mechanical or chemical techniques to remove weeds from areas such as tree pits, sidewalks, gutters, etc.
- It can be necessary to clear a build-up of debris in forbays.

For more information pg <?>

POST STORM EVENT

- Remove organic debris and removal of sediment from inlet pipe of basin and forebay areas after heavy intent rains
- Surface vacuuming should be conducted at least twice a year to allow the BMP to function as intended.

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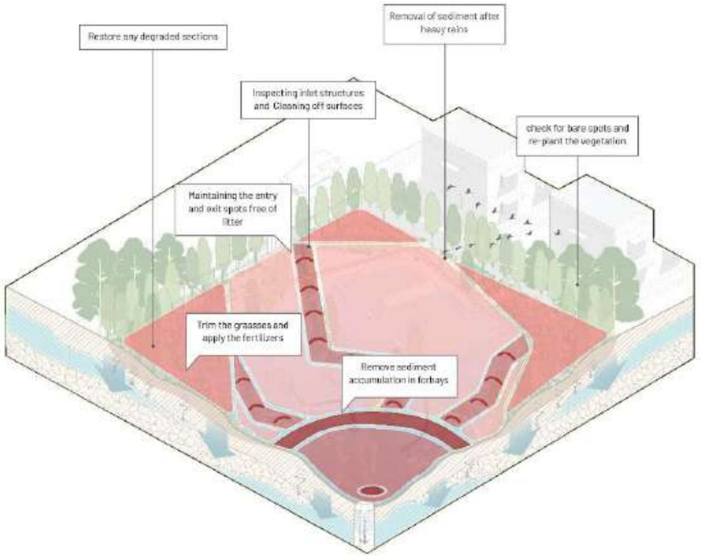

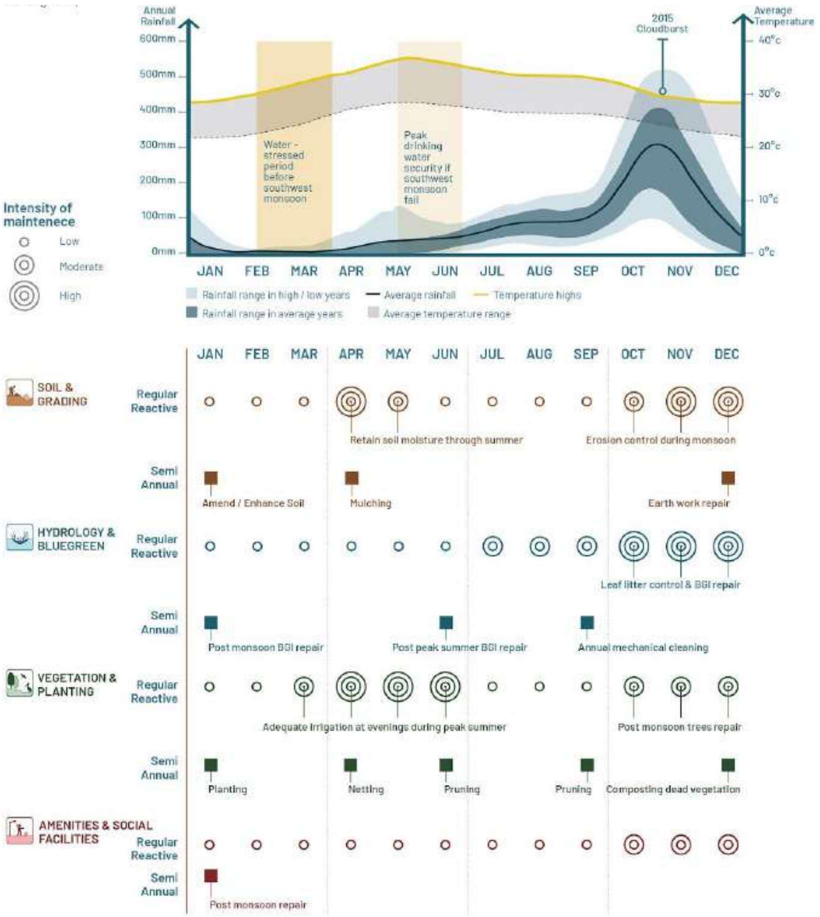

Table 4.1. Daily and Monthly Maintenance Routine

Schedule	Task	Applicable Toolkits	Descriptions	Preconditions	Protocol
Daily	General Care	Applied to all BGI	Clear SMP surfaces (such as sidewalks, gutterlines, tree pits,etc.) of debris and/or silt.	If present within BGI (sponge) Toolkits	4.3.1
			Remove organic debris (eg. leaves, feces, etc.) from BGI surfaces	If present within BGI (sponge) Toolkits	
			Wipe down signages	Dust, grime or residue on signs	
			Remove tags, strings, and expired no parking signage	If present within BGI (sponge) Toolkits	
		Wetlands, Bioswales, Raingardens	Remove settlement of debris from basin and forebay areas	If present within BGI (sponge) Toolkits	
Monthly	Erosion Repair	Applied to all BGI	Fill eroded areas, place erosion fabric, and, if necessary seed	If minor (<20 square), nonrecurring erosion is present within BGI components	4.3.2
	Concrete repair	Applied to all BGI	Repair hairline/cosmeic cracks	If present within BGI (sponge) Toolkits	4.3.3
			Replace loose, missing or displaced brick, stone or paver	If present within BGI (sponge) Toolkits	
	Settling	Applied to all BGI	Fill in sinkholes or slits with stone, then fill with dirt and mulch, if needed.	If sinkholes within GBI components are 24 inches deep or less	4.3.4
	Weeding	All vegetated BGI	Use a combination of mechani-cal and chemical weed removal techniques.	If present within BGI (sponge) Toolkits	4.2.1
	Mowing	Rain garden, Retension basin, wetlands, Bioswale	Mow turf grass	As directed by owner/operator	4.2.2
			Mow grasses to a height of 3-4 in.	If height of vegetation is > 4 in above ground surface elevation	
	Dead & Damaged Vegetation Removal	All vegetated BGI	Remove dead vegetation, trees or shrubs from BGI area as well as prune the vegetation	If damaged, diseased, and/or dead branches; suckers present within the BGI (sponge) Toolkits	4.2.3
	Cutting Back Vegetation	All vegetated BGI	Cut back dense vegetation	If the height of the dense vegetation at sidewalks is > 4, as measured from the top of the curb elevation	4.2.4
	Pest & Disease Management	All vegetated BGI	Treat vegetation to remove, destroy, or minimize pests and disease	If harmful insects (e.g., bag worms,wax scale, caterpillers, aphids, etc.); galls, mildew or fungus are present	4.2.5
			Remove small animal carcasses	If small animal (e.g., rat, bird, cat,etc.) carcasses are present within the BGI (sponge) Toolkits	
	Mulching	Tree trench, greengutter	Apply mulch to tree pits	If gap between top of sidewalk and top of mulch is > 1 in.	4.2.6
		All vegetated BGI	Move mulch away from a tree's base or a shrub with woody stems.	If mulch is within 3 in. of trunk	

Table 4.2. Semi annual and annual Maintenance

Task	Applicable Toolkits	Description	Conditions	Frequency	Protocol
General care	Applied to all BGI	Remove trash and/or sediment from all BGI surfaces & wipe down signage	If trash and/or sediment is present within the BGI area	3 times per year in April, July, and October	4.3.1
Weeding	All vegetated BGI	Remove weeds using one or more of the mechanical or chemical methods	If weeds are present within the BGI area	3 times per year in April, July, and October	4.2.1
Structural pruning	All vegetated BGI components	Complete selective pruning to improve tree architecture	none	Annually during the periodfrom December to the end of February	4.2.4
Cutting Back of Vegetation	All vegetated BGI components	Cut back herbaceous vegetation from previous growing season	If the height of herbaceous vegetation exceeds 8 in.	Annually during February and march	4.2.4
Dead & damaged vegetation removal	All vegetated BGI	Remove dead herbaceous vegetation or shrubs from the BGI area	If dead vegetation is present within the BGI area	3 times per year in April, July, and October	4.2.3
Mulch Care	Tree trench, stormwater tree	Remove existing mulch from tree pits and replace with fresh mulch	none	Annually during February march and April	4.2.6
	Rain garden/ Retension Basin	Apply mulch to the perimeter of landscaped beds > 2 years old and to entire bed for soft sites < 2 yrs old	none	Annually during February march and April	
Pest & Disease management	All vegetated BGI components	Treat vegetation to remove, destroy, or minimize pests and disease and Remove animal carcasses	If harmful insects galls, mildew or fungus are present within the BGI	As needed	4.2.5
Soil Amending	All vegetated BGI components	Tree/shrub appears unhealthy, unrelated to drought; soil issues observed. Amend soil as needed following annual nutrient test performed by the owner/operator	Soil tests report the need for soil amendment; Consult owner/operator	Depending on soil test results	4.2.7
Planting & Seeding	All vegetated BGI components	Bare areas in planted beds > 20 sqft during the growing season	Consult landscapearchitect or horticulturist and owner/ operator for plant selection	Replace plant(s)	4.2.8 & 4.2.8
	Rain garden/ basin, wetland, swale, green gutter	Bare areas in meadow areas or seeded areas (> 20 sqft) during the growing season		Perform seeding in spring (March 1 - May 15)	
Vacuum Cleaning	All GBI components with subsurface features	Vacuum clean trash sediment/ organic debris from subsurface access	If trash/sediment/organic debris present within structures	Once a year. Most preferably post monsoon	4.3.6
Inlet Pretreatment Device Maintenance	All GBI components with subsurface features	Empty and clean surface pretreatment devices	If trash, sediment, and/or organic debris is present in pretreatment devices	Once a year. Most preferably post monsoon	4.3.6
		Install permanent pretreatment devices	If pretreatment devices are not present		
Bolt & lock care	All GBI components with subsurface features	Clean and grease appurtenances	When bolts or locks is opened	Once a year. Most preferably post monsoon	4.3.5
Trees	All GBI componnets with the trees	Place water bag(s) on unhealthy tree	If tree leaves appear brown or wilted	Annually in April, or after planting	4.2.10
Herbaceous vegetation	All GBI componnets with the trees	Water herbaceous vegetation and shrubs	If there has been a period of 4 or more days without rain	Every 4 days from April to end of October	

DECOMMISSIONING AND UPGRADING SPONGE PARKS

Monitor Runoff Conveyance and Storage for Flood Mitigation Capacity

- ❑ How much runoff does the Sponge Park handle without overflow in a 2, 5, 10, 25, 50, and 100 year RP storm?
- ❑ Are storm events exceeding designed capacity due to climate change?

Monitor Depth to Water Table for Aquifer Recharge Capacity

- ❑ What is the depth to water table around Sponge Park relative to other areas after monsoon and during peak summers?
- ❑ Does the Sponge Park need to infiltrate more water due to climate change?

Monitor Groundwater Quality

- ❑ What is the quality of the groundwater?
- ❑ If pollution is detected, immediately seal recharge wells and infiltration basins

Audit Park Activity

- ❑ Has park attendance, programming, and recreational activity increased or decreased after upgrading into Sponge Park?
- ❑ If activity has decreased, decommission and rebuild BGI components for increased social activity and visual engagement

Monitor Ambient Temperatures

- ❑ Has urban heat island effect and heat waves increased in the neighbourhood of the Sponge Park?
- ❑ If so, increase green canopy cover in Spone Park

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WATER


Green Stormwater Infrastructure
Landscape Design Guidebook
Version 4.0 April 2020
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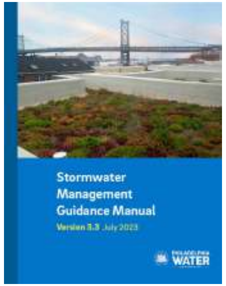
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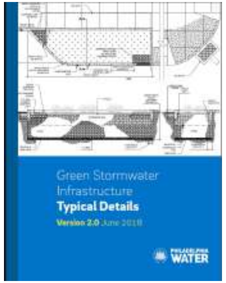
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The SuDS Manual
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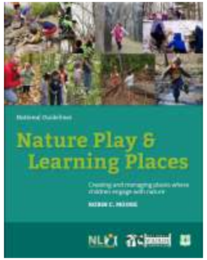
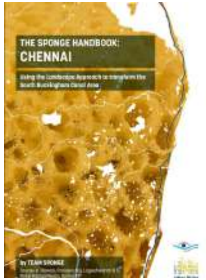

Nature Play & Learning Places


THE SPONGE HANDBOOK:
CHENNAI

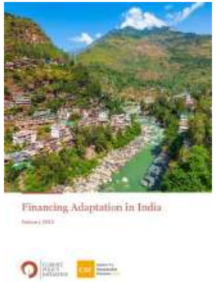

URBAN FOREST PLAN
CITY of BOSTON

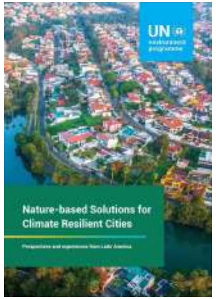

GREENING MUMBAI
CITIZEN'S HANDBOOK FOR GREENING INITIATIVES
from balcony gardens to large scale plots


GREEN INFRASTRUCTURE GUIDANCE MANUAL
FOR NEW JERSEY


USAID
Engaging the Private Sector in Green Infrastructure Development and Financing:
A Pathway Toward Building Urban Climate Resilience


Financing Climate Resilience


Financing Adaptation in India

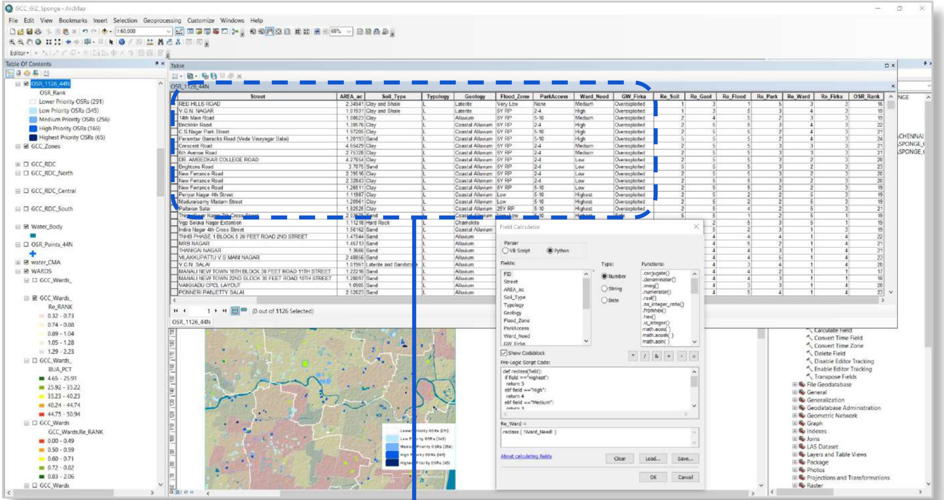

UN environment programme
Nature-based Solutions for Climate Resilient Cities

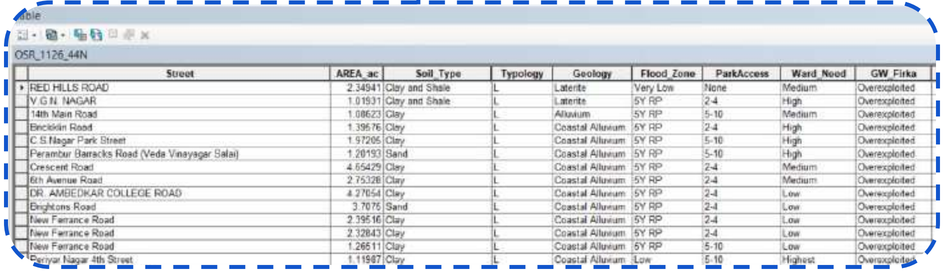
5

Workshop

- Sponge Park Manual and OSR Geodatabase
- GCC North Region Demonstration Site
- GCC Central Region Demonstration Site
- GCC South Region Demonstration Site
- Feedback on Improving Sponge Parks

Sponge Park Prioritisation Geodatabase of OSRs




OSR_1126_44N

Street	AREA_ac	Soil_Type	Typology	Geology	Flood_Zone	ParkAccess	Ward_Need	GW_Firka
RED HILLS ROAD	2.34941	Clay and Shale	L	Laterite	Very Low	None	Medium	Overexploited
V.G.N. NAGAR	1.01931	Clay and Shale	L	Laterite	5Y RP	2-4	High	Overexploited
14th Main Road	1.08623	Clay	L	Alluvium	5Y RP	5-10	Medium	Overexploited
Brickkiln Road	1.39576	Clay	L	Coastal Alluvium	5Y RP	2-4	High	Overexploited
C.S.Nagar Park Street	1.97206	Clay	L	Coastal Alluvium	5Y RP	5-10	High	Overexploited
Perambur Barracks Road (Veda Vinayagar Salai)	1.20193	Sand	L	Coastal Alluvium	5Y RP	5-10	High	Overexploited
Crescent Road	4.65429	Clay	L	Coastal Alluvium	5Y RP	2-4	Medium	Overexploited
6th Avenue Road	2.75328	Clay	L	Coastal Alluvium	5Y RP	2-4	Medium	Overexploited
DR. AMBEDKAR COLLEGE ROAD	4.27054	Clay	L	Coastal Alluvium	5Y RP	2-4	Low	Overexploited
Brightons Road	3.7076	Sand	L	Coastal Alluvium	5Y RP	2-4	Low	Overexploited
New Ferrance Road	2.39516	Clay	L	Coastal Alluvium	5Y RP	2-4	Low	Overexploited
New Ferrance Road	2.32843	Clay	L	Coastal Alluvium	5Y RP	2-4	Low	Overexploited
New Ferrance Road	1.26511	Clay	L	Coastal Alluvium	5Y RP	5-10	Low	Overexploited
Periyar Nagar 4th Street	1.11987	Clay	L	Coastal Alluvium	Low	5-10	Highest	Overexploited

OSRs will be prioritized if they are inside Wards with high social needs and located in flood prone areas with high recharge potential and need

Sponge Park Manual

GCC can consider OSRs with high rankings located within wards of high park need as ideal candidates to scale up the Sponge Park program

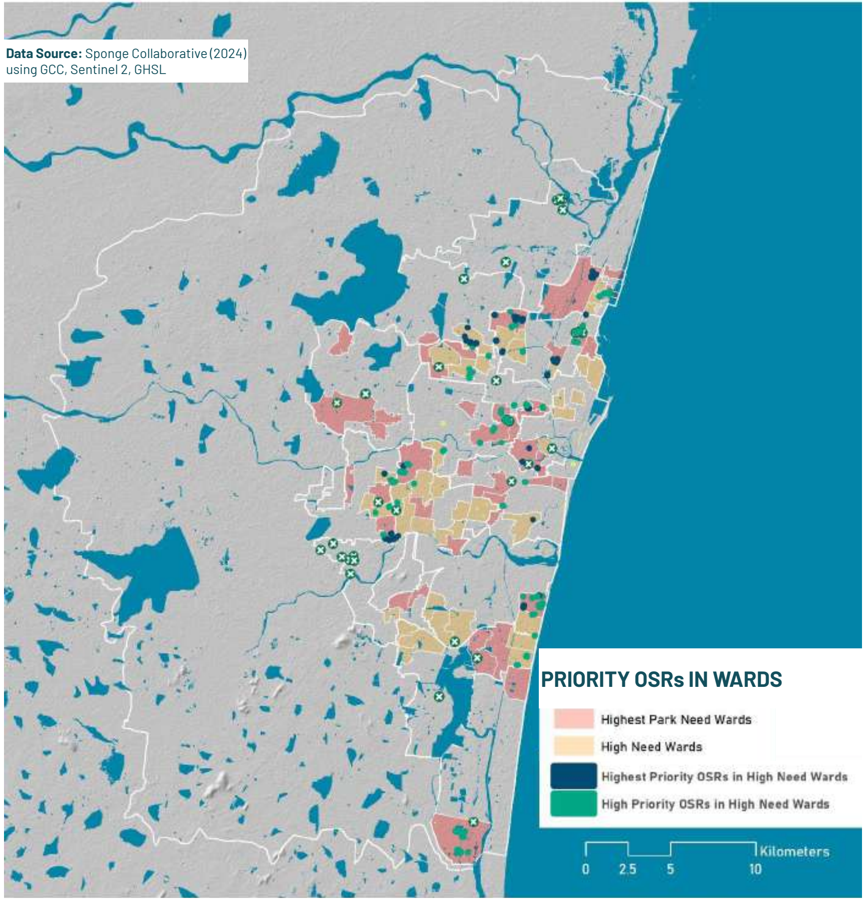
112 OSRs with high ranking because of their location in flood-prone areas and over permeable soil and geology are also located in wards with highest or high park needs.

These OSRs are distributed across 12 Zones and all 3 regions

49 of these are **Small OSRs** less than 0.2 acres

57 are **Medium OSRs** between 0.2 - 1 acres

6 are **Large OSRs** between 1 - 5 acres



Densely populated wards with low greenery, high built-up, low acreage of parks per capita, and low access to parks show up as red and orange

In the Chennai North Region, we zoom into Zone 3 where a number of high priority OSRs are found within wards of high park need

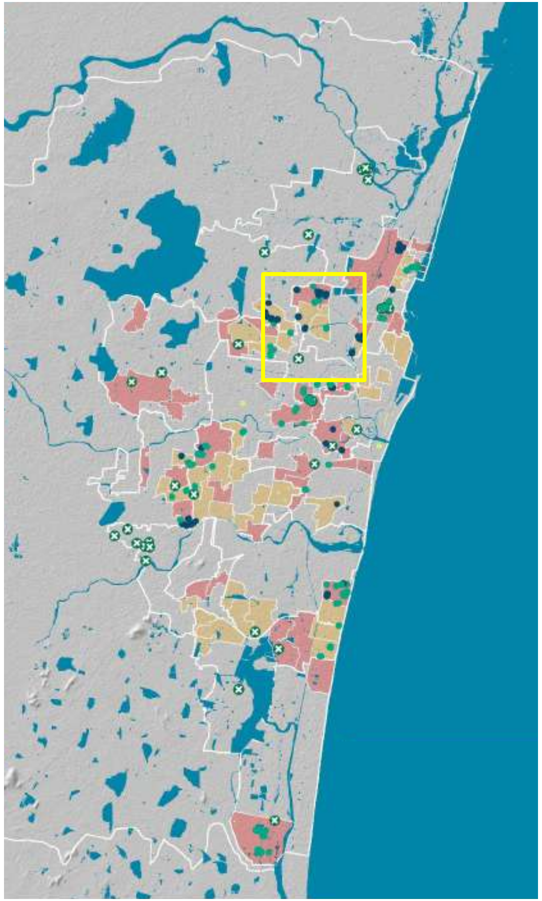
SITE 1

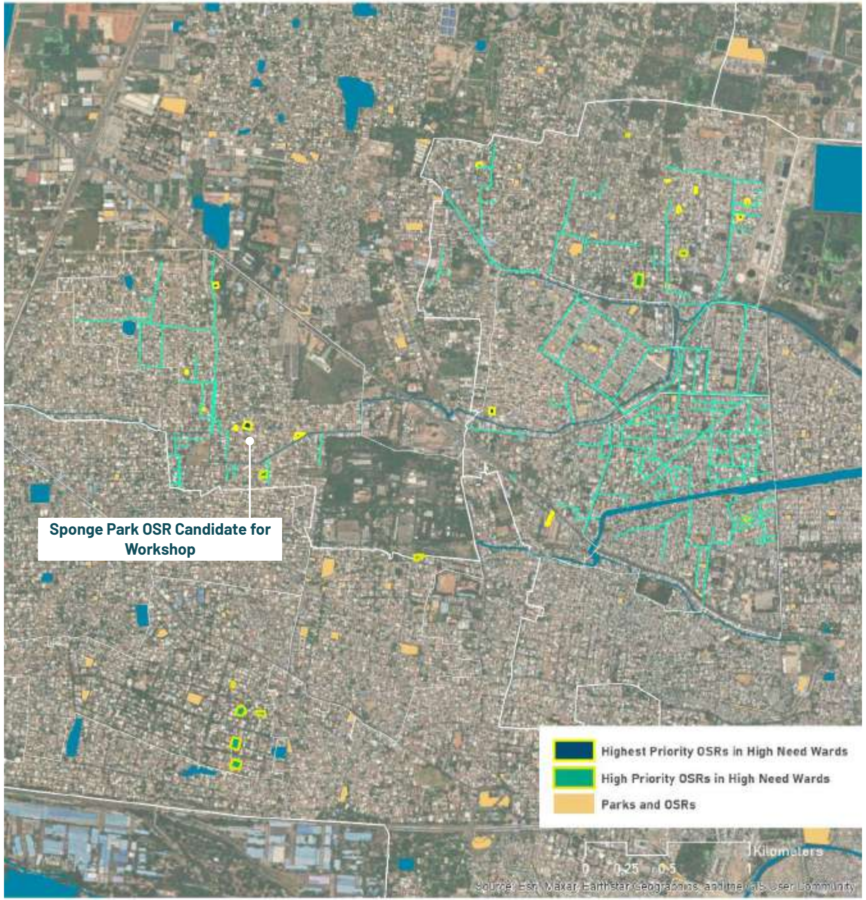
Ward 29

Ward 34

Ward 35

Ward 39





What assessments are needed at the catchment and site level before moving onto Concept Design of the Sponge Park?

Zone	Ward	Ward Pop.	Ward Need	Soil Type	Aquifer Category	Geology	OSR Area
3	29	52,239	Highest	Sand	Overexploited	Laterite	0.44 ac

How should the Sponge Park systems of soil, hydrology, vegetation, and social amenities be considered on this site? Which BGI toolkits would we use in this site?

In the Chennai Central Region, we zoom into Zone 8 where a number of high priority OSRs are found within wards of high park need

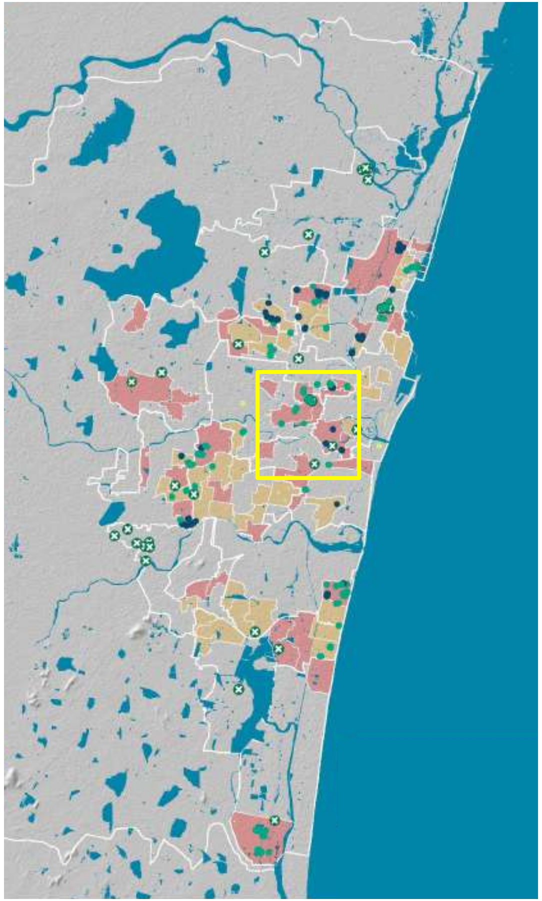
SITE 2

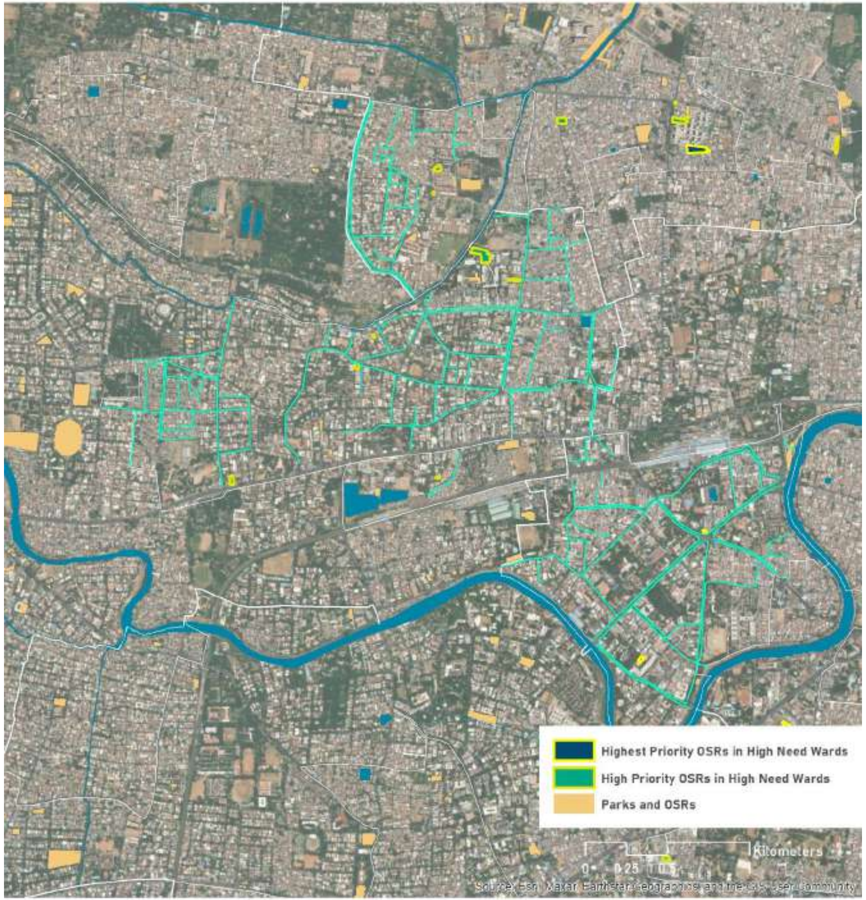
Ward 61

Ward 75

Ward 99

Ward 100





What assessments are needed at the catchment and site level before moving onto Concept Design of the Sponge Park?

Zone	Ward	Ward Pop.	Ward Need	Soil Type	Aquifer Category	Geology	OSR Area
8	99	34,309	High	Clay	Overexploited	Coastal All.	1.39 ac

How should the Sponge Park systems of soil, hydrology, vegetation, and social amenities be considered on this site? Which BGI toolkits would we use in this site?

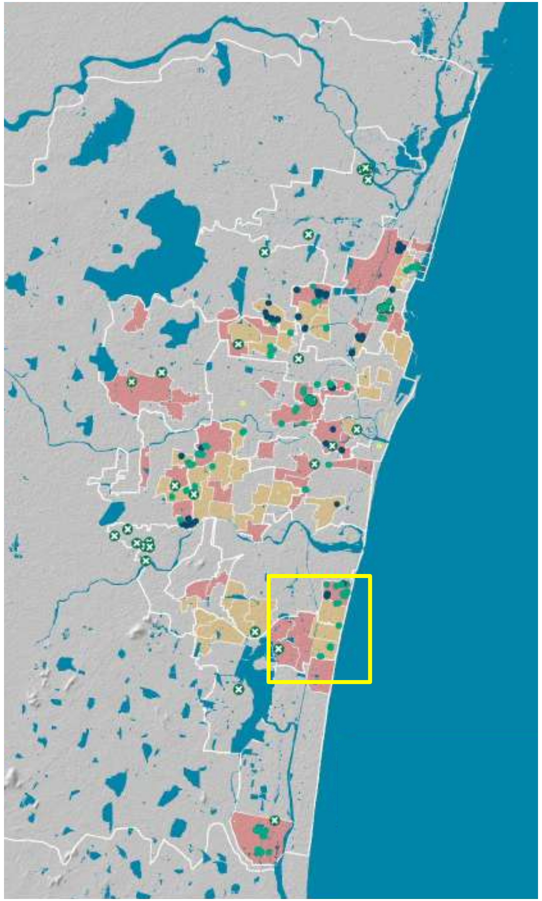
In the Chennai South Region, we zoom into Zone 3 where a number of high priority OSRs are found within wards of high park need

Ward 29

Ward 34

Ward 35

Ward 39



Densely populated wards with low greenery, high built-up, low acreage of parks per capita, and low access to parks show up as red and orange