SCHOOL OF WATER AND WASTE AAETI

NAMAMI GANGE

LAUNCH EVENT CUM WEBINAR

MAKING GANGA BASIN CITIES WATER SENSITIVE

Date **27th July, 2021** | Time **11:00 AM – 1:00 PM IST** | Venue **Online** | Language **English**

Roadmap for Implementation of Water-Sensitive Urban Design and Planning in Uttar Pradesh

Stormwater Harvesting in Parks and Open Spaces for effective urban flood management

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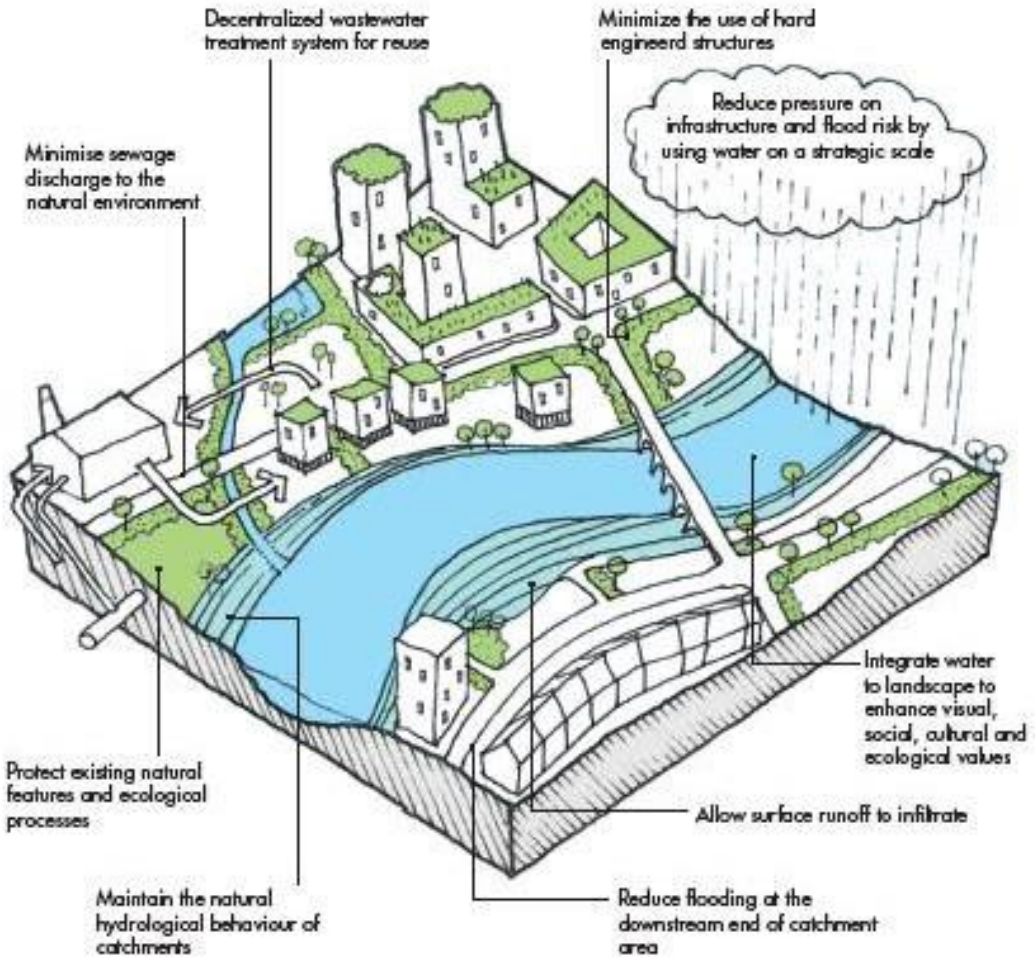
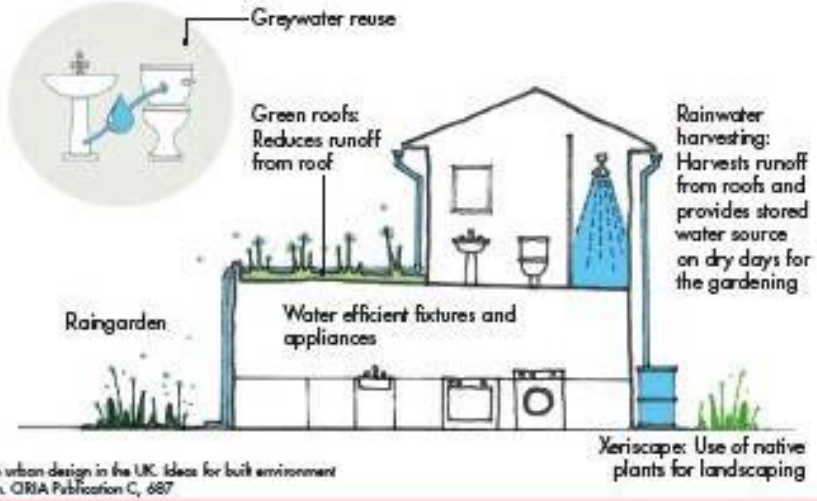
WSUDP APPROACH ON DIFFERENT SCALES

1 WATER-SENSITIVE PLANNING (CITY/ZONAL SCALE)



2 WATER-SENSITIVE DESIGNING (NEIGHBOURHOOD SCALE)

3 WATER-SENSITIVE DESIGNING (INDIVIDUAL SCALE)

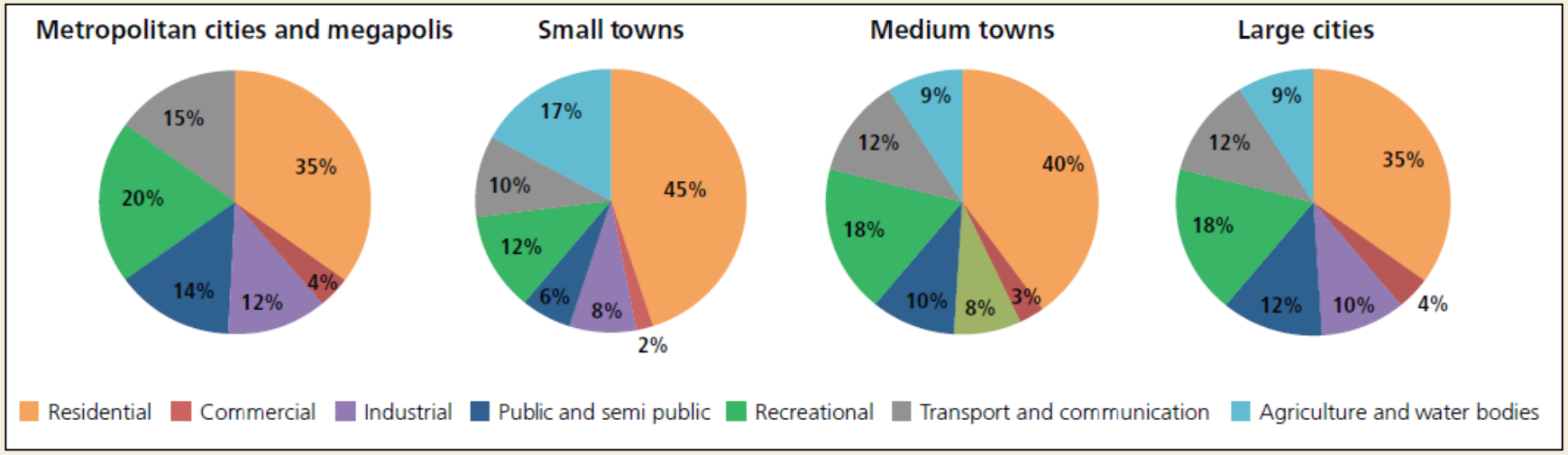


Adapted from: Morgan, C., Bevington, C., Levin, D., Robinson, P., Davis, P., Abbott, J. and Simkins, P., 2013. Water sensitive urban design in the UK. Ideas for built environment practitioners. CIRIA report C, 723; Dickie, S., McKay, G., Ions, L. and Shaffer, P., 2010. Planning for SuDS–making it happen. CIRIA Publication C, 687

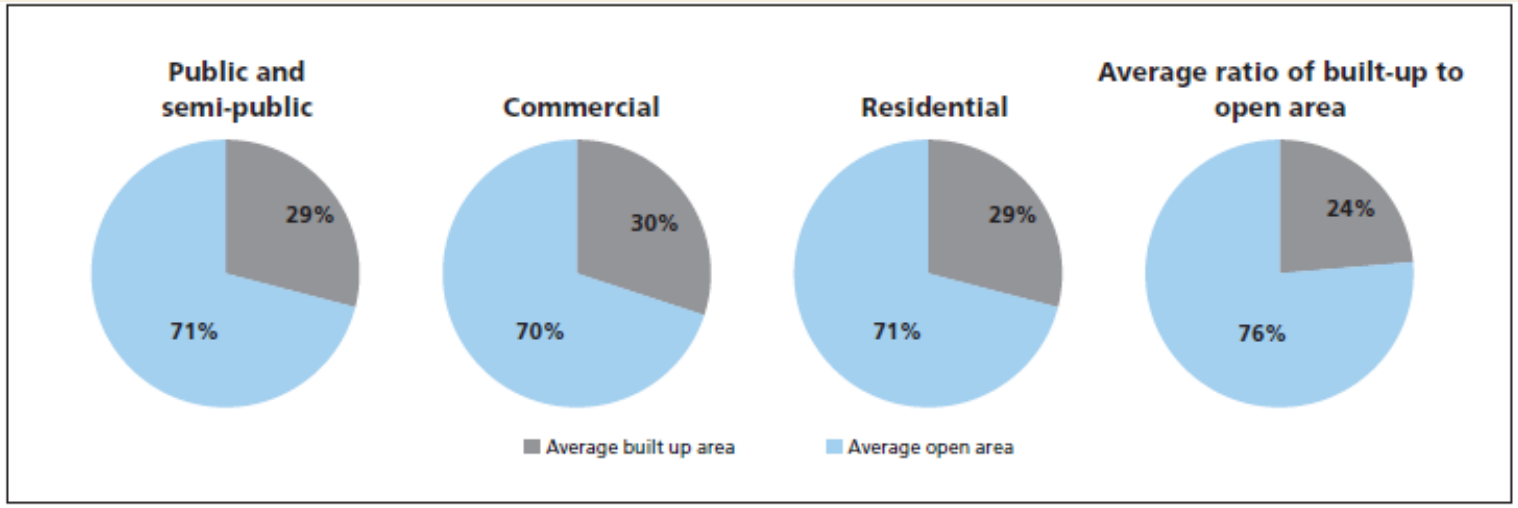
Scoping of WSUDP interventions in different urban development and planning stages

Scope of WSUDP interventions as per existing provisions

The residential cluster, which occupies the largest share of land use in city and towns, contains building rooftops, sidewalks, paved parking spaces, pervious areas that could be a garden or just open land and accessible roads.



Land-use pattern for different urban centers of India



Ratio of built-up to open area in different land uses

The average **Built up area range for a city/urban area is 21-26%** while area under **open spaces is 74 - 79 %.**

The standards and guidelines provide enough open area to design the SUDS structures

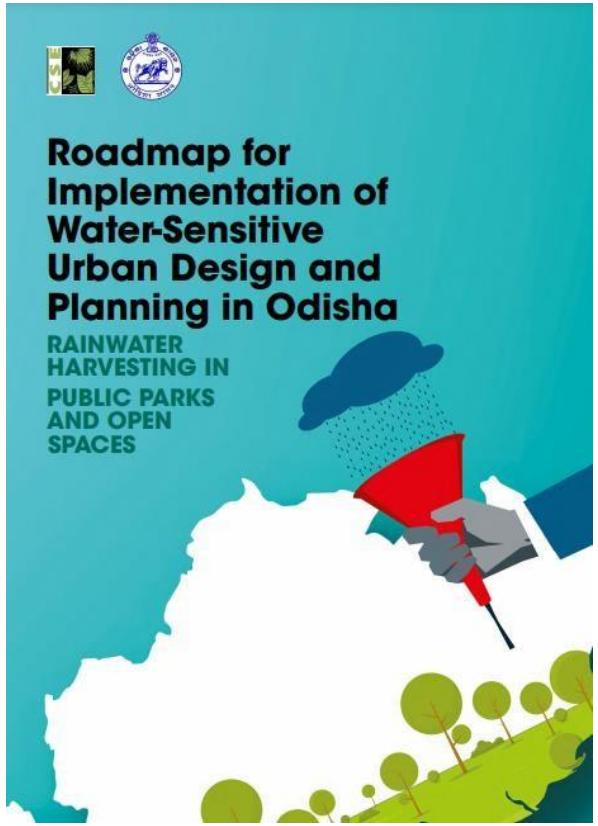
Application of RWH/ Stormwater harvesting measures on various scales

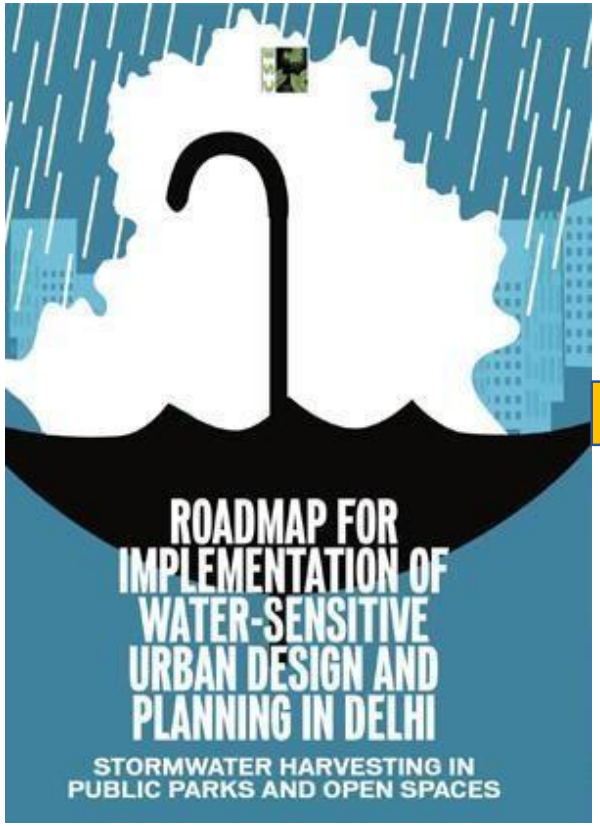
WSDP measures		Single detached dwellings	Commercial and industrial development	Medium- and high-density residential development	Public open space	Transport infrastructure	Waterbodies and surroundings
Storm-water management	Filter strips	✓	✓	✓	✓	✓	
	Swales		✓	✓	✓	✓	✓
	Bio-retention areas and rain gardens		✓	✓	✓	✓	✓
	Filter drains and trenches	✓	✓	✓	✓	✓	
	Permeable pavements	✓	✓	✓	✓	✓	
	Detention basins		✓	✓	✓	✓	
	Infiltration basins		✓	✓	✓	✓	
	Ponds		✓	✓	✓		✓

Source: WBM, B. (2009). Evaluating options for water sensitive urban design–a national guide. Joint Steering Committee for Water Sensitive Cities (JSCWSC)

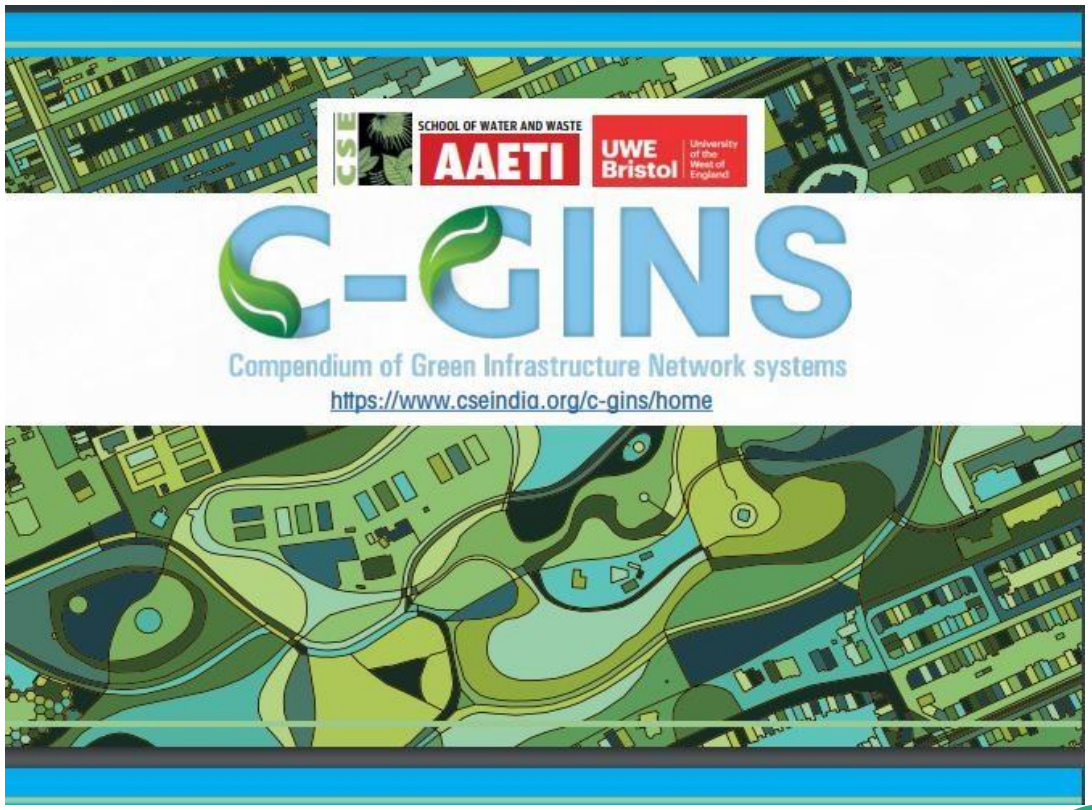
Refer: Pg 53to 54 of WSUDP: A Practitioner's Guide, Implementation of WSUDP

Mainstreaming Water Sensitive Urban Design (WSUDP) in India in Policy & Practice





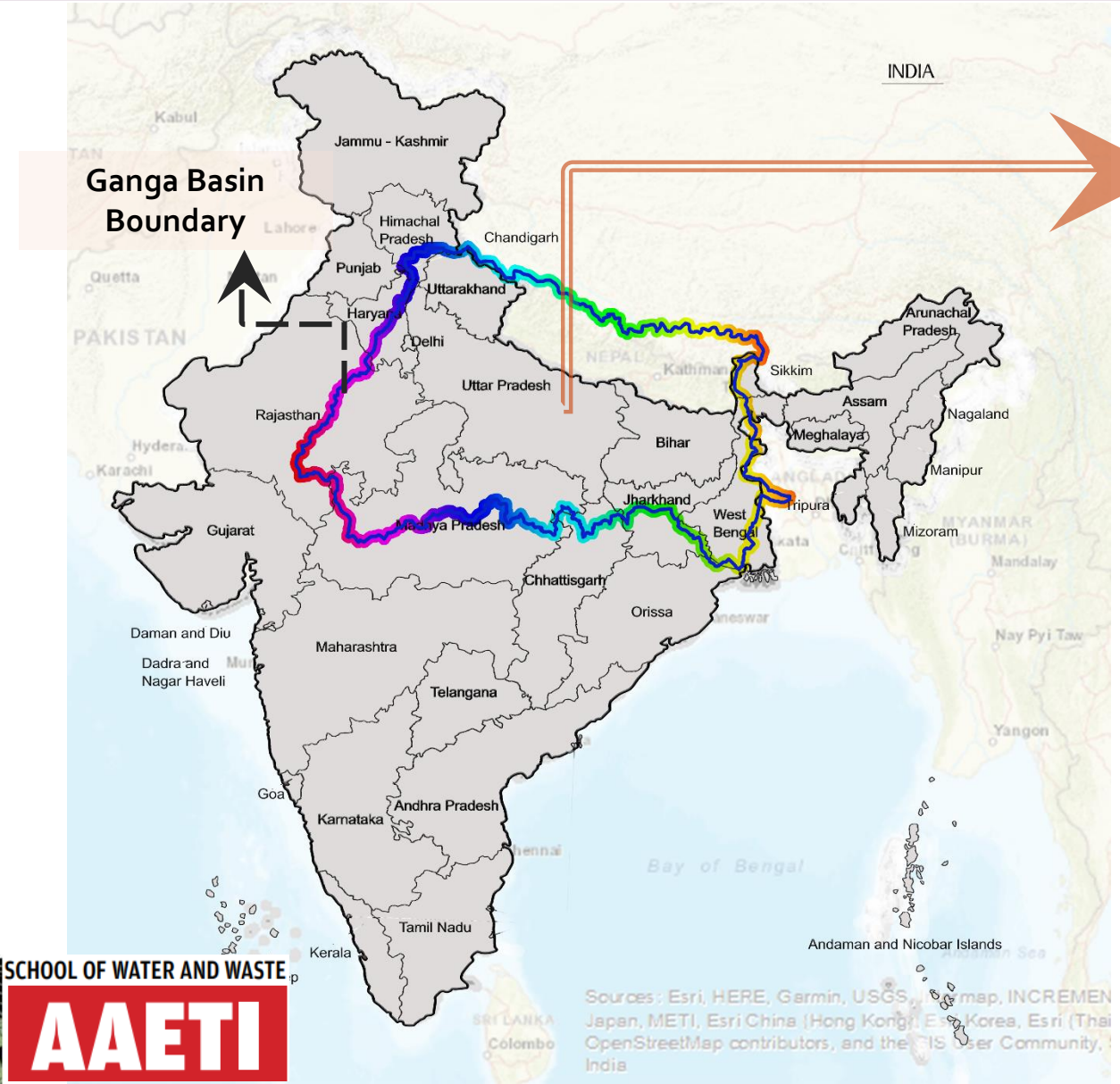
CSE Publications of July & November 2020



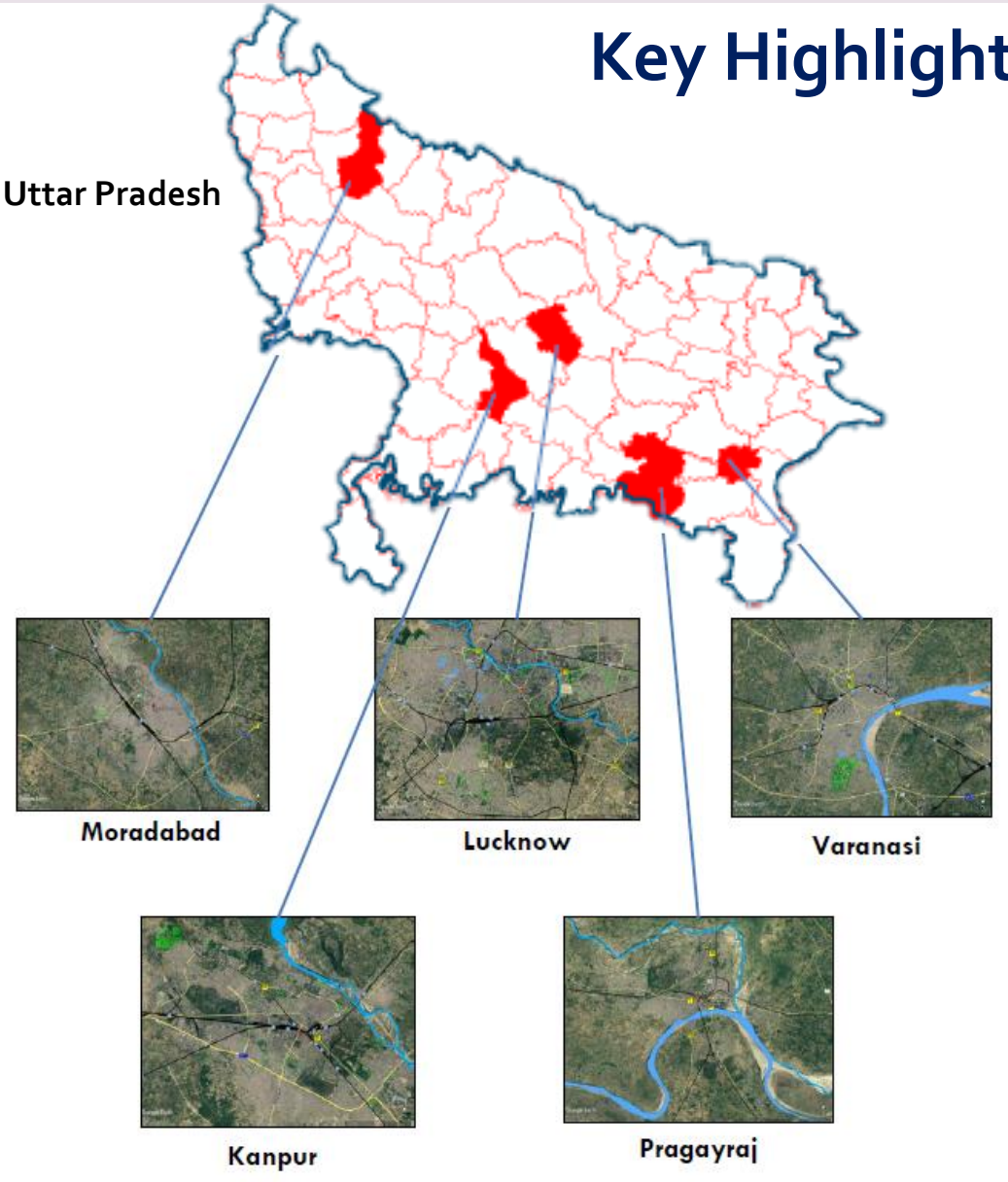
Web compendium

Launched in January 2021

CSE Report on RWH Potential of Parks / Open Green Spaces in Uttar Pradesh



Key Highlights



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Selection of Cities in Uttar Pradesh

Methodology for selection of cities for Pilot Projects

Cities in UP

- Smart cities in UP
- NMCG priority Ganga cities and towns
- Population and pace of urbanization of cities
- Ganga Cities in UP with master Plans and City Development Plans

Status of Urban Water Challenges in the cities

- Status of Groundwater exploitation
- Urban Flooding issues
- Loss of Water bodies
- Swach Sarvekshan Score 2020

5 Selected Smart Cities

Different hierarchical parks and open spaces of neighbourhood scale and zonal or city scale have been selected as pilot case studies

Key factors considered for selection of 5 smart cities

City	Pop. - 2011 (in Lakhs)	Master Plan	Swachh Sarvekshan, 2020 Rank	Groundwater Status (as per GEC-2015)	Urban Flooding	Loss of Waterbodies
Lucknow	29.02	Yes	12	**Over – Exploited**	Yes	Yes (46 %)
Kanpur	28.76	Yes	25	**Over – Exploited**	Yes	Yes
Varanasi	11.98	Yes	27	**Over – Exploited**	Yes	Yes
Prayagraj	11.95	Yes	20	**Over – Exploited**	Yes	Yes
Moradabad	8.78	Yes		**Over – Exploited**	Yes	

Proposed: Study/Research based decisions

POTENTIAL OF RWH IN CITIES OF UTTAR PRADESH

EXISTING

- Existing Water scenario
- Ground water
- Surface water
- Resource sustainability

- Study area – Uttar Pradesh and its cities profile
- Demography profile
- Water availability
- Hydro-geological set up – Ground water
- Water quality
- Drainage system – including water bodies
- Conclusion

ASSESSMENT

- RWH potential
- Identify recharge potential
- RWH in proposed and already landuse

- Climatic conditions - rainfall
- Geomorphic set up - soil
- Land use – Areas for runoff
- Conclusion

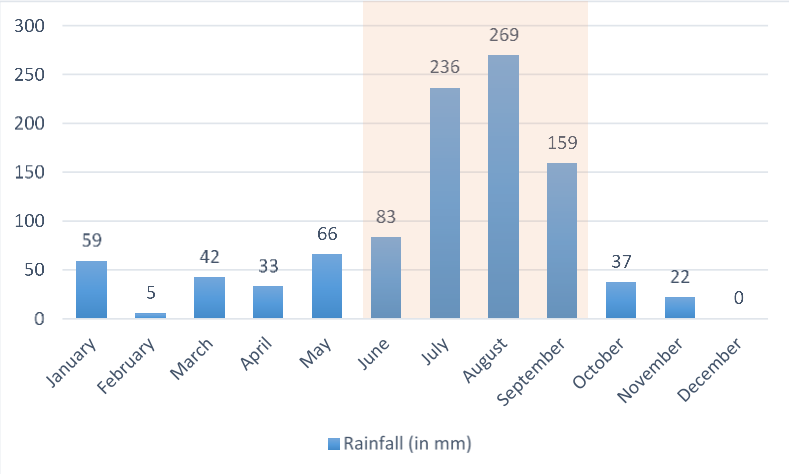
PROPOSAL

- Blue print for mainstreaming of city level RWH

- RWH concepts & techniques
- Area specific techniques
- Total potential versus demand

Rainfall Patterns Analysis

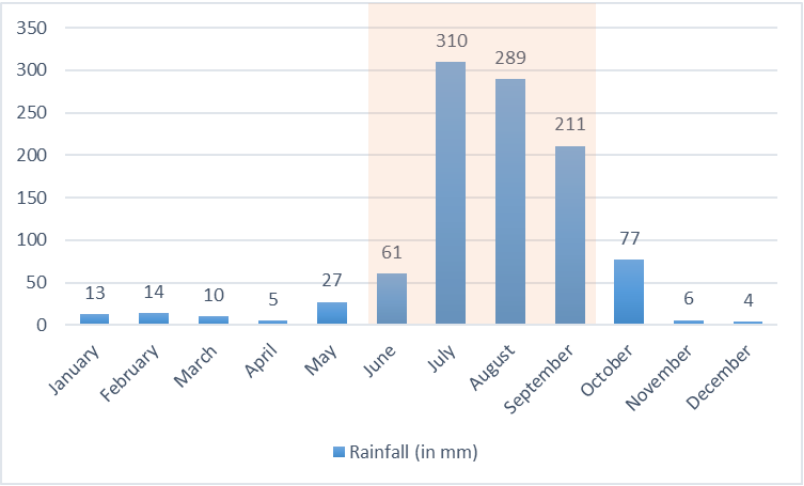
Lucknow



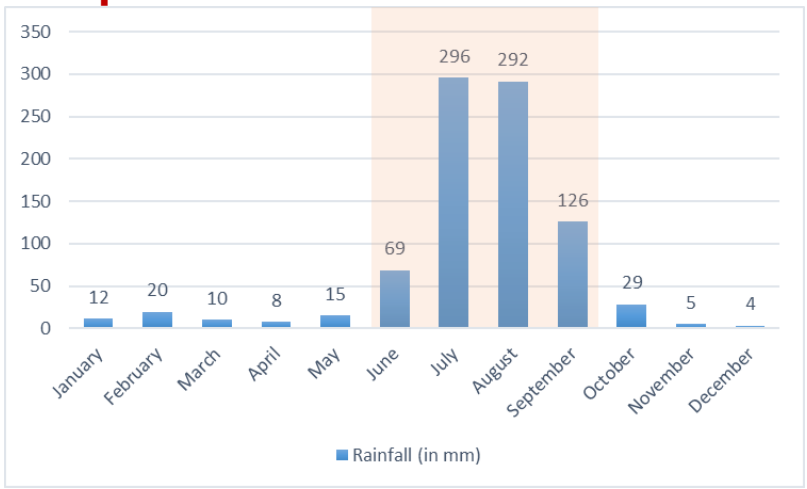
75% of annual rainfall falls in 5 months

Prayagraj

85% of annual rainfall falls in 4 months



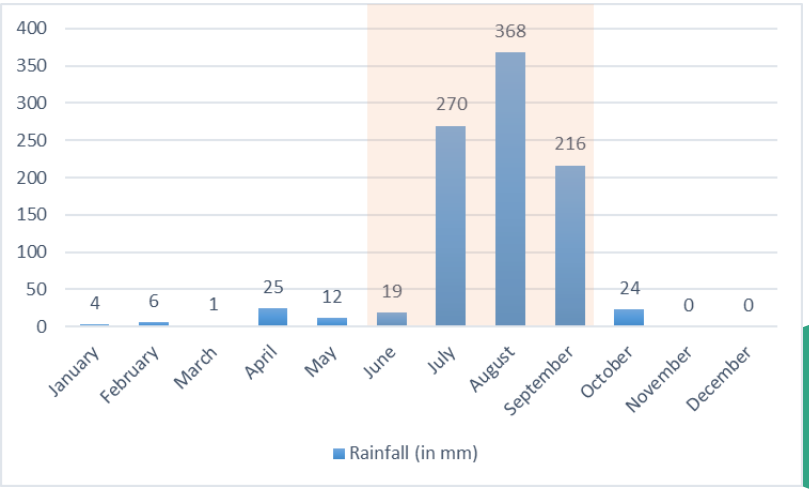
Kanpur



89% of annual rainfall falls in 4 months

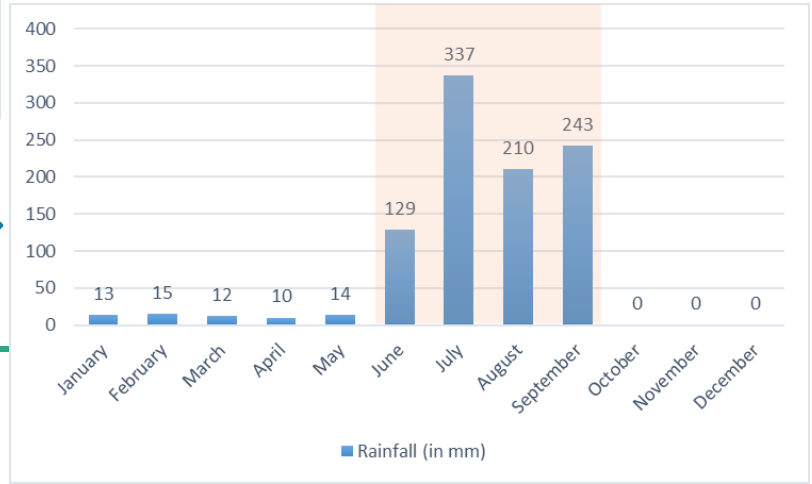
Moradabad

86% of annual rainfall falls in 4 months



Varanasi

88% of annual rainfall falls in 4 months



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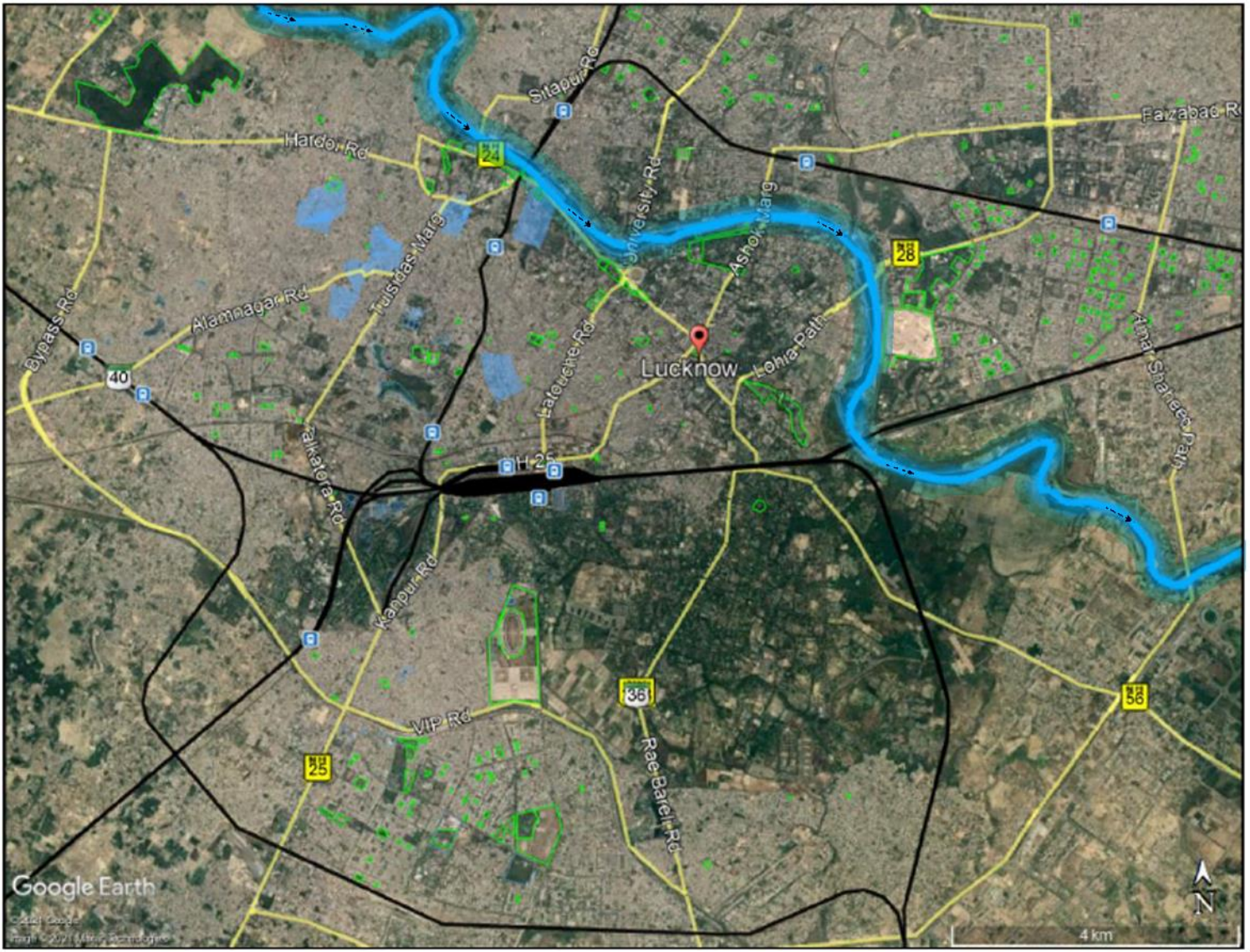
Lucknow



LEGEND

Roads | Railway Line | Ganga River | Green Areas/ Spaces

- Population: 28.17 lakhs (as per census 2011)
- Municipal Area: 349 sq. km
- Planning Area: 980 sq. km.
- General slope of the city area is towards south and south east
- **Soil profile:**
  - Alluvial soil covered with thick pile of quaternary sediments classified into older and newer alluvium
- **Annual Rainfall: 1,010 mm**

Season	GW Table (m b.g.l.)
Pre-monsoon	5 to 10*
Post-monsoon	2 to 5

* In some places, pre-monsoon GW table is reported as 20 m b.g.l. (as reported in Ground Water Year Book of Uttar Pradesh (2020))

- City level parks and neighbourhood parks exist in the city. There are 1684 parks and gardens under LMC jurisdiction with total area of **259 hectares**.

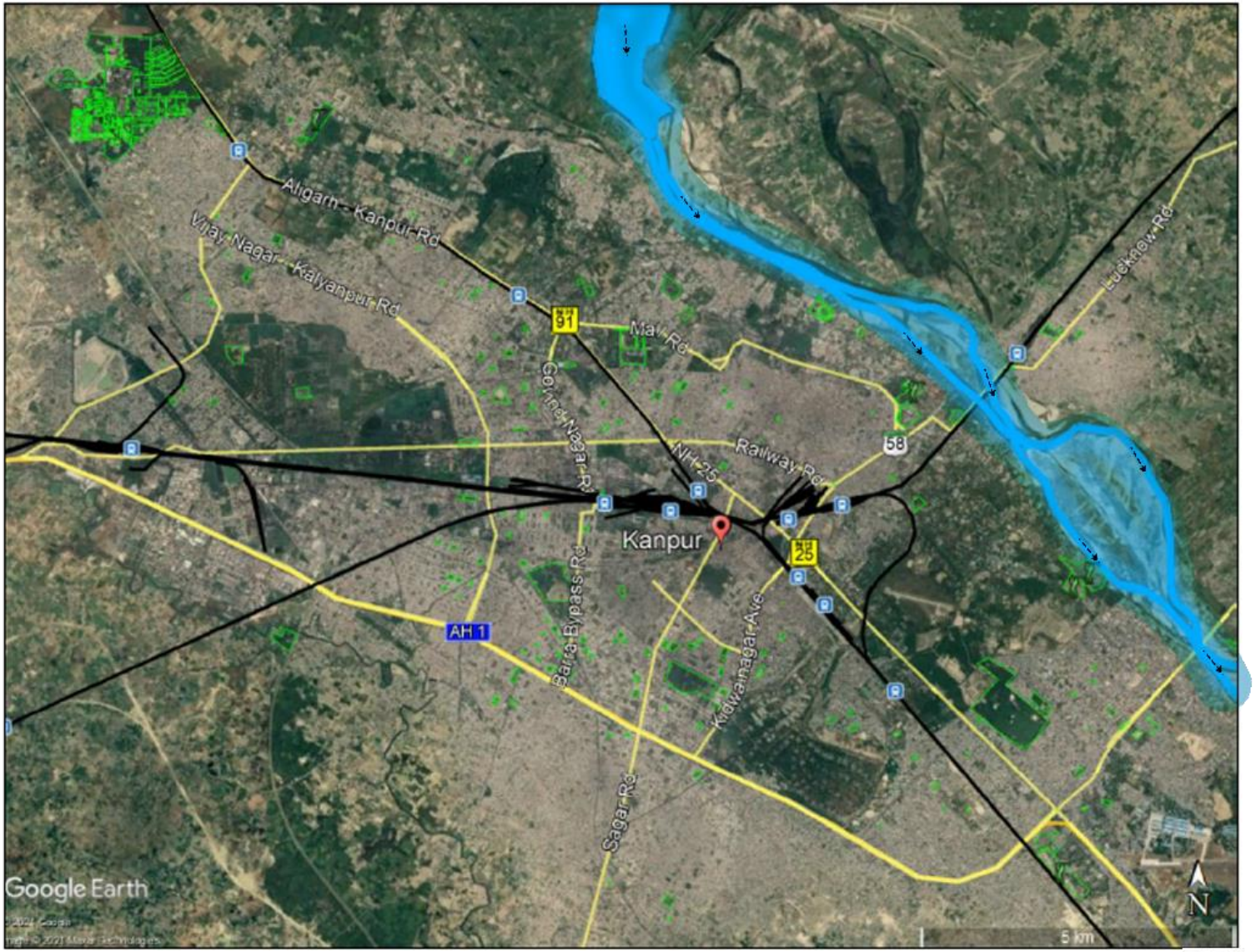
RWH in Selected Parks of Lucknow

Park	Dr Ram Manohar Lohia Park	Neighbourhood Park, LDA Colony	Indira Park
Area (sq. m.)	2,82,047	18,008	5,227
Scale	Sub-City	Community	Neighbourhood
Annual RWH Potential (KL)	32,760	2,092	607
Recommended Structure(s)	• Swale • Trench with filter strips • Bio-retention Area • Detention Basin • Infiltration Basin	• Swale • Bio-retention Area • Trench with Filter Strips • Infiltration basins	• Swale • Raingarden • Trench with Filter Strips
Total Area of Structures (sq. m)	3526 to 4512.7	225.1 to 288	65.3 to 83.6

- RWH structures require **1-3% of total area of Parks**
- **35.45 Mil L** can be harvested from these three parks annually
- Assuming **15 Neighbourhood parks** implement RWH in Lucknow, additionally **31.38 Mil L** can be harvested. **A total of 66.83 Mil L can be harvested annually**

As per CDP plan, 2041, Lucknow has 1,684 parks and gardens, spread across an area of 259 hectares, where stormwater harvesting can be implemented. Therefore, a **total of 309 million litres of rainwater can be harvested in Lucknow annually.**

Kanpur



- Population: 27.65 lakhs (as per census 2011)
- Municipal Area: 260.89 sq. km
- Planning Area: 563 sq. km.
- Sharp level rise from river bed to the high cliff (main city) and then gentle slope towards the central and south – eastern part.
- **Soil profile:**
  - Alluvial and sandy soil
- **Annual Rainfall: 885 mm**

Season	GW Table (m b.g.l.)
Pre-monsoon	5 to 10*
Post-monsoon	5 to 10

* Along the Ganga river, pre-monsoon GW table is reported as 10-20 m b.g.l. (as reported in CDP Kanpur))

- City level parks and neighbourhood parks exist in the city. There are **844 parks and gardens** under KMC jurisdiction with total area of **260 hectares.**

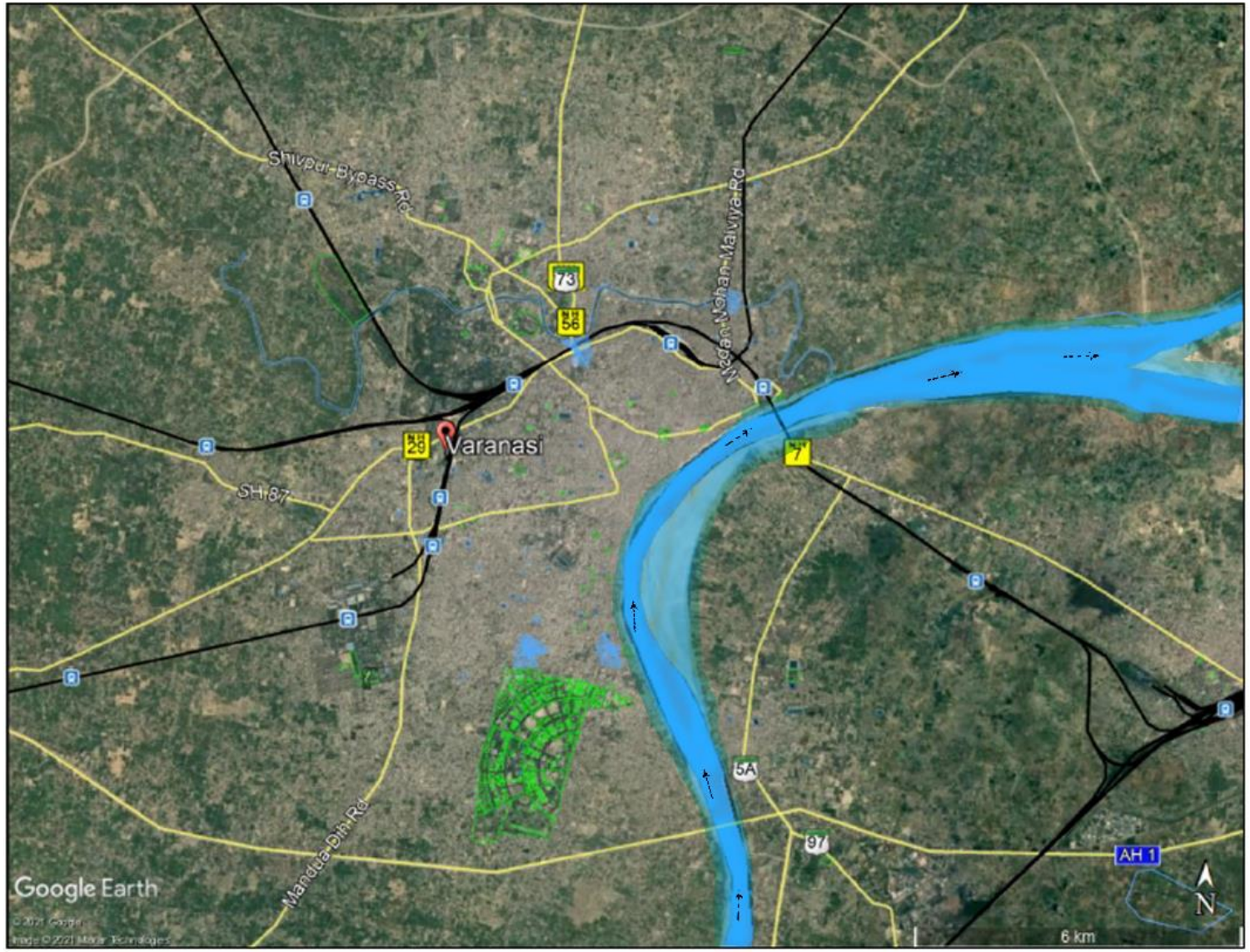
RWH in Selected Parks of Kanpur

Park	Eco Park	Central Park	Kamla Nehru Park
Area (sq. m.)	67, 396	33,135	11, 694
Scale	District	Community	Neighbourhood
Annual RWH Potential (KL)	**7,903**	**3,885**	**1,550**
Recommended Structure(s)	• **Swale** • **Trench with filter strips** • **Bio-retention Area** • **Detention Basin**	• **Swale** • **Bio-retention Area** • **Trench with Filter Strips**	• **Swale** • **Raingarden** • **Trench with Filter Strips**
Total Area of Structures (sq. m)	842.4 to 1213.1	414.1 to 596.4	146.1 to 210.5

- RWH structures require **1-3% of total area of Parks**
- **13.33 Mil L** can be harvested from these three parks annually
- Assuming 15 Neighbourhood parks implement RWH in Kanpur, additionally **23.25 Mil L** can be harvested. A total of **36.55 Mil L** can be harvested annually

As per City Development Plan, Kanpur has **844 parks and gardens**, spread across an area of 260 hectares, where stormwater harvesting can be implemented. Therefore, a total of **305 million litres** of rainwater can be harvested in Kanpur annually.

Varanasi



LEGEND

Roads | Railway Line | Ganga River | Green Areas/ Spaces

- Population: 11.98 lakhs (as per census 2011)
- Municipal Area: 82.1 sq. km
- Planning Area: 793 sq. km.
- Flat topography with a gentle slope towards south-east
- **Soil profile:**
  - Alluvial soil with layers of clay, fine sand, and clay mixed with kankar and stone bazari.
- **Annual Rainfall: 982 mm**

Season	GW Table (m b.g.l.)
Pre-monsoon	10 to 20
Post-monsoon	4

- **Neighbourhood parks and housing area parks** exist in the city. The recreational land use including parks and playgrounds constitutes 8 % i.e. **775.54 ha** under VMC jurisdiction.

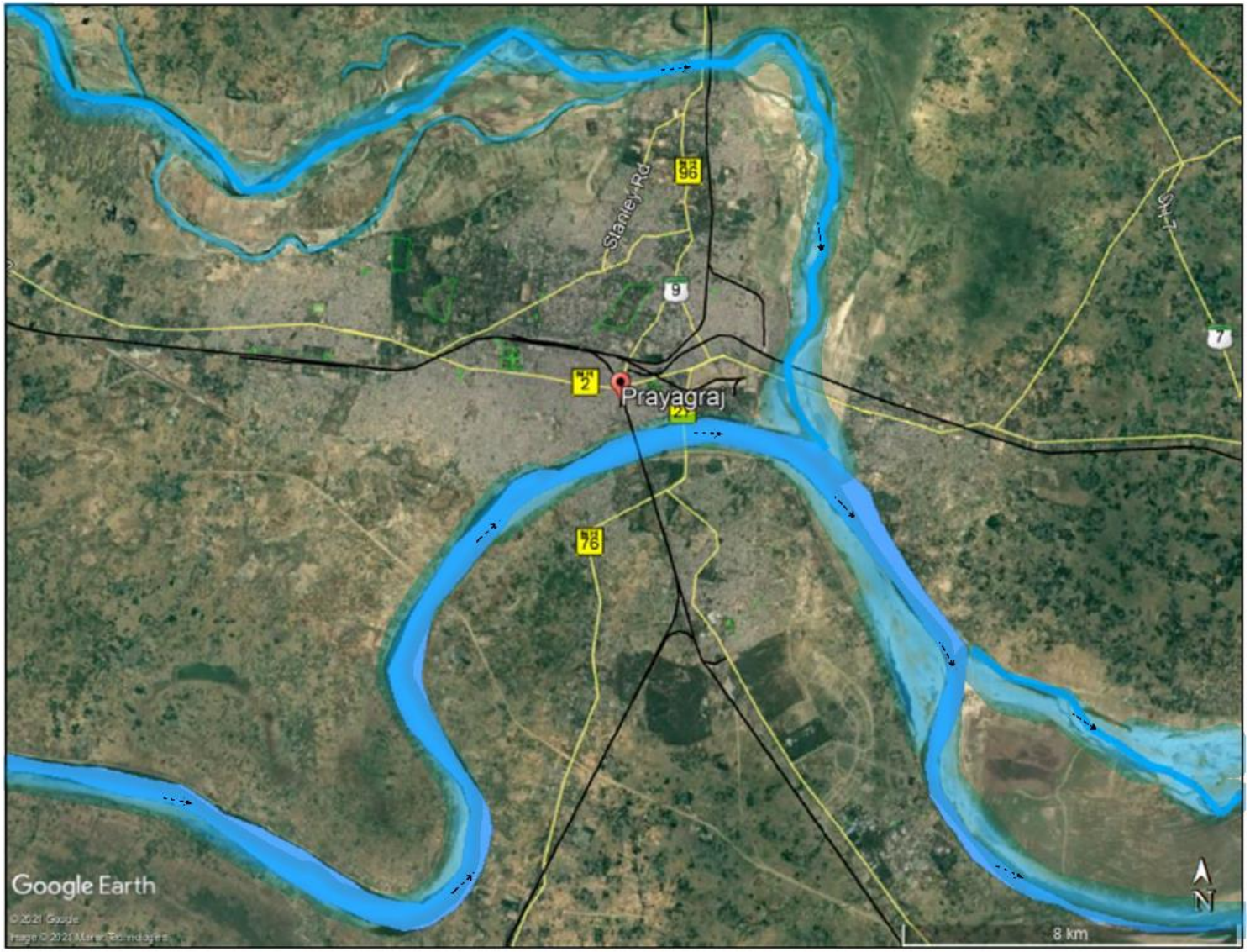
RWH in Selected Parks of Varanasi

Park	Shaheed Udhyan Park	Nehru Park	Ratnakar Park
Area (sq. m.)	17, 475	9,638	4,561
Scale	Community	Neighbourhood	Housing Area
Annual RWH Potential (KL)	**2,188**	**1,207**	**571**
Recommended Structure(s)	• **Swale** • **Trench with filter strips** • **Bio-retention Area** • **Infiltration Basin**	• **Swale** • **Bio-retention Area** • **Infiltration Trench with Filter Strips**	• **Swale** • **Raingarden** • **Trench with Filter Strips**
Total Area of Structures (sq. m)	218.43 to 279.6	120.47 to 154.20	57.01 to 72.97

- RWH structures require **1-3% of total area of Parks**
- **4 Mil L** can be harvested from these three parks annually
- Assuming 15 Neighbourhood parks implement RWH in Varanasi, additionally **18.10 Mil L** can be harvested. A total of **22.10 Mil L** can be harvested annually

As per CDP plan, 2041, Varanasi has parks and gardens spread across an area of **775.54 hectares**, where stormwater harvesting can be implemented. Therefore, a total of **971 million litres** of rainwater can be harvested in Varanasi annually.

Prayagraj



LEGEND

Roads | Railway Line | Ganga River | Green Areas/ Spaces

N

- Population: 11.12 lakhs (as per census 2011)
- Municipal Area: 70.05 sq. km
- Planning Area: 309 sq. km.
- General slope of the city area is towards east and south east
- **Soil profile:**
  - Terrace Alluvium soil consisting of sand, gravel and clay with occasional presence of thin to thick kankar intercalation.
- **Annual Rainfall: 1,027 mm**

Season	GW Table (m b.g.l.)
Pre-monsoon	3 to 15*
Post-monsoon	1.45 to 13

- **City level parks and neighbourhood parks** exist in the city. There are **150 parks spread across 140.14** hectares which are owned and maintained by AMC (Allahabad Municipal Corporation).

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RWH in Selected Parks of Prayagraj

Park	Minto park	Bharadwaj Park	Kalyani Devi Park
Area (sq. m.)	66,347	17,202	4,224
Scale	District	Community	Housing Area
Annual RWH Potential (KL)	**7,836**	**2,031**	**499**
Recommended Structure(s)	• **Swale** • **Trench with filter strips** • **Bio-retention Area** • **Detention Basin** • **Infiltration Basin**	• **Swale** • **Bio-retention Area** • **Trench with Filter Strips** • **Infiltration basins**	• **Swale** • **Raingarden** • **Trench with Filter Strips**
Total Area of Structures (sq. m)	829.33 to 1194.24	215 to 309.63	52.8 to 76.03

- RWH structures require **1-3% of total area of Parks**
- **10.36 Mil L** can be harvested from these three parks annually
- Assuming 15 Neighbourhood parks implement RWH in Prayagraj, additionally **7.48 Mil L** can be harvested. A total of **18 Mil L** can be harvested annually

As per CDP plan, 2041, Prayagraj has **150 parks and gardens**, spread across an **area of 140.04 hectares**, where stormwater harvesting can be implemented. Therefore, a total of **166 million litres of rainwater can be harvested** in Prayagraj annually.

Moradabad

LEGEND

Roads | Railway Line | Ganga River | Green Areas/ Spaces

N

- Population: 8.9 lakhs (as per census 2011)
- Municipal Area: 75 sq. km
- Planning Area: 390 sq. km.
- Distinct slope from north to south
- **Soil profile:**
  - Indo-Gangetic alluvium which consists of the alluvial sand, clay and loam.
- **Annual Rainfall: 944.3 mm**

Season	GW Table (m b.g.l.)
Pre-monsoon	2.2 to 12.52
Post-monsoon	1.70 to 13.69

- **City level parks and neighbourhood parks** exist in the city. The existing area of developed parks and open spaces is approximately **724.77 Ha** (2009).

RWH in Selected Parks of Moradabad

Park	Company Park	Gandhi Nagar Park	Chatrapati Shivaji Park
Area (sq. m.)	30,147	5,173	3,202
Scale	Community	Neighbourhood	Housing Area
Annual RWH Potential (KL)	**3,630**	**623**	**386**
Recommended Structure(s)	• Swale • Trench with filter strips • Bio-retention Area • Detention Basin	• Swale • Bio-retention Area	• Swale • Raingarden • Trench with Filter Strips
Total Area of Structures (sq. m)	376.8 to 428.35	64.6 to 82.76	40.02 to 51.23

- RWH structures require **1-3% of total area of Parks**
- **4.63 Mil L** can be harvested from these three parks annually
- Assuming 15 Neighbourhood parks implement RWH in Moradabad, additionally **9.34 Mil L** can be harvested. A total of **13.97 Mil L** can be harvested annually

As per Moradabad Mahayojna 2021, the existing area of **parks and open spaces is approximately 724.77 hectares,** where stormwater harvesting can be implemented. Therefore, a total of **873 million litres of rainwater can be harvested** in Kanpur annually.

RWH in Selected Parks of Lucknow

Park	Dr Ram Manohar Lohia Park	Neighbourhood Park, LDA Colony	Indira Park
Area (sq. m.)	2,82,047	18,008	5,227
Scale	Sub-City	Community	Neighbourhood
Annual RWH Potential (KL)	**32,760**	**2,092**	**607**
Recommended Structure(s)	• **Swale** • **Trench with filter strips** • **Bio-retention Area** • **Detention Basin** • **Infiltration Basin**	• **Swale** • **Bio-retention Area** • **Trench with Filter Strips** • **Infiltration basins**	• **Swale** • **Raingarden** • **Trench with Filter Strips**
Total Area of Structures (sq. m)	3526 to 4512.7	225.1 to 288	65.3 to 83.6

- RWH structures require **1-3% of total area of Parks**
- **35.45 Mil L** can be harvested from these three parks annually
- Assuming 15 Neighbourhood parks implement RWH in Lucknow, additionally **31.38 Mil L** can be harvested. A total of **66.83 Mil L** can be harvested annually

As per CDP plan, 2041, Lucknow has **1,684 parks and gardens**, spread across an area of **259 hectares**, where stormwater harvesting can be implemented. Therefore, a total of **309 million litres** of rainwater can be harvested in Lucknow annually.

Total potential of 5 Smart Cities in Uttar Pradesh

City	Area under Parks (Ha)	WSUDP Potential (Million L)
Lucknow	259	309
Kanpur	260	305
Varanasi	776	971
Prayagraj	140	166
Moradabad	725	873
Total	2,160	2,624

2,624 million litres run-off quantity is the missed potential which sometimes become a liability in these cities.

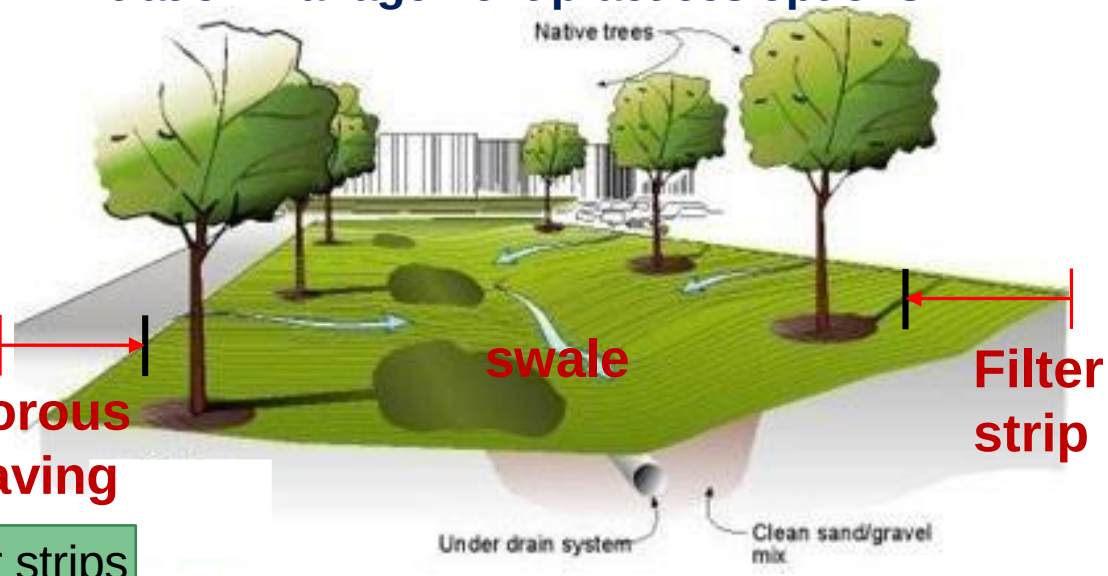
If managed efficiently, the runoff can be stored, recharged and moderated during peak rainfall

Options and Techniques for RWH in Parks

Integrating different stormwater harvesting and infiltration management practices options

Reduce volume and rate of runoff

- Reduce runoff
- Allow infiltration



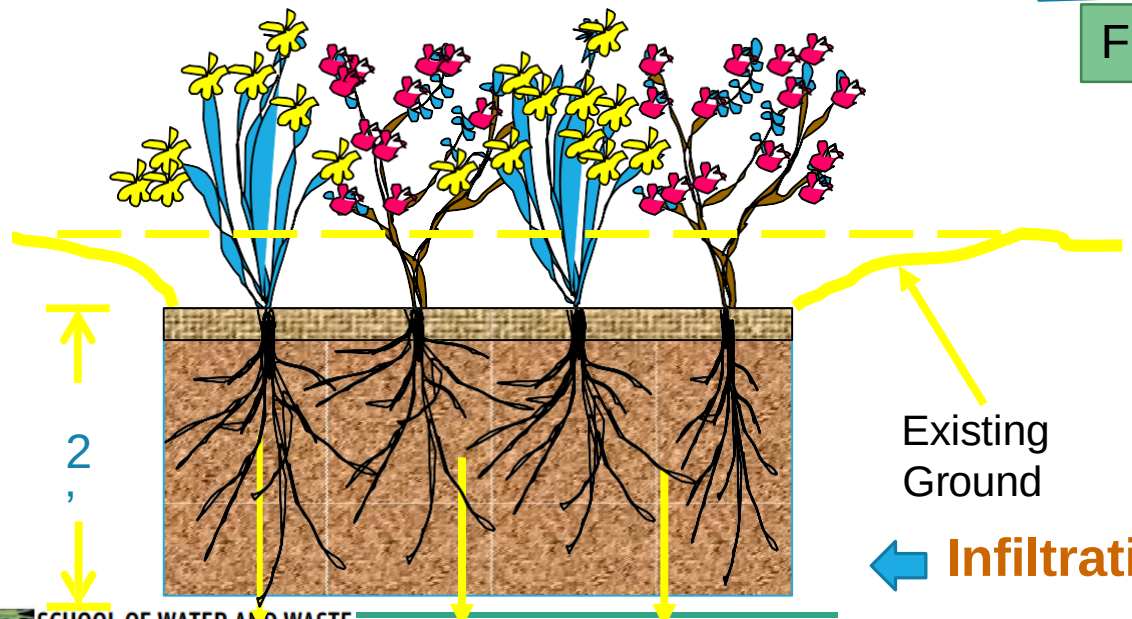
Porous paving

Filter strips

Swales

Bioretention areas and raingardens

Detention basins



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Data / information requirements

Preparing Preliminary Action Plans for WSUDP recommended structures

- No. of Parks ✓
- The Locational details (along the geo- coordinates, if possible) ✓
- Size of the Parks (in Sq. Mts.) ✓
- Topography- General gradient/ slope and orientation of the park ✓
- The soil condition (information on the soil profile) ✓
- The storm water drains existing in or near the parks ✓
- RWH structures existing in or near the parks ✓
- Rainfall data of the locality ✓
- Data on Aquifers: Type of Aquifer, Depth ✓
- Data on Groundwater Table, Groundwater Quality ✓
- Nature and type of green cover inside the park ✓
- Nature and extent of land covered by the water bodies, if any, inside the park ✓
- Utilities commissioned inside the parks and open spaces ✓
- Information on drinking water demand and Supply ✓
- Mining activities, if any in Urban Areas ✓

Thank You