URBAN RIVER MANAGEMENT PLAN

CHHATRAPATI SAMBHAJINAGAR (AURANGABAD)



CHHATRAPATI SAMBHAJINAGAR
MUNICIPAL CORPORATION

CHHATRAPATI SAMBHAJINAGAR SMART CITIES
DEVELOPMENT CORPORATION LIMITED

Maharashtra



URBAN RIVER MANAGEMENT PLAN CHHATRAPATI SAMBHAJINAGAR

CHHATRAPATI SAMBHAJINAGAR MUNICIPAL CORPORATION (CSMC)

CHHATRAPATI SAMBHAJINAGAR SMART CITIES DEVELOPMENT CORPORATION LIMITED (CSSCDCL)

Maharashtra





ACKNOWLEDGEMENTS

Project Mentors

Sh. G.Asok Kumar, Director General, National Mission for Clean Ganga;
Sh. Hitesh Vaidya, Director, National Institute of Urban Affairs

City Administration

Sh. Astik Kumar Pandey (IAS), Collector and District Magistrate, Chhatrapati Sambhajinagar;
Sh. G.Sreekanth (IAS), Municipal Commissioner & Administrator, CSMC;
Dr. Abhijeet Chaudhari (IAS), Former Municipal Commissioner & Administrator, CSMC;
Sh. Somnath Jadhav, CSMC, (Nodal Officer);
Sh. Aditya Tiwari, Assistant Project Manager, CSSCDCL (Nodal Officer)

URMP Working Group, Chhatrapati Sambhajinagar

City Departments - CSMC, CSSCDCL, Cantonment Board, Soil and Water Conservation, Waqf Board;
State Authorities - Conservator of Forests, Archaeological Survey of India, Groundwater Surveys and Development Agency, Irrigation and Flood Control, Maharashtra Jeevan Pradhikaran, State Archaeology, Maharashtra Pollution Control Board, Maharashtra Industrial Development Corporation, Groundwater Surveys and Development Agency;
Academic Institutions - Kamla Raheja Vidyanidhi Institute for Architecture, Dr. Babasaheb Ambedkar Marathwada University, MIT College, PES College of Engineering;
Industry Representatives - Confederation of Indian Industry and Varroc Industries;
Local NGOs - Aurangabad First

Apart from the URMP Working Group, a number of other departments in the city were consulted during the process.

NIUA Team

Nikita Madan, Ishleen Kaur, Anirudh Soni, Victor Shinde, Jyoti Verma
Aparna Dwivedi, Banibrata Choudhury, Lovlesh Sharma, Manju Rajeev Kanchan, Mehak Aggarwal, Rahul Sachdeva, Sahil Bharadwaj, Shilpi Chakraborty, Uday Bhonde

Local Partners

EcoSattva Environmental Solutions Pvt. Ltd.;
Jawaharlal Nehru Engineering College (JNEC), Chhatrapati Sambhajinagar

NMCG Team

Himansu Badoni, Dheeraj Joshi, Sumit Chakraborty, Ashwini Dubey

Disclaimer

The interventions proposed in this URMP document (Version 1) are detailed concept plans prepared in consultation with the working group and city stakeholders. For its implementation, a Detailed Project Report (DPR) needs to be prepared.

Publication Year 2023

KEY MESSAGES

Message from Director General, National Mission For Clean Ganga



Shri. G. Asok Kumar

Not all cities are fortunate to have rivers. Rivers are an invaluable asset for any city. However, these vital resources are in grave peril due to anthropogenic influences. While our cities have been making multiple attempts at river rejuvenation to address specific challenges, there is an immediate need for a comprehensive effort towards holistic planning and management of the river systems within the city.

It is a great pleasure to see that the city of Chhatrapati Sambhajinagar has undertaken this initiative to prepare its Urban River Management Plan (URMP), based on the framework developed by NMCG and NIUA. It is even more commendable that this is the first time in India that any city has attempted to prepare a URMP for a seasonal river.

I appreciate the city officials for taking this progressive step. I hope this will inspire other river cities in India to manage their rivers in an environmentally, economically and socially sustainable manner.

Message from Director, National Institute of Urban Affairs



Shri. Hitesh Vaidya

There are very few reforms in the urban sector that do not involve contentious trade-offs. Maintaining healthy rivers is one of these. The investments made in improving the state of urban rivers have no negative consequences at all. It is, in other words, a win-win situation for concerned stakeholders – the people, the government, and the river itself. Every city must endeavor to have healthy rivers.

I am, therefore, very happy to see this dedicated urban river management plan for the city of Chhatrapati Sambhajinagar. I commend the Municipal Commissioner and other actors for this progressive thinking, which I am certain, will be an inspiration for other cities across the country. I look forward to seeing the plan metamorphose into reality.

Message from Municipal Commissioner & Administrator, CSMC



Sh. G. Sreekanth (IAS)

Once a lifeline of the city, the Kham and Sukhna rivers flowing through Chhatrapati Sambhajinagar, are facing the distress caused by rapid urbanisation. While the city has undertaken multiple efforts towards restoring its rivers, there is a need for multi-disciplinary thinking in reviving the water systems.

The Urban River Management Plan for Chhatrapati Sambhajinagar has been prepared with an intent to manage the rivers and other associated water systems within the city in a sustainable manner. The plan will serve as a beginning towards holistic planning for all the water resources in the city.

I express my utmost pleasure and congratulate the NIUA and NMCG team for undertaking this task.

Message from Collector and District Magistrate, CSMC



Sh. Astik Kumar Pandey (IAS)

The mission for restoration of Kham river is of utmost priority for Chhatrapati Sambhajinagar. We are happy to extend these efforts, towards a holistic planning and management of the rivers and their associated ecosystems in the city.

I believe that the set of actionable interventions identified under the Urban River Management Plan, will help in restoring the health of these ecosystems, enhance the community's connect with these water features and strengthen the economic potential of these resources.

I am glad to be a part of this journey and would like to congratulate all the officials who were involved with the preparation of this plan.

Message from former Municipal Commissioner & Administrator, CSMC



Dr. Abhijeet Chaudhari (IAS)

The city of Chhatrapati Sambhajinagar has a strong connection with water resources, be it the ancient Nehar systems or the two seasonal rivers, Kham and Sukhna, which are lifelines of the city.

It is truly a matter of pride for the city to prepare the country's first Urban River Management Plan (URMP) for management of seasonal rivers. We see this plan as a dedicated attempt to improve the health of all the water resources in the city.

On behalf of the Chhatrapati Sambhajinagar Municipal Corporation, I am thankful to team NIUA and NMCG for taking up this initiative. I believe that URMP is a living document and it requires constant upgradation. The city administration intends to make all possible attempts to implement the interventions recommended in this plan.



CONTENTS

FOREWORD

EXECUTIVE SUMMARY

1. BACKGROUND AND CONTEXT 1

2. URMP BASELINE 11

3. PROPOSED INTERVENTIONS 60

List of Figures

Figure 1 Framework for preparing an Urban River Management Plan
Figure 2 Vision of URMP
Figure 3 Ten Objectives of the URMP
Figure 4 Process for preparation of URMP Chhatrapati Sambhajinagar
Figure 5 Inception meeting of the URMP working group
Figure 6 Site visits along the Kham and Sukhna rivers
Figure 7 Neher-e-Ambri
Figure 8 Historical Nahar systems of Chhatrapati Sambhajinagar (Source: Academic work)
Figure 9 Nehar-e-Panchakki
Figure 10 Existing and proposed land use as per Draft Development Plan of the city
Figure 11 Water quality at different stretches of Kham river (Source: Kham DPR, July 2022)
Figure 12 Details of Industrial Clusters (Source : MPCB, 2013-14)
Figure 13 Details of waste along Kham river (Source : Kham DPR, July 2022)
Figure 14 Biodiversity in Salim Ali
Figure 15 Details of STPs in the city
Figure 16 Existing eco-park along Kham river
Figure 17 Community engagement in Kham river cleaning and planting drives
Figure 18 URMP Monitoring and Evaluation to assess the current situation
Figure 19 Delineating of Red and Blue flood lines along Kham river, on the land use plan
Figure 20 Schematic showing the RENEU technology developed by CSIR-NEERI
Figure 21 Treatment of a stretch of Siddharth Garden Nala using RENEU technology
Figure 22 Before and after in-situ drain treatment
Figure 23 Process for implementation of TADOX at common ETP scale
Figure 24 Case example - 10 KLD TADOX plant at TERI Gram, Gurugram
Figure 25 Case example - Mechanised Dhobi Ghat in Delhi
Figure 26 Proposed location of real-time water quality monitoring stations
Figure 27 Parameters measured by real-time water quality monitoring stations
Figure 28 Process of operation of a 'Waste ATM'
Figure 29 'Waste ATM' installed at a public location
Figure 30 'Community Green Stations' for Solid Waste Management
Figure 31 Installations using waste, to prevent solid waste dumping
Figure 32 Contents in an ideal water body database
Figure 33 Parameters and indicators of the 'Urban Water Body Diagnostic Tool'
Figure 34 Score card on diagnosis of Kamal Talao
Figure 35 Interpretation Chart for the 'Urban Water Body Diagnostic Tool'
Figure 36 Conceptual references for elements in rejuvenation of Kamal Talao
Figure 37 Schematic diagram showing rejuvenation of Kamal Talao
Figure 38 Schematic diagram showing Telemetry system for groundwater monitoring
Figure 39 Proposed riparian stretches along Kham and Sukhna rivers
Figure 40 Type of species suitable for riparian zone
Figure 41 Type of species that should be avoided

Figure 42 Treatment of riparian edge
Figure 43 Potential for reuse of treated waste water from each STP
Figure 44 Business Models and Economic Approaches Supporting Water Reuse, IWMI
Figure 45 Location of proposed interventions for Eco- Heritage walk along Kham River
Figure 46 Conceptual plan for eco-heritage walk along Kham river
Figure 47 Conceptual plan for eco-heritage walk along Kham river
Figure 48 Urban eco-geo heritage potential along the Kham river
Figure 49 Potential recreational spaces along the Sukhna river
Figure 50 Adding new features to the existing 'Smart Nagrik Aurangabad (AMC)'

List of Maps

Map: 1 - Contextual Setting of Chhatrapati Sambhajinagar City
Map: 2 - 3-D Elevation of Chhatrapati Sambhajinagar City
Map: 3 - Godavari Basin Map
Map: 4 - Water Features of Chhatrapati Sambhajinagar
Map: 5 - Land Use Plan 2001
Map: 6 - Existing Land Use Plan (2016)
Map: 7 - Draft Development Plan of Chhatrapati Sambhajinagar , Additional area (Revised)
Map: 8 - Red-line, Blue-line (Kham River)
Map: 9 - Existing Industrial areas in Chhatrapati Sambhajinagar
Map: 10 - Waterbodies in Chhatrapati Sambhajinagar
Map: 11 - Existing Riparian Buffer - Kham and Sukhna River
Map: 12 - Existing Water Supply (AMC)
Map: 13 - Existing Sewage Network (AMC)
Map: 14 - Open wells and borewells mapped by AMC
Map: 15 - Proposed riparian buffer along Kham and Sukhna River
Map: 16 - Potential reuse of treated wastewater in 3 Km radius

Acronyms

CSMC	Chhatrapati Sambhajinagar Municipal Corporation
SCSCDCL	Chhatrapati Sambhajinagar Smart Cities Development Corporation Ltd.
M&E	Monitoring and Evaluation
URMP	Urban River Management Plan
URMindex	Urban River Management Index
CPCB	Central Pollution Control Board
OSS	On-site Sanitation Systems
MLD	Million Litres Per Day
STP	Sewage Treatment Plant
FSTP	Fecal Sludge Treatment Plant
DO	Dissolved Oxygen
IEC	Information, Education and Communication
NMCG	National Mission for Clean Ganga
NIUA	National Institute of Urban Affairs



FOREWORD



Satara Hills, Chhatrapati Sambhajinagar

As cities start to implement the river-sensitive development agenda, there is a unique opportunity for them to learn from each other, while at the same time inspire others to take up progressive action on this front. The River Cities Alliance (RCA), conceptualised by the National Institute of Urban Affairs (NIUA), Ministry of Housing and Urban Affairs, GoI and the National Mission for Clean Ganga (NMCG), Ministry of Jal Shakti, GoI, is intended to serve as an avenue precisely for this purpose.

The core objective of RCA is to provide the member cities with a platform to discuss and exchange information on aspects that are vital for sustainable management of urban rivers. At present, there are around 115 member cities across India, which are a part of this alliance.

Chhatrapati Sambhajinagar is one of the member cities of the River Cities Alliance. Under the activities of RCA, the National Institute of Urban Affairs is supporting the Chhatrapati Sambhajinagar Municipal Corporation (AMC) to prepare an 'Urban River Management Plan (URMP)' for the city. The URMP Chhatrapati Sambhajinagar is a comprehensive effort towards holistic planning and management of all the water resources within the city. It will focus on restoration of the Kham and Sukhna rivers, rejuvenation of the water bodies and revival of the lost water heritage structures, for ensuring water sensitive development in the city.

The URMP Chhatrapati Sambhajinagar is unique on several counts.

- It is one of the first URMPs being prepared for a city outside the Ganga basin.
- It is intended to address specific challenges associated with seasonal rivers. Kham and Sukhna, being seasonal rain-fed rivers, can play a very important role in the water-scarce, semi-arid city region of Chhatrapati Sambhajinagar .
- It is being designed to complement and synergise with the ongoing works within the city. Chhatrapati Sambhajinagar is in the process of preparing its Climate Action Plan. Various other initiatives are being undertaken by the city to restore its heritage water systems, management of underground aquifers and strengthening of the water supply systems. All these plans and initiatives are also feeding directly into the URMP.
- It is based on inter-coordination between multiple agencies working in the city. Cross sectoral and inter departmental meetings hosted by the Chhatrapati Sambhajinagar Municipal Corporation and the Chhatrapati Sambhajinagar Smart Cities Development Corporation Limited facilitate in building a shared understanding of the city's baseline.
- It is the first URMP to engage academia in the actual process of plan preparation. Students of MGM's Jawaharlal Nehru Engineering College, Chhatrapati Sambhajinagar , were involved in site surveys, baseline preparation, analysis and recommendation of specific projects for rejuvenation of the Sukhna river. Some of these proposed projects were instrumental in informing the URMP proposed interventions.
- It is being prepared with the support of a local partner engaged with the Chhatrapati Sambhajinagar Municipal Corporation, thereby harnessing the knowledge and experience of a local agency. EcoSattva Environmental Solutions Pvt. Ltd. supported in conducting the site surveys and analysis to capture the site-specific nuances efficiently.

EXECUTIVE SUMMARY



Kham River, Chhatrapati Sambhajinagar

A river and a city have a symbiotic relationship. While on one hand cities have largely been responsible for the deterioration of their river ecosystems, they also have a central role to play in its rejuvenation.

The purpose of the Urban River Management Plan (URMP) Chhatrapati Sambhajinagar is to develop a dedicated strategy for managing the Kham and Sukhna rivers that flow through the city, and their associated elements, in an efficient and sustainable manner. The document is based on 'A Strategic Framework for Managing Urban River Stretches: URBAN RIVER MANAGEMENT PLAN' developed by the National Institute of Urban Affairs (NIUA), in association with the National Mission for Clean Ganga (NMCG).

URMP Chhatrapati Sambhajinagar proposes a set of 21 tangible and practical actions for managing the city's water features, under the ten-point URMP agenda. While some of these interventions are planning oriented and conceptual, others are projects that can be directly implemented on ground. Most of these projects are influenced by successful ongoing experiences from other cities. Detailed Project Reports (DPRs) need to be prepared for each intervention, based on the concept ideas proposed in the document.

This version of the URMP (Version 1.0) for Chhatrapati Sambhajinagar city targets actions over a 3 year period. Each of the proposed interventions has a defined time-frame, viz, short/ medium/ or long term intervention. However, the URMP document is a living document for the city, which will address issues related to river management on continuous basis in subsequent versions.

PROPOSED INTERVENTIONS



Intervention 1
Strengthening planning provisions in the revised City Development Plan

Intervention 2
Implement NEERI's RENEU at Siddharth Garden Drain

Intervention 3
Treating industrial pollution using TADOX technology

Intervention 4
Treatment of waste water discharge from informal activities (dhobi ghats)



Intervention 5
Real-time water quality monitoring stations (RTWQMS)

Intervention 6
Waste ATMs/ Community Green Stations for Solid Waste Management

Intervention 7
Installations to prevent Solid Waste along rivers

Intervention 8
Link the existing solid waste fine collection and recording with a Mobile Application

Intervention 9
Develop a comprehensive GIS-based database for the water bodies in the city



Intervention 10
Regular assessment of all water bodies using 'Urban Water Body Diagnostic Tool'

Intervention 11
Rejuvenation of Kamal Talao Lake

Intervention 12
City-level aquifer mapping

Intervention 13
Develop riparian (plantation) stretches along the Kham and Sukhna rivers



Intervention 14
Reuse of treated wastewater within 3 km buffer zone of all STPs



Intervention 15
Economic models for reuse of treated wastewater

Intervention 16
Eco-heritage walk along Kham River



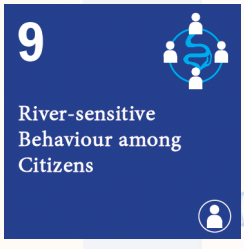
Intervention 17
Eco-heritage walk along Kham river (connecting Bibi-ka-Maqbara & Himayat Bagh)



Intervention 18
Urban eco-geoheritage potential along Kham river

Intervention 19
Concept for an Industrial recreational space along Sukhna river

Intervention 20
Enhance the existing river-based sensitization programme



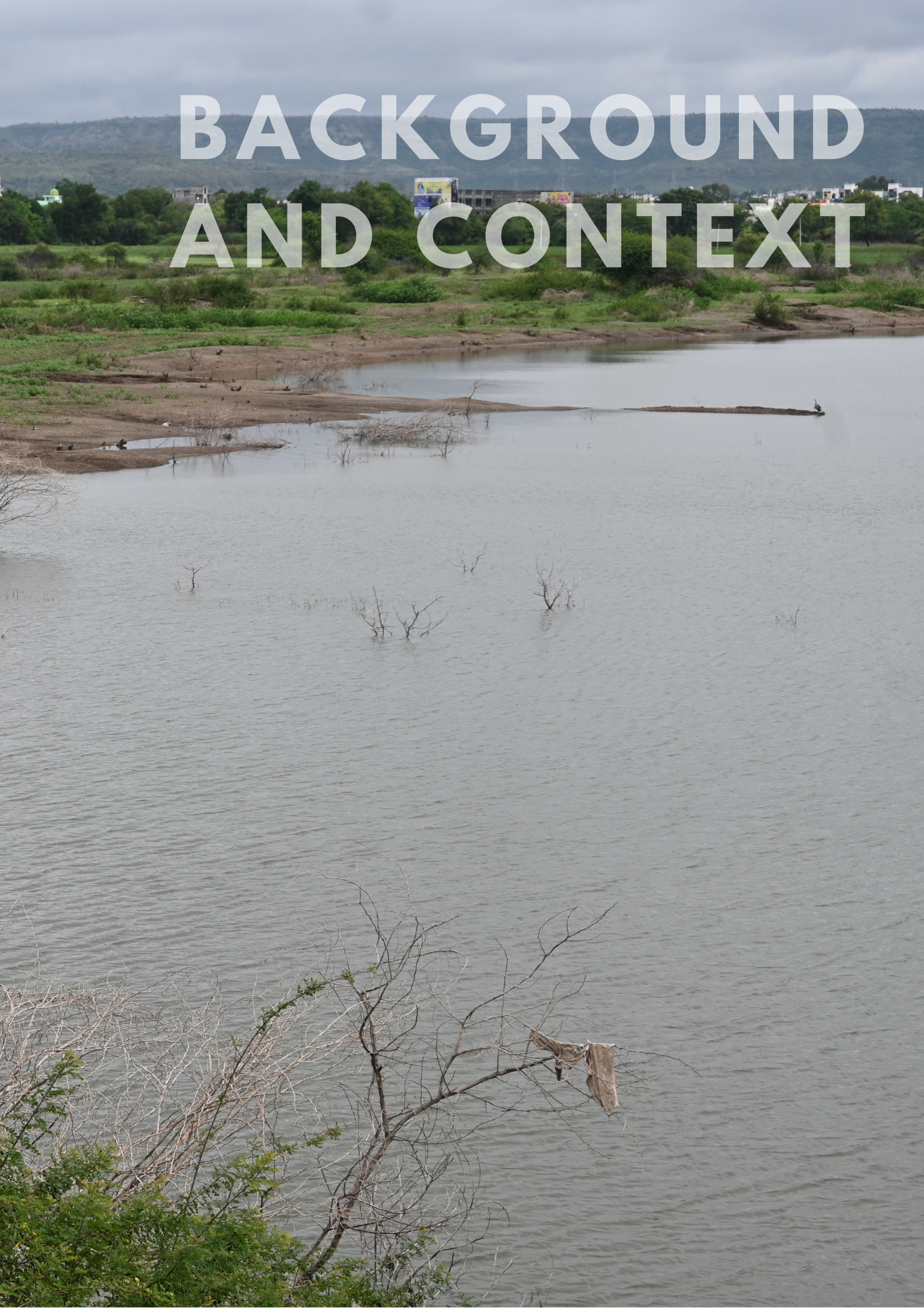
Intervention 21
Add new features to the existing 'Smart Nagrik Chhatrapati Sambhajinagar (AMC)' mobile application



CHHATRAPATI SAMBHAJINAGAR


01

BACKGROUND AND CONTEXT





1. BACKGROUND AND CONTEXT

The Urban River Management Plan (URMP) is an integrated approach to manage the river and its associated elements in a city sustainably.

The URMP framework is based on the three pillars of sustainable development – Environment, Economic and Social. Hence, it is envisaged that the activities carried out under the URMP will be:

- *Environmentally responsible*
- *Economically beneficial*
- *Socially inclusive*

1.1. Structure of the URMP Chhatrapati Sambhajinagar

The Urban River Management Plan (URMP) for Chhatrapati Sambhajinagar has been prepared with an intent to manage the Kham and Sukhna rivers and the other associated water systems within the city, in a sustainable manner. Following framework (figure 1), prepared by the National Institute of Urban Affairs (NIUA) and the National Mission for Clean Ganga (NMCG), has been followed for preparing the URMP Chhatrapati Sambhajinagar .

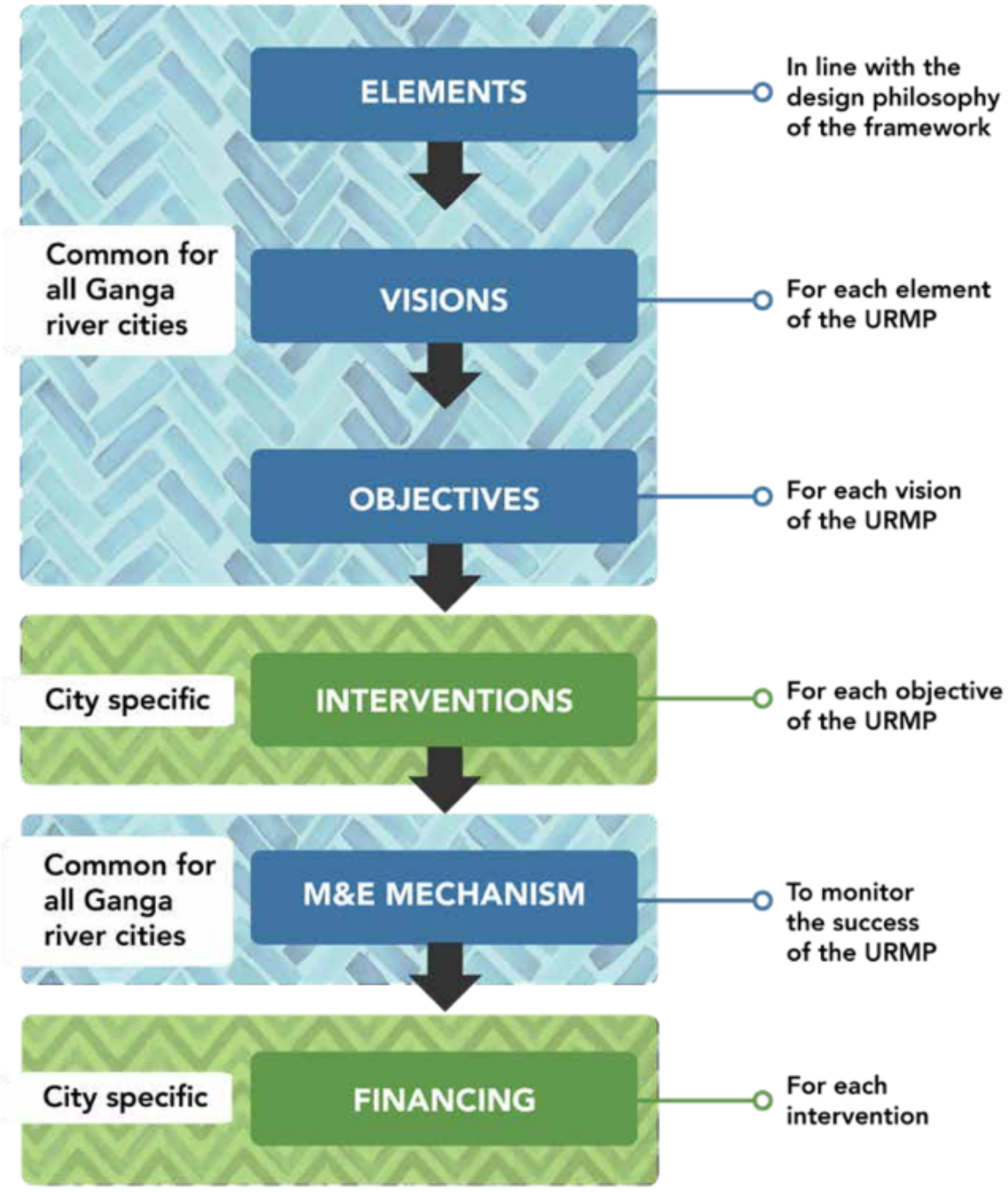


Figure 1: Framework for preparing an Urban River Management Plan;
Source: URMP Framework

The Plan is based on the three pillars of sustainable development, i.e. environment, economy and social. Each of these three elements corresponds with a vision statement (figure 2), which represent the envisaged outcomes of the plan in the long term.

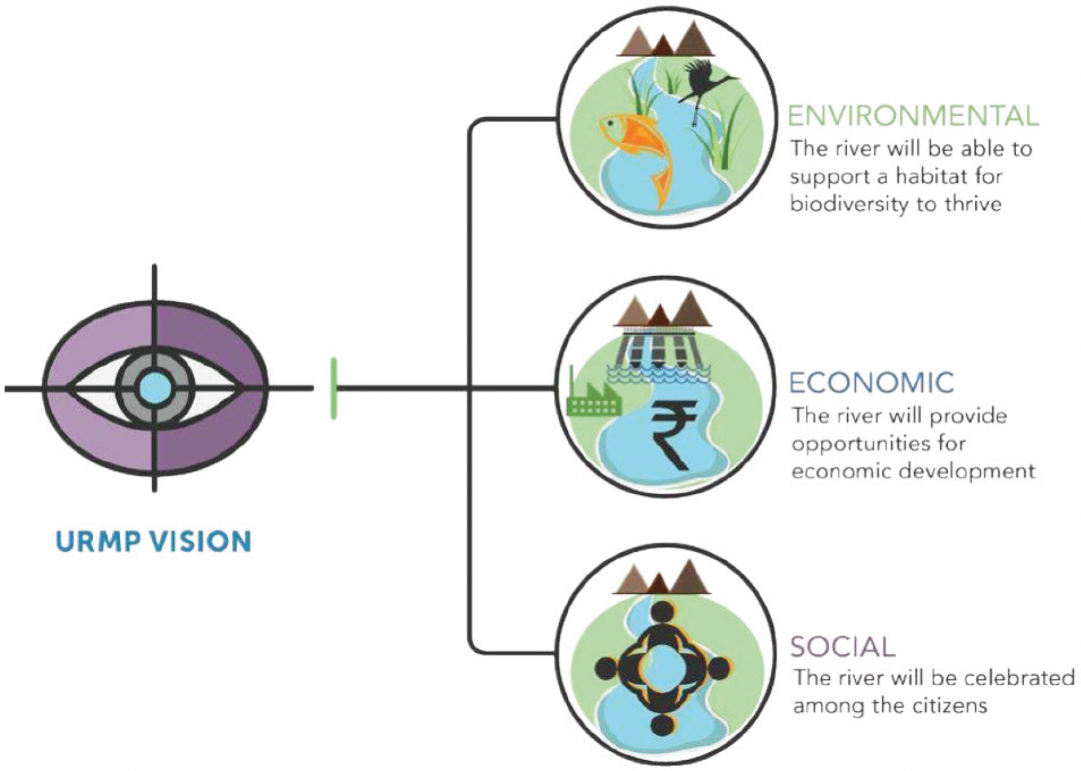


Figure 2: Vision of URMP; Source: URMP Framework

The URMP's vision shall be achieved through a set of ten objectives (figure 3), six of which are environmental, and two each for the economic and social visions. Each objective is unique and addresses a niche aspect of urban river management.



Figure 3: Ten Objectives of the URMP; Source: URMP Framework

In order to address each objective, specific interventions are identified based on the city's needs. These are a mix of on-ground projects and planning/ regulatory actions.

A clear stream of financing is also identified for each project-based intervention. These sources may include municipal funding, funding from urban missions, crowd-funding or funding from other sources.

Finally, the Plan establishes ten performance indicators, corresponding to the ten objectives. This Monitoring and Evaluation structure is used to measure the outcomes as a result of implementation of the Plan.

It is important to note that the URMP is a living document that shall evolve over time as more knowledge and resources become available. This version of the URMP (Version 1.0) targets only interventions that shall be implemented within 3 years. The URMP also indicates a phase-wise (short term, medium term, long term) implementation plan for these interventions.

1.2. Process for preparation of the URMP Chhatrapati Sambhajinagar

The following process has been followed for preparation of the URMP Chhatrapati Sambhajinagar
(figure 4).

- Step 1 - Identifying a nodal agency to anchor the preparation of the URMP and setting up a core working group of relevant stakeholders from different organisations
- Step 2 - Conducting a thorough baseline assessment of the relevant parameters in order to depict the current status
- Step 3 - Organizing stakeholder workshops for developing shared understanding of the URMP objectives and expected outcomes
- Step 4 - Identifying tangible interventions for each objective of the URMP framework
- Step 5 - Preparation of an action plan for prioritised implementation of the interventions, and linking each intervention to probable financing options

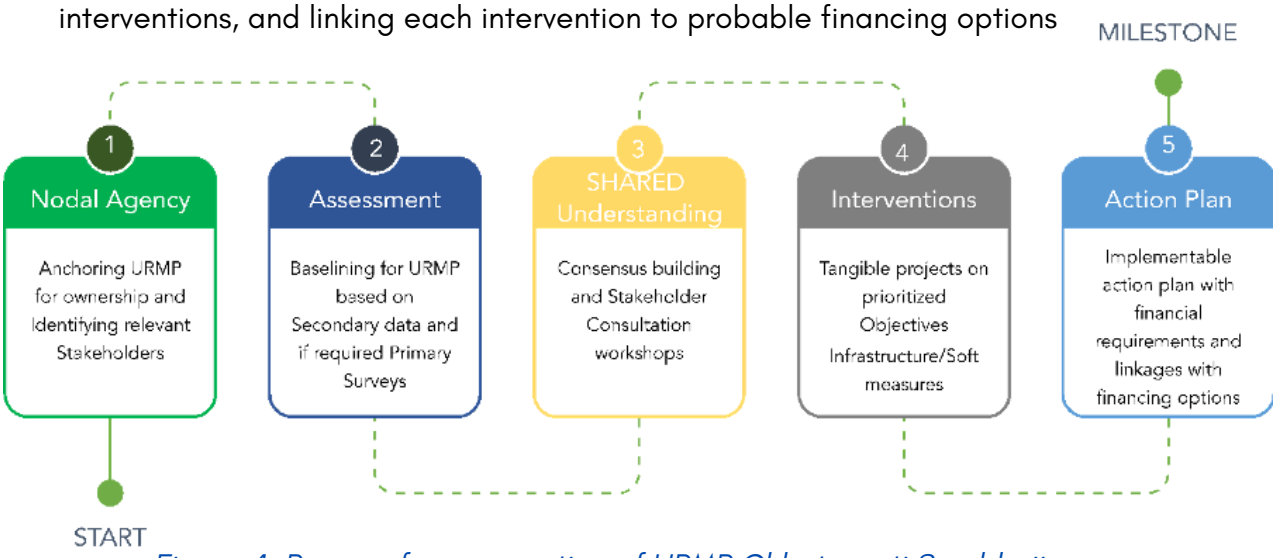


Figure 4: Process for preparation of URMP Chhatrapati Sambhajinagar

The preparation of URMP Chhatrapati Sambhajinagar was led by Chhatrapati Sambhajinagar Municipal Corporation and Chhatrapati Sambhajinagar Smart Cities Development Corporation Ltd., with adequate support from other relevant agencies in the city. NIUA and NMCG served as knowledge partners throughout the process of preparation of the plan. EcoSattva Environmental Solution Pvt. Ltd. acted as the local partner agency for preparation of the plan.

In order to facilitate the preparation of this plan in consultation with city stakeholders, a URMP working group was formed comprising of representatives from the Chhatrapati Sambhajinagar Municipal Corporation, the Chhatrapati Sambhajinagar Smart Cities Development Corporation, and their associated line departments.

As a first step, an in-person inception meeting of the working group was conducted on 6th July 2022, at the Chhatrapati Sambhajinagar Smart Cities Development Corporation (figure 5). At this meeting, chaired by the Hon'ble Municipal Commissioner of Chhatrapati Sambhajinagar , the city's river-related challenges were identified. The members of the working group were introduced to the concept of urban river management. A brief of the URMP framework as well as glimpses of experiences from the preparation of URMP Kanpur were also presented. The members of the working group shared insights of the ongoing works related to river management in the city. They also expressed their support and reflected on the model for adoption of the URMP framework in Chhatrapati Sambhajinagar .



Figure 5: Inception meeting of the URMP working group

Subsequently, multiple site visits and individual meetings with various city officials were conducted, to assess the onground situation and proposed plans for river management in the city. Site surveys and assessments, along the Kham, Sukhna, and other water bodies in particular, uncovered specific challenges faced by these water resources (figure 6).

Following are the key challenges associated with the rivers and associated systems in Aurangabad:

- Low seasonal flow in the Kham and Sukhna rivers
- Informal construction within the river floodplains
- Dumping of solid waste on the river banks
- Discharge of untreated waste water
- Lack of citizen connect with the Sukhna river
- Decreasing ground water levels
- Lost water heritage structures, like the historical Neher systems of the city



Figure 6: Site visits along the Kham and Sukhna rivers

1.3. URMP Working Group

The URMP Working Group for Chhatrapati Sambhajinagar comprised relevant government and non-government stakeholders, involved with the management of river-related elements in the city. The group was led by Hon'ble Municipal Commissioner, and supported by two Nodal Officers from Chhatrapati Sambhajinagar Municipal Corporation (CSMC) and Chhatrapati Sambhajinagar Smart Cities Development Corporation (CSSCDCL).

In addition to officials from the AMC and the ASCDCL, this group also included representatives from other city departments like Cantonment Board, Soil and Water Conservation, Waqf Board; relevant state authorities including Conservator of Forests, Archaeological Survey of India, Groundwater Surveys and Development Agency, Maharashtra Jeevan Pradhikaran, State Archaeology, Maharashtra Pollution Control Board, Maharashtra Industrial Development Corporation, Groundwater Surveys and Development Agency; universities and academic institutions like Dr. Babasaheb Ambedkar Marathwada University, Jawaharlal Nehru Engineering College, MIT College, PES College of Engineering; representatives from Confederation of Indian Industry and industrial groups like Varroc; and local NGOs like Aurangabad First and EcoSattva Environmental Solutions Pvt. Ltd. Details of the members of the working group are placed in Annex 1.

The purpose of the working group was to create a dedicated platform for these officials to brainstorm on various aspects of urban river management. This group supported the preparation of the URMP at all stages, which primarily involved conducting a baseline assessment and identifying relevant project interventions for the URMP.

The primary responsibilities of the working group were:

1. Support the preparation of a URMP Baseline, by sharing reports and necessary information related to the URMP from various agencies.
2. Organize stakeholder consultations with support from the NIUA team.
3. Help in identifying suitable interventions for the URMP, based on the baseline assessment and stakeholder consultations.



02



URMP BASELINE





2. URMP BASELINE

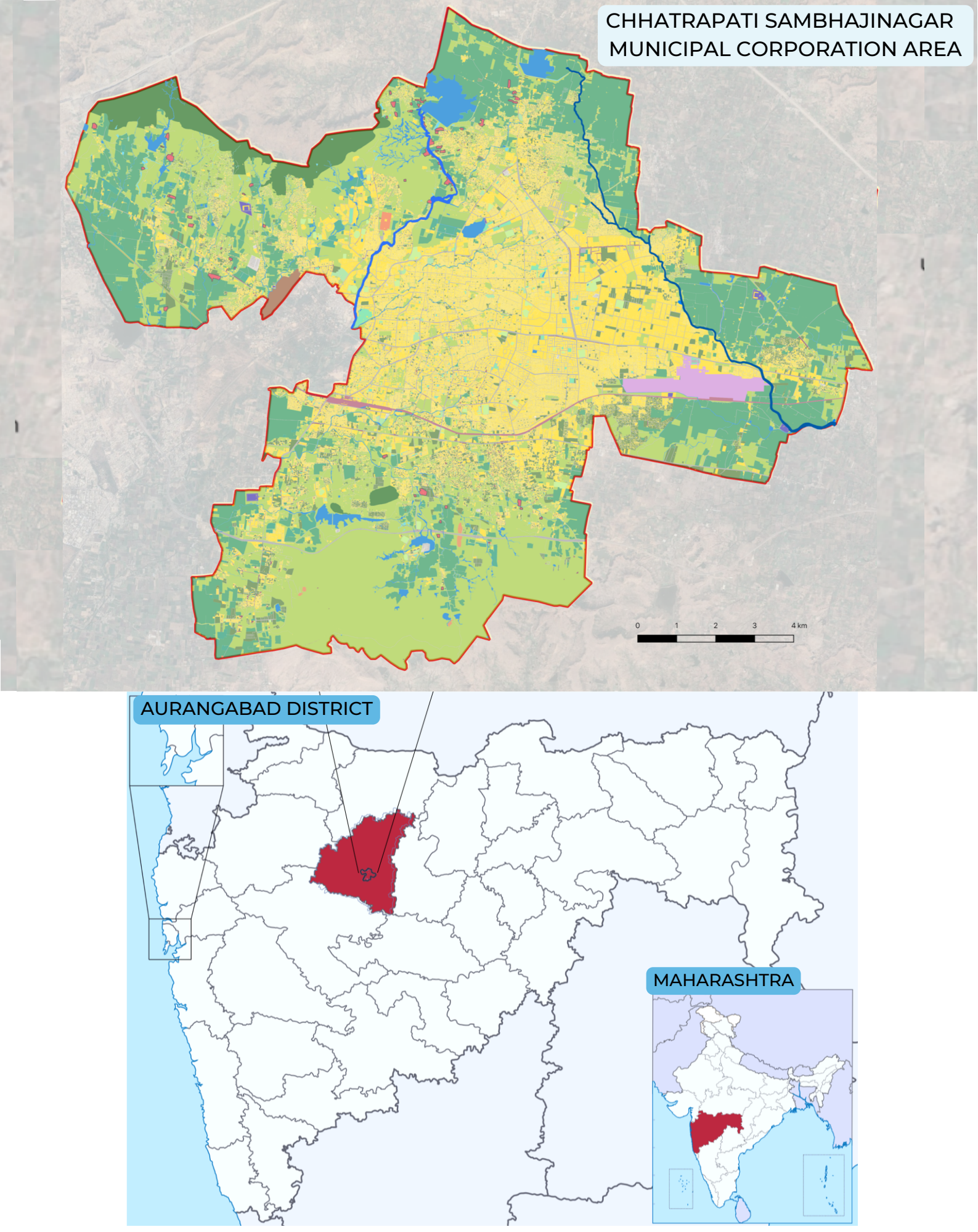
2.1. City Profile

Chhatrapati Sambhajinagar (formally Aurangabad) is a city located in the Indian state of Maharashtra. (map 1) Strategically located on a hilly upland terrain in the Deccan plateau, the city stands in the Dudhana valley, between the Lakenvara range on the north and the Satara hills on the south.

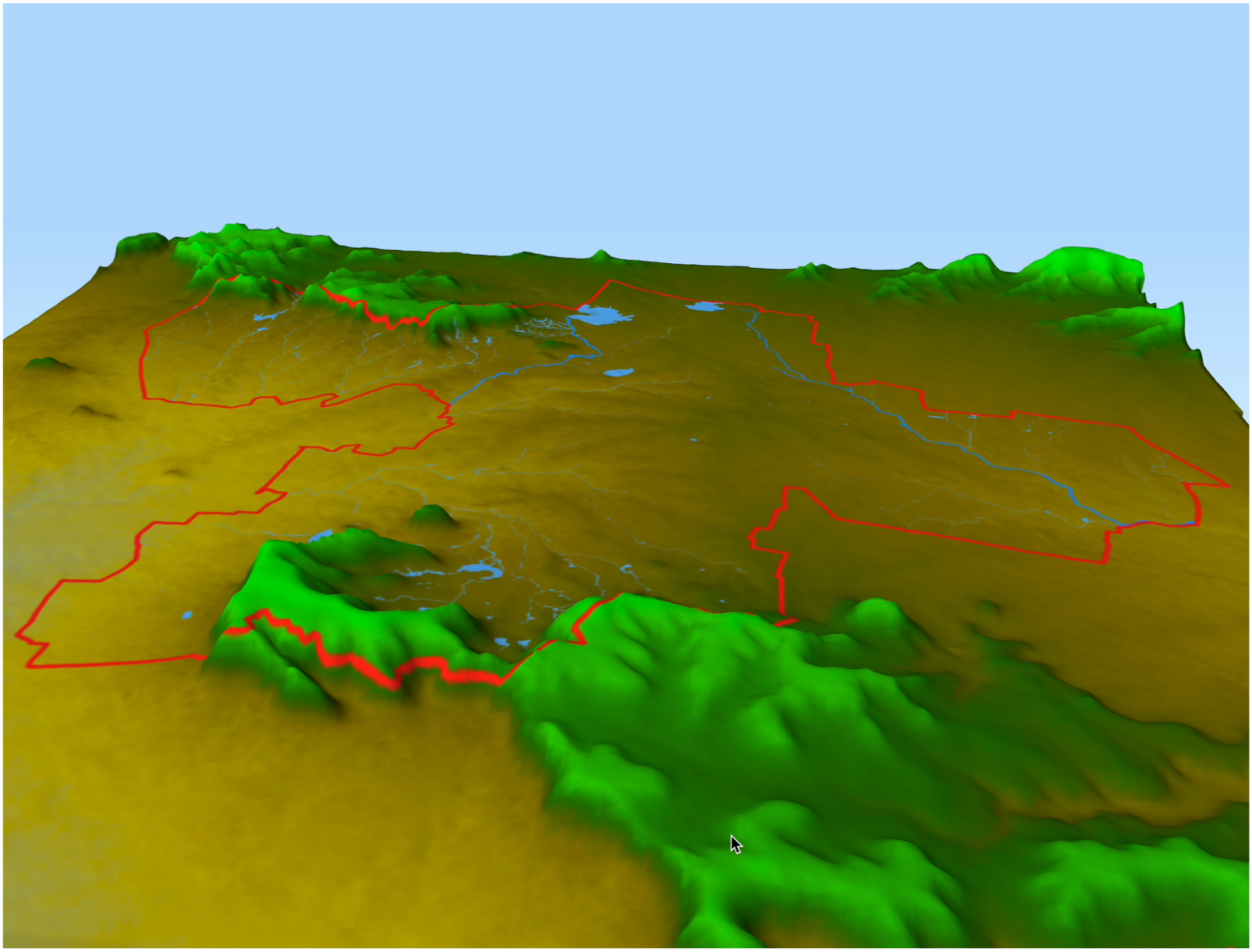
It is the administrative headquarters of Aurangabad district and is the largest city in the Marathwada region. The Chhatrapati Sambhajinagar Municipal Corporation has an approximate area of 179 sq km, divided into 9 zones and 119 wards. By population, it is the fifth largest city in Maharashtra, with a population of 11,75,116, as per provisional reports of Census India, 2011. The current estimated population of the city in 2023 is around 1,619,000. The city has been growing rapidly, in terms of its potential as an industrial, educational and tourism center.

Located mainly in the Godavari River Basin, the city is situated on the bank of Kham River, a tributary of the Godavari river.The city fetches water from Jayakwadi Dam (60 km downstream) and Harsul tank, for drinking and domestic purposes. In addition, a huge number of bore wells are excavated to cover-up the gap in water supply. As a result, the groundwater levels within the city are depleting. There are about 56 dug wells and 1300 bore wells in the city mapped by the Chhatrapati Sambhajinagar Municipal Corporation. (map 14)

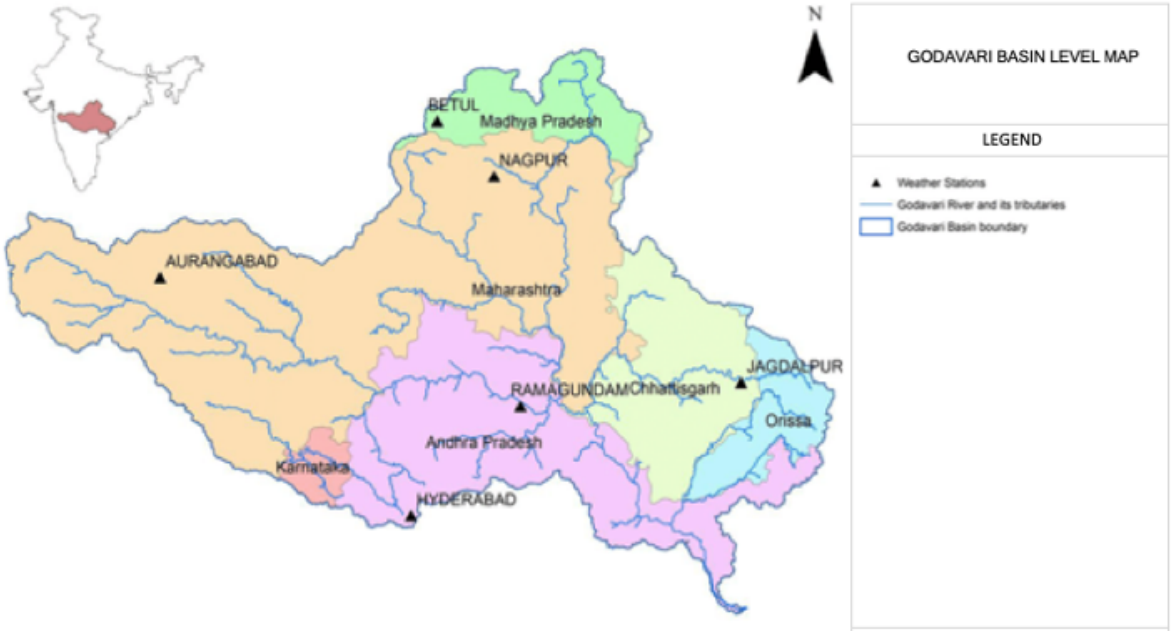
Historically, Chhatrapati Sambhajinagar is known as 'The City of Gates', with 52 gates spread across the city. It was founded in 1610 by Malik Amber. The city is also widely recognised as a tourism hub, surrounded by historical UNESCO World Heritage Sites like the Ajanta and Ellora Caves, and the Daulatabad Fort. The city features unique structures like the Aurangabad Caves, 17th-century marvel Bibi ka Maqbara, Panchakki, Shivaji Maharaj Museum.



Map: 1 - Contextual Setting of Chhatrapati Sambhajinagar City



Map: 2 - 3-D Elevation of Chhatrapati Sambhajinagar City



Map: 3 - Godavari Basin Map

The city is characterised by a hot and dry climate, with a normal average rainfall of about 72.50 cm. Most of the annual rainfall is generally during June to September, with heaviest downpour during the month of July. The annual rainfall varies significantly every year. Winter season lasts from mid-November to the end of January, followed by a dry hot summer from February to mid-June.

The geological formations of the city are characterised by the Deccan traps. The granitic rocks have given rise to red as well as black cotton soils. Major part of the city has deep black soil derived from the trap rock. Most of the hill tops are bare or covered by coarse gravel, while the low lying areas accumulate clay and loam. The area has two major types of rocks - Compact basalt and Amygdaloidal basalt, with amygdaloidal basalt being the dominating one.

2.2. Key Water Features

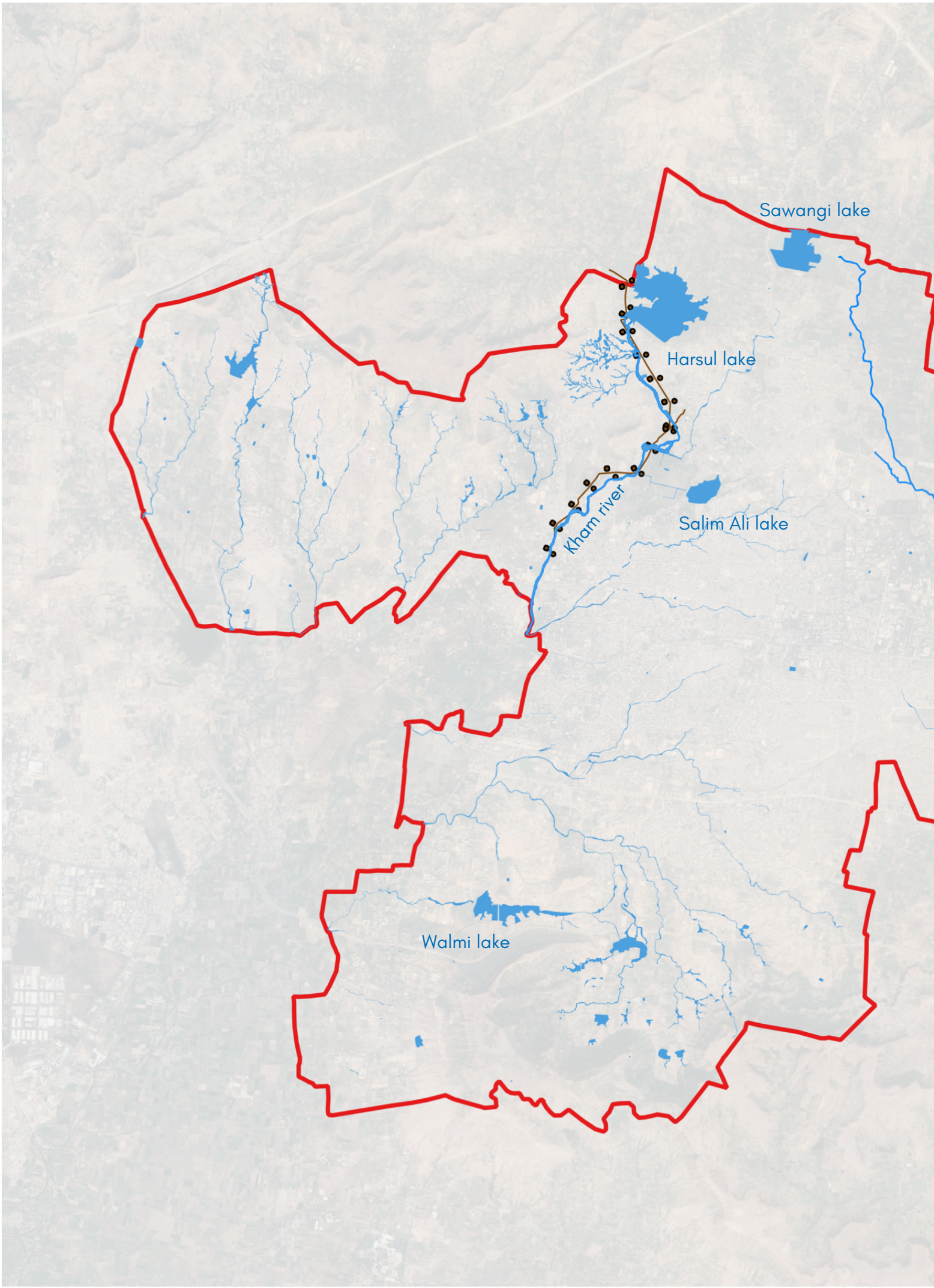
The city has a number of notable water features, shown in map 4.

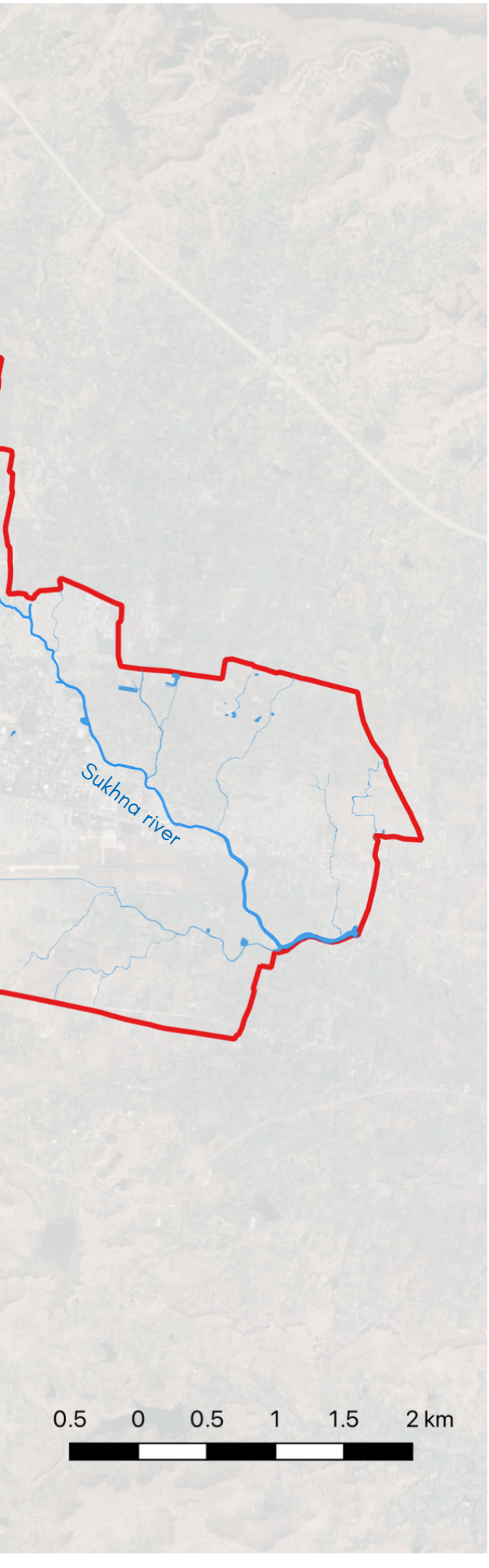
The **Kham River** is a tributary of the Godavari River. Originating in the Jatwada hills near the city, wherein the rain water is collected in the Harsul dam, the river traverses approx. 65 kms before it meets the Nathsagar water body near the Nadikathche Gaon. Being the first upstream urban area in the path of the river, the city of Chhatrapati Sambhajinagar has an important role in preserving the health and character of the river. The river has a length of approx. 14.73 km within the city.

Kham is a seasonal river, with an almost stagnant flow of 38-40 MLD in non-monsoon seasons, and 120-200 MLD flow in the monsoon months. The river gets most of its water from the natural catchment in the northern stretch, 7 major and 27 minor drains flowing into the river, untapped sewage, treated waste water and fresh water from the natural springs. Decreasing flow, poor water quality, indiscriminate encroachment and dumping of solid waste are the major challenges faced by this important resource for the city.

The **Sukhna River** is one of the main tributaries of Dudhana river, which originates from the Kolthan Hills near Kankura village and flows about 25 km before meeting the Dudhana river at Saigaon. Within the city of Chhatrapati Sambhajinagar , the river is surrounded by a number of industrial areas and agricultural pockets along its entire stretch. Hence, it has a huge potential for protection and restoration initiatives.

Chhatrapati Sambhajinagar is famous for its water heritage systems. The **Nahar-e-Ambari** (figure 7) is a unique water supply system constructed for public utility, by Malik Ambar in 1618 AD. This underground water channel/ tunnel system utilized subterranean water table of the mountainous elevated valleys, to guide the natural gravitational flow of water towards the town. Presently due to blocked or damaged arteries and underground channels, only a small portion of the intricate network is barely functioning and supplying water to the old city.


Sawangi lake
Harsul lake
Kham river
Salim Ali lake
Walmi lake



AURANGABAD MUNICIPAL CORPORATION

National Institute of Urban Affairs

WATER & ENVIRONMENT VERTICAL

WATER FEATURES OF CHHATRAPATI SAMBHAJINAGAR

LEGEND

- Water _Bodies
- nehar _e_panchakki
- AMC_Boundary

Source: Aurangabad Municipal Corporation

Map: 4 - Water Features of Chhatrapati Sambhajinagar



Figure 7: Neher-e-Ambri (Source: INTACH)

Located on the banks of Kham river, the **Nahar-e-Panchakki** (figure 9) is another unique water heritage structure at the heart of the city. Built by Hazrat Baba Shah Musafir in 1734, Panchakki is an old watermill from the seventeenth century, which was used to grind grains for pilgrims. Its elaborate underground channel was ingeniously designed to use the energy generated from flowing water from the nearby springs to turn the large grinding stones of the flour mill. Till date, water is carried by clay pipes from the source, which is about six kilometers north of the city. The water flows into a huge elevated masonry pillar from where it cascades down into the reservoir.

Chhatrapati Sambhajinagar has many more Nahar systems with historical significance, including Nahar-e-Palsi, Nahar-e-Koila, Nahar-e-Nasarullah, Nahar-e-Durga - Shab Ali Nahri, Nahar-e-Chausar, Nahar-e-Lal Mahal, Nahar-e-Darga Hazrat Shab Noor Hashmi, Nahar-e-Kiradpura, Nahar-e-Begampura, Nahar-e-Garkheda, and Nahar-e-Chhavni. (figure 8)

Besides these, the city also has a number of manmade and natural water bodies such as Kamal Talao, Salim Ali lake, Walmi lake, Sawangi lake, Harsul lake and a few others, forming a part of the larger ecosystem of the two rivers. Salim Ali lake is also an important avian biodiversity spot for the city.

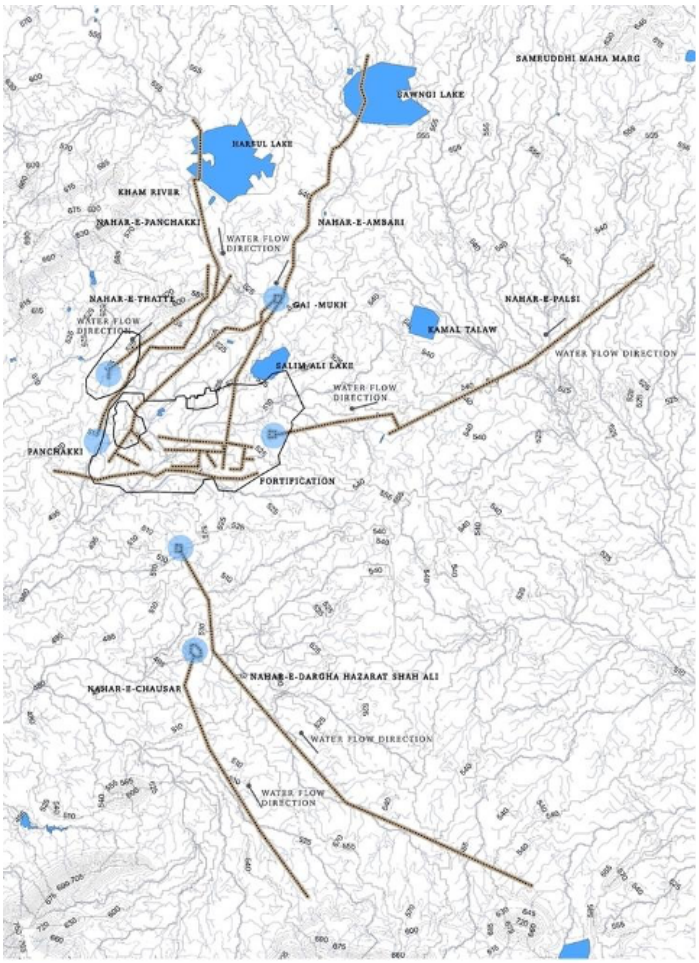


Figure 8: Historical Nahar systems of Chhatrapati Sambhajinagar (Source: Academic work)

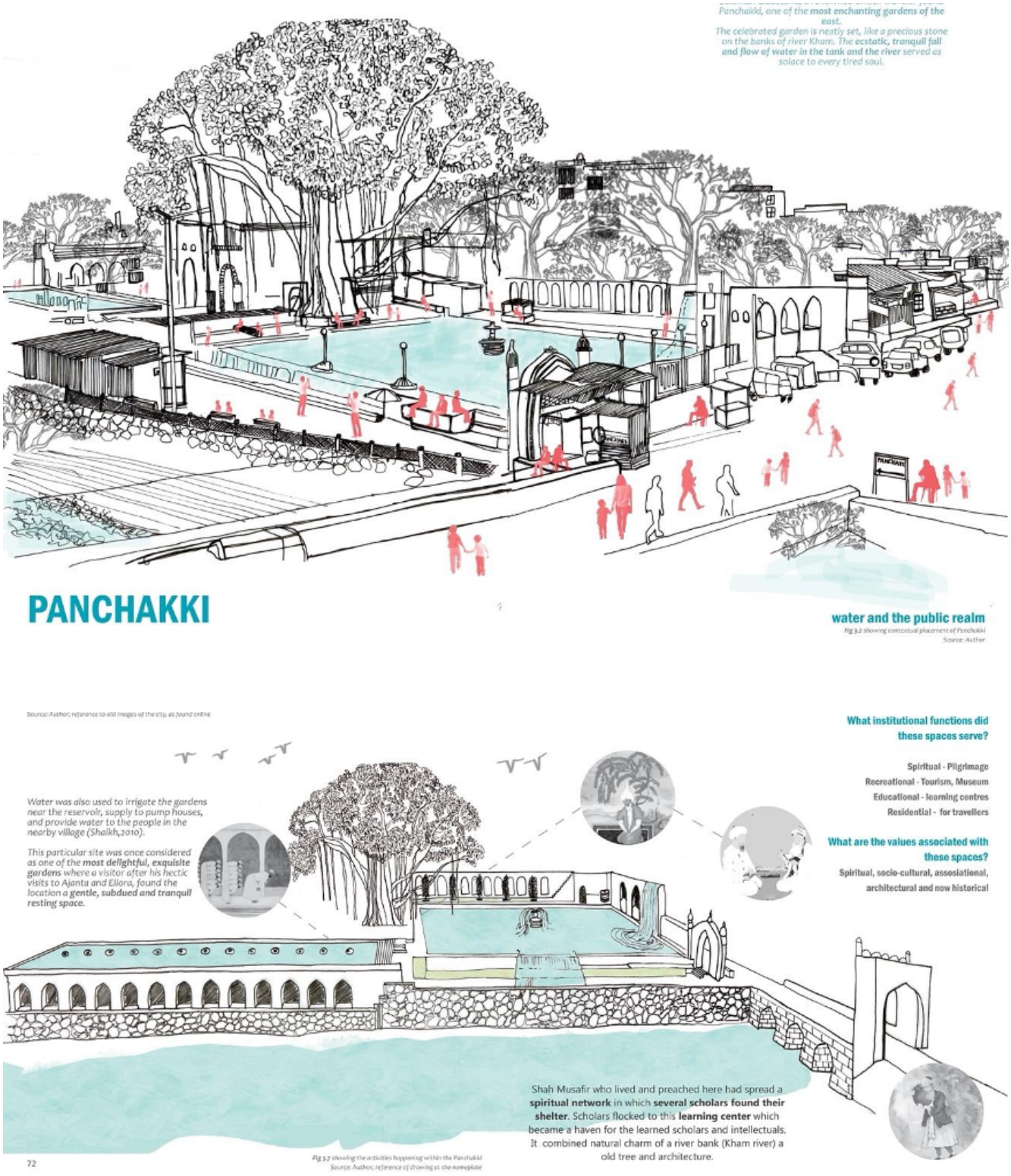


Figure 9: Nehar-e-Panchakki

(Source: Academic work by Ritika Somani, Kamla Raheja Vidyanidhi Institute for Architecture)

2.3. URMP Objective-wise Baseline

Objective 1 – To ensure effective regulation of activities in the floodplain

Rationale: A floodplain is defined as the area inundated by a flood that occurs once in a fixed number of years, typically hundred years for major rivers. The Development Plan/Master Plan of cities ideally would have some or the other regulations for land use and permissible activities in the river flood plains (if not the entire flood plain, then at least part of it). However, in several cities these areas have been encroached upon by unauthorized colonies, or used for unauthorized activities such as agriculture, sand mining, etc. Ensuring that only permitted activities and structures are allowed in the floodplains is crucial for the river's health.

Chhatrapati Sambhajinagar is developing rapidly due to availability of natural resources such as good agricultural lands in the hinterland, fast growing industrialisation, trade and commerce and convenient transportation and communication links. The economic activity of Chhatrapati Sambhajinagar is accelerating due to its location advantages and historic importance. Specifically, industrial growth has been substantial in the last two decades. Sporadic development has been coming up in municipal corporation limits.

LAND USE AND USE ZONES

The earlier Development Plan of Chhatrapati Sambhajinagar Municipal Corporation 2001 (map 5), was sanctioned in 1991 as per the provisions of Maharashtra Regional and Town Planning Act, 1966.

Thereafter, a Draft Development Plan of Chhatrapati Sambhajinagar , Additional area (Revised)+Cidco Denotified Area, 2016, was prepared for the five Planning Sectors.(map 7)

At present, the Development Plan of Chhatrapati Sambhajinagar is under revision.

A detailed analysis of the existing land use and the proposed land use as per the Draft Development Plan of Chhatrapati Sambhajinagar , shows that the total developed area is proposed to increase significantly. Large parcels of land, which are presently under agriculture, are proposed to be converted to residential landuse, especially in the area around the Sukhna river. Furthermore, the area proposed under water bodies land use is also decreasing. (figure 10)

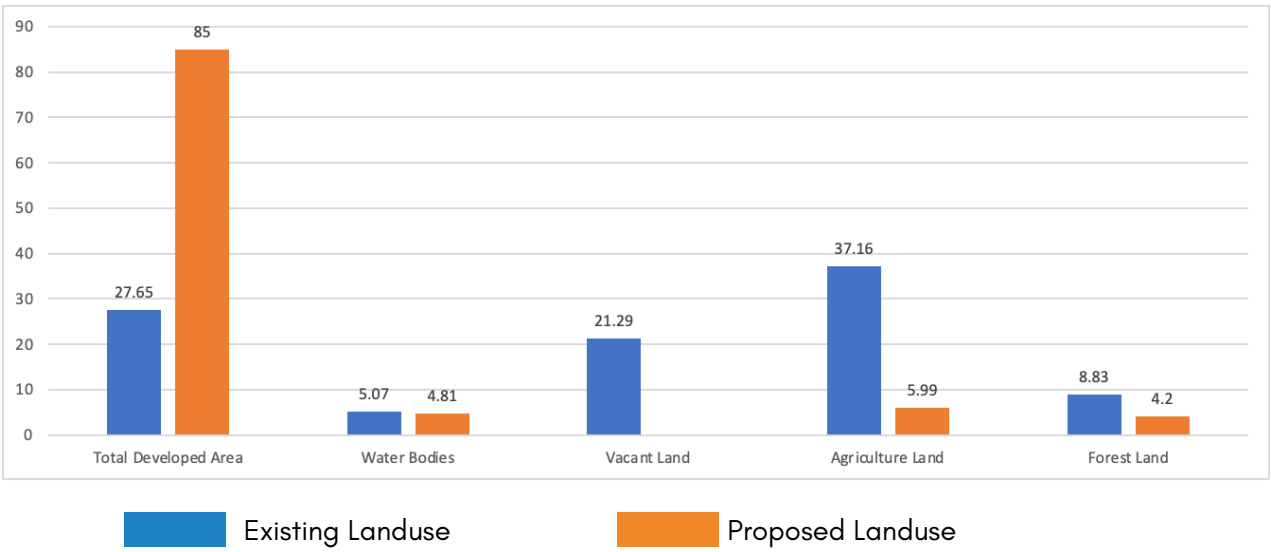


Figure 10: Existing and proposed land use as per Draft Development Plan of Chhatrapati Sambhajinagar

DEVELOPMENT CONTROL REGULATIONS

As per the Draft Development Plan of Chhatrapati Sambhajinagar , Additional area (Revised)+Cidco Denotified Area, 2016, "all the Nalas passing through Chhatrapati Sambhajinagar Additional Area have been proposed to be channelized; this will improve the hygienic and environmental consideration of the Chhatrapati Sambhajinagar Additional Area".

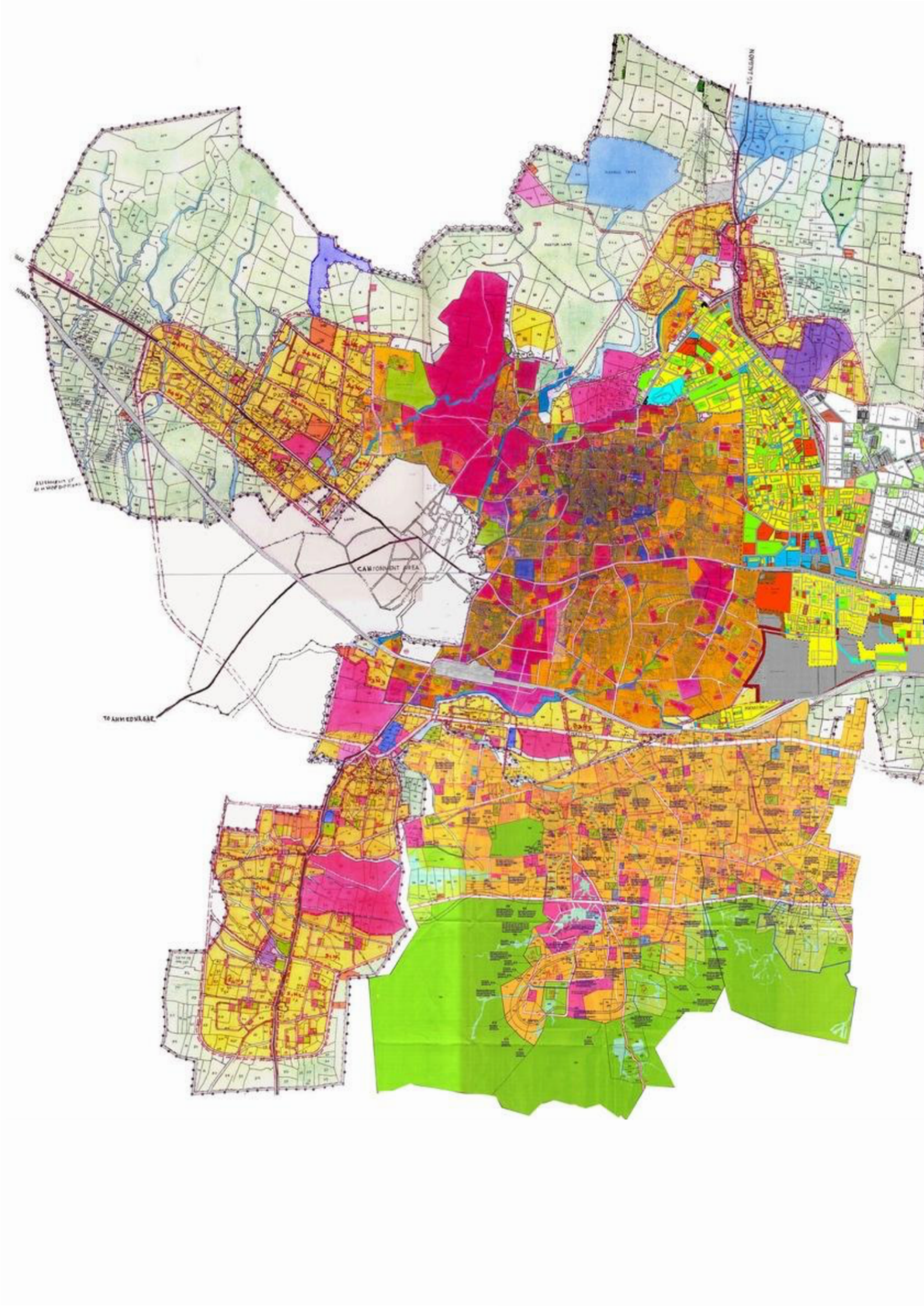
Also, the Development Control Rules under this plan state that "9.0 M. wide green belt shall be provided all along the nalas having minimum width of 3.0M. In this 9.0 M. wide green belt 3.0M. Width shall be developed as cycle track".

Additionally, there are multiple provisions for regulated development around water bodies, at the state level. The UNIFIED DEVELOPMENT CONTROL AND PROMOTION REGULATIONS FOR MAHARASHTRA STATE, 2020, by GOVERNMENT OF MAHARASHTRA URBAN DEVELOPMENT DEPARTMENT, has listed a number of regulations for development along rivers and water bodies.

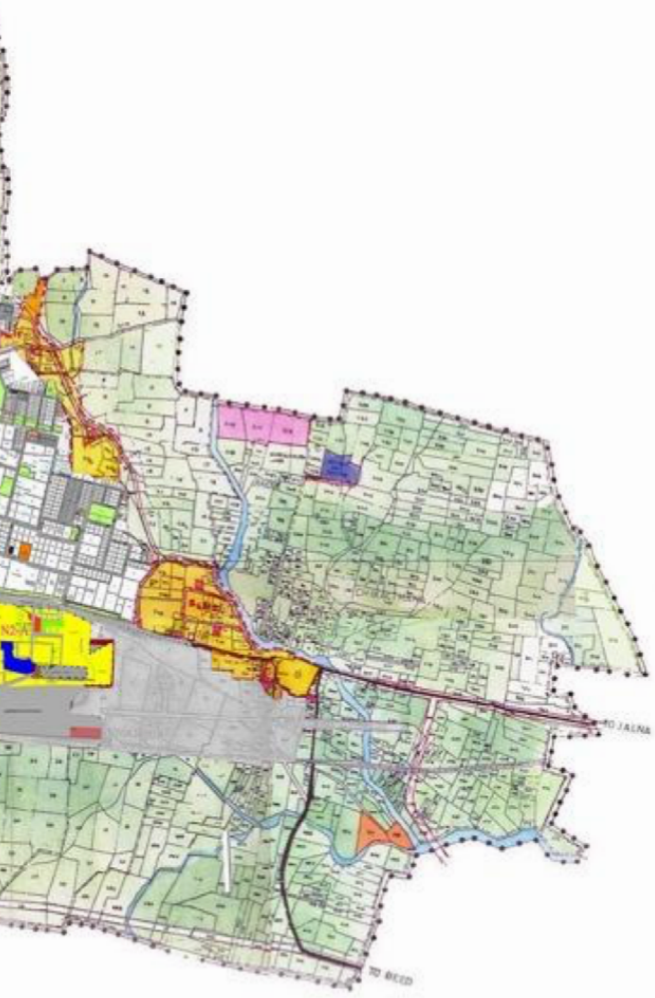
1. SITE NOT ELIGIBLE FOR CONSTRUCTION OF BUILDING

   No piece of land shall be used as a site for the construction of building,

- If the entire site is within a distance of 6 m. from the edge of water mark of a minor water course (like nallah, canal) and 15 m. from the edge of water mark of a major water course (like river) shown on Development Plan/Regional Plan or village/city survey map or otherwise.
- If the site is not drained properly or is incapable of being well drained;
- If the entire site is within a distance of 50 m. from the mean high flood level of a wetland. The mean shall be calculated as per the provisions of Wetlands (Conservation and Management) Rules, 2017.
- If it is within the river and blue flood line of the river (prohibitive zone), unless otherwise specified in these regulations.


CANTONMENT AREA

PROPOSED LAND USE PLAN FOR AURANGABAD 2001

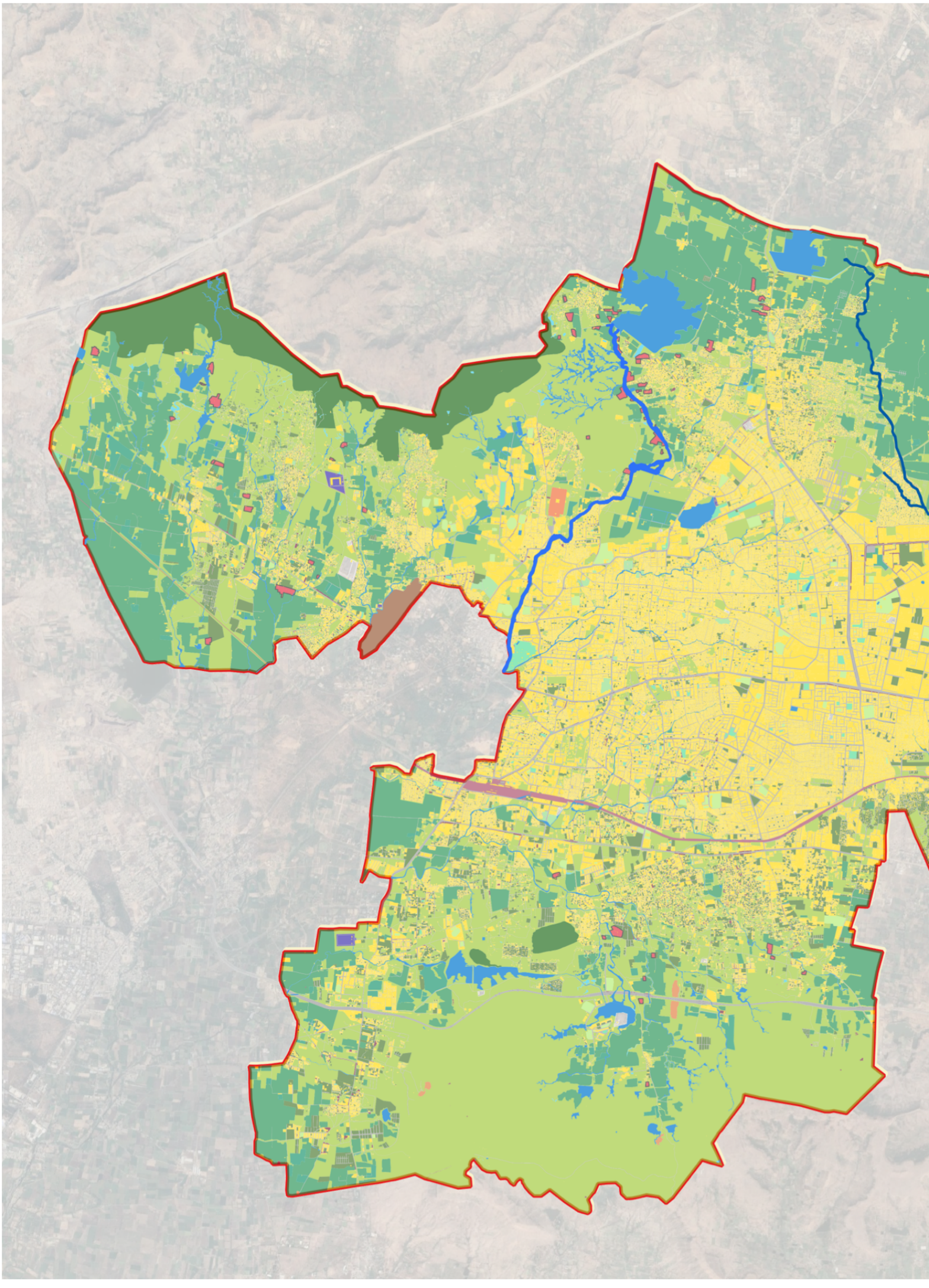


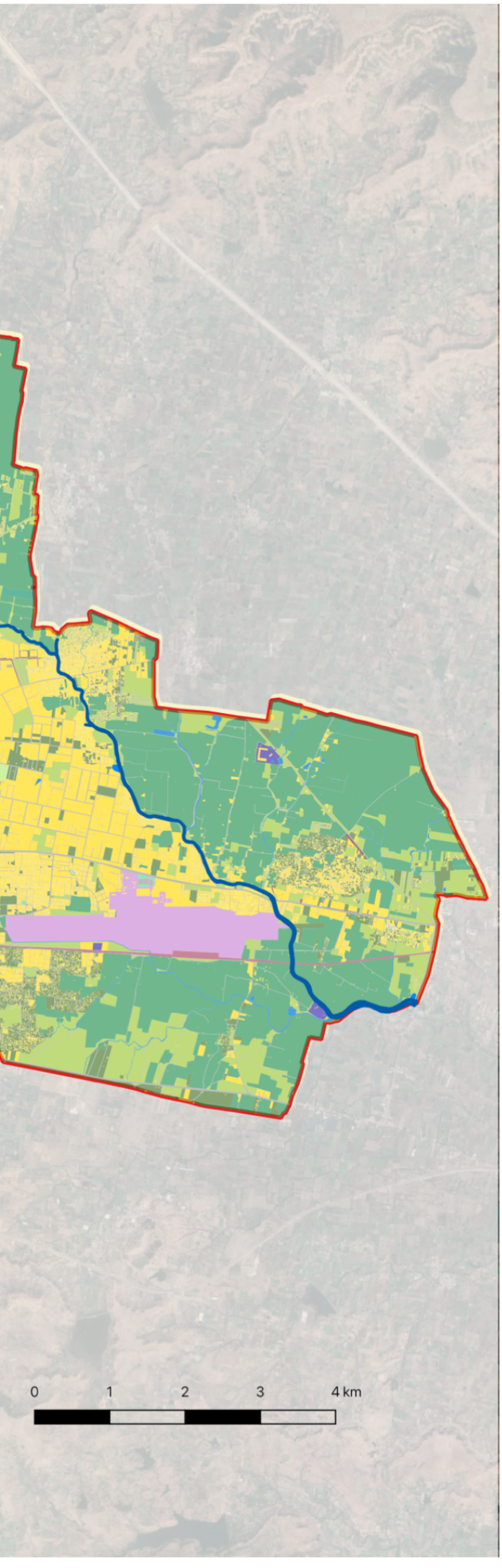
(Not to scale)

LEGEND

Source: Aurangabad Municipal Corporation

Map: 5 - Proposed Land Use Plan (2001)





EXISTING LAND USE PLAN

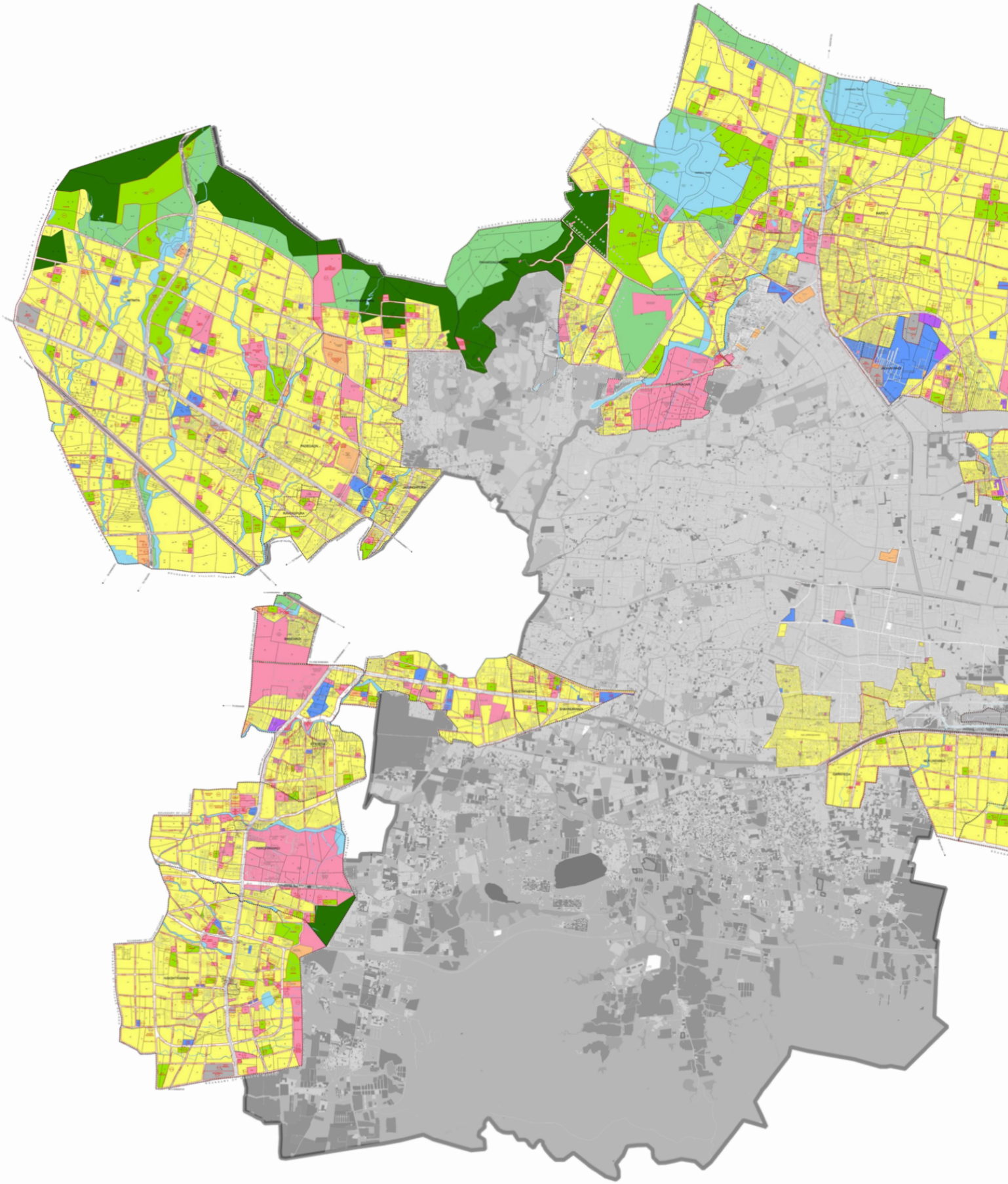
LEGEND

landuse

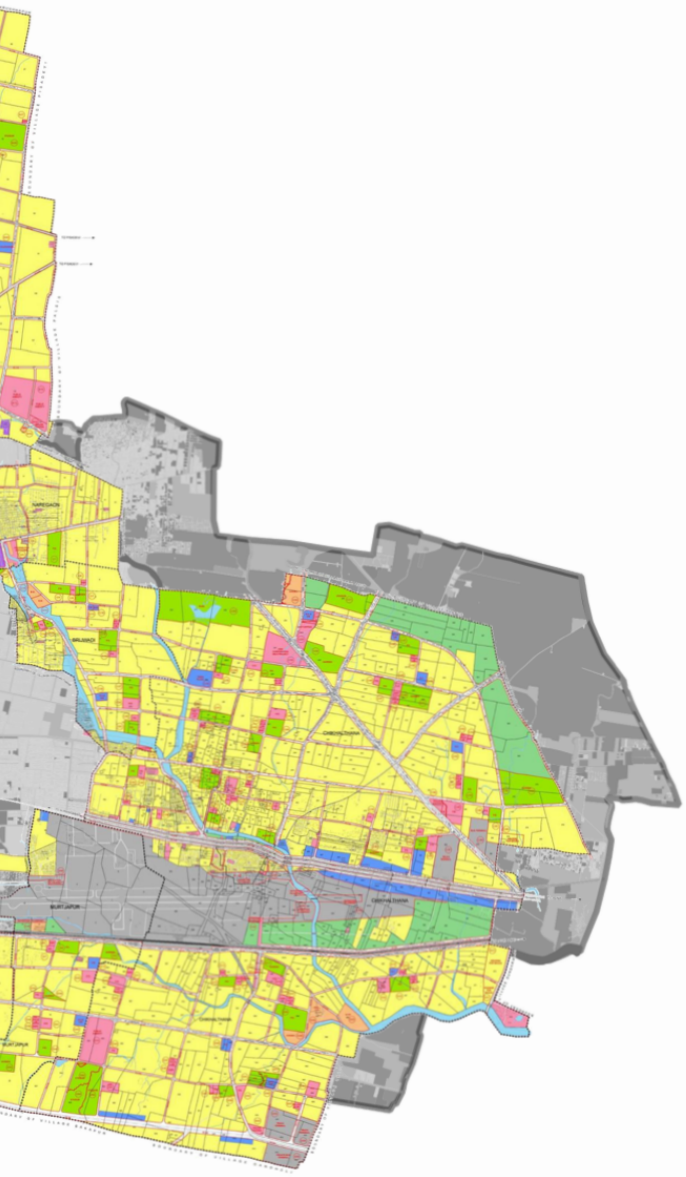
- Agriculture
- Airport Area
- Brick Creation Area
- Bridge
- Building Footprints
- Cantonment Area
- Dam/Barrage/Embankment
- Divider
- Footpath
- Forest
- Golf Course
- Grave Yard
- Monument
- Open Land
- Open Land - Residential Unoc
- Open Land (In Residential)
- Others
- Park and Garden
- Parking Area
- Plantation
- Play Ground
- Quarry & Mines Area
- Railway Property
- Road
- Statue
- Traffic Island
- Treatment Plant
- Water Bodies
- AMC_Boundary

Source: Aurangabad Municipal Corporation

Map: 6 - Existing Land Use Plan



DRAFT DEVELOPMENT PLAN OF CHHATRAPATI SAMBHAJINAGAR, ADDITIONAL AREA (REVISED)



(Not to scale)

LEGEND

- Agriculture
- Airport Area
- Brick Creation Area
- Bridge
- Building Footprints
- Cantonment Area
- Dam/Barrage/Embankment
- Divider
- Footpath
- Forest
- Golf Course
- Grave Yard
- Monument
- Open Land
- Open Land (In Residential)
- Others
- Park and Garden
- Parking Area
- Plantation
- Play Ground
- Quarry & Mines Area
- Railway Property
- Road
- Statue
- Traffic Island
- Treatment Plant
- Water Bodies
- AMC_Boundary

Source: Aurangabad Municipal Corporation

Map: 7 - Draft Development Plan of Chhatrapati Sambhajinagar , Additional area (Revised)

2. CONSTRUCTION WITHIN BLUE AND RED FLOOD LINE

a. Where Blue and Red flood line are marked on the Development Plan / Regional Plan or received from the Irrigation Department.

- The Red Flood Line and Blue Flood Line shall be considered as per the plan prepared by the Irrigation Department. The area between the river bank and blue flood line (Flood line near the river bank) shall be prohibited zone for any construction except parking, open vegetable market, garden, lawns, open space, cremation and burial ground, sewage treatment plant, water / gas / drainage pipe lines, public toilet or like uses, provided the land is feasible for such utilization. Provided that, redevelopment of the existing authorised properties, within river bank and blue flood line, may be permitted at a plinth height of 0.45 m. above red flood line level.
- Area between blue flood line and red flood line shall be restrictive zone for the purposes of construction. The construction within this area may be permitted at a height of 0.45 m. above the red flood line level.
- If the area between the river bank and blue flood line forms part of the entire plot in Development Zone, then, FSI of such part of land may be allowed to be utilised on the remaining land.
- The red and blue flood line, if shown on the Development/Regional Plan/ Planning Proposal shall stand modified as and when it is modified by the Irrigation Department.

b. Where Blue and Red flood line is not marked on the Development Plan / Regional Plan or not received from the Irrigation Department.

- Where Blue and Red flood line is not marked on the Development Plan / Regional Plan or not received from the Irrigation Department, the tentative Blue line shall be earmarked taking into consideration maximum observed flood level records available locally and also interacting with the residence in the area. The plan showing such tentative Blue line shall be got approved from Chief Engineer, Irrigation Department. The distance of 50 m. on landward side from this tentative Blue line shall be treated as No Construction Zone.
- In such cases, provisions of Regulation 2a. shall be applicable to that extent.
- Till such a tentative Blue line is prepared and marked on the plan, the development permission shall be governed by the provisions of Regulation 1.

3. DEVELOPMENT OF CYCLE TRACK ALONG RIVER AND NALLAH

A cycle track shall be developed in green belt areas earmarked on Development Plan along the rivers. Also, cycle track be developed along the major nallah.

A distance of 6 m. from the edge of minor water course (nallah) is to be left as marginal distance for construction of any building. A 3 m. strip of land from the edge of such water course out of this 6 m. distance to be left, shall be available for use as cycle track for general public. The compound wall shall be constructed excluding this distance of 3 m. strip for cycle track. The owner shall be entitled for FSI of this strip of land for cycle track, in-situ. This 3m. wide strip shall be handed over to Municipal Corporation for which, owner shall be entitled for TDR or in- situ FSI equivalent to 35% of the area of 3 m. wide strip.

This regulation shall be applicable for development of land along nallahs and Green Belt areas as and when it is notified by the Municipal Commissioner after identifying such green belt and nallahs.

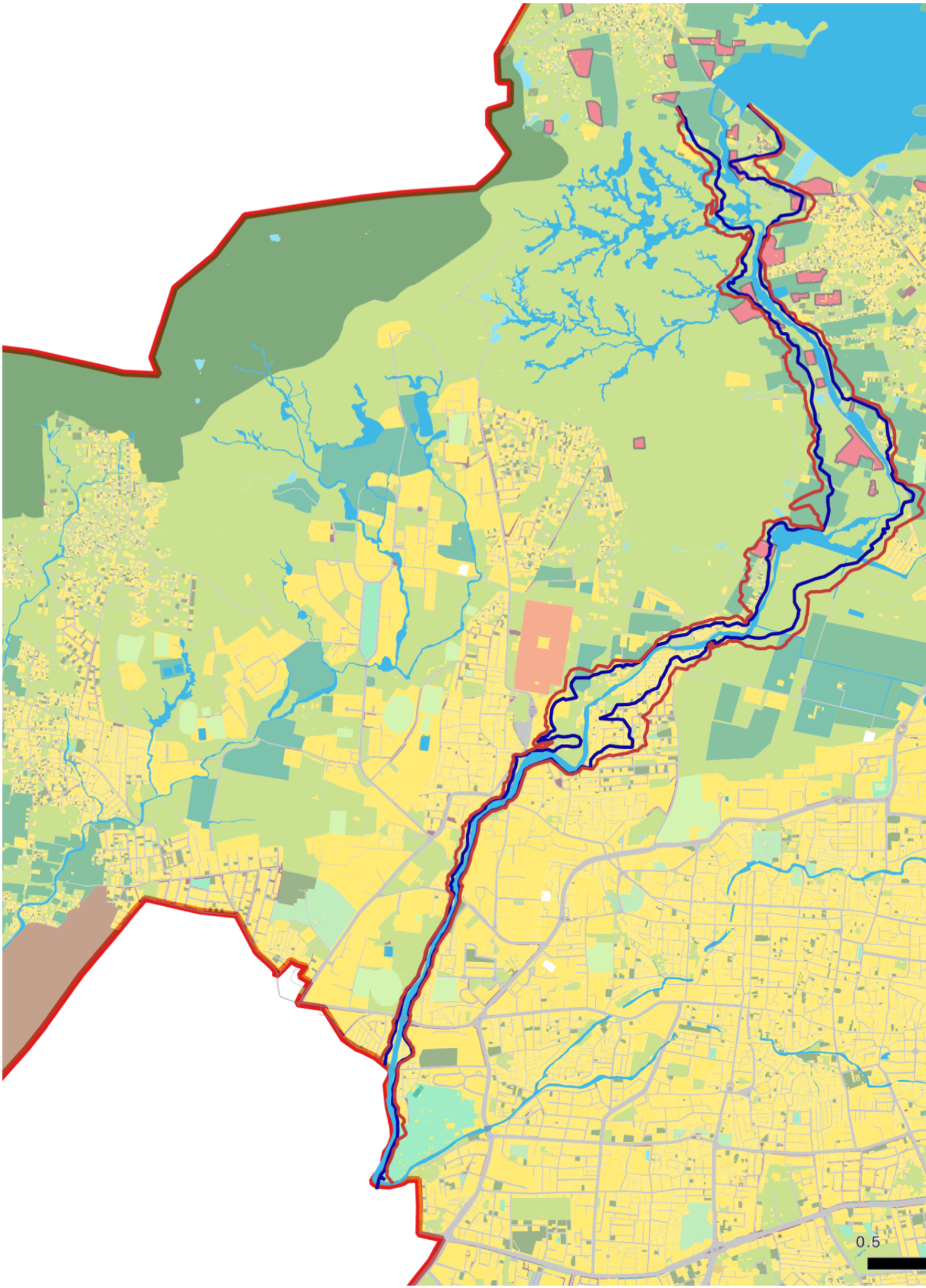
4. GREEN BELT ZONE / RIVER PROTECTION BELT
Following uses shall be permissible

- Agriculture,
- Tree Plantation, Gardens, Public park, Landscaping, Recreational Open Space, Forestry and Nursery etc.
- River front development by Authority or any institution authorised on behalf of Authority.
- Development of pedestrian pathways, Jogging tracks, Cycle tracks, Boat clubs etc.
- Swimming pools, club houses, recreational facilities after leaving 15 m. belt along river bank and 9m. from nallahs, subject to other provisions in these regulations.
- Public toilets as per requirement.
- Recreational open space of any layout/ sub-division/ development proposals, if submitted along with the developable land adjoining such green belt, after leaving marginal distances of minimum 15m. and 9m. from rivers and nallahs, respectively, or subject to distances mentioned in Regulation 2.

a. The uses and their extent shall be permissible in such Recreational open space, as prescribed in this regulation.
b. If the land under green belt zone, excepting open space therein, if any, is required by Authority for the public purposes mentioned above, the owner shall hand over the possession of such land for the development and maintenance of public purposes. Thereafter, such land shall remain open and accessible to general public for recreational activities.
c. The side/ rear marginal distances for a proposed building in a land adjoining a river/ nallah shall be the maximum of :-

- Side/ rear marginal distance, to be measured from river/ nallah, as required according to height of building or
- 4.5 m. from the dividing line between green belt zone and the other developable zone; or
- Mandatory distance of 15m. or 9m to be observed from a river or nallah respectively.

FLOODPLAIN DEMARCATION (Red and Blue flood lines)
The city has already adopted certain provisions for regulation of development along rivers. The Godavari Marathwada Irrigation Development Corporation has earmarked the 'Prohibitive' and 'Restrictive' Flood Zones for the Kham river. The map below (map 8) shows the 100 years flood (red line) and the 25 years flood (blue line) markings. However, these lines are yet to be validated with ground truthing and are to be marked on site. Additionally, there are plans to earmark the flood zones around the Sukhna river as well.


0.5



NAMAMI GANGE | AURANGABAD MUNICIPAL CORPORATION | National Institute of Urban Affairs | WATER & ENVIRONMENT VERTICAL

KHAM RIVER
RED-LINE , BLUE-LINE

LEGEND

- AMC_Boundary
- Redline
- Blueline

KEY MAP



Source: Irrigation and Flood Control Department, Aurangabad

Map: 8 - Red-line, Blue-line (Kham River)

Objective 2- To keep the river free from pollution

Rationale: Pollution is the biggest concern for the rivers. Rivers are the ultimate recipients of untreated wastewater from towns and cities. The wastewater discharged by one city becomes source of water supply for another city downstream, thereby creating a cycle of health hazards.

In Chhatrapati Sambhajinagar, three main sources of pollution in the rivers and water bodies have been identified. These include the untreated domestic sewage flowing through drains, industrial effluents being discharged in the water bodies and the dumping of solid waste along the river bank.

WATER POLLUTION

Water quality plays a crucial role in the health of a river ecosystem. At present, the city conducts manual testing of water bodies, based on its need. Water quality testing has been conducted at various locations along the Kham river.

As per a recent report of water quality in Kham river, the main indicators of water pollution viz. BOD, COD, Total Nitrogen, were recorded exceptionally high and way above the permissible standards. The BOD concentration in different stretches of the river ranged between 160-287 mg/l, and the COD values ranged from 400-800 mg/l, indicating high discharge of untreated organic and inorganic load in the river.

Following table (figure 11) shows the water quality at different stretches of Kham river. Their comparison with the surface water quality criteria of the Central Pollution Control Board shows that the water quality is beyond the permissible limits.

Parameters	Unit	Location					
		A	B	C	D	E	F
Location		Jaisinghpura	Khadkeshwar	Konkanwadi	Padampura	Pandharpur village	Pandharpur
Dissolved Oxygen	mg/l	2.077	2.0350	1.9834	1.9626	1.94012	1.92682
BOD	mg/l	123.326	125.934	130.3982	135.24	139.7369	143.36
Electrical Conductivity	µmhos/cm	1025.1	1041.5	1051.6	1091	1106.6	1108.4
Turbidity	NTU	27.66	34.61	38.56	54.38	57.99	62.99

Figure 11: Water quality at different stretches of Kham river (Source: Kham DPR, July 2022)

INDUSTRIAL EFFLUENTS

The city is surrounded on all sides by well-developed industrial areas. There are four industrial clusters in the city namely MIDC (Maharashtra Industrial Development Corporation) Railway Station, MIDC Chikalthana, MIDC Waluj and MIDC Shendra. However, the sector is expanding, with some scattered industrial development along Beed Road and Paithan road. (map 9)

The development of the industrial sector in Chhatrapati Sambhajinagar began as early as 1963, when MIDC developed around 34 Ha. near the railway station as the Chhatrapati Sambhajinagar Industrial Area. Thereafter in 1965, MIDC established the Chikalthana Industrial Area in the vicinity of Chhatrapati Sambhajinagar with a planned area of 724 Ha. The Waluj Industrial Area developed in 1982 has a planned area of 1563 ha, with a residential and commercial zone within the industrial area, and a planned water supply scheme of 72,000 cubic meters a day capacity. The more recently developed Shendra Industrial Area has an area of 927 Ha. The Industrial Unit at Chitegaon along Paithan road is prospering largely because of the rapid growth in the automobile and pharmaceutical sectors.

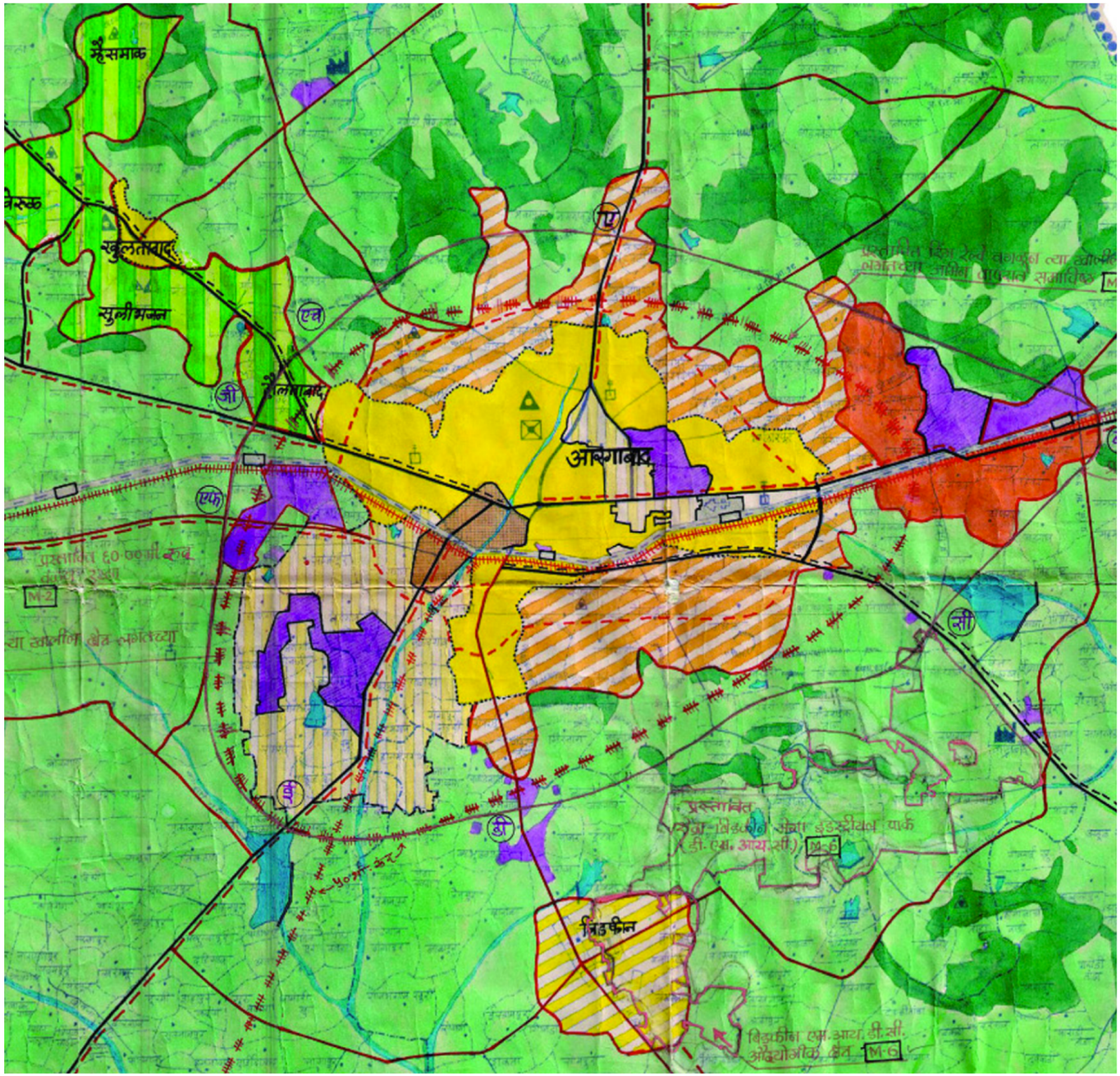
Chhatrapati Sambhajinagar has been identified as one of the critically polluted industrial clusters by CPCB. The effluent generated by the four MIDCs in Chhatrapati Sambhajinagar district is about 13.42 MLD (figure 12) and it comprises mainly of trade effluent, domestic waste from industrial clusters and the unorganised sector.

The Railway station MIDC has shown a significant growth of new commercial complexes and other types of infrastructural development as is bound to take place following the dying out of sick units and defunct industries. The major effluent generated here is of domestic nature. A proper collection and sewage treatment plant is of utmost importance.

Chikhalthana MIDC houses 21 trade effluent generating industries. This is an old industrial estate within the Chhatrapati Sambhajinagar Municipal Corporation limits. The effluent, trade/domestic, to the tune of 200 CMD finds its way into the Sukhna river. Of this, only a very small percentage is completely treated waste.

In Shendra MIDC, there are 5 effluent generating industries. The total trade effluent generation in the area is 700 CMD. Industries have provided adequate effluent treatment for treatment of trade effluent. The treated effluent is applied on land for gardening / irrigation purposes. Most of the industries have provided septic tank/STP for treatment of domestic waste. The run-offs from the treated, domestic and trade effluent may find its way into the Sukhna river.

In Waluj MIDC area, there are 105 units which are water polluting. Total quantity of industrial effluent generated from Waluj MIDC area is 10.72 MLD and total domestic effluent generated is 3.928 MLD. The total BOD load in the area is 8.69 kg/d. Large and medium scale industries have provided primary/ secondary effluent treatment plants and most of them have septic tanks or sewage treatment plants for domestic waste water. The run-offs/ seepages percolates into the ground or enter the River Kham.



NAMAMI GANGE | AURANGABAD MUNICIPAL CORPORATION | National Institute of Urban Affairs | WATER & ENVIRONMENT VERTICAL

INDUSTRIAL AREAS - AURANGABAD

LEGEND

- Kham River
- Sukhna River
- Water _Bodies_Poly
- landuse
- Agriculture
- Airport Area
- Brick Creation Area
- Bridge
- Building Footprints
- Cantonment Area
- Dam/Barrage/Embankment
- Divider
- Footpath
- Forest
- Golf Course
- Grave Yard
- Monument
- Open Land
- Open Land - Residential Unoc
- Open Land (In Residential)
- Others
- Park and Garden
- Parking Area
- Plantation
- Play Ground
- Quarry & Mines Area
- Railway Property
- Road
- Statue
- Traffic Island
- Treatment Plant
- Water Bodies
- AMC_Boundary

(Not to scale)

Source: Aurangabad Municipal Corporation

Map: 9 - Existing Industrial areas in Chhatrapati Sambhajinagar

Total generation of sewage in Chhatrapati Sambhajinagar city is 107 MLD. Chhatrapati Sambhajinagar Municipal Corporation is treating only 6.5 MLD of sewage, the rest is disposed without treatment into water bodies. The said STP, approved and designed for CIDCO and commissioned in Feb 1998, is located near Chhatrapati Sambhajinagar Airport at Murtuzapur. The treated wastewater is discharged in Kham and Sukhna river.

Name of Industrial Cluster	Distance from Chhatrapati Sambhajinagar	Area (Ha)	Number of effluent generating industries	Quantity of effluent (MLD)	Remarks
Railway Station MIDC	Within AMC area	20	2	negligible	Very small industrial area, with many sick units
Chikalthana MIDC area	Within AMC area	400	21	2.0	Old industrial area having mostly sick units
Shendra, MIDC area	15 km	600	5	0.7	New developing area, SEZ units
Waluj MIDC area	12 km	1520	105	10.72	Major industrial area near the city
Total			133	13.42	

Figure 12: Details of Industrial Clusters (Source : MPCB, 2013-14)

SOLID WASTE

About 450 tons per day of waste is generated in the city. While there is a provision for door to door collection of household waste using 'Ghanta Gadi' and private waste collection agencies, huge piles of solid waste end up along the city's rivers and other water bodies.

The main source of municipal solid waste in the city are the residential areas, commercial areas, vegetable markets, guesthouses, restaurants, hospitals and health centre and marriage halls. Besides these, street sweepings, drain cleanings and construction debris also form a significant component. The waste collection efficiency in the city is about 92%. Out of the collected waste, about 51% constitutes Organic Waste (Food Waste, Landscape & Trimming), about 17.5% constitutes Recyclable Waste (Paper, Card Board, Plastic, Glass & Metal) and about 31.5% constitutes Inert Waste (Stones & Slit, Bones & other inorganic Material). (Environment Status Report)

Based on information from a drone survey conducted along the stretch of Kham river within the city (Harsul Dam to Cantonment bridge), it is found that the middle stretch of river from Himayat Baug to Panchakki has considerable amounts of solid waste dumps on the bank. These waste dumps have further reduced the width of the channel.

The following table (figure 13) describes the load of waste and informal discharge along the Kham river.

Feature	Kham River Stretch							
	Segment A (Harsul Dam to Himayat Baug) Length: 3850 m		**Segment B (Himayat Baug to Panchakki) Length: 2700 m**		**Segment C (Panchakki to Cantonment bridge) Length: 1182 m**		**A+B+C Total length (7.732 km)**	
	Qty	**Area**	**Qty**	**Area**	**Qty**	**Area**	**Qty**	**Area**
Pipelines discharging sewage into the river	10	-	32	-	6	-	48	-
Solid Waste Dumps in river bed		3,755 m2		20,626 m2		7,844 m2		32,225 m2

Figure 13: Details of waste along Kham river (Source : Kham DPR, EcoSattva, July 2022)

Objective 3- To rejuvenate waterbodies and wetlands in the city

Rationale: In many cities, waterbodies and wetlands are intrinsically connected to rivers either through their drainage patterns or groundwater flow. Rejuvenating water bodies and wetlands can go a long way in reducing the burden on rivers. They improve groundwater recharge, which in turn helps augment the water supply of a city, and reduces the stress on rivers. Similarly, rejuvenated wetlands are natural "wastewater treatment plants" that can significantly mitigate the pollution load entering a river. The recreational benefits that these two interventions offer are an added incentive to the city.

The city has a limited number of water bodies, making it a strong case for the need to protect them. Key water bodies of the city include Harsul Lake, Sawangi Lake, Salim Ali Lake, Kamal Talao, and Walmi Lake. While there are plans for rejuvenation of some of these, many of them stand neglected.

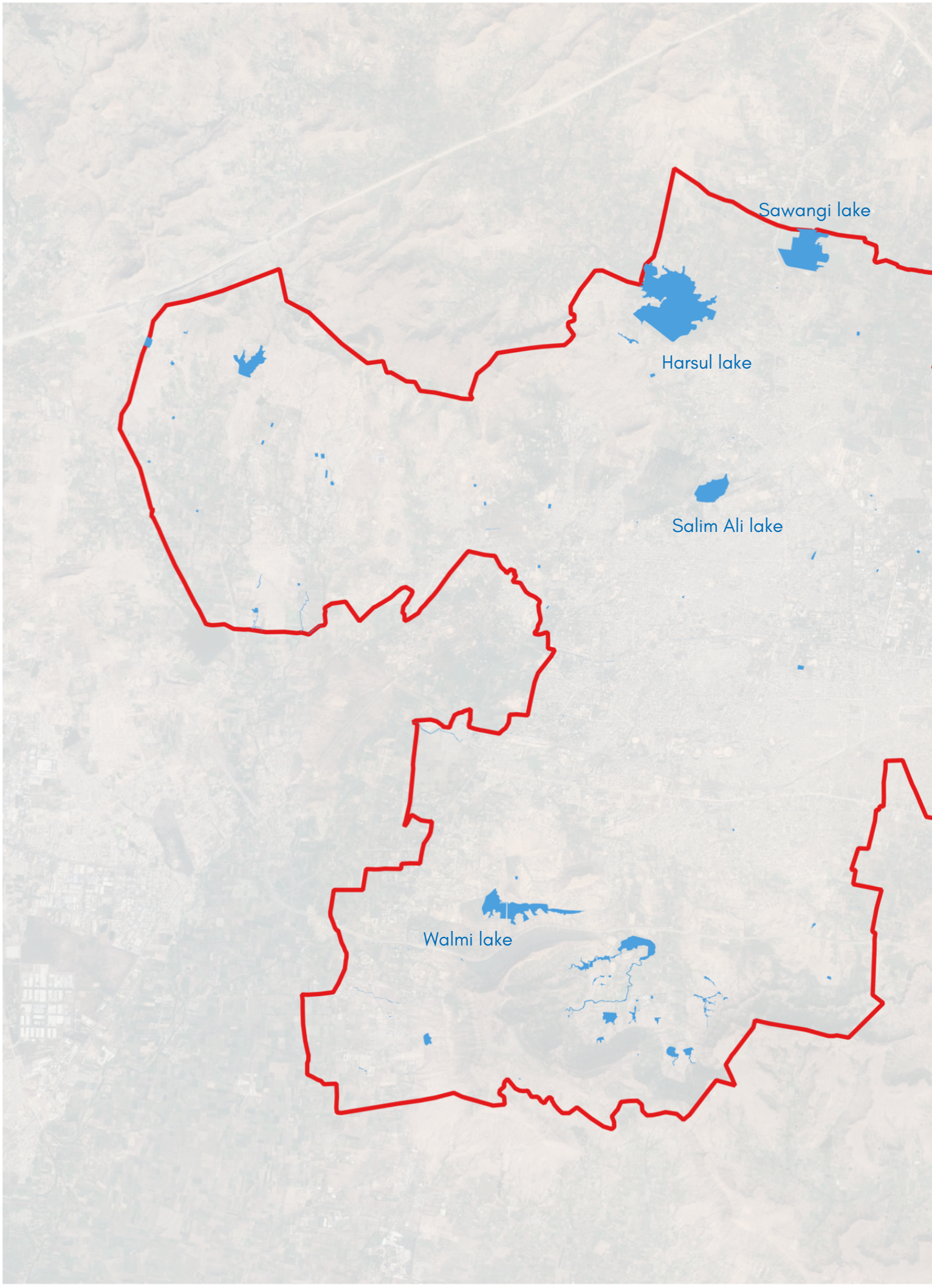
The Harsul Lake and dam is an important feature constructed on the river Kham in the year 1952. The basic purpose of this dam has been to supply water in nearby locality for domestic use. This lake is also being used for fishing. Studies show that there is no major pollution hazard in this lake.

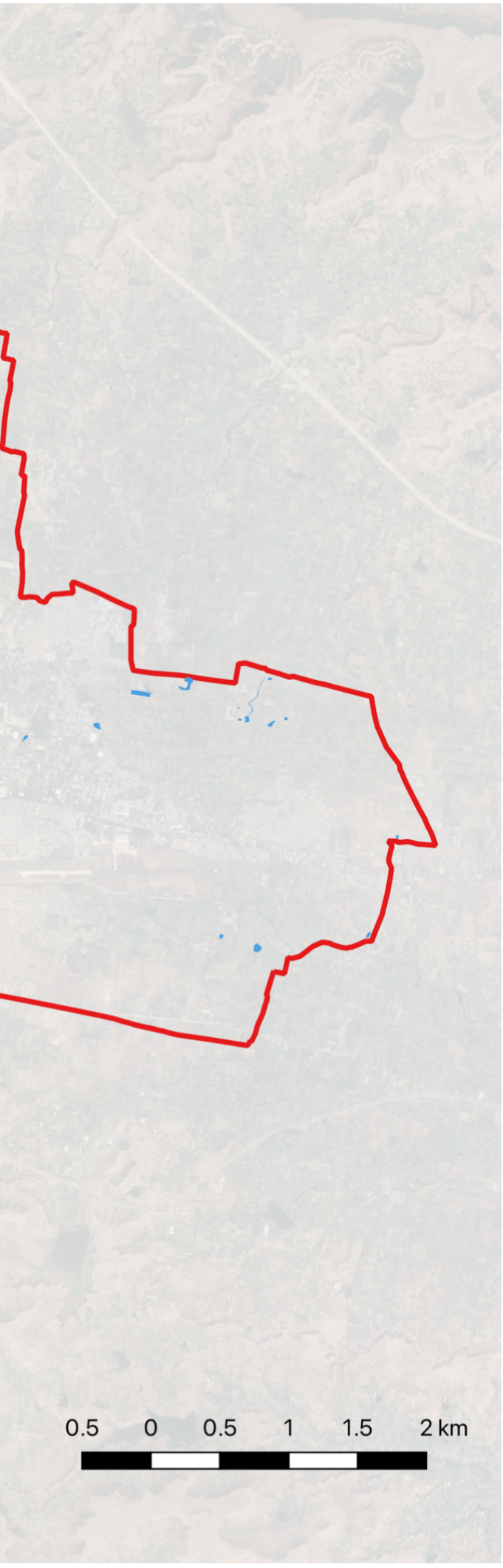
The Kamal Talao is a historic water body located within the city, built 400 years ago as a part of the water supply and management system constructed by Malik Ambar. As the name suggests, it was known for beautiful lotus pods. Earlier, the monsoon overflow from the present day Salim Ali Lake was channelled to this lake, through Himayat Bagh, which was eventually drained into Kham. This lake was thus crucial in maintaining the hydrological function of the entire ecosystem. However, recent human activities around the water body have led to a decrease in the area, increase in pollution load and degradation of the water body. There is also an existing National Green Tribunal order regarding the encroachment of this lake. At present, the lake covers an area of 5.10 acres.

Dr. Salim Ali Sarovar (lake) popularly known as Salim Ali Talab is located near Delhi Gate, opposite Himayat Bagh, Chhatrapati Sambhajinagar . It is located in the northern part of the city. During the Mughal period it was known as Khiziri Talab. It has been renamed after the great ornithologist and naturalist Salim Ali. The Salim Ali lake, Himayat Bagh and the Bamu campus are a few major bird habitats in the city. (figure 14)



Figure 14: Biodiversity in Salim Ali (Source: Tourism Chhatrapati Sambhajinagar)


Sawangi lake
Harsul lake
Salim Ali lake
Walmi lake



EXISTING WATER BODIES IN CHHATRAPATI SAMBHAJINAGAR

LEGEND

Water _Bodies

AMC_Boundary

Source: Aurangabad Municipal Corporation

Map: 10 - Existing Water Bodies in Chhatrapati Sambhajinagar

© National Institute of Urban Affairs

Objective 4 - To enhance the riparian buffer along river banks

Rationale: A riparian buffer is a longitudinal stretch of vegetation on either bank of a river, whose significance cannot be over-emphasized. It acts as a shock absorber for the river and its aquatic ecosystem from detrimental developmental activities. The buffer zone also protects the urban area from the impact of floods. Ideally, the riparian buffer should be a continuous stretch with a width of twelve to fifteen meters. Smaller cities may be able to achieve this faster. However, the present conditions should not dictate the ambition of the future, and cities must take up whatever is possible today, and aspire for the ideal condition in its long- term planning, syncing it with the Master Plan.

EXISTING RIPARIAN PLANTATION ALONG THE RIVERS

Most of the Kham river bank is being stabilised using stone pitching. However, in a few stretches along Kham and Sukhna rivers, plantation buffers also exist. The map below shows the existing stretches of plantation along the two rivers. (map 11)

Additionally, sites around the water bodies of the city, such as Himayat Bagh, Harsul Lake, and Salim Ali lake, are rich in biodiversity and have a huge potential for conservation. A floristic assessment was also conducted for Kham river in 2020, wherein a total of 86 plant species were identified. A few key species found along the river are listed below.

- Vallisneria, Ottelia, Kirganelia, Blumia, etc., found in the upstream stretch of the river (Harsul Dam to Himayat Baug)
- Castor spp, ipomoea palmata, Colocasia spp, etc. (species found in polluted and marshy habitats); and weeds such as Parthenium spp, Argemone Mexicana, Alternanthera spp, Leucaena spp, etc., found in the middle stretch of the river (Himayat Baug to Panchakki)
- River banks covered with grassy meadows interspersed with Prosopis juliflora shrubs; dense island vegetation of Canna indica, Colocaisa esculenta, Arundo donax, etc. (indicative of polluted and/or marshy habitat); and presence of duckweed (known to concentrate and remove elements from polluted water), found in the downstream stretch of the river (Panchakki to Cantonment bridge)

AGRICULTURAL ACTIVITIES ALONG THE RIVER BANKS

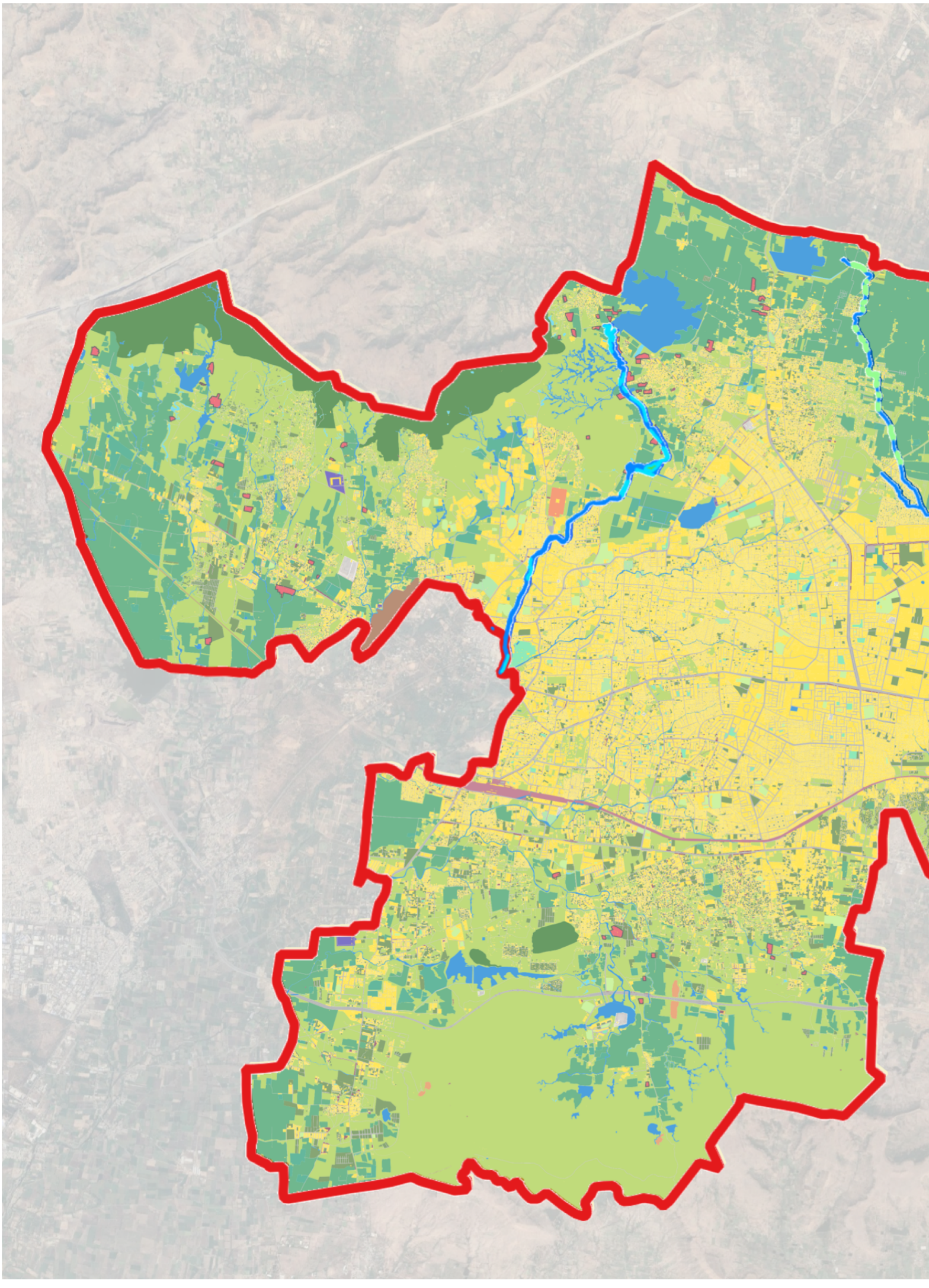
Chhatrapati Sambhajinagar also has extensive areas under agricultural use. A large part of the land adjoining Sukhna river and around Harsul dam is under agriculture. The major agricultural crops include Cotton, Oil seeds, Bajra, Jowar, Groundnut, Wheat, Safflower and Sugarcane. Grapes, Bananas, Sweet Limes and Oranges, Brinjal, Tomato, Onion, Potato and Leafy vegetables are also grown.

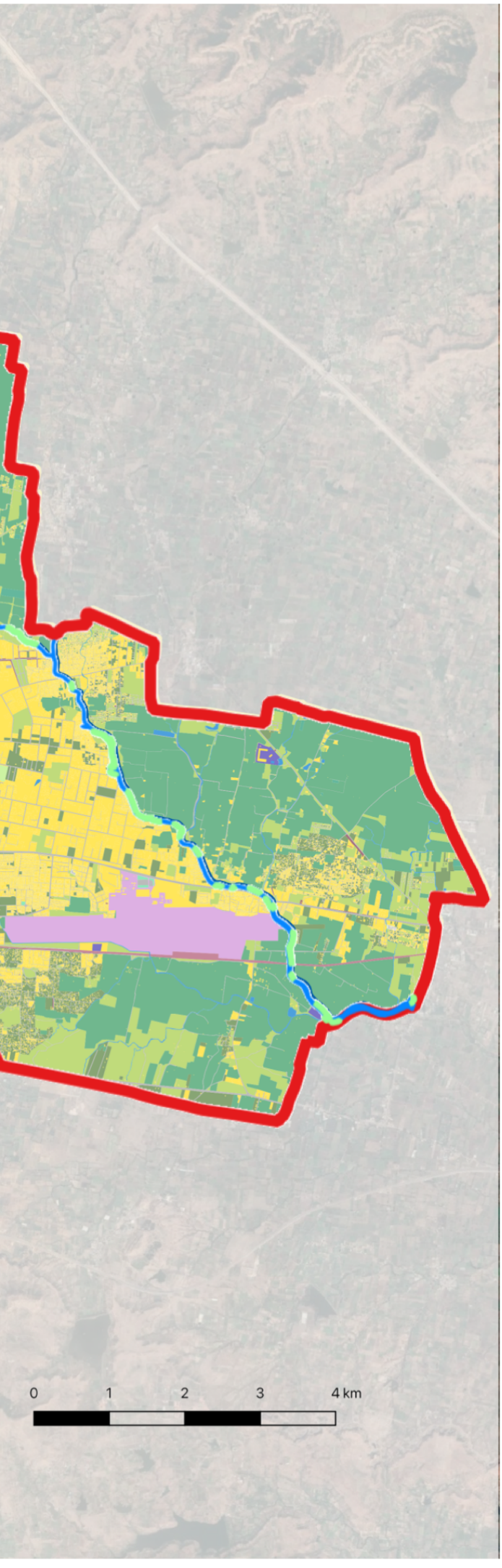
While there is a huge potential for the agricultural industry in the city, there is no formal mechanism for their operation in terms of the irrigation water requirements and chemical

SPECIES ACROSS THE CITY

As per the Environment Status Report of Chhatrapati Sambhajinagar , there is a diversity in the vegetation pattern across the city. The most common tree species observed throughout the city include Teak, Hardwickia, Banyan, sacred fig, yellow flame, Mango, Ashok, Peru, red date etc. Commonly occurring shrubs include Tantani, Neelpushpi, Aak, Bahava etc. Common birds which are observed perennially include Pond heron, Cattle egret, White breasted kingfisher, Red wattled lapwing, Indian ring dove, Crow pheasant, Jungle babbler, Common myna, Rose ringed parakeet, Tailor bird, Purple rumped sunbird, Indian robin and Magpie robin. Additionally, some species are found seasonally, like Black Ibis, European hoopoe and Coppersmith barbet in winter; and Grey hornbill and Tree pie in the beginning of rainy season.

There are a number of local bird watching groups within the city. The city has a huge potential for restoring ecological habitats that may serve as the grounds for such activities.





EXISTING RIPARIAN BUFFERS ALONG KHAM AND SUKHNA RIVER

LEGEND

- Rip_zone_Kham
- RIP_zone_sukh
- Water _Bodies_P
- AMC_Boundary

Source: Aurangabad Municipal Corporation

Map: 11 - Existing Riparian Buffer - Kham and Sukhna River

Objective 5: To adopt increased reuse of treated wastewater

Rationale: Reuse of wastewater is an excellent avenue to relieve the stress on rivers. This would result in lesser freshwater extracted from the river and more water available to maintain the environmental flow in the river. 75-80% of the freshwater supplied to a household returns as wastewater. This vast volume is nothing short of a new resource of water. Furthermore, in every city there is usually limited scope for direct reuse of treated wastewater. However, the remaining can easily be used to revive water bodies, and groundwater recharge, thereby augmenting the future supply of the city.

Objective 6: To ensure adequate good quality return flow from the city in the river

Rationale: This is based on the premise of a city making its contribution to maintain the environmental flow of the river. In its simplest form, environmental flow is water required by a river to sustain its natural habitat. Usually a city has very little control over the environmental flow in the river, given that this is regulated by national or state authorities. However, this should not absolve the city of its responsibility to the river. There is no definitive guideline of how much a city should give back to the river as this depends on site-specific factors. Cities will have to take stock of the rivers within their stretches, and decide upon an optimal contribution after adjusting for in-house uses. It is expected that the amount of return flow should be in proportion to the amount of water the city takes from the river. If the city decides on reserving a portion of the treated wastewater for return flow, it must ensure that the effluent meets the effluent standards set by CPCB.

WATER SUPPLY

The average daily water supply in Chhatrapati Sambhajinagar is around 136 million litres per day (MLD). The estimated water demand in Chhatrapati Sambhajinagar , considering 135 Lpcd as the benchmark, is between 230 to 240 MLD which is expected to reach up to 300 MLD by the end of 2031. Hence, this quantity perhaps does not meet the demand of the entire city, leading to water scarcity in some areas.

The primary source of water for the city is the Nathsagar-Jayakwadi Dam (130MLD), located about 50 km from Chhatrapati Sambhajinagar . The dam supplies water to the city through a canal system and a network of pipelines and is treated at Pharola Water Treatment Plant before distribution. In addition, the city also supplies around 4.5 MLD of water from Harsul lake. For this purpose, 38 service reservoirs of various capacities are constructed in the city area and the CIDCO-New Chhatrapati Sambhajinagar area.

The water supply network in Chhatrapati Sambhajinagar is extensive, covering most areas of the city. However, the newly developed areas are still not completely connected to the system and depend on groundwater. The existing water infrastructure, which was laid back in 1974 (28MLD), 1984 (28 MLD) and 1992 (100 MLD), is already being overutilized. The shortage of service reservoirs and increase in the supply area of each reservoir, further exacerbates the situation. This also points to a substantial dependence on groundwater to meet the water demands. Based on the documentation and mapping done by the CSMC, there are 137 municipal borewells and 1156 private borewells and dugwells within the city. (Map 14)

The Chhatrapati Sambhajinagar Municipal Corporation (CSMC) is working to address these issues by implementing various measures, such as the expansion of the water supply network, introduction of water management systems, and development of new sources of water.

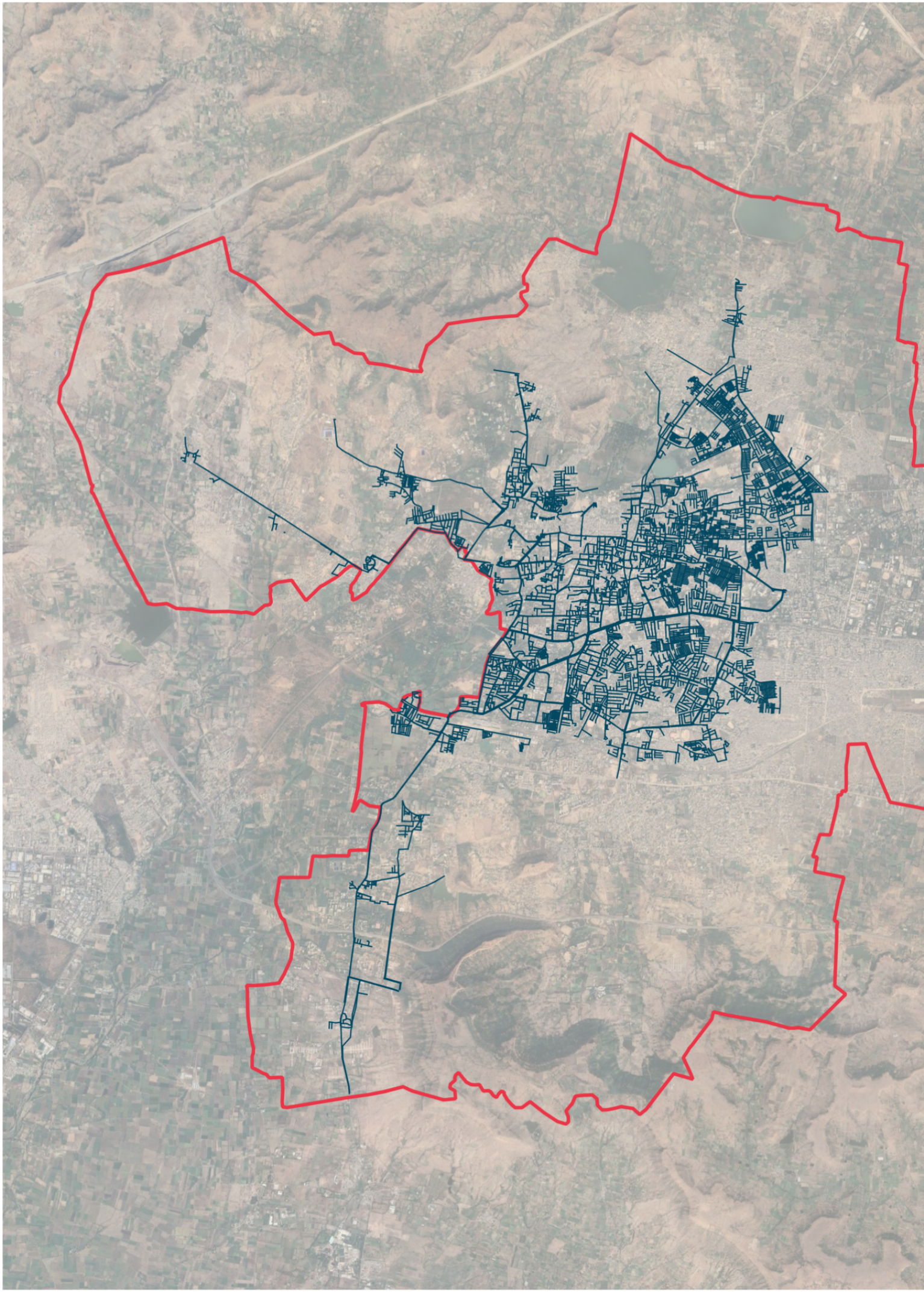
A proposed parallel water supply line project, called 'Samantar Yojna', is ongoing. The objective of this project is to augment the water supply to the city, particularly by creating a new water intake facility at Jayakwadi and improving the distribution network. The project involves the construction of new pipelines, storage tanks, and booster pumping stations, which will help to ensure an adequate and continuous supply of water to all areas of the city. The project also aims to reduce losses in the distribution network, which will help to conserve water and optimize the supply. Overall, the new project is expected to provide a major boost to the water supply scenario in Chhatrapati Sambhajinagar and improve the quality of life for its residents.

DRAINAGE AND SEWERAGE SCHEME

Total wastewater generation in the city is estimated to be 96 MLD. Currently 80 MLD of wastewater is being treated by 4 secondary-level sewage treatment plants. Chhatrapati Sambhajinagar City Underground Sewerage Scheme has been completed under UIDSSMT. Overall wastewater network is around 1250 Km catering to 80% of the total population, rest 20% unserved population depends on onsite disposal. The table below (figure 15) shows details of the 4 STPs in the city.

S. No.	Location of STP	Designed capacity in MLD	Operational capacity in MLD
1	Kanchanwadi	161	70
2	Zalta Chikalthana	35	10
3	Padegaon	10	2
4	Salim Ali	5	2

Figure 15: Details of STPs in the city (Source : AMC)





EXISTING WATER SUPPLY NETWORK AURANGABAD

LEGEND

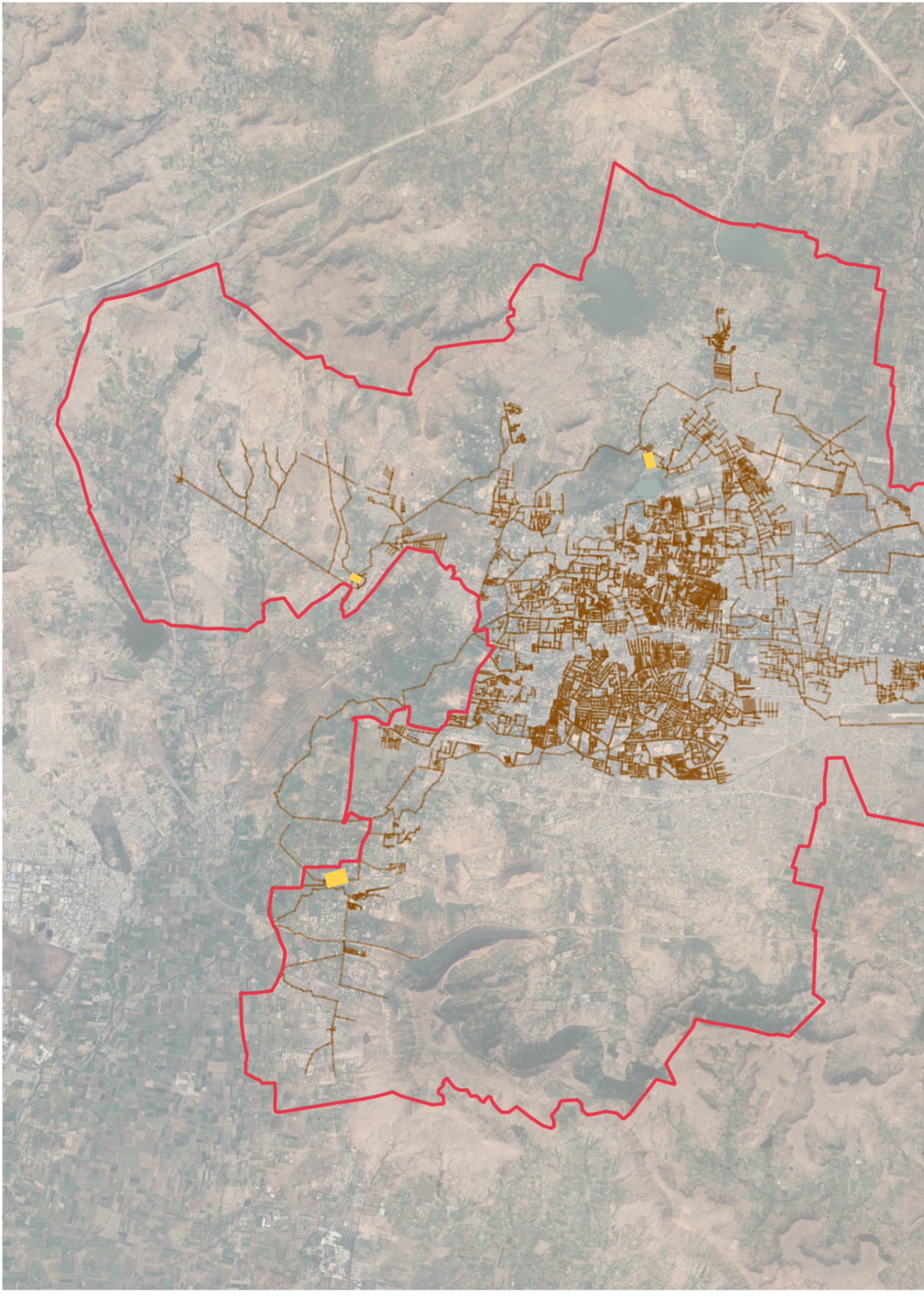
Water_Pipelines

AMC_Boundary

Google Satellite

Source: Aurangabad Municipal Corporation

Map: 12 - Existing Water Supply (AMC)





EXISTING WASTEWATER NETWORK AURANGABAD

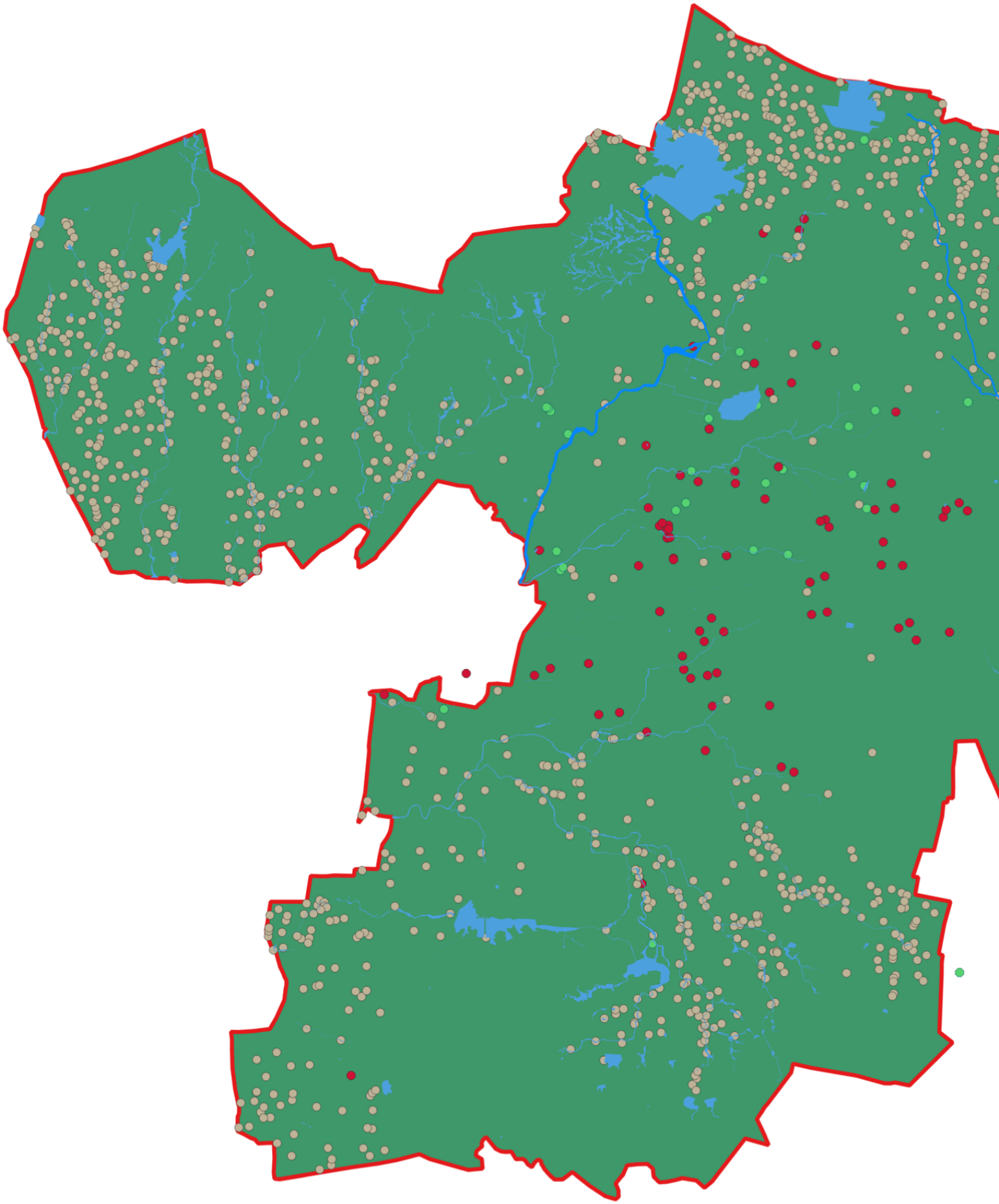
LEGEND

- STP
- AMC_Boundary
- Sewerage_Line

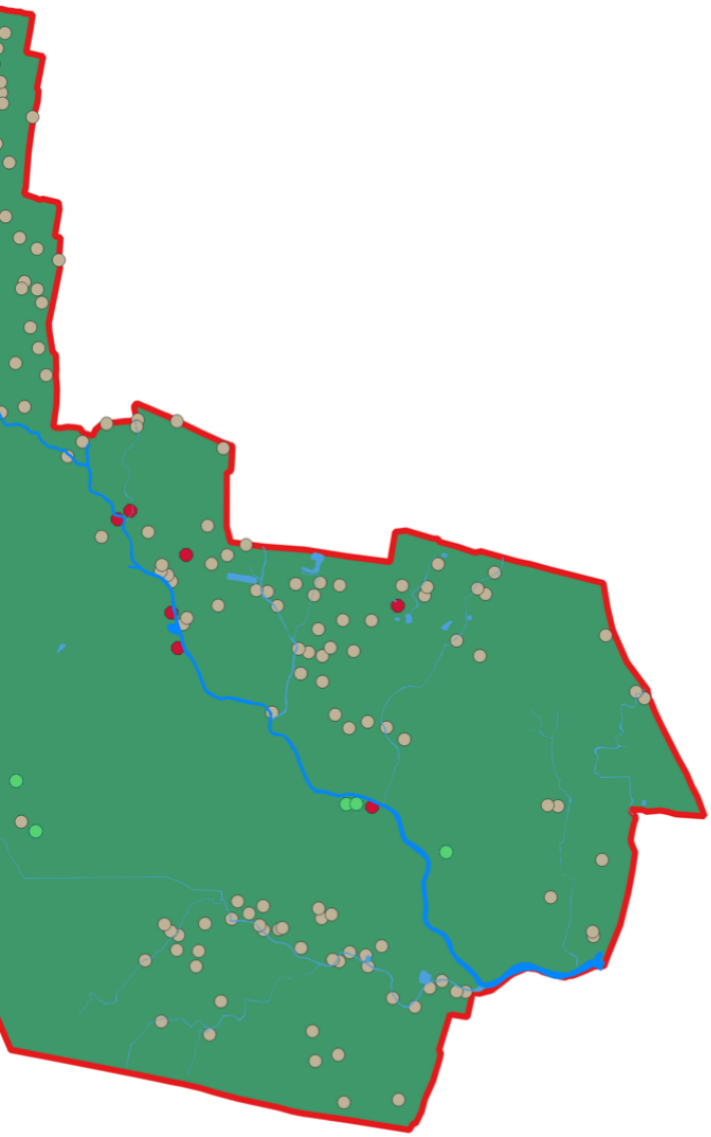
Google Satellite

Source: Aurangabad Municipal Corporation

Map: 13 - Existing Sewage Network (AMC)



OPEN WELLS AND BORE WELLS AURANGABAD



LEGEND

- Private Borewell

Government Owned wells

- Bore Well
- Open Well
- Principal Aquifer (Basalt)

0 1 2 3 4 km

Source: Aurangabad Municipal Corporation

Map: 14 - Open wells and borewells mapped by AMC

Objective 7: To develop eco-friendly riverfront projects

Rationale: Riverfronts add both aesthetic and economic value to the river. It serves as a medium to bring the river to the forefront. It is also a major avenue for recreation opportunities. In doing so, riverfronts become a wonderful instrument to connect citizens to the river, as well as become a source of revenue.

Objective 8: To leverage on the economic potential of the river

Rationale: Cities must begin to realize that a river has tremendous economic value through the ecosystem services it provides, and livelihoods it can support. Already cities across the globe have boosted their economies through river-centric activities. Rivers can help cities progress up the economic ladder, which every city aspires. Needless to say, the scale and extent of such activities must account for carrying capacity of the river.

Most of the riverfront area along the Kham and Sukhna rivers is presently under agricultural activities, settlements till the river edge, or a few open lands. However, given the lack of citizen connect with the rivers and very few open spaces in the city, there is a huge potential for lively riverfront spaces. Furthermore, there is a scope for connecting the individual heritage structures located along the stretch of the river, like the gates, Panchakki, Himayat Bagh, Bibi-ka-Maqbara, etc.

The ambitious and visionary Kham River Restoration Project undertaken by the city, is an expression of Chhatrapati Sambhajinagar city's commitment to its natural heritage and water resources. As a part of this project, an eco-friendly riverfront area, called the Kham Eco Park (figure 16), has been developed with an aim to build a blue-green space to enhance the citizen connect with the river. Built along a stretch of 1.5km along the river, this area is marked with grasses, butterfly and dragonfly garden, miyawaki forest, amphitheatre made from waste tyres, fresh-water pond, wetland, and is covered with around 50,000 native species of plants and trees. In addition to providing an ecological recreational space for citizens, the eco-park also reinvigorates the lost flora and fauna. Defining the river bank for eco-park also prevents any further encroachment.

So far, around 1250 mts. of porous pathways have been created; 6 kms of the river has been cleaned, dredged and widened; 3 kms of the river has been pitched with stones on both banks for stabilisation and 10 ecological riverfront spaces have been created. In the entire park, repurposed waste material is used wherever possible and electrification is done using re-used poles and solar lighting.



Figure 16: Existing eco-park along Kham river

Objective 9: To inculcate river-sensitive behaviour among citizens

Rationale: Citizen support is vital for long-term sustainability of urban river systems and the success of any initiative by urban local bodies. This support becomes far easier to solicit when citizens are aware of the issues at hand, and how they can help address those. Cities need to develop a dedicated strategy to spread awareness about the benefits of healthy rivers through innovative dissemination mechanisms. This will be stepping stone for the desired behavioural change.

Objective 10: To engage citizens in river management activities

Rationale: This is important to make a shift from 'citizens as spectators' to 'citizens as actors'. This also sends out the message that river management cannot be the government's mandate alone. Residents will need to step in and share the onus of responsibility. Most progressive societies have some or the other form of this governance model. In the long run, it will help create a transformation in the mindset of people towards ecological assets of the city.

As part of a residents survey carried out at the start of the ongoing Kham River Rejuvenation Project in Chhatrapati Sambhajinagar city, 40% of respondents reported not being aware of the presence of a river in their city. To improve this unsettling statistic, citizen engagement has been taken up as an important pillar of the existing Kham River Restoration Mission. The aim of this intervention is to increase awareness about the river, its socio-ecological as well as heritage value; and ultimately build ownership among citizens to ingrain sustainability within the current restoration efforts.

Since 2021, a number of events have been organised at the Kham Eco-park for engaging citizens (figure 17). These events engage key resource people to celebrate notable days and generate awareness around various relevant topics. Saturday civic engagements have been the center-piece of this movement, calling citizens to volunteer for river-cleanup, plantation and plogging drives. Citizens and volunteer groups also plant saplings along the river banks and nalas. Other interesting activities hosted under this initiative include webinars, painting competitions and the Kham song competition. This program is truly a partnership between the residents, administration and all other stakeholders. These efforts have led to behavioural change in the resident population.

However, all these efforts have been primarily limited only to a certain stretch along the Kham river.



Figure 17: Community engagement in Kham river cleaning and planting drives

2.4. Monitoring and Evaluation of the Current Situation

Monitoring and Evaluation (M&E) is a vital element of the URMP. It provides a mechanism to evaluate the progress of implementation of the URMP vis-à-vis its objectives. The implementation of the URMP shall be monitored through 10 indicators, one for each objective of the URMP framework. These indicators shall collectively culminate into an index called Urban River Management Index (URMindex). The URMindex is measured on a scale from one to five, and is useful to paint a snapshot of the situation, which can be used to monitor the implementation of the URMP, and develop overall strategies and policies for enhancement.

In order to understand the present status of water resources in the city, an assessment is made using the URMindex. With a score of 1.6, Chhatrapati Sambhajinagar is at elementary level of urban river management. This score shall improve upon implementation of proposed interventions against each objective. The graphic below shows how the city performs against each objective of urban river management. (figure 18)



Figure 18: URMP Monitoring and Evaluation to assess the current situation

2.5. SWOT Analysis

Based on the URMP Baseline and multiple discussions with the city stakeholders, a SWOT Analysis has been carried out for the river and its associated elements in the city. This was used as a base to identify the potential sectors for interventions.



STRENGTHS

- There is a general sensitivity towards rivers among the citizens of Chhatrapati Sambhajinagar
- Chhatrapati Sambhajinagar already has the required infrastructure for wastewater management, in terms of Sewage Treatment Plants and proposed network coverage
- Existing water bodies in the city can serve as strategic assets in restoring the river ecosystem in the city.



WEAKNESSES

- Lack of water in the rivers, thereby making river management a challenging concern
- There are huge dumps of solid waste along the water resources
- Ground water levels in the city are decreasing



OPPORTUNITIES

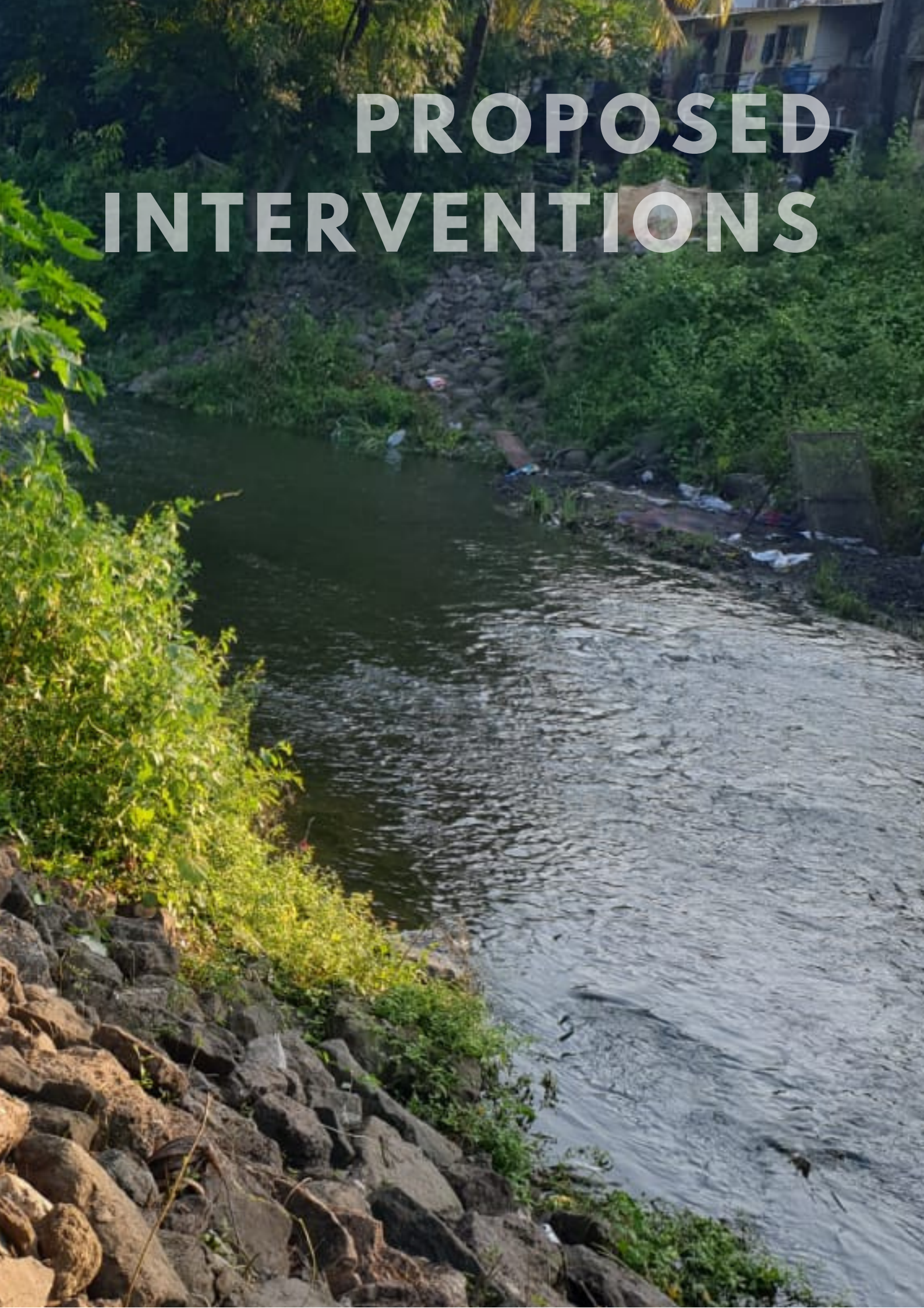
- Given the number of industries in the city, there is tremendous potential for their engagement in river management
- The seasonal nature of rivers provides opportunities for multiple use of the floodplains in a eco-friendly manner
- A number of local agencies and academic institutions are working on river management in the city
- Some floodplain stretches in the northern zone of Kham and along the Sukhna river have limited encroachment, and potential for eco-sensitive development



THREATS

- Solid waste dumping in the open areas is a commonplace
- Encroachment of the river bed and the floodplains.
- The water and waste water infrastructure laid out by the industries is completely separate from the municipal corporation infrastructure
- Some of the older industrial areas don't have effluent treatment measures and the necessary infrastructure.
- New industrial areas are proposed in and around the city, which will add


03



PROPOSED INTERVENTIONS





1 Regulation of Activities in Floodplain

3.1 Interventions for regulating activities within the floodplains

3.1.1 Intervention 1

Strengthening planning provisions in the revised Development Plan

The objective 1 recommends strengthening the planning provisions in the Master Plan, which have a direct impact on the conservation and management of rivers, drains and water bodies.

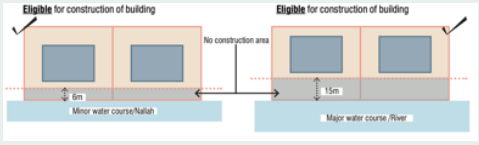
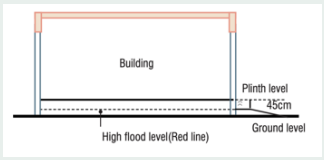
Chhatrapati Sambhajinagar is in the process of revising its existing Development Plan. While the new Development Plan includes certain provisions for protection of the Kham and Sukhna floodplains, it misses out on key elements such as delineation of the flood plains, regulation of activities within the flood plains and appropriate development control regulations to manage the flood plains in an ecologically sensitive manner.

Accordingly, as part of URMP, following suggestions shall be integrated in the revised Development Plan for Chhatrapati Sambhajinagar.

Provisions in the Existing Development Plan	**Recommendations for the Revised Development Plan**
The last Draft Development Plan notified in 2016 by AMC that was directed for revision by the Supreme Court broadly covered the following aspects for the environment*:	Recommendation: One of the objectives of the Chhatrapati Sambhajinagar Development Plan currently in progress can be:

Provisions in the Existing Development Plan	Recommendations for the Revised Development Plan
1. All the Nalas passing through Chhatrapati Sambhajinagar additional area have been proposed to be channelized; 2. Development of traffic islands 3. Sites to be reserved for garden at different locations 4. Fencing and protection of open areas by the AMC	One of the focus areas of the revised Development Plan can be to: "Protect, revive and manage the Kham and Sukhna River ecosystems in a sustainable manner embodying their ecological considerations while also celebrating their socio-cultural and economic value." **Rationale**: Both the Kham and Sukhna rivers in Chhatrapati Sambhajinagar are significant rivers in the historical development of the city in the semi-arid and drought prone Marathwada Region. With the fluctuating rainfall patterns and rapid urbanization, if these river ecosystems are built upon, these two rivers might cease to exist in the future.
Currently, the booming industrial city doesn't have a cohesive long term vision that includes its two rivers.	**Recommendation**: Including River Kham and Sukhna in the long-term vision of the city. **Rationale**: Both Kham and Sukhna Rivers pass through the heart of the Chhatrapati Sambhajinagar City. The long term vision must give prominence to the huge potential of the two rivers in the ecological, social and economic growth of the city.
The current and last Development Plans of the city do not direct the city to monitor and regulate the development in or around these Rivers.	**Recommendation**: Direct AMC to collate an extensive baseline of the qualitative and spatial aspects of the Kham and Sukhna rivers with support from different agencies to create a robust database for the rivers.

Provisions in the Existing Development Plan	Recommendations for the Revised Development Plan
As a result, the Kham river has encroachment along some stretches. There is also no direction on activities like sand mining, construction within the river bed, thus altering the flow and course of the river itself. Similar observations were made for Sukhna during the reconnoissance study. This has led to incidences of floods along both the Rivers in the last two years in high rainfall months. The other extreme is having minimal to no flow along the course of the two rivers through the city.	**Rationale**: In the run up to the Development Plan, studying the existing conditions, land use and the built development around the two rivers is paramount to restoring the two river ecosystems. The existing GIS based land use plan developed by the AMC and ASCDL must document and spatially map the built development existing on ground, not just along the river, but also in the watershed/ local catchments of the two rivers. This can be instrumental in ensuring that the two rivers maintain base e-flow during all times. The regular monitoring carried out by MPCB on the quality check of the rivers at some points must inform the Development Plan on incompatible and polluting uses in and along the rivers. This baseline will also help in setting more measurable goals and targets for the rivers.
The Chhatrapati Sambhajinagar Development Plan does not reflect the mandatory red and blue floodlines in the land use plan.	**Recommendation:** Delineate the red and blue flood lines for Kham and Sukhna rivers, as marked by the I&FC department, on the land use plan. Incorporate the floodplain regulations made in the national or state policies.

Provisions in the Existing Development Plan	Recommendations for the Revised Development Plan
	The existing Development Plan is guided by the provisions made in the Maharashtra Unified Development Control & Promotion Regulations**. The following are the river-related provisions that must be incorporated into the Plan: • Earmarking no-construction zones for both rivers and nallahs/ drains/ minor water courses:  • Provide the plinth height in the red-line zone  • Low development and low density activities permissible in the blue-line (restricted zone) as marked by the I&FC

**Supreme Court Judgement on the last Plan, Available at: https://main.sci.gov.in/supremecourt/2016/29400/29400_2016_32_1504_21665_Judgement_17-Apr-2020.pdf*

***Graphical Dictionary of Unified Development Control & Promotion Regulations for Maharashtra State, Available at: https://dtp.maharashtra.gov.in/sites/default/files/Notification/UDP_DTP/UDCPR%20an%20illustrative%20manual.pdf*

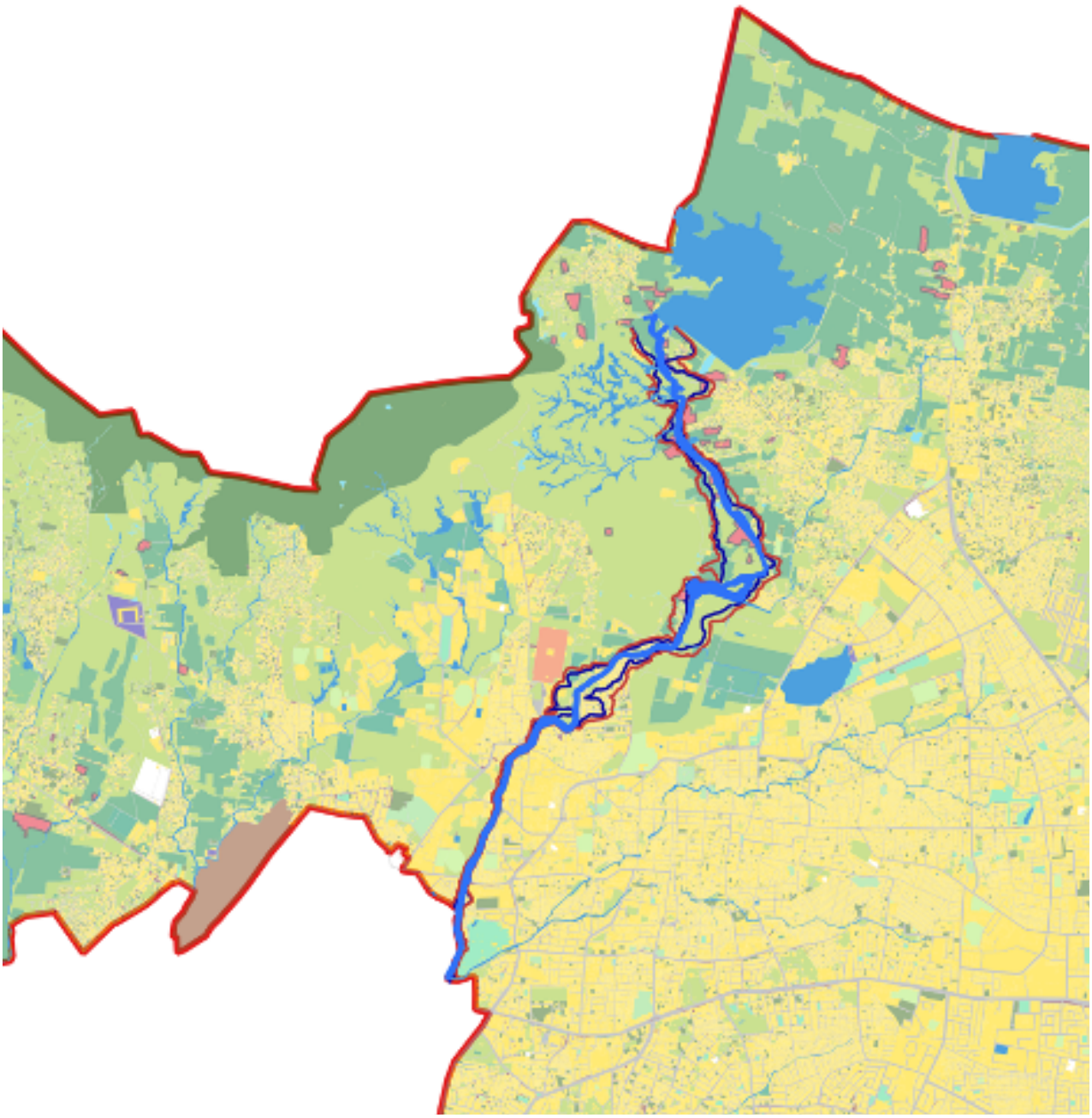


Figure 19: Delineating of Red and Blue flood lines along Kham river, on the land use plan

Besides the core recommendations, the following broad suggestions can be considered in the revised Development Plan, following the ground truthing of the red and blue flood lines along the Kham river and Sukhna River:

- Earmarking 'River Zone' in the Land use Plan: The next Development Plan can institute river-sensitive development by delineating the 'River Zone' (river+floodplains/ riparian buffer) within the land use plan, aligned to the red and blue line marked by the Irrigation Department. The permitted activities and development norms must adhere to the Unified Development Control and Promotion Regulations for Maharashtra State, 2020 and other policy directions for ensuring that any future development in this Zone is regulated.

- Regulating the existing development in the floodplains: The Development Plan shall provide directives for the existing formal and unauthorised development in the floodplains. A clear strategy shall be devised after documenting such developments, land ownership, unregulated or informal activities (such as sand mining, dhobhi ghats, cattle sheds etc.) towards retaining or relocating the activities in a sustainable manner.

- Providing buffers around drains and water bodies: The Maharashtra Development Control and Promotion Regulations mandates buffers around drains that shall be enforced by the Development Plan, specially for the 27 major drains in the city. The plan may also direct a competent authority to identify and establish adequate buffer standards (as per requirement and land availability analysis) for water bodies within the city to regulate development around them.

- Identifying and earmarking groundwater recharge zones: The Development Plan may direct the concerned authority to identify potential groundwater recharge zones within the city. These should be earmarked under appropriate land use category within the land use plan. It may also provide strategies for promoting recharge and reuse. (The City has already documented the public owned wells that can help in creating the database around groundwater levels in the city)

- Mandating 'no-solid waste' zones: The Development Plan may direct the concerned authority for removal of existing and emergence of any new formal/ informal dumping sites within the River Zone. It can also recommend the concerned department towards strengthening of waste collection system from unauthorized sector along the rivers.

The River -sensitive Master Plan Guidelines developed by NIUA and NMCG can be referred to design and incorporate more such strategies within the Development Plan, applicable to the context of Chhatrapati Sambhajinagar.







3.2 Interventions to keep the rivers free from pollution

3.2.1 Intervention 2

Implement NEERI's RENEU at Siddharth Garden Drain

One of the main concerns regarding the pollution load in Kham river, is the extensive load of untreated discharge from various drains. The average flow of Siddharth Garden drain is about 22-24 MLD. The Restoration of Nallah With Ecological Units (RENEU) technology, developed by CSIR-NEERI, can be used for in-situ treatment of this drain. (figure 19)

RENEU refers to "treatment of sewage in the running flow without displacing/disturbing the shape/structure of Nallah; and by employing physical and biological operations to treat the sewage". Major benefits of this technology, against the conventional treatment options, include considerable reduction in water pollution, low capital cost and O&M cost, no need of extra land space, aesthetical edge with other technologies, and no odour. the technology is being implemented in various cities including Mumbai, Daman, Ulhasnagar and Pune.

Key features of this technology:

- For implementation of this technology, drains having 1-10 MLD require a stretch of 180-200m and drains having flow greater than 10 MLD require a stretch of 200-600m.
- The cost of the project was Rs 835 Lakhs per MLD for civil construction and O&M of Rs 255 Lakhs per MLD (including manpower, consumables, electricity, testing, contingency and miscellaneous items).
- The technology demonstrates 40% reduction in pollution, with both BOD and TSS of treated water reduced to $\leqslant$ 30 mg/l.

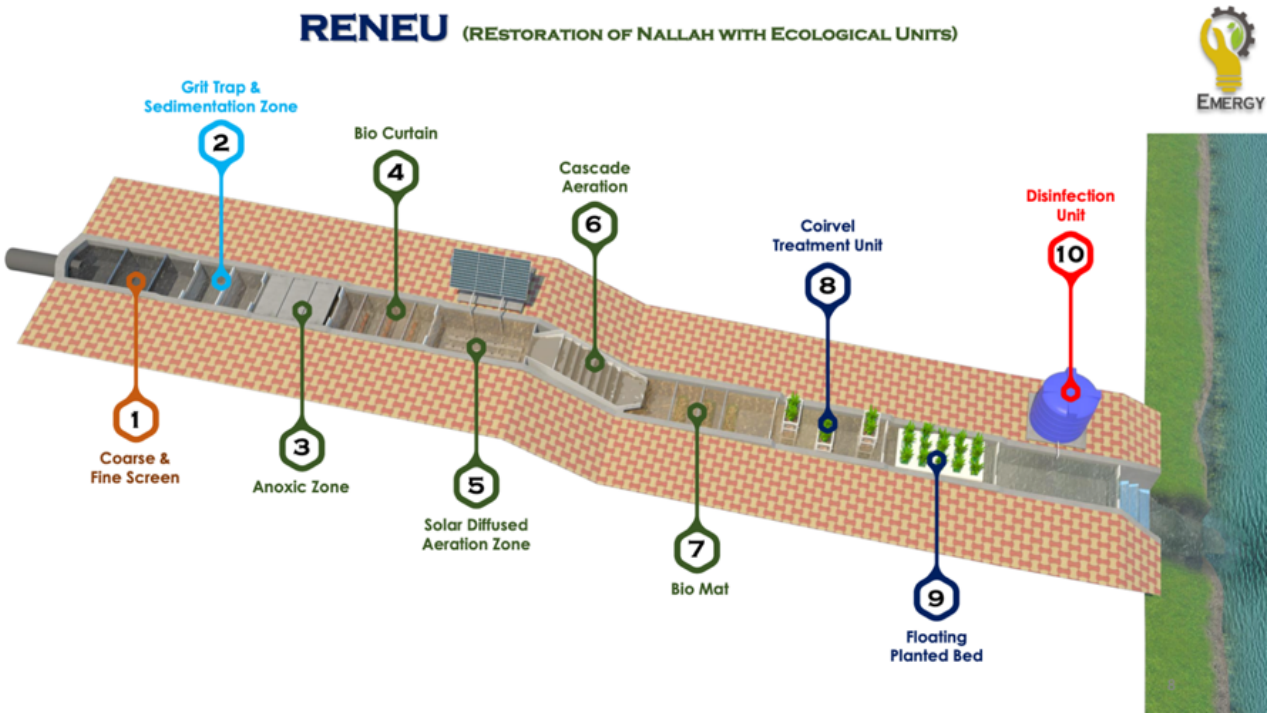


Figure 20: Schematic showing the RENEU technology developed by CSIR-NEERI

The 0.6 km Stretch of Siddharth Garden drain shown below, can be used as a test bed for the application of this technology. (figure 20)

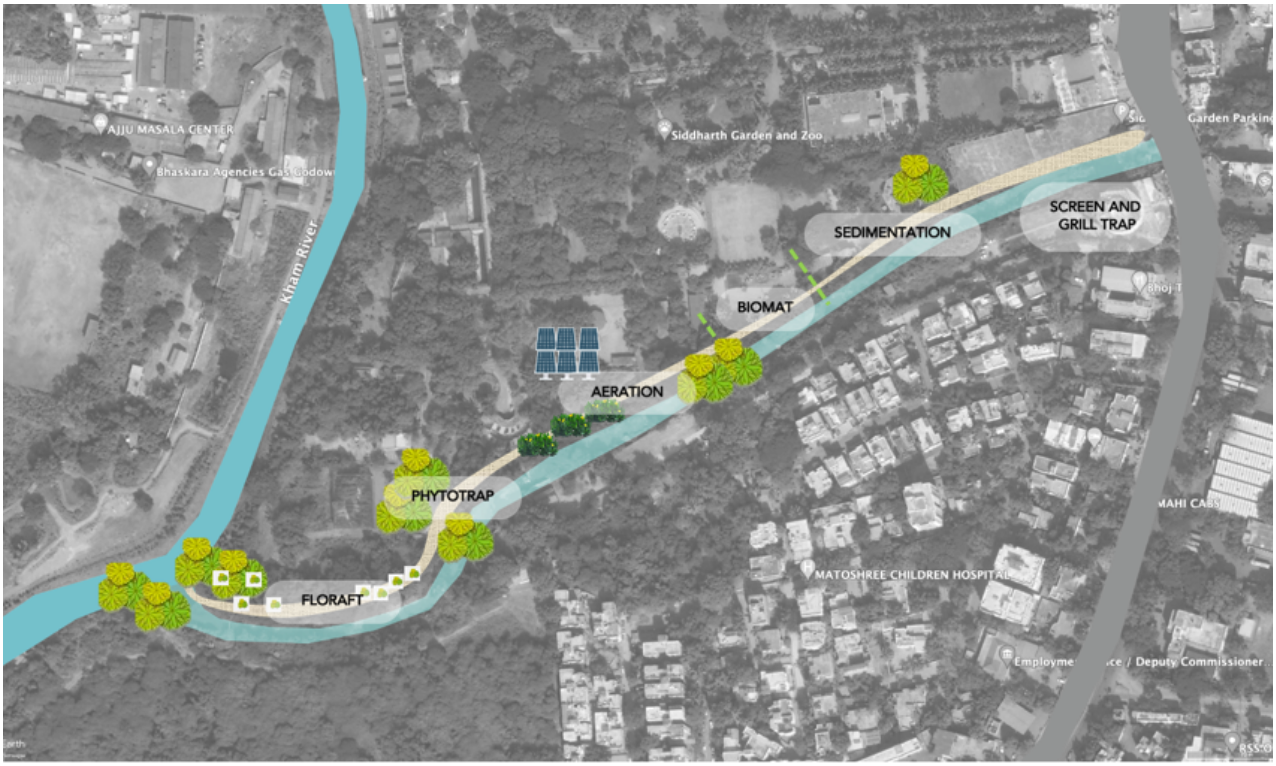
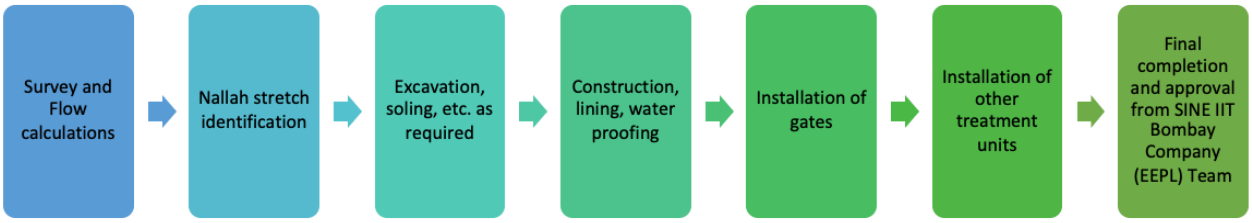


Figure 21: Treatment of a stretch of Siddharth Garden Nala using RENEU technology



Figure 22: Before and after in-situ drain treatment

Following process may be followed in order to implement this intervention



IMPLEMENTATION

Phase 1 - short term

ESTIMATED COST

INR 7,70,00,000/-

SOURCES OF FINANCING THE INTERVENTION

- *Corporate Social Responsibility*
- *Jal Jeevan Mission (Urban)*
- *National River Conservation Directorate funds*

LINKS FOR MORE DETAILS ABOUT THE INTERVENTION

- *Process - https://www.csir.res.in/renewing-and-restoring-sewage-using-reneu*
- *Key features - https://cpcb.nic.in/openpdffile.php?id=TGF0ZXN0RmlsZS8yODVfMTU4MjYzMjkxN19tZWRpYXBob3RvMjY3MzcucGRm*

- *Case studies - https://cdn.cseindia.org/attachments/0.54258900_1597398991_phytorid-and-reneu-for-decentralized-wastewater-treatment-by-dr-rakesh-kumar,-csir-neeri.pdf*
- *Acknowledgements - https://timesofindia.indiatimes.com/city/nagpur/neeri-bags-award-for-tech-to-treat-flowing-waste-water/articleshow/78340004.cms*
- *Solution providers - https://www.emergyenviro.com/Sub-Products/Restoration-of-Nallah-with-Ecological-Units-(RENEU)/6*

3.2.2 Intervention 3

Treating industrial pollution using TADOX

The Chikhalthana MIDC industrial area within the city is an old industrial estate, with 2.0 MLD effluent discharge. Out of this, only a very small percentage is treated, while the rest finds its way into the Sukhna river.

The Energy and Resources Institute's technology called 'The Advanced Oxidation Technology (TADOX)' can be used for treatment of waste water from these industrial areas, where there is no CETP or land and resources to develop one.

TADOX technology, which uses UV-Photocatalysis, can treat municipal sewage and highly polluting industrial wastewater streams and increase its reuse potential. It can reduce dependence and load on biological and tertiary treatment systems and help achieve Zero Liquid Discharge (ZLD). It can be integrated and retrofitted in existing treatment systems, making it a viable option as a novel Decentralized Wastewater Treatment Technology (DWTT) applicable in upcoming and existing infrastructural projects, townships, commercial complexes, green buildings, and smart cities.

Key features of this technology:

- It can bring down capital expenditure on ZLD by 25-30% and operating expense by 30-40% for industrial wastewater treatment.
- It provides an opportunity where bioremediation could be completely bypassed, leading to reduced footprint, capital expenditure, operational expenditure, together making the overall wastewater treatment much more affordable and sustainable.

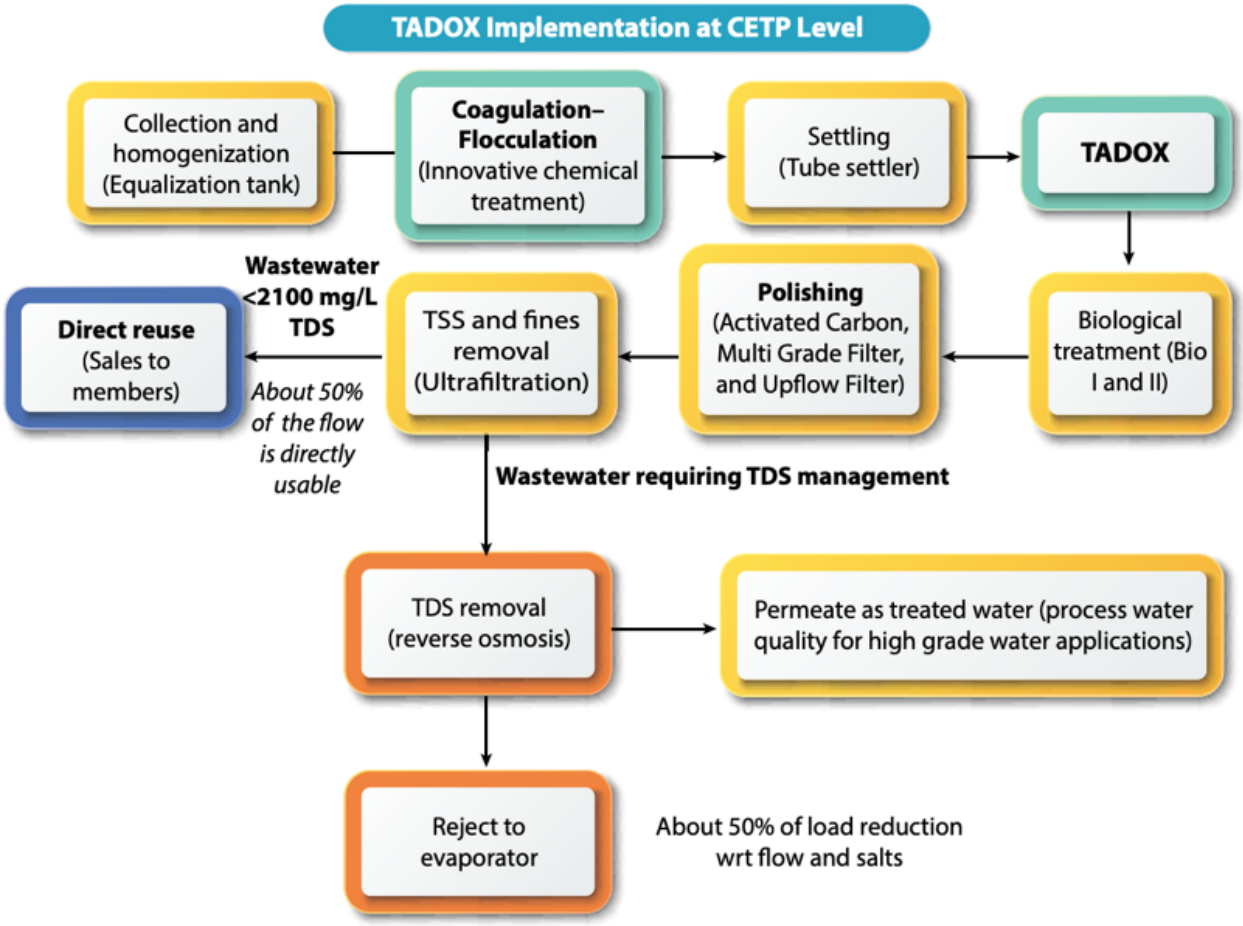


Figure 23: Process schematic for implementation of TADOX at common ETP scale, TERI



Figure 24: Case example - 10 KLD TADOX plant at TERI Gram, Gurugram

IMPLEMENTATION

Phase 2 - medium term



ESTIMATED COST

INR 12,00,00,000/-

SOURCES OF FINANCING THE INTERVENTION

- *Corporate Social Responsibility (CSR) from industrial groups*
- *Jal Jeevan Mission (Urban)*
- *CII/ MIDC/ Industrial Association*

LINKS FOR MORE DETAILS ABOUT THE INTERVENTION

- *Technology details - https://www.teriin.org/sites/default/files/2021-03/textile-dyeing-wastewater.pdf*
- *Acknowledgements - https://pib.gov.in/PressReleasePage.aspx?PRID=1748888*
- *Application - https://www.teriin.org/video/tadox-teri-advanced-oxidation-technology-wastewater-treatment-and-reuse*

3.2.3 Intervention 4

Treatment of waste water discharge from informal activities (dhobi ghats)

There is no formal system for waste management from informal activities such as cattle sheds and dhobi ghats in the river along the river. The water requirement and waste water discharge from these activities is not monitored.
According to the scale of the activity, decentralised water treatment measures for in-situ treatment of the discharge loaded with chemicals, detergents, organic waste etc. shall be made mandatory.

Currently, the waste water from the existing dhobi ghat adjacent to Kham river near Siddharth Garden, is directly discharged into the river. Installation of a decentralised treatment plant can help in decreasing the pollution load on the river. Additionally, the treated waste water can be recycled and reused for the water supply need of the facility. This shall reduce the existing burden on river and groundwater, as well as the power consumed to draw water.

A formal mechanism for the functioning of any dhobi ghat in this area, with details of the water demand, water source and management of waste water, will further support the agenda of river management. Less water intensive automatic machines can be installed. This will not only save water by recycling used water, but it will also ease the lives of the local washermen at large.

Delhi and Bangalore have established formal setups for some of the the dhobi ghats along their rivers and drains. In addition to being mechanised, these dhobi ghats are also set to recycle water by installing treatment plants on their premises. The administration of Rajnna Siricilla district of Telangana have also developed an old dhobi ghat into a modern laundry place with all facilities.



Figure 25: Case example - Mechanised Dhobi Ghat in Delhi

IMPLEMENTATION

Phase 1 - short term

ESTIMATED COST

INR 1,00,00,000/-

SOURCES OF FINANCING THE INTERVENTION

- *Corporate Social Responsibility (CSR)*
- *Urban Local Body funds*

LINKS FOR MORE DETAILS ABOUT THE INTERVENTION

Case Examples -

- *https://www.thehansindia.com/telangana/mahabubnagar-mechanised-dhobi-ghat-turns-a-boon-to-dhobis-719148*
- *https://telanganatoday.com/telangana-govt-to-set-up-modern-mechanized-dhobi-ghats-in-141-ulbs*

3.2.3 Intervention 5

Real-time water quality monitoring stations (RTWQMS)

Presently, the water quality of the Kham and Sukhna rivers are measured manually. This method is highly irregular, has scope for errors, and takes time for the data from stations to reach the officials. Hence, the traditional grab sampling method is unlikely to provide a reasonable estimate of the spatial and temporal variability in water quality at a particular site.

Sensor based real-time data networks for water management is a standard practice across cities for efficient management of urban rivers. This project is expected to provide a state-of-the-art, real-time picture of the water quality of Kham and Sukhna rivers, through the real-time data on predefined 15-20 parameters. These parameters include Ammonia, BOD, COD, BTX Chloride, DO, DOC, EC, Fluoride, Nitrate, Hydrogen Sulfide, pH, Potassium, TOC, TSS Turbidity, Colour, Temperature, Nitrites and water level.

Real-time data, collected at an interval of fifteen minutes will be transferred to the Central Repository / Data Server / RDBMS though the GSM / GPRS telemetry link. This may be integrated with the Smart City Command & Control Centre for live updates. The filtered and calibrated data will be analyzed and processed in the desired form to feed ASCDCL and support in decision-making.

These monitoring stations may be installed at the origin points of Kham and Sukhna rivers, as well as where these rivers exit the city. Additionally a study may be commissioned, to scientifically cite locations for any additional real-time water quality monitoring stations

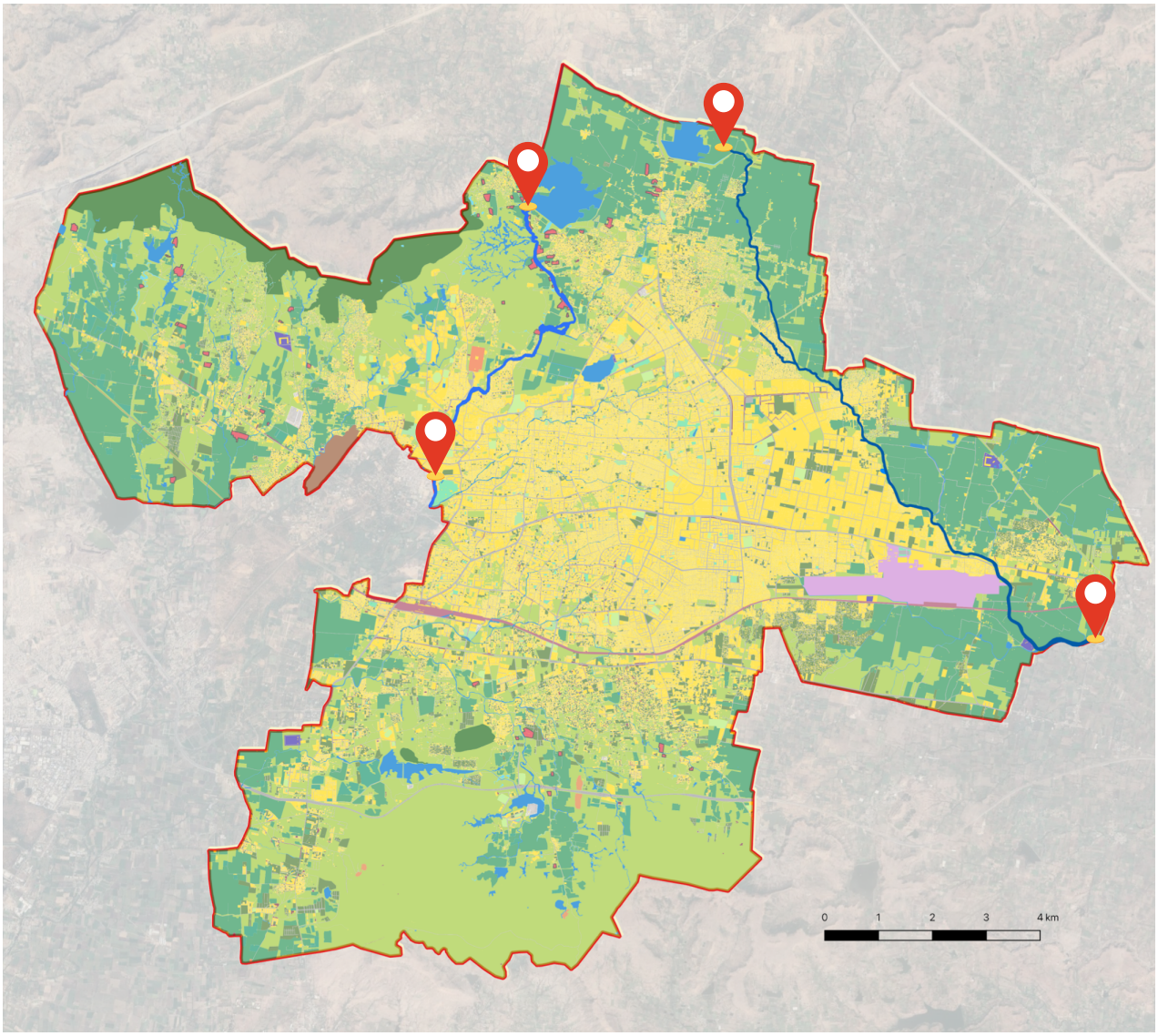


Figure 26: Proposed location of real-time water quality monitoring stations

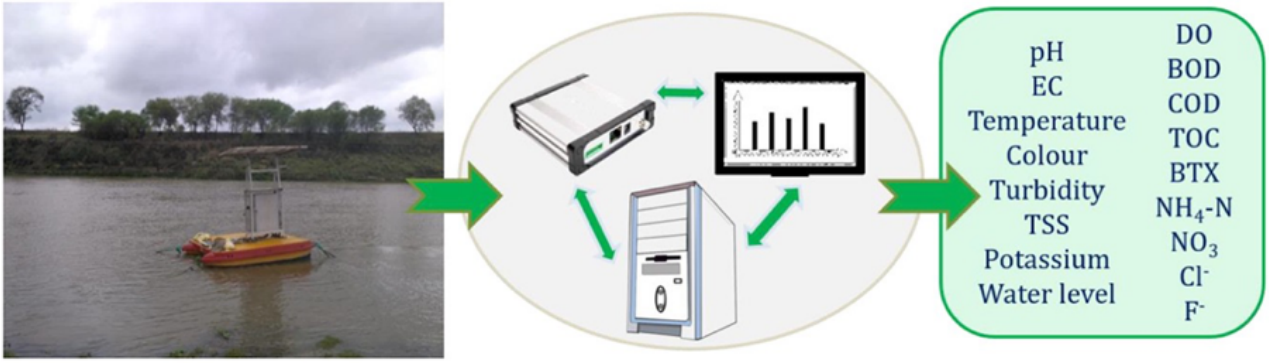


Figure 27: Parameters measured by real-time water quality monitoring stations (Source: NMCG)

IMPLEMENTATION

Phase 3 - long term



ESTIMATED COST

INR 1,00,000/-

SOURCES OF FINANCING THE INTERVENTION

- *Urban Local Body funds*
- *National River Conservation Directorate*
- *Maharashtra Pollution Control Board*

LINKS FOR MORE DETAILS ABOUT THE INTERVENTION

- *Technology details - https://www.sciencedirect.com/science/article/abs/pii/S1574954122002205*
- *Technology details - https://mission-ganga.thewaternetwork.com/article-FfV/monitoring-of-real-time-pollution-data-from-ganga-jyv7Av1hkH6OCOQnr_KgDQ*
- *Application - https://nmcg.nic.in/pdf/NMCGdocketonWQM.pdf*

3.2.4 Intervention 6

Waste ATMs/ Community Green Stations for Solid Waste Management

Even though there is an already existing waste collection mechanism in the city, huge loads of garbage dumps are found around the rivers and water bodies. There is a clear need to nudge public behaviour towards reducing this. An innovative way to instil a sense of cleanliness among the masses, is the use of 'Waste ATMs'/ 'Garbage ATMs'/ 'Community Green Stations' at specific solid waste hotspots.

These Waste ATMs are a unique way to draw public attention, by exchanging trash for monetary benefits. The machines can be used to dispose plastic packets, disposable water bottles, glass bottles, glasses, paper, cans and other waste. The machine incentivise users with cashless rewards through a mobile application, like free mobile recharge, free coupons, free tickets, cashback, or free vouchers.

As a pilot, these machines have been installed at specific accessible locations with large footfall, in Delhi, Varanasi and Pune. Each machine is worth ₹6 lakh, and requires an installation space of 6x4.

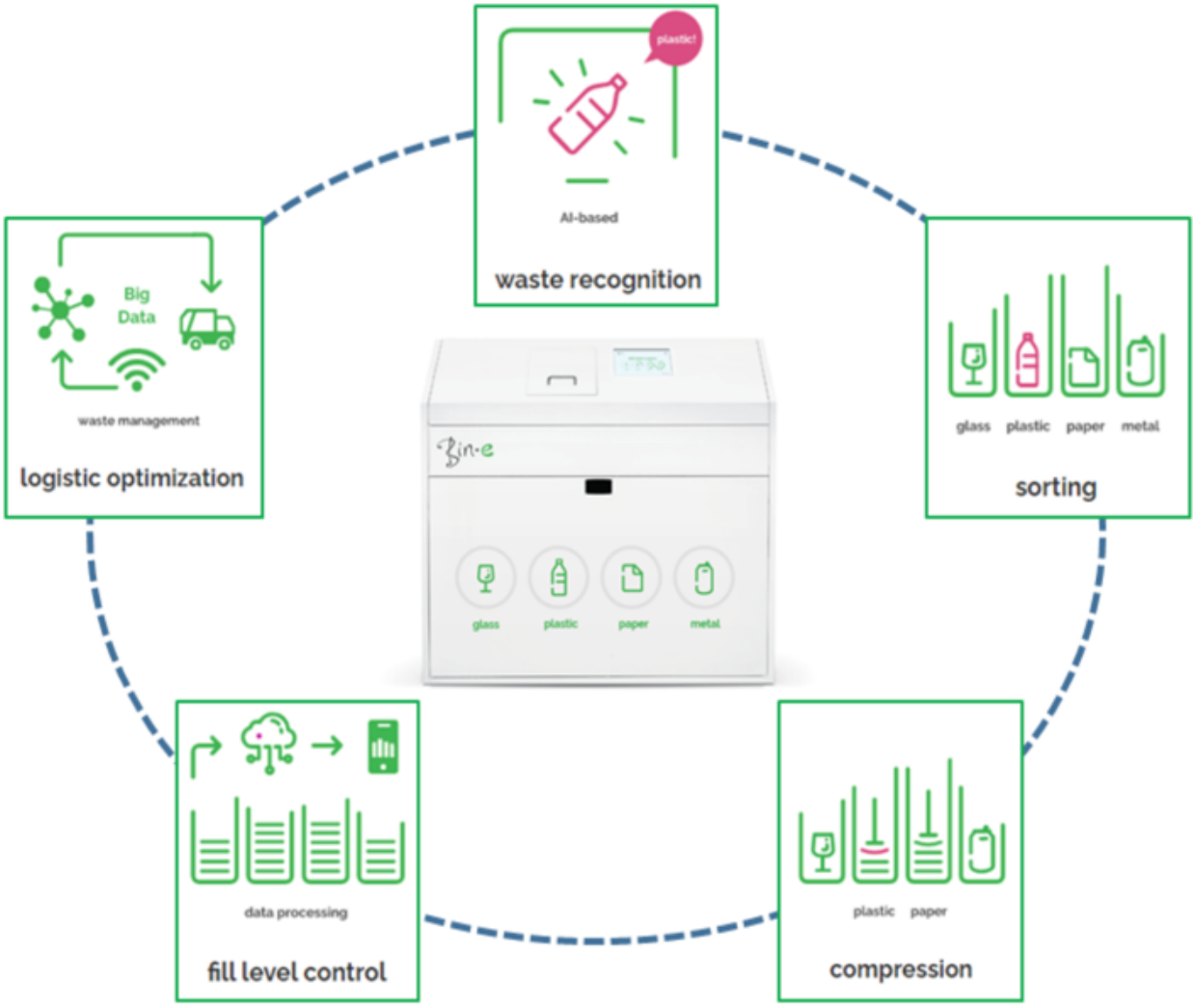


Figure 28: Process of operation of a 'Waste ATM'

Another innovative way to nudge public behaviour is by building a new community recycling network, including Recycling Stations, Recycling Stores and Recycling Spots. These units can accept different types of recyclables, including paper, metals plastics, glass bottles, regulated electrical equipment, small electrical appliances, fluorescent lamps and tubes, and rechargeable batteries, etc. These wastes can be exchanged for Green Coins or smart card, which can be redeemed for gift items. This concept has been adopted by Hong Kong.

Community Green Stations can be built as low-carbon structures or can be within an existing unused built space. These self-service Recycling Stores and Recycling Spots, have proven to facilitate and encourage the public to practice source separation of waste and recycling, so as to achieve "Save More, Recycle More" in Hong Kong.



Figure 29: 'Waste ATM' installed at a public location





Figure 30: 'Community Green Stations' for Solid Waste Management

IMPLEMENTATION

Phase 1 – short term

ESTIMATED COST

INR 6,00,000/-



SOURCES OF FINANCING THE INTERVENTION

- *Urban Local Body funds*
- *Corporate Social Responsibility*
- *Swachh Bharat Mission (Urban)*
- *Pilots*

LINKS FOR MORE DETAILS ABOUT THE INTERVENTION

- *Acknowledgements - https://www.pressreader.com/india/hindustan-times-lucknow/20190330/281496457641314*
- *Acknowledgements - https://www.hindustantimes.com/cities/pune-news/40-garbage-atms-to-be-installed-in-pune-city-in-3-years-101634147561519.html*
- *Acknowledgements - https://swachhindia.ndtv.com/waste-management-solutions-a-startup-develops-waste-atms-to-dispose-of-waste-and-use-e-wallet-to-transfer-money-8050/#:~:text=First%20of%20the%20four%20waste,meters%20away%20from%20the%20monument.*
- *Case example - https://www.wastereduction.gov.hk/en/community/crn_intro.htm*

3.2.5 Intervention 7

Installations to prevent Solid Waste along rivers

A common issue observed in the city is dumping of garbage from the bridges into the river or open spaces around them, specially in dense neighbourhoods and large footfall public areas. To curb this behaviour and sensitise people, art installations using waste can be a unique and creative solution. This will not only influence human behaviour against these malpractices, but also recycle some of the waste.

Selfie points can be created at some strategically identified locations along the Kham and Sukhna rivers, or along the bridges where maximum solid waste dumping is observed. These selfie points can have installations using waste, created with the help of local artists. Locals and students can also be involved while creating these installations. The discarded plastic containers and scrap metal along the banks of the river can be collected and used to make colourful installations. Such initiatives have the potential to reduce citizen antipathy by transforming the dumping spots in the city to art hubs/ vibrant public spaces.

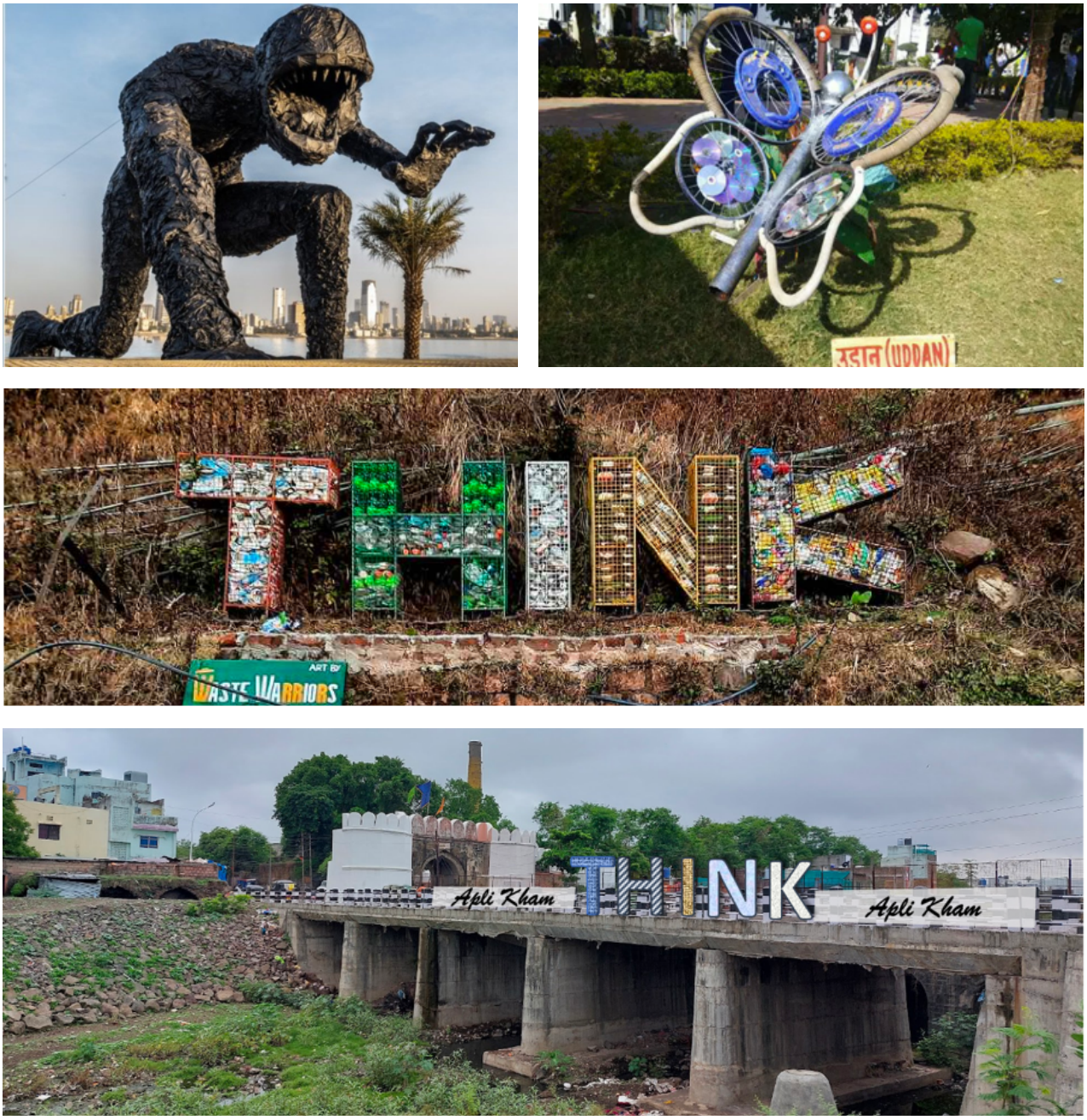


Figure 31: Installations using waste, to prevent solid waste dumping

IMPLEMENTATION

Phase 1 – short term

ESTIMATED COST

INR 25,000/-

SOURCES OF FINANCING THE INTERVENTION

- *Crowd Sourcing, Local NGOs and Influencers*
- *Corporate Social Responsibility*
- *Urban Local Body funds*
- *Swachh Bhatat Mission (Urban)*

LINKS FOR MORE DETAILS ABOUT THE INTERVENTION

- *Case example - https://www.youthkiawaaz.com/2019/10/art-installations-across-india-use-waste-to-promote-recycling/*

3.2.5 Intervention 8

Link the existing solid waste fine collection and recording with a Mobile Application

The already existing penalising mechanism for illegal dumping of waste along the rivers and water bodies can be strengthened using a mobile application. Many spot fine applications are available to enable government bodies and municipal corporations to accept payments of spot fines easily. Additionally there are mobile applications that allow citizens to register complaints against any form of pollution by sending pictures of the unclean and polluted areas.

The use of waste management applications, which comprise of complete waste management features, and provide a medium to access local details and waste management policies, can further inform the system. They include Waste Tracking & Fleet Management App, Waste Compliance App, Asset Maintenance And Management App, etc.

IMPLEMENTATION

Phase 3 - long term



ESTIMATED COST

INR 3,50,000/-

SOURCES OF FINANCING THE INTERVENTION

- *Pilot software by any agency*
- *Corporate Social Responsibility*
- *Swachh Bharat Mission (Urban)*

LINKS FOR MORE DETAILS ABOUT THE INTERVENTION

- https://www.emizentech.com/blog/waste-management-app-development.html
- *https://www.wastereduction.gov.hk/en/community/crn_intro.htm*
- *https://www.indiatoday.in/mail-today/story/delhi-government-manish-sisodia-swachh-delhi-app-garbage-pollution-complaints-351205-2016-11-09*
- *https://yourstory.com/2020/07/ezetap-launches-app-government-bodies-collect-spot-fines*







3 Rejuvenate Waterbodies and Wetlands

3.3 Interventions to rejuvenate waterbodies and wetlands in the city

3.3.1 Intervention 9

Develop a comprehensive GIS-based database for the water bodies in the city

The city shall prepare a GIS-based database of all its water bodies. The database shall have all information about the general, physical, chemical, and ecological parameters. The table below shows some parameters against which information may be documented to create the database.

S. No.	Aspect	Information
	General	Name Location Ownership Land Use/use zone as per Master Plan Neighbouring land use category as per master Plan Existing neighbouring land use Classification (natural or artificial) Type of recreational activities (if any) Revenue Generation (if any) Livlihood dependency (if any)

S. No.	Aspect	Information
2.	Physical	Boundary Average depth Water sources Water use(if any) Elevation above mean sea level Presence of solid waste (Y?N) Width of buffer (if existing
3.	Chemical	Dissolved oxygen pH Temperature Faecal Coliform
4.	Ecological	Type of trees and plants surrounding water body Presence of algal bloom (Y/N) Type of aquatic species present

Figure 32: Contents in an ideal water body database

IMPLEMENTATION

Phase 1 - short term



ESTIMATED COST

INR 30,000/-

SOURCES OF FINANCING THE INTERVENTION

- *Urban Local Body funds*
- Smart City Funds
- Volunteers from universities

3.3.2 Intervention 10

Regular assessment of all water bodies using 'Urban Water Body Diagnostic Tool'

In order to efficiently manage the water bodies, assessment of their current status becomes essential. For regular monitoring of all the water bodies within the city, an online web-based 'Urban Water Body Diagnostic Tool' prepared by NIUA and NMCG may be used.

The Urban Water Body Diagnostic Tool is a decision support system for cities to manage the water bodies within their jurisdiction. The diagnostic tool can help the city in assessing the status-quo of its water bodies, in terms of various physical, chemical, biological, and management parameters. Importantly, the tool helps in conducting a rapid assessment that a city can perform easily and periodically in order to identify immediate actions for their management. Following parameters and indicators are used for a rapid assessment of any waterbody using this tool.



Figure 33: Parameters and indicators of the 'Urban Water Body Diagnostic Tool'

The following figure shows an assessment of the Kamal Talao water body using the Urban Water Body Diagnostic Tool. Data is collected against each of the 10 indicators, and entered in the online tool, to get a score for the water body.

URBAN WATER BODY DIAGNOSTIC TOOL

City Name: **Aurangabad** **WaterBody Name:** **Kamal Talao**

Indicator Type	Indicator	Value	Score	Weight	Weighted Score
Physical Dimension	Algal Bloom	75 to 99	1.00	0.08	0.08
	Odour	Yes	0.00	0.08	0.00
	Solid Waste water body	10 to 75	2.00	0.15	0.30
	Solid Waste in buffer	Yes	5.00	0.09	0.45
Water Quality Dimension	Dissolved Oxygen	4.50	5.00	0.16	0.80
	pH value	5.00	5.00	0.09	0.45
Water Quantity	Change in Surface Area	11.18	3.00	0.10	0.30
Management Dimension	Built up in Buffer Area	71 - 100	0.00	0.08	0.00
	Vegetation in Buffer Area	1 to 25	1.00	0.04	0.04
	Management Protocol	3	3	0.12	0.36

UWD Value **2.78**

Figure 34: Score card on diagnosis of Kamal Talao

The score assigned to each water body indicates the status of that water body, and the kind of improvement measures it requires. For example, the above score of Kamal Talao shows that the water body is in 'Average' condition. While it performs well against some indicators, it performs poorly against others.

UWD Value	Interpretation	What it means?
0 to 1.59	Very poor	The waterbody is in an extremely neglected and dilapidated condition. It performs poorly against most of the indicators. There is an urgent need to revive and rehabilitate the water body.
1.60 to 2.59	Poor	The water body is in a poor condition. There is ample room for improvement against all indicators. It will take a significant effort to revive the water body.
2.60 to 3.59	Average	The overall condition of the water body is fair. While it performs well against some indicators, it performs poorly against the others.
3.60 to 4.59	Good	The overall condition of the water is good. It performs well against most of the indicators. The shortcomings are not very serious and can be addressed with relative ease.
4.60 to 5.0	Very good	The water body is in an ideal condition. It performs well against all indicators. There are hardly any shortcomings, and if there are, they can be fixed easily and quickly.

Figure 35: Interpretation Chart for the 'Urban Water Body Diagnostic Tool'

IMPLEMENTATION

Phase 1 – short term



ESTIMATED COST

INR 16,500/-

SOURCES OF FINANCING THE INTERVENTION

- *Urban Local Body funds*
- *Smart City Funds*
- *Volunteers from universities*

LINKS FOR MORE DETAILS ABOUT THE INTERVENTION

- *Details – https://niua.in/waterandenvironment/wp-content/uploads/2022/06/Manual-on-Urban-Water-Body-Diagnostic-Tool-final_compressed.pdf*
- *Application – http://uwdtool.in/*

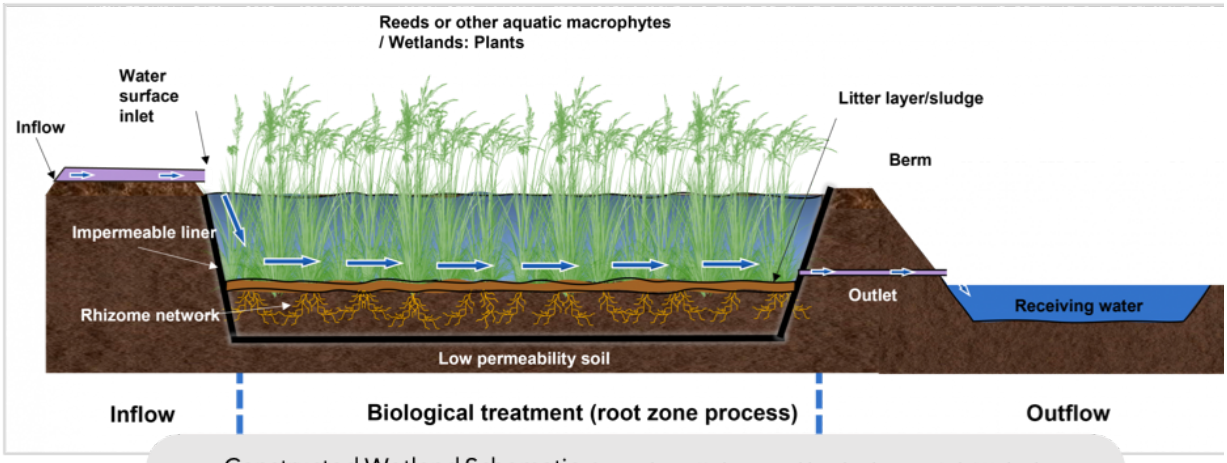
3.3.3 Intervention 11

Rejuvenation of Kamal Talao Lake

Kamal Talao, is instrumental to the health of the Kham river considering its one of the connected elements to the river ecosystem. It is currently surrounded by unauthorized construction on one side and collects untreated waste water from the surrounding settlements. The pond i

To improve the condition of this polluted water body, this waste water requires in-situ treatment before it enters the water body. A constructed wetland can be explored by the city for this purpose until the interception of wastewater is not feasible.

Constructed or treatment wetland can be used for treating organic, inorganic and excess nutrient contaminants in surface water. To achieve this, all the waste water outfall points shall be intercepted and diverted to the smaller portion of this water body. Screens shall be installed to prevent any solid waste and construction debris from entering the water body along with the liquid waste. The existing natural earthen berm, separating the water body into two sections, shall be retained. Overflow channels shall be created for treated water to pass to the other section of the water body. The area along the road shall be retrofitted with walking paths and seating. A corner signage with provision for a library, seating, or cycle stand, will add to the aesthetics and utility of this space.



Constructed Wetland Schematic, Source: https://wiki.sustainabletechnologies.ca/wiki/Wetlands



Conceptual reference for the waterbody edge treatment

Figure 36: Conceptual references for elements in rejuvenation of Kamal Talao



Figure 37: Schematic diagram showing rejuvenation of Kamal Talao

IMPLEMENTATION

Phase 1 - short term

SOURCES OF FINANCING THE INTERVENTION

- *AMRUT 2.0*

ESTIMATED COST

INR 6,40,000/-

LINKS FOR MORE DETAILS ABOUT THE INTERVENTION

- *https://timesofindia.indiatimes.com/city/delhi/4-constructed-wetlands-in-s-delhi-park-to-get-functional/articleshow/80657319.cms*
- *https://www.cseindia.org/constructed-wetland-to-treat-wastewater-at-indian-institute-of-technology-powai-mumbai-6209*

3.3.3 Intervention 12

City-level aquifer mapping

The groundwater levels in the city have been on a decline. Given the water crisis in the area, it becomes essential to map and preserve the underground water reserves.

As per the available records, there are 137 municipal borewells and 1156 private borewells and wells within the city.

The depth of these wells needs to be updated, to prepare a city-level aquifer map. To start with, the 137 municipal borewells can be considered for this purpose. This mapping will also help in the identification of the potential recharge and discharge areas within the city.

The following process may be followed for city-level aquifer mapping:
Identifying the 137 municipal-owned wells

- Measuring and updating the depth of these wells, by deploying a standard monitoring mechanism for measuring static water levels
- Preparing a city-level aquifer map, which helps in the identification of potential recharge and discharge areas

For the purpose of measuring the static water levels, 'Digital Telemetry Based Ground Water Level Recorder' may be used.The Telemetry Digital Ground Water Level Recorder is based on the principle that the measured static pressure of the liquid level is proportional to the height of the liquid. Costing around Rs. 15,000/- per unit, it is widely used for liquid level measurement and control in the fields of ground water level measurement, environmental protection, water conservancy, variable frequency water supply, industrial process control, and chemical industry.

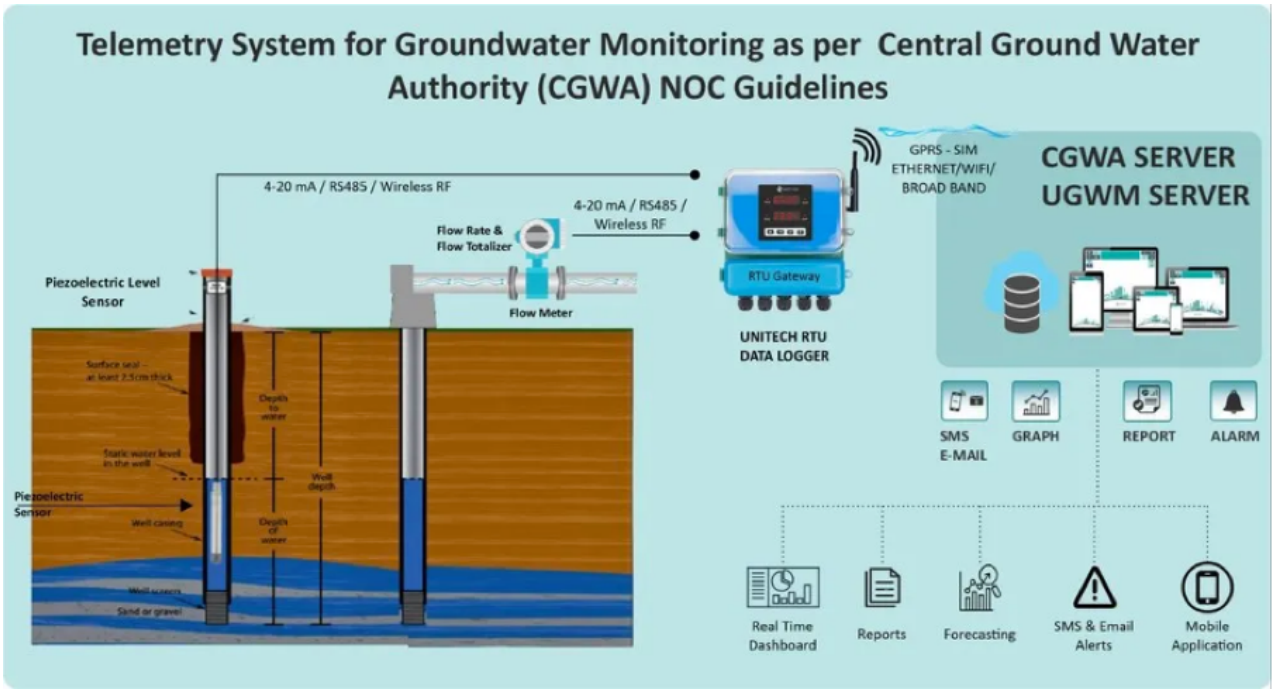


Figure 38: Schematic diagram showing Telemetry system for groundwater monitoring

IMPLEMENTATION

Phase 1 – short term

ESTIMATED COST

INR 6,40,000/-

SOURCES OF FINANCING THE INTERVENTION

- *Urban Local Body funds*
- *AMRUT 2.0*

LINKS FOR MORE DETAILS ABOUT THE INTERVENTION

- *Equipment Details - https://pdf.indiamart.com/impdf/24645356473/1993407/digital-ground-water-level-piezometer.pdf*
- *Specification - https://cgwa-noc.gov.in/landingpage/UserAssistance/Final%20Specification%20of%20Digital%20Water%20Flow%20meter%20with%20Telemetry%20System.pdf*



4 Enhance Riparian Buffer

3.4 Interventions to enhance the riparian buffer

3.4.1 Intervention 13

Develop riparian (plantation) stretches along the two rivers

Some of the undeveloped land along the river bank provides the potential to restore the natural riparian stretches along both the rivers.

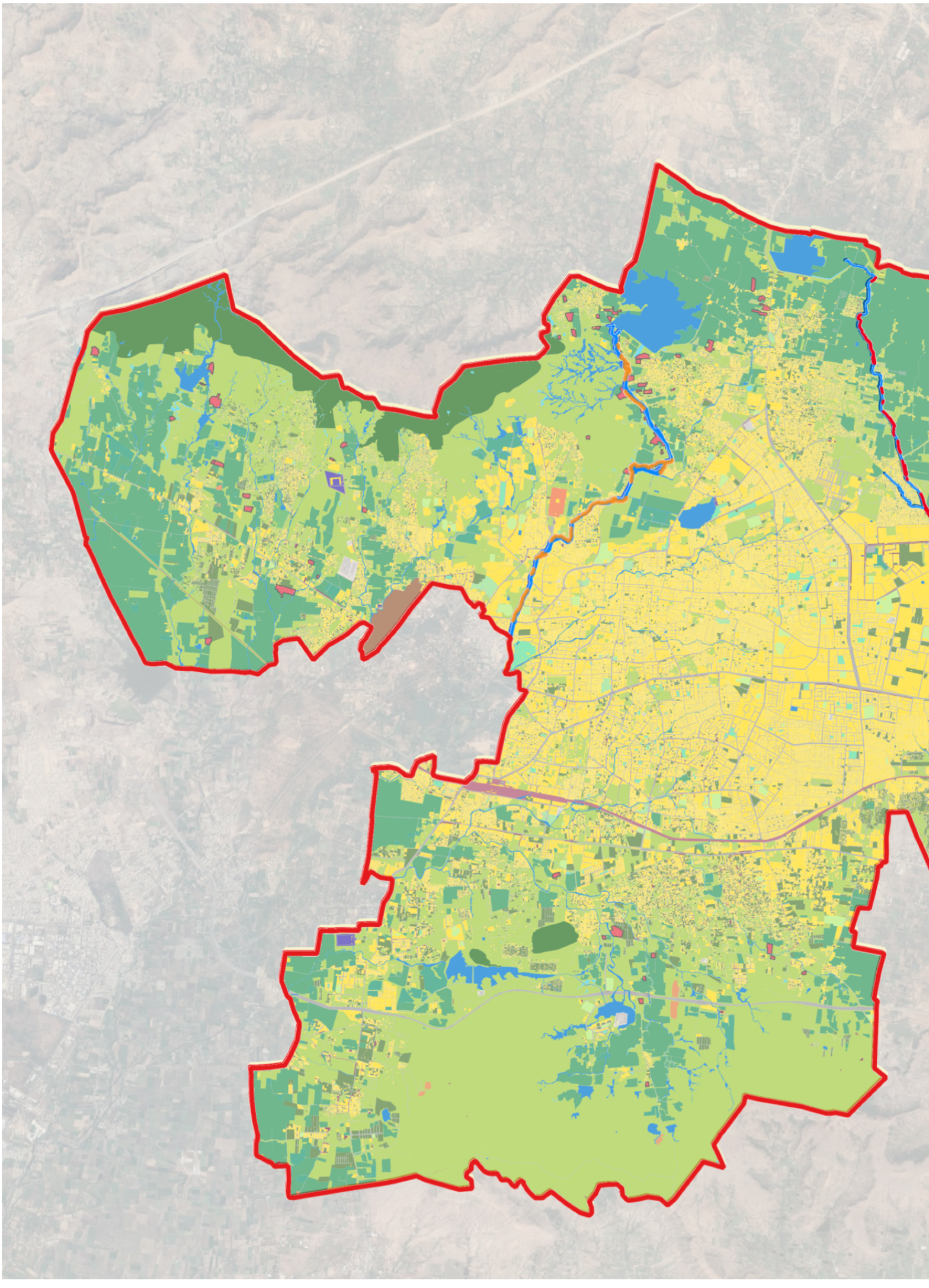
Seven land pockets covering approx. 34 Ha of land area along Kham, and seven land pockets covering approx. 51.5 Ha of land area along Sukhna, have been identified, that can be developed as riparian buffer zones. (A land suitability/ ownership mapping will have to be undertaken by the CSMC)

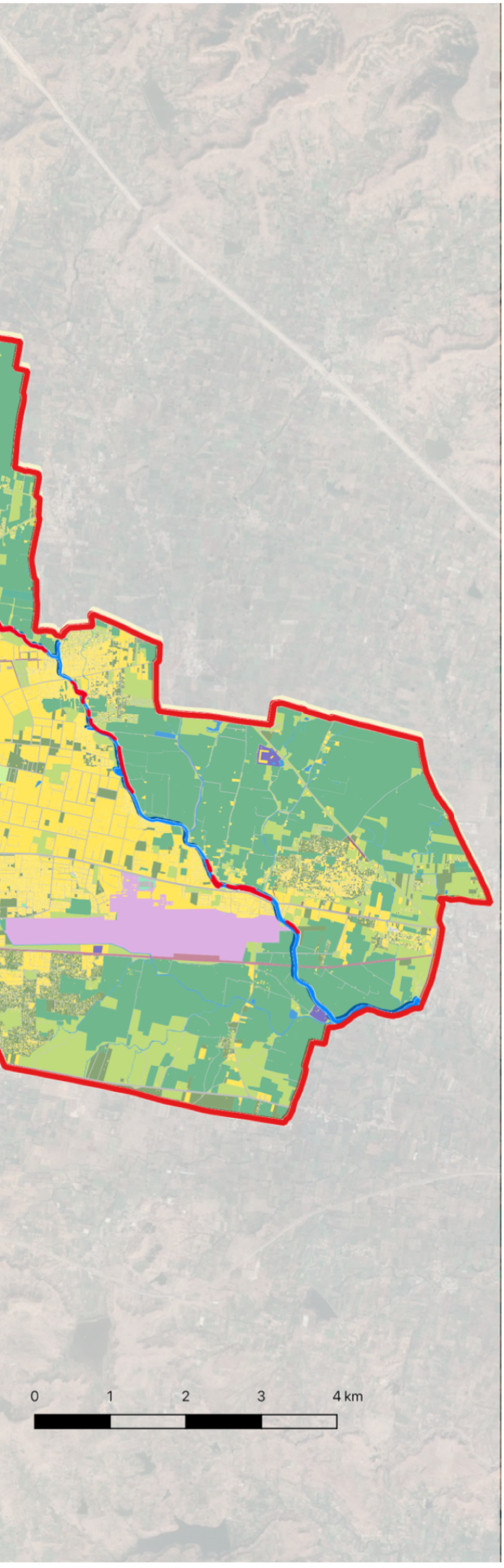
The map and table below highlight the stretches along Kham and Sukhna rivers, which have a potential for continuous riparian stretch.

KHAM RIVER		
Riparian Zone	**Length (Km)**	**Area (acres)**
K1	0.45	1.8
K2	0.15	0.5
K3	1.04	0.4
K4	1.61	2.19
K5	0.63	1.2
K6	0.50	0.4
K7	0.14	0.35

SUKHNA RIVER		
Riparian Zone	**Length (Km)**	**Area (acres)**
S1	0.2	0.53
S2	0.87	3.57
S3	1.04	1.68
S4	0.61	1.27
S5	1.25	3.78
S6	0.6	0.88
S7	1.01	3.47

Figure 39: Proposed riparian stretches along Kham and Sukhna rivers





NAMAMI GANGE | AURANGABAD MUNICIPAL CORPORATION | National Institute of Urban Affairs | WATER & ENVIRONMENT VERTICAL

PROPOSED RIPARIAN BUFFERS ALONG KHAM AND SUKHNA RIVER

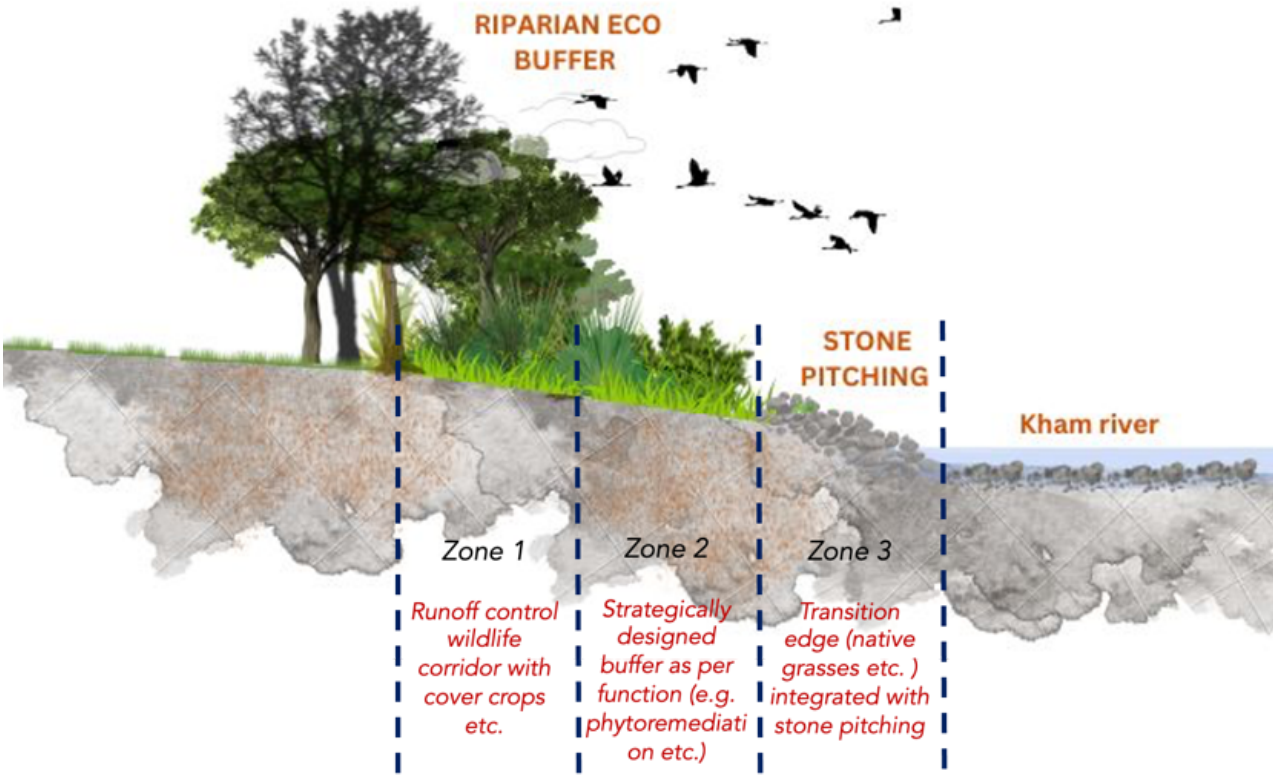
LEGEND

- AMC_Boundary
- PROPOSED _RIPB_KHAM
- PROPOSED _RIPB_SUKH
- Water _Bodies_Poly

Source: Aurangabad Municipal Corporation

Map : 15 - Proposed riparian buffer along Kham and Sukhna River

A 15m wide riparian buffer zone from the edge of the river is proposed to be implemented in the identified stretches, as per the Maharashtra state guidelines. The buffer will have three zones, as shown in the figure below. The type of species suitable in each zone, have been listed in the table below.



S.No	RIPARIAN PLANT SPECIES	TYPE
1.	Heteropogon contortus (Blackspear), Chrysopogon castaneus (Vetiver), Eulalia shrirangii (Shrirang Eulalia), Bambusa arundinacea (Giant Thorny Bamboo)	Grasses (Zone1)
2.	Ficus racemosa (Cluster fig), Ixora brachiata (Ixora), Ochna obtusata (Ramdhan champa), murraya paniculate (orange jessamine), Zizyphus mauritiana (Indian jujube)	Shrubs / Short trees (Zone2)
3.	Piliostigma foveolatum (Pore leaved bahunia) Manilkara hexandra (Khirni), Trema orientale (Indian charcoal), Adenanthera pavonina (Red Lucky Seed), Terminalia cattapa (Indian almond), Tamarindus indica (Tamarind), Bombax ceiba (Red Silk Cotton)	Trees (Zone3)

**The list is not exhaustive and may be modified depending on further knowledge*

Figure 40: Type of species suitable for riparian zone

Following are a list of some species that need to be avoided in the urban context. This list is not exhaustive and requires constant upgradation of research to be in loop regarding invasives.

S.No	PLANT SPECIES	TYPE	POTENTIAL SUBSTITUTES
1.	Lantana camara (West Lantana)	Shrub	Nerium oleander (Nerium), Ixora sp., Tabernaemontana divaricate (crepe jasmine)
2.	Sphagneticola trilobata (Wedelia) Parthenium hysterophorus (Carrot grass), Alternanthera philoxeroides (Aligator weed)	Grasses	Brassica juncea (Indian mustard), pennisetum setaceum (fountain grass)
3.	Leucaena leucocephala (River Tamarind)	Trees	Tamarindus indica (Indian Tamarind)
4.	Pontederia crassipes (Water hyacinth) Pistia stratiotes (Water lettuce)	Aquatic plants	Nelumbo nucifera (lotus), Nymphaea nouchali (blue lotus)

Figure 41: Type of species that should be avoided

Lastly, the riparian edge shall be treated with a mix of stone pitching and plantation, wherever possible. Newer technologies for soil stabilisation, using mesh, may be adopted, wherever required.





Figure 42: Treatment of riparian edge

IMPLEMENTATION

Phase 1 - short term

ESTIMATED COST

INR 4,45,000/-

SOURCES OF FINANCING THE INTERVENTION

- Social Forestry
- CAMPA Funds
- Corporate Social Responsibility




STL
(कदंब)
(जांभूळ)



3.5 Interventions to increase the reuse of treated wastewater

3.5.1 Intervention 14

Reuse of treated wastewater within 3 km buffer zone of all STPs

The table below shows the details of all parks and water bodies within 3 km of individual STPs, and the map below shows their spatial representation. The total water requirement of all parks within 3 Kms of the STPs is 11,86,000 litres = 1.2 MLD. Thus, there is enough treated wastewater available to meet the horticulture demand in the vicinity. The treated wastewater will be transported to the parks and gardens through tankers. The horticulture demand in the vicinity of the STPs is a very small fraction of the total treated wastewater available. Therefore, it is important to examine other large-scale uses of this treated wastewater. One such large-scale use is for reviving water bodies. The table below indicates that there are about 8 water bodies in the vicinity. Other potential uses include the reuse of treated wastewater for construction activities, agriculture, industrial sector, airport, among other activities.

STP	Estimated wastewater availability (MLD)	Waterbodies status within 3km buffer of STP	Parks status in 3km buffer of STP (Water @25,000 l/Ha)	Other potential uses
Padegaon	2	4 waterbodies in the area. Total area - 22.8 acre	Parks - 8 | Area - 3.24 Playgrounds - 7 | Area-2.3 Plantation -9 |Area-4.6 **Water Required - 2,53,500 l**	Safari Park, Slaughter House, Afforestation

STP	Estimated wastewater availability (MLD)	Waterbodies status within 3km buffer of STP	Parks status in 3km buffer of STP (Water @25,000 l/Ha)	Other potential uses
Kanchanwadi	70	2 waterbodies in the area. Total area - 13.4	Parks - 10 | Area - 5.1 Playgrounds - 4 | Area- 3.7 Plantation -7 |Area- 4.1 **Water Required - 3,22,500 l**	Industrial & Commercial Use
Zalta	10	No prominent waterbody in the area.	Parks - 8 | Area - 4.8 Playgrounds - 7 | Area- 3.5 Plantation -9 | Area- 5.2 **Water Required - 3,37,500 l**	Agriculture (Scale up of Pilot Project), Airport
Salim Ali	2	2 waterbodies in the area. Total area - 19.8	Parks - 7 | Area - 3.6 Playgrounds - 11 | Area- 5.5 Plantation -5 | Area- 1.8 **Water Required - 2,72,500 l**	Bibi ka Maqbara, Forest

Figure 43: Potential for reuse of treated waste water from each STP

IMPLEMENTATION

Phase 1 - short term



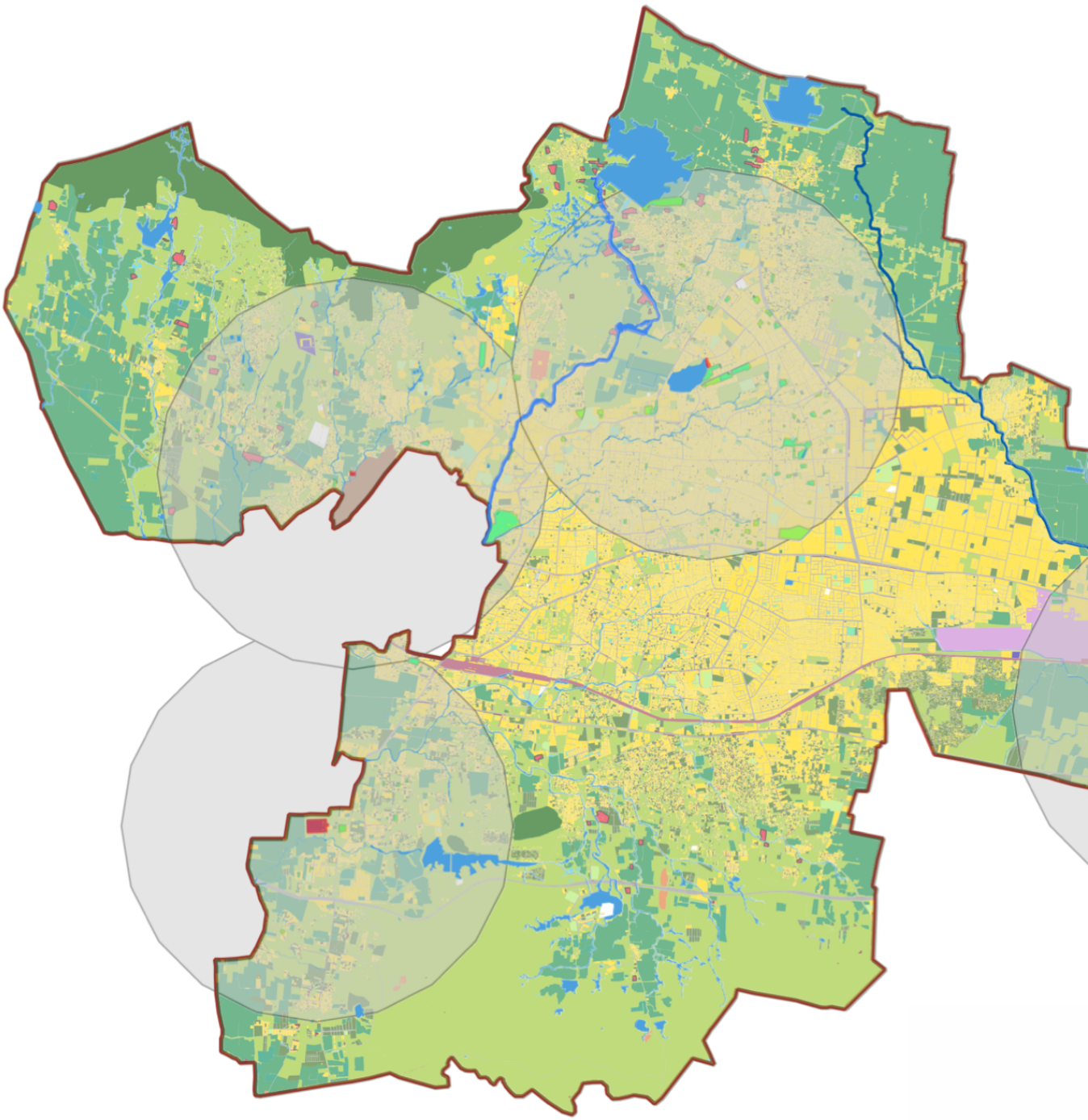
ESTIMATED COST

INR 2,75,00,000/-

SOURCES OF FINANCING THE INTERVENTION

- *Urban Local Body funds*
- Financial/ revenue models

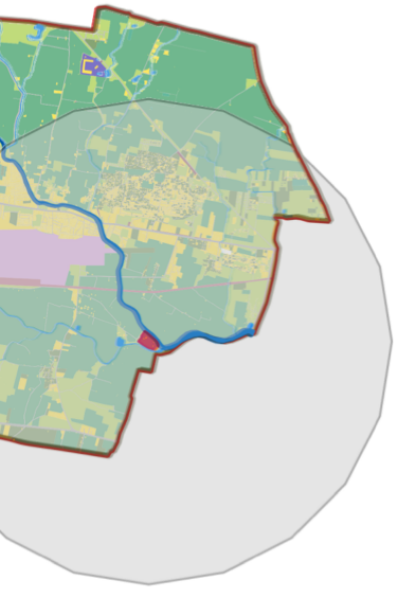




POTENTIAL REUSE OF TREATED WASTEWATER IN 3 KM RADIUS ALONG STPS

LEGEND

- Parks and Gardens
- Water Bodies
- AMC Boundary
- STP
- Buffer area from STP (3 Km radius)



5 0 2.5 5 km

Source: Aurangabad Municipal Corporation

Map : 16 - Potential reuse of treated wastewater in 3 Km radius

3.3.3 Intervention 15

Economic models for reuse of treated wastewater

Reuse of treated waste water can be promoted by either mandating its use for specific activities or making a business case for its usage. Cities like Bangalore and Surat earn revenues from sale of treated waste water for use within the commercial, residential and industrial sectors.

Given the high water requirement of the industrial sector in the city, this demand shall be met primarily from the reuse of treated waste water, wherever possible.

Under the reforms agenda of Atal Mission for Rejuvenation and Urban Transformation 2.0 (AMRUT 2.0), reforms on water conservation envisages recycle of treated wastewater to meet 20% of the total city water demand and 40% of industry water demand in aggregate at the state level. Even the Maharashtra State Water Policy (2019) encourages industries to recycle and reuse water, and follow the policy of 'Zero effluent' in the final stage.

The treated waste water from the STPs is being currently used for construction, agriculture and horticulture activities. The treated water from Kanchanwadi STP also has a potential for reuse in the industrial sector. Treated water can be used for the return flow in aquifers or added to the water reservoirs in the vicinity. A potential business case model, for use if treated water by the industrial sector, is shown below.

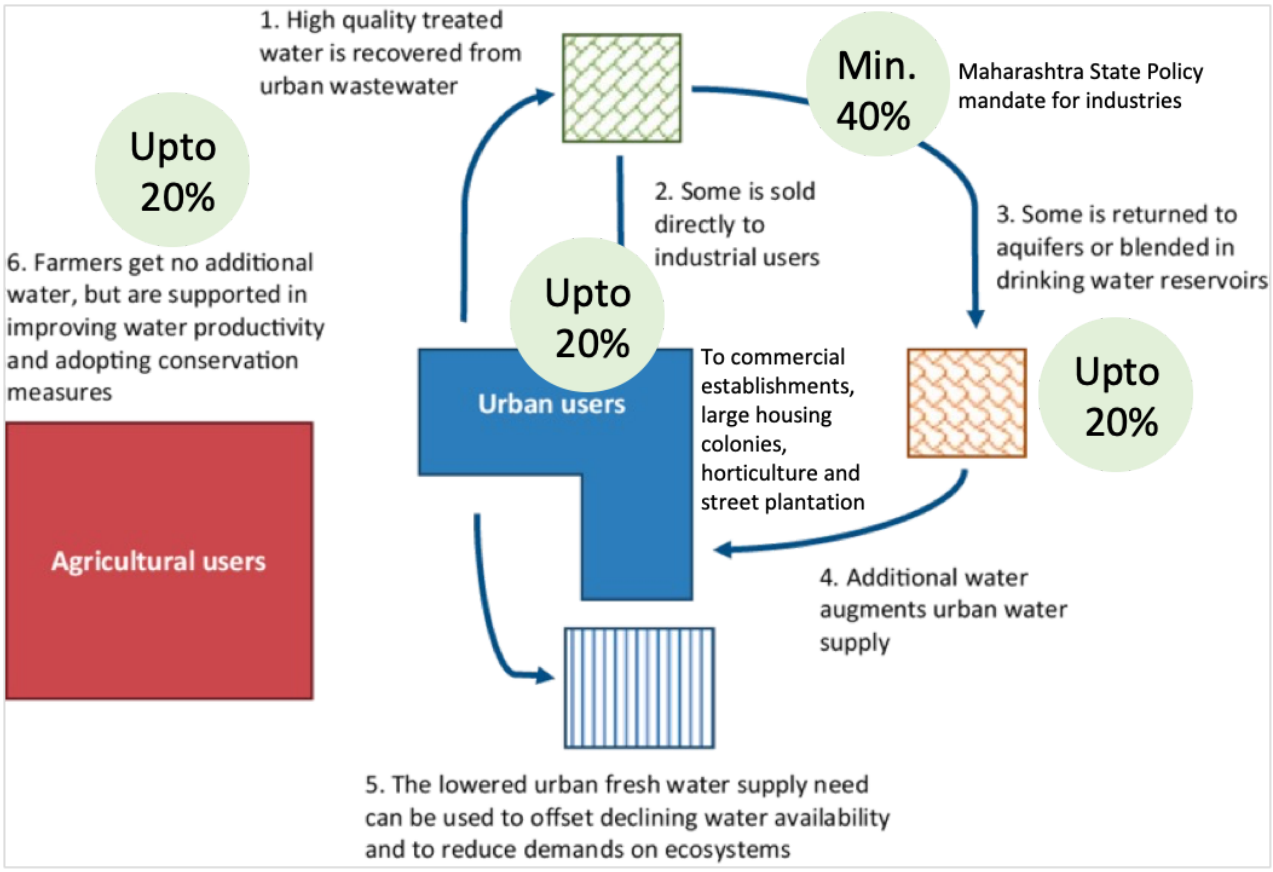


Figure 44: Business Models and Economic Approaches Supporting Water Reuse, IWMI

IMPLEMENTATION

Phase 2 - medium term



ESTIMATED COST

INR 20,00,000/-

SOURCES OF FINANCING THE INTERVENTION

- *Urban Local Body funds*
- *Revenue models*
- *Maharashtra Pollution Control Board (MPCB) funds*
- *Maharashtra Industrial Development Corporation (MIDC) or Confederation of Indian Industries (CII) funds*

LINKS FOR MORE DETAILS ABOUT THE INTERVENTION

- *https://mwrra.maharashtra.gov.in/en/wp-content/uploads/sites/2/2022/09/State-Water-Policy-2019.pdf*
- *https://timesofindia.indiatimes.com/city/aurangabad/industries-in-state-told-to-use-40-recycled-sewage-water/articleshow/73780106.cms*
- *https://cwas.org.in/resources/file_manager/reuse_plan_kolhapur.pdf*





3.6 Interventions related to river economy

3.6.1 Intervention 16

Eco-heritage walk along Kham River

The map below shows that there is a potential for a green-blue continuum and a heritage connect along the Kham river. Recreational and water body areas adjacent to the river, can be physically connected by establishing linkages, to ease movement across these areas. Individually, each of the habitat cores have a potential to be developed for a distinct use.

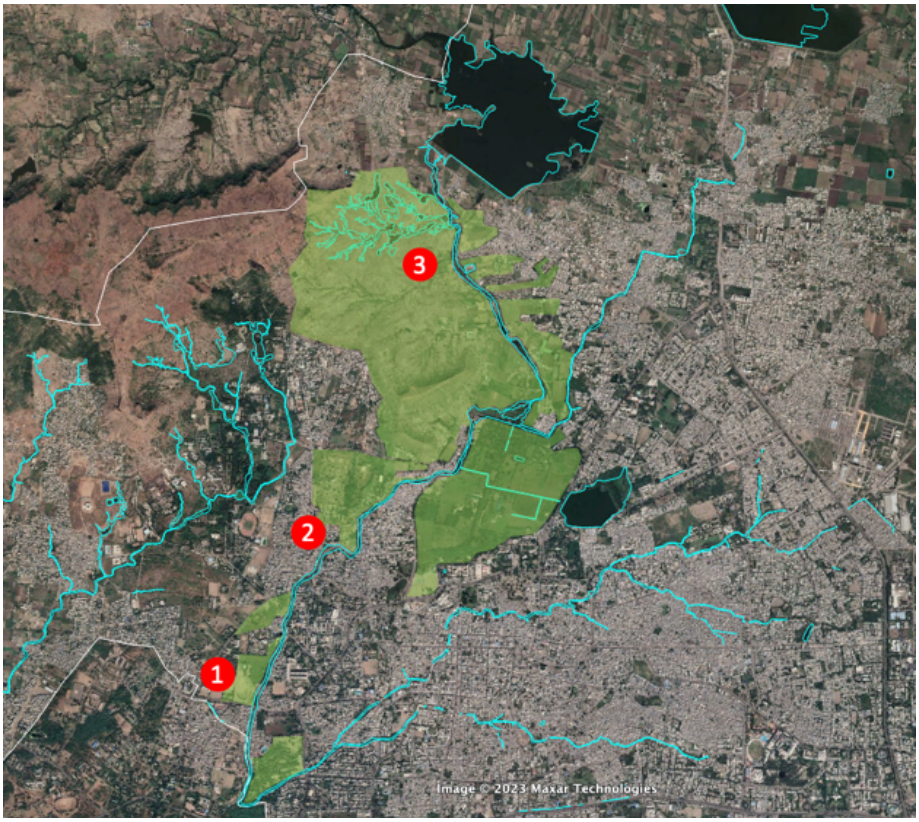


Figure 45: Location of proposed interventions for Eco- Heritage walk along Kham River

The area 1, marked in the above image, can be taken up for development as a 'Eco-heritage walk along the Kham river'. An open, vacant plot of land available along the Kham river, this site stretches between Barapulla Gate and Panchakki.

The proposed project site, directly overlooking the river, is surrounded by Institutional campus, BR Ambedkar stadium and Panchakki. Other key landmarks in the vicinity include the WAQF Board, Kohinoor Masjid, and police grounds. As per the existing land use map of the city, this area has been earmarked as 'Open land'.

Some of the key elements which can be incorporated in this space are enlisted below.

- Exhibit space and interpretation center, representing traditional nahar systems – Panchakki is an important water feature of the city, and is a unique tourist attraction. The area below the Panchakki has a great potential for connecting people. This space, which is presently defunct and unused, can be used as an open exhibit area made from natural materials like stone or wooden panels. The exhibit can depict the story behind the historical nehar systems of the city.




- Nature Trail/Boardwalk along river, with sensory experiences and amenities – To enhance the public experience of connecting with the river, a nature trail can be developed along the river in this stretch. Sensory experience using tactile paths for physical senses, clear visual corridors connecting the key nodes, and fragranced plantation species can enhance this experience.



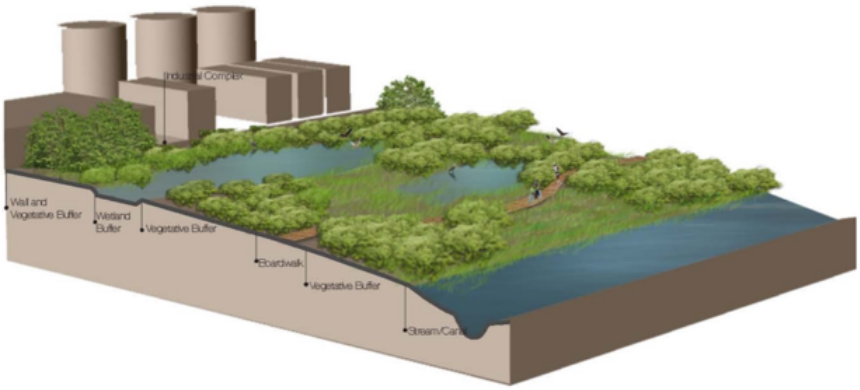



- Hybrid soil stabilization and riparian river edge – Stone pitching can be used to stabilise the river banks. These slopes may be additionally stabilised using riparian plantations in suitable stretches. Such riparian stretches help in biodiversity conservation, filtration of water before it enters the main channel, and enhancement of green cover, in addition to soil stabilisation.



- **Restoring the existing well** - The site has an existing well which is in a dilapidated condition and needs to be restored.
- **Detention/ Retention pond in the existing catchment** – Historical satellite images show water retention at a particular spot within the site. In order to prevent flooding of the entire area during monsoons, the existing catchment shall be preserved in the form of a detention pond.

By developing a public space along the river, this project intends to enhance public experience of engaging with the Kham river. At the same time, the creation of an exhibit area will connect people with the lost water heritage (Neher-e-Ambri and Neher-e-Panchakki).



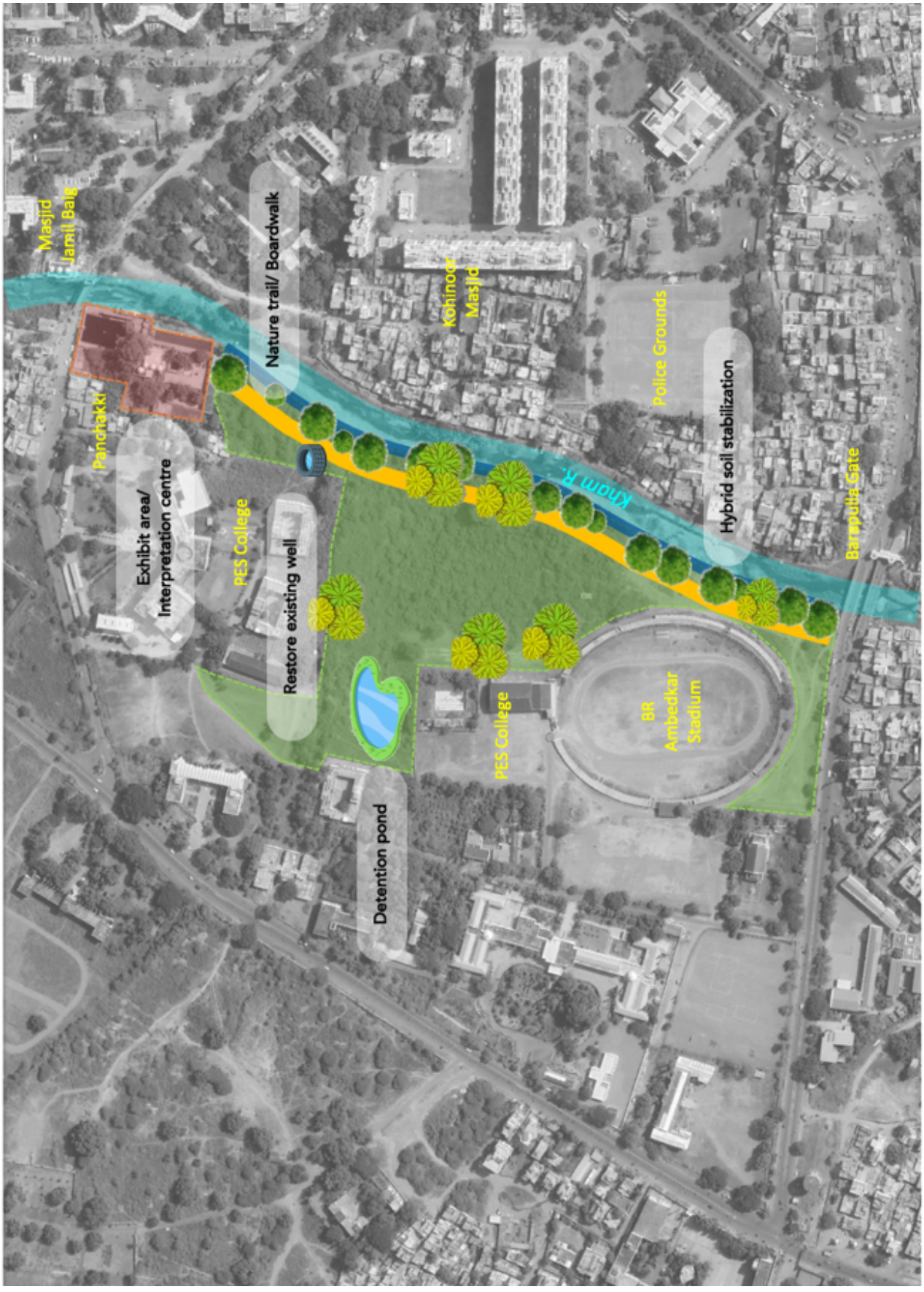


Figure 46: Conceptual plan for eco-heritage walk along Kham river

IMPLEMENTATION
Phase 3 - long term

ESTIMATED COST
INR 4,00,00,000/-

SOURCES OF FINANCING THE INTERVENTION

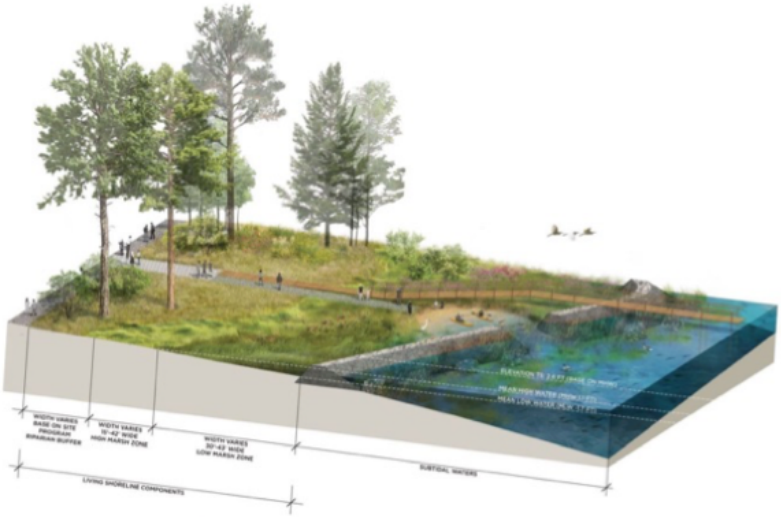
- *Urban Local Body funds*
- *National River Conservation Directorate funds*
- *CAMPA funds*

3.6.2 Intervention 17

Eco-heritage walk along Kham river (connecting Bibi-ka-Maqbara & Himayat Bagh)

Another stretch along the Kham river, marked in the above image as area 2, can be taken up for development as an eco-heritage walk. This site is a longitudinal stretch of land that is available along the river. This area is surrounded by important heritage structures like Bibi-ka-Maqbara and Himayat Bagh. The core idea is to connect these public heritage spaces with natural walkways. By developing a public space along the river, this project intends to enhance the public experience of engaging with the Kham river. Some of the key elements which can be incorporated in this space are enlisted below.

- Bridge over the river connecting the eastern and western banks - Both Bibi-ka-Maqbara and Himayat Bagh have a large human footfall. These areas can be connected, through a bridge across the river, to enhance the walkability



- Nature Trail/Boardwalk along the river, with sensory experiences and amenities - To enhance the public experience of connecting with the river, a nature trail can be developed along the river in this stretch. Sensory experience using tactile paths for physical senses, clear visual corridors connecting the key nodes, and flowering plantation species can enhance this experience.

- Viewing decks along the river - These can enhance the sensory experience by creating visual linkages to the key features in the vicinity



- Hybrid soil stabilization and riparian river edge - Stone pitching is being used to stabilise the river banks. These slopes may be additionally stabilised using riparian plantations at suitable stretches. Such riparian stretches help in biodiversity conservation, filtration of water before it enters the main channel, and enhancement of green cover, in addition to soil stabilisation.



- Restoring the existing well - The site has an existing well which is in a dilapidated condition and needs to be restored.

IMPLEMENTATION

Phase 3 - long term

ESTIMATED COST

INR 4,00,00,000/-

SOURCES OF FINANCING THE INTERVENTION

- *Urban Local Body funds*
- *National River Conservation Directorate funds*
- *CAMPA funds*



Figure 47: Conceptual plan for eco-heritage walk along Kham river

3.3.3 Intervention 18

Urban eco-geoheritage potential along Kham river

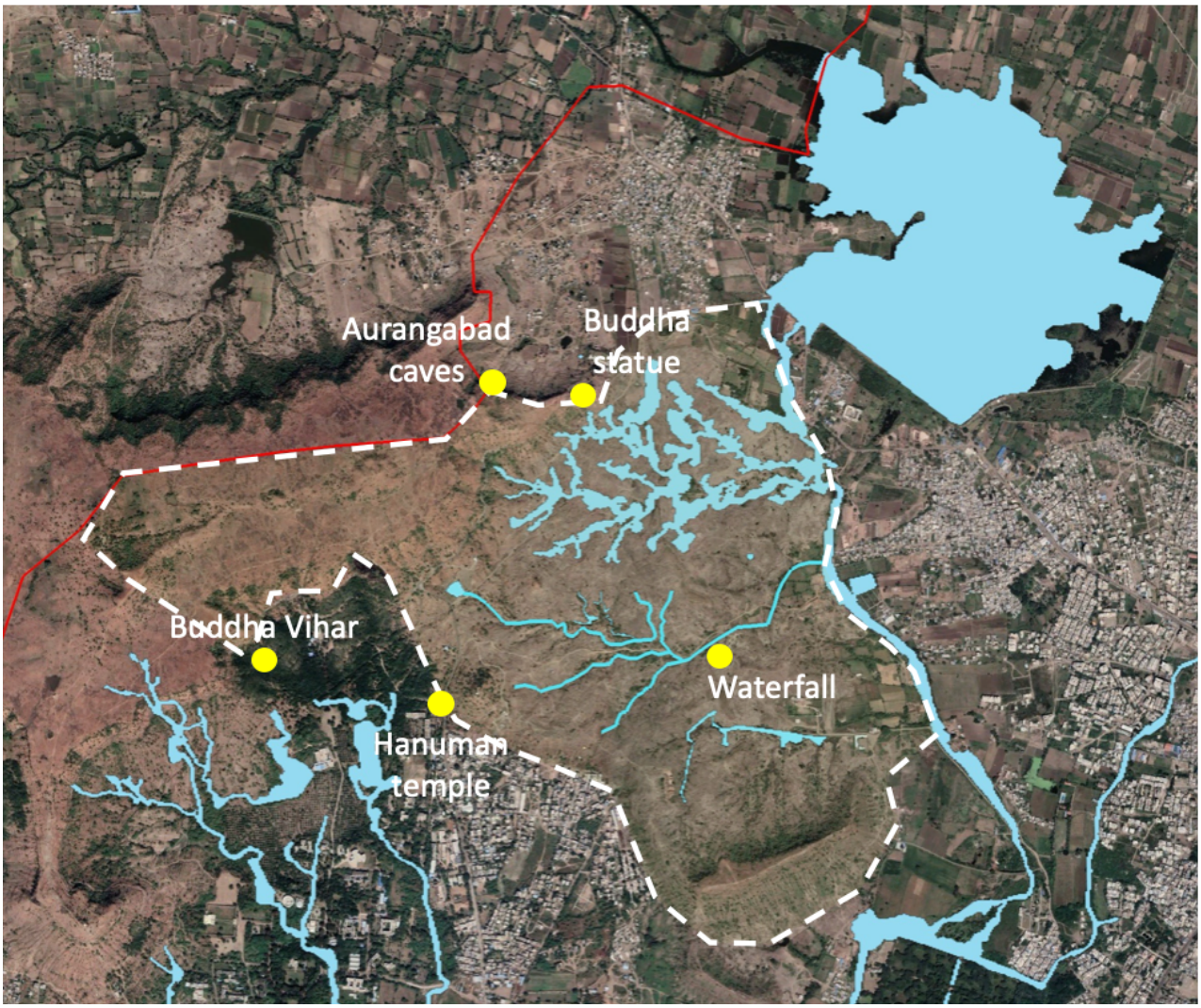
The floodplain area upstream of Kham, near the Harsul lake has a unique plateau like characteristic, surrounded by hillocks and the lake. This moderately dissected plateau has clayey soil and basaltic rocks, forming a series of plateau and depressions. The area acts as the catchment for collecting rain water and channeling it into the river. The Chhatrapati Sambhajinagar Master Plan can mark this region as a ecological zone. The area is also dotted with Aurangabad caves, Buddha statue, Hanuman temple, and a waterfall in the vicinity. Given the unique character of this area, it shall be restored in a manner that protects the ecological character of this space while also providing a unique eco zone to the city.






One similar example is the Kaas Plateau, a UNESCO's natural heritage site in the western ghats, is a plateau largely formed of basalt. This area has been developed as 'Eco-Geo Heritage Conservation'. The basalt rock is covered by a thin cover of soil formed due to erosion. At certain places water gets accumulated because of uneven surface. The plants growing on Kaas plateau are typically of herbaceous nature of like grasses. The small shrubs and trees are located at the periphery of the plateau.

The area downstream of Harsul lake, having the same natural character, may be developed in a similiar manner, with nature hikes, flood resilient grasses, native landscape mosaic and protected biodiversity zones. Any other type of development, which is in synergy with the natural habitat, can also be undertaken in this area.





Flower plateau



Nature hike connecting heritage sites



Flood resilient grasses

Flower species for the plateau



Impatiens lawii (jambhla terada)



Crinum brachynema Herb



Dipcadi maharashtrensis (endangered)



Strobilanthes callosa

Riparian species for the plateau



Chrysopogon castaneus (grass)



Eulalia shrirangii (grass)



Ficus racemosa



Syzium Cumini

Figure 48: Urban eco-geo heritage potential along the Kham river

IMPLEMENTATION

Phase 3 - long term

ESTIMATED COST

INR 10,00,000/-

SOURCES OF FINANCING THE INTERVENTION

- *National River Conservation Directorate (NRCD)*

LINKS FOR MORE DETAILS ABOUT THE INTERVENTION

- *http://terrepolicycentre.com/report/Annual_Report_2018_Kaas_Plateau.pdf*
- *https://indiabiodiversity.org/biodiv/content/documents/document-e224da9a-2223-48b4-9292-39d10dc087ee/450.pdf*

3.3.3 Intervention 19

Concept for an Industrial recreational space along Sukhna river

A number of vacant land parcels are available along the Sukhna river. These open spaces within the floodplains have the potential to be developed into recreational parcels, sponge park, rain gardens, etc. This will not only enhance the green cover of the city, but will also ensure protection of these spaces from informal development.

The Sukhna river flows adjacent to the major industrial areas in the city. As a result, it suffers from direct discharge of untreated domestic and industrial waste water. The ecosystem is also severely impacted by the dumping of domestic and industrial solid waste on the river banks.

As many of these land parcels lie around the industries functioning in these areas, there is a potential for these areas to be developed and maintained by the industrial groups. A conceptual representation for conservation of water bodies prepared by Aurangabad Industrial City (AURIC) is shown below. Similar projects may be proposed along the river. These recreational spaces can include natural elements like detention basins, riparian plantation with vetiver grass for soil binding and stabilization, percolating paving materials for walkways, waste recycling parks, river access points, etc.



Existing conditions where the river is being treated as the backside dumpyard



Conceptual reference from AURIC City proposed in Aurangabad)



Figure 49: Potential recreational spaces along the Sukhna river



IMPLEMENTATION

Phase 3 - long term

ESTIMATED COST

INR 10,00,000/-

SOURCES OF FINANCING THE INTERVENTION

- *National River Conservation Directorate (NRCD)*


JCB
JCB



3.7 Interventions to sensitise and engage citizens

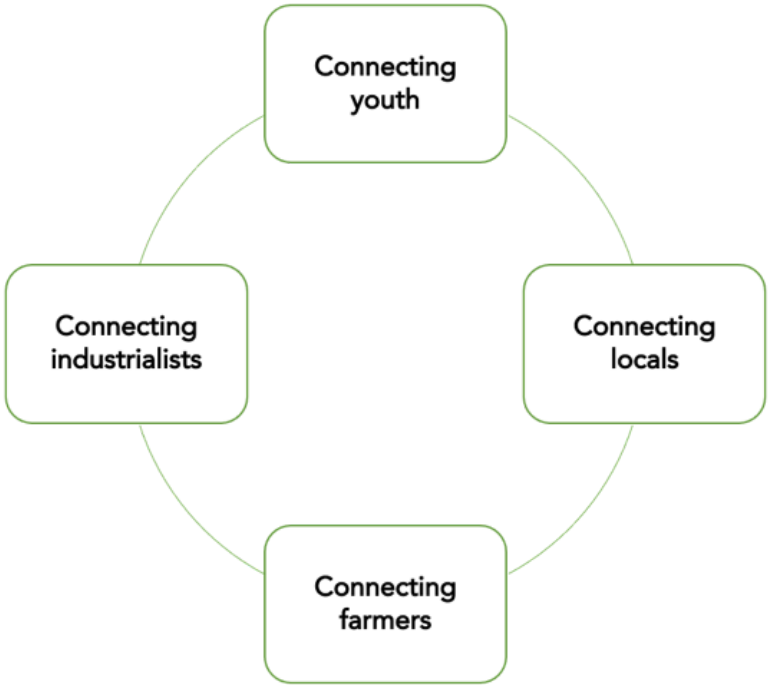
3.7.1 Intervention 20

Enhance the existing river-based sensitization programme

An all-in-one sensitisation programme to manage all the water resources in the city, is the next step towards enhancing the existing sensitisation activities. While this holistic approach will explore multiple avenues of public engagement, this shall also ensure involving different stakeholders like locals, youth, industrialists and farmers. Lastly, it is also essential to run these programmes for all water features in the city.



The following approach may be followed to engage each stakeholder group with river-based sensitisation programmes.



CONNECTING INDUSTRIALISTS

Forming an "Industrial Compact" of different associations including the commercial and hospitality industry

- An annual river/ water technology-related demonstration project with the industrial associations in collaboration with AMC
- An industrial award/ reward for the industries/ commercial establishments performing well on water conservation and resource optimization with a global jury
- Water dialogue series annually on industrial technological advancement and CSR allocations with the city/ peer cities and other regional industrial associations





CONNECTING YOUTH

- Identification of areas for research areas, organizing regular lectures/ training, engaging students in river activities, live studios etc.
- Launching a design/ technology competition annually based on river/water-related challenges AMC is facing

CONNECTING LOCALS

- Organizing heritage/ nature walks with the locals
- Using Citizen science to map/ geotagged location of floral, avian and faunal biodiversity
- AMC led social media campaign on "Stories of Kham and Sukhna"

CONNECTING FARMERS

- Engagement with farmers for less water intensive practices such as treated wastewater benefits
- Education programs around agroforestry and green economy alternatives to discourage land use change
- Monthly farmers market for fresh produce and flowers along the rivers

IMPLEMENTATION

Phase 2 - medium term



ESTIMATED COST

INR 25,00,000/-

SOURCES OF FINANCING THE INTERVENTION

- *CSR funds*
- *Local NGO's / influencers support*

3.7.2 Intervention 21

Add new features to the existing 'Smart Nagrik Aurangabad (AMC)'

The existing mobile application 'Smart Nagrik Aurangabad' shares public information regarding taxes, online services, citizen services, grievances, directories, water tap connections, trade, building permission, road-cutting permission, etc.

Apart from the above features, the application can host large amounts of information regarding the city's water resources. Following information can directly be added to thai app:

- Details of city's water features
- Information about water features, Hiking trails/ treks, Public parks
- Water quality monitoring and waste dumping
- Details of public celebrations and drives for river management
- Links to social media

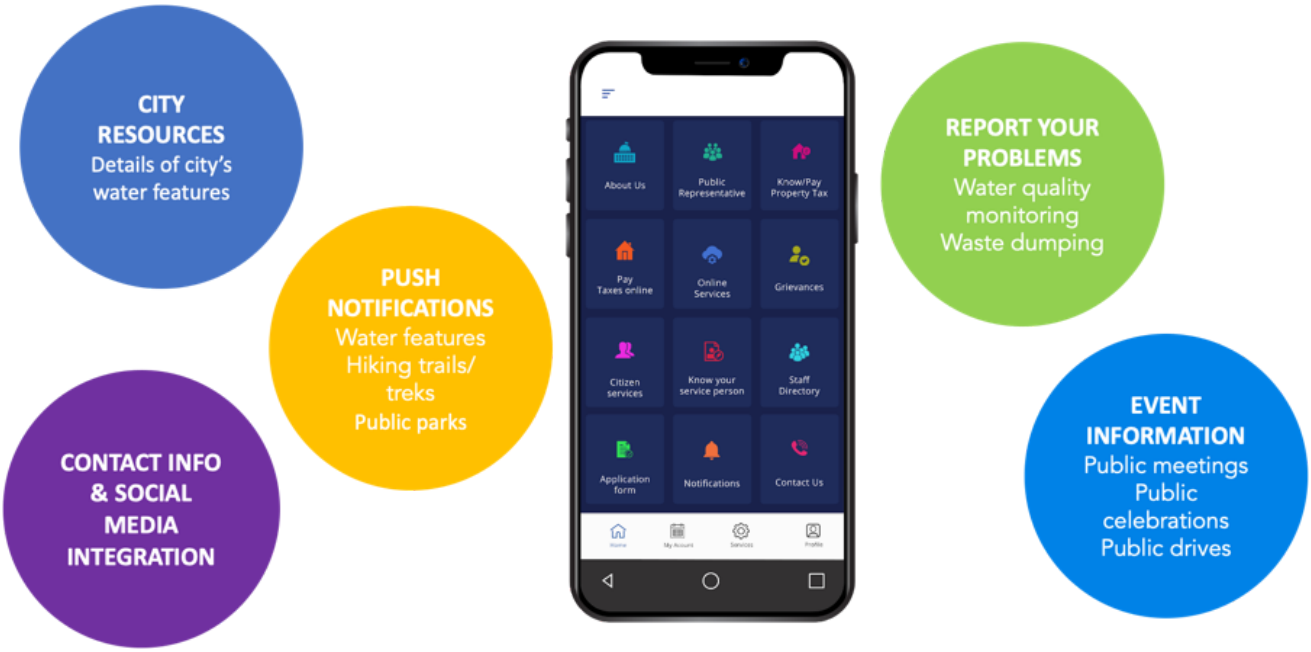


Figure 50: Adding new features to the existing 'Smart Nagrik Aurangabad (AMC)'

IMPLEMENTATION

Phase 2 - medium term

ESTIMATED COST

INR 25,00,000/-

SOURCES OF FINANCING THE INTERVENTION

- *Urban Local Body funds*
- *Smart City funds*



PROPOSED INTERVENTIONS

	Proposed Interventions	Estimated Cost	Potential Sources
INTERVENTION 1	Strengthening planning provisions in the revised Development Plan	0	
INTERVENTION 2	Implement NEERI's RENEU at Siddharth Garden Drain	7,70,00,000	AMRUT, ULB, NRCD, CSR
INTERVENTION 3	Treating industrial pollution using TADOX	12,00,00,000	AMRUT, CSR, CII, MIDC, Industrial Association
INTERVENTION 4	Treatment of waste water discharge from informal activities (dhobi ghats)	1,00,00,000	CSR, ULB
INTERVENTION 5	Real-time water quality monitoring stations (RTWQMS)	1,00,000	ULB, NRCD, MPCB
INTERVENTION 6	Waste ATMs/ Community Green Stations for Solid Waste Management	6,00,000	ULB, CSR, Pilot, SBM (U)
INTERVENTION 7	Installations to prevent Solid Waste along rivers	25,000	CSR, Crowd sourcing, Local NGO/ influencers, ULB, SBM (U)
INTERVENTION 8	Link the existing solid waste fine collection and recording with a Mobile Application	3,50,000	Pilot, CSR, SBM (U)
INTERVENTION 9	Develop a comprehensive GIS-based database for the water bodies in the city	30,000	ULB, involving universities, smart city funds
INTERVENTION 10	Regular assessment of all water bodies using 'Urban Water Body Diagnostic Tool'	16,500	ULB, involving universities, smart city funds
INTERVENTION 11	Rejuvenation of Kamal Talao Lake	6,40,000	AMRUT
INTERVENTION 12	City-level aquifer mapping	21,00,000	ULB, AMRUT
INTERVENTION 13	Develop riparian (plantation) stretches along the Kham and Sukhna rivers	4,45,000	CAMPA, Social Forestry, CSR
INTERVENTION 14	Reuse of treated wastewater within 3 km buffer zone of all STPs	2,75,00,000	ULB, Revenue models
INTERVENTION 15	Economic models for reuse of treated wastewater	20,00,000	Revenue models, MPCB, MIDC, CII, ULB

	Proposed Interventions	Estimated Cost	Potential Sources
 INTERVENTION 16	Eco-heritage walk along Kham River	4,00,00,000	NRCD, CAMPA
 INTERVENTION 17	Eco-heritage walk along Kham river (connecting Bibi-ka-Maqbara & Himayat Bagh)	4,00,00,000	NRCG, CAMPA
 INTERVENTION 18	Urban eco-geoheritage potential along Kham river	10,00,000	NRCD
 INTERVENTION 19	Concept for an Industrial recreational space along Sukhna river	10,00,000	NRCD
 INTERVENTION 20	Enhance the existing river-based sensitization programme	25,00,000	CSR, Local NGOs/ influencers
 INTERVENTION 21	Add new features to the existing 'Smart Nagrik Aurangabad (AMC)' mobile application	25,00,000	ULB, smart city funds
		32,78,06,500	

CHHATRAPATI SAMBHAJINAGAR MUNICIPAL CORPORATION
Main Building, Town Hall, behind Post Office, Chhatrapati Sambhajinagar, Maharashtra 431001
https://aurangabadmahapalika.org/

CHHATRAPATI SAMBHAJINAGAR SMART CITY DEVELOPMENT CORPORATION LTD. (SCSCDCL)
Chhatrapati Sambhajinagar Smart City Office, Near Aamkhas Maidan, Chhatrapati Sambhajinagar- 431001
https://aurangabadsmartcity.in/

NATIONAL MISSION FOR CLEAN GANGA
Ministry of Jal Shakti (Department of Water Resources, River Development & Ganga Rejuvenation) Government of India, 1st Floor, Major Dhyan Chand National Stadium India Gate, New Delhi - 110002
Telephone:+91-011-23072900-901
admin.nmcg@nic.in; www.nmcg.nic.in

NATIONAL INSTITUTE OF URBAN AFFAIRS (NIUA)
Ministry of Housing and Urban Affairs, Government of India, Core 4B, 1st Floor, India Habitat Centre (IHC), Lodhi Road, New Delhi – 110003
Telephone: 011 2461 7517 (ext. 214)
urvers@niua.org, https://niua.in/waterandenvironment/