Sustainable City Strategy - Vijayawada

Sustainable Cities - Integrated Approach Pilot (SCIAP)

UN-HABITAT FOR A BETTER URBAN FUTURE

vijayawada Municipal Corporation

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gef

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SUSTAINABLE CITY STRATEGY- VIJAYAWADA

Sustainable Cities Integrated Approach Pilot (SCIAP)
Component 1: Sustainable Urban Planning and Management

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List of Acronyms

ABD	Area Based Development
AFOLU	Agriculture, Forestry, and Other Land Use
APCRDA	Andhra Pradesh Capital Region Development Authority
APSRTC	Andhra Pradesh State Road Transport Corporation
APTIDCO	Andhra Pradesh Township and Infrastructure Development Corporation
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
CCTV	Closed Circuit Television
CDMP	City Disaster Management Plan
CSO	Civil Society Organization
CSR	Corporate Social Responsibility
DSW	Directorate of Social Welfare
ECS	Equivalent Car Space
EV	Electrical Vehicle
EWS	Economically Weaker Section
FFEWS	Flood Forecasting and Early Warning System
FPZ	Floodplain Zone
GDI	Gender Diverse Individual
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIS	Geographical Information System
GPSC	Global Platform for Sustainable Cities
HRVA	Hazard Risk Vulnerability Assessment
IAP	Immediate Action Plan
IEC	Information, Education and Communication
IPT	Intermediate Public Transport
IPPU	Industrial Processes and Product Use
ITDP	Institute for Transport Policy
LCCMP	Low Carbon Comprehensive Mobility Plan
LIG	Low Income Group
LPA	Local Planning Area
LPCD	Litre per Capita per Day
MEPMA	Mission for Elimination of Poverty in Municipal Areas
MoHUA	Ministry of Housing and Urban Affairs
NBS	Nature-Based Solutions
NGO	Non-Governmental Organization
NH	National Highway
NIUA	National Institute of Urban Affairs
NMT	Non-Motorized Transport

NPC	National Productivity Council
NUA	New Urban Agenda
NUP	National Urban Policies
PPH	Persons Per Hectare
PPP	Public Private Partnership
PT	Public Transport
PWD	Public Works Department
PwDs	People with Disabilities
RoW	Right of Way
RWA	Residents Welfare Associations
SAPCC	State Action Plan on Climate Change
SBM	Swachh Bharat Mission
SCIAP	Sustainable Cities – Integrated Approach Pilot
SCS	Sustainable City Strategy
SDA	Slum Dwellers Association
SHGs	Self Help Groups
SRC	Slum Rehabilitation Coalition
T&CP	Town & Country Planning Department
TDR	Transfer of Development Rights
TOD	Transit Oriented Development
TTMC	Traffic Transit Management Centres
ULB	Urban Local Body
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UN-HABITAT	United Nations Human Settlements Programme
UN-HABITAT ROAP	United Nations Human Settlements Programme Regional Office for Asia & the Pacific
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UPA	Urban Poverty Alleviation
URDPFI	Urban and Regional Development Plans Formulation and Implementation
USAF	Urban Sustainability Assessment Framework
USIR	Urban Sustainability Indicators Report
VMC	Vijayawada Municipal Corporation
VAMBAY	Valmiki Ambedkar Awas Yojana
WD&CW	Women Development and Child Welfare
WHO	World Health Organization
WPR	Work Participation Rate
ZDP	Zonal Development Plan

MG Road, Vijayawada

1 INTRODUCTION

1.1 Report Objectives

The Sustainable City Strategy (SCS) consitutes the final step of a three-step process under the Sustainable Cities Integrated Approach Pilot (SCIAP) Component 1 of the project. The first two steps being the application of the Urban Sustainability Assessment Framework (USAF) captured in the Urban Sustaibaility Indicators Report (USIR) and the City Profile and Diagnostic Report. The Vijayawada City Profile and Diagnostic Report identified very specific diagnostic issues, which were essentially the key problem areas, obsctacles and developmental challenges being faced by the city. These challenges were ascertained on the basis of evidence collected and assesed through the USAF[1]. As the third and final step, this report documents the SCS for Vijayawada, which is a spatial strategic plan with very specific actions and interventions designed to be targeted and impact-oriented on the ground. These strategies will strengthen and enable city leadership and managers to drive future development based on quantifiable data and assessment using rationale decision-making.

In this context, the main objectives of this report are:

i) To identify strategic development opportunities for the city based on spatial evidence aligned with local, state and national policies and regulations.
ii) To design cross-sectoral and intra-sectoral strategies for an inclusive, sustainable and resilient future development of the city, and contribute towards improving the city's climate emissions profile.
iii) To design and develop area-based, transformative interventions to demonstrate change on ground
iv) To ascertain specific actions and interventions necessary for transformative impact over a five-year period
v) Recommend convergence with national/ state missions for financing and technical resources.

1.2 Approach and Methodology

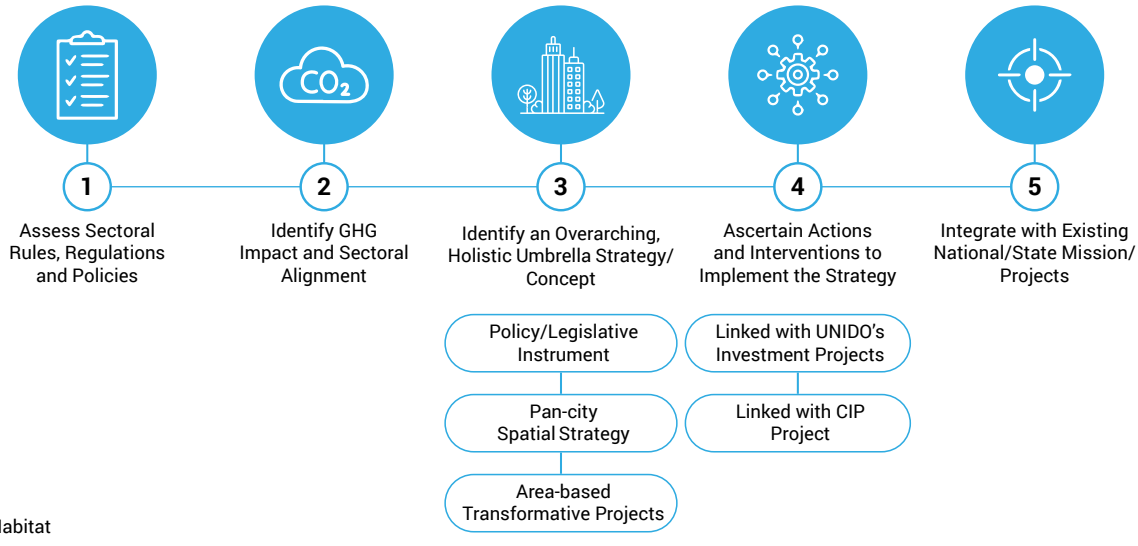
The foundation of the SCS is in the New Urban Agenda (NUA) with the following five pillars (except Pillar 1, since it is beyond the scope of SCIAP) of the NUA having been the guiding document in framing the SCS.

i) National Urban Policies (NUPs)
ii) Rules and Regulations
iii) Urban Planning and Design
iv) Financing Urbanization
v) Local Implementation

A detailed guidance note on the development of the SCS has been shared in Annex 1. The strategies could take the form of pan-city, intersectoral spatial interventions, area-based projects and even legislative/ policy-based intruments. Emphasis has been given to the carbon footprint profile of sectors and their relationship with the intended strategic interventions to ensure that maximum carbon capturing is achieved. Significant effort has been made to ensure convergence with projects and sectors covered by the national missions and state schemes/ policies with the recommended interventions.

The overarching steps followed for developing the SCS have been illustrated in Figure 1.1

FIGURE 1.1 Sustainable city strategy development process



Source: UN-Habitat

1 The Urban Sustainability Assessment Framework (USAF) was developed by UN-Habitat India as a part of the SCIAP project. Further details are available in the Urban Sustainability Assessment Framework Report.

1.3 Scope and Limitations

The SCS is intended to be very targeted and to cater to specifically identified issues in the previous stage of the project. SCS would complement a city's master plan and development plans by synergizing the proposed actions and interventions within the broad mandate and vision of these plans. SCS strengthens the implementation of city's development vision by preparing specific actions and interventions for on-ground transformation and impact.

This SCS will help municipal corporations to identify the following:[2]

1. Where are the areas of growth and what type of growth?
2. Where should investments from various national and state missions/ schemes be located to maximize their impact on vulnerable social groups?
3. How can the existing natural and economic assets of the city be preserved and enhanced?
4. How can quality of life and equitable provision of urban amenities be enhanced?
5. How can interventions be prioritized to ensure practicality and maximum impact?

The following limitations need to be considered while assessing the strategic interventions:

1. The cost estimates have been calculated on block cost thumb rules derived from industry standards adopted in the national missions of India. All assumptions have been included in detail for context building and understanding.
2. The concept designs and spatial location of proposed interventions are shown for approach demonstration purpose only, the interventions would require detailed planning and engineering studies to arrive at accurate costing and spatial design.
3. The greenhouse gas (GHG) savings given for the strategic interventions are based on very high-level standards and metrics since these must be calculated at the detailed design stage with site specific inputs.
4. The analysis of legislations and policies is limited to its high-level implication of diagnostics issues. The SCS does not intend to provide detailed assessment of legislative framework, nor is it intended as an amendment to the existing policy and legislative frameworks.
5. The SCS is based on secondary sources available in the public domain. Primary data collection involved site visits and stakeholder consultations by the UN-Habitat team.
6. In some aspects of issue assessment and strategy building, certain assumptions have been made where the latest spatial data, such as land use and population densities of Vijayawada, was unavailable from the Urban Local Bodies (ULBs).
7. Gender Equality and Social Inclusion (GESI) recommendations are based on secondary data collection and analysis. This could be further refined on the basis of additional on-site discussion and consultations with organizations representing women, people with disabilities (PwDs), gender minorities and government agencies.

2 https://unhabitat.org/sites/default/files/2014/07/A-guide-for-Municipalities-Inclusive-and-Sustainable-Urban-Development-Planning-Volume-1.pdf.

MG Road (Bandar Road) towards Benz Circle

2 CITY DIAGNOSTICS

2.1 Climate Context and GHG Emission Profile

2.1.1. Climate profile and projections

Vijayawada, the second-largest city in Andhra Pradesh, lies on the banks of the Krishna River, and is dotted with hills and canals. About 70 km from the Bay of Bengal along the eastern coast of India, the city is highly influenced by winds and accompanying precipitation. Vijayawada's climate is tropical with a hot summer and moderate winter. The city receives an average annual rainfall of 974 mm, and its average annual temperature is 28.2°C. The peak temperature reaches 45°C in May–June, while the winter months see temperatures of 17–25°C. Vijayawada receives rainfall from both the South-West and North-East monsoons.[3]

The Hazard Risk and Vulnerability Analysis (HRVA)[4] for Vijayawada, prepared in 2014 by UNDP, mapped seven major hazards that the city is prone to, each with significant variations in their vulnerability levels – urban floods, landslides, heat waves, cyclones, rock fall, drought, and epidemics (selected water and vector borne diseases). The key highlights of the city's climate predictions are summarized below:

Temperature increase: Temperature is likely to rise by about 1.25°C and 2.50°C, respectively, around the middle and end of this century. Minimum night-time temperatures could exceed 1.50°C and 2.80°C, respectively.

Increase in monsoon rainfall: The monsoons are projected to increase by about 0.5 mm/day (a total of 60 mm in the season) and about 0.8 mm/day (100 mm in the season) over the city by the middle and end of this century, respectively. On an annual basis, rainfall increase over the region would be limited to 0.15 mm/day (a total of only 50 mm in a year) and about 0.37 mm/day (130 mm in a yar) by the middle and end of this century, respectively.

2.1.2. GHG emissions profile

In 2015-16, Vijayawada emitted 1,888,582 tCO_2-eq from sectors, stationary energy, transportation, waste, and agriculture, forestry, and other land use (AFOLU). The total CO_2, CH_4, and N_2O emitted stood at 1,675,863 T, 7,093 T, and 53 T, respectively (see Figure 2.1). Emissions from stationary energy were the highest contributors to GHGs, accounting for 65.4 per cent of the city's total emissions. The transportation sector emitted 23.3 per cent, and the waste sector 11 per cent of the total GHG emissions for the period under study.

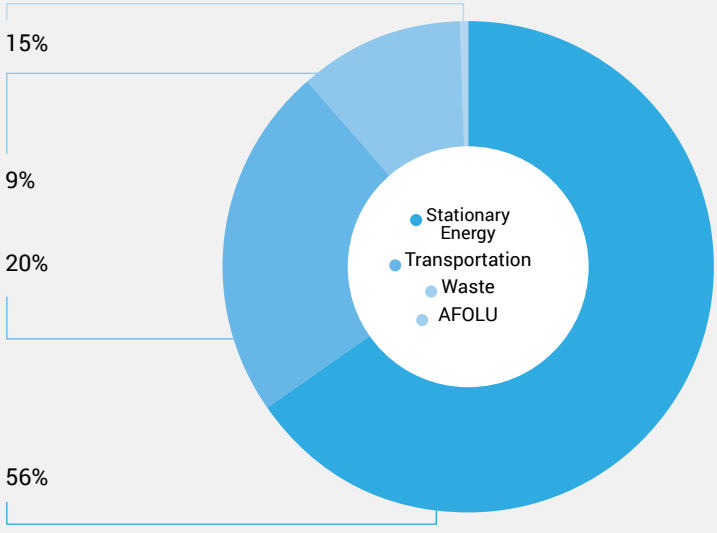
IMAGE 2.1 Areas along Krishna River affected by floods in 2019

Source: VMC

3 UNDP. (2014). Hazard Risk and Vulnerability Analysis (HRVA) for the City of Vijayawada.

4 Ibid.

FIGURE 2.1 Sector-wise GHG emissions (Mt CO_2-eq.) in Vijayawada during 2015-16



Source: UN-Habitat

2.2 Sectoral Assessment

The City Profile and Diagnostic Report situates Vijayawada in its regional context and provides a comprehensive outlook of the city's performance by applying the USAF under 12 sectors, namely, governance and data management, finance and economy, housing and property, water supply, sanitation, waste management, clean energy, disaster management, environment, public space, urban form and safety, transport, and social facilities and services.

Out of 131 indicators across 12 USAF sectors, 103 indicators were collected for Vijayawada, thus accounting for 79 per cent of the indicators. See Figure 2.2 for the percentage of indicators collected for each sector with an overall city score of 4, denoting medium performance. Finance and Economy, Governance and Data Management, Clean Energy, Solid Waste Management, Sanitation, Water Supply, Social Facilities and Services were the top-performing sectors. In contrast, the lowest-performing sectors were Housing and Property, Transportation, and Environment and Ecology.

For sector-wise indicator performance, refer to the Vijayawada Urban Sustainability Indicators Report and for detailed, sector-wise inferences refer to the section on Sectoral Context of the Vijayawada City Profile and Diagnostic Report.

2.3 Key Issues Diagnosed

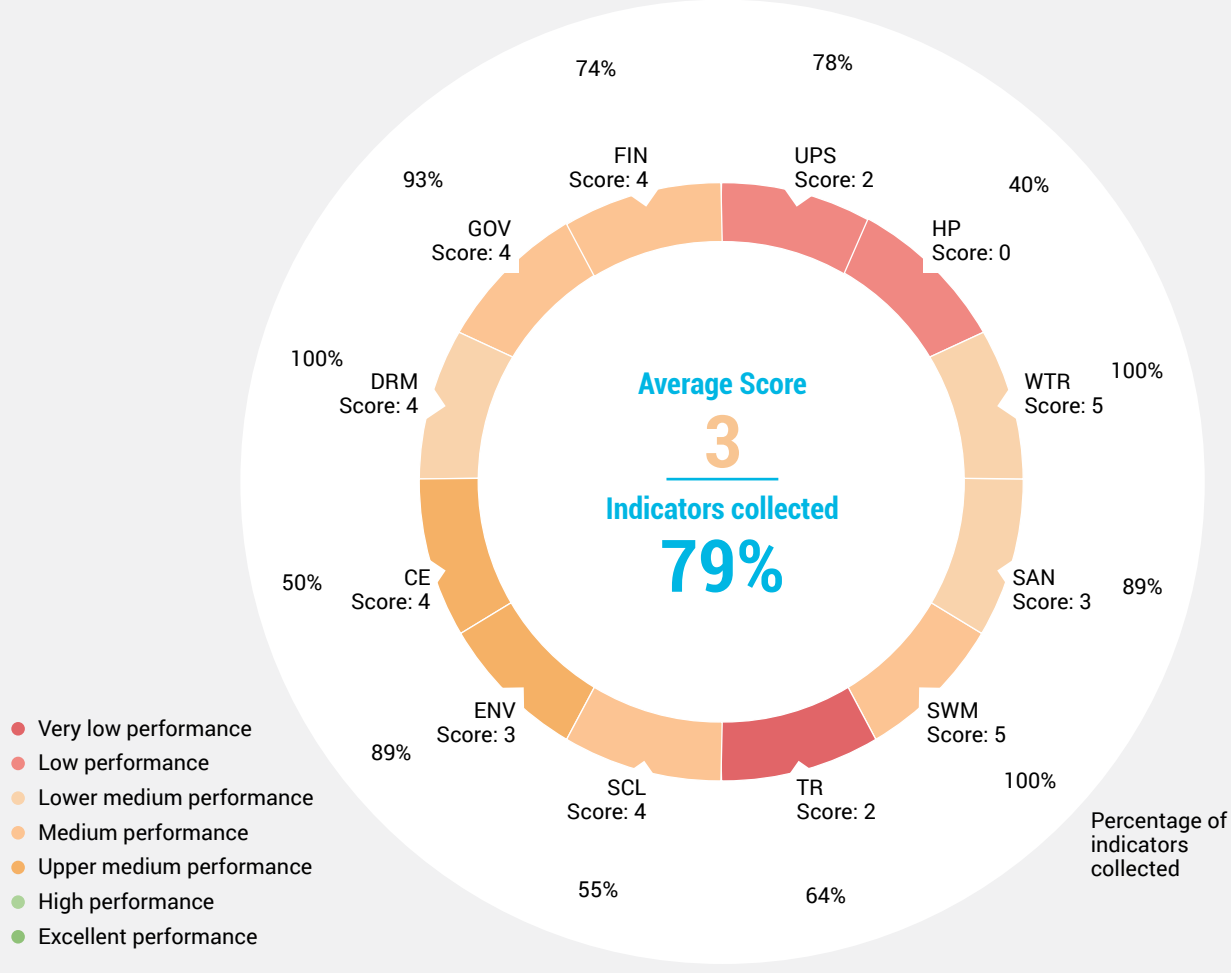
The Vijayawada City Profile and Diagnostic Report has identified the following critical spatial aspects for identifying strategic issues and developing sustainable city strategies:

Existing and proposed land use: The Vijayawada Zonal Development Plan (ZDP) 2021, notified in 2006, has considered 100 per cent of the city area as developable and converted all the existing green cover (agriculture as well as vacant land) in the city as proposed residential use (24 per cent existing vis-à-vis 51 per cent proposed in 2021). Even with the increased residential land use, the share of transportation area has reduced from 16 per cent to 13 per cent, which is well below the norm (30 per cent) as per URDPFI guidelines.

City core and peripheral development: The city evolved along the foothills of the Kanaka Durga Temple as ancillary religious events began to be celebrated near the temple town around 1855. Later, with the establishment of the Railway Junction connecting all states in the country, urbanization was accelerated. Consequently, the population registered an almost threefold increase in the last three decades ending in 2011, with a population count of 10.34 lakh.[5]

5 APCRDA (2019). Vijayawada Immediate Action Plan for Transport, 2019.

FIGURE 2.2 Average score, performance and percentage of indicators collected for the 12 USAF sectors



Source: UN-Habitat

Most of the institutional and administrative uses in the city are concentrated within a radius of 2.5 km of the city centre, leading to a higher density of 16,518 persons/sq. km. within the city core, which is greater than even Delhi, the national capital, and far more than the state density of 308 persons/sq. km.[6] Even though the proposed land use in ZDP 2021 recommends the peripheral areas be utilized for residential use to decongest the city core, Vijayawada's existing built form in 2019 reveals that most of those areas lay vacant. This could be attributed to a lack of transportation network, physical and social infrastructure, and economic opportunities in these areas. Some of these neighbourhoods are Nandamuri Nagar to the North-West, Nunna to the North, and Ajith Singh Nagar to the North-East.

Social vulnerability: Vijayawada is one of the largest cities in Andhra Pradesh, covering an area of 61.86 sq. km. with a total population of 10.3 lakh. The city has an average decadal growth of 23.3 per cent against the national average of 17.64 per cent (2001-11).[7] Over the last few decades, the city's built-up area has increased by 372 per cent, while agricultural area has decreased by 65 per cent and barren area by 61 per cent.[8] The city's expanded building footprint and contracted green spaces tend to increase its vulnerability to natural hazards, particularly floods and heatwaves.

It is to be noted that the impact of hazards is more significant for vulnerable groups (women, elderly, adolescents and children) who constitute 70 per cent of

6 UNDP. (2014). Hazard Risk and Vulnerability Analysis (HRVA) for the City of Vijayawada.
7 Census of India. (2011). Available at: www.censusindia.gov.in/2011-prov-results/data_files/india/final_ppt_2011_chapter3.pdf.
8 UNDP. (2014). Hazard Risk and Vulnerability Analysis (HRVA) for the City of Vijayawada.

IMAGE 2.2 Aerial view of built-up area in the city core (right) and peripheral zones (left)

Source: VMC

the city's total population. There is a high share of informal settlements within Vijayawada Municipal Corporation's (VMC's) jurisdiction, with 45 per cent of the city's population living in slums. About half the slum population are women, making up 24 per cent of the city's total workforce. A higher Work Participation Rate (WPR) is found among women living in informal settlements than among the overall share of women workers in the city.

Owing to the population growth during the last decade, Vijayawada's population density has increased with development making its way into ecologically sensitive areas such as steep hill slopes and the Krishna River floodplains. As per the City Disaster Management Plan (CDMP) 2015, 48 per cent (1,34,965) of the city's households are at risk of displacement because they live in areas with non-mitigable risk. In terms of spatial distribution, 17 wards out of 64 are prone to landslides and 11 wards are flood prone.[9]

The city's four lowest-performing USAF sectors identified four strategic issues using the lowest-performing indicators within the respective sectors. Consultations with city officials complemented an inter-sectoral linkage to arrive at the following Strategic Issues:

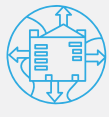
FIGURE 2.3 Broad issues identified for Vijayawada

1

Access to sub-optimal urban mobility and public transportation

2

Inadequate public green spaces and fragmented blue-green network



3

Sprawling and scattered development

4

Vulnerable informal settlements

Source: UN-Habitat

9 City Disaster Management Plan, 2015, Vijayawada.

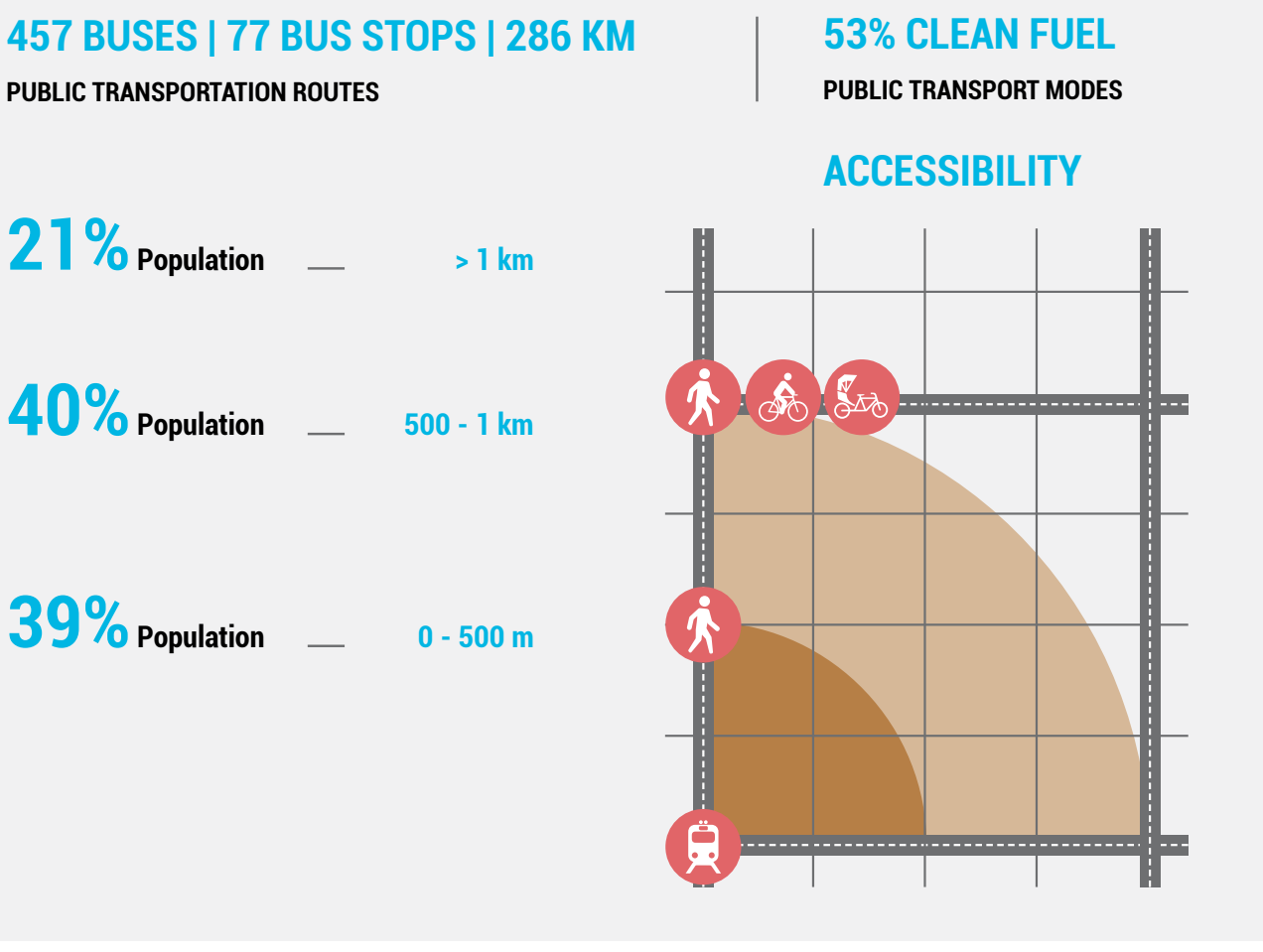
2.3.1. Issue 1: Sub-optimal urban mobility and access to public transportation

Vijayawada holds the distinction of being a major railway junction in India with a well-connected regional road, rail, and air network. Vijayawada is connected by two National Highways –NH-16 connecting Chennai and Kolkata, and NH-65 connecting Hyderabad and Machilipatnam Port, resulting in heavy vehicular traffic. However, at the city level, despite rapid physical growth in the past few years, transport infrastructure within the city has not kept pace with demand. Overall, the city's transportation sector ranked low on the USAF with an array of mobility challenges for Vijayawada's residents.

Existing road hierarchy: Streets in Vijayawada have undergone many changes to adjust and adapt to the changing demands of traffic volume, traffic flow, functions and behavioural patterns of users leading to demand-based extensions and an undefined hierarchy. Overall, the average percentage of the road network in the city is 16 per cent, which is inadequate to address the current travel demand. Moreover, the roads in the city are of moderate width, with only a few kilometres of four-lane roads.

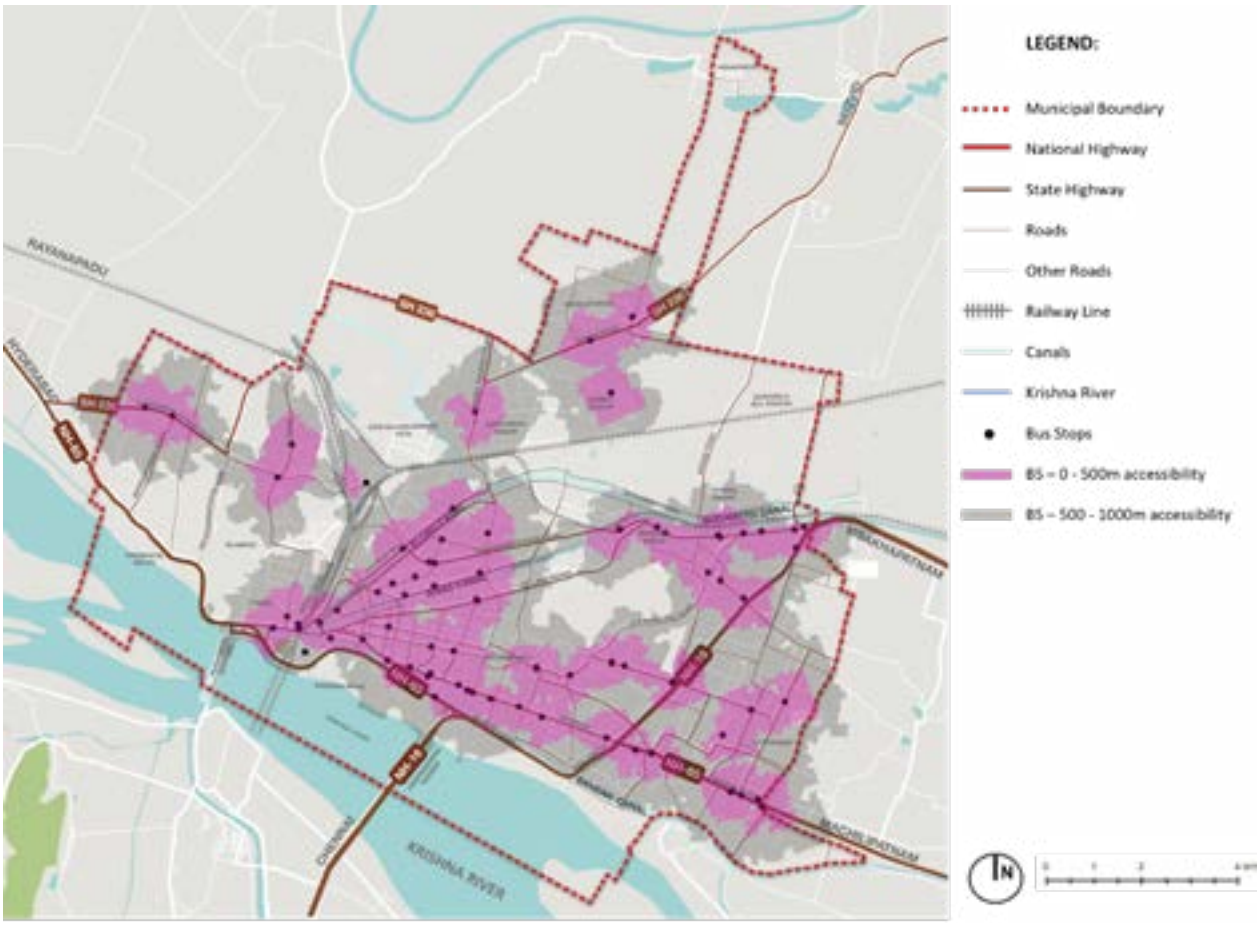
Public transportation: Vijayawada's public transport mainly consists of Andhra Pradesh State Road Transport Corporation (APSRTC) buses, with only 39 per cent of the total population having access to public transport within 500 m. of a bus stop. Meanwhile, auto-rickshaws continue to play an essential role in filling the gaps of citizens' mobility needs. Concurrently, ownership of private vehicles is on the rise with 73.5 per cent more bikes and 40 per cent more cars in 2017 than the previous year.[10] This higher volume of private vehicles may cause increased congestion in peak traffic hours on major thoroughfares.

FIGURE 2.4 Public transportation snapshot



Source: UN-Habitat

10 Teja, Charan. (2017). Amaravati effect? 4 lakh more cars and bikes on Vijayawada's roads in just one year. 15 December 2017. Retrieved from www.thenewsminute.com.



Map 2.1: Existing bus stops with accessibility

Source: UN-Habitat

Traffic congestion: Over the years, Vijayawada has experienced growth along the major corridors leading to ribbon development. Primarily consisting of shopping and commercial centres with high parking demands, they have hampered the free flow of traffic along the main roads. Adding to it are infrastructure utilities and street vendors who consume the road width, consequently narrowing the area available for traffic movement. Currently, the existing road systems in the city do not cater to the needs of bicycles and pedestrians. Due to undesignated pathways, a mix of traffic leads to greater conflict between pedestrians and motorists.

Inaccessible areas: The peripheral areas in the North, North-East, and North-West micro-markets of Vijayawada have limited accessibility due to the north-eastern railway line that trifurcates the city. Moreover, the city's northern and southern zones are connected by only a single flyover at Singh Nagar, increasing average trip lengths and creating bottlenecks at bridges crossing the canals.

FIGURE 2.5 City level NMT summary

113.4 km/ 1,260 km - 9%
MAJOR ROAD WITH F.P (>1.2M)

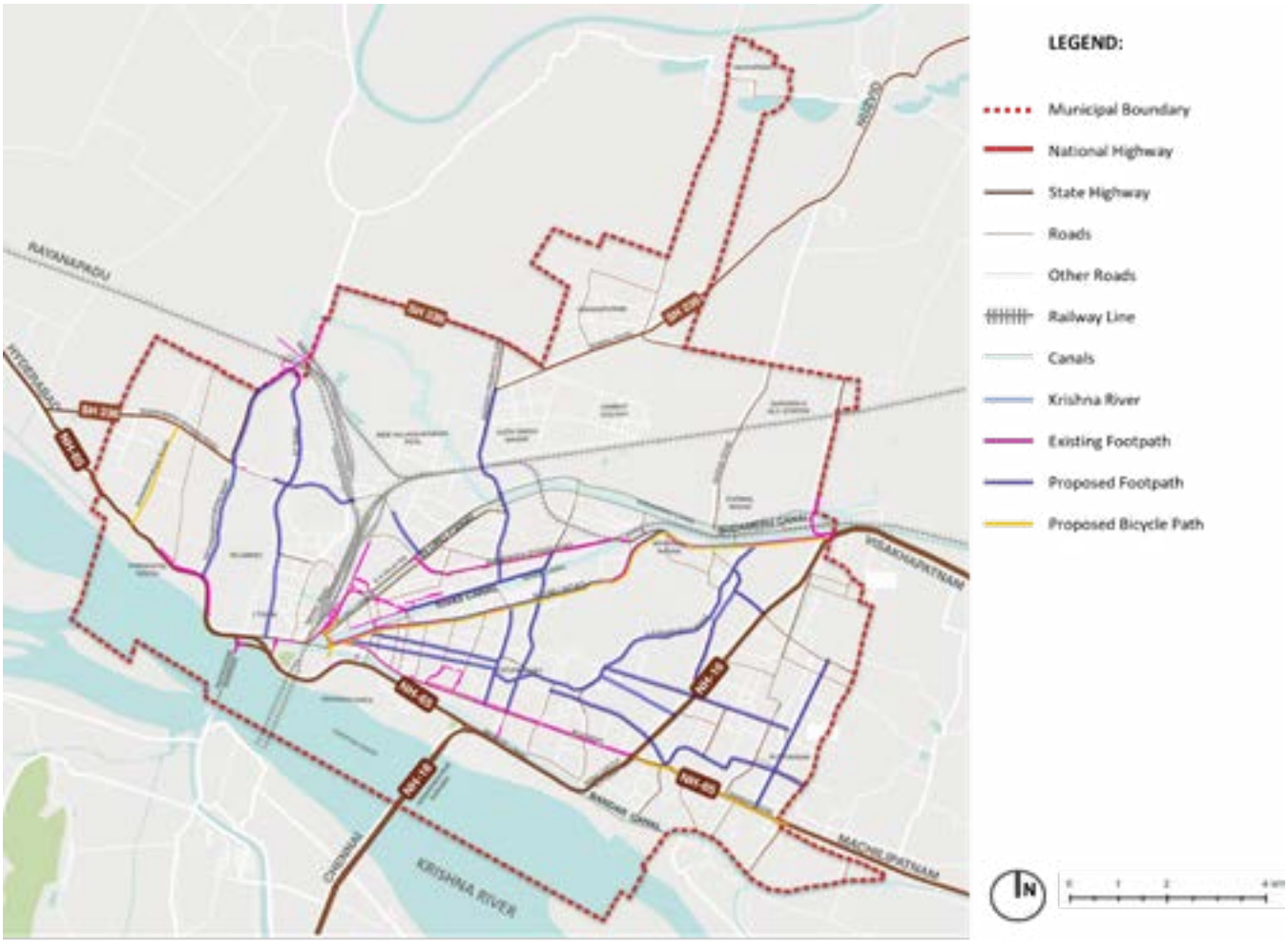
43.8 km/ 1,260 km - 3.5%
PROPOSED IMPROVEMENTS IAP

Total 11.93%
MUCH BELOW USAF INDICATOR (75%)

0%
KM OF BICYCLE PATH PER 100,000 USAF INDICATOR (25km)

10.1km
PROPOSED BICYCLE PATH IAP

Source: VMC, UN-Habitat GIS Analysis



Map 2.2: City level NMT services

Source: UN-Habitat

2.3.2. Issue 2: Inadequate public green spaces and fragmented blue–green network

The Krishna River and its four canals – Budameru, Eluru, Bandar and Ryves – are Vijayawada's natural assets that define its blue network. Along the canal and riverbanks, a significant amount of underutilized land is available with the potential to be developed as accessible open spaces. In addition, a series of formal and informal parks define the greenspaces of Vijayawada. The city's landscape is punctuated by prominent hills that remain largely undeveloped (except along their lower slopes) and have religious shrines/ temples at prominent vantage points. USAF identified nine indicators in this sector and ranked Vijayawada's overall performance in this sector as 'lower medium'. The key identified challenges are:

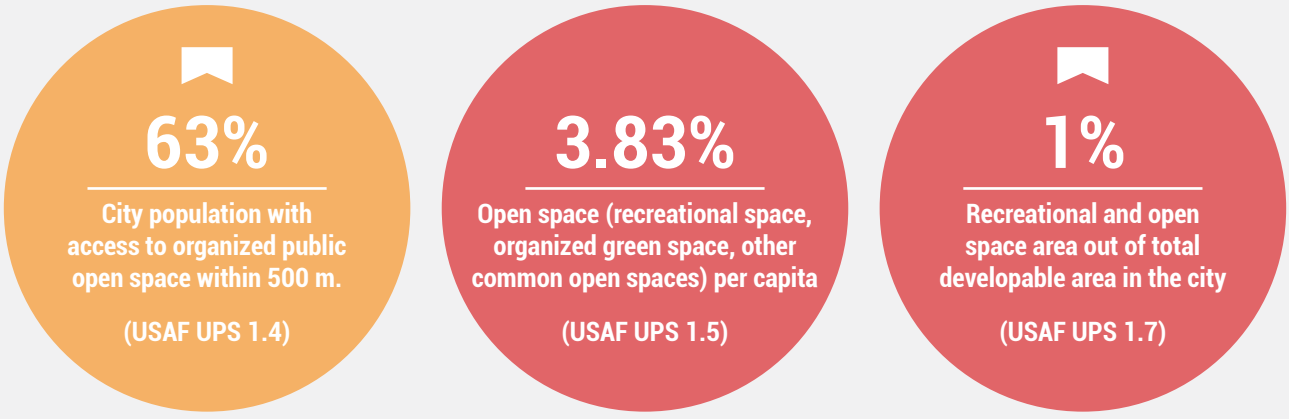
Accessible spaces versus open spaces: Open spaces in Vijayawada are defined by parks, open areas, green bunds, avenue plantations, medians and roundabouts that account for a total green cover of 4.59 sq. km. (7.4 per cent) of the city's total area. However, of this total green cover, only 0.42 sq. km. (1 per cent) (parks, open spaces and green bunds) is accessible for recreational use against the standard 12–14 per cent as per URDPFI guidelines.

Low per capita open space: The development of parks and green open spaces is a priority area for the VMC, which has developed many area-level parks over the last decade through general funds and programmes like the Atal Mission for Rejuvenation and Urban Transformation (AMRUT). Despite innovatively creating open spaces such as canal embankments, eco-sensitive parks, and play areas beneath flyovers, the city still lacks adequate organized open spaces.

In Vijayawada, open spaces account for 3.83 sq. m./person, against URDPFI and AMRUT guidelines of 12 sq. m./person. Spatial analyses based on the Geographical Information System (GIS) data collected in 2019 reveals that only 63 per cent of the city's population has access to parks and open spaces within 500 m. of their homes.

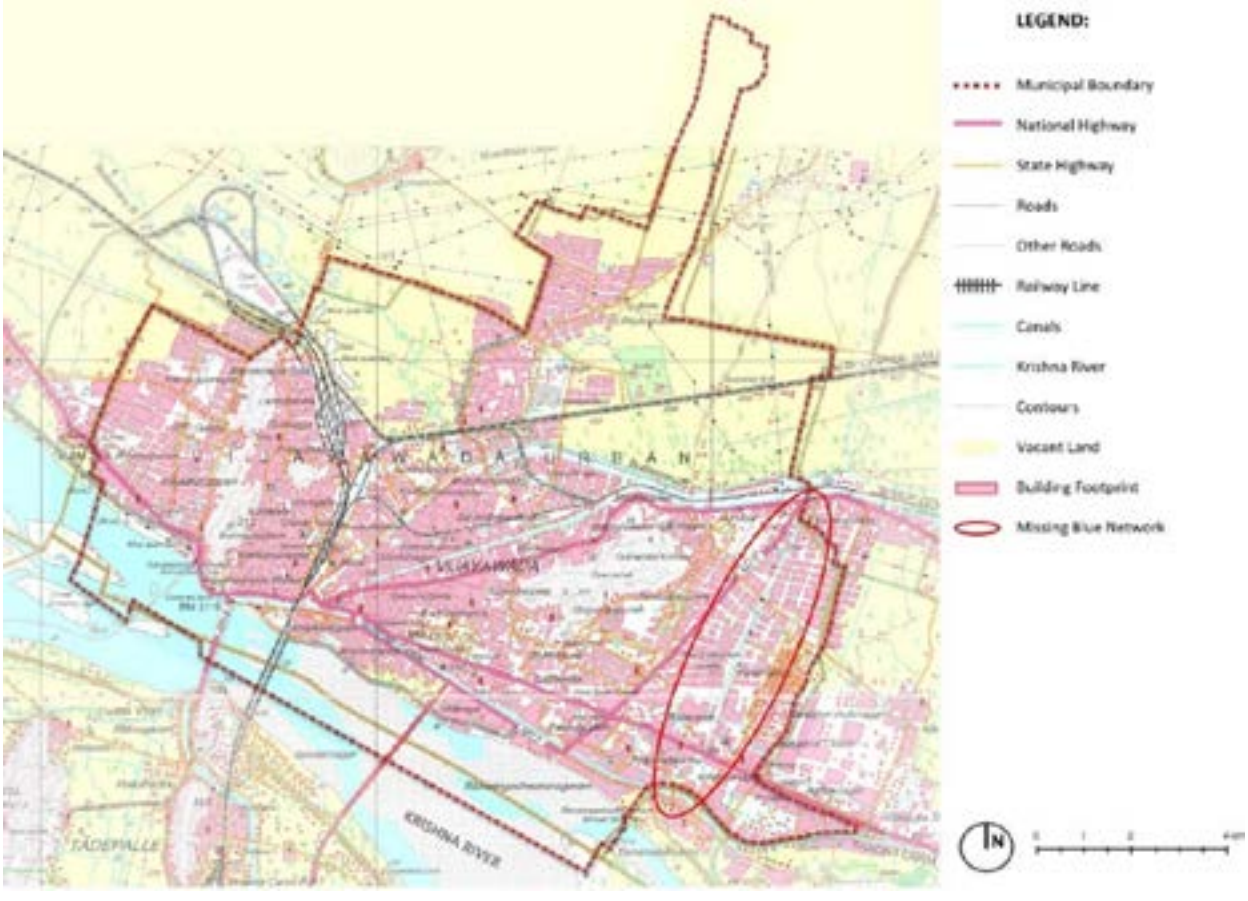
Fragmented blue network: Over the last few decades, most significant changes have occurred to the river and watersheds in Vijayawada. Intense urbanization has

FIGURE 2.6 Snapshot of open spaces in Vijayawada



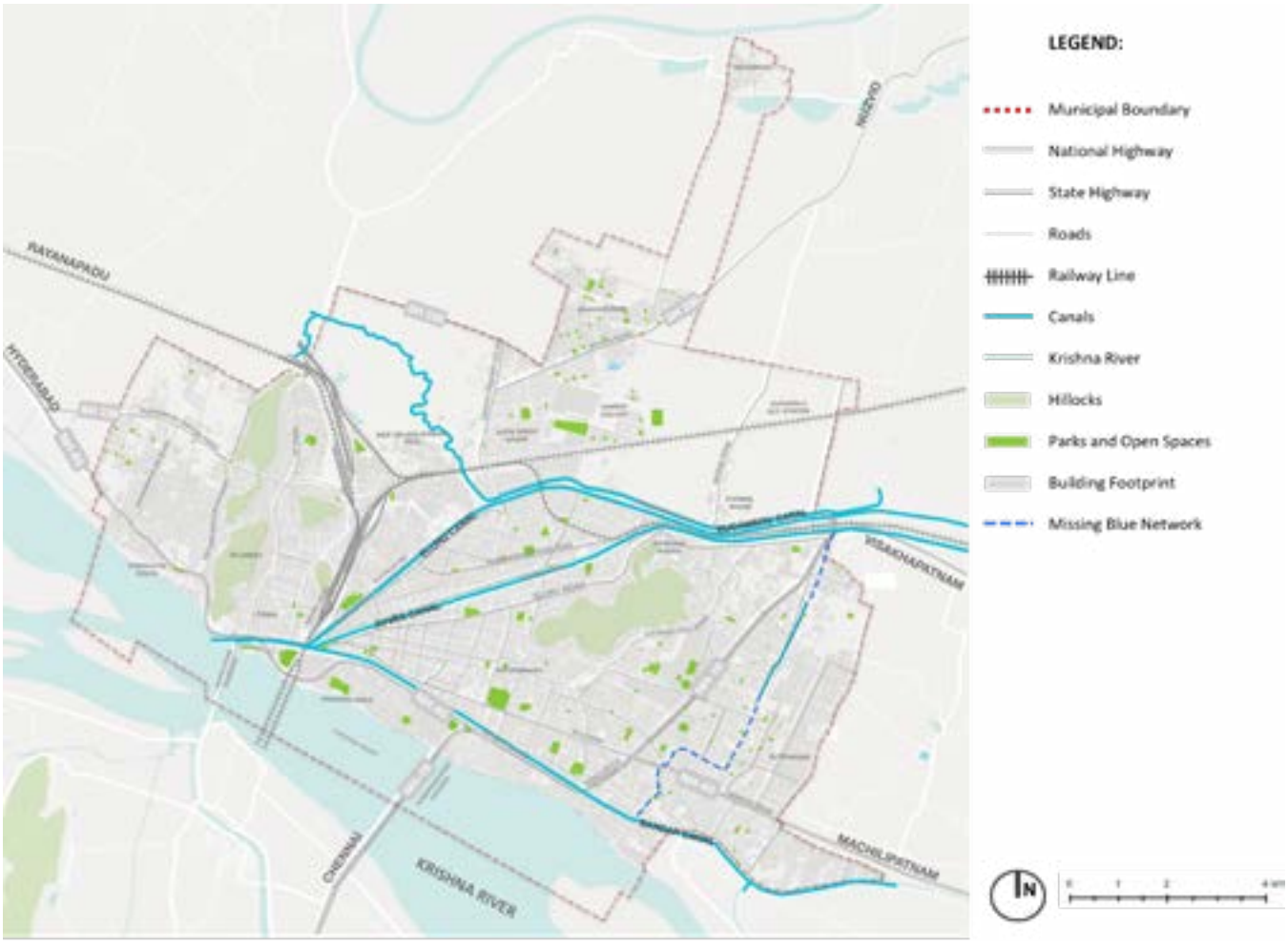
Source: UN-Habitat

resulted in stream alterations, increased pollution, and combined sewer overflow discharges. Despite various initiatives by VMC for cleaning the canals and removing encroachments along the embankments, there is a proliferation of construction activities in a few areas. A comparative study of the current layout of the canals with the original alignment given in the toposheet from 1975-76 (updated in 2005-06) reveals that a connection of 5.3-km along Kanak Durga Colony Road, between Ryves and Bandar that used to directly allow the runoff to flow into the river, has been disrupted. At present, only 1.14 km of the stream exists for drainage while the remaining may have been encroached by the surrounding residential development.



Map 2.3: Highlighting the missing blue link from the toposheet (surveyed in 1975-76 and updated in 2005-06)

Source: UN-Habitat



Map 2.4: The missing blue link at present (reference from toposheet)

Source: UN-Habitat

2.3.3. Issue 3: Sprawling and scattered development patterns

High core density: The city shows a high variation in density with a very dense urban core as high as 600 PPH vis-à-vis large parts of the peripheral zone with a density lower than 75 PPH. Ninety per cent of the city's population lives in precincts with densities higher than 150 PPH, which is considered to be the optimum population density by global best practices for designing cities. Spatially, the high-density wards are concentrated in the city core (2.5 km radius from the railway station) and along the primary road network, while existing intercity railway lines impact spatial growth in the North, North-East and North-West micro-markets with lower densities.

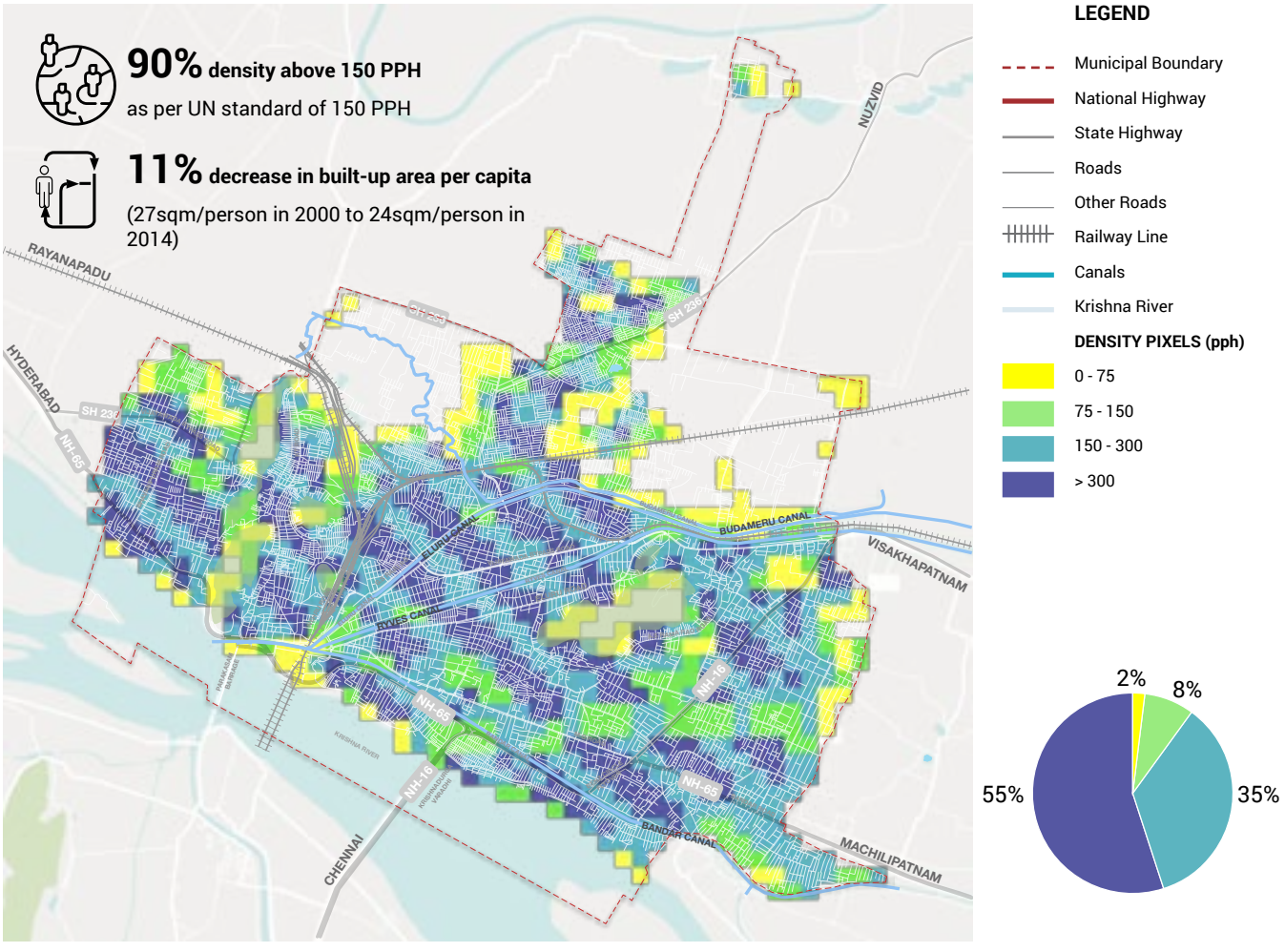
Fragmented peripheral development: The ZDP 2021, prepared in 2006, identifies Vijayawada as 100 per cent developable, changing the existing agricultural land use along the VMC boundary to residential, leading to an influx of development activity in a scattered manner along major road corridors. However, most civic facilities, infrastructure, and economic opportunities are concentrated in the city core, in contrast to Vijayawada's peripheral zones, which still have limited infrastructure development.

This leads to increased high dependency on mobility from the periphery. About 22 per cent of the overall urban population of Krishna District commute a distance of 6-10 km for work. The low WPR of 37 per cent for the overall city and 18 per cent for women in Vijayawada is linked to the city's limited infrastructure and mobility access.

Vulnerability to flooding: The entire northern and north-western zones of the city along the Budameru River channel experience waterlogging, limiting the overall development opportunities for this region. Budameru is a seasonal canal that discharges excess floodwaters; however, over the years, the canal's carrying capacity has reduced due to silting of drains, development activities, and encroachments. In addition, settlements along the riverbanks and the vast land pockets on either side of Budameru–New Raja Rajeswari Peta and Rajeev Nagar are prominent low-lying areas prone to floods. Recently, the state government has initiated building a retaining wall along the Budameru rivulet to prevent inundation, which will open up more land for development, going forward.

IMAGE 2.3 Development pattern in Vijayawada

Source: UN-Habitat



Map 2.5: Population density estimates (2015)

Source: UN-Habitat

2.3.4. Issue 4: Vulnerable informal settlements

As shown in Figure 2.2, Vijayawada scored 'very low' in the Housing and Property sector. The major reasons behind this low score are all associated with informal settlements. About 29 per cent of households in Vijayawada live in 111 informal settlements (USAF HP 2.1). Slums constitute about 15 per cent of the city area (9 sq. km.) (USAF HP 2.2). These informal settlements face various problems that are discussed below.

- **Overcrowding:** About 94 per cent of the informal settlements have a population density greater than 150 PPH, while 59 of the 111 slums have a population density of more than 300 PPH.

- **Low service coverage:** Only 30 per cent of the city's slum population has access to public transport nodes; 54 per cent has access to parks or organized open spaces within 500 m. of their homes and only 55 per cent has a healthcare facility within a 800-m radius. About 69 per cent of these informal settlements are deprived of any two or more of the five services assessed in the USAF.[11] Most underserved informal settlements are located in natural hazard vulnerable areas such as along hillslopes, the foothills of Indrakeeladri and Gunadala Hills, and along the banks of River Krishna and its canals.

- **Encroachment of conservation zone:** The Zonal Development Plan 2021 had demarcated conservation zones[12] on the hills, along the river and canals. However, in many cases, the conservation zone has been encroached by informal settlements.

- **Hazard vulnerability:** Vijayawada is vulnerable to multiple natural hazards such as flooding, landslides, heatwaves and cyclones. As per the findings of the City Disaster Management Plan (2015) and GIS analysis, about 9.5 per cent of the city's total population is vulnerable to landslides and 10 per cent to flooding. Of this, about 61 per cent who are vulnerable to landslides and 33 per cent who are vulnerable to floods, live in informal settlements.

Refer to Section 5.1.1 of the Vijayawada City Profile and Diagnostic Report for a detailed analysis of the above findings.

11 The USAF has five indicators to assess the service accessibility of citizens to public transport nodes (within 500 m.), parks and open spaces (500 m.), healthcare facilities (800 m.), education facilities (800 m.) and fire stations (4,000 m.).

12 The Zoning Regulations of Vijayawada ZDP 2021 has demarcated a Conservation Zone for hills, rivers and canals. Land uses permitted in this zone include horticulture, forestry and agriculture. All developmental activities and quarrying are prohibited here.

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3

STRATEGIC RESPONSES

3.1 Core Planning Principles

In response to the diagnostic issues summarized in Section 2.3; four overarching urban planning principles have been identified for Vijayawada. These principles will help shape its future growth and anchor the resultant strategic responses to the issues outlined in Section 3.

3.1.1. Principle 1: Low carbon development

As mentioned in Chapter 2, Vijayawada has several low-lying areas, and experiences repeated flooding. Low carbon development is one of the most important principles while embracing climate change and vulnerability as a platform to influence Vijayawada's development composition.

The low carbon development concept takes a 'development-first' approach over the 'climate first' approach, rethinks development planning, and proposes structural, policy solutions (alternative infrastructure, renewable energy dependency, and spatial planning) with lower emission trajectories. It focuses on addressing and integrating climate change with development objectives. In practice, the low carbon strategies and actions are tailored to local needs.[13]

3.1.2. Principle 2: Transit oriented development

This principle presents a new paradigm for growth in Vijayawada – an integrated approach to transportation-oriented land use planning, placemaking, and economic development. Transit-oriented development, commonly known as TOD, is a planning and design strategy that focuses on creating urban development patterns that facilitate public transit, walking and cycling as primary modes of transport and support vibrant, diverse and liveable communities.[14] In Vijayawada, this principle reinforces the definition of transit to include all mobility options and forges strategies to strengthen first and last-mile connectivity. TOD has been envisioned as corridors and nodes that are compact, moderate-to-high density developments of mixed-use character and interconnected with other land uses by bicycle and pedestrian-friendly mobility networks.

3.1.3. Principle 3: Complete streets

'Complete streets' is an urban planning concept of 'streets for all, where streets are designed to cater to the needs of all users and uses through equitable allocation of road space'.[15] A complete street ensures efficient mobility through multiple modes of travel, especially high-quality facilities for public and non-motorized transport (NMT). A complete street moves more people with a greater capacity by allocating space equitably for all users, without prioritizing only private motor vehicles.[16]

Complete streets help create liveable communities by prioritizing sustainable transportation networks and activating public spaces that benefit everyone, including marginalized groups – leading to long-term benefits for public health, safety, land value, and the environment. The Complete Streets principle is reflected in the National Urban Transport Policy (NUTP) in India.

3.1.4. Principle 4: Sponge city

Vijayawada suffers from intensified hazards such as urban flooding, cyclones, and extreme weather fluctuations. Resilience has to be built in the city's infrastructure planning and development of new neighbourhoods. The principle of 'sponge city' is applied to Vijayawada to manage flooding, encourage water conservation, water quality improvement, natural ecosystem protection, urban heat island effect reduction, and urban value enhancement. The concept proposes ecologically suitable alternatives to transform natural resources, urban green areas, and urban infrastructures into green infrastructures that can capture, control and reuse rainwater in a useful and ecologically efficient manner.[17] The ongoing national programme, Jal Jeevan Mission (Urban), further supports the concept of 'sponge cities' for integrated urban water management.

3.2 Strategic Response 1: Revitalizing Urban Transit System

Transportation networks are a dominant force in shaping sustainable growth patterns in cities. In the case of Vijayawada, the development focus has been on

13 UN SDG Knowledge Platform – Low Carbon Development; https://sustainabledevelopment.un.org/index.php?menu=1448 (accessed on 4 April 2022).

14 Global Platform for Sustainable Cities; World Bank. 2018. Transit-Oriented Development Implementation Resources and Tools. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/31121 License: CC BY 3.0 IGO."

15 Ministry of Housing and Urban Affairs, April 2019, Complete Streets Policy Framework.

16 National Association of City Transportation Officials, Global Designing Cities Initiative, 2016, Global Street Design Guide.

17 UN Environment. (January 2018). Early Warning, Emerging Issues and Futures: Emerging Sponge Cities. Foresight Brief; https://environmentlive.unep.org/media/docs/early_warning/foresight_brief_005.pdf. Accessed on 4 April 2022.

strengthening its regional transport system – enabling long-distance commute through railways and highways. However, this has resulted in an unintended consequence of fragmented internal circulation patterns with limited accessibility to the city's neighbourhoods.

Considering the city's anticipated growth and trajectory, the Vijayawada Sustainable Cities Strategy is built upon the need for creating a robust and diverse transport network as the foundation for adopting an integrated planning paradigm for future development. This section details the Strategic Response of 'Revitalizing Urban Transit Systems', with an overarching goal of creating an efficient transit framework in Vijayawada – one which is intrinsically connected to the land use, densities, and travel patterns. It primarily addresses the issue of sub-optimal urban mobility and access to public transportation with impact on the other three issues of: i) blue-green disconnect, ii) scattered development patterns, and iii) vulnerable informal settlements. The strategic response adheres to the overarching planning principles of Low Carbon Development and Transit Oriented Development.

3.2.1. Proposed interventions within the strategic response

To facilitate better connectivity, the Strategic Response identifies three interventions to provide safer and more comfortable choices to users:

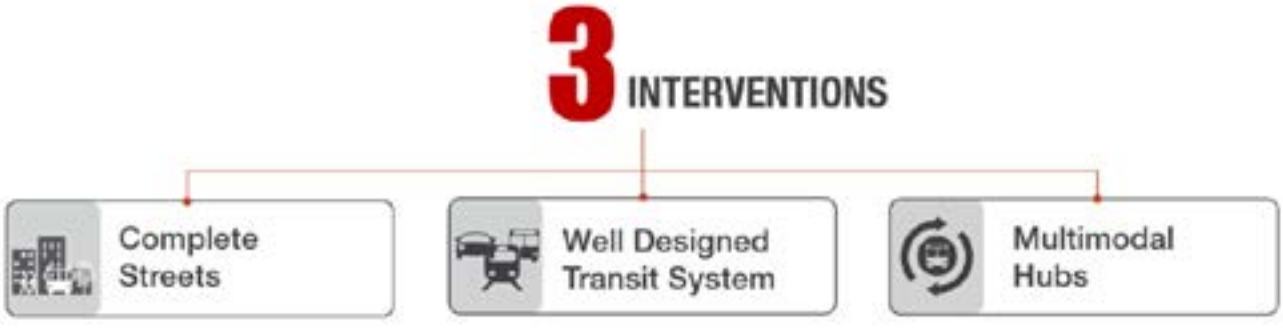
Intervention 1.1: Complete Streets

In urban areas, roads are critical for their growth, economic development, and providing access to social amenities. The city of Vijayawada has an extensive road network of 1,260 km, functioning as the backbone of the city's transportation system. However, this road network is characterized by an ambiguous street hierarchy, dominated by streets with rights-of-way (RoW) less than 12 m.

As evident in urban areas globally, an increase in motorized vehicles over time causes stress on street designs, often prioritizing private motor vehicles and pushing pedestrians and cyclists to the edges of safe movement.[18] Of the 1,260-km road network, the city has only 113.4 km of footpaths. Moreover, these footpaths are either too narrow, too high or have poor surfaces or have been infringed upon by street vendors, utilities and parking.

Only one-fourth of the total population of the urban Krishna District travel to work on foot. In the urban district, 49 per cent of women walk to work, as a major mode of travel (B-28, Census of India 2011). A high share of women among pedestrians suggests the need for interventions with priority to addressing women's needs in complete streets.[19] The modal share of commuting by bicycle in the overall district is high with 24 per cent of the total population, of whom 6 per cent are women.

FIGURE 3.1 Proposed Interventions for revitalizing the urban transit system in Vijayawada



Source: UN-Habitat

18 Indian Road Congress. (August 2020). Draft Guidelines for Pedestrian Facilities. Available at: www.irc.nic.in/admnis/admin/showimg.aspx?ID=237.

19 The data refers to urban Krishna District and may not completely reflect modal share statistics of Vijayawada.

There is an urgent need in Vijayawada to create street sections that respond to land use and help achieve environmental goals, while meeting the travel needs of the community. The concept of **Complete Streets** is proposed to enable safe access for all users, including pedestrians, bicyclists, motorists and transit riders of all ages and abilities.[20] It includes the following components:

- **Appropriate allocation of road space** to accommodate more people than vehicles
- An **attractive streetscape and public realm** by creating active, vibrant and safe public places such as plazas, parks, and pedestrian-only streets for social interaction and physical activity
- Re-imagining streets as agents for **carbon sequestration** through increased green cover and nature-based solutions (NbS).
- Delineate space for all activities within the public realm, **such as street vendors and parking**
- **Adopt transit priority measures** to ensure the efficient movement and integration of formal public transport, paratransit and cycle sharing within a walking distance.

Under this intervention of Complete Streets, **73.3 km of new roads** have been identified to create an interconnected system of streets and blocks with routes **providing direct connections between transit stops and other destinations** (see Map 3.1). Further, a new highway alignment has also been recommended for NH-16 along Yanamalakuduru Konda Road to avoid traffic congestion within the city. It starts from the Iskcon Temple and ends at Vidhyanagar Colony near Tadigadapa–Penamaluru Road. The alternative route, approximately 6-km long, is expected to improve the connectivity in and around Vijayawada by formulating the radial-ring road network in collaboration with other ring roads – such as the Inner Ring Road and Vijayawada Bypass – identified as part of the Capital Region Draft Perspective Plan, 2050.[21]

The Complete Streets approach also identifies a **clear hierarchy of roads** to accommodate a wide range of users, including pedestrian, cycling and vehicular traffic. The proposed network also considers the already identified **47.41-km road network** under the Vijayawada Immediate Action Plan (IAP), 2019, for transport and proposed roads for improvement by the VMC.

The vision is to provide more and enhanced mobility choices for Vijayawada's residents and discourage the use of cars for shorter local trips. The Complete Streets approach identifies diverse design elements based on contextual variations and modal priorities, applicable within a radius of 100 m. and 300 m. from the transit stop (see Figure 3.2).

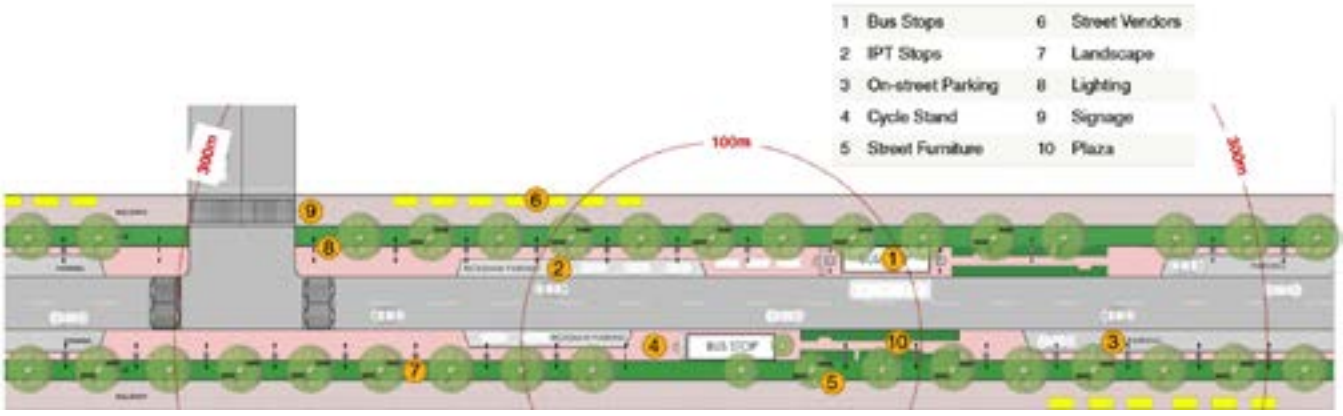
Map 3.1: Proposed complete streets

Source: UN-Habitat

20 National Association of City Transportation Officials. (2016). Global Designing Cities Initiative, Global Street Design Guide.

21 A detailed traffic analysis and alignment feasibility study will have to be conducted to ascertain the exact location of the proposed highway link.

FIGURE 3.2 Complete Street design elements



Source: UN-Habitat

TABLE 3.1 Complete Street design elements and proposed basic and premium requirements

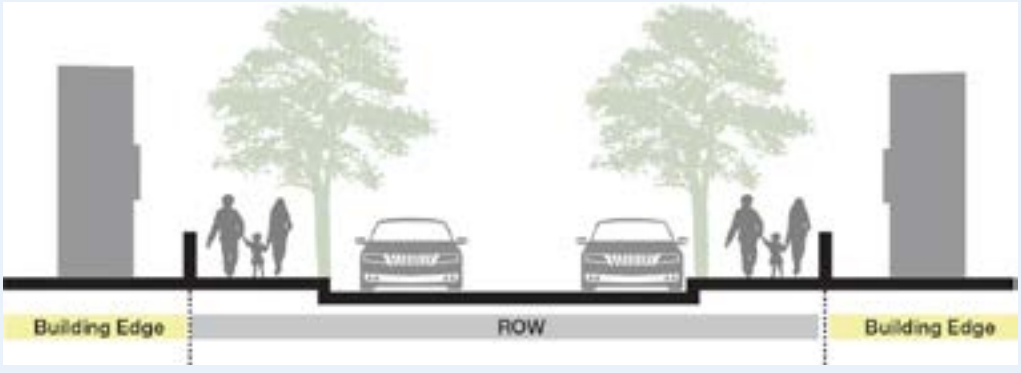
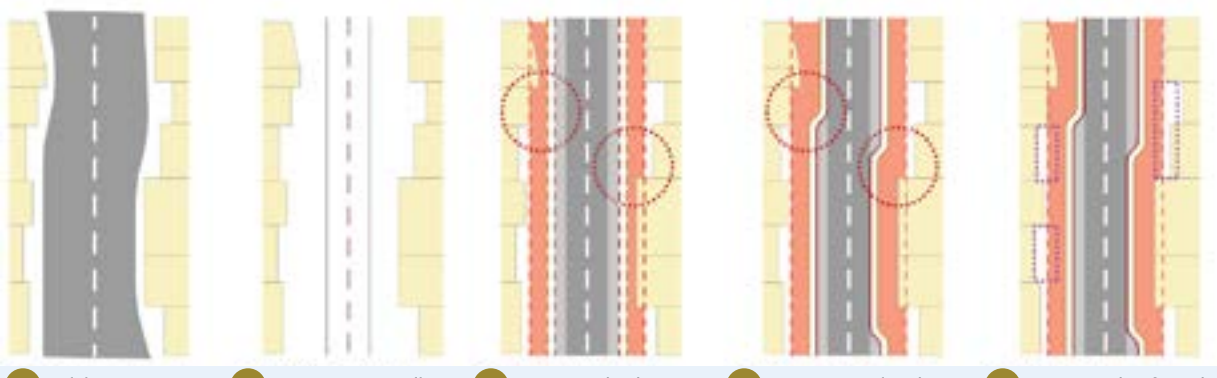
	BASIC	PREMIUM
WITHIN 100M	**Designated parking area for autorickshaws & cycle rickshaws** within 100 m. of walking distance from the bus stop. Provide **real-time information on service information** Physical protection of footpath & bicycle track Passenger Waiting Area | Trash Bins | Public Toilets (Male, female and universally accessible gender-neutral toilets) Drinking Facility | Public Bicycle Integration	Pedestrian-only plazas Passenger pick-up and drop-offs Technology Interventions: CCTV + Safety Buttons
WITHIN 300M	**Pedestrian crossings & connections:** Clear, direct, and short transfers between transit modes and routes by minimizing walking distances Providing **designated vending kiosks & landscape buffers** On-street parking along with the landscape buffer **e-Charging Stations**	Parking Lots Vending Zones & Commercial Areas Wide Shaded Sidewalks

Source: UN-Habitat

The design elements are also supported with the strep-by-step guide that is intended as a reference for starting street redevelopment process. It illustrates the possible design and infrastructural elements, based on site constraints and opportunities, including adjacent land use, proximity to a natural resource, if any, site vulnerabilities or ecological risks, modal share, and street configuration.

This approach can assist in the planning and development of shared infrastructure while helping to identify the opportunities for revenue generation that can sustain the development of an extensive Complete Streets network for Vijayawada (see Table 3.2).

TABLE 3.2 Strep-by-step guide for complete street implementation proposed for Vijayawada

	STEPS	DESIGN ELEMENTS
1	**Initiate a topographical survey** from building edge to building edge along with pedestrian counts | Traffic Counts | Parking Demand	
2	**Map land uses and key traffic generators** to understand modal priorities, traffic volumes and origin-destination travel patterns.	
3	Prepare street alignment for envisioning the desired RoW allocation, followed by detailed tender drawings and material specification after approval of conceptual design.	

Source: Draft BDP 2031

CASE STUDY: CHANDRA RAJESWARA (CR) RAO ROAD

Using the above methodology for adopting Complete Streets, a conceptual design for CR Rao Road has been prepared, which includes transforming the underutilized space along the road's edges into a pedestrian promenade. With the proposed transformation, a 200-m stretch of 30-m RoW would result in a 35 per cent increase in green cover and a 55 per cent increase in permeable surface area. Annex 4 includes the detailed design and process followed for CR Rao Road.

Figure 3.3: Streetscape improvement for CR Rao Road using Complete Street approach

Source: UN-Habitat

Intervention 1.2: Create a Robust and Well-designed Transit System

This intervention is based on three factors:

i. Identification of Vijayawada's most critical transport corridors with high ridership at present

ii. Potential new nodes/ areas in upcoming growth areas, which will create more demand

iii. A strong feeder service network to ensure complete transit connectivity across the city

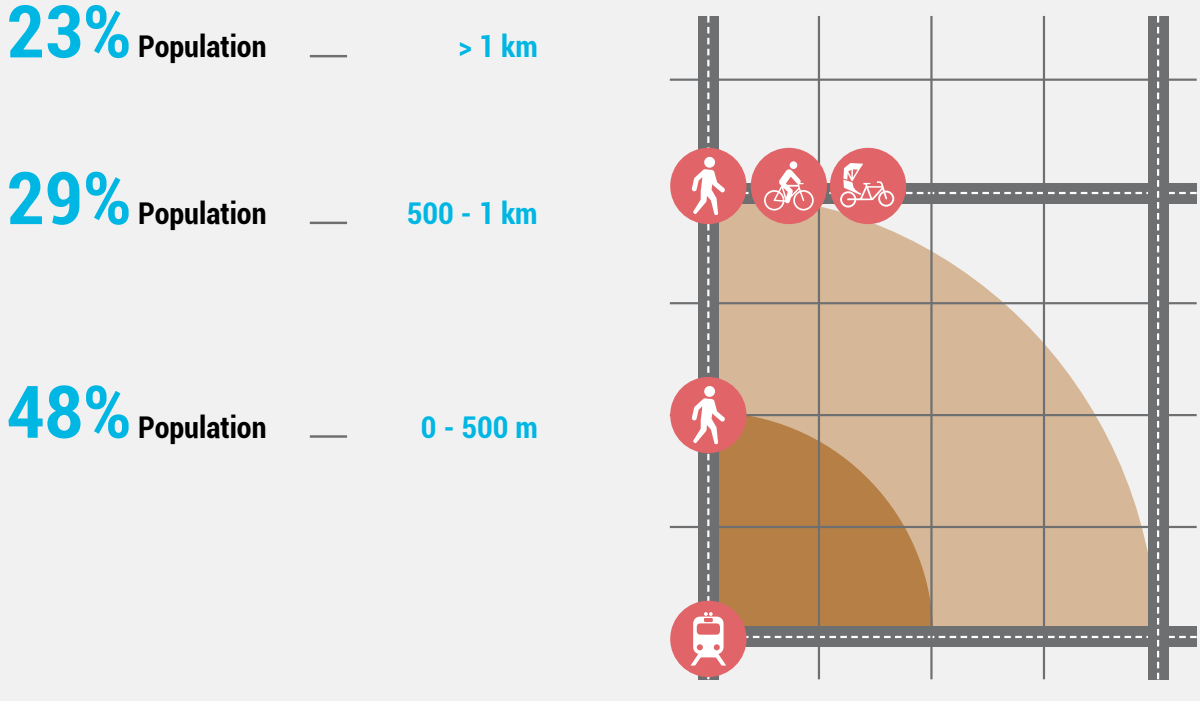
At present, APSRTC is responsible for inter-city and intra-city public transport in Vijayawada and operates its network on 22 per cent (286 km) of the total road length. As per the city's existing GIS database (2019), 77 bus stops have been identified along the primary road network, providing public transit access to only 39 per cent of the population within 500 m. (10-minute walk) of a bus stop. There is an urgent need to develop an efficient, seamless and integrated transit system to address the transportation challenges faced by the city.

A. To **augment the current bus system, additional routes and bus stops** need to be added after a detailed route rationalization study. The basic premise for this periodic study should be to make bus service accessible to maximum users within a 10-minute walking distance. The following criteria may be used during the route rationalization study to ensure adequate coverage:

- Analyse primary trip generating uses during peak time to ascertain travel demand.
- Identify appropriate routes; either: (a) high boarding/ alighting routes, or (b) routes with latent demand (potential land uses that generate more travel demand);
- Assess the catchment area around the existing and proposed bus stops, ideally within a radius of 500 m.–1 km.
- Examine the road network within the catchment area to identify roads with appropriate RoW to support frequent bus service.

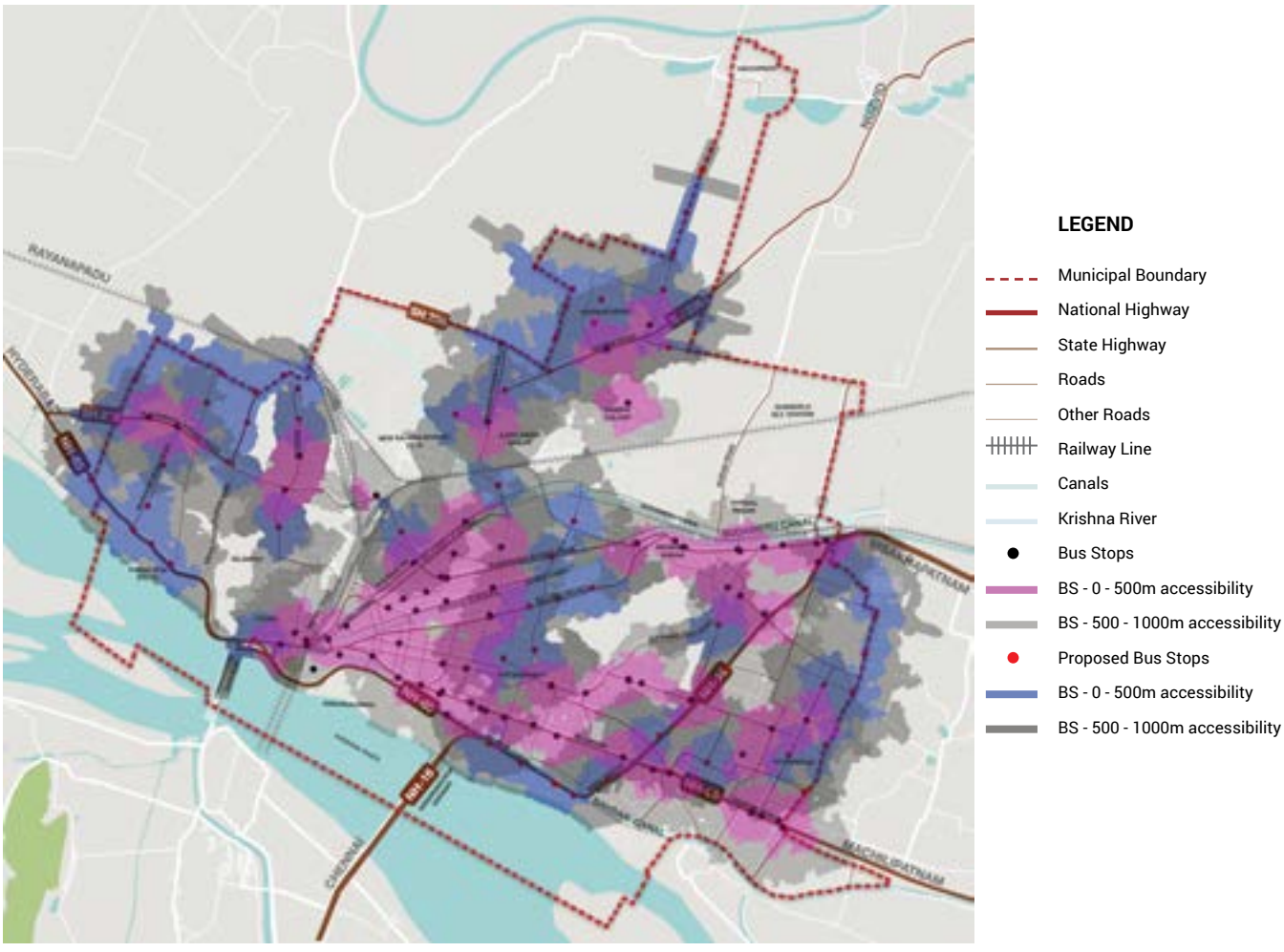
Based on the above criteria, tentative locations for future bus stops have been identified[22] in Map 3.2. While identifying additional routes and finalizing new stops, it is recommended that a detailed route rationalization study be undertaken to ensure that future networks are based on the latest ground realities.

FIGURE 3.4 Increased accessibility with proposed bus stops in Vijayawada



Source: UN-Habitat

22 Due to limited available data such as updated spatial data, ridership trends and population density, the proposals have been prepared with certain assumptions. Detailed traffic and feasibility studies would be needed to ascertain the exact locations on ground.



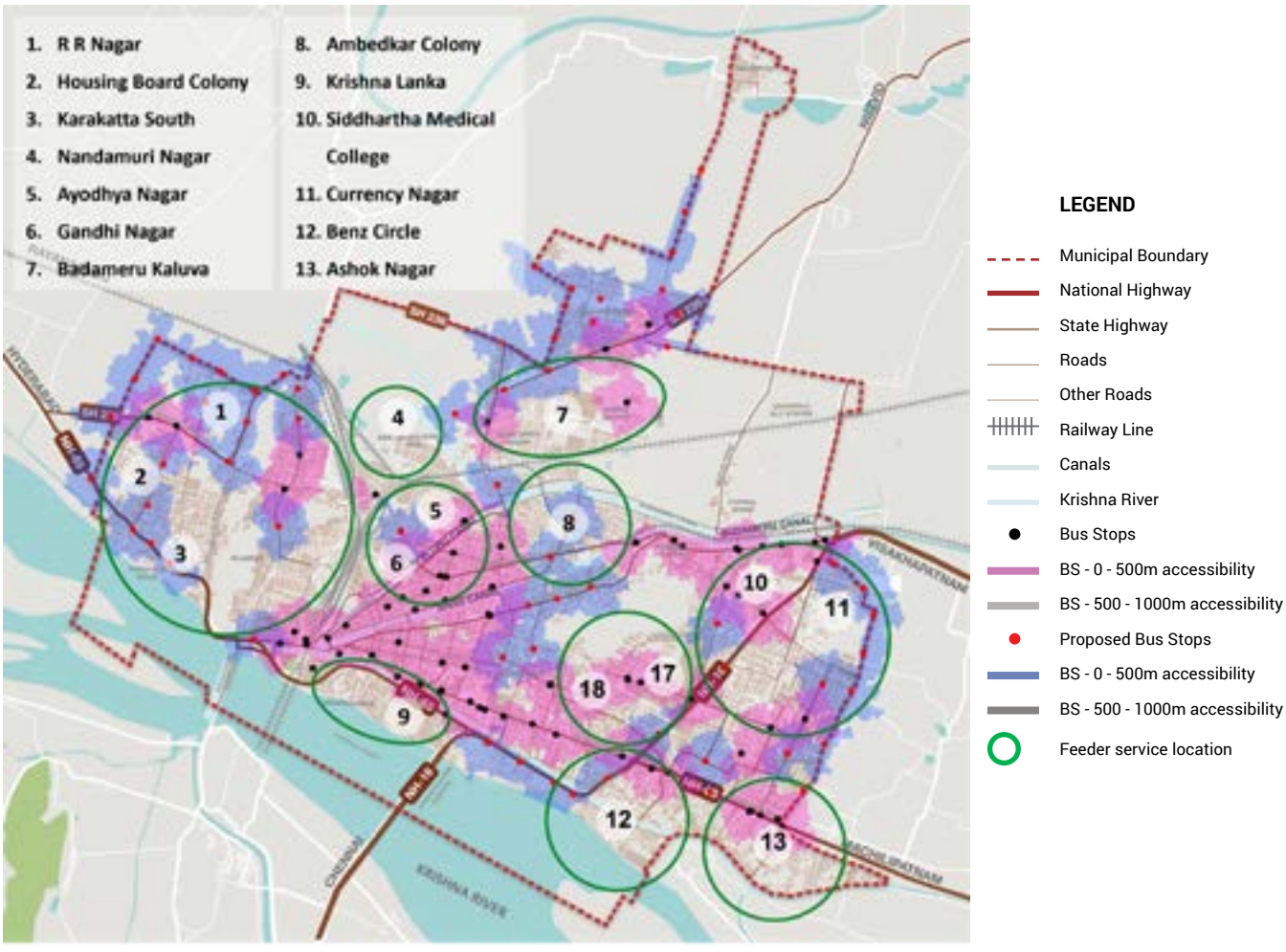
Map 3.2: Proposed bus stop locations

Source: UN-Habitat

B. **Explore options for strengthening Intermediate Public Transport (IPT) feeder service network,** complementary to the existing APSRTC routes. Feeder services, including private autos and aggregator cab services, while operating as an informal system, play an essential role in Vijayawada's transportation system at present. To ensure seamless integration between the formal bus network and the informal IPT network, it is imperative that the IPT modes be regularized along with a transition to electric vehicles (EVs). This action will help support network expansion in the short-term, while serving the first and last-mile connectivity in the mid-to-long term transit enhancement strategy.

C. **E-rickshaws** are recommended to be introduced in areas where the bus services are currently not available, as a pilot project. These areas include Valmiki Ambedkar Awas Yojana (VAMBAY) Colony, Krishna Lanka, Nehru Nagar, and Karakatta South, as well as the new planned regions where the demand to add a new bus service, is not feasible (see Map 3.3). The following guidelines may be adopted during the planning and implementation of e-rickshaws:

- Locate e-rickshaw stands in all terminals (stations and stops) as well as within RoW of streets with designated spaces for auto-rickshaws (see Map 3.3).
- Encourage services such as 'dial a rickshaw' to provide citizens broader and more efficient service.
- Explore technology integration to improve the Automatic Vehicle Location System, integrated apps providing real-time information to the public, manage travel demand, and enhance customer experience.
- Programmes such as driver training and certification may be explored to tap into existing auto-rickshaws and transition into a planned service by the government to ensure safety on the street for passengers and other road users.
- Identify areas where cycle rickshaws ply and invest in training their drivers to operate e-rickshaws.



Map 3.3: Proposed potential locations for feeder network

Source: UN-Habitat

Intervention 1.3: Creation of Multimodal Hubs

To tie the earlier interventions of improving the bus network and strengthening the IPT feeder network, this intervention proposes multimodal hubs at strategic locations to ensure seamless integration between the APSRTC bus system, railway stations, and IPT routes. It also ensures efficient connections to all modes of access to and from regional and local origin-destinations. These proposed multimodal hubs are envisioned to provide easy and convenient access to different transit modes by minimizing walking distances and eliminating physical obstructions within transit facilities. These hubs will also serve a dual purpose of providing much-needed public spaces for people to gather and can be easily accessed by walking, cycling, IPT modes, public transit, and personal vehicles (see Figure 3.5). Multimodal hubs, when designed sensitively, are catalysts for efficient operations of different travel modes and enabling effective synergies between land use activities and transportation.

It is recommended that multimodal hubs be developed based on conducting a comprehensive mobility study. The travel behaviour data, disaggregated by gender, age, income, ability may be collected and assessed. Specifically, the perception and experience of safety and sexual harassment on streets, access zones and waiting areas for public transport (and paratransit), travel inside the vehicles must be measured. Gender inclusive amenities be provided within multimodal hubs in well-lit and accessible areas. This includes

- At least one nursing room, drinking water facilities, public toilets (male, female and universally accessible gender-neutral toilets)
- Waiting rooms (at least one AC waiting room with public toilets for women, gender minorities and women with family)
- Night shelters with reserved accommodation for women, gender minorities and women with children of 15 years and below
- Restrooms for male, female and gender diverse individual's (GDI's) staff

- Signages, real-time and static information, display helpline and emergency phone numbers.

Additional amenities may be provided as per the requirement, based on a conducted mobility study.

Based on the surrounding land use, the nature of these multimodal hubs may be customized into different typologies. The size of a multimodal hub is typically dictated by the volume of pedestrian traffic and transit riders, type of transport modes, and the surrounding land use activities. The intervention also suggests the following typologies that may be applied at various locations, along Vijayawada's transit corridors, depending on the characteristics of the area.

FIGURE 3.5 Proposed illustration for multimodal hub

Source: UN-Habitat

FIGURE 3.6 Proposed typologies for multimodal hub

Source: UN-Habitat

FIGURE 3.7 Concept of proposed mobility hub and streetscape improvement along MG Road

Source: UN-Habitat

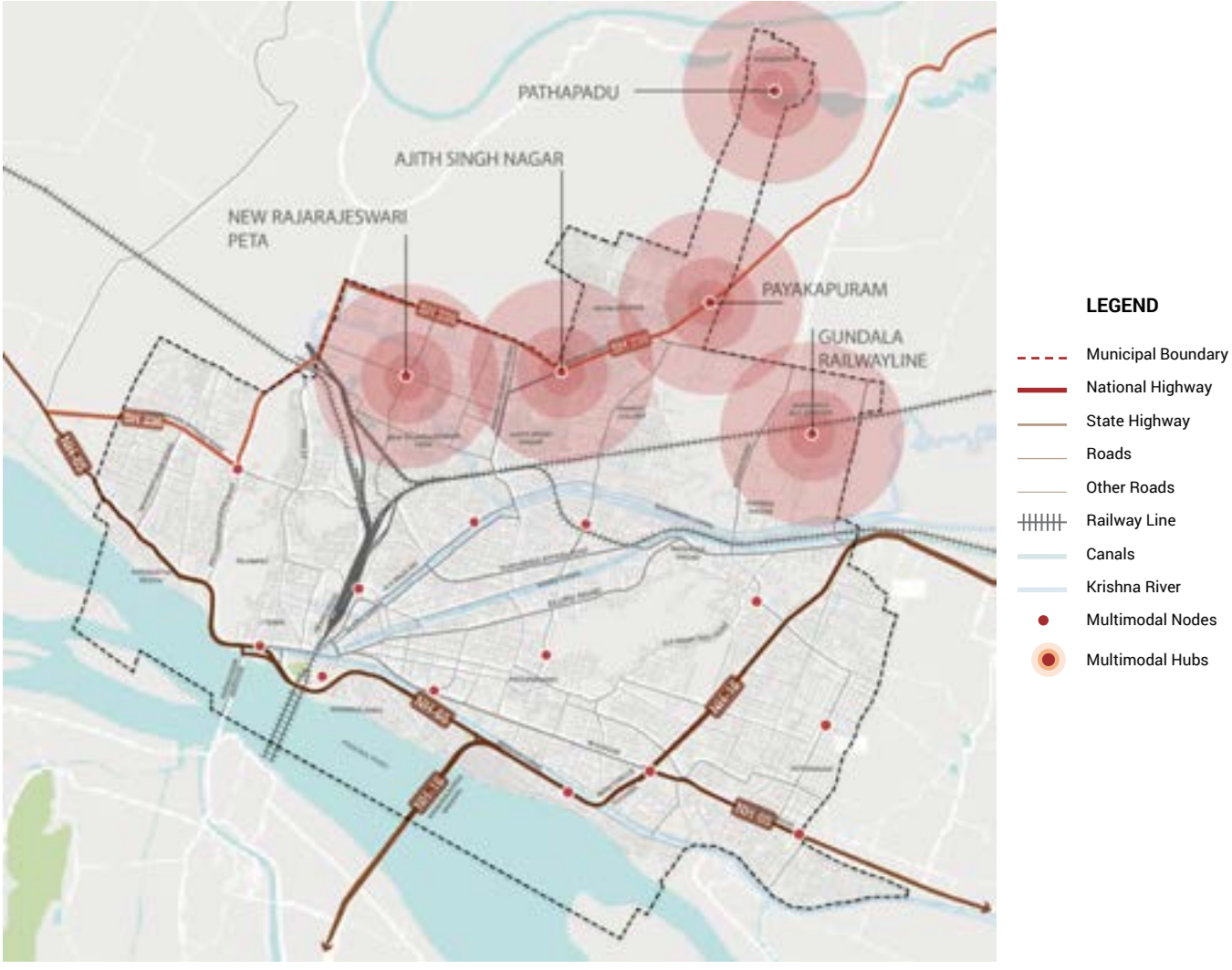
TABLE 3.3 Proposed typologies and mix uses for multimodal hubs

TYPOLOGY	CHARACTERISTICS	MIX OF USES
Transit Plaza	Significant hubs of transport activity with supporting commercial and informal activities	Private Vehicles Parking: Long Term: 30% | Short Term: 20% E-Rickshaw Parking: 25% Street Vendors/ Public Plazas: 25% Bike Share Area: Large Size (20-30 vehicles)
Activity Plaza	Significant centre of economic and community activity. Areas with main public / semipublic amenities & offices of the city.	Private Vehicles Parking: Long Term: 20% | Short Term: 40% E-Rickshaw Parking: 20% Street Vendors/ Public Plazas: 20% Bike Share Area: Medium Size (15-20 vehicles)
Destination Plaza	Areas with access to unique destinations	Private Vehicles Parking: Long Term: 20% | Short Term: 35% E-Rickshaw Parking: 25% Street Vendors/ Public Plazas: 20% Bike Share Area: Large Size (20-30 vehicles)
Neighbourhood Plaza	Predominantly residential districts with narrow roads in dense pockets.	Private Vehicles Parking: 50% E-Rickshaw Parking: 15% Street Vendors/ Public Plazas: 35% Bike Share Area: Small Size (10-15 vehicles)

Source: UN-Habitat

The following step-by-step process may be adopted to guide the planning and design of multimodal hubs. Based on the methodology, 18 potential locations for multimodal hubs and five potential development nodes (see Map 3.4) have been identified.

- **Site selection**: The areas should support regional connectivity and be planned around high demand land use/ activity generators (residential areas/ employment centres and recreational/ entertainment hubs)
- **Availability of well-planned and designated spaces:** All modes of public transportation should be available: E-rickshaw | Buses | Cycles
- **Surrounding road network:** The available RoW should be able to support the increased demand of vehicles and be well-connected to nearby arterials.
- **Availability of land:** In terms of its utilization, should have the capacity to support public amenities planned under multimodal hubs.
- **On-site features:** Features such as suitability of the terrain or eco sensitive areas.



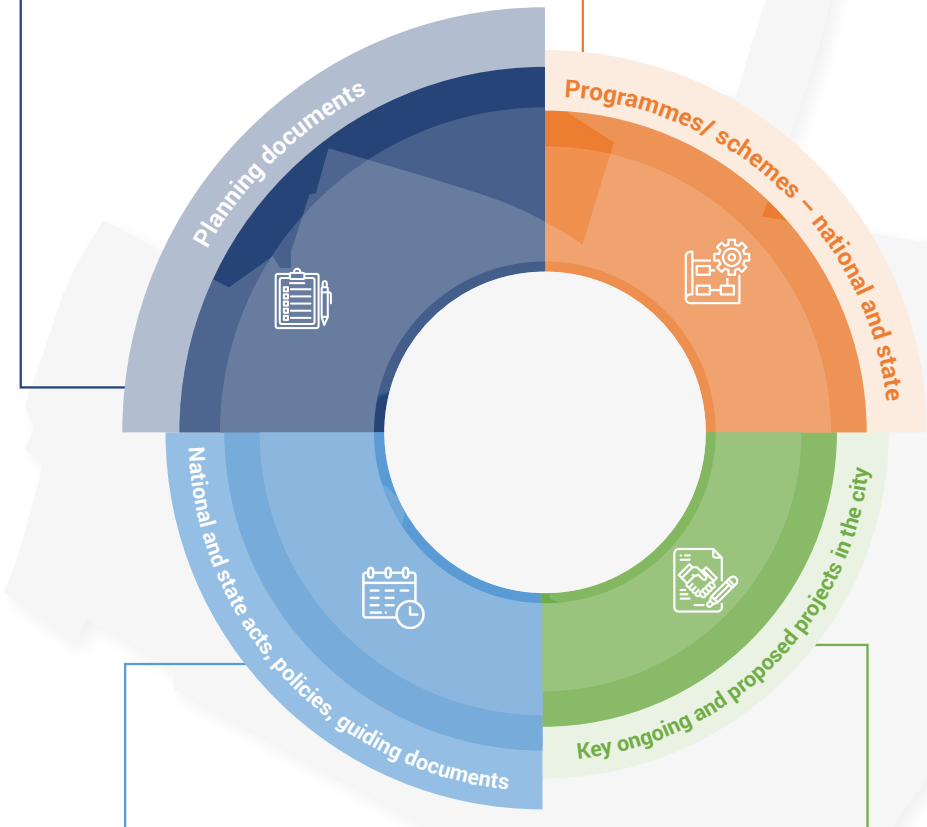
Map 3.4: Proposed multimodal hubs and potential development nodes

Source: UN-Habitat

3.2.2. Alignment with national, state policies, programmes and ongoing, proposed capital projects in the city

- Zonal Development Plan 2021
- Vijayawada Immediate Action Plan 2019
- Capital Region Draft Perspective Plan 2050

- AMRUT
- AMRUT 2.0 / Jal Jeevan Mission (Urban)
- Clean Andhra Pradesh (CLAP)
- Street 4 People, ITDP & MoHUA



- National Urban Policy Framework 2018
- National Urban Transport Policy 2014
- National Mission on Sustainable Habitat 2021-2030
- Non-Motorized Transport Guidance Document 2016
- Transit Oriented Development Guidance Document 2016
- APPCB Clean Air Action Plan 2019
- Urban and Regional Development Plans Formulation and Implementation Guidelines (Volume 1) 2014
- Urban Road Codes

- Vijayawada Master Plan/ ZDP 2035 (currently under progress)
- Proposed road and flyover construction in the city highlighted in ZDP 2021
- Development of new real estate and residential complexes to the West, North and eastern end of the city
- Construction of flyovers and bridges (Benz Circle flyover, foot over bridges)
- Development of IRR and Vijayawada Bypass proposed in Capital Region Draft Perspective Plan, 2050

3.2.3. Gender and inclusion

This strategic response by revitalizing transit systems, NMT networks and public transportation offers an affordable and accessible transportation system. This could be of high benefit to women and low-income groups. Women, elderly, children and adolescents comprise 70 per cent of the total population of city, which signifies need for an inclusive approach. It is recommended that the urban transit plan collect and report travel behaviour data, disaggregated by gender, age, abilities, income, and abilities for inclusive mobility system.

In Intervention 1.1 – Complete Streets with improving the safety and comfort of pedestrian routes by creating an active public realm, plazas, and parks could improve participation of women and vulnerable groups. Improved comfort with street lighting, street furniture, shading elements along with creating activity zones could encourage more pedestrians on the street. In the vendor zones proposed designated zones for women vendors could be considered as part of the strategic response.

Intervention 1.2 on the creation of a well-designed transit system, additional routes and bus stops transportation network, and strengthening IPT services offers gender mainstreaming with improved accessibility. Effective first and last mile connectivity could encourage more women to commute and pursue education and employment opportunities as they were found to opt for job opportunities within a distance of 0-5 km of their homes.

The multimodal hub as part of Intervention 1.3 should cater to providing gender inclusive amenities such as nursing rooms, public toilets (male, female, universally accessible gender neutral), drinking water facilities, and waiting rooms. Specifically, the perception and experience of safety and sexual harassment on mobility hubs, streets, waiting zones for public transport (and paratransit), and travel inside vehicles must be measured. Ensure representation, employment and effective participation of women and gender minorities at leadership and mid-managerial positions in the transportation sector. Employing women self-help groups (SHGs) for electric buses and vehicles – in positions such as drivers, conductors, and management of EV charging infrastructure – could be considered. The transit, activity, destination and neighbourhood plaza may employ women/ gender minorities in possible areas such as frontline/ backline/ managerial posts.

The complete streets toolkit and mobility plans should address mobility of care, universal accessibility, and safety of marginalized groups, specifically women and gender minorities. Night programmes for safer travel is suggested in transit hubs. Some components of safer travel are women led police patrols, night accommodation for women, streets vendors as street marshals, request stop service, etc. (see Annex 5 for GESI guidelines).

3.2.4. Climate convergence

This strategic response includes the redesigning of major streets into complete streets with improved NMT facilities. The objective of the strategic response is to promote transport modal shift from private vehicles to public transportation or use of NMT in the city that can aid in overall reduction of GHG emissions in the transportation sector. Additional interventions like tree lining, shift towards green fuel (CNG / electric) and promoting shared mobility may reduce the overall emissions in the long-term. The GHG emission savings for proposed strategic response is summarized below:.

TABLE 3.4 Project CO_2 storage potential for Strategic Response 1

Intervention	Project	Potential GHG emissions sequestration (tCO_2-e per annum)	Remarks
Intervention 1.1: Complete Streets	Develop 25.89 km of streetscape including 6-km of alternate alignment for the highway.	810	Tree planting, bioswales (~10x3m), and median planting (lawn)
	Develop 47.41 km of streetscape for the proposed roads identified by VMC and the ZDP	1,483.5	

Source: Various sources have been used in the calculation of emissions savings potentials. Please see Annex 13 for Climate Savings Calculation Methodology for the calculation breakdown and assumptions made.

3.2.5. Estimated project costs

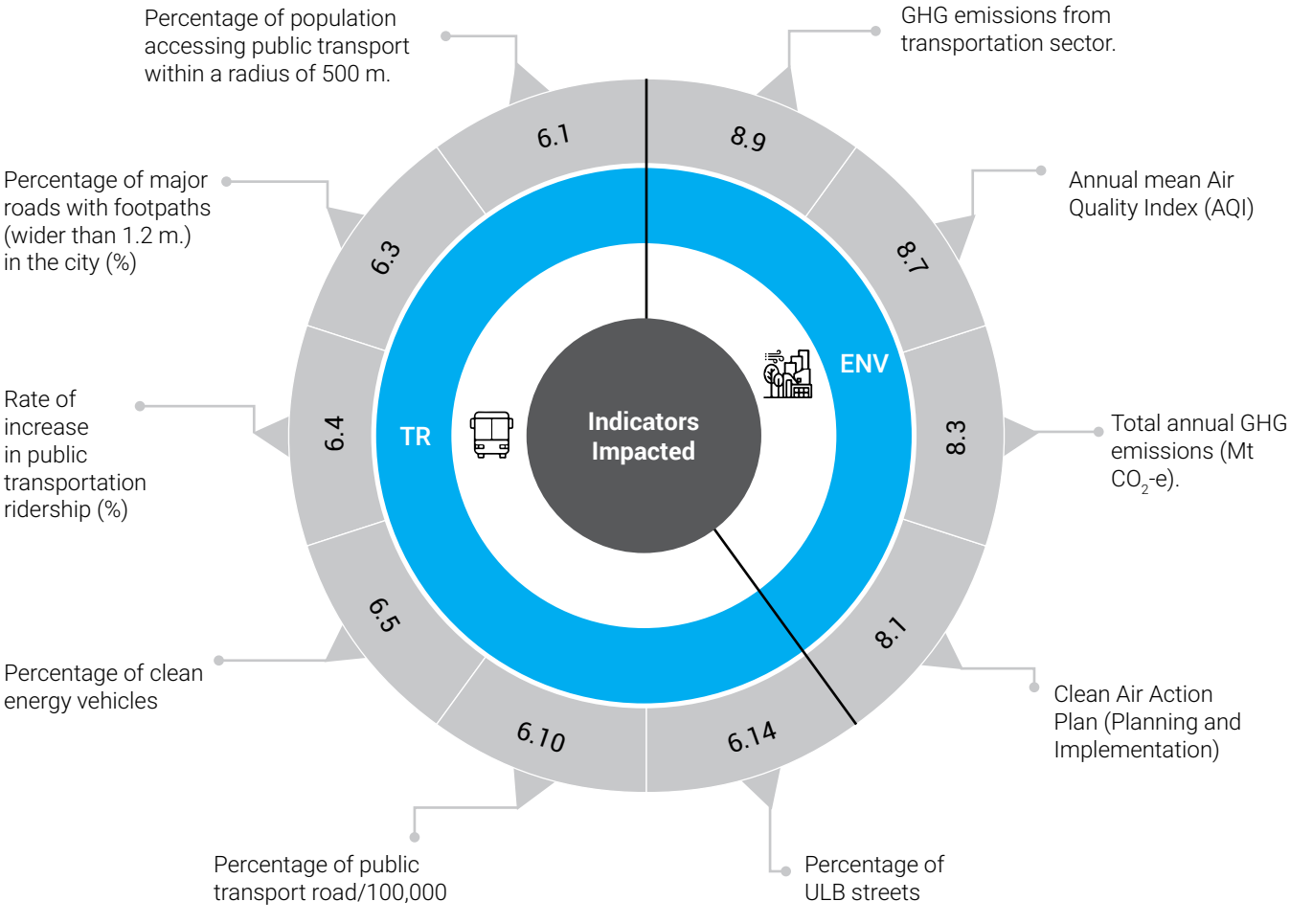
Cost estimate for a few proposed actions in this strategic response totals INR 21,485.6 lakh (see Table 3.5).

TABLE 3.5 Summary of estimated project costs for Strategic Response 1

Intervention	Project	Estimated Project Cost (INR lakh)	Remarks
Intervention 1.1: Complete Streets	Develop 25.89 km of streetscape including 6-km alternative alignment for the highway.	7,223	Green streets with trees, street improvement, NMT/Ped facilities, lighting, etc.
	Develop 47.41 km of streetscape for the proposed roads identified by VMC and ZDP.	13,226	
Intervention 1.2: Creation of Robust and Well-Designed Transit System	Adding 66 new bus stops. 2. Procurement of e-rickshaws on pilot basis.	265.8	New bus stops proposed for increased accessibility and feeder services such as e-rickshaws are proposed on pilot basis (~30)
Intervention 1.3: Creation of Multimodal Hubs	Creating 18 multimodal hubs	769.86	Creating multimodal hubs at 18 locations, which will work in phases. For Phase 1, five locations in the city with different functions are selected.

Source: Various sources have been used in the calculation of project costs. Please see Annex 12 for cost estimates breakdown and assumptions made.

3.2.6. Indicators impacted



3.3 Strategic Response 2: Restoring Ecological Assets

This strategic response addresses the second diagnostic issue of inadequate public green spaces and fragmented blue–green network in Vijayawada. As described in Chapter 2: City Profile and Diagnostic Report, Vijayawada is endowed with rich and extensive biodiversity and natural assets. However, the city has witnessed changes along the river, canals, and watershed in the past few decades. Intense urbanization has resulted in the ongoing loss of green areas, canal alterations, increased pollution, and combined sewer overflow and industrial waste discharges.

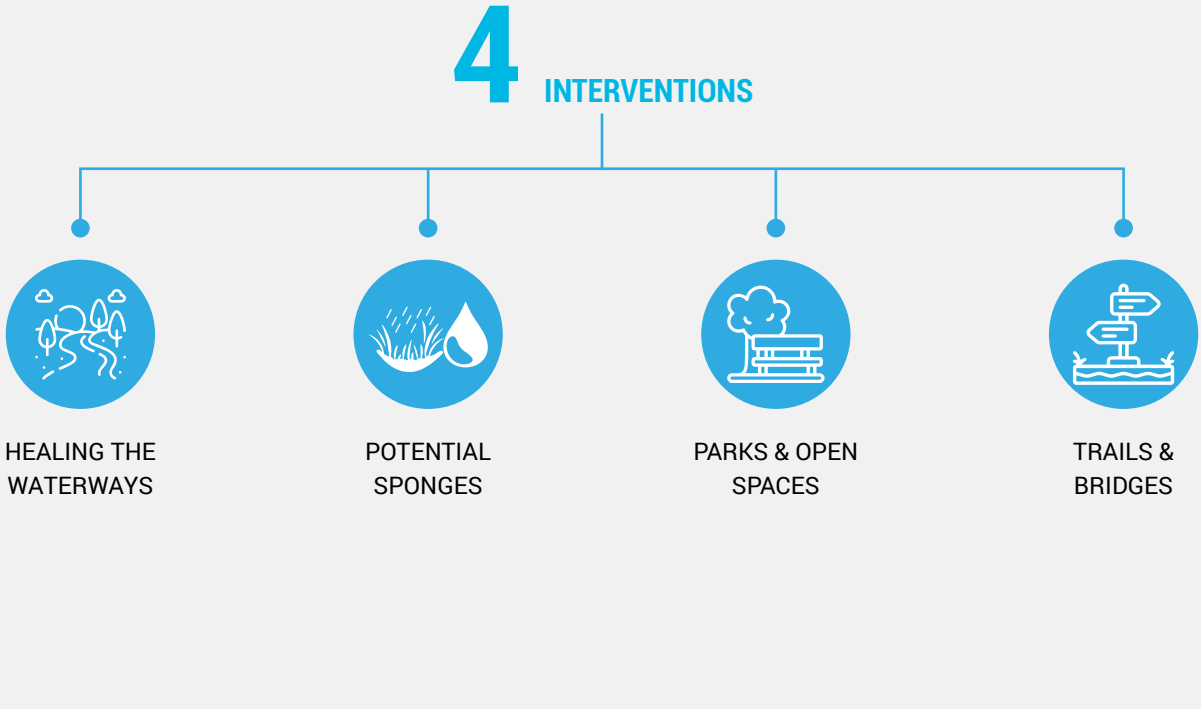
The banks of the Krishna River and canals have remarkable assets: cultural landmarks, existing neighbourhoods, a significant amount of publicly held underutilized lands. This presents a unique opportunity to transform these natural assets into a city-scale green area, particularly if strategic investments are also made to improve the water quality of the city's canals and water bodies.

The strategic response – **Restoring Ecological Assets** – aims to provide recommendations to help in achieving optimum, efficient and sustainable use of the city's existing underutilized natural assets (water bodies) and resources (vacant land parcels). The interventions proposed focus primarily on resolving the pressing challenges of inadequate public spaces, activating the passive parks, and improving accessibility by creating a system of trails and conservation of water bodies. The contemporary landscape planning principles of 'Sponge Cities' and 'Complete Streets', are adapted to develop the proposed interventions under this strategic response.

3.3.1. Proposed interventions within the strategic response

To facilitate better blue and green connection, this Strategic Response identifies five interventions to foster a resilient and sustainable approach for developing the city's blue-green assets.

FIGURE 3.8 Proposed interventions for Strategic Response 2 – Restoring Ecological Assets



Source: UN-Habitat

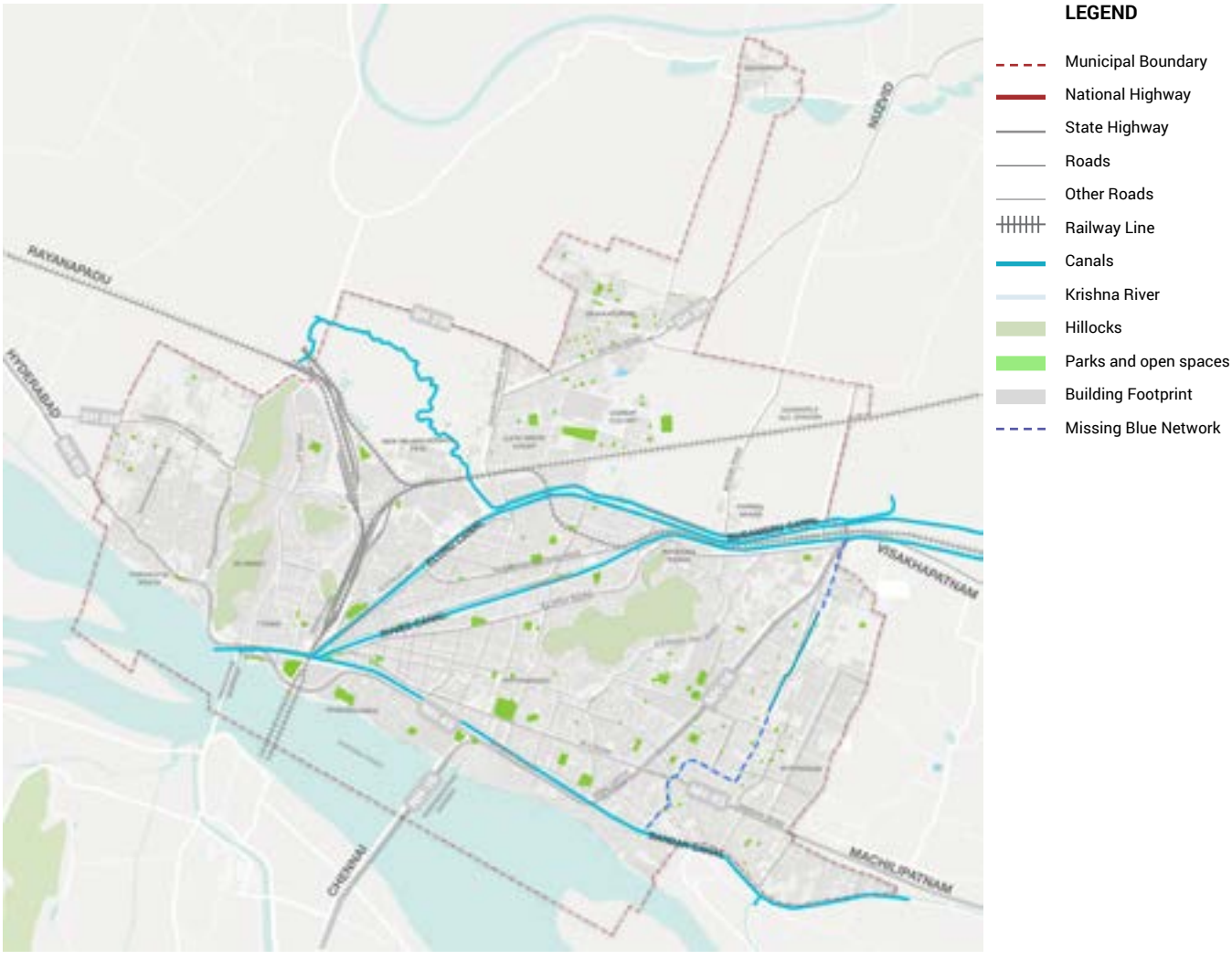
Intervention 2.1: Healing the Waterways

When comparing the current layout of the canals to the original alignment given in the Survey of India toposheet from 1975-76 (updated in 2005-06), a connection of 5.3-km along Kanak Durga Colony Road, between Ryves and Bandar canals that directly allowed the runoff to flow into the river, had been disrupted. At present, only 1.14 km of the stream exists as a drain while the remaining may have been encroached upon by the surrounding residential development (see Map 3.5 and Map 3.6).

Various state and local government agencies are involved in managing the city's water resources from reducing pollution to cleaning the canals, and removing encroachments on the embankments, such as unauthorized construction along the canals.

Map 3.5: Satellite imagery showing the remaining blue connection

Source: Google Earth and Toposheet reference



Map 3.6: Proposed stream connection between Ryves and Bandar Canal

Source: UN-Habitat

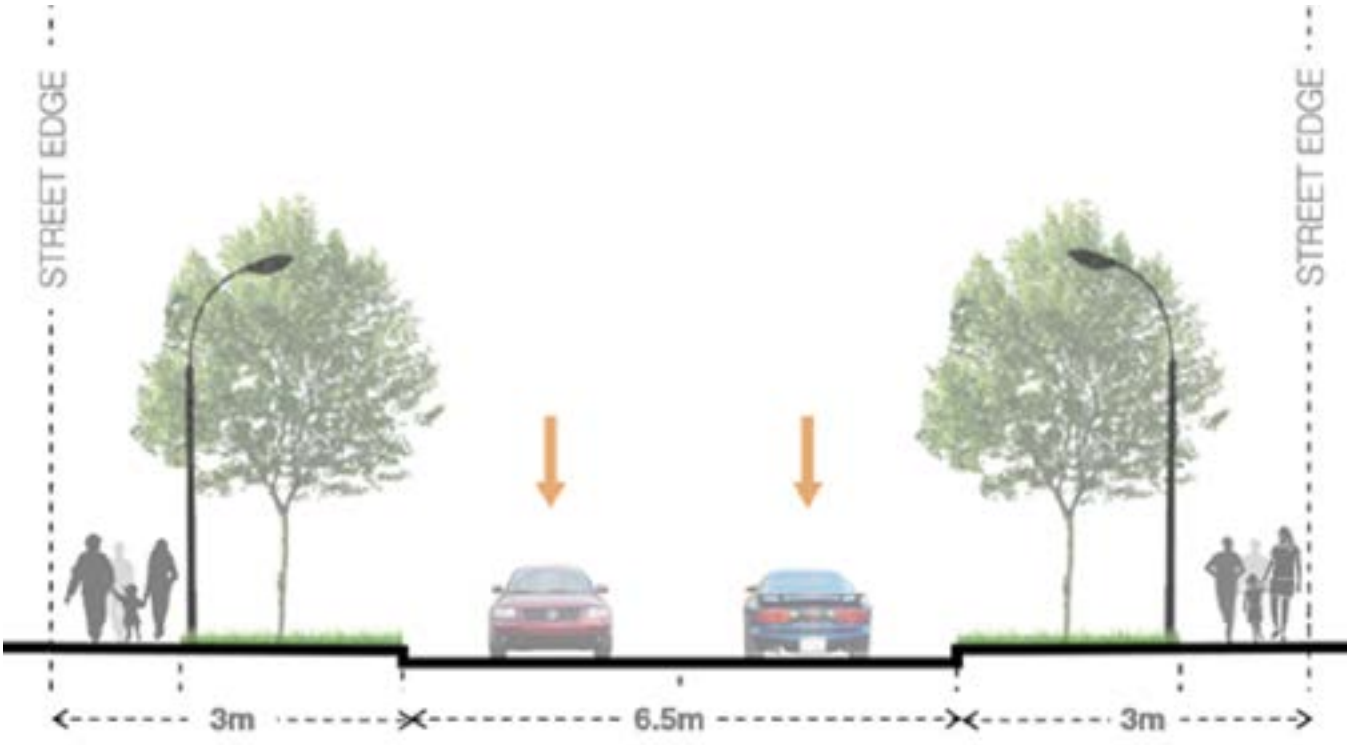
As part of the intervention, 'Healing the Waterways' involves rebuilding or recreating damaged tributary streams by taking a stream or stormwater drainage route out of buried pipes and integrating it into the landscape. Key components of this intervention include:

- **Utilizing the existing drain verge** and constructing a linear treatment system to support water quality treatment and improved landscape along the street with minimal disruption to existing commerce or activity.
- **Implementing the Green Streets concept** for the remaining section to retain and filter runoff on-site or route stormwater through green swales to the canal.

On the southern end, near the Bandar Canal (where the location and density of the development pre-empt surface water treatment), the use of localized, below-grade storm retention and filtration systems may be evaluated as an option (see Figure 3.9 and Image 3.1).

- **Introducing high permeable pavement surfaces** to improve rainwater percolation
- **Increasing the landscape areas,** including planter boxes, bio-swales, rain gardens, and stormwater curb extensions, etc., wherever the RoW permits.
- **Including native flora for carbon sequestration** and improved soil health.

FIGURE 3.9 Proposed typical section for the street to recreate the stream through the Green Streets concept



Source: UN-Habitat

IMAGE 3.1 References for Green Street

Source: Saving Our Trees – Marrickville municipality[23]

23 Saving Our Trees. Accessible at: https://savingourtrees.wordpress.com/2013/03/14/greening-greenbank-street.

Intervention 2.2: Potential Sponges

WVijayawada's hills, canals, and river as assets have their own character, potential, and range of recreational and cultural opportunities for residents and visitors. The 2021 proposed land use plan identifies environmentally sensitive areas around these assets. Hill slopes, canals and river margins that are encroached, roads and railway banks, informal settlements, and barren hills are the critical physical features that have been identified as environmentally fragile, requiring attention. The major environmentally sensitive physical zones as per the proposed land use plan are depicted below as part of the conservation use (see Map 3.7).

Further, a few low-lying areas along the river experience waterlogging, particularly during the retreating monsoons – as it enters the city from the North along Budameru River – leading into the Budameru Canal, which runs parallel to Eluru Canal. As part of the interventions, these areas are also proposed to be part of the environmentally sensitive zones (see Map 3.8).

Map 3.7: Proposed land use 2021, Vijayawada

Source: ZDP 2006

Map 3.8: Vulnerable slums along the Krishna River and canals

Source: UN-Habitat

Map 3.9: Proposed sponges in Vijayawada

Source: UN-Habitat

The intervention recommends creation of conservation buffers along the canals and riverfront, water channels, and major stormwater drains in accordance with the Andhra Pradesh Building Rules, 2017, and restoring the water bodies to act as sponges. These sponges will act as ecological buffers to include:

- **Bank/ bed renaturation** to restore the natural dynamics of the river and its shape, creating physical structures to direct the flow of water, providing habitat for aquatic species.
- **Continuous open green spaces along the Krishna River and canals** that naturally detain and filter water as well as foster urban ecosystems, boost biodiversity, and create cultural and recreational opportunities
- **Porous design interventions for the plazas and pathways,** including the construction of bioswales and bioretention systems to detain run-off and allow for groundwater infiltration
- **Porous roads and pavements** along the edge that is durable for car and pedestrian traffic, while allowing water to absorb, permeate, and recharge the groundwater.

Restoring and maintaining the water bodies by adopting the 'Sponge City' concept will help recharge groundwater, reduce flooding and urban heat island intensity, increase the water holding capacity of water bodies, and protect ecological systems (see Map 3.9). Other environmental benefits include improved biodiversity, cleaned and recharged water bodies and new, well-designed public spaces. Some such examples are highlighted in the case study of urban ecological restoration/ Sponge City project at Bishan-Ang Mo Kio Park along the Kallang River in Singapore.

The Jal Jeevan Mission (Urban)/ AMRUT 2.0 programmes launched by the Central Government in 2021 also emphasize the sponge cities concept to promote the circular economy of water – recycling/ reusing treated sewage, rejuvenating waterbodies and water conservation.

Proposed actions aligning with objectives of SBM U 2.0:

- Rejuvenating water bodies by desilting (includes clearing garbage and measures to stop the accumulation of garbage)
- Diverting polluting drains and preventing them from entering the waterbody.
- Creating/ strengthening storm water drains around the waterbody.

Proposed actions aligning with objectives of AMRUT 2.0:

- Rejuvenating waterbodies to augment water and enhance amenity value and development of green spaces.

TABLE 3.6 Total increase in green spaces from sponges

S.No.	Type	Area (sq.km)	Percentage Increase
1	Existing Green Spaces	4.59	34% increase in total green spaces
2	ZDP Canal Conservation Zone	1.55	
3	Proposed Sponges (low lying areas, along the canal & Krishna River)	3.38	
4	Total	9.52	

Source: UN-Habitat

CASE STUDY: BISHAN-ANG MO KIO PARK, SINGAPORE

Image source – American Society of Landscape Architects (ASLA) (https://www.asla.org/2016awards/169669.html)

Effective improvement in environmental quality: The Bishan Ang Mo Kio Park project transformed 3-km of Singapore's longest river, Kallang River, from a concrete canal into a natural river with bioengineered slopes and landscaped banks, across 64 hectares. In 2006, Singapore's national water agency, PUB, initiated the Active, Beautiful and Clean Waters Programme, a long-term initiative to transform the functionality of the nation's water bodies beyond just drainage and water supply, into vibrant, new spaces for community bonding and recreation.

Ecological regeneration: The new river showed a 30 per cent increase in biodiversity even before construction was complete. Soil bioengineering techniques have since stabilized the river banks, which can withstand strong flood flows and also provide habitats for local wildlife. The flood plains provide generous open space for recreational activities and, in case of a heavy storm, the park functions like a real river plain, allowing the river water to spread and slow down through friction.

Ecologically sensitive public space design: Designed along the concept of a floodplain, people can get closer to the water and enjoy recreational activities along the river banks when the water level is low. During heavy rains, the park land by the river doubles up as a conveyance channel, enabling multiple land uses and creating more spaces for communal activities. The design of the floodplain also adopts a new typology and quality of urban public space in Singapore with three new bridges, a terraced riverside gallery, river platforms, stepping stones across the river and a water playground.

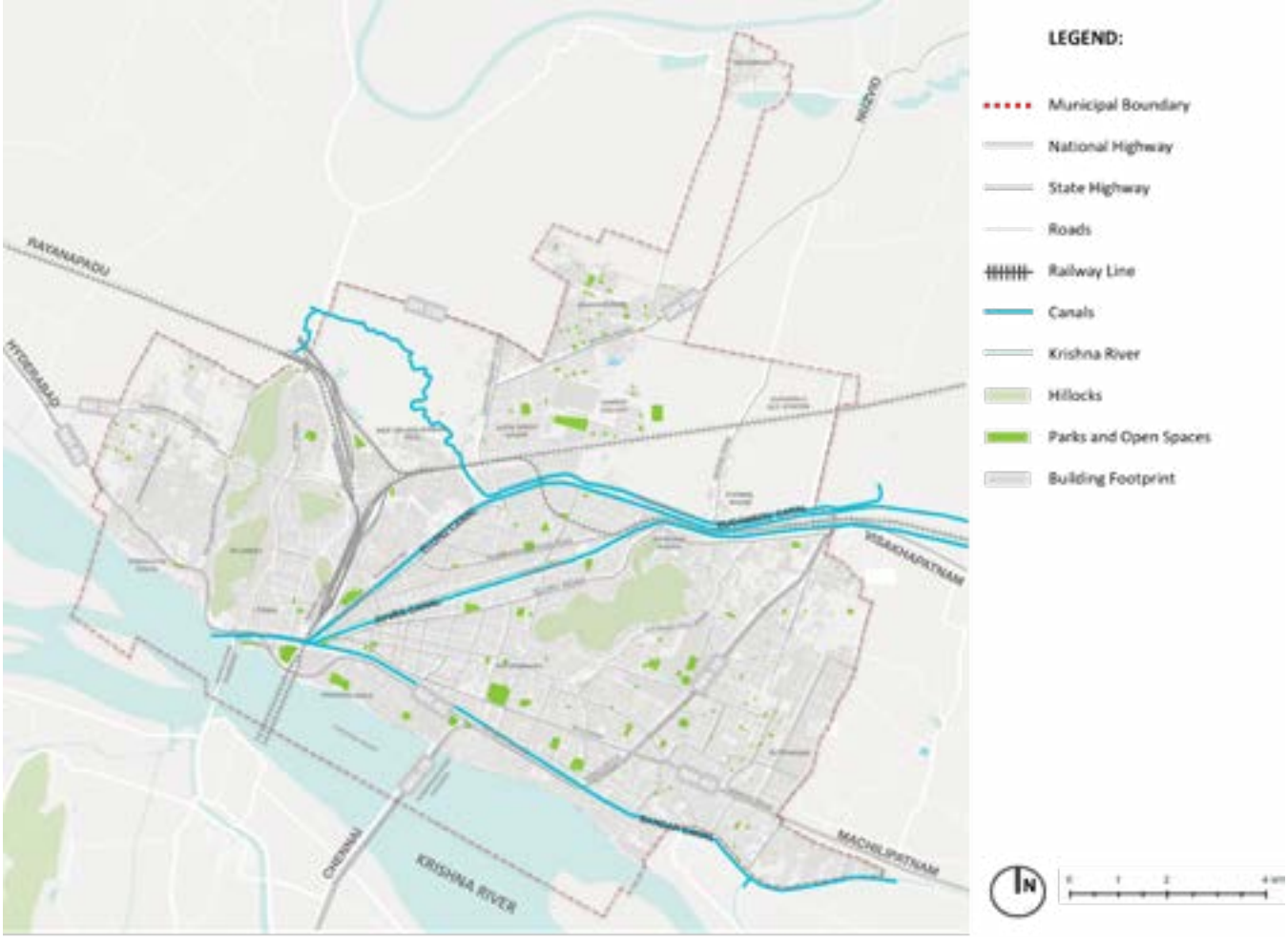
Innovative infrastructure and iterative process: A new model of landscape infrastructure was developed for tropical urban hydrology, enabling water supply independence, and proper flash flood management for Singapore. Prior to redevelopment, Kallang River was a clear concrete divider between the park and the community. Results proved healthy vegetation growth and, in a reiterative process, soil conditions, slope and plant root strength were examples of adjustments made to the models. The new approach maximizes land, financial and human resources. Simple, yet highly engineered, the river park blurs the divide between infrastructure and recreation, and has transformed the community's pragmatic perception of urban water systems.

Source: ASLA, https://www.asla.org/2016awards/169669.html (accessed on 4 February 2022).

Intervention 2.3: Innovative Creation of Parks & Open Spaces

The intervention is formulated in line with the reforms suggested for enhancement of green spaces and parks under AMRUT and in accordance with URDPFI's recommendation of organizing green spaces and parks in ULBs into five categories. VMC has initiated the redevelopment of a remediated dumpsite into an eco-park in Ajith Singh Nagar, developed bunds along the canals, created under-flyover parks and has further approved the development of city-level parks and open spaces. Despite these initiatives, the city still lacks government-owned vacant lands near residential pockets for creating new parks and other organized open spaces.

EXISTING GREEN SPACE 6,89,793 m^2	**PER CAPITA COVERAGE** 3.83 m^2 BENCHMARK: 10 - 12 m^2	**TOTAL TREE COVER** 3% OF THE TOTAL ULB AREA BENCHMARK: 10%
GREEN SPACE COVERAGE 63% OF THE POPULATION	**TOTAL OPEN SPACE AREA** 1% OF THE TOTAL DEVELOPABLE AREA BENCHMARK: 35%	



Map 3.10: Spatial distribution of parks and open spaces in Vijayawada

Source: UN-Habitat

IMAGE 3.2 Existing parks & open spaces in the city


CANAL EMBANKMENT


K.L RAO PARK


RAJIV GANDHI PARK


UNDER FLYOVER SPACES

Source: UN-Habitat

Considering VMC's ongoing and proposed initiatives to enhance urban greenery, the following hierarchy of public green spaces is proposed according to the norms set forth under AMRUT. The water body and its buffer areas proposed as environmentally sensitive areas in Intervention 2.2 are also considered open spaces. The intervention also emphasizes expanding the under-flyover open spaces concept being implemented by the city in strategic locations.

TABLE 3.7 Classification of urban green areas in Vijayawada

S.No.	Category of green spaces	Population served per unit	Area requirement (Ha)
1	Sub-City Park	10 lakhs	25 & above
2	District Park	5 lakhs	5–25
3	Community Park	1 lakh	1–5
4	Neighbourhood Park	15,000	0.5–1
5	Housing Area Park	5,000	Less than 0.5

Source: Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines, 2014

Proposed actions aligning with objectives of AMRUT 2.0:

- Developing community green spaces linked to a clean waterbody
- Strengthening/ rejuvenating aquifers/ community wells
- Harvesting rainwater through storm water drains into the waterbody

Intervention 2.4: Connect Trails and Bridges

After filling in the gaps in recreational places and transportation in Vijayawada, there is a compelling opportunity to create a continuous CanalWalk: a trail

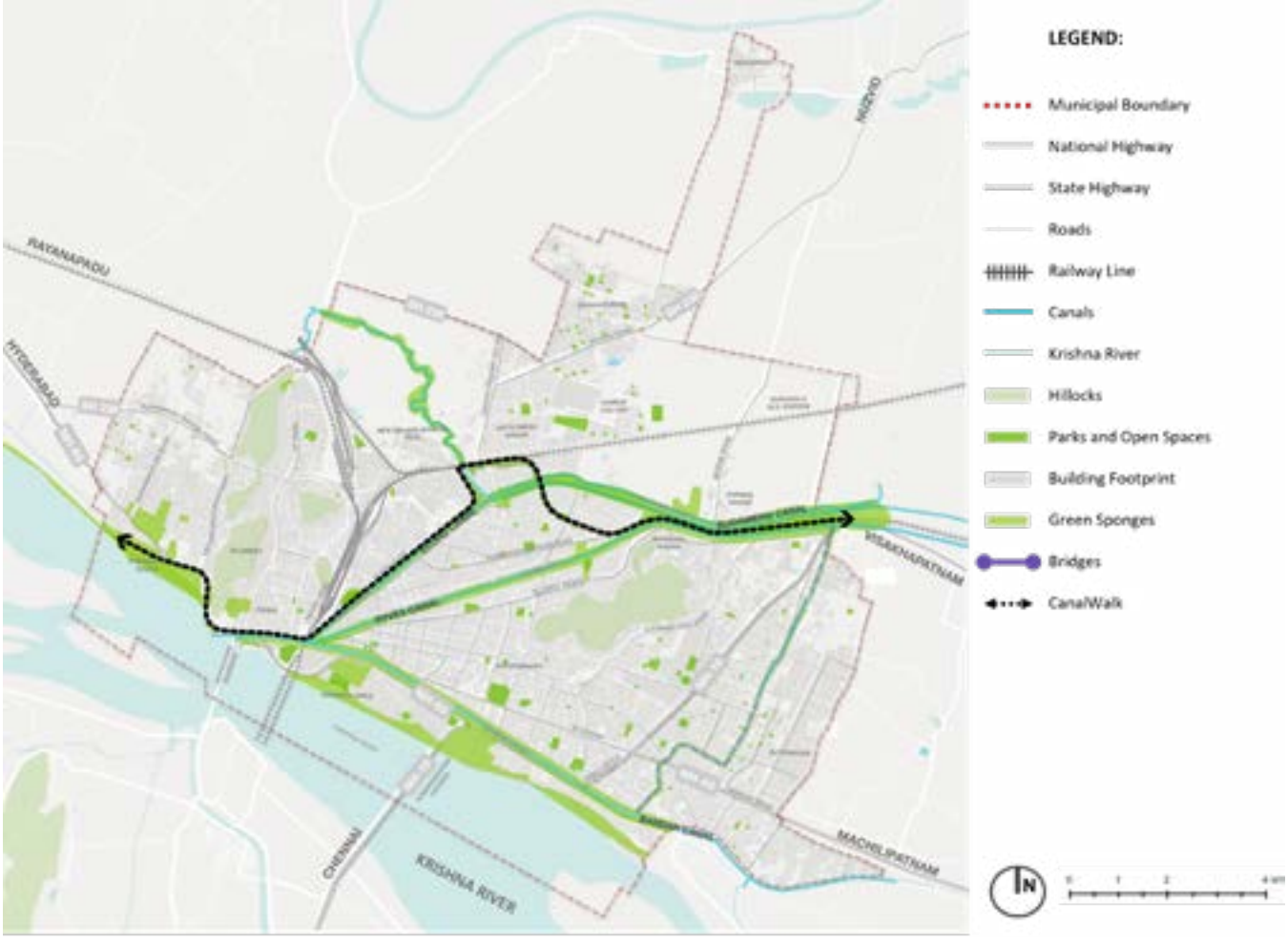
along the eastern and western banks of the Eluru Canal, connecting the Budameru Canal to the North and Krishna River to the South. The proposed CanalWalk is envisioned to be developed into a recreational amenity and a transportation alternative for local commuters, connecting neighbourhoods to parks and open spaces.

The CanalWalk and its loops will provide 14 km of waterfront trails. With different corridors and loops to choose from, users will find a great variety of experiences and connections in this system. Where feasible, the CanalWalk will maintain a 50-ft. setback from the edge, meandering gently to provide changing views of the landscape, passing through and around a connecting series of parks. Places and facilities that bring visitors close to the water will dot the trail along its length, allowing spectacular views along the canal front. The following features will contribute to the CanalWalk's success:

- A series of trail loops encircling the distinctive canals and Krishna River (see Map 3.11)
- A comprehensive, coordinated sign and information system with interesting destinations and activities
- Easily accessible and marked connections between the CanalWalk and surrounding neighbourhoods
- Multiple points where pedestrians and cyclists may cross the river through existing/ proposed bridges. This feature will give residents access to parks on either side.

The trails and bridge loopwill be planned to ensure visibility and avoiding dark corners and blind spots. Adequate resting places should be provided along the CanalWalk to cater to the elderly, differently abled, pregnant women, caregiving women with children and other vulnerable groups. Public toilets (male, female, universally accessible gender neutral) and private nursing rooms may also be provided along the trail. Women SHGs of the city may be employed in the maintenance and management of the CanalWalk.

For the first loop, the CanalWalk will follow Budameru Canal to Madhura Nagar using the existing road alignment. The second loop from Madhura Nagar along the Railway Corridor could be a walking trail alongside the rail system



Map 3.11: Proposed Canal Walk in Vijayawada

Source: UN-Habitat

FIGURE 3.10 Proposed trail along the railway corridor (the top image refers to the existing area and the bottom image refers to the proposed intervention)

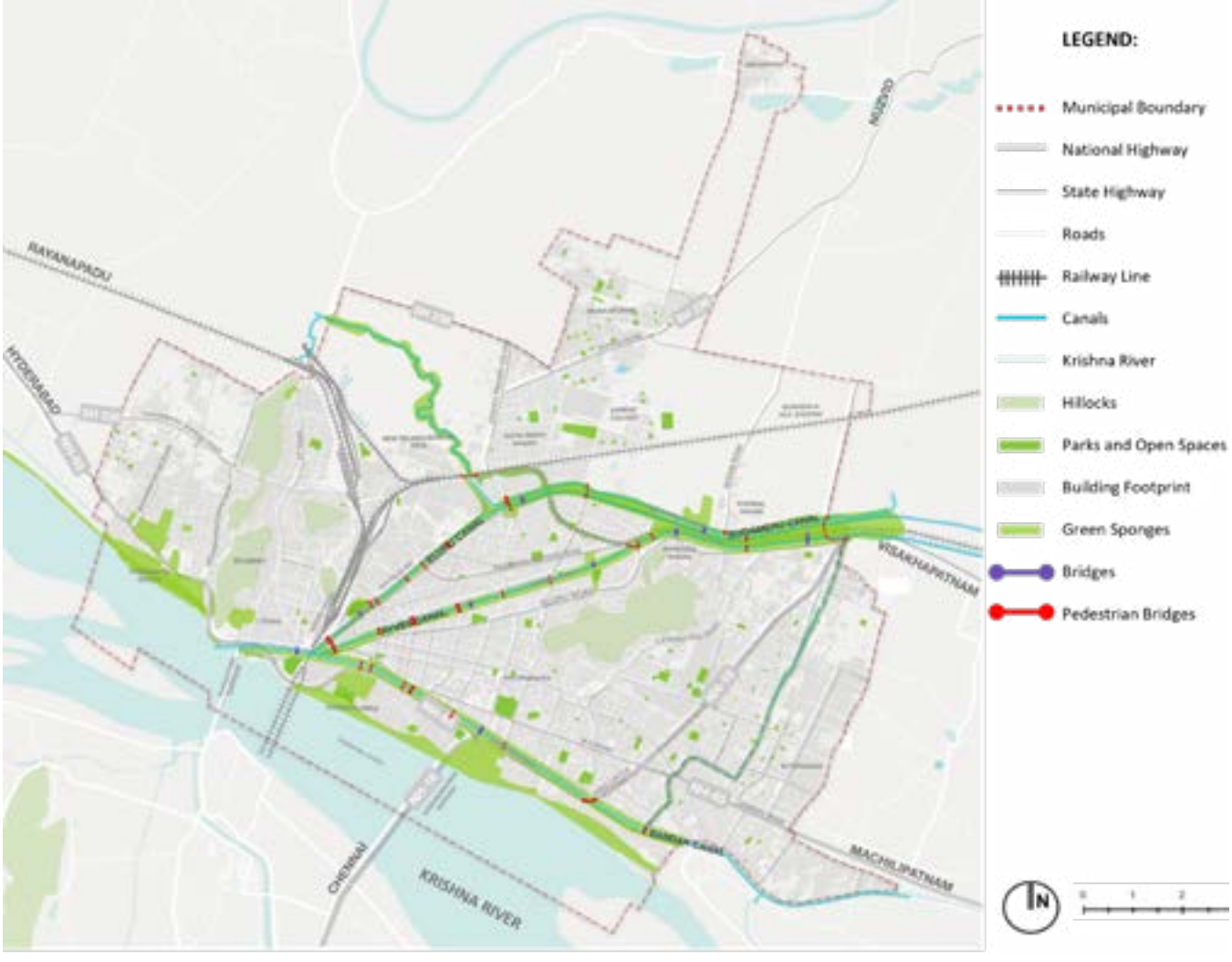
Source: UN-Habitat

with all safety measures in place, followed by the third loop over a boardwalk running alongside Eluru Canal. This loop will run past enhanced green areas on the eastern side of the canal and recreation fields on the western side. The last leg of the trail will run parallel to Durga Ghat via the Kanak Durga flyover (see Map 3.11).

The trail passing along the Railway Corridor will be planned in consultation with the Railway Authority with minimal interventions such that the land can be utilized by Railway Land Department for future railway planning and expansion.

The railway trail should be programmed with suitable activity along the stretch to prevent inactive zones and ensuring citizen visual surveillance. Activity zones such as designated vendor zones, badminton court, neighbourhood park, outdoor food zones could be provided. Adequate streetlight, floodlight, street furniture, inclusion of vendor zones at every 50m is recommended

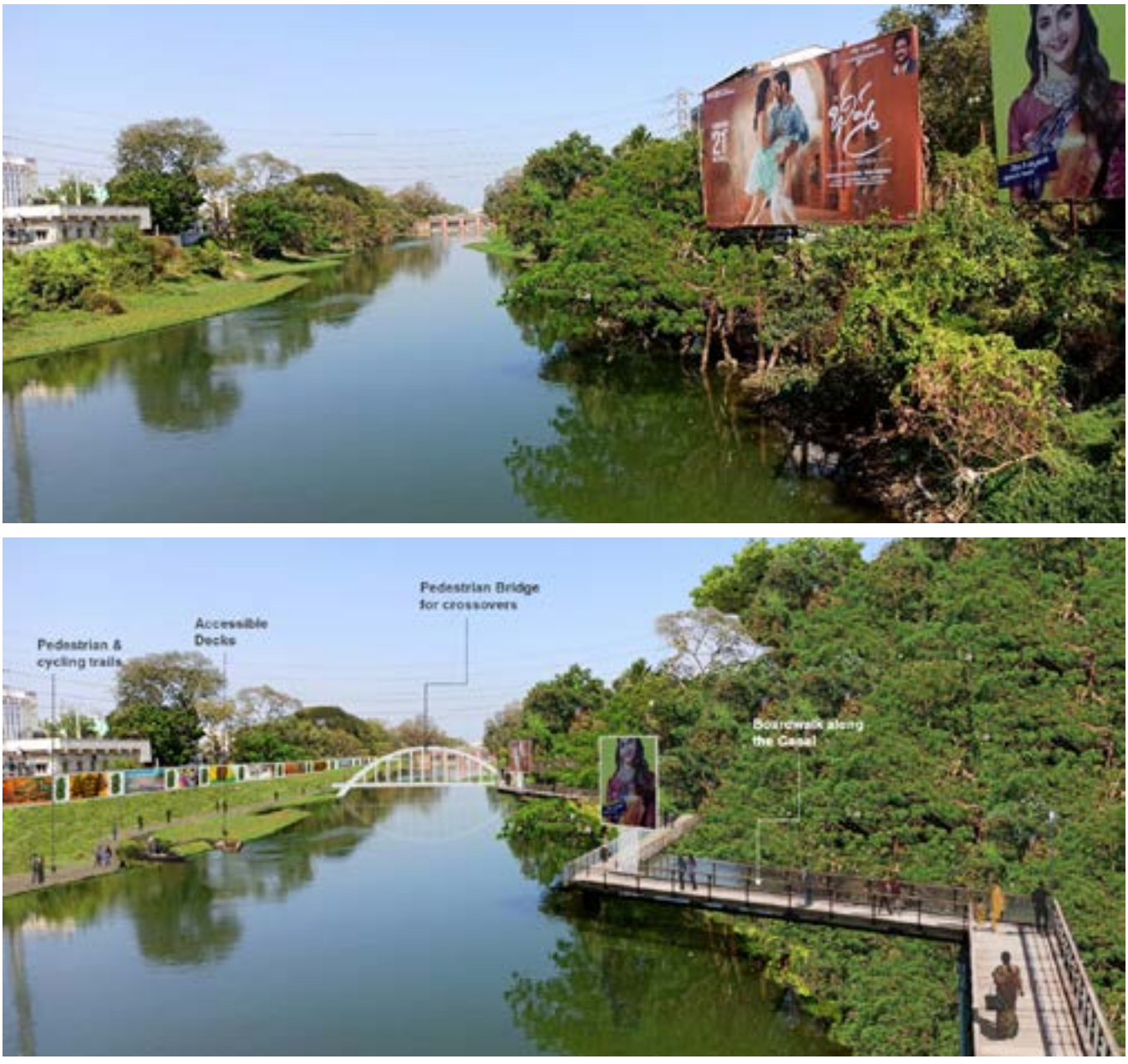
The city has 25 existing bridges, generally absent of pedestrian amenities and without connections with local streets and the canal front. Taking advantage of the trail and making the canal accessible, 15 new pedestrian bridges have been identified connecting the trails, canal front and the 'waterfront' neighbourhoods (see Map 3.12).



Map 3.12: Proposed pedestrian bridges along the canals

Source: UN-Habitat

FIGURE 3.11 Proposed interventions along Eluru Canal (the top image refers to the existing area and the bottom image refers to the proposed intervention)

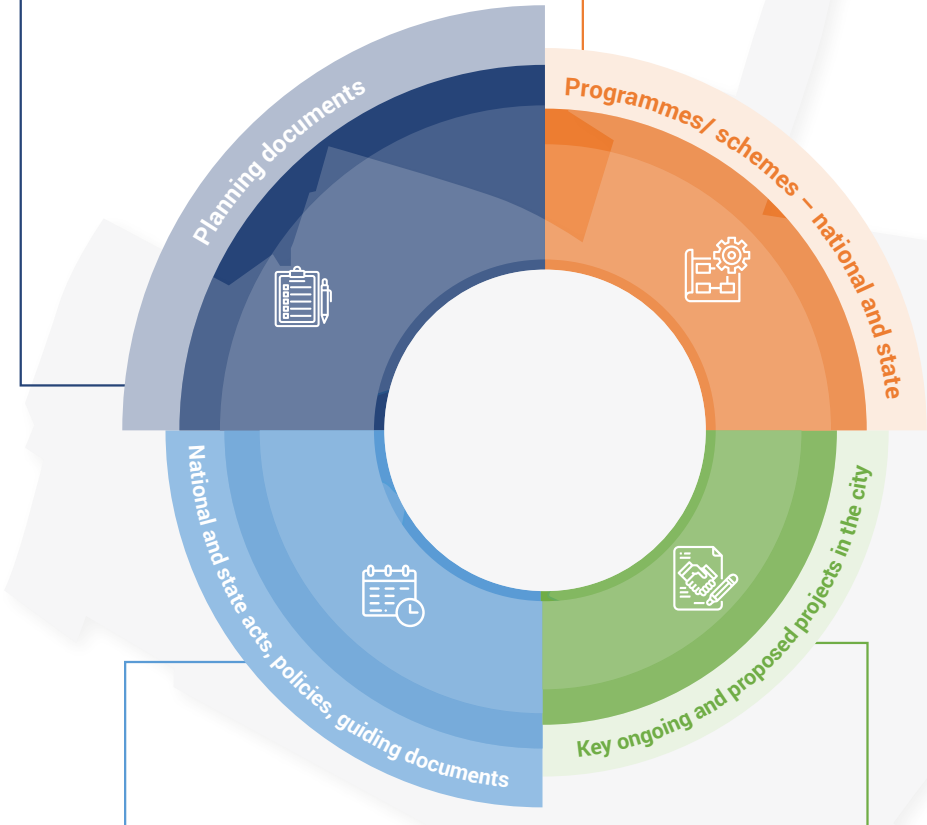


Source: UN-Habitat

3.3.2. Alignment with national, state policies, programmes and ongoing, proposed capital projects in the city

- Zonal Development Plan 2021
- Vijayawada Immediate Action Plan 2018-2020
- Comprehensive action plan for clean air for non-attainment cities of Andhra Pradesh

- AMRUT
- AMRUT 2.0 / Jal Jeevan Mission (Urban)
- Swachh Bharat Mission (Urban) 2.0
- Pradhan Mantri Awas Yojana - Urban
- Navaratnalu – Jalayagnam
- Jagananna Pachathoranam
- Street 4 People, ITDP and MoHUA



- Andhra Pradesh Pollution Control Board Guidelines
- Andhra Pradesh Water, Land and Trees Act, 2002
- Andhra Pradesh Building Rules, 2017
- APPCB Clean Air Action Plan, 2019
- Urban and Regional Development Plans Formulation and Implementation Guidelines (Volume 1), 2014
- Urban Road Codes

- Vijayawada Stormwater Project Summary Report, 2019
- Vijayawada Master Plan/ ZDP 2035 (currently under progress)
- Proposed road and flyover construction in the city highlighted in ZDP 2021
- Construction of under-flyover spaces in the city
- Conversion of Ajith Singh Nagar dump yard into an eco-park.

3.3.3. Gender and inclusion

The restoration of ecological assets provide scope to ensures creation of safe and secure public spaces for women and marginalized groups where they can participate, interact and contribute to the community. The strategic response offers scope for a gender transformative approach in all its interventions. The conservation and preservation of waterways, potential sponges, vacant open spaces the waterfront development is recommended to follow gender inclusive guidelines (See Annex 6 for GESI guidelines for public open spaces). Existing women SHGs in the city could be enabled to undertake water-sensitive planting, maintenance and management of waterbodies as public spaces. They could be employed in paid work for landscape management, creation of green sponges such as rainwater harvesting, waterfront conservation, and flood protection.

Enabling ecologically sensitive public spaces in diverse forms, scales and function as part of the strategic response would aid in creating gender inclusive recreational spaces. The waterfront trails envisioned as alternative transportation corridor and recreational amenities would promote community use of underutilized spaces. The proposed bridges ensuring accessibility for residents to parks on both sides could improve safety for women and children. The trail along the railway corridor could also be of high impact to improving safety of the transit zone. However, it would be imperative to provide activity zones, such as vendor zones, badminton courts, neighbourhood parks, outdoor food zones, etc. The railway trail should be programmed with suitable activity to prevent inactive zones, ensuring citizen visual surveillance. Adequate streetlight, floodlight, street furniture, inclusion of vendor zones within every 50 m. is recommended.

3.3.4. Climate convergence

Developing waterbodies as community parks can decrease the carbon storage potential of the site, due to construction of accessibility and recreational infrastructure (such as pathways, parking, and social facilities). On the other hand, using sponge city techniques can improve the quality and quantity of water sources, reduce the impacts of flooding, increase NbS to water filtration and protect waterbodies from pollution caused by human activities through natural buffers.

TABLE 3.8 GHG emission sequestration estimates for key actions proposed in Strategic Response 2

Intervention	Project	Potential GHG emissions sequestration (tCO_2-e per annum)	Remarks
Intervention 2.1: Healing the Waterways	Revival of lost blue network, a 4.16-km stretch at the Kanakdurga Colony in the South-East	164.7	Includes Green Streets Concept with bioswales, trees, canal planting and green cover
Intervention 2.2: Potential Sponges	Development of green sponges and canal planting along the three canals and Krishna River	391.95	Includes green sponges and plantation along the canals and vulnerable slums within an area of ~218 Ha
Intervention 2.3: Parks and Open Spaces	Creation of new parks and open spaces with new under-flyover spaces at different locations (7 UFOs)	17.58	A (as a proxy) landscaped area of 1 Ha with approximate composition of 25% green lawn and 25% trees for common public use (regeneration includes public pathways and facilities)
Intervention 2.4: Trails and Bridges	Development of trails/ CanalWalk along a 14-km stretch along the railway corridor from Gundala Railway Station to Durga Ghaat	437.94	Inclusion of green streets, bioswale, tree plantation, and landscaped areas.

Source: Various sources have been used in the calculation of emissions savings potentials. Please see Annex 13 for Climate Savings Calculation Methodology for the calculation breakdown and assumptions made.

3.3.5. Estimated project costs

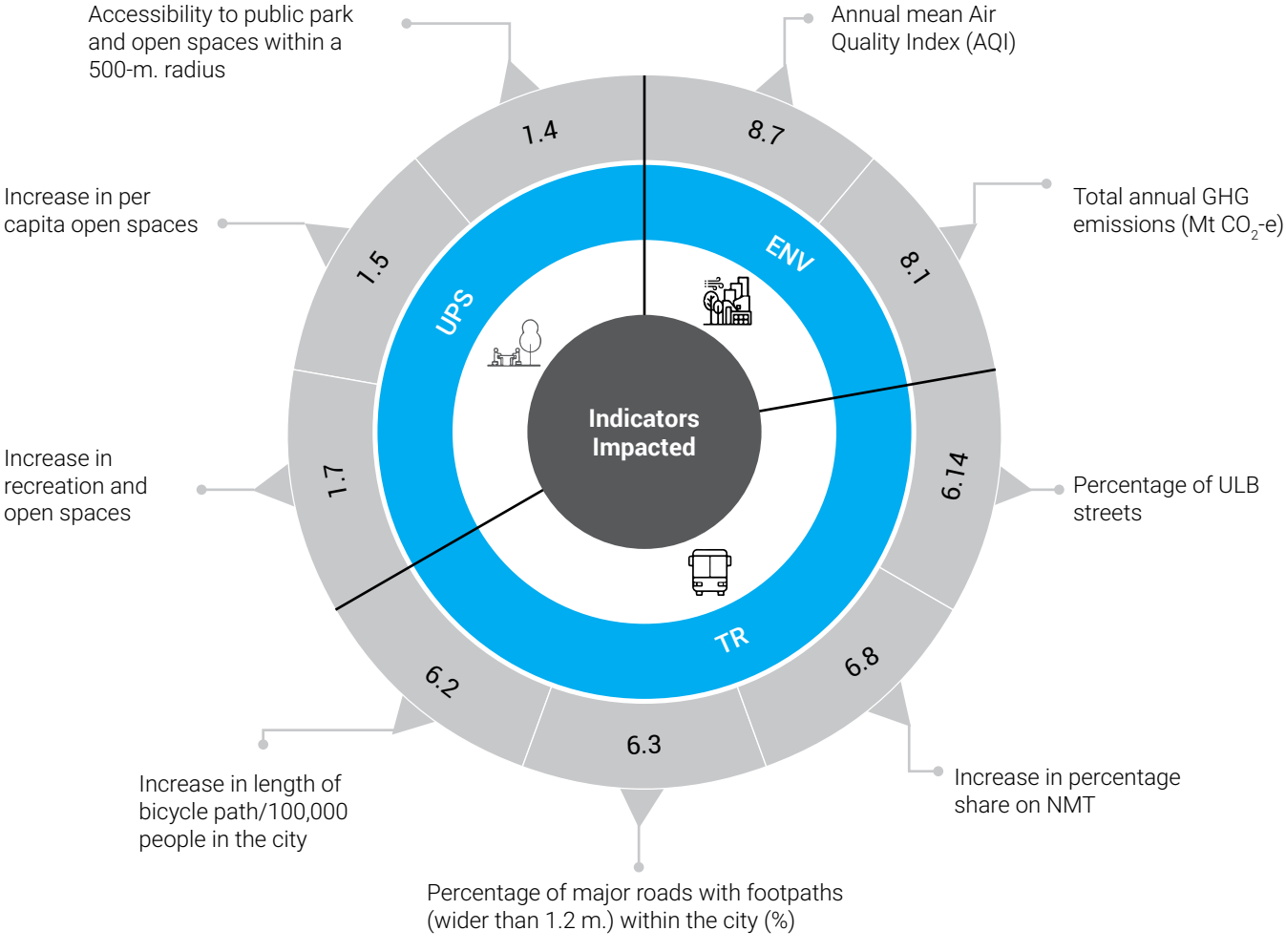
Cost estimates for this strategic response is INR. 8,069.47 lakh.

TABLE 3.9 Summary of estimated project costs for Strategic Response 2

Intervention	Project	Estimated Project Cost (INR lakh)	Remarks
Intervention 2.1: Healing the Waterways	Revival of lost blue network, a 4.16-km stretch at the Kanakdurga Colony in the South-East	40.47	Includes Green Streets Concept with bioswales, trees, canal planting and green cover
Intervention 2.2: Potential Sponges	Development of Green Sponges and canal planting along the three canals and Krishna River	4,453.74	Includes green sponges and plantation along the canals and vulnerable slums within an area of ~218 Ha
Intervention 2.3: Parks and Open Spaces	Creation of new parks and open spaces with new under-flyover spaces at different locations (7 UFOs)	7.7	
Intervention 2.4: Trails and Bridges	Development of trails/ CanalWalk along a 14-km stretch along the railway corridor from Gundala Railway Station to Durga Ghaat	3,567.56	Inclusion of green streets, bioswale, street furniture, NMT/Ped. facilities, smart bins, public toilets, tree plantation, bridges

Source: Various sources have been used in the calculation of project costs. Please see Annex 12 for Cost Estimates Methodology for the calculation breakdown and assumptions made.

3.3.6. Indicators Impacted



3.4 Strategic Response 3: Optimizing development and guiding future growth

The overarching idea behind this strategic response is to direct development in identified areas of the city with diverse spatial growth characteristics in a sustainable manner. The interventions formulated would primarily address the diagnostic issue of sprawling and scattered development patterns and a few concerns identified in other three strategic issues. The planning principles – Complete Streets, Low Carbon Development and Transit Oriented Development – have been adopted for formulating the interventions. They shall align with the city master plan, which is due for revision.

3.4.1. Proposed interventions within the strategic response

Five interventions are proposed under this strategic response, which are detailed as follows:

Intervention 3.1: Promote Mixed-Use Development

This intervention promotes mixed use development along major corridors to regulate densities and promote optimum use of city amenities. Vijayawada ZDP 2021 notified in 2006 has proposed only 74 Ha (1.18 per cent of the area) under the mixed-residential land use category for the horizon year 2021. Within this land use category, all land uses, except industrial, are permitted. Over the years (especially post bifurcation of Andhra Pradesh in 2014), Vijayawada has experienced significant growth in terms of population and economy, leading to rise in commercial and mixed-use developments. As per VMC's GIS database (2019), about 8 per cent of buildings in the city are mixed-use and 11 per cent are under commercial use (see Section 4.2.4 in Vijayawada City Profile and Diagnostic Report). These mixed and commercial land uses are evident along the major corridors (see Map 3.13). To encourage this trend in an organized manner, Intervention 3.1 proposes to ensure change of land use along the major corridors to mixed-use in the master plan, which is due for revision.

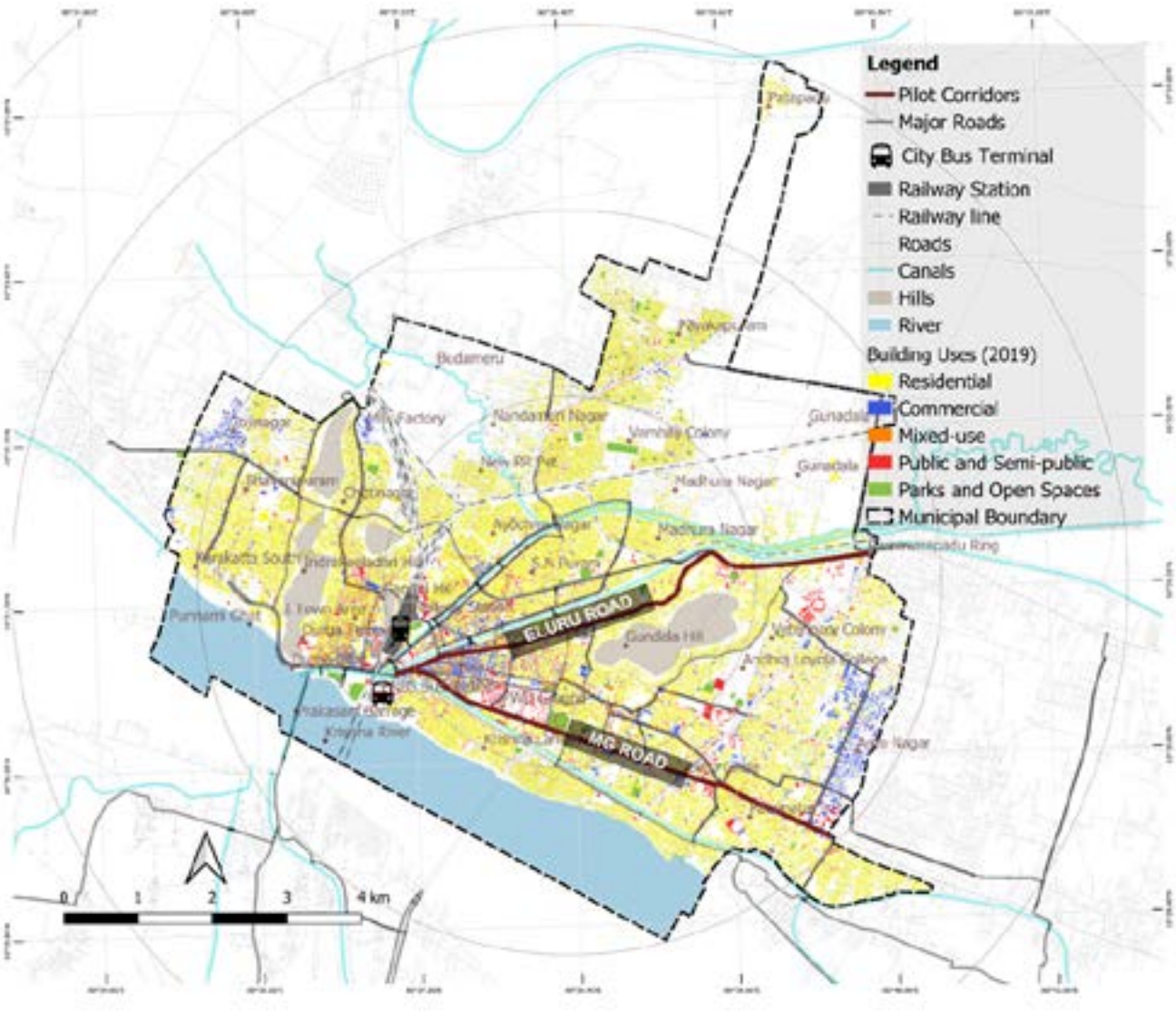
Under this intervention, on a pilot basis, two major corridors in the city, i.e., Mahatma Gandhi Road (or Bandar Road) and Eluru Road are identified for promoting mixed-use development on either side. Various factors listed in Table 3.10 are considered for identifying the said corridors for mixed use development as a priority.

As shown in Map 3.13, Eluru Road (7-km stretch) starting near City Bus Terminal up to Ramavarppadu Ring runs parallel to Eluru Canal to the North-East. MG Road or Bandar Road (6-km) starting near City Bus Terminal up to Auto Nagar Bus Terminal runs parallel to Bandar Canal to the East. Five hundred metres along the two corridors may be considered for mixed-use development in line with the recommended accessible distance to a public transport node. The mixed-use may be truncated wherever it encounters barriers such as canals, the river, railway lines, hills, etc. However, a detailed study is recommended for the Andhra Pradesh Capital Region Development Authority (APCRDA) as part of the revised master plan to identify the appropriate extent of mixed-use development in the city.

TABLE 3.10 Factors considered for identifying MG Road and Eluru Road corridors for mixed-use development

S.no	Factors	Details
1	Accessibility	• RoW ranging 80–150 ft (4–6L divided) • Capacity to carry high traffic volumes and connect directly to NH-16 and NH-65, other major prominent corridors of the city.
2	Public transportation	• Good connectivity and accessibility along the stretch with multiple bus stops • Connects Railway Station and City Bus Terminal • Corridors identified for introduction of Mass Rapid Transit (MRT) corridors
3	Location of city level amenities	• Location of amenities such as government offices, commercial areas, medical, educational facilities, stadium, and parks, etc.
4	Other factors	• Low hazard vulnerability (as per HRVA 2014) • Higher land value than other localities of the city. • Conversion of land use from residential to mixed, commercial uses

Source: UN-Habitat



Map 3.13: Pilot corridors (Eluru Road and MG Road) identified for mixed-use development

Source: UN-Habitat

The following activities are identified for VMC, APCRDA, to implement the proposed interventions in an effective manner.

- **Promote land consolidation schemes** along the corridors – as permissible building height in the city depends on plot area along with road width, consolidation of land parcels will give way to create large scale projects.
- **Strengthen NMT facilities** along MG Road and Eluru Road, making them user-friendly with focus on developing footpaths with minimum 2-m. width on either side; safe pedestrian crossings; road markings and signages. The proposed action has been detailed in Intervention 1.1.
- **Promote first and last-mile connectivity** through feeder services, e-rickshaws, shared mobility to connect the corridors with other areas. The proposed action has been detailed in Intervention 1.2.
- Ensure all new building conversions (residential to mixed-use, commercial) and new constructions **provide vehicular parking facility** with at least 50 per cent of available parking space reserved for visitors of non-residential uses within the building.
- **Identify organized/ designated parking areas** (both on-street and off-street with parking fee) in a few locations along the two corridors; also covering mixed land use zone. Impose penalty for parking in non-designated areas.

IMAGE 3.3 MG Road (Bandar Road) towards Benz Circle, enroute to Auto Nagar

Source: UN-Habitat

Intervention 3.2: Strengthen Access to Public Services and Amenities

For improving access to services for neighbouring communities, reducing associated travel needs, and in turn GHG emissions, a few of the multimodal hubs proposed in Intervention 1.3 could be enhanced as activity nodes. The current intervention proposes to create community shopping areas/ complexes within the multimodal hubs. These areas/ complexes shall accommodate necessary services and amenities for the community's daily needs such as vegetable shops, medical shops, supermarkets, sub-city level government offices, other required. public amenities such as urban health clinic, skill centre, or any other amenity that does not exist within 800 m. of the multimodal hub.

VMC may explore the Public–Private Partnership (PPP) mode to develop these community shopping centres/ complexes. The ground and first floors of these complexes could be reserved for facilities required for the multimodal hub (see Intervention 1.3). Further, these complexes could also accommodate various state government initiatives such as Mahila Mart, aqua and milk outlets, and others, by engaging women SHGs, thus creating new employment opportunities. Town planning instruments such as transfer of development rights, land consolidation, land pooling and other initiatives can be explored for developing these shopping complexes at respective locations.

A detailed study to access the availability of space and other requirements need to be undertaken by VMC.

(See Annex 7 for recommendations on gender inclusive community shopping centres, multimodal hubs)

Intervention 3.2: Promoting Development in Northern Vijayawada

The ZDP 2021 proposed developable uses across the city, barring the area under natural features such as hills, river, canals and their respective buffer/ conservation zones (see Section 4.2.4 in Vijayawada City Profile and Diagnostic Report). However, the northern part of the city, especially the North-East and North-West pockets, have experienced lesser growth than the rest of the city (see Map 3.14). The primary reason for this could be physical barriers such as railway network and canals (see Map 3.14)

CASE STUDY: TRAFFIC TRANSIT MANAGEMENT CENTRES, BENGALURU

Bangalore Metropolitan Transport Corporation (BMTC) developed Traffic Transit Management Centres (TTMCs) in 45 bus stations across Bengaluru. TTMCs are an integrated transportation facility with adequate facilities and amenities for all user groups. The TTMCs have bus stands on the ground floor and parking space either on the ground floor or the upper floors. The topmost floors have amenities such as food court, department stores, gift shops, and crèches, apart from basic amenities like drinking water facilities, public healthcare, post office, counters for bus, train, and air reservations, counters for utility bill payments, etc.

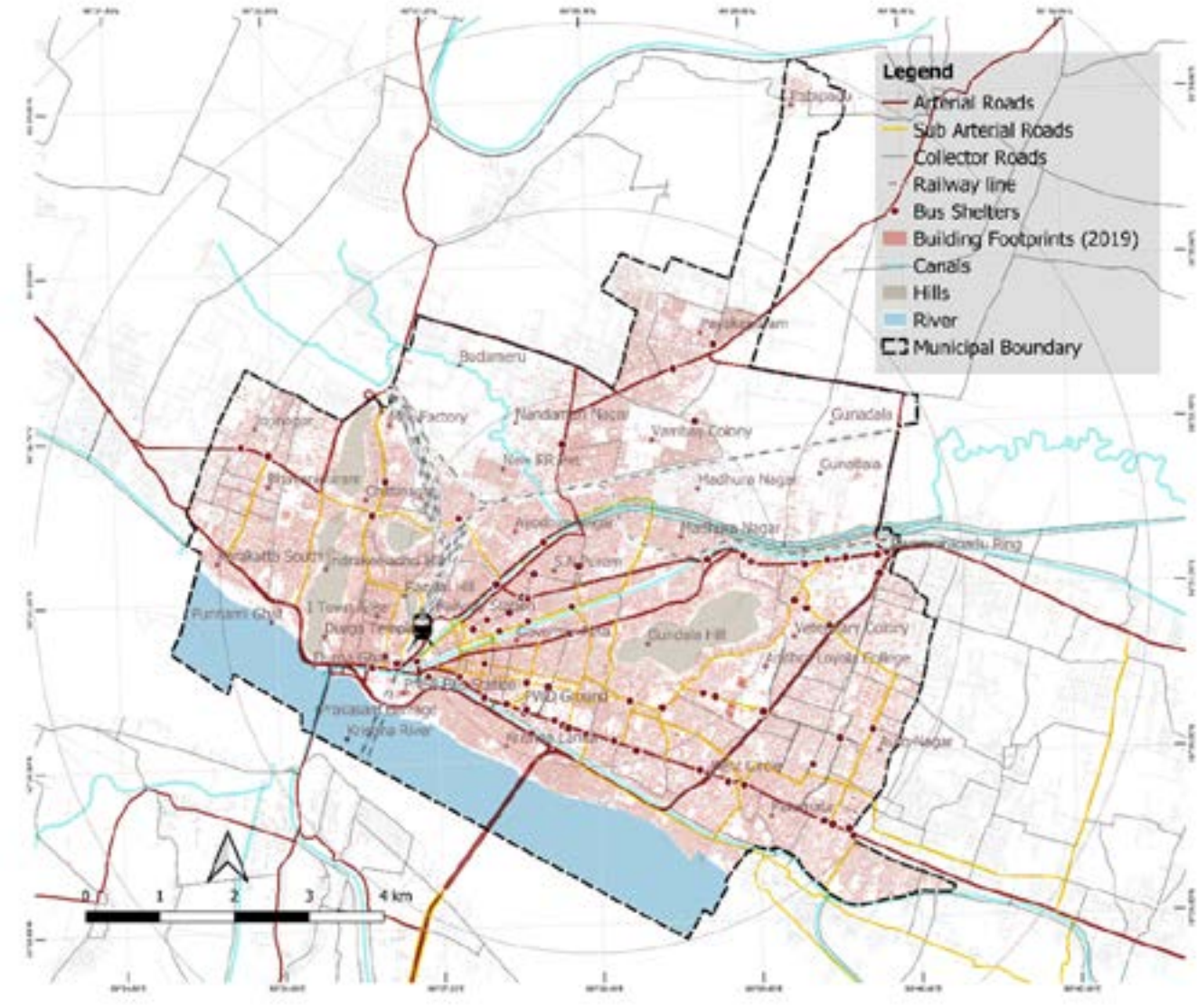
The idea behind developing TTMCs was to encourage use of public transport and provide first-mile connectivity through the provision of park and ride facilities in the bus stations; ease traffic congestion in the city, and minimum or no conflict between various traffic types like passengers, buses and private vehicles.

TTMC at Banashankari, Bengaluru

Source:
https://mybmtc.karnataka.gov.in/info-1/Bus+Stations/en
https://www.dnaindia.com/india/report-bangalore-bus-stops-to-have-shopping-malls-1170085
https://www.trafficinfratech.com/traffic-transit-management-centres-in-bangalore/

that separate these pockets from the higher-density and more developed neighbourhoods. Further, the North-West pocket is vulnerable to flooding due the Budameru Canal flowing through it. Additionally, these areas[24] are among the least served with respect to infrastructure, amenities, and transport connectivity (see Sections 4.4.3, 4.4.4, 4.4.6 and 4.4.7 in the Vijayawada City Profile and Diagnostic Report). This intervention aims to encourage development in the northern micro-market through two ways – primarily improving transport and transit connectivity, and creation of development nodes.

24 Ward numbers 1, 57, 58, 59, 60, 61, 62, 63 and 64



Map 3.14: Lesser spatial growth & transport connectivity in northern zone than other parts of the city

Source: UN-Habitat

Intervention 3.2 (a): Improving connectivity

Improving connectivity to these underserved areas may encourage and spur development. As shown in Map 3.15, the northern part of the city is connected with the rest of the city at only three locations. Of these, two are in the peripheral areas of the city, i.e., Vijayawada Nuzvid Road across the railway track near Milk Factory (see marker '1' in Map 3.15) and at Ramavarappadu Ring across the railway track, Ryves and Eluru Canals (see marker '2' in Map 3.15). The Singh Nagar flyover across the Ryves, Budameru Canals and railway track is the only link to and from the city centre (see marker '3' in Map 3.15).

The draft Vijayawada Immediate Action Plan for Transport (2018-20) and VMC proposed new road linkages in the city (see Map 3.15). Complementing these new road linkages and new linkages identified in Intervention 1.3, the current intervention proposes new connections at two locations connecting the northern part of the city with the city centre (see Map 3.15). One location lies across the railway track connecting New Raja Rajeswari Peta (see marker '4' in Map 3.15) and another with two connectivity links across Budameru Canal and the railway track connecting Vambay Colony (see marker '5' in Map 3.15).

To increase internal connectivity to the northern part of the city, a few additional linkages were identified (see Map 3.15). These linkages connect the roads proposed by VMC and the Immediate Action Plan for Transport.

Intervention 3.2 (b): Node-based development

As detailed in Intervention 1.3, five nodes have been identified in northern Vijayawada as potential Development Nodes (see Map 3.4). VMC shall focus on node-based development for overall distribution, optimum utilization of services and amenities, thus, promoting development in the northern micro-market.

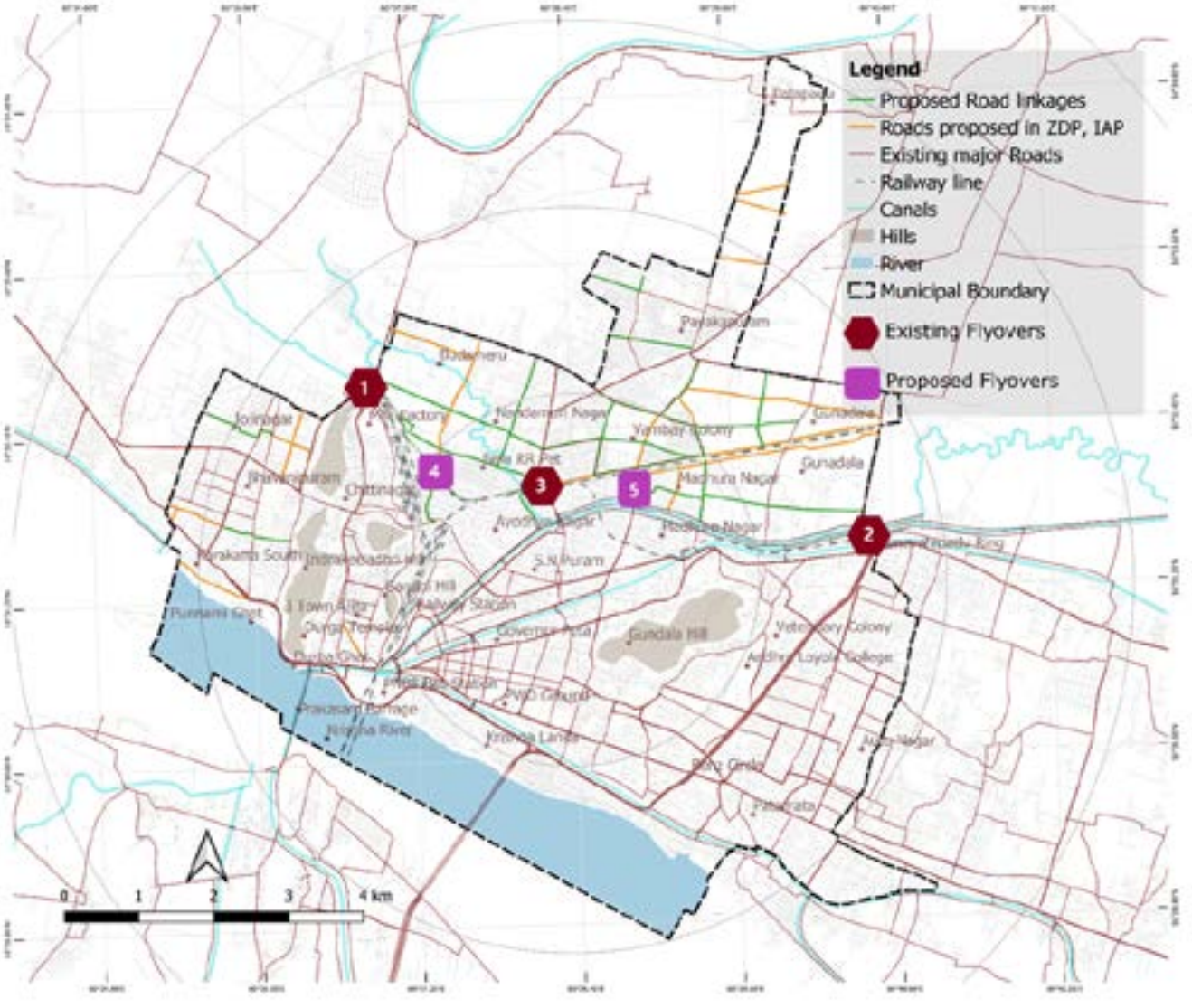
Provision for the following aspects is crucial for node-based development:

- Road connectivity
- High frequency public transportation
- Availability of public services and amenities

Various other interventions proposed under the SCS have made provisions for the above listed aspects within these nodes. In addition, the node-based development shall also consider the topography while planning for provision of services, amenities, population and built-up area densities. This has been illustrated in Section 3.6 through Node-based Development at New Raja Rajeswari Peta near Budameru Canal.

Intervention 3.3: Regulate Development in Ecologically Sensitive Areas

A few ecologically sensitive areas in the city, such as flood plains along River Krishna, canal banks, hill slopes and foothills, have been encroached upon. This intervention proposes to protect such areas and contribute to reduced hazard vulnerability and decongestion.



Map 3.15: Road connectivity to the northern part of the city (existing and proposed)

Source: UN-Habitat

Intervention 3.3 (a): Inclusion of floodplain zone (FPZ) in city zoning regulations

The intervention is formulated in line with the recommendations of River Centric Urban Planning Guidelines (2021), MoHUA, GoI, to regulate development activities along the river and its floodplains. This is crucial to prevent encroachment of the floodplains, restoring natural environment and river ecology, and to reduce flood risks. The Vijayawada ZDP, which is due for revision, shall demarcate the floodplain zone in the proposed land use plan. Supplementing this, 'Floodplain Zone' shall be incorporated in the Zoning Regulations.

Floodplain zoning at two hazard levels has been recommended, as detailed below:

Floodplain Zone 1 (protected/ prohibited activity zone): This zone shall comprise the floodplains of River Krishna, which is prone to frequent flooding. The affected area of Budameru Canal in the North-West part of the city shall also be included in this zone. It shall be reserved for urban forestry, gardens and open spaces, though temporary structures such as platforms for organizing religious activities. All other development activities shall be prohibited.

Floodplain Zone 2 (regulated activity zone): This zone lies slightly farther from the river (beyond FPZ 1) but is vulnerable to flooding/ water logging. Land use categories such as industrial, central commercial, general commercial, transport use shall be prohibited in this zone.

The prohibited land use categories mentioned above are in accordance with Zoning Regulations of Vijayawada ZDP 2021. Refer to Annex 8 for details of various activities within each land use category.

In FPZ 2, VMC may promote Disaster Risk Insurance of housing structures by undertaking Information, Education and Communication (IEC) activities, providing property tax reduction incentives for owners with insurance and complying with building codes and other prescribed guidelines. VMC may also consider implementing town planning schemes such as Transfer of Development Rights (TDR) to move people from FPZ 2 to safer areas within the city and its immediate outskirts (see Intervention 3.4) and acquire land parcels to develop them as green areas to act as sponges (see Intervention 2.2).

Through a technical study, VMC shall identify the floodplains and demarcate the boundaries of floodplain zones for enforcement.

Intervention 3.3 (b): Protection of natural resources, area earmarked as conservation zone in ZDP 2021 through NbS

Refer to Interventions 2.2 and 4.2 for details of proposed conservation of ecologically sensitive areas through NbS.

Intervention 3.4: Development of Growth Centres beyond Vijayawada

To reduce further densification and dependency on Vijayawada for employment, public amenities and services, this intervention recommends development of towns beyond the municipal limits. About 90 per cent of the developed area within Vijayawada city limits has a population density of more than 150 PPH[25] (see Section 4.2.3 of Vijayawada City Profile and Diagnostic Report). These high densities put tremendous pressure on existing infrastructure and amenities.

This intervention proposes to develop growth centres around Vijayawada, specifically along the major development corridors to absorb the upcoming population and new developments. This shall be supported by providing necessary infrastructure, land use interventions to create employment opportunities and liveable areas. Vijayawada is already experiencing significant outward growth to the East, West and North-East along NH-65 and NH-16. Four growth centres along these areas on the national highways are identified based on the factors listed below. These growth centres are envisaged for the growing housing demand in Vijayawada and for creating new employment opportunities.

Factors considered for identifying the growth centres:

- **Connectivity:** Location along the national highways or state highways with high frequency public transport connectivity to Vijayawada
- **Existing major settlements** (sizable population of around 15,000) around Vijayawada with availability of functional amenities such as education and health facilities, public transport nodes, and commercial activity, etc.
- **Proximity** to Pedalandariki Illu Housing Colonies proposed for development by VMC.

25 150 PPH is the recommended global practice for designing optimum population density for cities. Source: UN-Habitat. (2014). A New Strategy of Sustainable Neighbourhood Planning: Five principles; https://unhabitat.org/a-new-strategy-of-sustainable-neighbourhood-planning-five-principles-0.

Below is the list of proposed growth centres with their existing populations, as per Census 2011.

- Ibrahimpatnam (29,500)
- Gannavaram (21,000)
- Kankipadu (15,000)
- Nunna (14,200)

In Map 3.16, the information regarding the distance of growth centre from Vijayawada and the number of housing units (HU) sanctioned in the housing layouts at these locations being developed under the Pedalandariki illu programme are mentioned.

The master plan, which is due for revision, should incorporate these growth centres with supporting infrastructure. APCRDA and VMC may explore the options of allocating benefits of land value capture methods such as TDR, land pooling and others in the proposed growth centres in lieu of encouraging growth here.

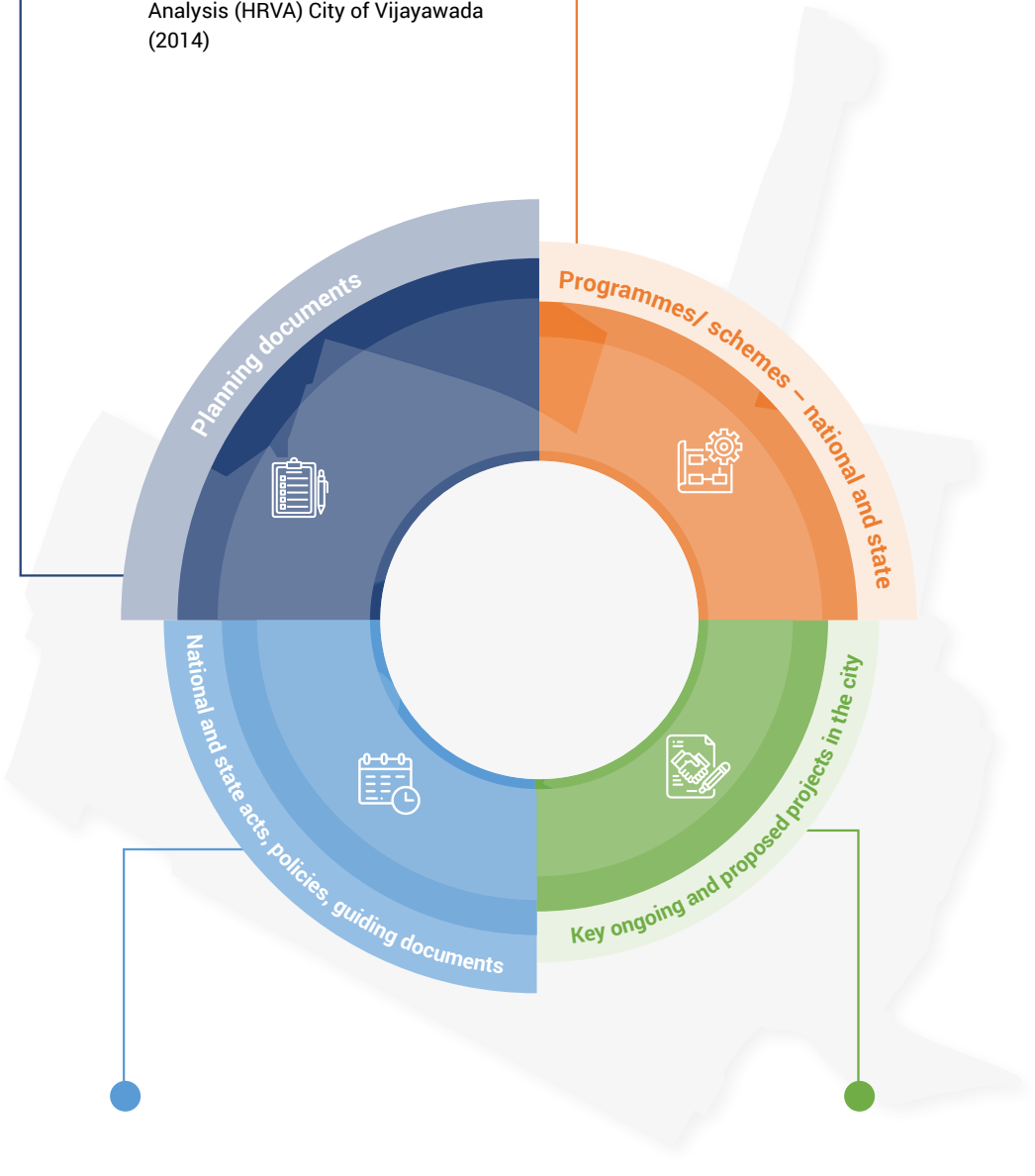
Map 3.16: Proposed growth centres for Vijayawada

Map Source: Google Earth imagery (March 2022)

3.4.2. Alignment with national, state policies, programmes and ongoing, proposed capital projects in the city

- Zonal Development Plan 2021
- Vijayawada City Disaster Management Plan
- Hazard Risk and Vulnerability Analysis (HRVA) City of Vijayawada (2014)

- Pradhan Mantri Awas Yojana - Urban
- Navaratnalu – Pedalandariki Illu (Housing for All Poor)



- National Urban Policy Framework, 2018
- River Centric Urban Planning Guidelines, 2021
- Andhra Pradesh Capital Region Development Authority Act, 2014
- AP Building Rules, 2017

- Vijayawada Master Plan/ ZDP (currently under revision)
- Navaratnalu – Pedalandariki Illu
- NH-16 Western By-pass

3.4.3. Gender and inclusion

This strategic response supports gender inclusive development in all its interventions and specifically in improving public services and amenities, nodal development and creation of peripheral growth centres.

Community shopping complex, vending zones, mixed use development, other activities proposed within the growth centres create employment opportunities for women. The planning of community centre should adhere to gender inclusive amenities (further details in Annex 7). Allocating a few shops in the complexes to women SHGs will generate new employment opportunities and could be of high impact to improve women Work Participation Rate (WPR) in the city. They could also be involved in management of community centre, skill development centres, others.

Public transportation connectivity, NMT infrastructure significantly contributes towards improving access, safety for women and children. This could support access to education, employment opportunities and healthcare for vulnerable groups.

3.4.4. Climate convergence

The proposed activities in Interventions 3.1 and 3.2, such as improving NMT infrastructure, promoting first and last-mile connectivity through feeder services, e-rickshaws, shared mobility, provision of public amenities through construction of community shopping centres within multimodal hubs, etc., would contribute to increase in non-motorized travel. Reducing citizens travel needs (reduction of average trip length) could reduce dependency on private vehicles and in turn GHG emissions.

Both Interventions 3.1 and 3.2 emphasize the optimum usage of existing infrastructure. This leads to more efficient use of the existing infrastructure. Efficient use of the city's existing infrastructure is a key aspect of sustainability.

On the other hand, promoting mixed land use development, development of northern Vijayawada by constructing infrastructure (roads, flyovers), amenities, and housing may lead to high emissions, if sustainable construction methods are not considered. For example, constructing one new housing unit of 72-sq. m., G+2, without a lift, using regular construction materials such as concrete, cement bricks, clay bricks, ceramic and clay tiling, steel, XPS, spray foam and paint can emit up to 98.65 tCO_2-e.[26] On the other hand, by using sustainable materials such as fly ash or wood, straw bale, cork, and bamboo, a housing unit has the potential to store 20.03 $tC0_2e$ per annum.[27] Therefore, it is important that new development (Interventions 3.1 and 3.2), or development induced by these interventions, adopts a sustainable construction method. Usage of locally available, green material and sustainable construction practices shall be adopted for the construction of community shopping complexes, roads, flyovers.

Intervention 3.3 (flood plain zoning, protection of natural resources, conservation zone through NbS) once implemented would significantly increase the green cover in the city and, thus, the city's GHG sequestration potential. The GHG sequestration potential estimates of proposed NbS are presented in Sections 3.3.4 and 3.5.4.

TABLE 3.11 GHG emission sequestration estimates for key actions proposed in Strategic Response 3

Intervention	Action / Project	Potential GHG emissions sequestration (tCO_2-e per annum)	Remarks
Intervention 3.1: Promote Mixed-Use Development	Strengthening NMT infrastructure along Eluru Road (7 km) and MG Road (6 km)	276	Components considered include trees, bioswales, lawns – central median and pedestrian median (sq. m.)

Source: Various sources have been used in the calculation of emissions savings potentials. Please see Annex 13 for Climate Savings Calculation Methodology for the calculation breakdown and assumptions made.

3.4.5. Estimated project costs

Below are the estimated project costs for implementing a few proposed projects (see Table 3.12) for Strategic Response 3: Optimizing Development and Guiding Future Growth.

26 This uses the potential CO_2-e emissions per kg of material and the acquisition of material includes demolition, destruction, collection, etc. of the materials, which amounts to 10% of total construction carbon emission; Kurian, R., Kulkarni, K. S., Ramani, P. V., Meena, C. S., Kumar, A., & Cozzolino, R. (2021). "Estimation of carbon footprint of residential building in warm humid climate of India through BIM." Energies, 14(14), 4237.

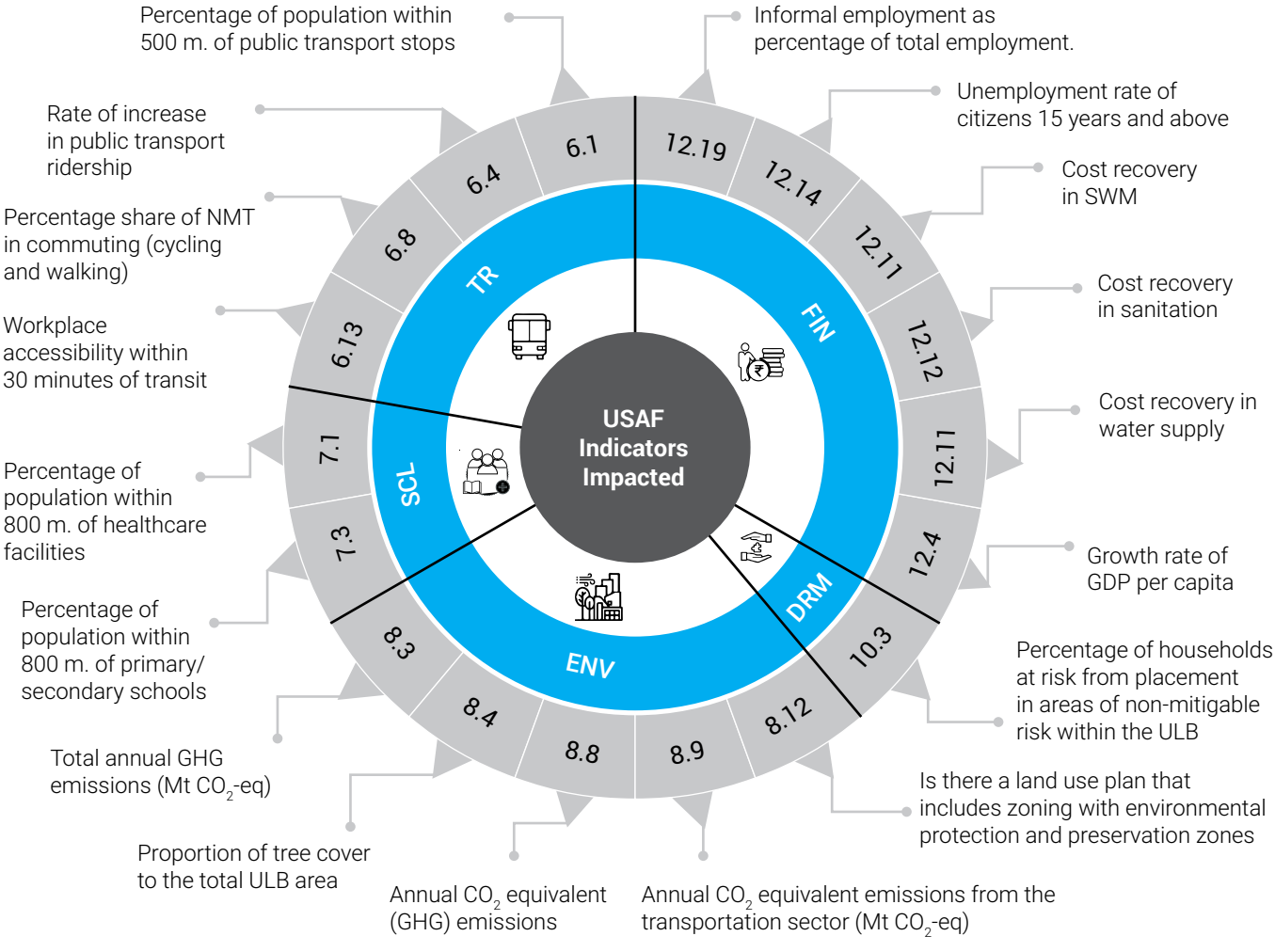
27 Kuittinen, M., Zernicke, C., Slabik, S., & Hafner, A. (2021). "How can carbon be stored in the built environment? A review of potential options." Architectural Science Review, 1-17.

TABLE 3.12 Estimated project costs for a few key actions proposed in Strategic Response 3

Intervention	Project	Estimated Project Cost (INR lakh)	Remarks
Intervention 3.1: Promote Mixed-Use Development	Strengthening NMT Infrastructure along Eluru Road (7 km) and MG Road (6 km)	509	Components include footpaths of minimum 2-m width on either side; raised pedestrian crossings (32); road markings, signages and street furniture, plantation, bollards & physical barriers, removal of encroachments.
	Develop organized on-street and off-street parking facilities at various locations along Eluru Road and MG Road	250	This task needs a detailed study for identification of feasible locations, estimating the parking demand. Hence the cost is given for a typical on-street/off-street stack parking system[28] with 50 Equivalent Car Space (ECS).
Intervention 3.2: Improving access to public services and amenities	Construct Community Shopping complex at proposed multimodal hubs	1,000	This action requires a detailed study to assess the availability of land, requirement of community shopping complex at the proposed multimodal hub. Cost proposed here is for one shopping complex (warm shell) of area 20,000 sq. ft. @ INR 5,000 per sq. ft. The cost of land is not considered.
Intervention 3.3: Promoting development in Northern part of the city	Construction of Two flyovers connecting the northern part of the city	2,730	One Rail Over Bridge (2 -Lane) of length ~ 0.15 km and another Flyover (2-Lane) across Budameru canal and railway track of length ~ 0.90 km.

Source: Various sources have been used in the calculation of project costs. Please see Annex 12 for cost estimates breakdown and assumptions made.

3.4.6. USAF indicators impacted



28 Stack parking system allows two or three cars stacked on top of each other. Its single post saves space and offers flexibility. Based on requirement and space constraints either one level or two levels can be added to this system.

3.5 Strategic Response 4: Reducing Vulnerability in Informal Settlements and Building Resilience to Natural Disasters

This strategic response would address the concerns identified in strategic issues – vulnerable informal settlements and inadequate public green spaces and fragmented blue–green network. The planning principle of 'sponge city' has been adopted for formulating a few interventions.

Of the 111 informal settlements in the city, 38 were identified as highly vulnerable due to the following reasons:

- Location in ecologically sensitive/ protected areas
- Location in areas historically exposed to natural hazards
- Low adaptive capacity due to limited infrastructure coverage – viz., low or no coverage of water supply, sanitation, roads, and public transportation
- Low access to critical amenities – health and education facilities, fire services, etc.
- No scope for development – Earmarked as no development/ protected areas by ZDP 2021, other legal instruments.

Refer to the Vijayawada City Profile and Diagnostic Report for details on the disaster profile of the city (Section 4.4.10), and the vulnerability profile of informal settlements (Section 5.1.1).

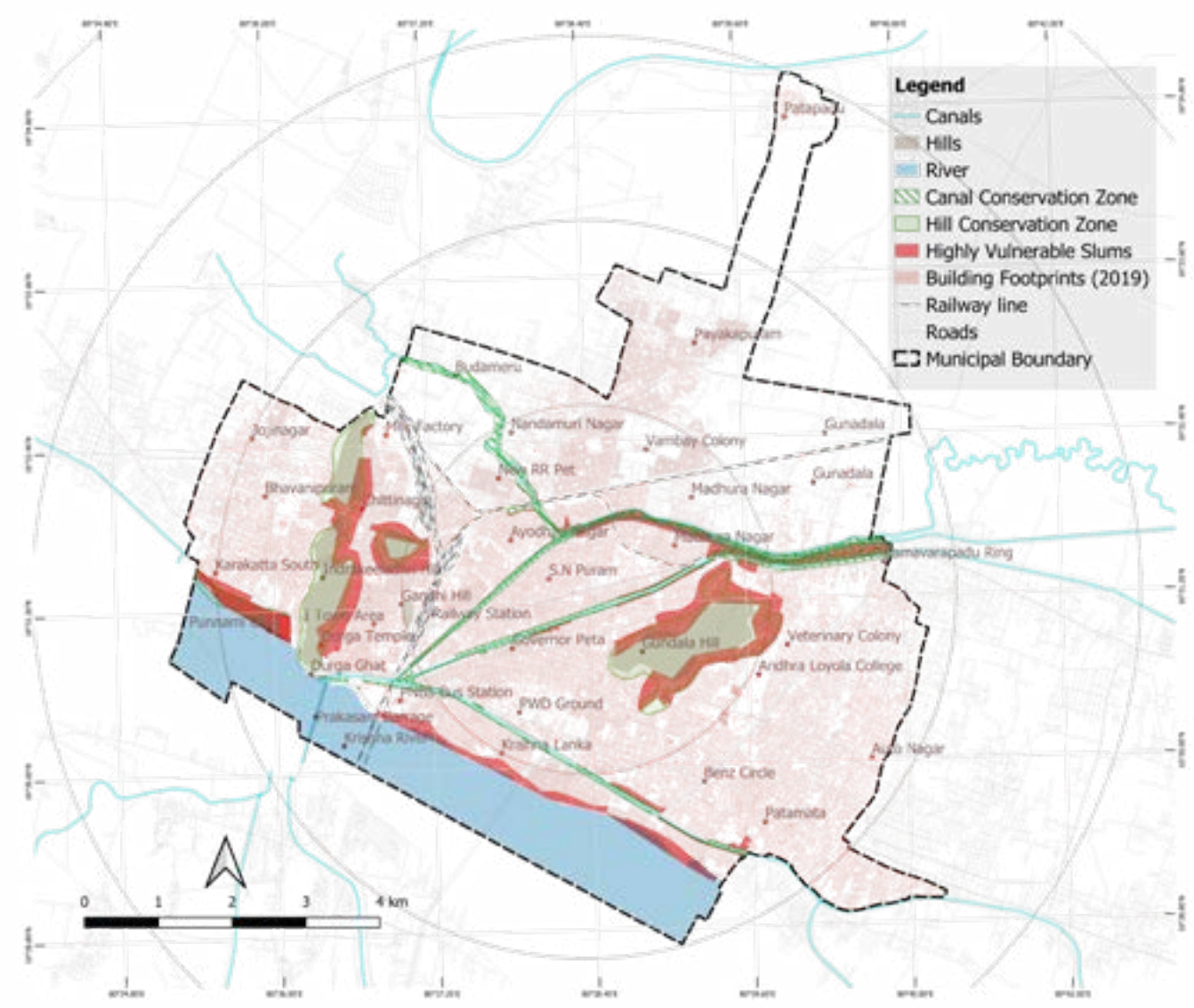
As seen in Map 3.17, 38 informal settlements/ slums are in the following hazard prone areas – a) floodplains of River Krishna[29]; b) area along the canal banks earmarked as conservation zone[30]; c) on the hill slopes and foothills reserved as conservation zone. These areas have been frequently experiencing flooding and landslides. The intensity of flooding surges during cyclone, windstorms. Of these 38 slums, the boundaries of 31 are partially located on the hills and canal conservation areas. Around 14,000 households with about 45,500 people live in these 38 slums (see Table 3.13 for the location-wise details of the city's highly vulnerable slums).

IMAGE 3.4 Water logging along the banks of River Krishna during August 2019 floods

Source: VMC

29 A 100m buffer from the embankment (retaining wall) of River Krishna / riverbank (in area with no retaining wall) is considered as area highly vulnerable area in line with the provisions of River Centric Urban Planning Guidelines (2021), MoHUA, GoI.

30 Vijayawada ZDP 2021 has earmarked certain areas along the banks of canals, hills and foothills as conservation zones.



Map 3.17: Highly vulnerable slums in the city

Map Source: UN-Habitat; Data Source: VMC

TABLE 3.13 Details of highly vulnerable slums

Location	Slums (no.)	Households^	Population	Area (Ha)
Floodplains of River Krishna	7	4468	13,300	103.43
Canal Conservation Zone*	11'	2813	7,800	33.12
Hill Conservation zone*	21	6978	24,500	132.50

Source: GIS Analysis (2019)

*The details provided are for the portion of respective slums falling within conservation areas
' One Slum (Karakatta Down South) also falls within the floodplains of River Krishna
^ The number of slum households falling within these areas are identified on the basis of GIS analysis.

IMAGE 3.5 Encroachments in the conservation zone along Budameru Canal

Source: UN-Habitat

Refer to Annex 9 for the location-wise names of the city's highly vulnerable slums.

In-situ development options for highly vulnerable slums

In-situ slum upgrading is proven to be a more effective option than resettlement of slum dwellers and is the norm in most slum-upgrading projects and programmes.[31] Accordingly, a couple of in-situ slum development options have been explored to reduce vulnerabilities.

Option 1: In-situ upgradation and settlement on the non-conservation areas

In this option, for slums located within the conservation areas, an option to accommodate the population within conservation areas to the parts of the respective slums outside conservation zones has been evaluated. The population density in slum areas falling outside the conservation zone is in the range of 175–350 PPH. If the total population within the notified slum area beyond the conservation area were to be accommodated through in-situ development, the resulting population density would reach up to more than 500 PPH in many cases. Moreover, this task also requires the consent of residents living beyond these conservation areas. In case of in-situ development, slum inhabitants will need to be relocated to temporary accommodations during the construction period.

Option 2: In-situ upgradation in floodplain and canal conservation areas through flood resilient structures

In-situ development of slums on the banks of River Krishna and in canal conservation areas may occur by constructing flood resilient housing structures. A few types of flood resilient housing include, floating houses, elevated houses, and flood proofing of houses using water-resistant

30 The challenge of slums: Global report on human settlements, 2003; United Nations Human Settlements Programme.

materials. These types of structures are in use in the flood prone areas Kerala and Assam in India, as well as in various places across the world. A few general limitations of these flood resilient structures are as follows.

Floating houses: Safety concerns for children, pets, and livestock; high construction and maintenance cost, infrastructure provision, balancing the structure weight.

Elevated houses: Expensive due to structural concerns (requires pile foundation); soil erosion may affect the structure; poor access and lack of natural surveillance of the street; hard for elderly to climb the stairs.

Flood proof resilient structures: Less/ no protection in case of heavy floods; high material and maintenance cost; high maintenance costs after the event of flooding.

In addition to the above, key factors to consider in Vijayawada for identifying the appropriate type of flood-resilient structures (excluding engineering / technical aspects) are:

- Variations in water volume in River Krishna and the reservoir
- The city's moderate vulnerability to cyclones and windstorms

Through a detailed technical study, VMC may explore the possibility of in-situ development of highly vulnerable slums using the above-mentioned technology.

Floating Houses
Image location: Copenhagen, Demark

Elevated Houses
Image location: Alapuzha, Kerala, India

Image sources: Floating House: https://www.stirworld.com/see-features-big-builds-affordable-floating-village-urban-rigger-in-copenhagen-denmark (accessed on 12 March 2022).

Elevated House: https://deccanchronicle.com/amp/nation/current-affairs/230819/homes-that-build-hopes.html (accessed on 12 March 2022).

3.6.1. Proposed interventions within the strategic response

Five interventions are proposed under this strategic response, which are detailed as follows:

Intervention 4.1: Resettlement and Rehabilitation of Highly Vulnerable Slums

The 38 highly vulnerable slums are located on physically hazardous and ecologically sensitive areas. With high densities, provision / upgradation of infrastructure (especially water and sanitation) is challenging. Therefore, resettlement and rehabilitation of highly vulnerable slums to safer locations is recommended. As seen in Table 3.13, about 14,200 households live in highly vulnerable slums. It has been assumed that 30 per cent of families in these slum settlements have been provided with housing sites under the state government's flagship housing scheme, Pedalandariki Illu (see Annex 2 and 3 for details of ongoing programmes in the city) and allocated houses by VMC under Andhra Pradesh Township and Infrastructure Development Corporation (APTIDCO) programmes. Therefore, the estimated number of households to be relocated could be about 10,000. Assuming the average slum household size[32] as 4.5 persons, with a population density of 175 PPH, about 257 Ha of land is required for relocation. Consequently, the following options are proposed for relocation and rehabilitation:

32 As per census 2011, the average slum household in India was 4.7 people

Option 1: Gradual relocation to the new group housing projects in the city

For the new group housing projects in the city (more than 2.023 Ha), Andhra Pradesh Building Rules has provisions for allocating 10 per cent of the total built-up area towards EWS/LIG units or 25 per cent of the total number of housing units. These housing units shall be provided within the site or within a radius of 10 km of the project site, or within 5 km from the nearest aerial route boundary of the municipal limits. VMC shall purchase these EWS/LIG housing units from the developers of the upcoming group housing projects and relocate highly vulnerable slum dwellers gradually.

The relocation could impact existing livelihoods of residents and, hence, should be undertaken gradually. It would be helpful to assess impact on livelihood and develop strategies to mitigate the same. Social protection, livelihood promotion, financial inclusion, social empowerment are key components to consider. Based on assessment and understanding of existing supply chain and livelihood, it is suggested that shifting allowance to beneficiaries be provided.

- A subsistence allowance be provided as social protection to enable beneficiaries to meet immediate needs
- Provide livelihood options matching previous employment
- Improve financial literacy and access to savings and financial services
- Workshops and counselling for psychosocial support and to induce positive behaviour change among relocated communities.

The number of upcoming group housing projects and EWS/LIG units available could not be assessed as it is market driven. Hence, arriving at a particular timeline for accommodating all the highly vulnerable slum dwellers would be difficult and may be taken up by VMC in a concerted manner as the options become available.

Option 2: Identification of locations for resettlement and rehabilitation

There are several documented challenges arising due to relocation, such as loss of jobs or income from informal enterprises, increased travel time and costs, loss of community ties, reduced access to basic amenities such as health, education, etc.[33]

To address the above concerns, northern Vijayawada could be considered by VMC for relocating the identified highly vulnerable slum dwellers. This area has been recommended due to the availability of vacant land, comparatively lower population density, relocation sites within municipal limits (to reduce the relocation distance to the possible extent) and is supported by other interventions proposed in this document. These include improved road connectivity, strengthening public transportation (see Interventions 1.1, 1.2 and 3.2) public parks and open spaces (see Interventions 2.2, 2.3 and 2.4), development of growth nodes, multi-transit hubs (see Interventions 1.3 and 3.2b) and measures to reduce flood risk (see Interventions 2.1, 2.2 and 4.4), among others.

VMC shall explore the possibilities to obtain land from landowners through application of town planning schemes or through direct purchase.

Key steps and departments responsible for executing the intervention include:

1. Mapping and listing of exact slum households (excluding families received housing sites in Pedalandariki Illu and other government schmens) located on river floodplains, hill, and canal conservation zone through survey

   Department responsible: VMC, Revenue department and Irrigation department

2. VMC shall purchase, obtain required land parcels from private owners, application of town planning schemes.

   Department responsible: VMC, Revenue Department

3. Provide necessary infrastructure, amenities, and construct housing complexes for identified beneficiaries

   Department responsible: VMC, line departments such as APSRTC, others.

4. Shifting of all identified families from identified high hazard vulnerable areas to newly constructed housing complexes.

   Department responsible: VMC, Disaster Management and Fire Services Department.

5. Acquire high hazard vulnerable land parcels.

   VMC may issue a public notice to not undertake any kind of activity in the aquired land without VMC's permission and any vilolations shall be taken legal actions.

   Key agencies responsible: VMC, Revenue Department, Irigation Department.

Gender inclusive urban development guidelines given in Annex 10 are suggested to be followed for the housing redevelopment zones.

33 The challenge of slums: Global report on human settlements, 2003; United Nations Human Settlements Programme.

Intervention 4.2: Conservation of Reclaimed Land in Highly Hazard Prone Areas through NbS

This intervention proposes NbS[34] that VMC could undertake in the reclaimed land parcels.

Floodplain Restoration of River Krishna

To reduce the impact of flooding on the population residing along the banks of River Krishna, VMC has constructed a retaining wall of about 3.84 km length in 2021. Currently, VMC is in the process of extending the wall along a few other stretches (see Image 3.7). The retaining wall may create a few challenges as follows:

- Polluted runoffs gather at the wall
- Loss of visual and physical connect between city and the river

NbS can reduce the impact of natural hazards in cities and complement grey infrastructure such as retaining walls and embankments. Globally, integration of NbS has proven to be cost-effective and sustainable.[35] Restoration actions on floodplains such as development of riverine vegetation, removal or rebuilding of the embankments at a different location, creation of flood bypasses, and excavation of the floodplain, contribute to enhanced flood protection. Floodplain/ riverine vegetation through native plants including trees, shrubs, and grasses that can survive frequent or prolonged floods act as defence and reduce floodwater speed when rivers overflow their banks.

In addition, floodplain restoration significantly contributes to carbon storage and sequestration[36], improve biodiversity and water quality, reduces environmental pollution, mitigate soil erosion, and facilitates sediment transport and storage. In addition to the ecological benefits, such river floodplains create opportunities for developing tourism and recreational activities in the city and increase the urban value.

The images below show the existing situation (see Image 3-6) along the banks of River Krishna and illustration of proposed NbS concept for the same area (see Figure 3.12).

Application: Area from the Krishna riverbank to the present retaining wall and a further 100-m buffer outside the retaining wall. In stretches with no retaining wall, 100 m. from the riverbank.

Land use: Reserved for natural open space, gardens; temporary structures organizing religious activities. All development activities shall be prohibited.

Urban alignment: Krishna River floodplain could be an integral component of eco-conservation programmes, new development, and new natural green area, public open space.

KEY BENEFITS FOR THE CITY

Restore and protect floodplain ecosystem

Combine public recreation with natural restoration

Restore connection between the river and the city

Prevention from encroachments

34 Nature-based solutions are actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits; https://www.iucn.org/commissions/commission-ecosystem-management/our-work/nature-based-solutions#:~:text=Nature%2Dbased%20Solutions%20(NbS),%2Dbeing%20and%20biodiversity%20benefits%E2%80%9D (Accessed on 05 April 2022).

35 World Bank. (2021). A Catalogue of Nature-based Solutions for Urban Resilience. Washington, D.C. World Bank Group; pg.10.

36 Appropriate trees for carbon sequestration which are efficient at absorbing carbon will need to be selected for this restoration.

IMAGE 3.6 Retaining wall under construction in the floodplains of River Krishna in Vijayawada[37]

Source: UN-Habitat

FIGURE 3.12 Conceptual illustration of NBS interventions in the floodplains of River Krishna

Source: UN-Habitat

37 Photographed on 19 March 2022

Hill Slope Renaturation

Terracing is a land management practice to manage stormwater runoff, mitigate erosion and hill rockslides. Terraced hill landscapes avoid structural damages from pluvial flooding, landslide risk to properties and infrastructure downstream. This nature-based solution has been used in India and globally, with difference in size, use, construction techniques. Complementing the terracing, techniques such as fences, wire/iron mesh, others are in use to act as short retaining walls to reduce the impact of rolling materials during floods, storms, protect the slopes from fast moving stormwater.

Reverse/ inward sloping terraces could be best suited for Vijayawada considering the heavy rainfall and less permeable soils on the hill slopes.

In addition to the above, renaturation of hills promotes farming and forestry within the city, contributes to carbon sequestration, improve biodiversity, and creates opportunities for developing tourism and recreational activities in the city.

Similarly, the conservation area along the canal banks could be developed through NbS to reduce the impact of flooding, protect the canals, develop new recreational areas as illustrated in Interventions 2.1 and 2.2, and transformative project II in Area-based Development.

Based on GIS analysis, a total of about 269 Ha (conservation area under canal, hills, river flood plains) is occupied by highly vulnerable informal settlements (see Map 3.18). A detailed survey shall be undertaken to map the area under highly vulnerable slums that could be preserved and protected through NbS. This constitutes about 30 per cent of area under informal settlements in the city and 4.3 per cent of the total city area.

IMAGE 3.7 Hill slope terrace in Uttarakhand, India

Image source: Aroon Thaewchatturat / Alamy/ Kasturi Das[38]

38 https://www.thethirdpole.net/en/climate/climate-change-forces-migration-uttarakhand-farmers/ (accessed on 15 April 2022)

Application: Hillslopes and foothills of Indrakeeladri, Gunadala and Chittinagar hills – includes area encroached by slums, hill conservation area earmarked in ZDP 2021.

Land use: Agriculture, forestry, parks, public utilities such as electricity, telecommunication infrastructure, etc. All development activities shall be prohibited.

Urban alignment: Local food production, development of green areas, public parks and reforestation programmes.

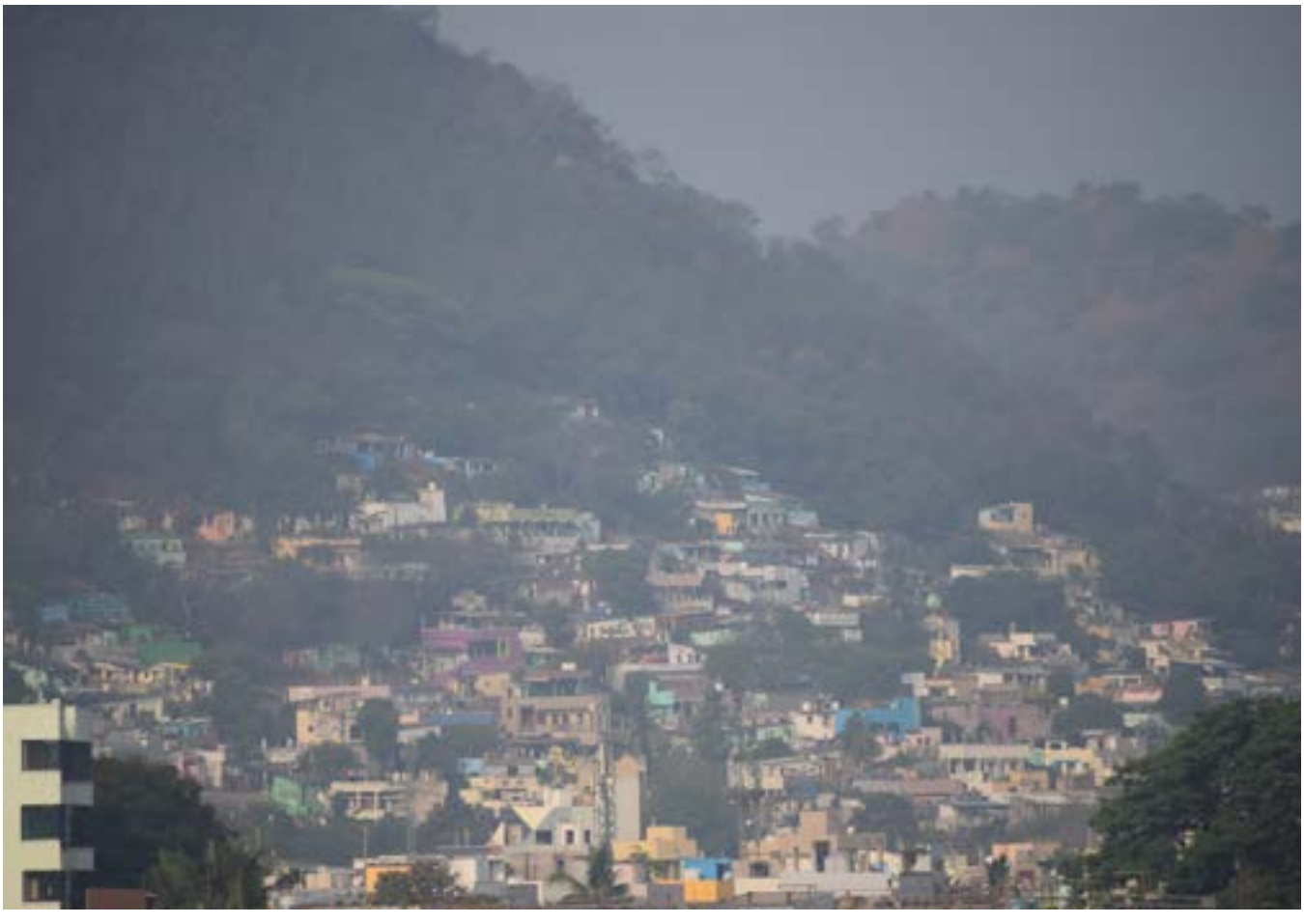
KEY BENEFITS FOR THE CITY

Protect hill ecosystem

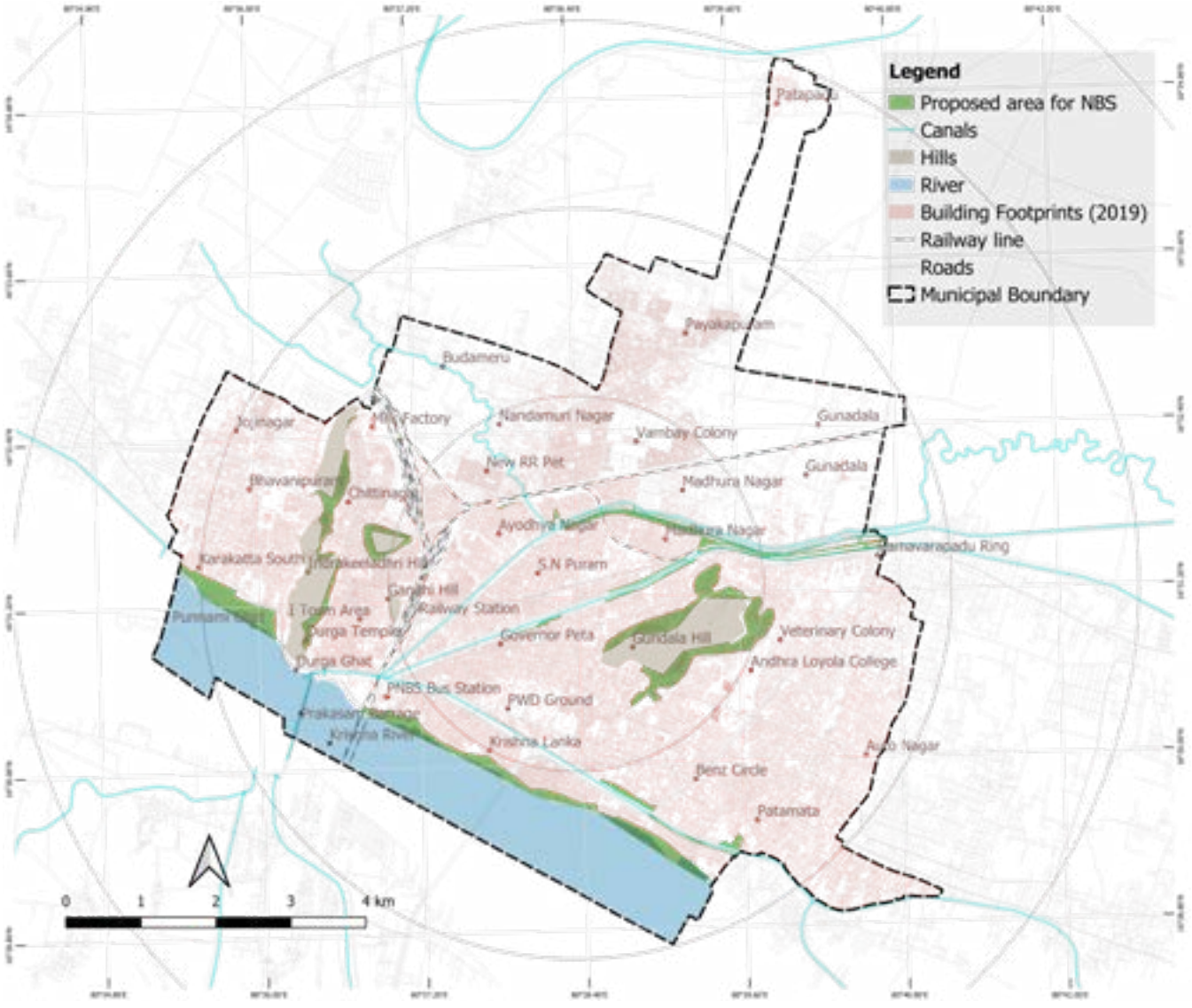
Combine public recreation with natural assets

Prevention from encroachments

IMAGE 3.8 Houses on the hill slopes in Vijayawada



Source: UN-Habitat



Map 3.18: Areas proposed for implementing Nature-based Solutions

Map Source: UN-Habitat; Data Source: VMC

Intervention 4.3: Retrofitting Slum Areas

This intervention targets reducing the severity of hazards, improve the adaptive capacity of the portions of 31 highly vulnerable slums that fall beyond the canal and hill conservation zones (see Map 3.17). These are categorized as developable areas in ZDP 2021. With their proximity to high hazard risk areas, these portions of slums are also vulnerable, with low access to public transport, public open spaces, and health services (see Chapter 5.1 in the Vijayawada City Profile and Diagnostic Report). In these areas, VMC shall take measures to primarily address the deficiencies of housing conditions, provision of infrastructure and amenities.

VMC shall undertake a detailed survey to assess the condition of housing structures in these portions of 31 slums. Provide technical and financial assistance to retrofit the housing structures identified in weak/bad conditions. Various flood resilient housing structures discussed earlier in this section such as elevated houses, flood proofing of houses using water-resistant material could be considered based on suitability. The interventions proposed in other strategic responses address the aspects of public transportation, road connectivity, public parks and open spaces, other amenities. On implementation of these strategies, the accessibility of the informal settlements to urban amenities would be greatly improved.

As an immediate measure, fencing foothills using iron mesh or zero wires to hold the rolling boulders shall be considered till other NbS are implemented. Similarly, use of sandbags, water blockers may be considered as an interim and temporary measure to reduce the impact of runoff.

Intervention 4.4: Augmentation of Flood Forecasting and Early Warning System (FFEWS)

The proposed intervention intends to equip slum dwellers, communities, and other stakeholders living in areas vulnerable to flooding to act appropriately based on real time updates on flood inundation levels.

The early warning monitoring and dissemination infrastructure available at VMC includes the following:

- SMS-based Early Warning System (bulk SMS to key stakeholders)
- Software to communicate and alert key stakeholders, based on hazard event and location
- Voice broadcasting via telephone/ cell phone link
- Flood Action Plan with SOP for relevant line departments
- Command and Control Centre

The intervention proposes to strengthen the existing early warning infrastructure in VMC by linking to automatic sensor nodes installed at various flood-prone locations in the city to improve the quality of flood forecasting and response.

The proposed FFEWS includes installing automatic inundation sensor nodes (operates through mobile sim card) in informal settlements (22 slums) in high flood vulnerable areas[39] (see Map 3.19) at appropriate locations such as street poles, evacuation routes, buildings to monitor the flood inundation levels. Install automatic water level monitoring censors near River Krishna and canal banks. These sensors are connected to the server in VMC. The real-time information is communicated from VMC's Command and Control Centre to the District Collectorate, relevant line departments, other stakeholders including NGOs, slum dwellers, and local communities located in flood prone areas via mobile alerts (bulk SMS) and other means of communications.

This initiative would improve flood awareness and safety at community levels, reduce economic loss and impact on livelihoods.

Refer to Annex 11 for names of 22 slums located in high flood vulnerable area.

CASE STUDY: CITY-LEVEL FLOOD FORECASTING & EARLY WARNING SYSTEM, KOLKATA

India's first comprehensive city-level flood forecasting and early warning system (FFEWS) was installed in Kolkata in 2018.

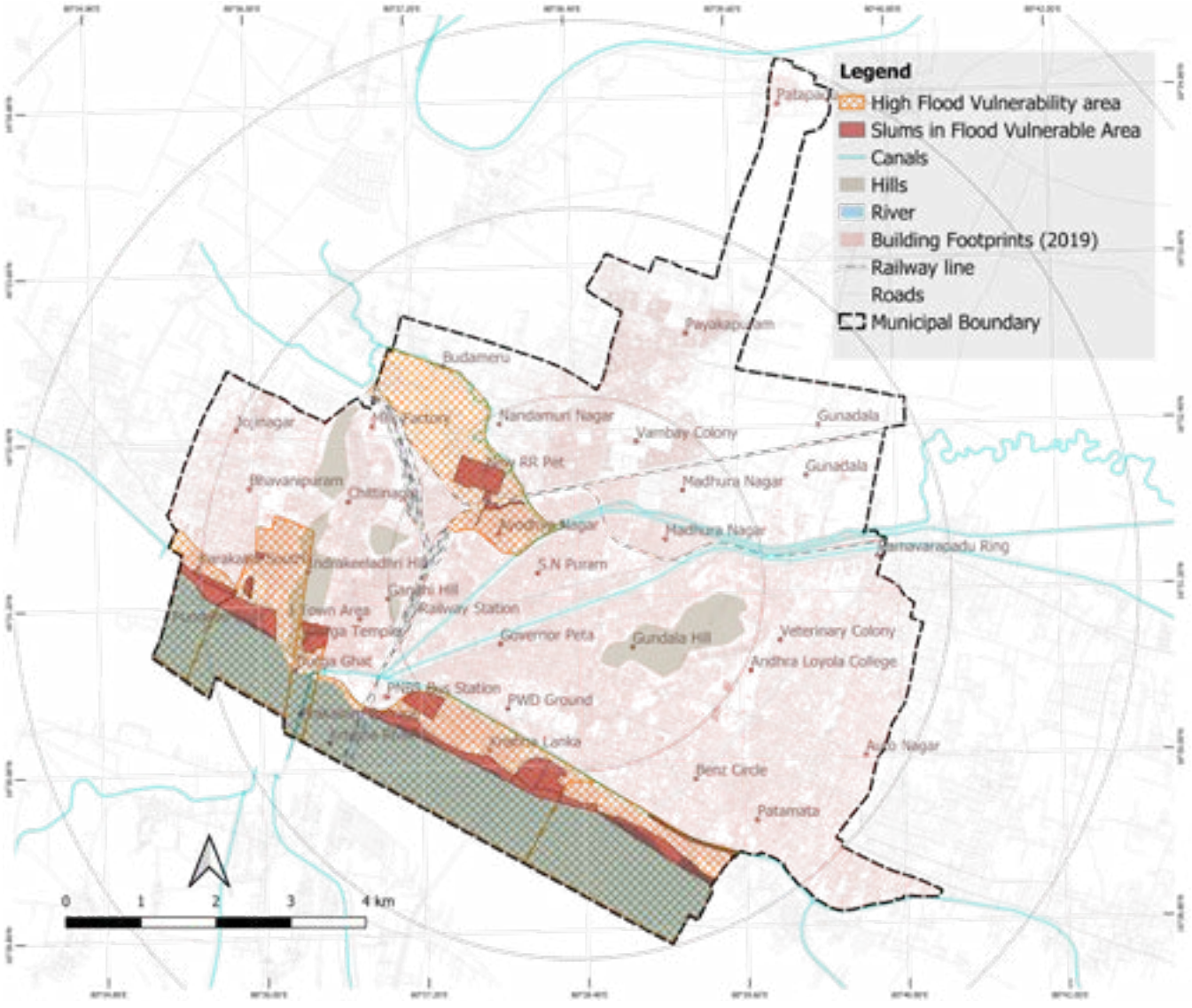
The system provides forecasts as well as real-time updates from sensor nodes installed in key points throughout the city. Information generated and disseminated by the FFEWS will enable informed decision-making before and during disasters. The system includes weather forecasts; flood models for various intensities of rainfall; real-time information (inundation, temperature, air quality, and other climate related data); and a messaging system to provide warnings and real-time information to city officials and citizens.

Other expected key outcomes of FFEWS include:

- Flood-informed urban planning.
- Improved flood awareness and safety at community level.
- Reduced economic loss and impacts on livelihoods.
- Reduced impacts from flood-induced traffic congestions.

Source:
https://www.adb.org/sites/default/files/publication/452576/toward-resilient-kolkata.pdf (accessed on 16 April 2022)
https://www.adb.org/news/kolkata-gets-indias-first-comprehensive-city-level-flood-forecasting-and-warning-system (accessed on 16 April 2022)

39 Hazard Risk Vulnerability Assessment (2014) study for Vijayawada regarding level of flood vulnerability mapped the city into four categories – High, Medium, Low and Not Vulnerable



Map 3.19: Slums in high flood vulnerable areas

Data Source: Vijayawada HRVA (2017); Map Source: UN-Habitat

IIntervention 4.5: Transforming Slums as Better Livable Spaces through Community Engagement

As per Census 2011, Vijayawada has 111 slum settlements. During the consultations with VMC officials, it was learnt that since 2011 various slum improvement programmes/ schemes (funded by both Central and state governments), urban poor housing programmes, social welfare programmes were implemented in the city with focus on upgradation of housing, infrastructure, creation of employment opportunities, etc. Through various government schemes, grants, and general budget, VMC has provided services and infrastructure in various slums such as roads, water supply, drainage, social amenities, and relocation of houses located in hazard vulnerable areas. However, after Census 2011 no survey was conducted to assess the condition of slums in the city and the number of notified slums remained the same.

Comprehensive City Level Slum Survey

A comprehensive survey covering all the slum settlements in Vijayawada shall be undertaken. Various aspects to ascertain include but not limited to demography, socio-economic condition (including record of availing government welfare schemes), housing condition, land tenure and ownership, access to physical and social infrastructure. The upcoming Census survey, master plan of the city, which is due for revision, provides an opportunity to undertake this survey.

De-notification of Slums

Through such surveys, VMC shall de-notify the slums in accordance with the provisions of applicable legislation. Even after de-notification, these slums shall be supported with required incentives and services for a stipulated time as decided by VMC.

Establishment of Slum Rehabilitation Coalition (SRC)

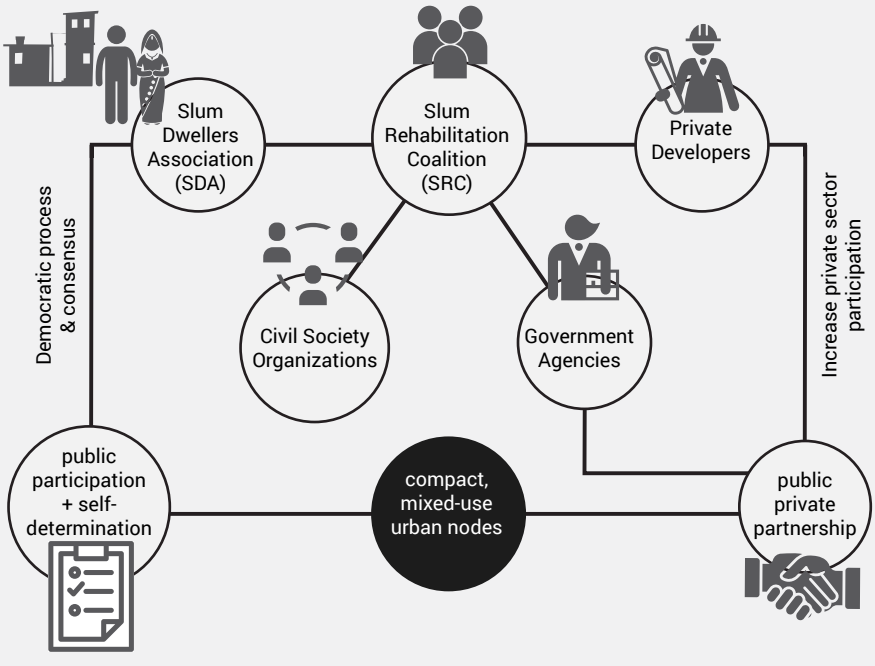
To upgrade the settlements, which still exhibit the characteristics of slums with required facilities, this intervention proposes the establishment of Slum Rehabilitation Coalition (SRC). Slum rehabilitation/ upgradation requires active participation from multiple stakeholders including the local communities, relevant government departments, NGOs, private developers (in case of PPP for provision of capital for services, housing development, etc.). This collaborative participation is envisaged via the formation of an SRC, as shown in Figure 3.13.

Features of the SRC

The creation of a SRC is recommended to catalyse inclusive, collaborative and integrated slum rehabilitation in Vijayawada. The components of the SRC are listed below:

- The SRC is envisioned as a diverse and representative body, bringing government, slum dwellers, NGOs, and the private housing sector together to streamline and expedite affordable housing development, community-driven housing, and infrastructure improvements in slum settlements. SRC shall include representatives of the affected slum communities, elected representatives, and subject experts from housing, town planning, real estate, and financing industries.
- Collaborations between the government and the private sector may include financial institutions, banks, lending institutions and real estate developers,

FIGURE 3.13 Slum rehabilitation coalition composition



Slum Dwellers Association (SDA)	Civil Society Organizations	Government and Affiliated Agencies	Private Developers
• Representatives of all informal settlements in the city • Occupational associations	• Residents Welfare Associations (RWA) • Self Help Groups (SHG) • NGOs	• VMC, MEPMA, AP CRDA • Women Development and Child Welfare Department, Directorate of Social Welfare • AP Housing Corporation, AP TIDCO	• Financial Institutions • Private Developers

Source: UN-Habitat

to create innovative public-private partnerships, financing models, and operating procedures, for self-sustaining, infrastructure creation, affordable housing developments in the city.

- To ensure self-determined priorities and needs, of and by the community, slum dwellers of each settlement should be represented by an individual Slum Dwellers Association (SDA), the features of which are listed below.

    a. The SDA must feature one female and one male member from each household, if available.

    b. Decisions made by the SDA represent the entire slum settlement community and must be passed by a simple majority vote for consensus.

    c. The SDA body should be represented in the SRC by community-selected leaders, of whom 50 per cent should be female, 10 per cent gender minorities and PwDs.

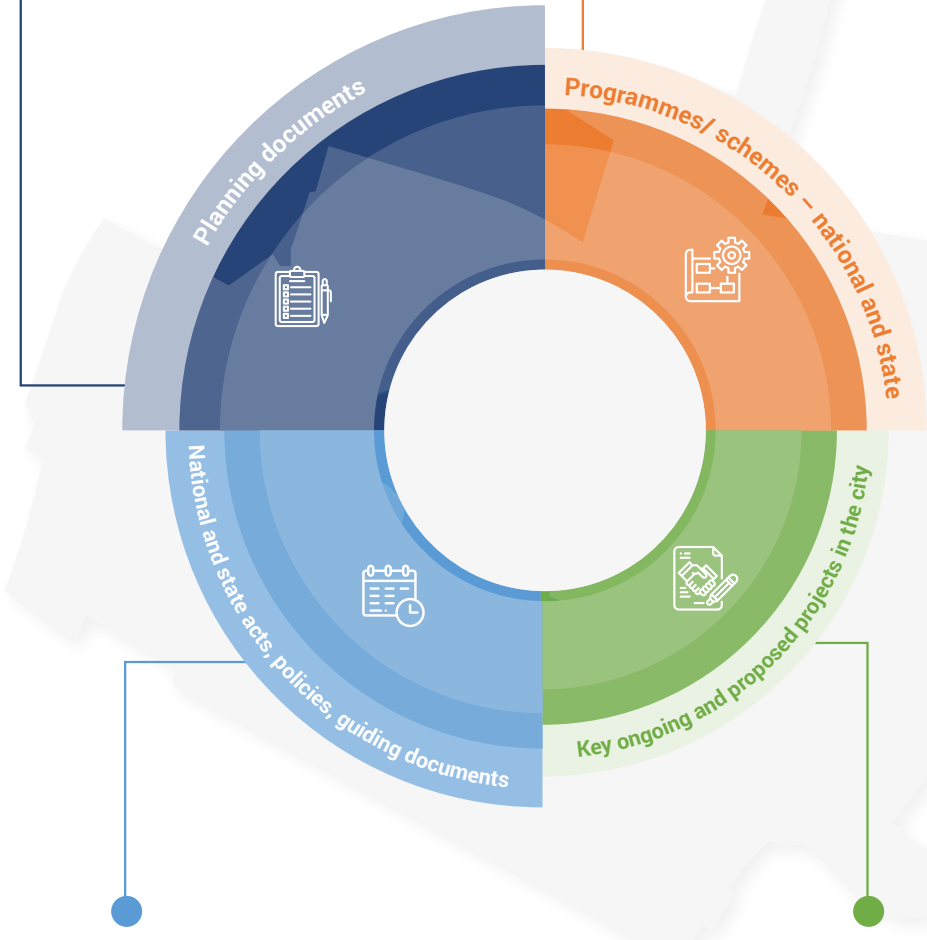
    d. The Urban Poverty Alleviation (UPA) Cell, VMC with the Women Development and Child Welfare (WD&CW) Department and the Directorate of Social Welfare (DSW) should guide and facilitate the SDA for efficient participation in the SRC.

- The UPA cell shall leverage the strengths of NGOs and educational institutions for community capacity building, knowledge-sharing, public awareness and sensitization to local ecological threats and land issues.
- Skill building programmes for SDA regarding law and policies may also be facilitated by the CSO guided by UPA, WD&CW and DSW.
- The SDA, CSO meeting venue and time may be scheduled considering convenience of female members. In case of travel requirements reimbursement should be provided for female, gender minorities and PwDs.
- The SRC builds a greater sense of ownership over community-driven projects through frequent participation and representation during the planning process and may enable opportunities for community-led maintenance. Community members can become valuable contributors to finding localized solutions to inherent roadblocks and challenges. This process may also facilitate new community leaders, advocates, and increase participation by women and other marginalized groups within the communities.

3.6.2. Alignment with national, state policies, programmes and ongoing, proposed capital projects in the city

- Zonal Development Plan 2021
- Vijayawada City Disaster Management Plan
- Hazard Risk and Vulnerability Analysis (HRVA) City of Vijayawada (2014)

- Pradhan Mantri Awas Yojana – Urban
- Swachh Bharat Mission (Urban) 2.0
- AMRUT 2.0 / Jal Jeevan Mission
- Navaratnalu – Pedalandariki Illu (Housing for All Poor)
- Jagananna Pachathoranam



- National Urban Policy Framework, 2018
- River Centric Urban Planning Guidelines, 2021
- Urban Flooding – Standard Operation Procedure, 2017
- Rajiv Awas Yojana Guidelines
- Andhra Pradesh Capital Region Development Authority Act, 2014
- AP Slum (Identification, Redevelopment, Rehabilitation and Prevention) Act, 2010
- AP Building Rules, 2017

- Vijayawada Master Plan/ ZDP (currently under revision)
- Navaratnalu – Pedalandariki Illu
- NH-16 Western By-pass
- Construction of retaining wall along the banks of River Krishna

3.6.3. Gender and inclusion

This strategic response provides opportunity for equitable amenities for all and resilience on multi-hazards. This could significantly benefit women, children, PwDs and the elderly who are more prone to impact from natural disasters.

It is also recommended that gender, age, income, ability disaggregated data (religion also where relevant) be collected for housing development and to develop inclusive disaster mitigation, climate resilience policies to address multi-hazard vulnerability. Gender inclusive urban development guidelines may be followed for resettlement and rehabilitation of vulnerable slums. A gradual relocation approach is recommended.

The relocation process and programme should assess the use of existing housing, street network and public spaces and how women, girls and gender minorities use them. Based on impact, if required a mobility subsidy to compensate for the increase in transportation cost is recommended. In new group housing project creation of affordable rental housing for single women, gender minorities or those with a single income should be considered. The social infrastructure requirements of women, girls, gender minorities in the city should be included. The facilities may include shelters for survivors of domestic violence, shelters for homeless, counselling centres, working women's hostels.

The mixed-use mixed income housing envisioned as part of urban retrofitting provides opportunity for equitable amenities for all. In-situ infrastructure improvement can address the deprivation faced by vulnerable communities. This intervention could significantly benefit the time poverty faced by women and children by resolving additional time spent on travel to safe access to basic services, water supply, sanitation, etc.

The participatory approach of SRC, with a capacity building cell constituting civil society organizations and educational institutions to guide SDA could guide community sensitive relocation. The involvement of women, PwDs and gender minorities should be ensured in the structure of SRC representation and at planning, private developers, SDA, CSO, government and affiliated agencies. Women Development and Child Welfare Department and the Directorate of Social Welfare may be involved as a guiding agency for SRC.

3.6.4. Climate convergence

Intervention 4.1 proposes the resettlement and rehabilitation of highly vulnerable slums through construction of new housing units/ complexes to accommodate slum dwellers currently residing in high hazard vulnerable areas. Construction of new housing units will contribute to emit GHG emissions. Also, as these housing units/ complexes are proposed to be constructed in the northern part of the city, the average trip length of the respective population may also increase. Each new affordable housing unit constructed for EWS (30 sq. m.) under affordable housing schemes may emit up to 4.1 tCO_2-e per annum, and development of each LIG unit (60 sq. m.) may emit 5.48 tCO_2-e per annum. Adoption and incorporation of green construction technology, locally sourced construction materials and environmentally sensitive design and construction methods could reduce the impact of GHG emissions from housing development and related activities. Usage of public transportation by these population would also contribute to reducing the quantum of GHG emissions

Retrofitting of weak housing units (Intervention 4.3) using recycled/ upcycled construction materials could also emit the least amount of GHGs. Carbon footprints could be reduced in the long run through improvements such as energy-efficient building insulation, ventilation and building operations.

The proposed activity of restoration the banks of River Krishna may emit about 76,300 kg CO_2-e during construction (considering a length of ~7,000 m. for restoration).[40] Conserving the river floodplains and reclaimed slum area (highly hazard prone area) by developing NbS (Intervention 4.2) would significantly contribute to sequestration of GHG emissions (see Table 3.14).

3.6.5. Estimated project costs

The project costs for implementing a few proposed projects (see Table 3.15) in Strategic Response 4: Reducing Vulnerability in Informal Settlements and Building Resilience to Environment and Natural Disasters is INR 2,403.26 lakh.

40 GHG emissions of restoring a river habitat is averaged at 10.9 kg CO_2-e per metre. Source: Chiu, Y., Yang, Y. & Morse, C. (2022). "Quantifying carbon footprint for ecological river restoration." Environ Dev Sustain 24, 952–970; https://link.springer.com/article/10.1007/s10668-021-01477-y#citeas (accessed on 26 April 2022).

TABLE 3.14 Potential GHG emission sequestration estimates for key actions proposed in Strategic Response 4

Intervention	Project	Potential GHG emissions sequestration (tCO_2-e per annum)	Remarks
Intervention 4.2: Conservation of reclaimed land in highly hazard prone areas through NbS	Restore flood plains of River Krishna through development of NbS	347	Allocation of area under flood plains (~103.43 Ha) for activities such as conservation buffer, landscaping; development of organized parks, greenery; construction activities for waterfront development (ghats, footways, other activities, facilities within parks, part of riverfront development)
	Conserve hills through hill slope renaturation	520	Allocation of area for activities such agriculture; development of organized parks, greenery; provision of public utility infrastructure such as electricity, telecommunication infrastructure and keeping the existing infrastructure, such as roads steps, water supply lines, to support proposed activities.

Source: Various sources have been used in the calculation of emissions savings potentials. Please see Annex 13 for Climate Savings Calculation Methodology for the calculation breakdown and assumptions made.

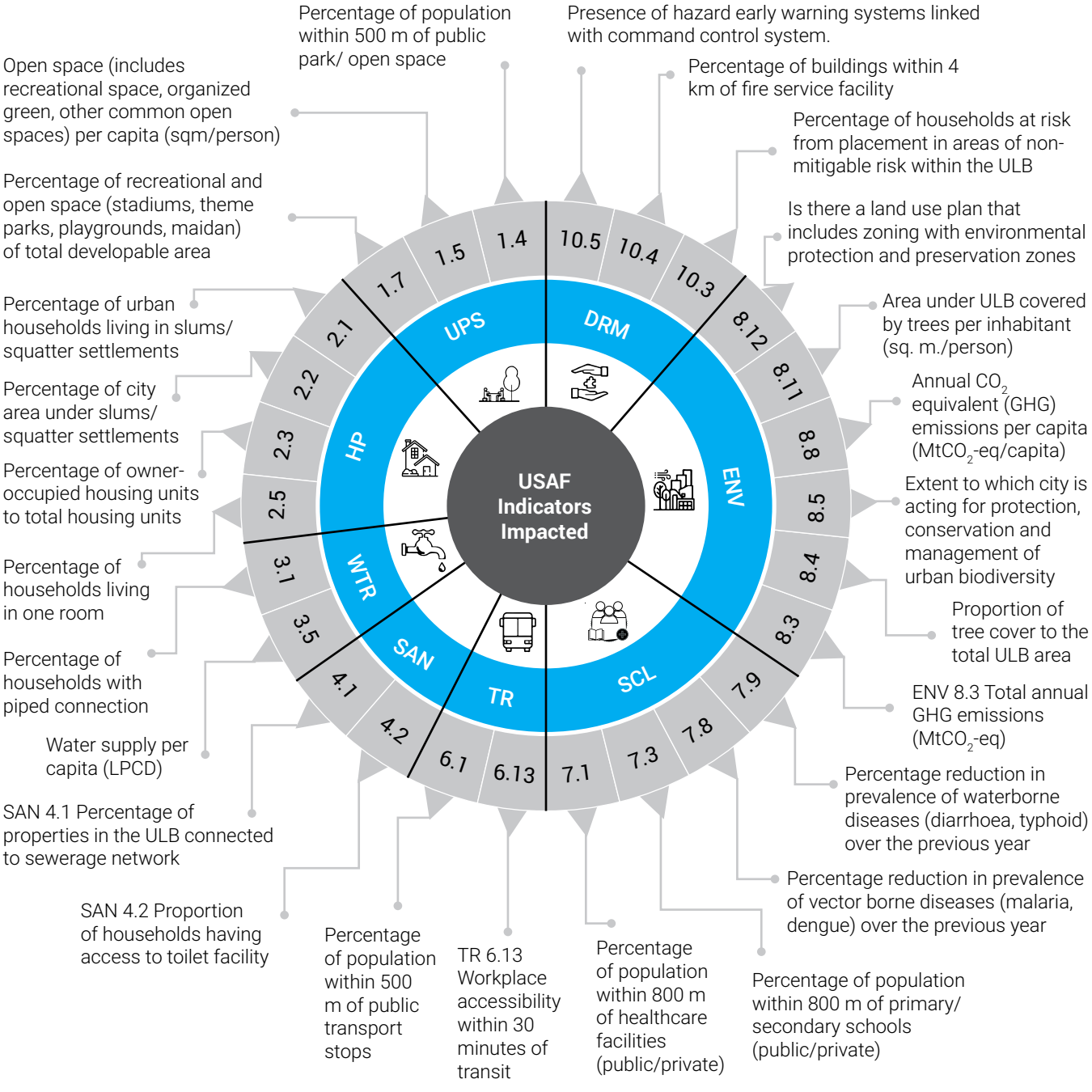
TABLE 3.15 Estimated project costs for a few key actions proposed in Strategic Response 4

Intervention	Project	Estimated Project Cost (INR lakh)	Remarks
Intervention 4.2: Conservation of reclaimed land in highly hazard prone areas through NbS	Restore flood plains of River Krishna through development of NbS (103 Ha)	2,275	Key actions include reshaping riverbank to prevent erosion and support natural vegetation – bank stabilization and revegetation measures, vegetation (native plants - trees, shrubs, and grasses that can survive frequent or prolonged floods).
	Conserve hills through hill slope renaturation (66 Ha)[41]	79	Construction of terraces, preparation of plants in the nursery, transplantation and manual harvesting.
Intervention 4.4: Augmentation of FFEWS in the city	Installation of FFEWS in the city	48.6	Installation of automatic inundation censors in flood vulnerable slums (27 slums @ 3 sensors per slum)

Source: Various sources have been used in the calculation of project costs. Please see Annex 12 for cost estimates breakdown and assumptions made.

41 50 per cent of area under hill conservation zone is proposed for terracing.

3.6.6. USAF indicators impacted



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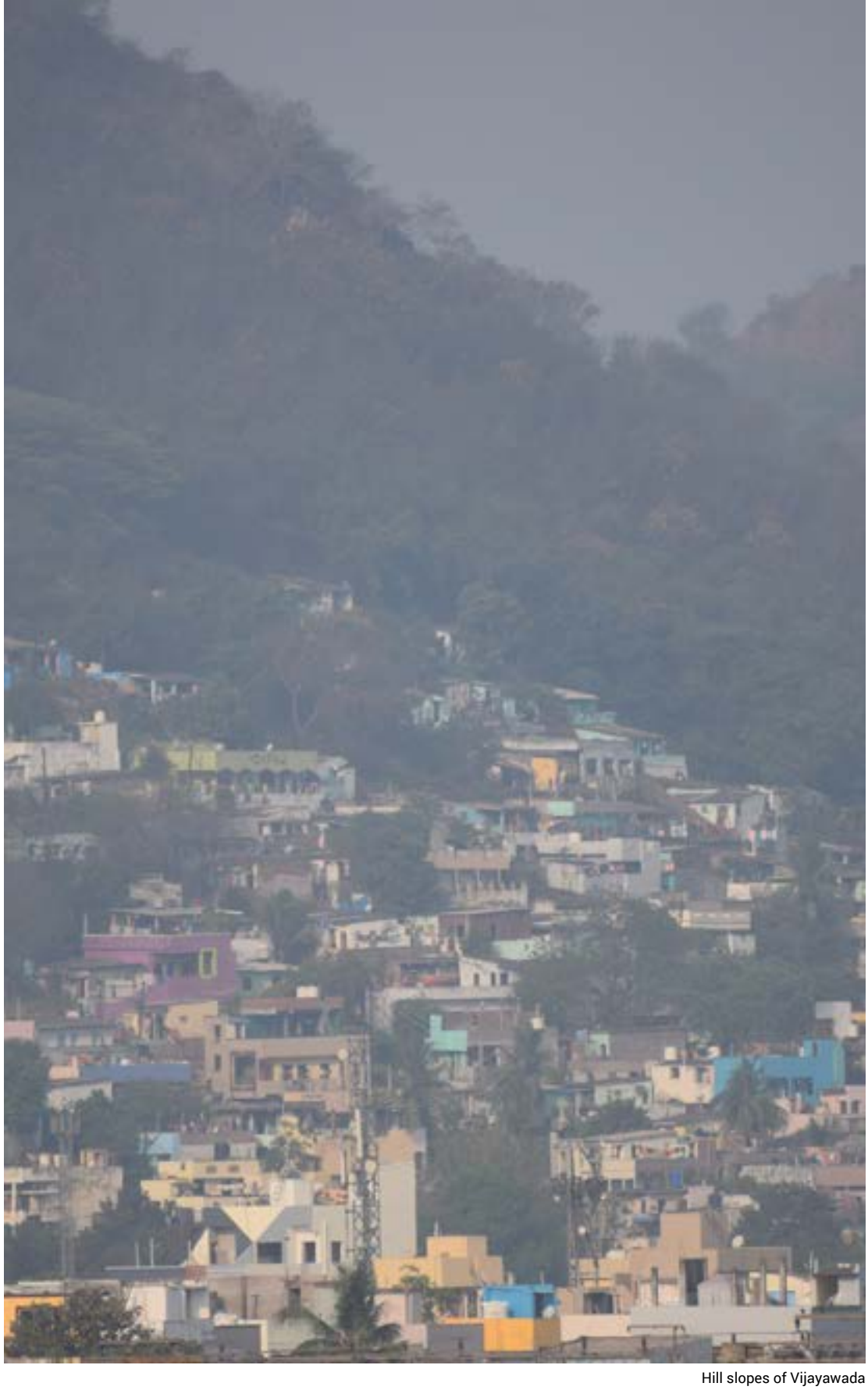


Hill slopes of Vijayawada

TRANSFORMATIVE PROJECT (ABD)

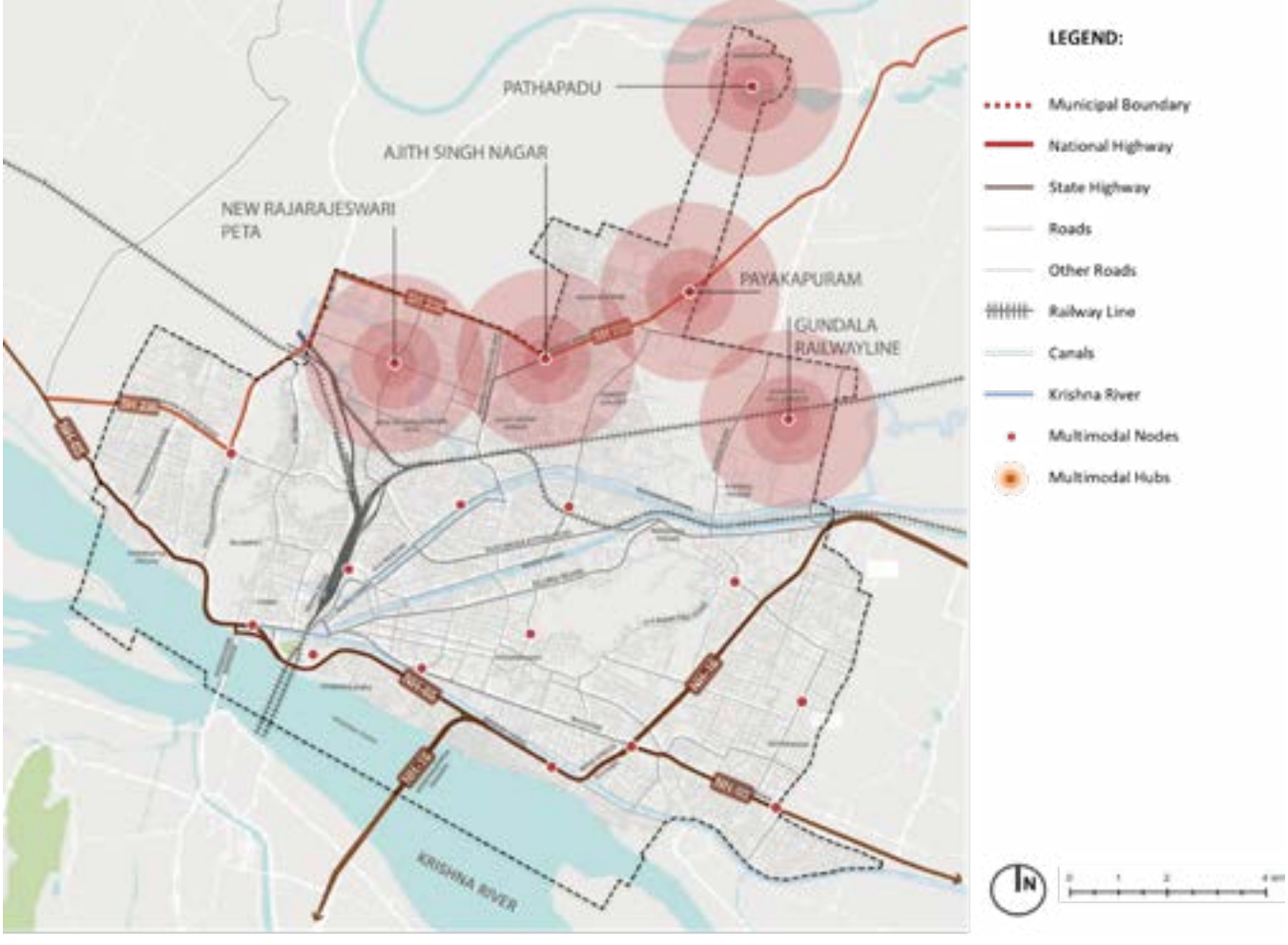
4.1 Scope of Area-Based Project

The Area-Based Development (ABD) project aims to showcase the practical application of some of the proposed strategic interventions, and the **proposed Urban Growth Node area in northern Vijayawada, i.e., New Raja Rajeswari Peta,** have been selected for the same. It is among the areas experiencing waterlogging and flooding, particularly during the retreating monsoons and has a concentration of various challenges identified in the four strategic issues (see Section 2.3: Key Issues Diagnosed).

Recommendations on strategic densification at the growth node – New Rajarajeswari Peta – aim to showcase key design principles at the neighbourhood scale for block, public space, intersection, and street redesign. These will provide more detailed guidance in transforming the area of the urban growth node into a compact and integrated neighbourhood with a safer street network and a well-defined system of inclusive and accessible public spaces.

The current availability of vacant parcels provides opportunities to illustrate the design of new mixed-use blocks for optimized development. The Restoration of the Ecological Assets recommendations will tackle the low-lying areas and create more organized open spaces and parks along the canal front. Introducing public transport routes and pedestrian infrastructure in response to low service coverage will be supported by street design focused on safety and accessibility to all street users.

As an extension of the strategic recommendations, the area-based project will apply the UN-Habitat principles for sustainable neighbourhood planning[42], applicable to the Vijayawada context.



Map 4.1: Delineation of area for demonstrating growth node for Sustainable City Strategies

Source: UN-Habitat

42 UN-Habitat. (2014). A New Strategy of Sustainable Neighbourhood Planning: five principles; https://unhabitat.org/sites/default/files/documents/2019-05/five_principles_of_sustainable_neighborhood_planning.pdf.

4.2 Strategic Interventions Proposed in ABD

The proposed strategic interventions in the ABD are applicable across different scales – neighbourhood, street, and public spaces – the details of the design interventions are discussed in this section. Table 4.1 is a summary of design interventions and strategic recommendations that address identified challenges.

TABLE 4.1 Summary of design interventions and strategic recommendations

Strategic Issue	Proposed interventions	Design intervention
Sub-optimal urban mobility and access to public transportation	1.1 Complete streets 1.2 Well-designed transit system 1.3 Multimodal hub	Complete Streets & Multimodal Hub
Inadequate public green spaces and fragmented blue–green network	2.2 Potential sponges 2.3 Parks & open spaces 2.4 Trails & bridges	Budameru Canal as a public space
Sprawling and scattered development patterns	3.2: Promoting development in northern Vijayawada 3.3: Regulating development in ecologically sensitive areas	Optimized densification through compact integrated neighbourhoods

Source: UN-Habitat

4.2.1. Transformative Project – 1: Complete streets & multimodal hub

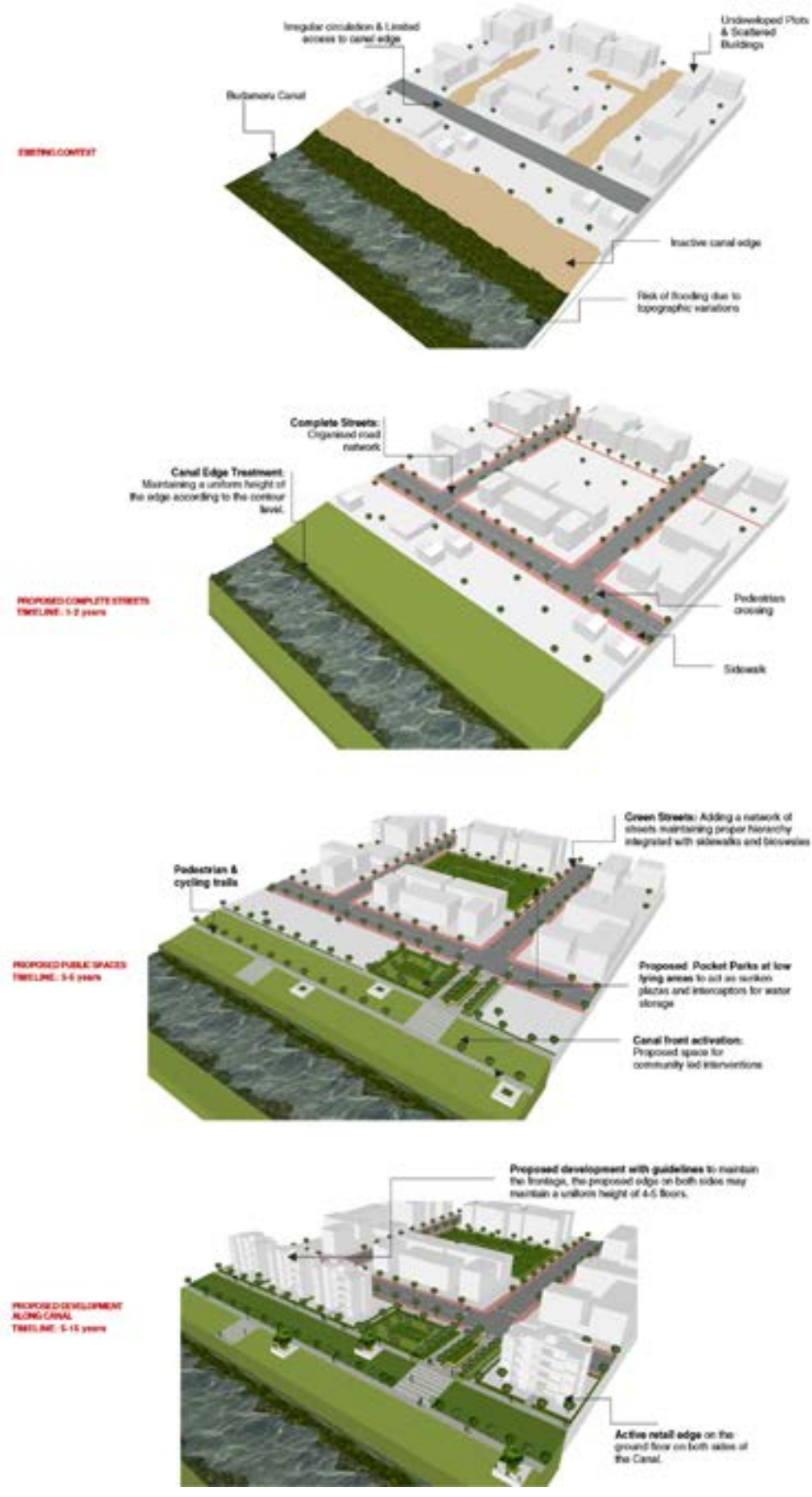
Vijayawada's Complete Streets strategy proposes a set of interventions for creating an interconnected street and blocks system in the ABD area that ensures safe, accessible, and healthy travel for all users, including pedestrians, cyclists, and vehicles. As shown in Image 4 1, the proposed road network of the northern node builds on the existing road network as well as adds new connections to complete a grid of 250m by 250m, as suggested by ITDP TOD Standard.[43]

The new and existing streets are proposed to be designed with the intent to prioritize walking and public transit without disrupting or demolishing the existing structural elements. The roads will cater to lower speeds, safer pedestrian crossings, mid-block crossings with appropriate traffic calming and streetscape measures. The proposed urban design recommendations for the street network and the multimodal hub include:

- **Define the edge of Budameru Canal:** Bio-engineer the water's edge to recreate the edge habitat and control runoff. In addition, an environmentally sensitive zone along Budameru Canal is defined and spatially articulated to promote context-specific vegetation, aligning with the 'Sponge City' concept. These eco-sensitive sites can be preserved by developing active community engagement spaces, demonstrating innovations, piloting nature-based solutions, and promoting community participation in safeguarding natural assets.
- **Comfortable and inclusive environment for all street users:** Optimize the utilization of Right of Way space for vehicles to incorporate other users' needs on the streets. The streets need to cater to the growing demand for vehicular traffic but without compromising the needs of public transit, bicyclists and pedestrians. The street design should ensure that streets provide an inclusive environment for all social groups of ages and abilities. That implies considering technical aspects to make the roads more inclusive (tactile walking indicators, ramps and curb cuts,

43 TOD Standard. (2017). 3rd ed. New York: ITDP. Accessible at: https://itdpdotorg.wpengine.com/wp-content/uploads/2017/06/TOD_printable.pdf.

FIGURE 4.1 Proposals overview for ABD



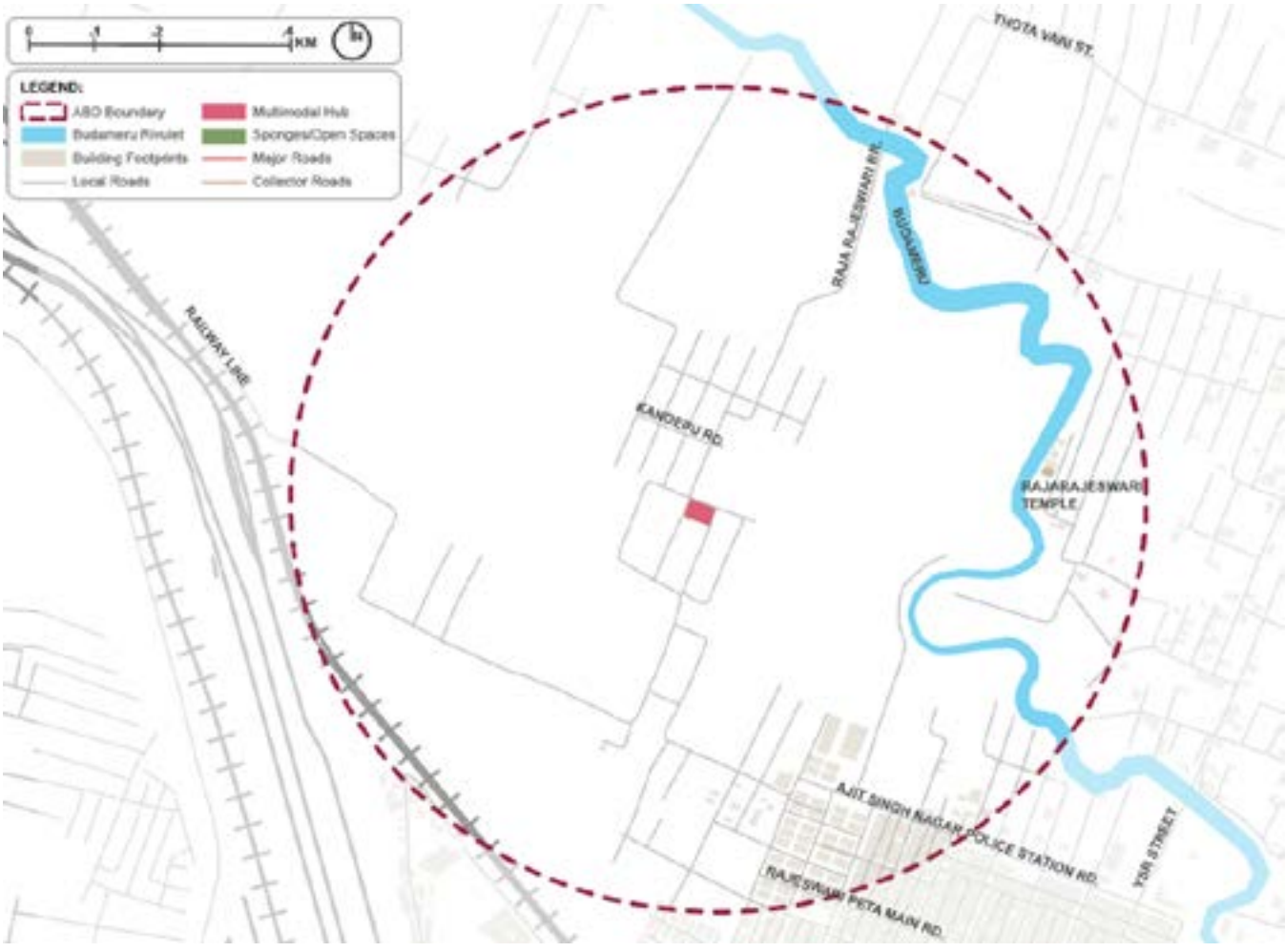
Source: UN-Habitat

accessible pedestrian signals, etc.) and functional aspects (more vegetation to reduce noise and urban heat island, more child-friendly spaces close to social facilities, etc.). Public toilets (male, female and universally accessible gender-neutral toilets), nursing rooms, drinking water amenities should be provided assessing existing requirements.

- **Achieving transit-friendly & multi-use public spaces with multimodal hub:** Expand the existing APSRTC services and provide additional feeder network options within the ABD area. The transit service in the ABD area is supported by improved transit stops for riders, including shaded structures, site furniture, parking facilities, open plaza spaces etc. A tentative location for the Multimodal Hub has been identified in Map 4.3. Near the Hub, connecting streets where the land is available, green buffer zones and public plazas should be introduced. These plazas should emphasize street edges by using elements such as paving material, landscaping, trees, lights, public art, directional signage, and pedestrian signage.
- Re-imagining streets as **necessary carbon sequesters** through increased green cover and nature-based solutions. The planned streets in the ABD area are retrofitted with "green infrastructure" such as bio-swales, recharge pits, and detention ponds to improve the quality of runoff and reduce the rate of runoff through possible water conservation measures.

IMAGE 4.1 The highlighted existing roads followed for creating the grid pattern in the ABD area

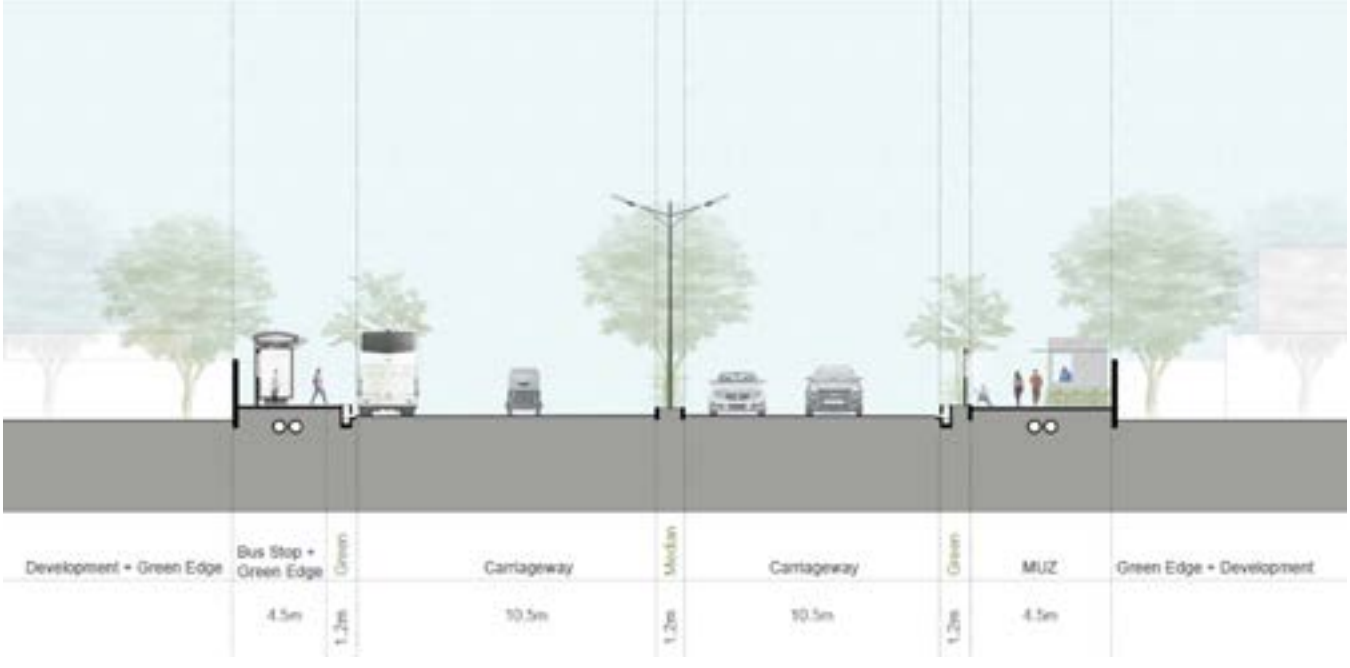
Source: UN-Habitat



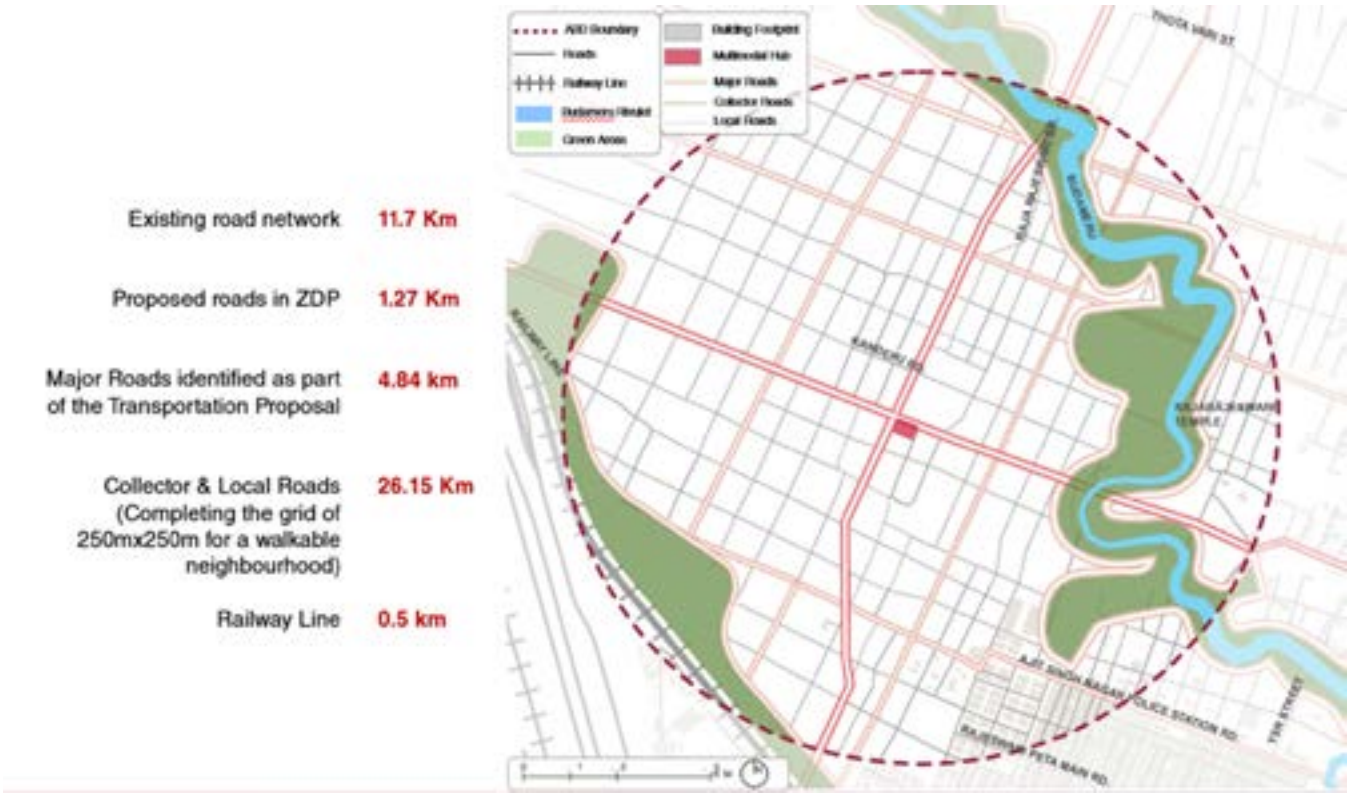
Map 4.2: Existing street network in the ABD area

Source: UN-Habitat

FIGURE 4.2 Typical section of a Complete Street proposed in ABD area



Source: UN-Habitat



Map 4.3: Proposed street network and indicative location of multimodal hub

Source: UN-Habitat

4.2.2. Transformative Project – II: Budameru Canal as a public place

The ABD area has been experiencing a series of flooding incidents due to flash rains, which have caused considerable loss to public and private properties and curtailed the development opportunities in northern Vijayawada. The potential reasons include silting of drains, illegal dumping of debris, inactive canal edge, developments and encroachments.

The proposed interventions incorporate resiliency-based planning concepts and promote an integrated 'blue' network into the urban environment. The project suggests enhancing and improving pedestrian linkages to the canal front through the system of paths/trails and adding access points with a range of canal front amenities, including restaurants, open craft/vendor's kiosks, dock structures etc. Apart from mandatory technical recommendations (such as removal of invasive weeds and cleaning from garbage), the key steps to enhance the experience around the canal front include:

- **Parks & open spaces:** The lands bordering Budameru Canal appear as one large, continuous green mosaic from the top. However, on the ground, they dissolve into a series of discrete and disjointed areas due to limited connectivity, and undulating topography, making them impossible to navigate. The area-based project proposes a network of public spaces of various sizes and characters. Most open green spaces along the canal front are designed as active urban plazas, shaded multimodal streetscapes and pedestrian amenities.
- **Activating canal edge through public amenities:** Further, to improve access to and between Canal front destinations, the ABD proposes a green urban corridor paralleling the canal on each side. A system of signages informing pedestrians and motorists of nearby waterfront access points and destinations, landscaping, façade improvements, furniture and lighting will be added along the canal to enhance user experience. Male, female and universally accessible gender-neutral toilets, nursing rooms, drinking water be provided assessing existing requirements.

FIGURE 4.3 Reference for activating canal edge through public amenities

Source: The Sponge Handbook, Chennai[44]

Map 4.4: Proposed sponges in the ABD area

Source: UN-Habitat

44 Biswas, S.K. Raj, P., RSL, Balaganesan, B., & KP, S. (2019). 'The Sponge Handbook, Chennai', GIZ.

4.2.3. Transformative Project – III: Optimized densification through compact and integrated neighbourhoods

The process of optimized densification of the area-based project is aligned with the UN-Habitat's principles for sustainable neighbourhood planning, supporting three key features- compact, integrated, and connected.[45] As development trends in Vijayawada steadily move North, the revitalization of the Budameru Canal front represents an opportunity to improve the quality of life in neighbourhoods on both sides of the canal. By creating a canal front, this transformative project seeks to revitalize surrounding communities, provide enhanced park areas, and restore public lands for the benefit of the city. The potential neighbourhood design envisages the following components that are aligned to the principles for sustainable planning:

1. **Building on the existing potential:** The project leverages the existing infrastructure (road network, canal edge) and builds a more integrated environment through environmentally sensitive development and connectivity strategies. To ensure that new development fits in with and protects adjacent neighbourhoods, higher densities are focused around the proposed transit corridors (including multimodal hub) and canal front and gradually moving to lower densities closer to existing residential communities. The growth planned as part of the project area will guide development, public realm improvements, transportation network, and promote job opportunities. The strategic densification along major arteries ensures an adequate increase in density with a target of at least 150 PPH.
2. **Human-scale development:** Medium/ high densities ranging between 150–200 PPH is planned for the ABD area. The compact built environment will be composed of human-scale housing blocks (3–5 storeys), which allow sufficient space between the units to be reserved for public space and parking. Map 4.5 identifies the areas proposed with medium to high population densities.
3. **Variety of housing typologies:** While promoting new mixed-use development, it is essential to provide a variety of plot sizes and housing types to cater to the diverse housing needs of the community. A mix of apartment types, sizes and tenures provides a wider variety of housing options for a more diverse range of households. These may include compact studios, one-bedroom apartments for younger/ smaller families, two- or three-bedroom apartments for larger families, affordable rental housing for multiple tenants, etc. The development of housing typologies should consider local ways of living and include comfortable spaces for women and youth, child-friendly spaces, active block frontages ensuring passive surveillance for better street safety etc.
4. **Green public space:** A variety of public spaces should be considered to ensure a vibrant environment in the neighbourhood. Public spaces should be adapted to the needs of all community members according to the universal design standards, prioritizing women and girls, older persons, and those with disabilities. The project proposes lively pedestrian-priority streets, marketplaces and areas with kiosks, child-friendly spaces and community gardens. In addition, the project supports the concept of 'Sponge City' by providing more permeable open spaces that can act as rain gardens and bioswales.
5. **Vertical zoning:** To ensure greater resilience to flash floods in this area, vertical zoning is applied to buildings:
    - Lower block levels with higher plinth levels to support economic activities, particularly along the major roads and canal front.
    - 'Green' roofs increase vegetation cover, reduce the heat island, and include community spaces for growing food and potential rainwater collection systems.

The snapshots of design recommendations provide practical guidance for targeted actions ensuring both short-term and long-term impact. For instance, while the infill development drives the process of densification, meeting the needs for compact development, the street redesign will act as a "quick-win" that immediately impacts the communities with better public space and safer streets. In addition, the targeted actions in line with a broader vision to allow for more focused financing in a coordinated manner.

45 Please note, the five principles are currently being updated by UN-Habitat. Existing publications outlining these principles can be found online at: https://unhabitat.org/five-principles-of-neighbourhood-design.

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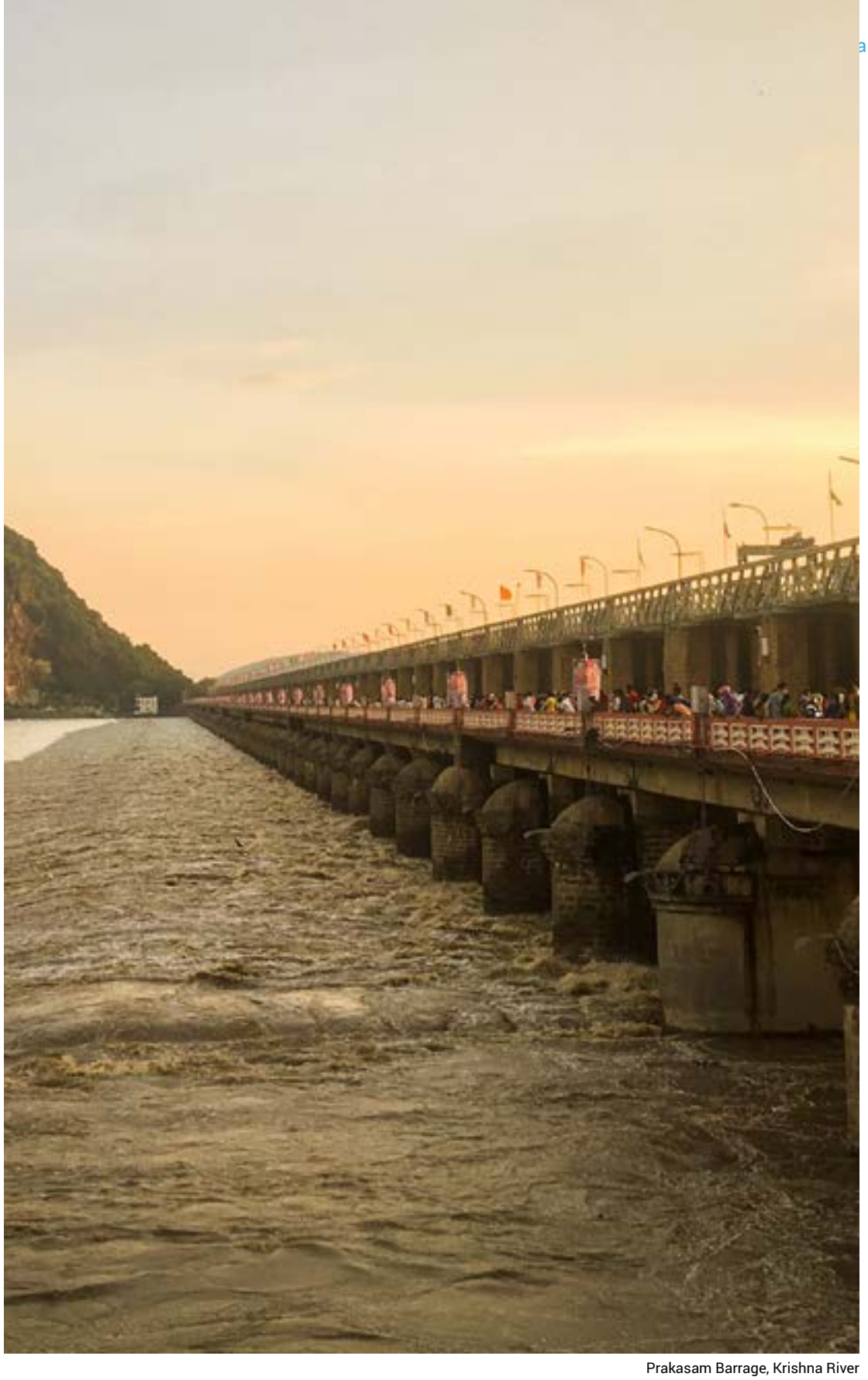
Moderate- to high-density with mix of uses
commercial, employment, public - semi public, and residential uses

Moderate- to low-density predominantly
residential uses supported by some mix of local retail and public / semi-public

Map 4.5: Proposed strategic densification of the ABD area

Source: UN-Habitat



Prakasam Barrage, Krishna River

ANNEXURES

4.1 Annex 1 – Proposed Framework for Developing Sustainable City Strategies

This document outlines the overall methodology for developing Sustainable City Strategies (SCS) with its foundation in the New Urban Agenda. The following five pillars (except Pillar 1, since it is beyond the scope of SCIAP) of the NUA shall be the guiding elements in formulating the SCS:

1. National Urban Policies (NUPs)
2. Rules and Regulations
3. Urban Planning and Design
4. Financing Urbanization
5. Local Implementation

STEP 1: Assess the relevant Rules, Regulations and Policies associated with the Sector

In order to build a complete picture of the planning legal instruments available, as a first step, list all the relevant plans, policies, rules and regulations that are applicable to the issue and it's predominant sector. It is also essential to map the interrelationships between various instruments and regulations to the issue and develop a schematic for better understanding.

Ascertain the gaps in the existing rules that have prevented progress towards the diagnostic issue. In addition, assess if any regulatory changes would be beneficial to the overarching strategy and/or if the strategy is complementing the regulations.

STEP 2: Identify GHG Impact of the Issue and the related sector

Ascertain if the diagnostic issue aligns positively or negatively with GHG emissions and if the climate consequences can be quantified. Identify what kind of factors pertaining to the diagnostic issue have a significant impact on climate mitigation and if any of the rules and regulations assessed in Step 1 can aid in developing the strategic response. Please use UNIDO's study for this step.

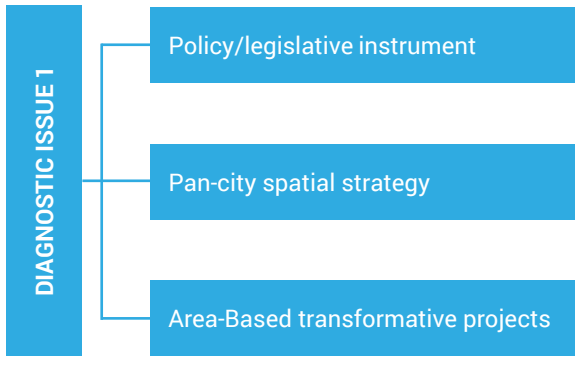
STEP 3: Identify an overarching umbrella strategy/concept that addresses the diagnostic issue in a holistic manner

Most diagnostic issues may be addressed by designing an overarching umbrella strategic response which can be detailed through a series of actions and interventions. For example, a lack of open spaces in a city can be addressed by a strategy that focusses on creating and strengthening an integrated blue-green network which positively impacts the quality of life of the city residents. In some instances, more than one umbrella strategy may be needed but it needs to be kept in mind that we are building a strategic action plan and only the most critical and impactful actions should be prioritized. In addition, emphasis should be laid on inter-sectoral strategy so that multiple sectors are integrated true to the principles of the project and urban development in general (see Figure 4.1).

The strategy can take the form of the following two types-

1) City -wide or pan-city application
2) Area based development where a few strategic responses may be clubbed together to enhance their impact on the city's urban fabric and its residents through transformative projects.

FIGURE 4.1 Types of Strategic Responses to Diagnostic Issues



Source: UN-Habitat

STEP 4: Ascertain Actions and Interventions required to implement the overall Strategy

The actions and interventions may be in any of the following formats/types:

i. City Wide Policy or an amendment to an existing policy
ii. City Wide Plan/Network or an amendment to the existing plan through a review process
iii. Development Guideline (Urban Design, Landscape, Street Design, etc)
iv. Byelaws
v. Detailed Project Report/feasibility Study for an already identified action/project
vi. Area-Based Development Plan or a Precinct Design (urban design scale)

For the area based transformative projects, through spatial analyses and consultation with the Tier 1 stakeholders, identify locations for which an urban design scheme can be developed to illustrate the key import of the overarching strategy.

A tabular collation of the actions and interventions as given below may be prepared and the UN-Habitat SCS may detail some of these as part of the strategic planning response to the diagnostic issue (Please see Table 4.1). **The work that has already been done by the team such as the Master Plan Reviews, Sanitation Byelaws, UNIDO Investment Projects and projects captured in the CIP need to be integrated into this list and find their place in the overall strategic plan.**

Similarly, projects from the sustainable city strategy will be integrated into the CIP to complete the loop.

The strategy should clearly articulate that the city managers (municipal commissioners) may use this list to monitor the progress and ensure that these are implemented over the course of five years. Corresponding performance should be mapped using the USAF and captured in the USIR.

TABLE 4.1 Sample Actions and Interventions List

Action	Duration (short, medium, long)	Next Steps	Responsibility	Source of Financing/Mission	USAF Indicator Impacted

Source: UN-Habitat

STEP 5: Ascertain existing investments in the city and their integration with the overall strategic response

All cities have ongoing national or state level investments through the missions or schemes. It is imperative to map those and integrate the investments into the strategic response for the diagnostic issue. In addition, through the identification of under-serviced sections of the city or areas that have multiple deprivations and a higher density of people, areas should be identified for future investments under these missions and schemes.

For example, through spatial diagnosis illustrated above, the strategic response can advise where the next park should be planned so it can be accessed by a greater number of city dwellers. Financial implications for some interventions may be resolved by attaching them with the national and state level schemes, etc.

4.2 Annex 2 – Relevant Programmes, Plans, Legislation at National, State and Local Level

A. National programmes

Programme	Description
Atal Mission for Rejuvenation and Urban Transformation (AMRUT)	AMRUT launched in 2015 is a national scheme being implemented in the 500 ULBs across India. The components of the AMRUT consist of capacity building, reform implementation, water supply, sewerage and septage management, storm water drainage, urban transport and development of green spaces and parks. Under AMRUT, Guntur is undertaking various projects including water supply works, provision of water supply house service connections, construction of parks, others.
AMRUT 2.0	AMRUT 2.0 launched on 2nd October 2021 is an extension (second phase) of AMRUT. The second phase aims at making the cities 'water secure' and providing functional water tap connections to all households. This is planned to be achieved through circular economy of water. Mission also targets to provide 100% sewage/ septage management in 500 AMRUT cities. One of the key components, proposed projects in the mission is Rejuvenation of water bodies (including urban wetland) and creation of green spaces.[1]
Jal Jeevan Mission (Urban)`	Announced in Union Budget 2021-22, the JJM(U) is applicable for 500 AMRUT ULBs. The mission has a reform agenda focused on financial sustainability and water security of ULBs. Under the mission, the ULBs are proposed to prepare detailed City Water Balance Plans and City Water Action Plan with the focus on improving sustainability and efficiency in water sector which includes Rejuvenation of water bodies and creation of green spaces as one of the components. Application of Sponge Cities concept to reduce floods and enhance amenity value through an Urban Aquifer Management plan is one of key areas of the Mission.[2]

1 PAtal Mission for Rejuvenation and Urban Transformation 2.0: Operational Guidelines October 2021

2 https://pib.gov.in/PressReleasePage.aspx?PRID=1694420 (accessed on 2 December 2021)

Programme	Description
Pradhan Mantri Awas Yojana - Urban	PMAY-U (2015 - 2022) is a flagship Mission of Government of India being implemented by Ministry of Housing and Urban Affairs (MoHUA). The Mission purpose is to address urban housing shortage among the EWS/LIG and MIG categories including the slum dwellers across all the ULBs in the country by ensuring a pucca house to all eligible urban households by the year 2022. The mission is being implemented through States Government, Union Territories (UTs) and Nodal Agencies.[3]
Swachh Bharat Mission Urban	SBM-U launched on 2nd October 2014 aims at making urban India free from open defecation and achieving 100% scientific management of municipal solid waste. The objectives of the mission included elimination of open defecation, eradication of manual scavenging, generating awareness and bringing about a behaviour change regarding sanitation practices, and augmentation of capacity at the local level. SBM-U is implemented by MoHUA in all through States/ UTs in all statutory towns in the country.[4]
Swachh Bharat Mission Urban 2.0	SBM-U 2.0 launched on 2nd October 2021 for a period of five years (till 2026) is an extension (second phase) of SBM-U. The mission aims to make all statutory towns in the country 'Garbage Free' in order to contribute to the achievement of the Sustainable Development Goals (SDG) 2030, which will ultimately improve the quality of life and ease of living of urban populations, thus leading to urban transformation. SBM -U 2.0 through the planned activities also aimed at contributing for Clean Air, Clean Water and Clean Land. The mission is aligned with various National Missions and National Priorities such as National Clean Air Program, Namami Gange, Digital India, National Urban Digital Mission, Smart Cities Mission, Start-up India, Make in India, others.[5]
Street for People Challenge	VMC is participating in the Streets for People Challenge - an initiative of the Smart Cities Mission, MoHUA, GoI. The objective of the initiative is to inspire cities to create walking-friendly streets through quick measures in response to COVID-19. Sivalayam street (along with main SN Puram Main Road) and Ajith Singh Nagar (VAMBAY Colony) sites for the design competition.

B. State Government programmes

Programme	Description
Jagananna Pachathoranam – Vana Mahotsavam	An extensive mass plantation drive programme launched in 2021 with an aim to increase area under tree cover and environmental protection. The programme Includes three components: 1) Avenue plantation; 2) Open space plantation and 3) Plantation in urban poor Housing colonies.
Navaratnalu -Pedalandariki Illu	A flagship scheme of Government of Andhra Pradesh intended to provide Housing sites for the house less urban poor families. The programme also includes providing Housing to all beneficiaries who have been granted house site pattas by the State Government. Providing Infrastructure facilities viz., Roads, Water supply and Electrification in layouts. In Guntur housing sites (44.4 Sq. yd each) were provided to about 21,440 urban poor families in three locations outside VMC limits (Nunna, Velagaleru, Vanukuru).
Clean Andhra Pradesh (CLAP)	Clean Andhra Pradesh (CLAP)- Jagananna Swachha Sankalpam programme to clean up urban and rural areas, improve sanitation conditions and waste management with public participation. Under CLAP, 225 CNG garbage collecting vehicles were allocated to VMC.

C. City level planning documents

Plan / Document	Description
Zonal Development Plan (ZDP) 2021	The ZDP for Vijayawada was approved in 2006 for the horizon year 2021. The ZDP consists of proposed land use plan for the horizon year 2021, land use zoning regulations and strategies / actions proposed for various urban development sectors. The revision of ZDP / Master Plan for Vijayawada is under preparation.
City Disaster Management Plan	Vijayawada Disaster Management plan was prepared in 2015. The plan detailed the hazard risks and vulnerabilities in the city. Roles & responsibility of VMC, various line departments during different stages of a disaster. The plan includes disaster specific Contingency Plans for various types of hazards. The plan also includes expert recommendations for Disaster Mitigation in Vijayawada. The plan can be accessed from this link. (Web link accessed on 28 April 2022)

3 https://pmaymis.gov.in/ (accessed on 2 December 2021)

4 Guidelines for Swachh Bharat Mission – Urban: Revised as on 5th October 2017

5 Swachh Bharat Mission - Urban 2.0: Operational Guidelines October 2021

Plan / Document	Description
Clean Air Action Plan (2018)	In 2019, Vijayawada was identified as one of the non-attainment cities[6] in India. To curb the increase in pollution levels, Andhra Pradesh Pollution Control Board has prepared Comprehensive Action Plan for Clean Air for Guntur city. The plan recommended various strategies in the areas of traffic and transportation, NMT, renewable energy, solid waste management, mining, urban greening and forests, others. The plan can be accessed from this link. (Web link accessed on 28 April 2022)
Hazard Risk and Vulnerability Analysis (HRVA) 2014	Vijayawada HRVA aims to reduce disaster risks in the city by enhancing institutional capacities of VMC and to integrate climate risk reduction measures in the development programmes as well as to undertake mitigation activities based on scientific analyses. HRVA report provides findings of hazard risk and vulnerability assessment of the key natural hazards the city is exposed to namely – cyclonic wind, flood, rock fall, heat wave, and epidemics. Quantitative modelling techniques based on GIS was used for the mapping and analysis using standard public domain models. Based on the results recommended action for various mitigation and adaptation was also provided.
Immediate Action Plan for Transport (Draft)	Vijayawada Immediate Action Plan (IAP) for Urban transport is prepared as part of Comprehensive Traffic and Transportation Study (CTTS) for Andhra Pradesh Capital Region. The study undertaken with the Japan International Cooperation Agency (JICA) is coordinated by APCRDA. Vijayawada IAP (Draft) had identified immediate /short-term projects that could be implemented by VMC, APSRTC and other government organizations with local transport responsibilities in the time period of two financial years. A few projects were proposed at specific locations in the city. The nature of proposed projects includes, road corridor improvements, pedestrian footway improvements, road safety improvements and traffic management measures, public transport improvements, junction improvements and provision of vehicular parking facilities.

D. National level policy / guiding documents

Policy / Guiding document	Description
National Urban Policy Framework (NURF) 2018	NUPF outlines an integrated and coherent approach towards the future of urban planning in India. The NUPF is structured along two lines. Firstly, at the NUPF's core lie ten sutras or philosophical principles. Secondly, the ten sutras are applied to ten functional areas of urban space and management. Within each functional area, the status quo and its challenges are analyzed, key priorities formulated, and specific possible actions points suggested.[7] Weblink for NUPF.
National Urban Housing & Habitat Policy (NUH&HP) 2007	NUH&HP focuses on provision of "Affordable Housing For All" with special emphasis on vulnerable sections of society. The policy promotes urban planning, appropriate fiscal concessions for housing, technical and cost-effective innovations in the area of housing and infrastructure. The policy emphasizes to promote various types of public-private partnerships for realizing the goal of affordable housing for all.[8] Weblink for NUH&HP.
National Urban Transport Policy (NUTP)	NUTP, launched in 2006, aims at providing better mobility and sustainability by focussing on people mobility and not vehicle mobility. The objective of this policy is to ensure safe, affordable, quick, comfortable, reliable and sustainable access for the growing number of city residents to jobs, education, recreation and such other needs within our cities. Weblink for NUTP.
Non-Motorized Transport Guidance Document, 2016	The document presents a compendium of strategies and recommendations for integrating accessibility with land use and infrastructure investment decisions in shaping NMT-friendly street designs. The guidance document provides overview about promoting NMT in Indian cities by analysing challenges encountered in attempting to invest in pedestrian and cycling infrastructure around the country. Weblink for NMT Guidance Document.

6 The Central Pollution Control Board (CPCB) has identified 122 towns and cities in India as non-attainment cities for not meeting the National Ambient Air Quality Standards (NAAQ) between 2014-2018.

7 https://smartnet.niua.org/nupf (accessed on 7 December 2021).

8 National Urban Housing and Habitat Policy 2007; MoHUA, GoI, https://www.nhb.org.in/Urban_Housing/HousingPolicy2007.pdf (accessed on 7 December 2021).

Policy / Guiding document	Description
Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines 2014	URDPFI Guidelines - 2014 provides integrated framework for urban and regional plan formulation and implementation. The guidelines provide comprehensive framework, direction for promoting balanced and orderly regional and urban planning and development. The guidelines also provide provisions of the legal and policy guidelines of the line Ministries, best practices of the States and the planning systems in vogue. The URDPFI Guidelines, 2014 comprise two Volumes. Weblink for Volume 1 and Volume II.
National Mission on Sustainable Habitat 2021-2030	The NMSH 2021-2030 document provide roadmap for States / UTs/ULBs to promote low-carbon urban growth and building resilience of cities to 'bounce back better' from climate related extreme events and disaster risks. Broad interventions to be undertaken at local level are listed under five thematic areas: Energy and Green Buildings; Urban Planning, Green Cover and Biodiversity; Mobility and Air Quality; Water Management; and Waste Management.

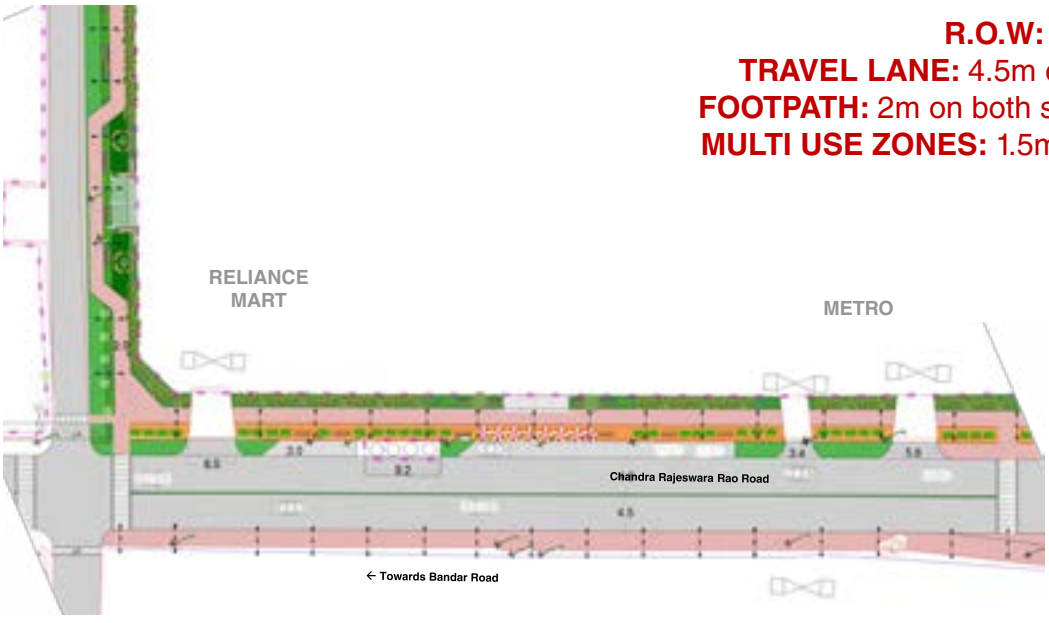
E. State level policy / guiding documents

Policy / Guiding document	Description
Andhra Pradesh Building Rules 2017	Comprehensive Building Rules and other related rules which are applicable to ULBs and areas within UDAs in the State. The Building Rules has distinct rules applicable to regulate the building activities in different categories of ULBs and areas within UDAs. Vijayawada Municipal Corporation being one of the major ULBs in the state has some special provisions specified. Weblink for Andhra Pradesh Building Rules 2017.
State Action Plan on Climate Change (SAPCC) for Andhra Pradesh (AP)	SAPCC for AP is prepared in line with National Action Plan on Climate Change (NAPCC) to address existing and future climate risks and vulnerabilities. 11 major sectors that includes urban development, transportation is identified seriously impacted by climate change have been identified for the State. The issues, concerns and specific interventions for these sectors have been discussed. Weblink for SAPCC for AP.
Andhra Pradesh Metropolitan Region and Urban Development Authorities (APMR&UD) Act, 2016	The Act provide legal framework for the establishment of the Metropolitan Region and Urban Development Authorities in the state for the purposes of planning (including the process of preparing /revising development plan (master plan / zonal development plan /area development plan / infrastructure plan, other plans), coordination, execution, supervision, financing, funding and for promoting and securing the planned and sustainable development of the development area and for related matters. Weblink for (APMR&UD) Act 2016.
Andhra Pradesh Capital Region Development Authority (APCRDA) Act, 2014	The Act provide legal framework for the declaration of the new capital area for the state of Andhra Pradesh and establishment of the Andhra Pradesh Capital Region Development Authority for the purposes of planning (including the process of preparing /revising development plan (master plan / zonal development plan /area development plan / infrastructure plan, other plans), coordination, execution, supervision, financing, funding and for promoting and securing the planned development of the capital region development area, undertaking the construction of the new capital region development area , and new capital for Andhra Pradesh and for managing and supervising urban services in the new capital area and for related matters. Guntur city is within APCRDA Jurisdiction. Weblink for APCRDA Act 2014.
Andhra Pradesh Slum (Identification, Redevelopment, Rehabilitation and Prevention) Act, 2010	The Act provide legal framework for comprehensive reconstruction of the existing slums in the state in terms of housing, infrastructure facilities by assisting property rights to the slum dwellers and envisage the prevention of formation of new slums. Weblink for AP Slum Act 2010.
Andhra Pradesh Street Vendors (Protection of Livelihood and Regulation of Street Vending) Rules, 2017	The rules were enacted to regulate street vendors in public areas and protect their rights. The states rules were prepared considering the Central Act, Street Vendors (Protection of Livelihood and Regulation of Street Vending) Act, 2014. Weblink for AP Street Vendors Rules 2017.

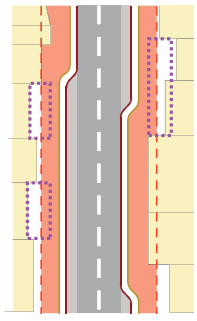
4.3 Annex 3 – A few relevant ongoing and planned projects in the city

Sector	Project	Implementing agency	Convergence	Status (as of December 2021)
Planning and development	Preparation of revised Zonal Development Plan / Master Plan for Vijayawada	APCRDA	NA	Ongoing
Planning and development	Revised Vijayawada Hazard Vulnerability and Risk Assessment	UNDP	NA	Ongoing
Urban Greenery	Eco-Park in Dump Site in Ajith Singh Nagar	VMC	NA	Ongoing
Urban Greenery	Development of Walking track, Pathways, Food Courts, Plazas, Children play equipment, Adventure theme zone and skating ring in 'Rajiv Gandhi Park' opposite to Pushkar Ghat.	VMC	NA	Ongoing
Urban Greenery	Development of greenery at CVR Flyover.	VMC	NA	Proposed
Urban Greenery	Development of greenery at Benz Circle flyover under	VMC	NA	Completed
Urban Greenery	Development of Sibar Disney Land water theme Amusement Park through PPP	VMC	NA	Proposed
Water body rejuvenation	Canal front development in Ryves canal.	VMC	NA	Ongoing
Water body rejuvenation	Protection and Restoration of water bodies (Pykapuram)	VMC	NA	Ongoing
Water body rejuvenation	Krishna - Riverfront development in Bhavanipuram.	VMC	NA	Ongoing
Housing	Construction of Houses to Houseless Urban Poor under Pedalandariki Illu	GoAP, VMC, State Housing Dept.	PMAY (U)	Ongoing
Transportation	Detailed Project Report preparation for 38 Km Road Corridor Improvement	VMC	NA	Design finalization in progress
Transportation	Development of walking track in Swaraj Maidan (PWD ground)	VMC	NA	Proposed
Others	Construction of Retaining wall along the banks of River Krishna	Irrigation Department, VMC	NA	Ongoing
Others	Development of Food Street at Red Circle	VMC	NA	Ongoing
Others	Development of Shopper's Street in Beasant Road	VMC	NA	Ongoing

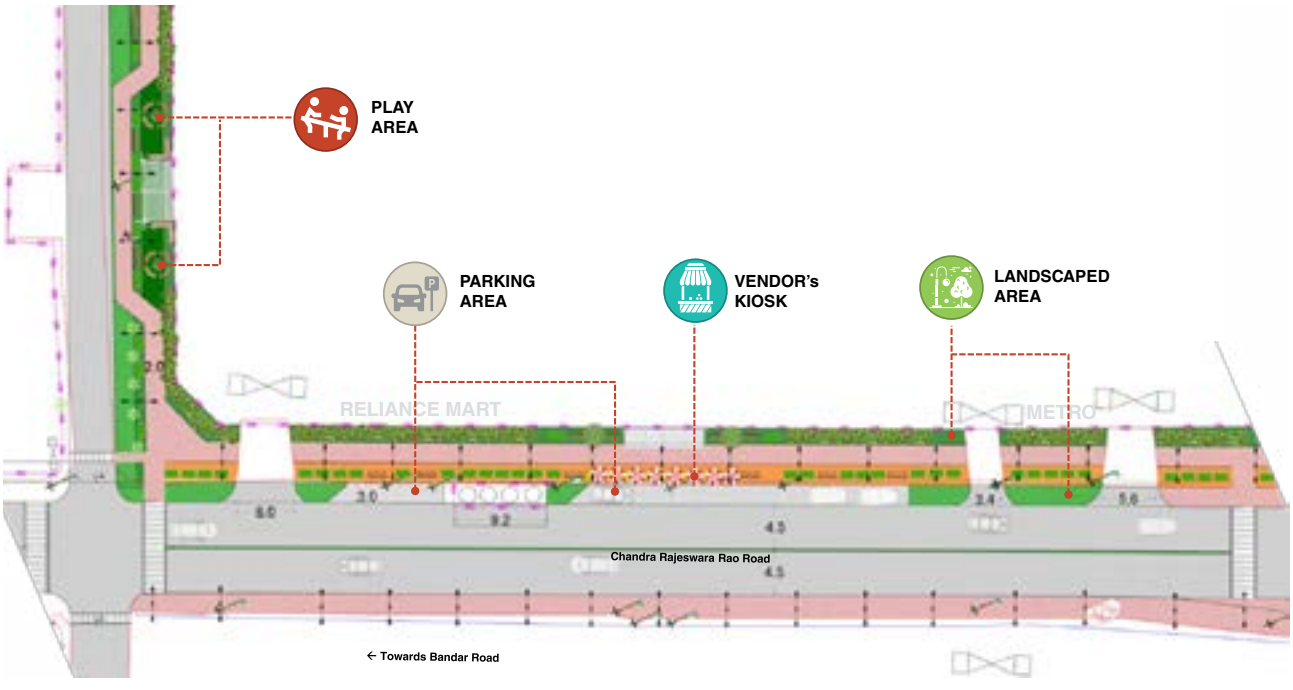
4.4 Annex 4 - Detailed design and process followed for CR Rao Road



R.O.W: 20m
TRAVEL LANE: 4.5m each
FOOTPATH: 2m on both sides
MULTI USE ZONES: 1.5m-2m



05 **STEP 04:** Identfiy and design placemaking opportunities in the additional or available space within the pedestrian realm



Source: UN-Habitat

4.5 Annex 5 - GESI guidelines to improve public transport and non-motorized transport

It is recommended that the mobility plan collect and report travel behaviour data, disaggregated by gender, age, income (and religion, where relevant). Specifically, the perception and experience of safety and sexual harassment on streets, access to and waiting for public transport (and paratransit), travel inside the vehicles must be measured. The mobility plan should adopt gender-inclusive indicators and benchmarks (see Table 4.2).

TABLE 4.2 Gender-inclusive mobility indicators

	Indicator	Measure
1	Developed area near transport (DNT)	Developed area within 500m of frequent bus-based public transport (6 schedules per hour) Informal settlements within 500m of frequent bus-based public transport (6 schedules per hour)
2	Median block perimeter	Median block perimeter (400-600m) bounded by publicly accessible roads on all sides
3	Mode shares, disaggregated by sex, age and income	Percent of walking, cycling, public transport (buses, train and metro-rail separately), intermediate public transport
4	Median non-motorized trip time, disaggregated by sex, age and income	Median walking and cycling trip time
5	Cost on transport per month	Individual monthly expenditure, disaggregated by sex and income; Household monthly expenditure on transport, disaggregated by income groups/ quintiles
6	Sexual harassment faced and perception of safety	Sexual harassment faced by women, girls, gender and sexual minorities on the streets, waiting for buses and IPT, boarding and alighting and traveling inside the vehicles Women, girls', gender and sexual minorities' perception of safety in public spaces, accessing and using public transport in the day and night

The comprehensive mobility plan should include the following amenities as outlined in Table 4.3. The involvement of more women and gender minorities in the transportation sector can create safer mobility systems and encourage more women to travel for work/leisure.

TABLE 4.3 Gender-inclusive amenities

	Amenities	Requirements
1	Nursing rooms	At least 1 nursing room in every bus terminal, ISBT, railway station and metro-rail station located in well-lit and easily accessible areas
2	Public toilets	Male, female and universally accessible gender-neutral toilets in every bus terminal, ISBT, railway station and metro-rail station, available for use free of cost; located in well-lit and easily accessible areas
3	Waiting rooms	At least 1 AC waiting room for women, trans persons and families with public toilets at inter-state bus terminals and inter-city railway stations.
4	Night shelters	Reserved accommodation for women, trans persons and boys of 15 years and below at inter-state bus terminals and inter-city railway stations at nominal cost, in line with NULM guidelines for night shelters Emergency accommodation for women with boys of 15 years and below, and families.
5	Pedestrian facilities	Universally accessible footpaths of at least 4m width in bus terminals, railway and metro stations, subject to a LOS approach

	Amenities	Requirements
6	Bus stops	All bus stops have well-lit, shaded and universally accessible bus shelters with real-time and static information, display help-line and emergency phone numbers (see Figure 4.1)
7	Drinking water	Purified water for drinking to be provided, free of charge, at every bus terminal, ISBT, railway station and metro station
8	Vending	Street vending areas to be provided within bus terminals for passenger convenience.
9	Bus depots	Bus depots include at least 1 day care centre, waiting room, nursing room, and well-maintained universally accessible gender-neutral toilets to encourage women and transgender staff.

Redesign streets to create safer cities for women and girls

This can be done by creating comprehensive street guidelines for the city, with a focus on gender and universal access (as illustrated by those created for the state of Bihar). These can serve as the basis for redesigning streets. The guidelines can include the following structure:

- Street design principles focused on safety, mobility of care, universal access, environment sustainability, behaviour change
- Land-use and transport integration: Street network planning and location of amenities
- Defining a street hierarchy, and typology based on the land-use context
- Street elements such as footpaths, cycling infrastructure, carriageway, traffic calming elements, pedestrian crossings, IPT stands, street vending, lighting, utilities, street furniture, trees and other shading devices
- Street design process and team within urban local bodies.

Improve public transport and reorganize and improve paratransit

Following recommendations for reorganization of para transit suggested.

- Promote e-rickshaws as a green paratransit mode and provide subsidies to unemployed to start e-rickshaws, preferably for people from lower economic groups.
- Encourage women workers in e-rickshaw waste management project initiative of Swachh Bharat Mission as short-term goal and introduce and encourage female e-rickshaw operators-vahinis as in case of Delhi for medium term projects
- Connect paratransit system to surveillance system as pick up point-destination mapping.

4.6 Annex 6 - GESI guidelines for public open spaces

Components	Recommendations
Urban form	• Planning of urban form, arrangement of built and open space with consideration to visibility, diverse uses • For smaller public open spaces (POS), the proportion of building height to the width of the POS should be at least 1:2 to avoid a sense of cramped feeling among users (ADB, 2022) • Compound walls providing a clear line of sight and in permeable material • Defined edge of parks/open spaces with natural landscape plants
Spatial structure and layout	• Create a network of non-motorized transport pathways (connected to the city-level network) interlinked to smaller sub-spaces • Provide open spaces of different scale to suit diverse uses • Reuse of underutilized spaces in the city for public spaces • Consider adaptability for future needs

Components	Recommendations
Safety, security and universal access	• In the design of pathways, parks, location of toilets ensure a clear line of sight, connected spaces and paths to encourage natural surveillance • Plan for street vending • Provide pedestrian-scale street lighting • Avoid dark corners and blind spots • Universal accessibility design codes should be followed
Age, gender and ability-inclusive activities	**Persons with disabilities** • Playscapes to be provided to cater the needs of children of different physical and developmental disabilities • Suggested to include sensory play areas, silent zone for mentally retarded and children with autism • Natural elements such as lawn, textured stones, trees of different types can be included for sensory stimulation of the differently abled • Universal design standards to be followed in design of benches and equipment **Boys and girls** • Providing spaces for diverse activities that can be enjoyed by both boys and girls, and inclusive of age, ability • New activities can be incorporated through rain shelters, outdoor gymnasium equipment and dance areas, art pavilions, water play areas/interactive fountains, providing spaces for different kinds of sports such as cricket and badminton **Elderly** • Include space for interaction, age-appropriate physical activity such as jogging, group exercise classes etc
Nature-based solutions	• Trees can also provide shade, break-up larger areas, designing for environmental sustainability, drainage, in situ rainwater harvesting
Amenities	• Public toilets (men, women, universally accessible), private nursing spaces, drinking water and spaces for women street vendors should be provided
Audio and visual communication	• Communicate zero tolerance to sexual harassment and encourage by-standers and victims to report harassment along with providing contact details. • The POS can also become a place to understand and bring visibility to women and other gender minorities' contribution to the city.

Source: Adapted from (ADB, Fair shared green and recreational spaces guidelines for gender-responsive and inclusive design, 2021; Manual for Gender Mainstreaming in Urban Planning and Urban Development, 2013)

4.7 Annex 7 - Gender inclusive guidelines for developing community shopping centres/ complexes and multimodal hubs

The community centre/multi modal hub shall be developed based on gender inclusive amenities and universal accessibility. The following aspects / facilities shall be provided in proposed community shopping complexes, multi-modal hubs.

- Provision and safe access to public toilets (men, women and universally accessible gender neutral), private nursing rooms, accessible baby/child change facility, drinking water
- Larger toilet compartments may be provided for easier access to those with trolleys or parcels, wheelchair users, parents with pushchairs or accompanying small children, those using walking or mobility aids.
- Provide diverse seating options in the site services and in interior for users.
- Access routes to be clear of obstructions and away from any projecting columns or return walls
- Provision of legible gender-neutral signage in multiple languages indicating route and amenity centres. Using recognized symbols/pictograms for help differently abled (cognitive difficulties/reading) also recommended.

4.8 Annex 8 - List of various activities within various land use categories as per Zoning Regulations of ZDP 2021

Tentative list of Prohibited uses (and activities) in proposed Floodplain zone 2

a. Central and General Commercial use

All types of retail businesses, departmental stores, hotels and restaurants and their accessory uses professional business establishments, libraries, offices, banks, financial Institutions, Shopping malls, multiplex, theatres, cinema halls and public assembly halls, Cultural centres, social and welfare institutions, commercial entertainment of transient nature, service industries, Petrol filling stations with garage and service stations, public utility buildings, computer software units, IT enabled services, Whole sale markets, newspaper offices with printing presses, taxi and scooter stands, sport stadium, transport terminals for both goods and passengers, colleges, technical and research institutions, polytechnics, Quarrying, warehousing, storage of perishable and inflammable commodities, Transport terminals for goods and passengers.

b. Transportation use

Road Transport Terminus (Bus terminals & depots), goods terminals, truck terminal, petrol filling stations.

c. Industrial use

All types of industries especially hazardous industries.

4.9 Annex 9 - Location-wise names of identified highly vulnerable slums

a. Slums in Canal Conservation area

S.no	Slum Name	Name of locality in the city
1	Ambedkar Nagar canal hutting upto Madhura Nagar	Madhura Nagar
2	Budameru flood bank Ramakrishnapuram	Devi Nagar
3	New Ayodhyanagar Donka	Ayodhya Nagar
4	Ramalingeswara Nagar canal hutting	Ramalingeswar Nagar
5	Malapalli canal hutting (Patamata Ambedkar Nagar)	Darsipeta
6	Karakatta Down South	Punnami Ghat Area
7	Ryves canal Hutting North &South from Dal Mill	Carmel Nagar
8	Eluru Road hutting (Ring Road East Extension)	Madhura Nagar
9	Kothavanthena Canal hutting west side	Seetharam Puram
10	Maruthinagar Canal Hutting	Maruthi Nagar (Machavaram)
11	Pakeer Gudeam	Brundhavan Colony

b. Slums along Krishna River

S.no	Slum Name	Name of locality in the city
1	Budameru flood bank Ramakrishnapuram	Devi Nagar
2	Karakatta Down South	Punnami Ghat Area
3	Karakatta Down North	Punnami Ghat Area
4	Bramarambapuram River Bund Burial Ground	Krishna Lanka
5	Riverbank Rpakalu Bramarambapuram	Ramalingeswar Nagar
6	River Bund low level north Ranigarithota	Krishna Lanka
7	River Bund Ranigarithota Nehru Nagar	Krishna Lanka
8	By the Side of Lorry Stand, Vidyadharapuram	Vidhyadharapuram Area

c. Slums in Hill Conservation area

S.no	Slum Name	Name of locality in the city
1	Lambadipet Chittinagar Hill area	Chitti Nagar, Mahanti Puram
2	Slum behind SAS College	Chitti Nagar, Mahanti Puram
3	Mallikharjunapet	Mallikarjuna Peta
4	Arul Nagar (Gunadala)	Kristuraja Puram
5	Ayyappa Nagar Quarry (Vijay and Uma Nagar)	Loyola College Area
6	Christurajapuram	Kristuraja Puram
7	Lurd Nagar	Ayyappa Nagar (Gunadala)
8	Machavaram Down, Karmika Nagar	Machavaram
9	Machavaram upto Quarry Hill area	Bethalham Nagar
10	Tailorpet Hill area	Gollapalem Gattu
11	Frizerpet Hill area	Wynch Peta
12	Kothapet Hill area upto Srinivasa Mahal Hill	Kotha Peta
13	Kothapet Hill area from Srinivasa mahal to Tunnel South	Kotha Peta
14	Tunnel North Hill area	Chitti Nagar, Mahanti Puram
15	Tunnel South Hill area	Vidhyadharapuram Hill Area
16	Wynchipet Hill area	Wynch Peta
17	Chinthalamala Palli	Wynch Peta
18	Machavaram Hill slope down Harijana Wada	Machavaram
19	Mogalrajupuram Hill Area East	Moghalrajpuram
20	Mogalrajupuram Hill Area West	Moghalrajpuram
21	Bethlaham Nagar	Bethalham Nagar

4.10 Annex 10 - Gender inclusive urban development guidelines for housing redevelopment areas

The following aspects shall be provided in new housing colonies / complexes that would be developed in new areas for highly vulnerable slum households.

- Provide safe and frequent public transport connectivity (minimum of 6 schedules per hour), safe and convenient access to well-lit, safe bus and paratransit stops with good visibility and weather protection.
- Conceptualize the housing redevelopment as a low-rise, medium density, mixed-use scheme with creche facilities, pharmacies, primary school and health centres, libraries, community centres in proximity.
- The EWS, LIG housing to be provided with adequate community spaces
- Develop a dense street network for walking and cycling and reduce trip distances and accommodate vending spaces.
- It is recommended that redeveloped housing units be registered in the name of women or as joint ownership. The entrances should be near public transportation stops in combination with pedestrian-oriented uses for greater social control.
- The buildings can be oriented toward outdoor spaces (within visual and voice range, to encourage passive participation in activities within the immediate surrounding)
- Avoid dark corners, blind spots and create direct sight lines.
- Consider housing units as live and workspaces with a height of 14 feet to accommodate a mezzanine.

- Decouple parking from housing units and provide sheltered parking for bicycles and assess the need for cycle-rickshaw, auto-rickshaw parking.

In the housing redevelopment, providing affordable rental housing units for single women, single women with children, women with disability, gender minorities, and low-income groups is suggested to consider.[9] The requirements of women, girls, people with disabilities, gender minorities in the city should be assessed and additional social infrastructure to be included. The facilities may include creches, shelters for survivors of domestic violence, shelters for homeless, counselling centres, and working women's hostels.

4.11 Annex 11 - Slums located in high flood vulnerable area

S.no	Slum Name	Name of locality in the city
1	Ambedkar Nagar canal hutting up to Madhura Nagar	Madhura Nagar
2	Budameru flood bank Ramakrishnapuram	Devi Nagar
3	New Ayodyanagar Donka	Ayodhya Nagar
4	Cement factory hutting	Ayodhya Nagar
5	Nandamuri Taraka Rama Nagar	Ayodhya Nagar
6	Sawmill Hutting	Krishna Lanka
7	Ramalingeswara Nagar canal hutting	Ramalingeswar Nagar
8	Karakatta Down South	Punnami Ghat Area
9	Karakatta Down North	Punnami Ghat Area
10	Mallikharjunapet	Mallikarjuna Peta
11	RTC Workshop Gorrela Doddi	Vidhyadharapuram Area
12	Sanjay Gandhi Labour Colony	Vidhyadharapuram Area
13	Kothapet Hill area up to Srinivasa Mahal	Kotha Peta
14	New Raj Rajeawari Pet	New Raja Rajeswari Peta
15	T.Subbaraju Nagar	New Raja Rajeswari Peta
16	Bramarambapuram River Bund Burial Ground	Krishna Lanka
17	Riverbank Rpakalu Bramarambapuram	Ramalingeswar Nagar
18	River Bund low level north Ranigarithota	Krishna Lanka
19	River Bund Ranigarithota Nehru Nagar	Krishna Lanka
20	Chalasani Nagar Ranigarithota	Krishna Lanka
21	Ranigarithota Bhaskara Raopet	Krishna Lanka
22	By the Side of Lorry Stand, Vidyadharapuram	Vidhyadharapuram

9 At present 12 per cent of all households in urban areas in Krishna district (Census of India-2011) are headed by women and significant gap in asset ownership and access to amenities in comparison to male headed households is found. In urban Krishna district only 45 per cent of women had access to banking services, 48 per cent to mobile phones, 21 per cent bicycle and only 10 per cent owned two-wheelers in female headed households. (Census 2011)

4.12 Annex 12 – Cost Estimates Methodology

Strategy	Project	Component/ details	Quantity Proposed	Unit of Measurement	Unit cost (Lakhs)	Total Cost (in Lakhs)	Source
SR 3: Optimizing development and guiding future growth	Strengthening NMT Infrastructure along Eluru Road (7 km) and MG Road (6 km)	Strengthening / Construction of Footpaths of 2m width (on either side of the road)	26	km	4	104	Jabalpur, Madhya Pradesh https://smartcities.gov.in/node/118
SR 3: Optimizing development and guiding future growth	Strengthening NMT Infrastructure along Eluru Road (7 km) and MG Road (6 km)	Road markings and signage	13	km	0.9	11.70	Vijayawada Immediate Action Plan for Transport, 2018-2020 (Draft)
SR 3: Optimizing development and guiding future growth	Strengthening NMT Infrastructure along Eluru Road (7 km) and MG Road (6 km)	Raised pedestrian crossings (one for every 400m)	32	no	0.1	3.20	Vijayawada Immediate Action Plan for Transport, 2018-2020 (Draft)
SR 3: Optimizing development and guiding future growth	Strengthening NMT Infrastructure along Eluru Road (7 km) and MG Road (6 km)	Street furniture, plantation, bollards & physical barriers, removal of encroachments	13	km	30	390	Vijayawada Immediate Action Plan for Transport, 2018-2020 (Draft)
SR 3: Optimizing development and guiding future growth	Organized on-street and off-street parking facilities at various locations along Eluru Road and MG Road	Stack parking system with 50 Equivalent Car Space (ECS).	50	ECS	5	250	Prayagraj Smart City Limited - Feasibility Report on Automated Parking System (2020)
SR 3: Optimizing development and guiding future growth	Construct Community shopping complex at proposed Multi-modal hubs	One shopping complex (warm shell) of area 20,000 sq. ft	1	no	1000	1000	https://www.makaan.com/price-trends/property-rates-for-buy-in-vijayawada (accessed on 24 April 2022)
SR 3: Optimizing development and guiding future growth	Construction of flyovers	Rail Over Bridge (2 -Lane) of length 0.15 km (approx.)	0.15	km	2600	390	Details of Road Projects in Andhra Pradesh in 2019; https://static.pib.gov.in/WriteReadData/userfiles/Detailsh.pdf (accessed on 24 April 2022)
SR 3: Optimizing development and guiding future growth	Construction of flyovers	Flyover (2-Lane) across Budameru canal and railway track of length 0.90 km (approx.)	0.90	km	2600	2340	Details of Road Projects in Andhra Pradesh in 2019; https://static.pib.gov.in/WriteReadData/userfiles/Detailsh.pdf (accessed on 24 April 2022)

Strategy	Project	Component/ details	Quantity Proposed	Unit of Measurement	Unit cost (Lakhs)	Total Cost (in Lakhs)	Source
SR 4: Reducing Vulnerability in Informal Settlements and Building Resilience to Environment and Natural Disasters	Development of Nature Based Solutions along River Krishna	Floodplain restoration of River Krishna	103.43	Ha	22.00	2275	World Bank, 2021. A Catalogue of Nature-based Solutions for Urban Resilience. Washington, D.C. World Bank Group; pg.190
SR 4: Reducing Vulnerability in Informal Settlements and Building Resilience to Environment and Natural Disasters	Hill slope renaturation	Construction and the first two years of maintenance (including preparation of the plants in the nursery and transplantation and manual harvesting)	66.00	Ha	1.20	79	World Bank, 2021. A Catalogue of Nature-based Solutions for Urban Resilience. Washington, D.C. World Bank Group; pg.64
SR 4: Reducing Vulnerability in Informal Settlements and Building Resilience to Environment and Natural Disasters	Installation of Flood Forecasting and Early Warning System (FFEWS) in the city	Installation of automatic inundation censors in automatic inundation sensors in flood vulnerable slums (27 slums @ 3 sensors per slum)	81	no.	0.60	48.6	https://www.indiamart.com/proddetail/digital-flood-detector-20731717230.html?pos=3&pla=n (accessed on 27 April 2022)

4.13 Annex 13 - Climate Savings Calculation Methodology

The climate savings data collection methodology is consistent across all sectors, however, there are some variations in its application. Three key sectors were most relevant for the interventions proposed in this city. These are housing, nature/green coverage, transport. A primary research phase to collect a basis of data for each sector was undertaken. Next, a tailored set of calculations were applied to contextualize this data.

In the housing sector emissions assessment, regular housing materials and their emissions were compared with green structure substitutes. These were applied to the number of housing units proposed in the intervention, using MOHUA guidelines for ratio of LIG and EWS dwellings for each housing complex, and dwelling size (sq m.). Some limitations to this sector's emissions estimates include the lack of long-term emissions estimates, from, for example ongoing usage.

For green coverage, a core data set of standard vegetation savings potential was collected. The area created through the implementation of the interventions was then calculated. These calculations used quantity and coverage standards. Limitations to this sector's emissions estimates included lack of specificity in plant species, as well as generic scales of coverage for each planting type.

Finally, transport sector data was collected, such as modal share, trip rate per capita and emission rate for each mode of transport. Using this data, an emissions estimate could be calculated which gave an indication for the additional emissions that building housing units far from the city's economic centre may have.

The GHG equivalent emissions calculations are outlined in the tables below, and include sources as well as assumptions made for reference.

TABLE 4.4 Data for GHG emissions assessment: Landscaping and green coverage potential for CO_2 storage

Category / Component	Potential GHG emissions (in tCO_2e)	Unit of Measurement	Source
Trees	8.00	tCO_2/ha/annum	Chen (2015), Velasco et al. (2014), Nowak et al. (2013)
Lawns	2.05	tCO_2/ha/annum	Raciti et al. (2011), Smith et al.(2018)
Bioswales (trench with planting)[10]	3.75	tCO_2/ha/annum	

TABLE 4.5 Application - Strengthening NMT infrastructure along Eluru Road (7 km) and MG Road (6 km)

Road name	RoW (ft)	RoW (m)	Road Length (m)	Trees (no.) [11]	Bioswales (m2)[12]	Lawn - central median and pedestrian/cyclist median (m2)	Potential for CO_2storage	Unit of Measurement
Eluru Road	120	36.6	7,000	2,100	5,250	10,500	148.85	tCO_2/ha/annum
MG Road (Bander Road)	120	36.6	6,000	1,800	4,500	9,000	127.58	tCO_2/ha/annum
Total			**13,000**	**3,900**	**9,750**	**19,500**	**276.43**	tCO_2/ha/annum

TABLE 4.6 Application - Restore flood plains of River Krishna through development of NBS

Component	Description	Area (ha)	Ratio of trees	Ratio of lawns	Ratio of Bioswales	Potential for CO_2 storage	Unit of Measurement	Remarks
Conservation Buffer	Conservation buffer (30m along the Bank of River)	21	80%	-	20%	142.28	tCO_2/ha/ annum	30 m conservation buffer along 7000 m length of Riverbank (approx. 20% of flood plain zone area)
Parks and Greenery	Landscaping, development of parks	51	30%	60%	10%	204.26	tCO_2/ha/ annum	landscaping; development of organized parks, greenery (approx. 30% of flood plain zone area
Construction related activities	Ghats, footways, other activities, facilities within parks	31	NA	NA	NA	NA	NA	Construction related activities for waterfront development
Total		103	-	–		346.53	tCO_2/ha/ annum	-

10 The Co_2 potential for bioswales uses a bracket of 1.5-9 ha. An average of 3.75 has been taken to scale up/down and contextualise the Co_2 storage potential.

11 Assumes an average distance between trees of 10m. Considered three rows of tree planting for 120 ft RoW Road.

12 Assumes an average bioswale size of 10m x 3m, distance between two 30m for 120 ft RoW Road.

TABLE 4.7 Application – Hill renaturation through NBS

Component	Description	Area (ha)	Ratio of trees	Ratio of lawns	Ratio of Bioswales	Potential for CO_2 storage	Unit of Measurement	Remarks
Conservation through hill slope renaturation	Forestry and Agriculture	66	60%	NA	40%	415.80	tCO_2/ha/ annum	50 per cent of total area proposed for development of forest, agriculture activity.
Parks and Greenery	Landscaping, development of parks	26	30%	60%	10%	104.13	tCO_2/ha/ annum	20 per cent of total area (near the foothills) proposed for development of public open spaces.
Public utility infrastructure and existing infrastructure	Ghats, footways, other activities, facilities within parks and part of Rivet Front development	40	NA	NA	NA	NA	tCO_2/ha/ annum	Provision of public utility infrastructure such as electricity, telecommunication infrastructure and keeping the existing infrastructure, such as roads steps, water supply lines, to support proposed activities.
Total		132	--	--	--	520.00	tCO_2/ha/ annum	--

Additional sources used in the estimation of GHG emissions potential:

Adekunle, A., Ibhadode, O., Ibhadode, A. P., & Caesar, S. M. (2020). Assessment of Carbon Emissions for the Construction of Buildings Using Life Cycle Analysis: Case Study of Lagos State. IJERAT, 6(8).

India GHG Program. (2015) India Specific Road Transport Emission Factors. Available Online at [https://shaktifoundation.in/wp-content/uploads/2017/06/WRI-2015-India-Specific-Road-Transport-Emission-Factors.pdf].

International Council on Clean Transport (2014). Bharat Stage IV Emission Standards for Two-wheelers in India. Available Online at: [https://theicct.org/sites/default/files/publications/ICCTupdate_BSIV-motorcycles_aug2014.pdf].

Iyer N.V., (2012). A Technical Assessment of Emissions and Fuel Consumption Reduction Potential from Two and Three Wheelers in India. Prepared for: the International Council on Clean Transportation. Washington, DC.

Kuittinen, M., Zernicke, C., Slabik, S., & Hafner, A. (2021). How can carbon be stored in the built environment? A review of potential options. Architectural Science Review, 1-17.

Kumar, G. V., Dongre, D. A., & Srinivas, G. (2017). A Case Study–Affordable Housing. Khairatabad, Hyderabad.

Kurian, R., Kulkarni, K. S., Ramani, P. V., Meena, C. S., Kumar, A., & Cozzolino, R. (2021). Estimation of carbon footprint of residential building in warm humid climate of India through BIM. Energies, 14(14), 4237.

Lolli, N., Fufa, S. M., & Kjendseth Wiik, M. (2019). An assessment of greenhouse gas emissions from CLT and glulam in two residential nearly zero energy buildings. Wood Material Science & Engineering, 14(5), 342-354.

MOHUA (2013). Affordable Housing Partnership. Scheme Guidelines. Available online: at [https://mohua.gov.in/upload/uploadfiles/files/6AHP-Guidelines.pdf].

Shinde, S. S., & Karankal, A. B. (2013). Affordable housing materials & techniques for urban poor's. IJSR, 1(5), 30-6.

Thakur, P., Pal, S. (2018) Estimating vehicular emissions from auto rickshaws plying in Bengaluru. International Journal of Scientific & Engineering Research Volume 9, Issue 5, May-2018 2241 ISSN 2229-5518. Available Online at: [https://www.teriin.org/infographics/estimating-vehicular-emissions-auto-rickshaws-plying-bengaluru].

Vidya, A., & Ar, R. (1980). Alternative Low-Cost Building Materials.

GHG emissions of restoring a river habitat is averaged at 10.9 kg CO_2-e per metre. Source: Chiu, Y., Yang, Y. & Morse, C. (2022). "Quantifying carbon footprint for ecological river restoration." Environ Dev Sustain 24, 952–970; https://link.springer.com/article/10.1007/s10668-021-01477-y#citeas.

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5

ACTIONS AND INTERVENTIONS, AND EMISSIONS OVERVIEW

Table 5-1 summarizes the key interventions and actions, the total GHG emissions and block cost estimates, the intervention duration, implementing agency and mission convergence.

TABLE 5.1 Summary actions and interventions

S.No	Strategic Response	Proposed Action / Project	Block Cost Estimate (lakh)	Climate Savings (tCO_2-eq)	Location	Nature of Project	Duration (short, medium, long)	Implementing Agency	Sources of Finance	Convergence with National/ State Missions or Schemes
1	Strategic Response 1: Revitalizing Urban Transit System	Intervention 1.1: Complete Streets Creating new streets with dedicated NMT corridor to complete the grid network Footpath, dedicated cycling lane, tactile flooring, underground service duct, tree plantation, and furniture (proposed for 25.89 km)	7,223	810	VMC city boundary	Infrastructure Project – Streetscape & NMT improvements	Long (5 – 15 years)	VMC	PPP, VMC Budgetary Allocation	Streets4People, Jagananna Pachathoranam
2	Strategic Response 1: Revitalizing Urban Transit System	Intervention 1.1: Complete Streets Dedicated NMT corridor and tree lining for the proposed roads identified by VMC and Zonal Development Plan Footpath, dedicated cycling lane, tactile flooring, and and plantation of trees (Proposed for 47.41 km)	13,226	1483.5	VMC city boundary	Infrastructure Project – Streetscape & NMT improvements	Long (5 – 15 years)	VMC	PPP, ZDP 2021	Streets4People, Jagananna Pachathoranam
3	Strategic Response 1: Revitalizing Urban Transit System	Intervention 1.2: Well-designed transit system Expand the existing public transportation services as well as add 66 new bus stops in the identified underserviced areas.	215.5	_	VMC city boundary	Infrastructure Project	Medium/ Long term (3 - 10 yrs.)	VMC, APSRTC	AMRUT 2.0, VMC Funding, Government Grants, PPP, CSR funding	AMRUT 2.0,

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4	Strategic Response 1: Revitalizing Urban Transit System	Intervention 1.2: Well-designed transit system Create a feeder network plan for e-rickshaw to identify the capacity of the vehicles and identify potential service routes in the city.	_	_	VMC city boundary	Technical Study (Feasibility/DPR/ Plan)	Short (0 - 2 years)	VMC, APSRTC		Smart City Mission, FAME-II
5	Strategic Response 1: Revitalizing Urban Transit System	Intervention 1.2: Well-designed transit system Procurement of 30 e-rickshaw on pilot basis with the supporting charging infrastructure.	51.3	_	VMC city boundary	Infrastructure Project	Short (0 - 2 years)	VMC, APSRTC		Smart City Mission, FAME-II
6	Strategic Response 1: Revitalizing Urban Transit System	Intervention 1.3: Multimodal Hubs Development of multimodal Hubs with dedicated bus stop, parking, electric vehicle charging, parking bay for shared vehicles and cycle sharing area.	_	769.86	18 locations	Infrastructure Project	Short / Medium-term (0-5 years) Pilot Project: Short term (0-2 years)	VMC, APSRTC	AMRUT, Smart City Mission, PPP	AMRUT 2.0, FAME-II
7	Strategic Response 2: Restoring Ecological Assets	Intervention 2.1: Healing the Waterways Streetscape development with Bioswales (Trench with plantation) Bioswales, semi-permeable paved surfaces and ground water recharge	40.47	164.7	Currency Nagar – Autonagar Gate Kanakdurga Colony (the missing link)	Environmental Feasibility	Short (0 - 2 years)	VMC	Jal Jeevan Mission (Urban), AMRUT 2.0, PPP, Government Grants	AMRUT 2.0, SBM, Jal Jeevan Mission, Jagananna Pachhathoranam

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8	Strategic Response 2: Restoring Ecological Assets	Intervention 2: Potential Sponges Protection of water bodies and promoting public amenities on under-utilized vacant land along the canals (156 Ha)	4453.74	391.95	Along the three canals (Eluru, Ryves, Bandar, Budameru), Krishna River (NH16 Service Road)	Infrastructure Project	Short (0 - 2 years)	VMC,	VMC, Government Grants, PPP Model	AMRUT 2.0, Jal Jeevan Mission, SBM 2.0
9	Strategic Response 2: Restoring Ecological Assets	Intervention 3: Parks & Open Spaces Create a hierarchy of organized public green spaces	_	_	VMC city boundary	Policy/Legal Reform or Amendment and Infrastructure Project	Short / Medium (0 - 5 years)	VMC	AMRUT 2.0, VMC Funding, Government Grants, PPP, CSR funding	AMRUT, AMRUT 2.0
10	Strategic Response 2: Restoring Ecological Assets	Intervention 3: Parks & Open Spaces Developing under flyover parks (7Nos)	7.7	17.58	7 Locations (At IRR, Singh Nagar Flyover, Vijayawada – Guntur Highway, Durga Ghat, Kaleswara Rao Flyover, Kanakadurga Flyover, Benz Circle Flyover	Infrastructure Project	Short / Medium (0 - 5 years)	VMC	AMRUT 2.0, VMC Funding, Government Grants, PPP, CSR funding	AMRUT, AMRUT 2.0
11	Strategic Response 2: Restoring Ecological Assets	Intervention 4: Trails & Bridges Redesign of CanalWalk trail Streetscaping and integrating canalfront and railway stretch. Walkways and cycle corridors and green spaces.	3567.56	437.94	Trails: Along the train trail (From Durga Ghaat – to Gundala Railway Station) and Bridges on connecting three canals (Eluru, Ryves and Bandar with each other)	Infrastructure Project	Medium / Long (3-10 years)	VMC	VMC funding, PPP	AMRUT 2.0
12	Strategic Response 3: Optimizing development and guiding future growth	Intervention 3.1: Promote Mixed-Use Development - Allocate mixed use along the major corridors in the city	NA	NA	Along Eluru Road and MG Road (pilot)	New Policy Guideline/Legal Instrument	Short (0-2 yrs.)	APCRDA	NA	NA

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13	Strategic Response 3: Optimizing development and guiding future growth	Intervention 3.1: Promote Mixed-Use Development - Strengthen NMT Infrastructure along the major corridors in the city	508.90	276	Along Eluru Road and MG Road (pilot)	Infrastructure Project	Short (0-2 yrs.)	VMC	VMC funding, Government Grants, PPP, CSR funding	NA
14	Strategic Response 3: Optimizing development and guiding future growth	Intervention 3.1: Promote Mixed-Use Development -Identify and develop designated parking areas (both on-street and off-street) along the major corridors in the city	250	NA	Along Eluru Road and MG Road (pilot)	Technical Study (Feasibility/ DPR/Plan) and Infrastructure Project	Short (0-2 yrs.)	VMC	VMC funding, PPP, CSR funding	NA
15	Strategic Response 3: Optimizing development and guiding future growth	Intervention 3.2: Improving access to public services and amenities - Construct Community shopping areas / complexes within the locations of multimodal hubs	1,000	NA	18 locations across the city	Technical Study (Feasibility/ DPR/Plan) and Infrastructure Project	Short / Medium (0 - 5 yrs.)	VMC	VMC funding, PPP, CSR funding	NA
16	Strategic Response 3: Optimizing development and guiding future growth	Intervention 3.3: Promoting development in the northern part of the city - Construction of two Rail Over Bridges and one bridge across Budameru canal	2730	NA	2 locations - One location across railway track connecting New Raja Rajeswari Peta and another with two connectivity links across Budameru canal and railway track connecting Vambay Colony	Technical Study (Feasibility/ DPR/Plan) and Infrastructure Project	Short / Medium term (0-5 yrs.)	VMC	VMC Funding, Government Grants	NA
17	Strategic Response 3: Optimizing development and guiding future growth	Intervention 3.3: Promoting development in Northern part of the city - Development of Growth Nodes with required public facilities and amenities	NA	NA	5 locations - New Rajarajeswari Peta, Ajit Singh Nagar, Patahapadu, Payakapuram, Gunadala	New Policy Guideline/Legal Instrument; Technical Study (Feasibility/ DPR/Plan) and Infrastructure Project	Medium/ Long term (3 - 10 yrs.)	APCRDA, VMC	VMC funding	NA

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18	Strategic Response 3: Optimizing development and guiding future growth	Intervention 3.4: Inclusion of floodplain zone (FPZ) in city Zoning Regulations	NA	NA	Along River Krishna	New Policy Guideline/Legal Instrument and Technical Study (Feasibility/DPR/ Plan)	Short (0-2 yrs.)	APCRDA	NA	River Centric Urban Planning Guidelines (2021)
19	Strategic Response 3: Optimizing development and guiding future growth	Intervention 3.5: Development of Growth Centres outside Vijayawada - Preparation of detailed plan for development of Growth Centres	NA	NA	4 Growth Centres - Ibrahimpatnam, Nunna, Gannavaram, Kankipadu	Technical Study (Feasibility/DPR/ Plan)	Short (0-2 yrs.)	APCRDA	APCRDA	NA
20	Strategic Response 4: Reducing Vulnerability in Informal Settlements and Building Resilience to Environment and Natural Disasters	Intervention 4.1: Resettlement and rehabilitation of highly vulnerable slums - Detailed study demarcating the highly vulnerable slum areas, identification of vulnerable households within these areas for relocation	NA	NA	Slum settlements located in the floodplains of River Krishna, conservation area earmarked in ZDP 2021 for canals, hills	Technical Study (Feasibility/DPR/ Plan)	Short (0-2 yrs.)	VMC, Revenue Department and Irrigation Department	VMC	NA
21	Strategic Response 4: Reducing Vulnerability in Informal Settlements and Building Resilience to Environment and Natural Disasters	Intervention 4.1: Resettlement and rehabilitation of highly vulnerable slums - Identification of locations for resettlement of identified vulnerable houses in slums and construction of housing colonies with required infrastructure and amenities	NA	NA	Northern part of the city. However, the locations need to finalize by VMC thought a study.	Technical Study (Feasibility/ DPR/Plan) and Infrastructure Project	Medium/ Long term (3 - 10 yrs.)	VMC, AP Housing Corporation	VMC funding, Government Grants	PMAY (U), Pedalandariki illu

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22	Strategic Response 4: Reducing Vulnerability in Informal Settlements and Building Resilience to Environment and Natural Disasters	Intervention 4.2: Conservation of reclaimed land in highly hazard prone areas through Nature-based Solutions - Restore flood plains of river Krishna through development of NBS	2275	347	Floodplains of River Krishna	Technical Study (Feasibility/DPR/ Plan)	Medium term (3 - 5 yrs.)	VMC, Irrigation Department, Revenue Department	VMC funding, Government Grants	AMRUT 2.0
23	Strategic Response 4: Reducing Vulnerability in Informal Settlements and Building Resilience to Environment and Natural Disasters	Intervention 4.2: Conservation of reclaimed land in highly hazard prone areas through Nature-based Solutions - Conserve hills through Hill slope renaturation	79	520	Hills, Foothills (earmarked for conservation in ZDP 2021)	New Policy Guideline/Legal Instrument; Technical Study (Feasibility/ DPR/Plan) and Infrastructure Project	Medium/ Long term (3 - 10 yrs.)	VMC, Irrigation Department, Revenue Department	VMC funding, Government Grants, PPP, CSR funding	AMRUT 2.0
24	Strategic Response 4: Reducing Vulnerability in Informal Settlements and Building Resilience to Environment and Natural Disasters	Intervention 4.3: Retrofitting of slum area - Detailed survey to assess the condition of housing and infrastructure	NA	NA	Portion of the highly vulnerable slum areas falling outside the hazard vulnerable area	Technical Study (Feasibility/DPR/ Plan)	Short (0-2 yrs.)	VMC, Irrigation Department, Revenue Department	VMC funding, Government Grants, PPP, CSR funding	NA
25	Strategic Response 4: Reducing Vulnerability in Informal Settlements and Building Resilience to Environment and Natural Disasters	Intervention 4.3: Retrofitting of slum area - Provision of technical and financial assistance to upgrade housing, infrastructure	NA	NA	Portion of the highly vulnerable slum areas falling outside the hazard vulnerable area	Infrastructure Project	Medium/ Long term (3 - 10 yrs.)	VMC, Irrigation Department, Revenue Department	VMC funding, Government Grants,	PMAY (U)
26	Strategic Response 4: Reducing Vulnerability in Informal Settlements and Building Resilience to Environment and Natural Disasters	Intervention 4.4: Augmentation of Flood Forecasting and Early Warning System (FFEWS) in the city	48.60	NA	Slum settlements situated in flood vulnerable areas	Infrastructure Project	Short (0-2 yrs.)	VMC, AP State Disaster Management Authority	VMC funding, CSR	NA

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27	Strategic Response 4: Reducing Vulnerability in Informal Settlements and Building Resilience to Environment and Natural Disasters	Intervention 4.5: Transforming slums as better livable spaces through community engagement - Comprehensive slum survey to assess existing situation of Slums; Comprehensive action plan to address the concerns	NA	NA	All the slum settlements in the city	Technical Study (Feasibility/DPR/ Plan)	Short (0-2 yrs.)	VMC, Revenue Department	VMC funding	NA
28	Strategic Response 4: Reducing Vulnerability in Informal Settlements and Building Resilience to Environment and Natural Disasters	Intervention 4.5: Transforming slums as better livable spaces through community engagement - Establishment of Slum Rehabilitation Coalition (SRC)	NA	NA	All the slum settlements in the city	New Policy Guideline/Legal Instrument	Medium (3 - 5 yrs.)	VMC, MEPMA	NA	NA

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