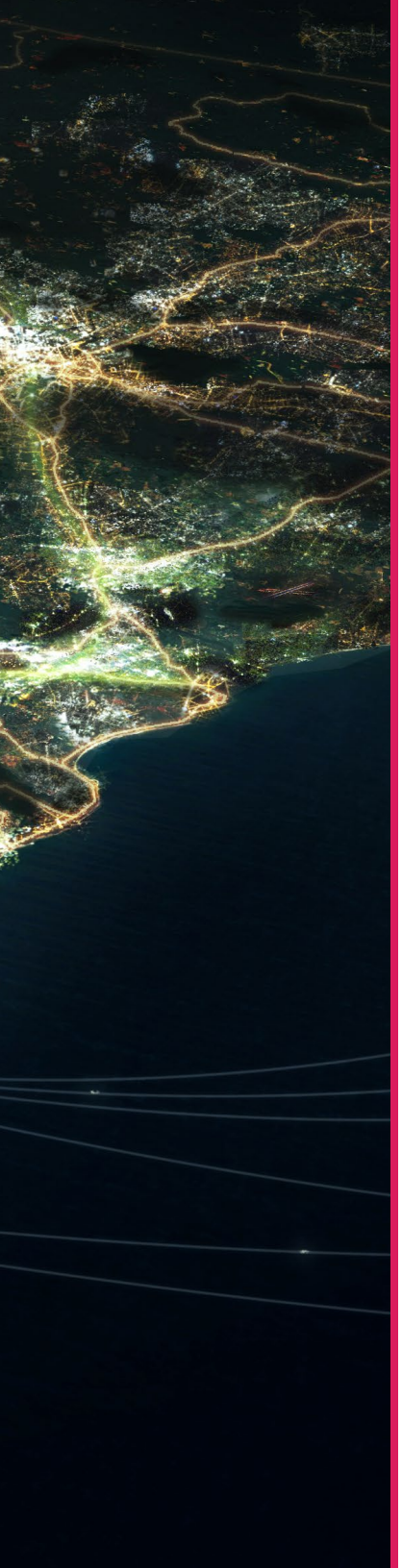
Smart City Master Planning and Sector-specific Smart City Infrastructure Projects for **Visakhapatnam**

INTEGRATED SMART CITY FRAMEWORK PLAN

AECOM IBM KPMG



As a destination city, **Visakhapatnam** has a lot to offer: beautiful beaches, friendly people and a robust economy. With a great natural harbor, Vizag is a natural hub for defense, shipping, trade, and manufacturing. The division of Andhra Pradesh into two states has given additional impetus to an already vibrant economic growth trend in Vizag. The advantages of living in Vizag as opposed to other knowledge industry capitals have not been lost on India's young professionals, who appreciate the unspoiled natural environment, affordable housing and laid-back lifestyle on offer. Vizag, with its increasingly diverse economy and proven leadership team, is poised to grow. The challenge for Vizag will be to realize its ambitious economic growth goals while preserving and enhancing livability for the benefit of local citizens.

The **Smart City Framework Plan** lays the groundwork for the development of Visakhapatnam from a 20th century port city into an integrated 21st century city-region. Each of the four major centers of Visakhapatnam Metropolitan Region (VMR) will develop its own distinct urban character:

1. **The city center will raise** its profile as the business and cultural center of the region by carrying out signature development projects in the Central Business District, along the beach road and at Old Town.
2. **The southern industrial area will develop** of smaller, mixed-use urban sub-centers that offer jobs-housing balance and improved living conditions for the local workforce.
3. **Madhurawada and Rushikonda will emerge** as high-end knowledge industry clusters that offer world-class educational, recreational and tourism facilities.
4. **Vizag's unique selling point** — its coastline — will be developed as a set of distinct recreational, ecological and livelihood destinations.

New growth areas within all four centers will locate housing near jobs, preserve ecological assets, and minimize natural hazard risk. Binding the centers into a coherent regional whole will be smart transport, water and energy infrastructure that ensures smooth and timely flows of people and resources throughout the VMR. ICT innovations will allow infrastructure managers to anticipate stress points, take corrective action and enhance system performance. Citizens in Smart Vizag will also gain visibility into infrastructure systems and be able to participate in decisions about future improvements.

By embracing Green Living and Smart Business, Visakhapatnam Metro Region will become South and Southeast Asia's Clean Commerce Capital for the 21st century.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This work is a product of the staff of AECOM with contributions from IBM and KPMG. The findings are based upon geographic and demographic data obtained from State and Local entities as well as data transposed from publicly available sources. As such, AECOM does not guarantee the accuracy of the geographic and demographic data included in this work.

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Acronyms and Abbreviations

APEPDCL	Andhra Pradesh Eastern Power Distribution Company Ltd.
APGENCO	Andhra Pradesh Power Generation Company
CEO	Chief Executive Officer
CMAR	Construction Manager at Risk
DB	Design-Build
DBF	Design-Build-Finance
DBFOM	Design-Build-Finance-Operate-Maintain
DBOM	Design-Build-Operate-Maintain
EoI	Expression of Interest
GHG	Greenhouse Gas
GVMC	Greater Visakhapatnam Municipal Corporation
HPSC	High Powered Steering Committee
IT	Information Technology
kV	kilovolt
MW	megawatts
NREDCAP	New & Renewable Energy Development Corporation of Andhra Pradesh Limited
O&M	Operations and Maintenance
OT	Operational Technology
PV	Photovoltaic
RFP	Request for Proposals
RFQ	Request for Qualifications
SCADA	Supervisory Control and Data Acquisition
SOQ	Statement of Qualification
SPV	Special Purpose Vehicle
ULB	Urban Local Bodies
VfM	Value for Money
Vizag	Visakhapatnam
VUDA	Visakhapatnam (Vizag) Urban Development Authority

I. INTEGRATED FRAMEWORK PLAN

Introduction and Background

The AECOM team, including partner firms IBM and KPMG, is carrying out the assignment "Smart City Master Planning + Sector Specific Smart City Infrastructure Plans for Visakhapatnam" on behalf of the Government of Andhra Pradesh (USTDA financing). With a view to promoting the development of Visakhapatnam ("Vizag") into a smarter city, the assignment includes baseline analysis, formulation of a development strategy and guidelines, preparation of a smart city master plan, and feasibility analysis of smart city projects. It is anticipated that the work will be completed over three 5-month phases, as follows:

- **Phase I** – Baseline, Smart City Development Strategy and Action Planning for Two Smart City Projects (March 2016 – August 2016)
- **Phase II** – Preparation of the Smart City Master Plan
- **Phase III** – Implementation Plan and Feasibility Studies for Four Smart City Projects

Phase I was contracted on February 12, 2016 and has been completed. Phase I included six tasks:

- Task 1 – Defining Visakhapatnam Smart City Vision
- Task 2 – Review and Analysis of Existing Conditions and Corresponding Best Practices
- Task 3 – Strategic Planning for Regulatory and Infrastructure Framework
- Task 4 – Sector-Specific Strategies
- Task 5 – Action Planning for Two Smart City Projects
- Task 6 – Interim Report

Phase II was contracted on August 29, 2016 and is currently underway. Phase II includes six tasks:

- Task 7 – Master Planning Kick-off Workshop
- Task 8 – Draft Integrated Smart City Master Plan
- Task 9 – Stakeholder Workshop on the Draft Integrated Master Plan
- Task 10 – Final Integrated Master Plan
- Task 11 – Presentation of the Final Integrated Master Plan
- Task 12 – Final Report

Phase III will include more detailed planning for four selected projects as well as capacity building and training assistance for those implementing 'Smart City' projects.

The Vision for a Smarter Greater Vizag

Building upon the existing diverse economic base and inherent livable amenities and lifestyle, the vision was set for greater Vizag to become South and Southeast Asia's Clean Commerce Capital by 2030. This goal aims to protect and enhance quality of life for residents and businesses alike by pursuing two fundamental objectives:

Green Living

- Preserve and celebrate the unspoiled environment
- Promote a healthy lifestyle
- Provide access to amenities
- Promote clean air and clean water

Smart Business

- Maintain and expand ease of doing business
- Facilitate and require clean manufacturing
- Plan and deploy intelligent infrastructure
- Facilitate and require socially responsible businesses practices

Achieving the vision will require a “Smart City” approach to regional development and infrastructure planning and delivery. The intent of the Smart City framework, programs and projects will be to accelerate provision of basic services, employ creative approaches to cost-effective service delivery, and set in motion a virtuous circle of infrastructure investment, high-quality urban environment initiatives, workforce attraction and retention, increased local government revenue, and additional infrastructure investments.

The intent is for Smart City projects to be deployed throughout the region to catalyze sustainable, cyclical progress toward regional goals by promoting:

- Higher customer satisfaction and citizen buy-in
- More responsive service delivery and smaller carbon footprint
- Conservation and enhancement of natural and social resources
- Lower marginal costs for improved services
- Lower overall infrastructure development and operations costs for improved services
- Closure of infrastructure gaps in the most intelligent way possible

Guiding Principles and Approaches

When approaching the planning process and early project identification, the following people-centric guiding principles will be used to leverage the greatest benefit from early infrastructure enhancements:

- Understand behavior patterns in order to address peak-use challenges
- Acknowledge and leverage connections between infrastructure of different types
- Enable feedback loops between infrastructure systems, utilities, and customers
- Bring people to services while at the same time bringing services to people
- Track progress toward success with specific benchmarks and targets

When approaching the planning process and early project identification, the following system-centric guiding principles should be used to leverage the greatest benefit from early infrastructure enhancements:

- Get the most out of existing infrastructure systems and investments
- Acknowledge and leverage connections between infrastructure of different types
- Develop and use more storage strategies to ease peak-use constraints
- Prioritize retrofit over redevelopment and greenfield expansion
- Leapfrog over unresponsive technologies to select more efficient information and communications technology (ICT)-enabled delivery methods
- Cultivate resilient, networked systems to build capacity and reduce vulnerability

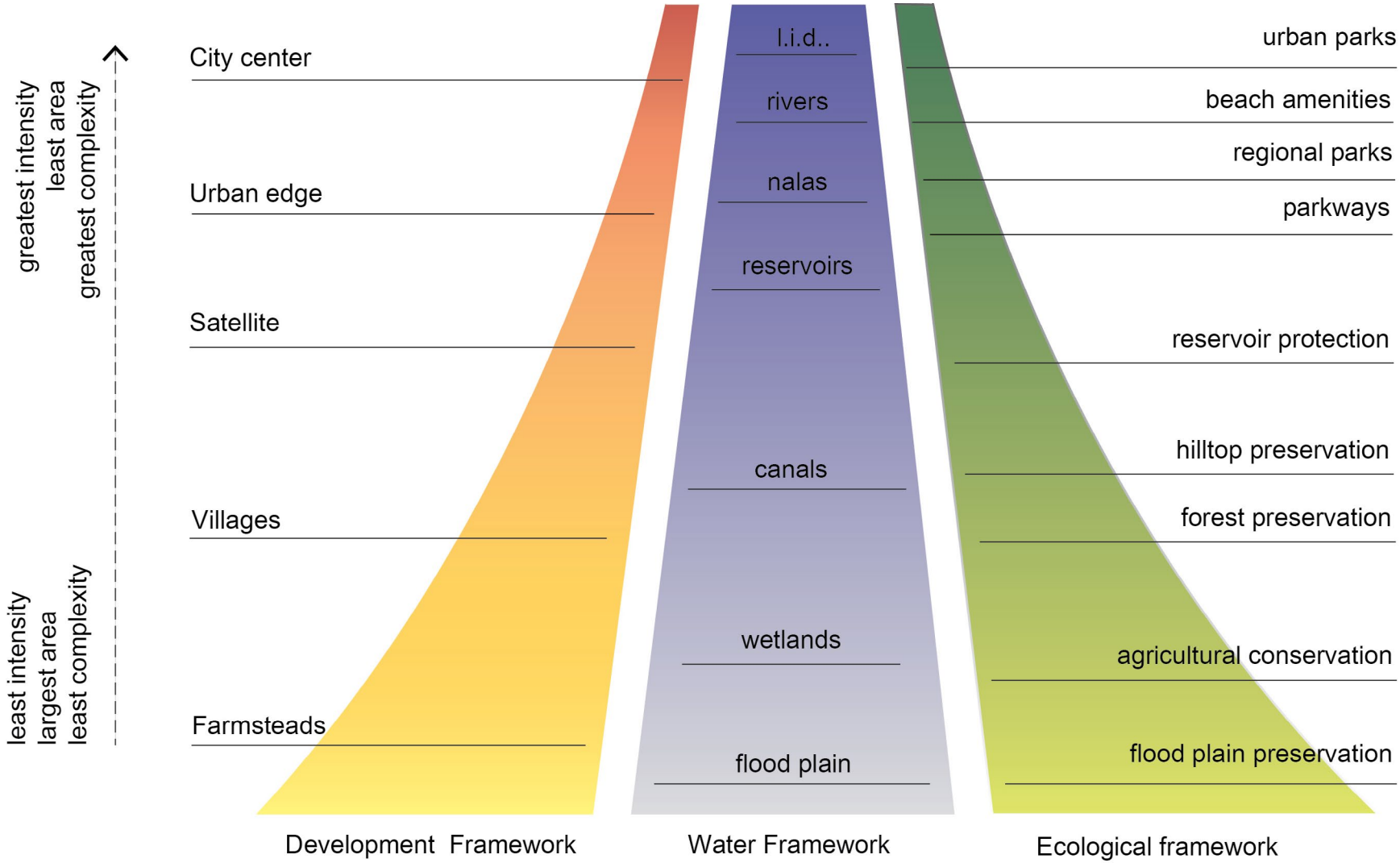
Delivering ‘Smart City’ solutions to infrastructure challenges is by nature more complex than a traditional approach. These guidelines are intended to better equip decision makers on how to manage that complexity and use it as an advantage in accelerating improved quality of life for businesses, residents and visitors.

Definition of the traditional approach- Using local tax revenue, federal funding, municipal debt and donor funding individually to build and maintain basic service infrastructure scaled to peak demands.

Definition of ‘Smart City’ Approach- Maximizing the co-benefits and throughput of existing and proposed infrastructures through information feedbacks, peak-shaving, demand management and accelerated deployment of basic infrastructure through creative, multi-source funding vehicles that attract investment by the private sector.

The Integration of the Growth framework is based upon the fundamental alignment of its Development, Water and Ecological components. These three interdependent systems each have a heirarchal structure with complimentary elements. Connected through mobility, energy, water and social infrastructures, these structures act as a platform for Smart City policies, programs and projects.

Figure 1.1 Integrated Framework for Growth



Accessing the Draft Planning Components

The Integrated Framework Plan can be viewed in draft form on www.smartvizag.in. This website was developed as part of task 8 to be a single point for reviewing draft text and graphic materials and to solicit feedback on the draft plan and projects from citizens and civil society via a cross-platform web portal and print-based mass media campaign. The content can be reviewed and or downloaded in the *Plan* and *Projects* sections of the website. The following diagram outlines the contents and organization of the website. It also shows how concurrent projects within Vizag can be linked and coordinated.

The Integration of the Growth framework is based upon the fundamental alignment of its Development, Water and Ecological components. These three interdependent systems each have a hierarchal structure with complimentary elements. Connected through mobility, energy, water and social infrastructures, these structures act as a platform for Smart City policies, programs and projects.

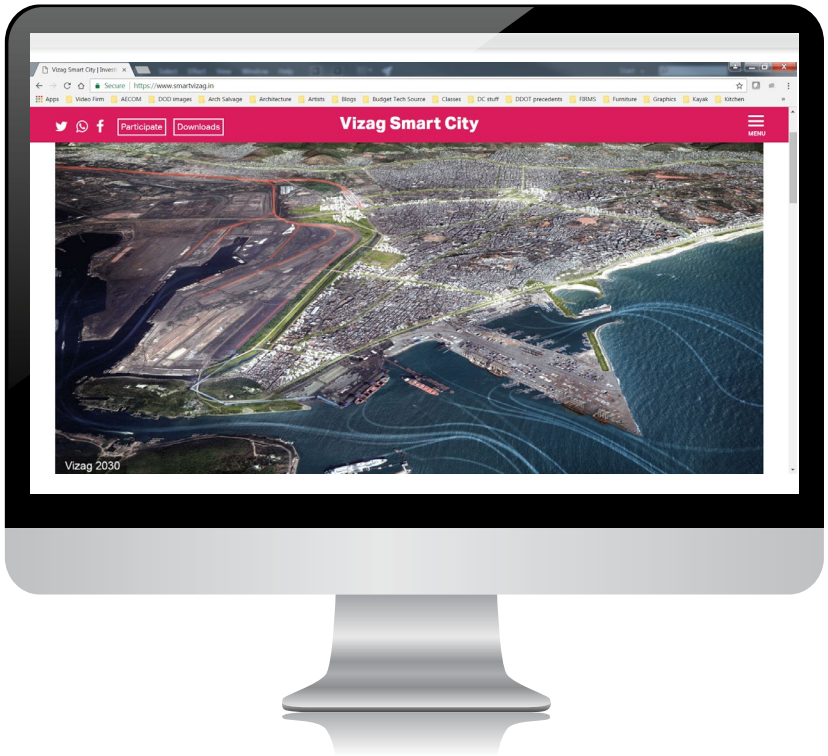
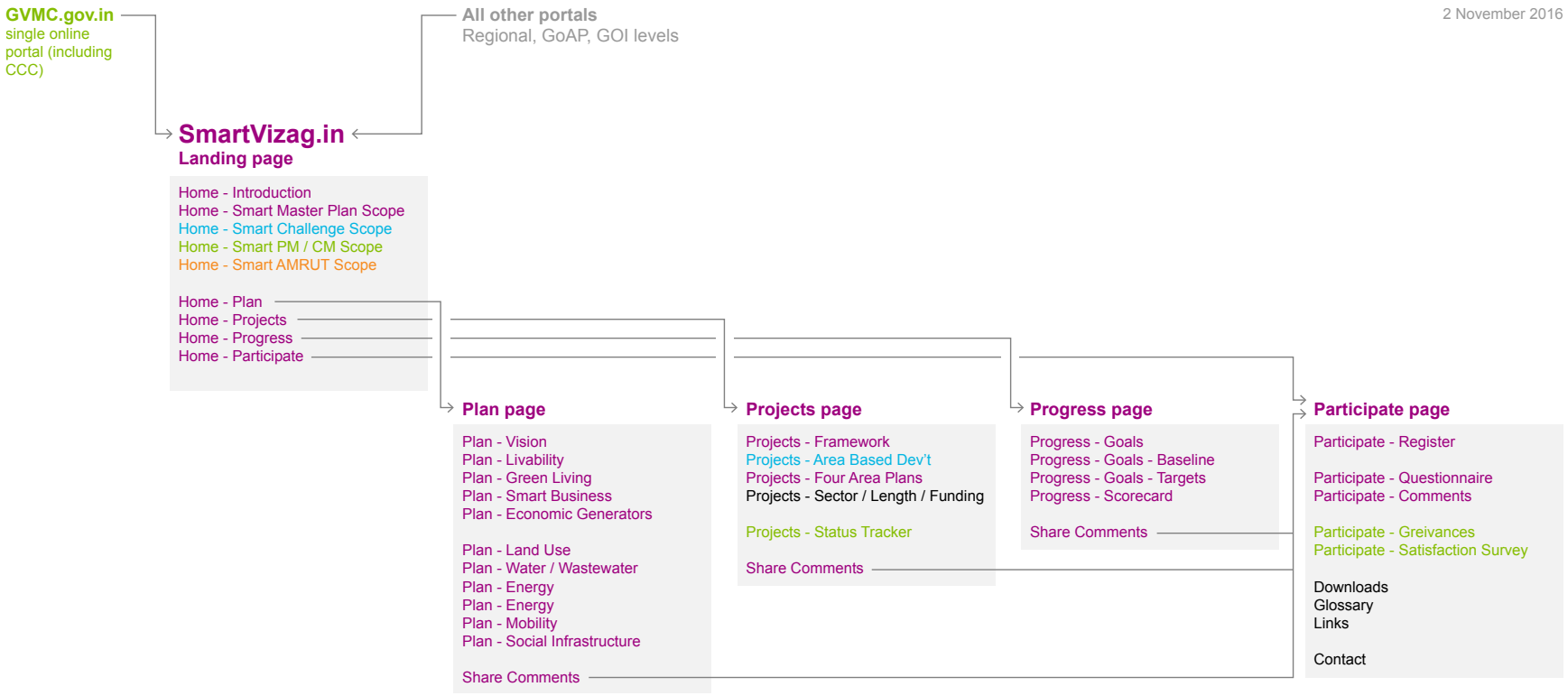


Figure 1.2 Organization of Website



SmartVizag.in offers a single, visually-enhanced online portal to seamlessly integrate community engagement for Phase II of the USTDA funded Vizag Smart City Master Plan & Projects and the Vizag Smart City Challenge, PM / CM, and AMRUT scopes of work.

The site integrates smooth cross-platform interactions with best-in-class survey / comment, mapping, and content management system components, and utilizes international standards for universal design and accessibility. These components provide access to the GVMC to securely pull information in real-time from the site.

Legend

Content developed by all AECOM scopes
Content developed by AECOM Smart City Challenge scope
Content developed by AECOM / USTDA Smart City Master Plan & Projects scope
Content developed by AECOM PM / CM scope
Content from AECOM AMRUT scope

II. URBAN DEVELOPMENT FRAMEWORK

Introduction

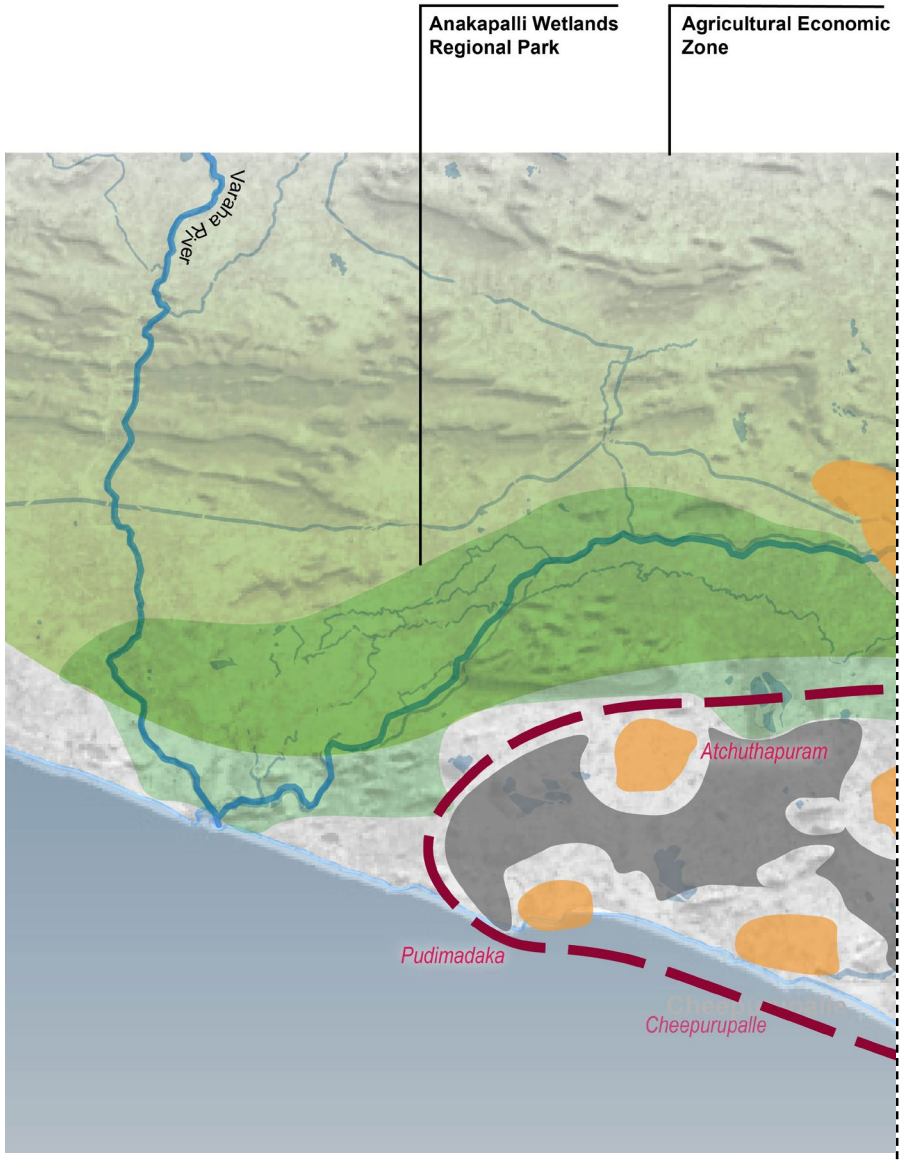
The **Smart City Master Plan** lays the groundwork for the development of Visakhapatnam from a 20th century port city into an integrated 21st century city-region. Each of the four major centers of Visakhapatnam Metropolitan Region will develop its own distinct urban character and economic function:

1. **The commercial center** will raise its profile as the business and cultural center of the region by carrying out signature development projects in the Central Business District, along the beach road and at Old Town:
   - RTC complex and adjacent properties can be redeveloped into a state-of-the-art smart and sustainable Central Business District that ties into new MRT and BRT lines, offers district cooling services, and provides an entertainment and shopping area necessary for a knowledge industry capital city.
   - A new cruise terminal will boost international tourism and provide revenue for upgrading facilities for the adjacent local fishing community. A culture and entertainment complex across the beach road will be attract tourists and provide a gateway into Old Town.
   - On the opposite side of Old Town, a revitalized Lavender Canal will provide green open space, accelerate freight evacuation from the port, and improve wastewater and storm water treatment.

These new development centers will be linked together with revitalized, pedestrian-friendly Smart Streets that provide enhanced public transportation services.

2. **The heavy industrial growth zone** will develop smaller, mixed-use urban sub-centers that offer jobs-housing balance and improved living conditions for the local workforce. Located near, but not adjacent to, factories and industrial parks, these centers will incorporate existing villages into larger agglomerations, while ensuring the delivery of higher quality water, wastewater and environmental management services. Future industrial development will be located between the sub-centers and adjacent to the existing industrial projects and parks located south of Dolphin Nose.

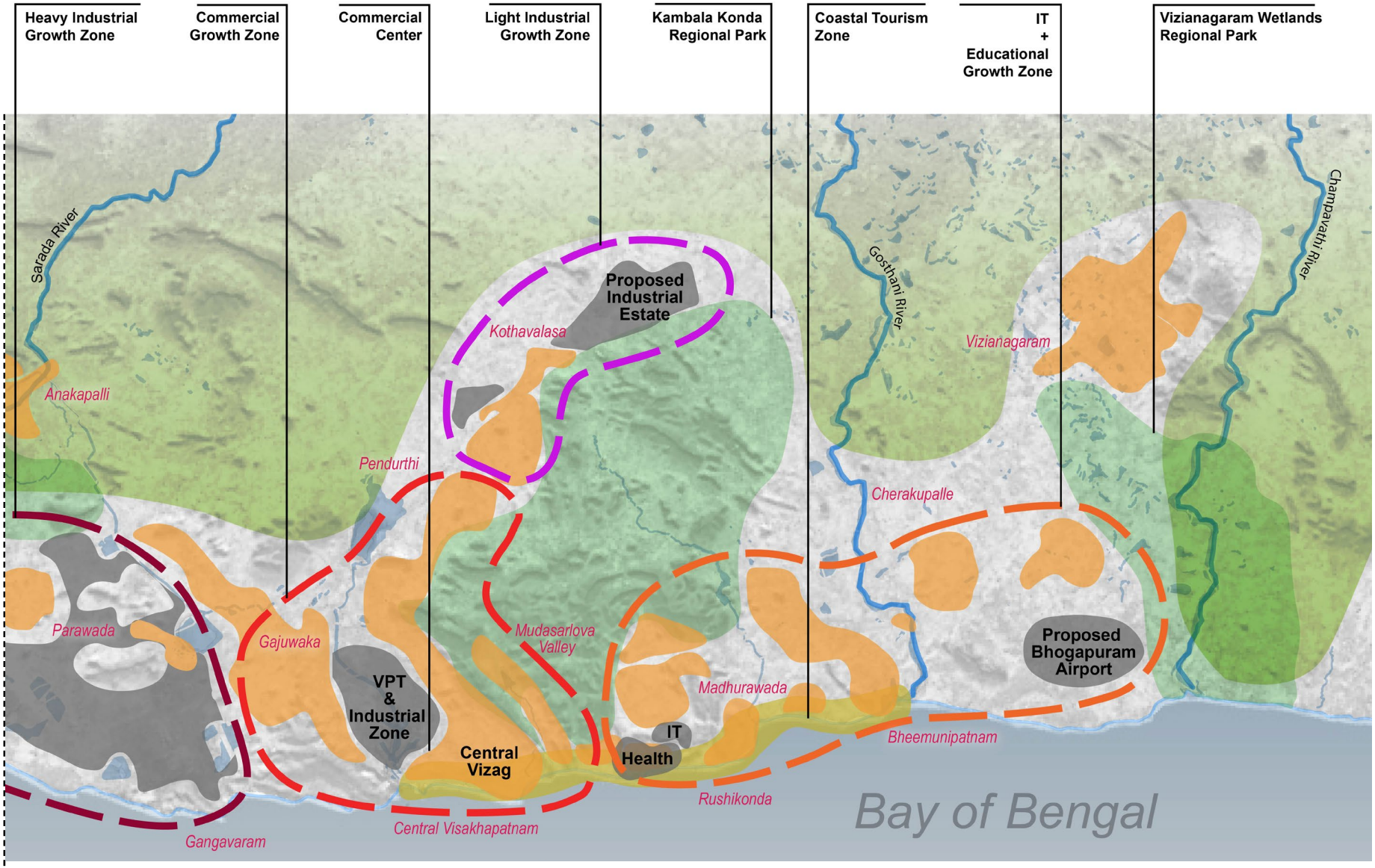
Figure 1.1 Regional Map of Emerging Economic Character Zones



3. **The IT and education growth zone** north of Kailasgiri and extending to the Bhogapuram aerotropolis will be a high-end knowledge industry cluster offering world-class educational, recreational and tourism facilities. The coastline — Vizag's unique selling point — will be developed as a set of distinct recreational, ecological and livelihood destinations appropriate for different types of visitors, residents and employees. At the southern end of this zone, Rushikonda will provide housing, recreation and social amenities to meet the demands of knowledge-industry workers. New parks, open spaces, and waterways will model low-impact development for the region by employing green infrastructure and waterway rehabilitation projects.
4. **The light industrial growth zone** from Pendurthi to Kothavalasa will use phased development of distribution centers to boost the logistics sector in the metropolitan region. Housing and commercial mixed-use development will allow workers to locate near their jobs, while the upgraded BRT line will provide access to other regional employment centers too.

New growth areas within all four centers will locate housing near jobs, preserve ecological assets, and minimize natural hazard risk. Binding the centers into a coherent regional whole will be smart transport, water and energy infrastructure that ensures smooth and timely flows of people and resources throughout the VMR. ICT innovations will allow infrastructure managers to anticipate stress points, take corrective action and enhance system performance. Citizens in Smart Vizag will also gain visibility into infrastructure systems and be able to participate in decisions about future improvements.

Match p. II-3



Heavy Industrial Growth Zone
Light Industrial Growth Zone
Commercial Growth Zone
IT + Educational Growth Zone
Ecological Conservation Areas
Agricultural Economic Zone
Mixed Use 2030
Industrial 2030
Coastal Tourism Zone
Rivers

Match p. II-2

Population

VUDA projections for the Greater Visakhapatnam Municipal Corporation and the Visakhapatnam Metropolitan Region (VUDA planning area) depict a region that will slowly expand to 6.1 million people by 2021. The Average Annual Growth Rate (AAGR) from 2001 to 2011 is only 1.34%. Based on an AAGR of 2%, the population will rise to 7.56 million in 2030. More than half of the total regional population will still live in GVMC.

Table 1.1 Population of VMR, 2016-2030

Area	2001	2011	2021	2030
GVMC area	2,200,000	2,797,100	3,195,200	4,169,000
Other VMR	2,000,000	2,542,900	2,904,800	3,395,674
Total VMR	4,200,000	5,340,000	6,100,000	7,564,674

Source: GVMC, VUDA 2006; Census of India 2001, 2011; GVMC = Greater Visakhapatnam Municipal Corporation; VMR = Visakhapatnam Metropolitan Region

The average household size in the planning area, according to the 2011 census, was 3.91 persons. The following table breaks population down into households during the planning period. The five-year period between 2016 and 2021 is treated separately from the ten-year period between 2021 and 2030 (inclusive).

Table 1.2 Household Projections, 2016-2030

Area	Households 2021	Households 2030	Change in HH 2016-2021	Change in HH 2021-2030
GVMC area	817,187	1,066,240	51,740	249,053
Other VMR	742,916	868,459	47,032	125,543
Total VMR	1,560,102	1,934,699	98,772	374,597

Source: VUDA; AECOM, 2016

Housing

The household projections above form the basis of the following Housing Needs Projections. The largest generators of housing need are (1) the formation of new households from among the existing population, and (2) the in-migration of new households from outside the VMR. The total number of new households over the first five years of the planning period is approximately 135,000. During the following 10 years, an additional 375,000 households are expected to be formed or migrate to Vizag.

Table 1.3 Housing Needs Projection VMR, 2016-2030

Area	Additional HH 2016-2021	Overcrowded Households 2016	Total DUs required 2021	Additional HH 2021-2030	Total DUs required 2030
GVMC households	51,740	25,097	76,837	249,053	325,890
Other VMR households	47,032	10,756	57,788	125,543	183,331
Total households	98,772	35,853	134,625	374,597	509,222

Source: AECOM 2016 based on census data

In addition to the new households, existing households living in overcrowded conditions are in desperate need of new housing. The UN-Habitat's work in slum ho using indicates that approximately 50,000 households in existing slums in Vizag required new housing in 2006. Since then, 14,000 units have been delivered through low-income housing programs. For the remaining 35,000, housing solutions are still needed. This is a conservative estimate, as additional households have surely migrated to and settled in informal areas in the intervening years. The total number of required dwelling units during the planning period is about 509,000.

The expanding city should provide housing solutions for all of these households. The type, size, and character of the housing solutions will vary with the buying power and individual preferences of the household, among other factors. Most households will find housing through existing market mechanisms. Even for low-income households, it is not necessary for GVMC or any public entity to construct housing for all of the households; rather, satisfying housing need for the society as a whole is about enabling the provision by many different actors (most of them private sector) of a broad range of housing solutions, from apartments to free-standing houses to serviced residential land plots.

Densification Potential

Densification of existing urban areas presents opportunities to fully utilize existing infrastructure, and is therefore generally considered more economically efficient than greenfield development at the urban periphery. This section looks at the potential for densifying VMR's existing urban fabric in order to absorb a share of the future population and household growth described above.

The existing urban centers around VMR have generally been developed to a density that is appropriate for the location and size of the city. The prevalent mid-rise, party-wall construction type (5-8 stories) has a number of attributes:

- It is relatively compact, with a corresponding small carbon footprint;
- It is human scale, and provides a physical framework for the creation of walkable streets and public open spaces;
- It has parcel sizes that are small enough to provide some diversity of urban form and building design, which adds to the character and attractiveness of the public realm.
- It sits comfortably within the green ridges that separate Vizag's urban centers into a series of urban "rooms," many of which face the sea.

For these reasons, redeveloping existing neighborhoods in Vizag to a higher density is generally not advised. Razing whole localities of mid-rise buildings and replacing them with high-rise buildings will not, in most cases, yield a higher quality urban environment. Moreover, mid-rise, party-wall development is often built at a similar density to high-rise development, given the need to locate the high-rise buildings farther from each other.

This does not preclude the redevelopment of some smaller localities within the city to a higher density than currently exists in Visakhapatnam. The revitalization of the central business district, which is identified as a key project in the Vision Statement, could potentially include some high-rise development. High-rise development may be appropriate if the future CBD sees an increase in explicit financial services functions concurrent with the strengthening of Vizag's logistics sector. The CBD is one of a number of nodes within the existing fabric of the city center that would be an appropriate location for moderate densification using a mid-rise development model (see Figure 1-3).

Other sites with potential for densification are existing vacant parcels within the urbanized area. There are 2,740 vacant parcels with a total area of 534 acres scattered around the city, even in areas with high land values, such as those along R.K. Beach Road. These parcels should be prioritized for new development. Infill development using such parcels should be privileged over greenfield development outside of the existing urbanized area. The land use proposals in the Smart City Master Plan will support and target an infill development strategy.

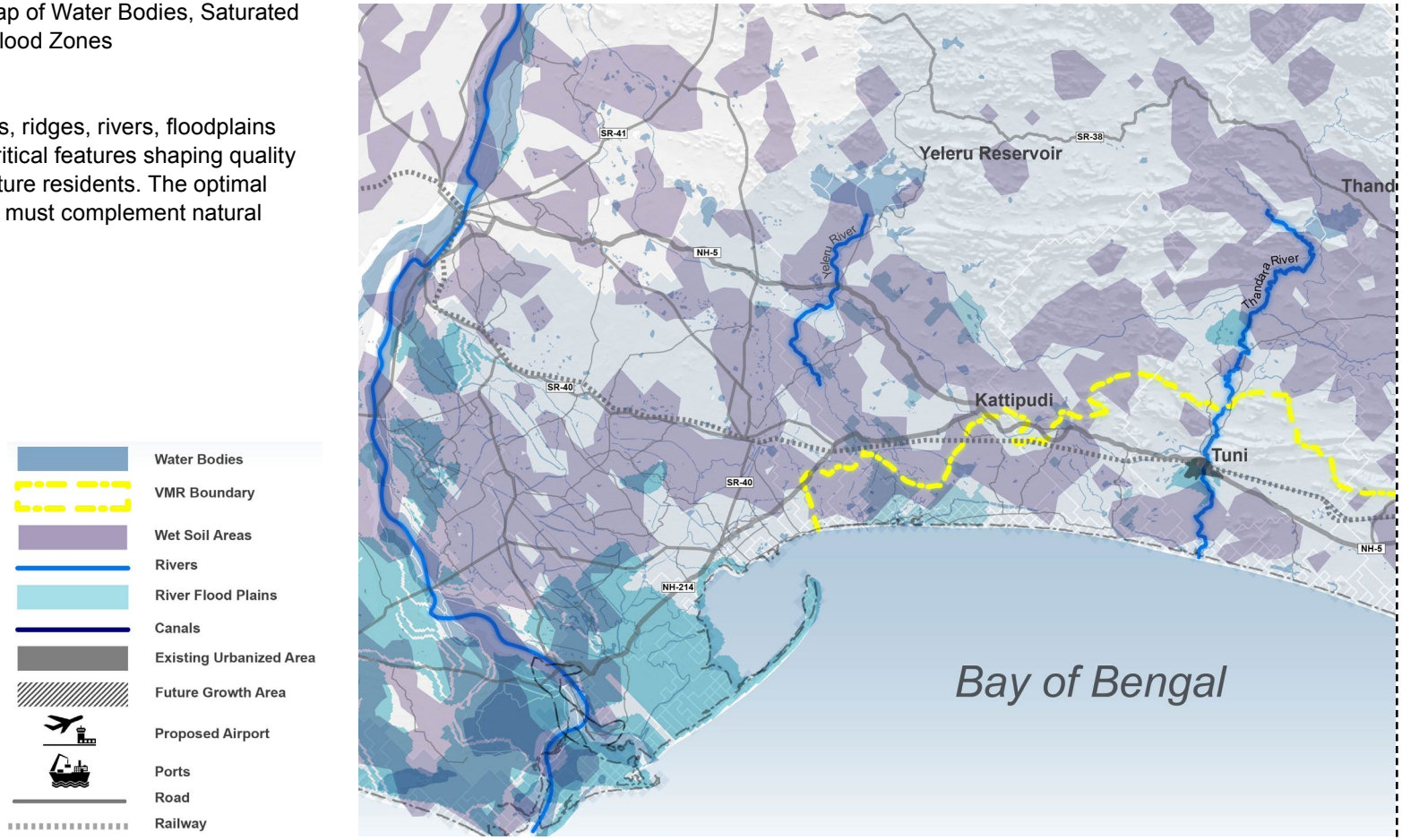
Challenges to Address

The proposed urban development framework addresses a range of socio-economic, environmental and economic challenges identified during the assessment phase. Additional socio-economic, spatial, and environmental challenges inform the proposed urban development framework. Insights from the Task 2 representative household survey have guided the tone for interventions as part of the Smart City Master Plan and Sector-Specific Projects. Survey findings verify many of citizens' concerns with quality and quantity of access to water, sewerage, energy, transit options, and a safe public realm. Field observation by the AECOM consortium team confirms these findings.

Another challenge is the current pattern of urbanization, and its conflicts with the existing water system, topography, and ecology. The Visakhapatnam regional study area includes greater Visakhapatnam and Vizianagaram, which are more intensely developed and connected, and lack the agricultural productivity of the diffused network of smaller towns, villages, industrial estates and agriculture that are also part of the greater regional study area. Agricultural land along transit and economic corridors has been the preferred land type for development in the recent past. Retrofitting dilapidated buildings/infilling vacant and reserved land within previously developed areas has been a less popular development option. This pattern of urbanization has occurred at times in conflict with the existing water systems, topography, and ecology, leading to erosion and increasing public health risks, such as flooding and landslides, ground and surface water pollution, and human settlement in areas with saturated, poorly-draining soils.

Figure 1.2 Regional Map of Water Bodies, Saturated Soils, and Flood Zones

The region's watersheds, ridges, rivers, floodplains and wetland soils are critical features shaping quality of life for current and future residents. The optimal pattern of future growth must complement natural systems.



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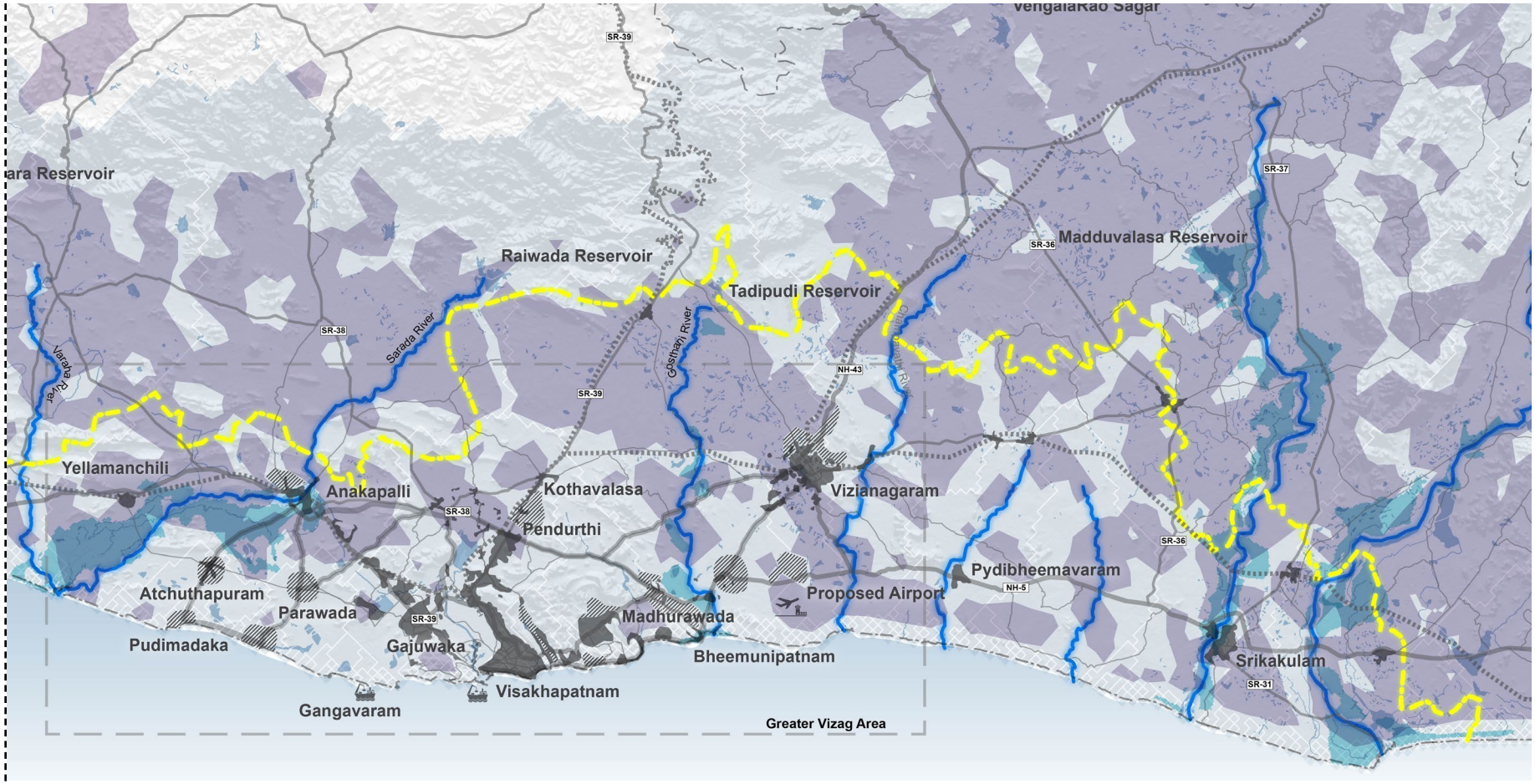

Raiwada Reservoir
Tadipudi Reservoir
Madduvalasa Reservoir
Sarada River
Gosthani River
Yellamanchili
Anakapalli
Kothavalasa
Pendurthi
Vizianagaram
Pydibheemavaram
Proposed Airport
Atchuthapuram
Parawada
Pudimadaka
Gajuwaka
Madhurawada
Bheemunipatnam
Visakhapatnam
Gangavaram
Srikakulam
Greater Vizag Area
SR-39
SR-38
SR-37
SR-36
SR-31
NH-43
NH-5

Match p. II-8

Alternative Growth Scenarios

As the VMR population grows to over 7.5 million people during the planning period, new growth areas must be planned, in order to accommodate population growth and preserve and enhance livability for all residents.

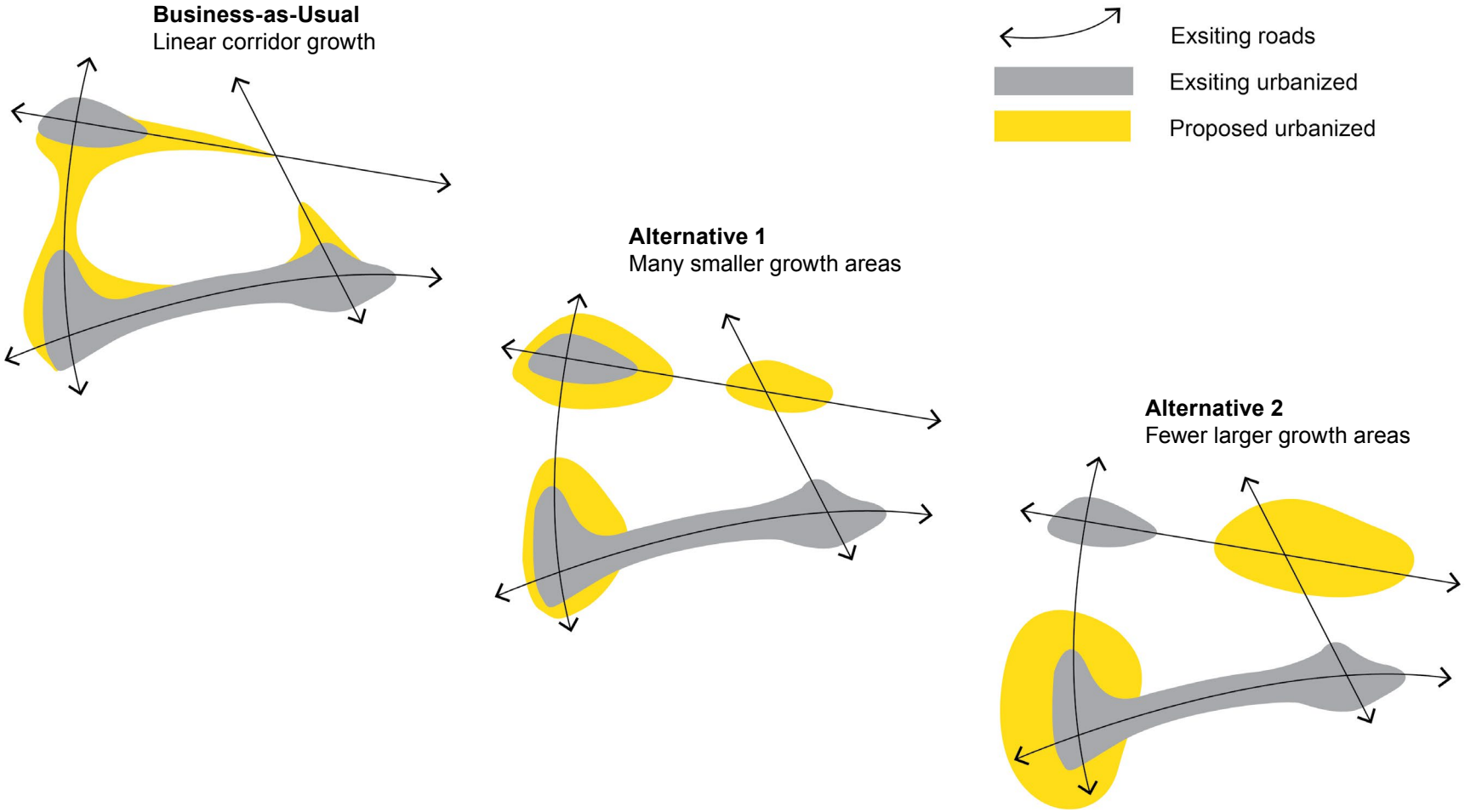
Given the limited densification potential that can be accommodated through infill development within existing localities, most of the new households and commercial growth will have to be accommodated through greenfield development. But the amount of land required, and the growth pattern for that expansion/development, will vary based on the predominant uses and density of the development type adopted.

Three alternative growth scenarios have been defined and evaluated using social, economic, and environmental criteria, with a view towards identifying a preferred scenario. These criteria include:

- The compactness of the metropolitan development pattern. Urbanizing land near existing built-up areas is both more effective and more cost efficient, as existing trunk infrastructure systems can often serve both existing and new areas. Siting of new mixed use residential areas near existing employment areas will shorten commute distances, which in turn enhances environmental quality and livability for residents, and can increase the competitiveness of the region's urban economy. The mean distance from the center of growth areas at build-out to major employment centers is used to evaluate the compactness of the development patterns.
- Sensitivity to the regional water system. Urbanization away from low-lying and flood-prone areas lowers disaster risk, reduces the incidence of mosquito-borne diseases, and avoids some of the negative impacts of urban growth on natural watersheds. Growth scenarios are evaluated according to the percentage of built area constructed on saturated (wet) soils, and the percentage of built area lying within flood plains.

The following three scenarios are explored in this section:

5. **Business-as-usual** – Assumes that existing urban development trends will continue. Also takes into account existing plans for local area development. Manifests itself as contiguous, often ribbon-style development along roads and on greenfield sites, sometimes in flood-prone areas.
6. **Alternative 1** – Future growth occurs primarily as infill development in existing urbanized areas, and incrementally within a number of smaller greenfield development areas adjacent to existing urbanized areas distributed throughout the greater Visakhapatnam region. Explicitly aims to achieve live/work balance at the sub-regional level, and to locate development in areas with suitable soils/ lower natural hazard risks.
7. **Alternative 2** – Future growth occurs primarily as infill development in existing urbanized areas, and incrementally within a few large greenfield development areas distributed throughout the greater Visakhapatnam region. Explicitly aims to achieve live/work balance at the sub-regional level and to locate development in areas with suitable soils/lower natural hazard risks.


Business-as-Usual
Linear corridor growth
Exsiting roads
Exsiting urbanized
Proposed urbanized
Alternative 1
Many smaller growth areas
Alternative 2
Fewer larger growth areas

In the Business-as-Usual scenario, 10% of the population growth would be accommodated through infill redevelopment, and the remaining 90% of the population growth would be accommodated through greenfield development. Assuming an average of 40 dwelling units per hectare (DU/ha), the total greenfield land requirement over the planning period is 15,903 hectares. This growth pattern yields a mean distance from growth areas to major employment centers of 7.87 km. Approximately 79% of the growth would be on saturated soils, and 27% would fall within floodplains.

In the Alternative 1 scenario, 20% of the population growth would be accommodated through infill redevelopment, and the remaining 80% would be accommodated through greenfield development. At an average of 40 DU/ha, the total greenfield land requirement over the planning period is 14,136 ha. This growth pattern yields a mean distance from growth areas to major employment centers of 3.33 km. 58% of the growth would be on saturated soils, and 11% would fall within floodplains.

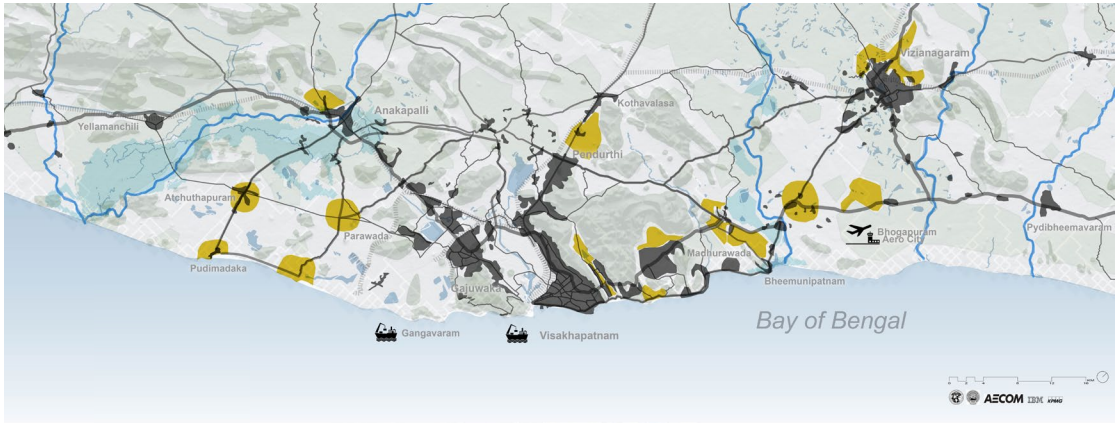
In the Alternative 2 scenario, 20% of population growth would be accommodated through infill redevelopment, while the remaining 80% would be accommodated through greenfield development. The total greenfield land requirement over the planning period is 14,136 hectares at an average of 40 DU/ha. This growth pattern results in a mean distance from growth areas to major employment centers of 3.33 km. About 56% of the growth area we be on saturated soils, while 11% would fall within floodplains.

Table 1.4 Evaluation of Growth Scenarios Against Criteria

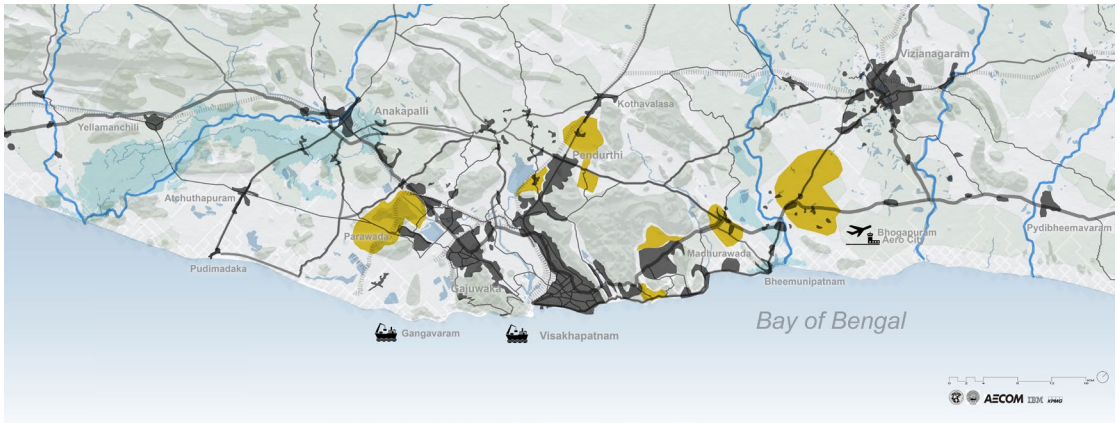
	Compactness (Mean distance from the growth area in 2030 to major employment centers)	**Sensitivity to Watershed** (Percentage of 2030 urbanized area within saturated soils)	**Sensitivity to Watershed** (Percentage of 2030 urbanized area within floodplains)
Existing Condition	>7.87 km	74.4 %	15.2 %
Business-as-Usual	7.87 km	78.92 %	27.4 %
Alternative 1	3.33 km	55.71 %	11.4 %
Alternative 2	4.26 km	55.71 %	11.4 %

The table shows that Alternatives 1 and 2 both achieve higher marks for compactness, as new growth areas are located closer to existing employment centers. They also interfere less with natural water systems than the “Business-as-Usual” scenario. Alternative 1 increases the proximity of new growth areas to existing employment centers more than Alternative 2 does, by dispersing the more compact, lower-impact development around employment centers throughout the region. As compared to Alternative 2, Alternative 1 is simpler and less costly to implement, because it takes advantage of existing trunk infrastructure (and therefore has lower per-unit development costs). Alternative 2 has the higher commercial risks associated with undertaking large satellite-city-type development in outlying locations, e.g., near the proposed Bhogapuram Aero City. (*Sometimes when you built it, they don’t come.*) Alternative 1 is considered the preferred scenario.

Business-as-Usual
Growth Scenario

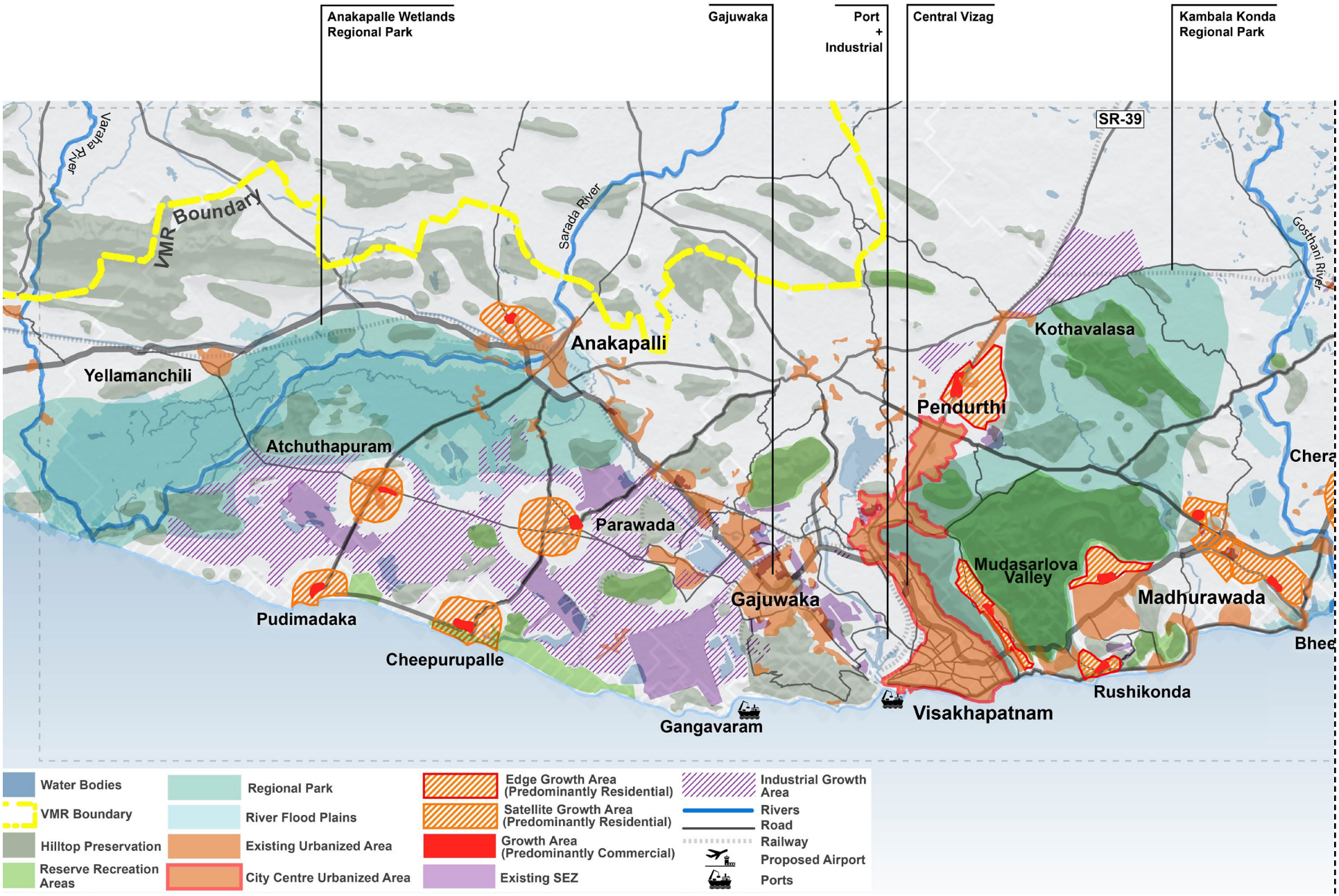


Alternative 1
Growth Scenario

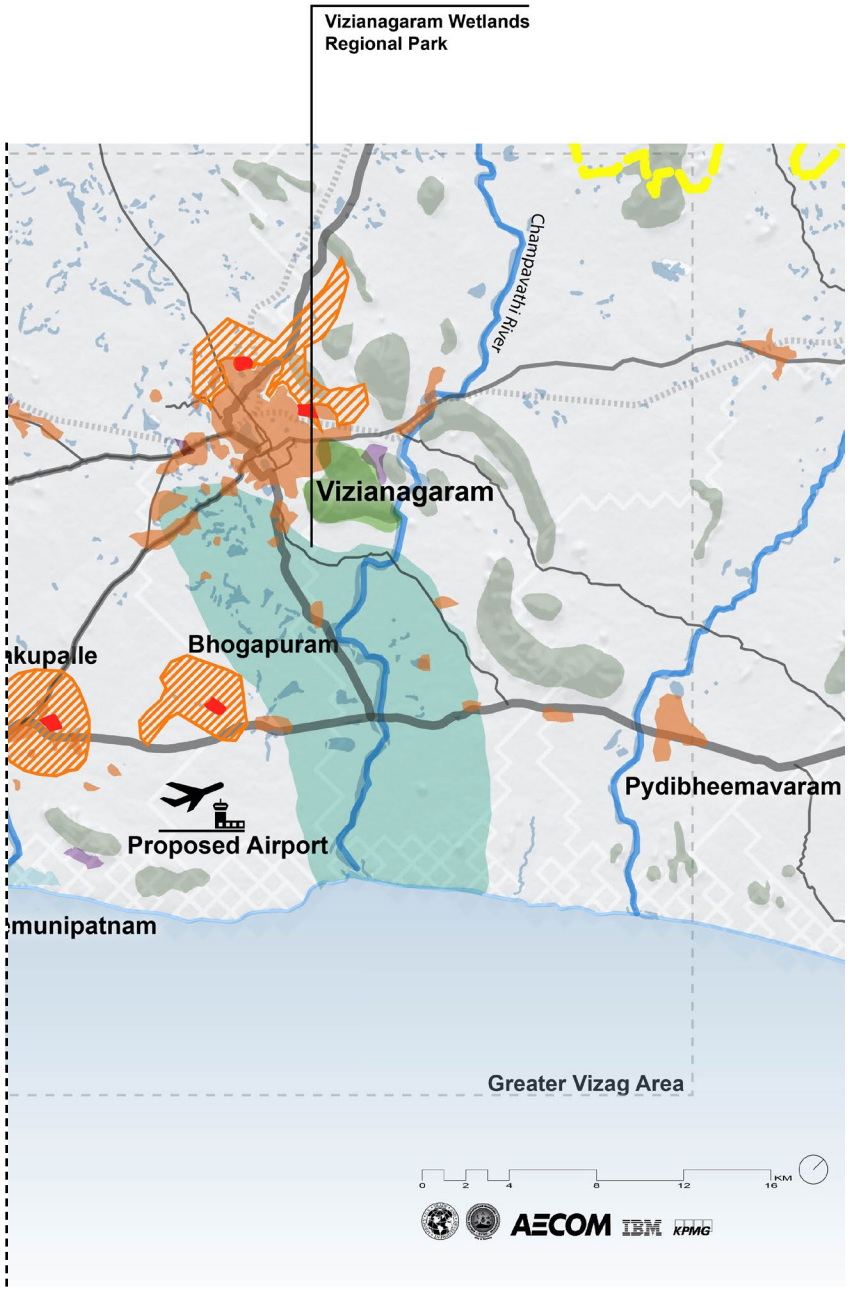


Alternative 2
Growth Scenario

Figure 1.3 Schematic Representation of Urban Development Scenarios



Match p. II-15



Match p. II-14

Settlement Typologies

A number of high-level development typologies have been formulated to serve as guidance for the nature and character of the different proposed greenfield development areas. These typologies are mixed use, mimicking existing land use patterns in Vizag, and reflecting international best practices for developing vibrant and sustainable communities. However, each typology has a predominant use that is either commercial or residential. There is also a density (and built intensity) gradient originating from the city's center, and spreading to the built-up areas at the urban edge and non-contiguous communities in more remote locations. The higher intensity of the more centrally-located areas reflects their complexity and socioeconomic functions within the metropolitan area.

The proposed settlement typology is not intended to replace the local area planning or zoning instruments in place in Vizag today. Rather, it provides a way to establish, at a high level, the character of each new development area, as well as the relationships among the 15 new greenfield areas in the VMR.

Figure 1.4 Transit Oriented Infill Typology for City Centre Growth Area

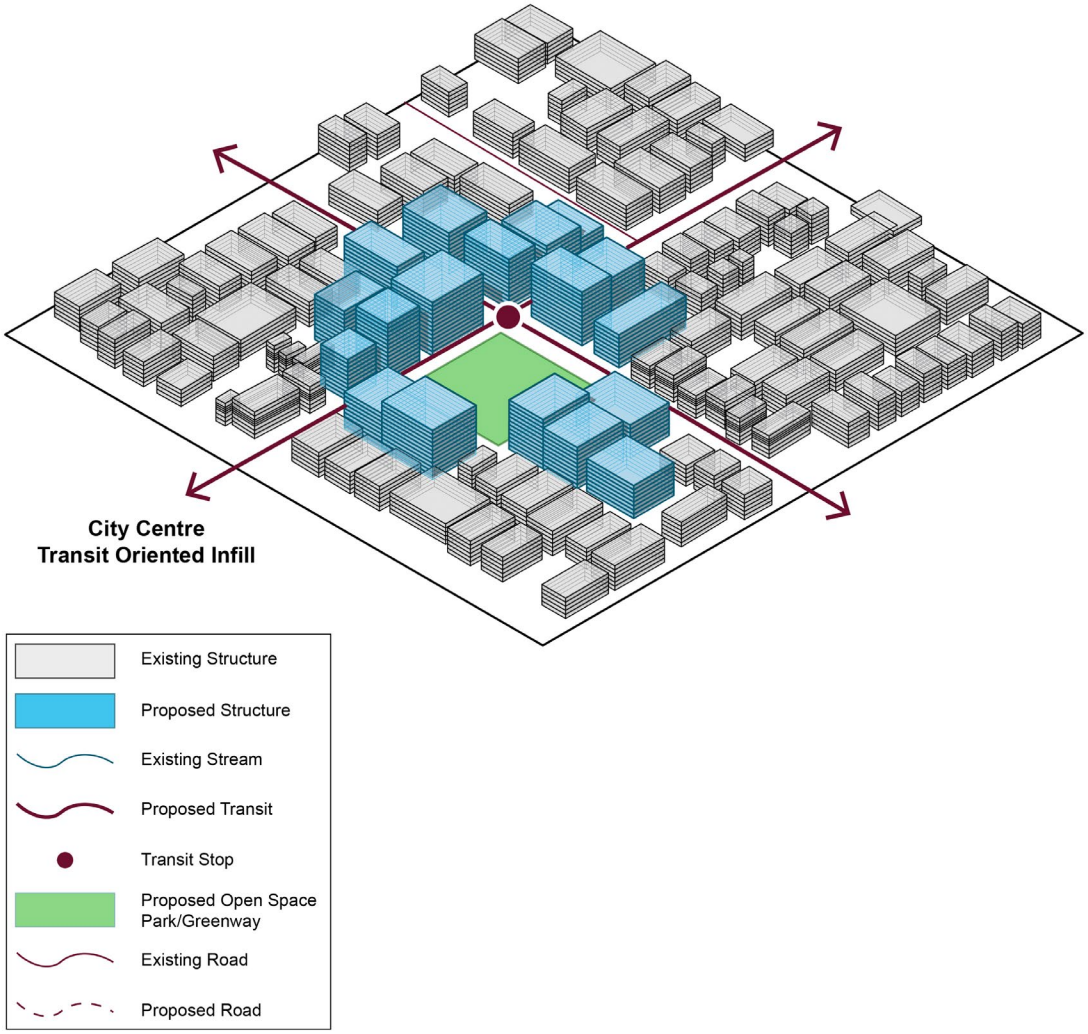


Table 1.5 Settlement Typologies Hierarchy

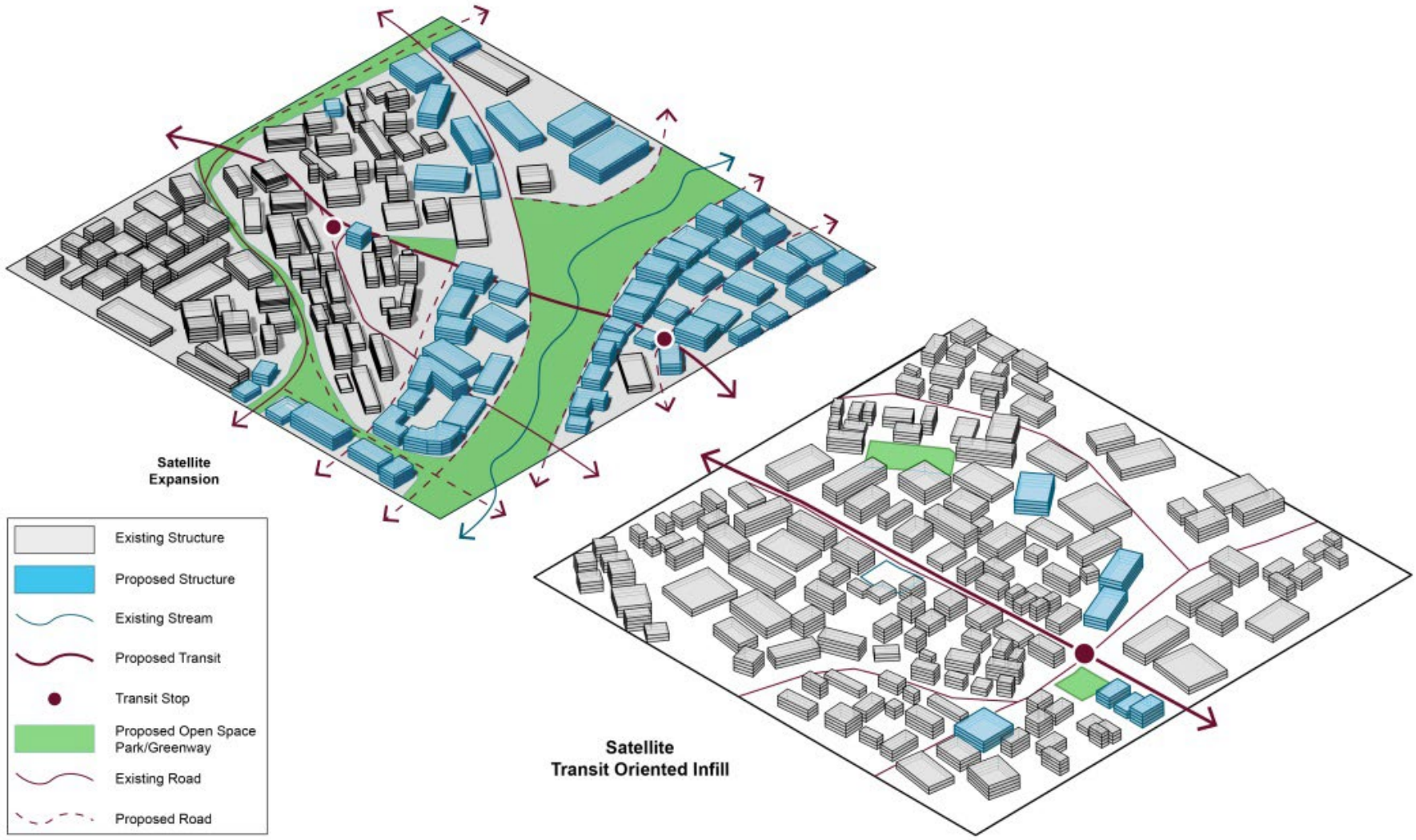
Type Number	Type Name	Allowable Land Uses	Average Density (DU/ha)	Maximum Building Height (stories)
1	City Centre - Commercial High Density	Primarily commercial; also residential, institutional	70	G+9 to G+13
2	City Centre - Commercial	Primarily commercial; also residential, institutional, low-impact industrial	50	G+4 to G+9
3	City Centre - Residential High Density	Primarily residential; also commercial, institutional	80	G+4 to G+9
4	City Centre - Residential	Primarily residential; also commercial, institutional, low-impact industrial	50	G+2 to G+5
5	Urban Edge - Commercial High Density	Primarily commercial; also residential, institutional	20	G+7 to G+9
6	Urban Edge - Commercial	Primarily commercial; also residential, institutional, low-impact industrial	40	G+3 to G+5
7	Urban Edge - Residential	Primarily residential; also commercial, institutional	40	G+3 to G+5
8	Satellite - Commercial	Primarily commercial; also residential, institutional, low-impact industrial	20	G+2 to G+4
9	Satellite - Residential	Primarily residential; also commercial, institutional, low-impact industrial	30	G+2 to G+4
10	Agricultural	Agricultural, Conservation	15	G to G+1
11	Industrial	Industrial	0	G to G+2

Figure 1.5 Expansion and Transit Oriented Infill Typologies for Urban Edge Growth Areas

Table 1.6 Breakdown of Land Use Typology by Polygon of Greenfield Development

Land Use Typology			Vizag Airport	Mudasarlova Valley	Madhurawada	Rushikonda	Pendurthi	Pudimadaka	Atchutapuram	Cheepurupalle	Parawada	Anakapalli	Bheemunipatnam	Cherakupalle	Bhogapuram	Vizinagaram	Total HH
Total Area	DU/ ha	ha	688	541	1,420	327	1,420	618	997	1,097	1,266	780	918	1,709	1,210	1,915	
City Centre Commercial - High Density	70	%															
		ha															
City Centre Commercial	50	%	15%														
		ha	103														
City Centre Residential - High Density	80	%	35%														
		ha	241														
City Centre Residential	50	%															
		ha															
Urban Edge Commercial - High Density	20	%					10%										
		ha					142										
Urban Edge Commercial	40	%		10%	10%	10%											
		ha		54	142	33											
Urban Edge Residential	40	%		90%	90%	90%	90%										
		ha		487	1,278	295	1,278										
Satellite Commercial	20	%						8%	8%	8%	8%	5%	5%	5%	5%	5%	
		ha						49	80	88	101	39	46	85	60	96	
Satellite Residential	30	%						92%	92%	92%	92%	95%	95%	95%	95%	95%	
		ha						569	917	1,009	1,165	741	872	1,624	1,149	1,819	
Households			**24,430**	**21,640**	**56,800**	**13,120**	**53,960**	**18,050**	**29,110**	**32,030**	**36,970**	**23,010**	**27,080**	**50,420**	**35,670**	**56,490**	**478,780**

Figure 1.6 Expansion and Transit Oriented Infill Typologies for Satellite Growth Areas



Area Vision Plan Summaries

Central Vizag

Context in Region
The proposed regional growth framework emphasizes using infill development strategies and building new settlements in close proximity to expandable existing infrastructure and employment centers. As the heart of regional employment, and the epicenter of both population and services, Central Vizag will need to accommodate future population growth within its boundaries, in order to maximize the benefit of both the existing and proposed infrastructure systems.

Socioeconomic Positioning
The central city must be able to support new residential, commercial, institutional and recreational amenities in order to achieve the city's overall potential. The development of mixed-use infill sites and a hierarchy of improved corridors for better connecting these destinations with existing hubs of activity are key components of the overall strategy.

Improved Connectivity Corridors
The Central Vizag Area framework includes the following key connectivity and mobility enhancements:

- **Improved Primary Corridor** – Enhanced corridors with improved ITC, signalization, pedestrian space and multi-modal transport amenities.
- **New Primary Corridors** – New streets, pedestrian space and adjoining development built to better connect segments of existing primary corridors.
- **Port Logistics Route** – New roadway built to better convey port traffic.
- **Bus Rapid Transit (BRT)** – Enhanced and expanded routes for ICT-enabled dedicated bus facilities
- **Metro Rapid Transit (MRT)** – New corridor for metrorail access connecting northeast to the new Airport and Southwest to Anakapalle.

Local Development Strategies
The Central Vizag Area framework includes the following key infill development opportunities:

- **Lavender Canal redevelopment** – Redevelopment along the eastern edge of a restored Lavender Canal. This will be completed along with new Port access road along the west side of the canal.
- **RTC transit oriented development** – Redevelopment of the exiting RTC complex to better integrate mixed-use development and multimodal connections between pedestrians, vehicles, BRT, and MRT, along with spaces for supporting amenities, and livelihood-generation through restaurants, rest areas, entertainment, and retail.
- **Gateway development** – Mixed-use infill development south of the Train station at the intersection of Port Main RD and Route 39.
- **Beachfront redevelopment** – Infill of new residential, hospitality, cultural, and recreational amenities along the Beach Rd.
- **Airport redevelopment** – After the new airport comes on line, the current airport site could be redeveloped to create new flood-protected, transit–oriented, mixed-use development opportunities, and a system of wetland parks along the waterfront.
- **Cruiseship Terminal** – Establishing a docking pier and associated retail/commercial tourism amenities that reinforce beachfront destinations and Old town area.
- **Fishing Harbor** – Modernizing the fishing harbor will include upgrades to facilities and water, energy, and structural infrastructure, for use in the operation of fishing boats, bunkering, cold storage, maintenance, and ecologically-responsible hygienic waste-handling by the fishing community, wholesalers, retailers, small vendors, retail buyers, and transporters.
- **Ryuthu Bazaars** – Modernization of existing markets will include upgrades to infrastructure for farmers, traders, transporters and customers, including hygienic restroom and waste processing facilities, rest areas, lighting, and circulation.
- **Poorna Market** – Enhance existing energy, water, circulation, and payments infrastructure

Figure 1.7 Proposed Regional Growth Framework in Central Visakhapatnam

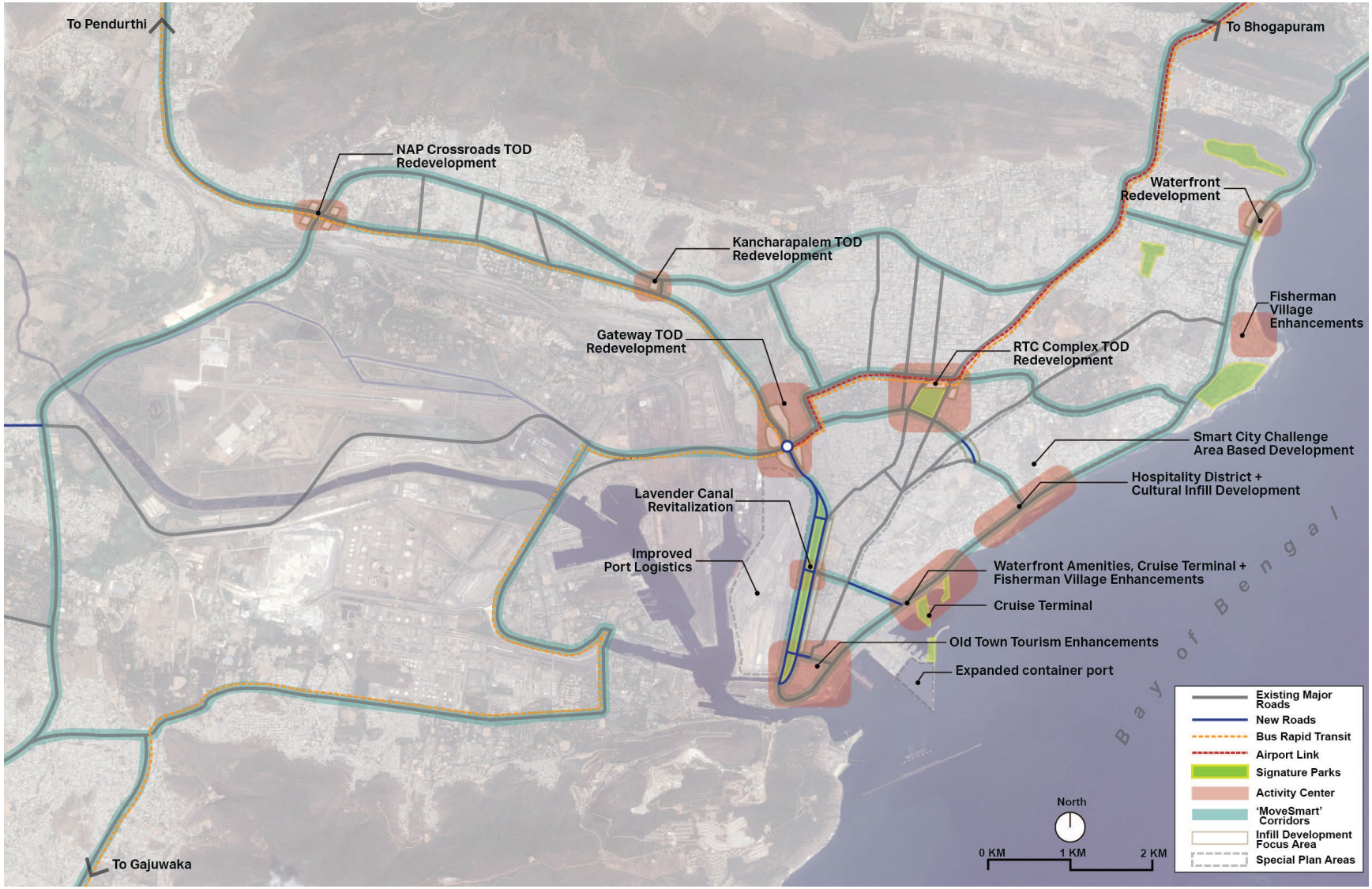
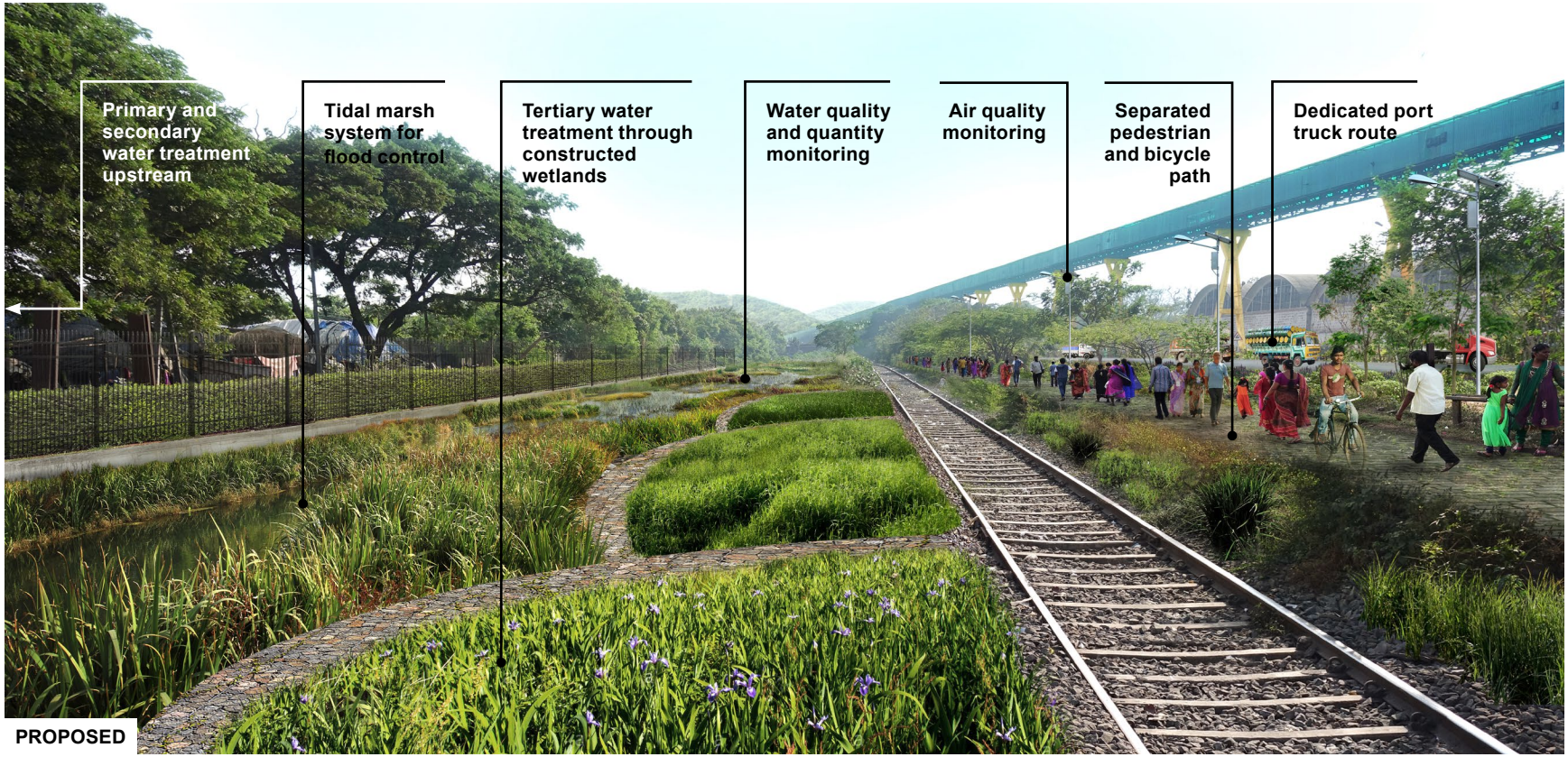
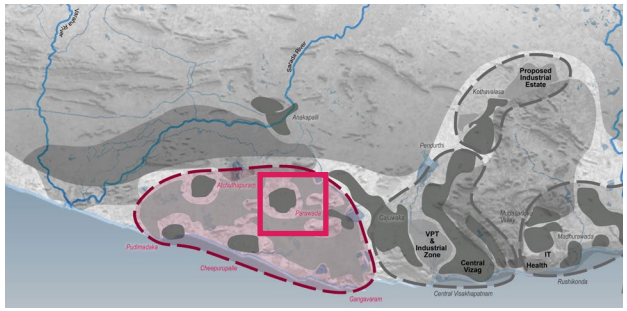


Figure 1.8 Lavender Canal Existing Conditions

Figure 1.9 Proposed Tertiary Water Treatment and Public Realm Rehabilitation at Lavender Canal





Parawada Area

Context in Region

The proposed regional growth framework targets the area southwest of Gajuwaka for industrial growth that will be served by compact villages offering services, amenities, and residential opportunities for employees. The area surrounding Parawada exemplifies how existing villages can be expanded to better serve growing populations, reduce commuting times, and support adjoining industrial development while promoting a higher quality of life.

Socioeconomic Positioning

Near Parawada, existing village clusters are in relatively close proximity to one another at the intersections of major thoroughfares. These villages are within 3 km of Pharma City, 4 km of the NTPC power plant, 10 km of the steel plant and 14 km of the Brandix complex. By sensitively expanding these villages and others in the area nearby, they will be well-positioned for future industrial growth, and in the meantime, employees can easily commute to existing industrial destinations.

Improved Connectivity

The proposed Parawada-area framework suggests the following mobility enhancements:

- Connect the fragmented primary road network to improve the flow of traffic, and establish locations for new commercial centers.
- Connect the heart of the new community to nearby industrial estates with both circulator bus routes and bus routes to and from Central Vizag.

Local Development Strategies

- The Parawada-area framework suggests the following local development strategies:
- Develop new housing areas between the three existing villages.
- Create a mixed-use activity hub at the center of the new development that can serve adjacent existing villages.
- Surround the development area with an agricultural preservation zone and a forest preservation area, located on the hill tops to the east.

Figure 1.10 Proposed Regional Growth Framework in Parawada

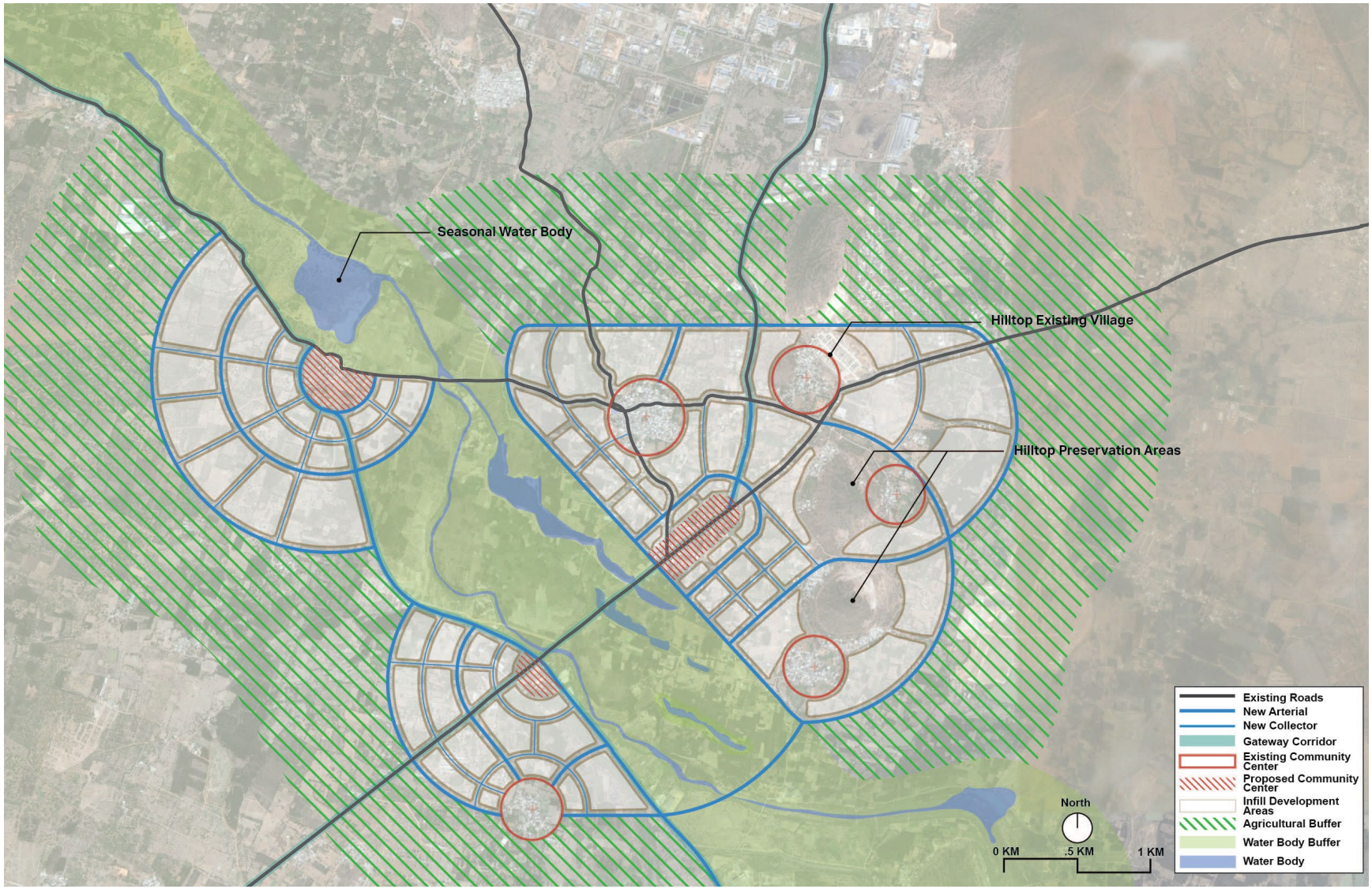
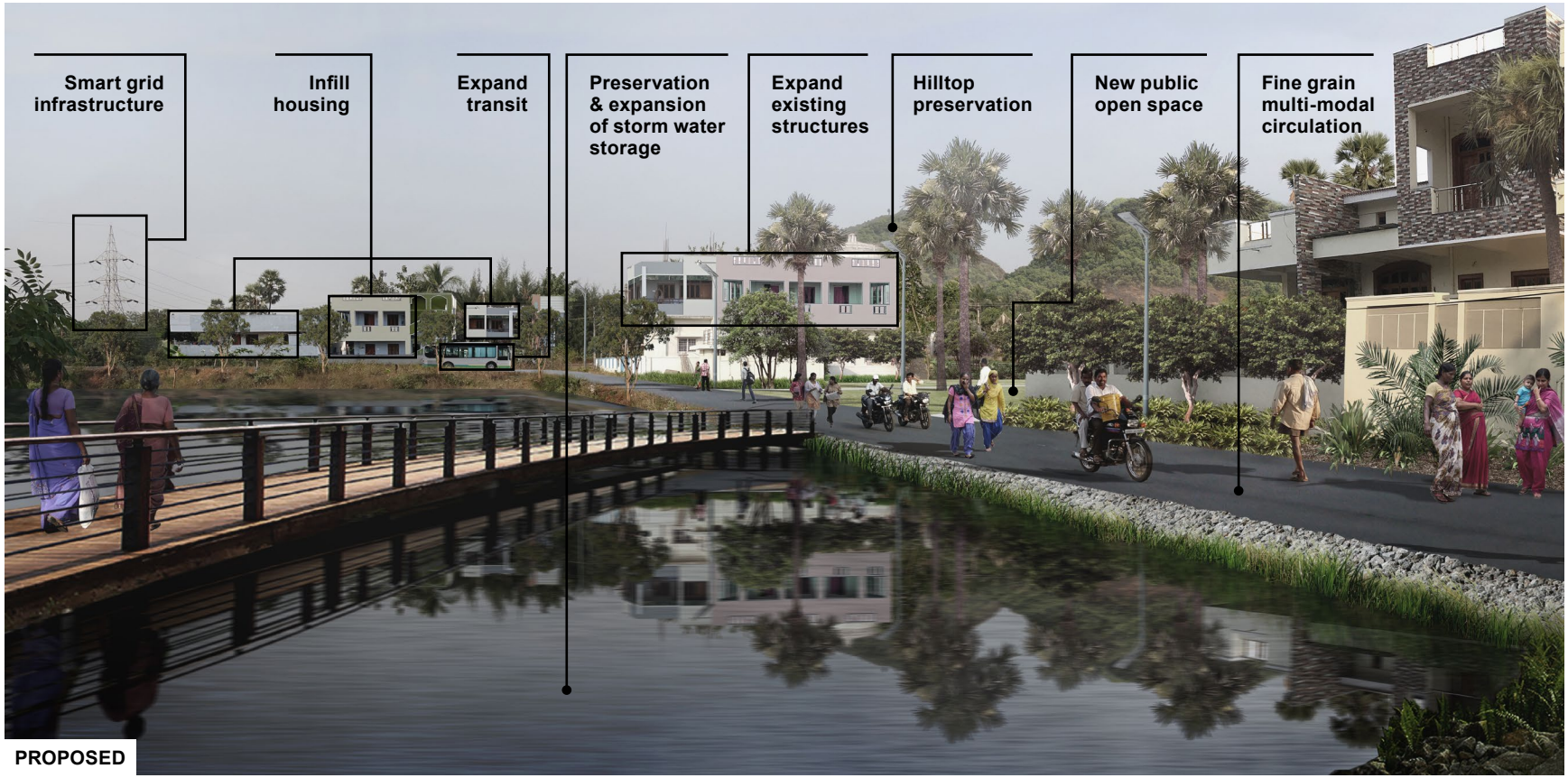
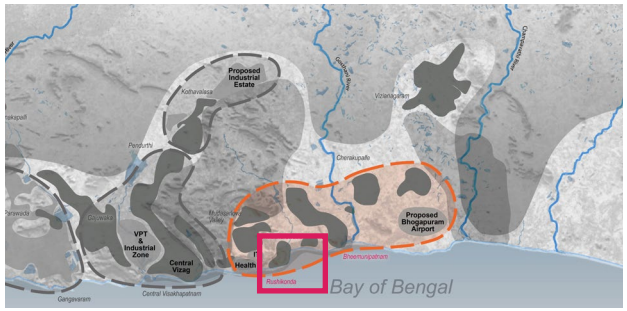


Figure 1.11 Parawada Community Existing Conditions

Figure 1.12 New Housing, Mixed Use Activity, and Water Storage Enhancements at Parawada

Figure 1.13 Stormwater Catchment and Groundwater Recharge at Parawada





Rushikonda Beach

Context in Region

The proposed regional growth framework emphasizes using infill development strategies and building new settlements in close proximity to expandable existing infrastructure and employment centers. As the core of regional knowledge industry employment,, Rushikonda will need to provide housing, additional knowledge industry and support livelihoods, recreation, and social amenities to meet growth demands. New parks, open spaces, and waterways will model low impact development for the region by employing green infrastructure and waterway rehabilitation projects.

Socioeconomic Positioning

One key node in the coastline is Rushikonda, an area of natural beauty that also has significant economic development potential. The growth of the Rushikonda area will build on the tourism potential of the oceanfront, and the development potential of the nascent IT sector, to create an integrated, high-quality “live, work, play” environment

Rushikonda will be developed as two distinct zones, with complementary economic functions and urban characters. The southern zone will be developed along the coastline (Ocean Drive) as a center for domestic beach/recreation tourism. The target market will be upper-middle-income Indian tourists, similar to those that already come to Vizag in significant numbers. There will be small “boutique” hotels on or near the beach, with some mid-sized resort hotels along the stream and facing the sea (see schematic plan diagram). One 5-star hotel on the peninsula at the southern end of the beach will cater to high-income visitors to Vizag.

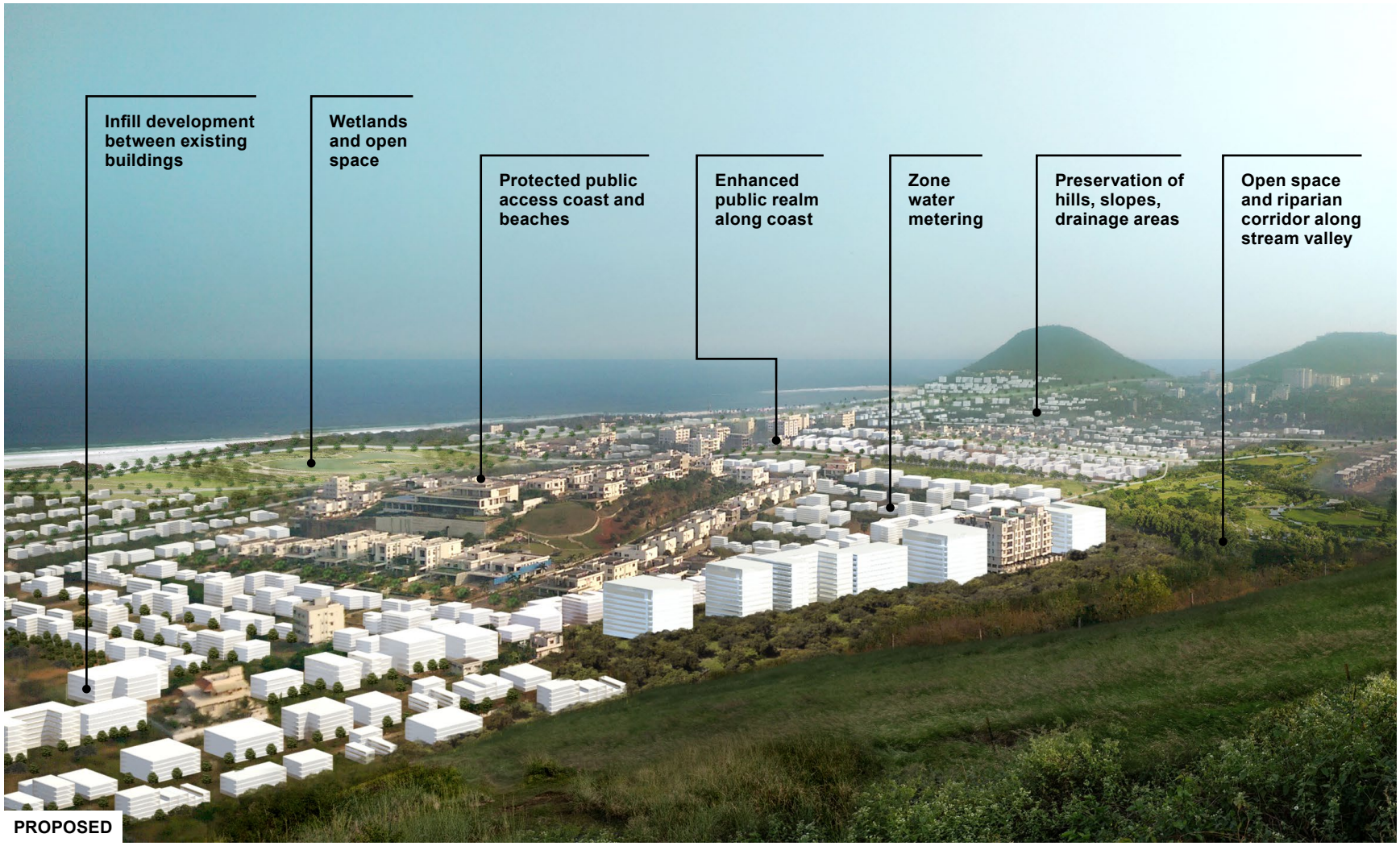
In contrast, the proposed growth framework for the northern zone builds on the existing “IT City” on top of the ridges to create a vibrant, mixed-use seaside town. The residents are anticipated to be mostly members of the “creative class” that work in IT, R&D, education, and related fields that require highly skilled workers. The atmosphere of the town would resemble the highly liveable and attractive towns located on the coast of California, USA, like Santa Barbara, for example. The area in the valley in between the ridges and the sea will be developed as medium-to-lower-density housing, and will include local retail and services. The area will be pedestrian and bicyclist-friendly, and will incorporate high-quality public spaces. Infill housing would allow residents to travel short distances to the “knowledge industry” jobs in the IT City and in nearby Madhurawada. The area along the shoreline will be developed for entertainment uses. The dunes and beach on the east side of Ocean Drive will be a “no build” area, set aside for public access and use.

Rushikonda naturally divides into several distinct zones, each of which could develop its own distinct land uses that would accommodate different functions and activities.

Figure 1.14 Proposed Regional Growth Framework in Rushikonda

Figure 1.15 Rushikonda Existing Condition

Figure 1.16 Infill Development, New Parks and Waterway, And Hill Conservation at Rushikonda



Ocean Drive

At the southern end, beginning at Rushikonda Point, the existing hospitality and tourism uses could be augmented with additional hospitality and entertainment options on a similar scale, using the Beach Road as a retail and dining “corniche” that connects the beachfront and beachfront views with hospitality options and a mix of uses. This area could capitalize on beachfront development for tourism and recreation, and provide a mix of uses, extending out to the natural greenway to the ocean. Beyond this area, it is recommended that development be less dense.

Town Center South: The “College Town”

Across the Beach Road, a mixed-use area will build on the presence of GITAM University and existing university housing to support tourism development. A mix of uses will be located on existing major roads, with a denser block layout and some mid-rise (G+4) development. Open space (intentionally identified for active use) and natural features would be preserved to form natural edges. These greenways and topography would support the denser development to the north of GITAM. A new neighborhood center with local retail and services can be located inland, away from Ocean Drive. This area would facilitate improved transportation throughout the region, with enhanced linkages to Madhurawada, Health Valley, and other inland areas.

Town Center North: Live/Work/Play by the Sea

To the north of the natural greenway area, Rushikonda would be developed at a lower density, but with a similar character, with a defined block network and a center of activity away from Ocean Road. While the waterfront would continue to be a point of reference and a commercial zone, tourism options would be more limited. The presence of existing IT and "creative class" employment provides a basis for the continued development of "knowledge industry" and IT jobs, with the addition of residential options that might attract the employees of these industries. While still compact, this area would be lower-density that the southern area, (G+1 to G+3), and the grid and site lines would be strongly oriented towards the coast. Leveraging the higher incomes and associated expectations of workers and residents, this area would develop a more modern, "higher end," exclusive feel. A neighborhood center could be developed around a common park or plaza inland from the beach.

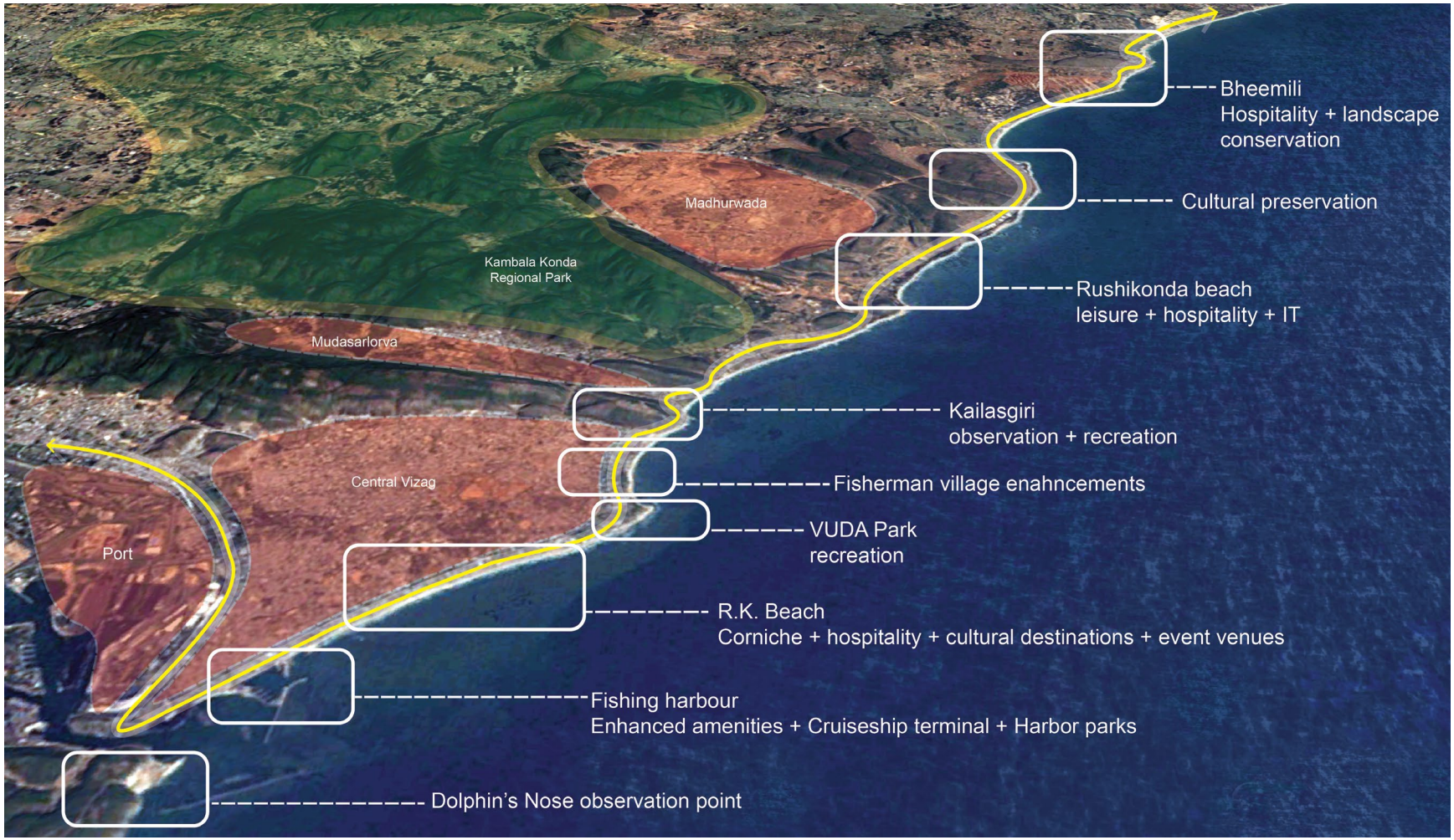
Local Development Strategy

The Rushikonda area framework suggests the following local development strategies:

- Critical to supporting the development of Rushikonda is the recognition that the area's ecological assets provide significant value, and should therefore be protected. In particular, development should be extremely limited along the ridges, and beachfront development should be very sensitive to the environment, especially water sector and green infrastructure networks.
- Guidelines supporting appropriate building use and height should be developed and enforced. Additionally, a high-level architectural character for the area should be established and implemented. This would support a sense of character and of place that would help attract employees and residents.
- Supporting core infrastructure should be designed to support the anticipated development density, be environmentally sensitive, and meet the standard of its anticipated users.
- Development partners that have specific experience in the desired development type should be identified, and tax incentives/TIF tools should be evaluated as a way to attract and secure desired partners.

Coastal Development Strategy

Figure 1.17 Proposed Coastal Development Strategy



Context in Region
The regional growth framework aims to maximize the potential of one of Vizag's "Unique Selling Points:" its coastline. The coastal development strategy covers the entire oceanfront, from the port in the south to Bheemilipatnam in the north. As context for the planning framework for Rushikonda, the diagram below and associated text identify the future positioning and character of the different segments that make up the coastline. The contract among the different segments is intentional, and is central to the successful development of the coastline. The Coastal Development strategy aims to facilitate the delivery of public and private sector investments along the oceanfront, and support integrated development opportunities.

Socioeconomic Positioning
A coastal system that integrates component sites is critical to increasing tourism along the regional coast per the Andhra Pradesh Department of Tourism's planning agenda. Physical and programmatic infrastructures link the sites and reinforce the coast as a continuous set of livelihood, recreation, ecological and cultural experiences.

Local Development Strategy
The Coastal Development Strategy suggests integration of the following:

- **Modernization of the fishing harbor with enhanced amenities and harbor parks**
  Fishing communities will benefit from enhanced cold storage monitoring an inventory management, maintenance and operations facilities, and data generation, analysis, and communication on catch quality and quantity, climate, and safety. Residents and tourists will enjoy improved harbor parks.
- **Corniche with hospitality and cultural destinations, event venues along R.K. Beachfront**
  A wide signature public realm along the R.B. Beachfront will provide residents and tourists with continuous pedestrian experiences, infrastructural support for festivals and events, and integrate the numerous cultural heritage assets along the beach.
- **IT industry offices, leisure and hospitality destinations along Rushikonda Beachfront**
  Infill growth in the Rushikonda area will build on the tourism potential of the oceanfront, and the development potential of the nascent IT sector, to create an integrated, high-quality "live, work, play" environment.
- **Natural heritage preservation along the Kapuluppada and Thimmapuram coast**
  Preservation of sand dunes, grass habitats, wetlands and beaches will provide high value natural heritage experiences for residents and tourists along the coast.
- **Hosptality destinations and natural asset conservation at Bheemilipatnam**
  Activity: Small-scale hotels, restaurants, coastal parks and trails will support a range of experiences around the coast, lifestyle amenities, and coastal habitats.
- **Observation points, recreation, and natural asset conservation at Dolphin's Nose, Kailasgiri**
  Residents and tourists will trek, picnic, and enjoy dramatic views of the Viskahapatnam's coastline at Dolphin's Nose and Kailasgiri hills through a network of low-impact walking trails, seating areas, and scenic overlooks.

III. OPEN SPACE

Introduction

Vizag's open space system informs the plan's proposed growth patterns, and provides the guiding framework to achieve both "Green Living" and "Smart Business" aspirations. This framework layers different strategies to protect and improve environmental quality and public health, as well as make visible Vizag's unique features of livability. In many cases, these features will drive economic value and contribute to the region's brand identity. These strategies will also help determine the sites of future settlements and employment centers in a manner that will protect public health, and streamline logistics for doing business. The individual layers form a connected system to preserve unique environmental features, provide valuable ecosystem services, and support urban resilience. These elements are described below, and are organized based on the intensity of the design, from least to greatest, and from larger-scale regional policy to finer-grained urban destinations.

Floodplain-Sensitive Development

The region's riverbanks draw settlements and industrial operations, due to the need for access to potable and process water, and because of the natural logistics advantages offered by waterways. But the flood risk associated with riverbank activities threatens the public health and economic stability of riparian businesses. In addition, establishing and maintaining

public services within floodplains can also increase capital and operational costs, significantly hindering their ability to efficiently serve households and businesses. New growth shall be located outside 100 year floodplains, as mapped by the APSDPS Planning Department, to the greatest extent practical.

In some cases, floodplain development has already taken place, or will be unavoidable in the future for certain water-dependent uses like ports and beachfronts, or treatment plant facilities, where gravity dictates their siting. In those cases, specific design attention shall be paid to anticipating flood flows, planning for the protection of critical structures, and shaping the land to guide, receive and manage the flow of water. Overall, new construction within the delineated 100-year floodplains shall be avoided, unless a floodway strategy has been developed that manages inundation risk through siting of structures, adaptive architectural design, and appropriate landscape treatment.

Wetland/Wet Soils Conservation

Due to the region's climate, geology, and topography, large areas of ground are saturated with moisture during and directly after the monsoon season. A network of irrigation canals, combined with the impacts of rice cultivation, increases this saturation. This phenomenon spurs economic and ecological productivity. The saturated soils support agricultural operations, and act like sponges that retain stormwater runoff, helping to recharge aquifers and reduce flooding in nearby river systems. However, these saturated soils also pose challenges to urban development, in that they are structurally less suitable for large buildings, and their moisture content exacerbates issues with mold and mosquito-borne disease. Due to their ecological and economic benefits, and their poor suitability for development, these soils should be preserved for agriculture and wetland conservation.

Areas of wet soil should be conserved, with residential density in these areas limited to no more than 5 dwelling units per hectare, and industrial, commercial, and institutional uses should be avoided. For the purposes of planning and regulation, wet soils shall be defined as those having a Normalized Difference Water Index (NDAWI) value of .6 – 1.0 in the second fortnight of September 2016. These soils were measured with the highest soil moisture content following the 2016 Monsoon season. Mapping of these soils is produced by the Government of Andhra Pradesh Integrated Seasonal Monitoring system, and can be found here: http://www.apsdps.ap.gov.in/drought/drought_report.pdf

These soils are mostly found within the southern and northern extents of the VMR. Most of the dryer, more development-friendly soils are found within the greater Vizag area.

Forest Preservation and Establishment

The region's forest lands play an important role in maintaining air quality, preventing erosion, providing habitat, sequestering carbon, and filtering runoff. They also contribute greatly to the visual beauty and perceived health of the region. The loss of the benefits of these forests due to development could be detrimental to public and environmental health. Development within these lands is also unnecessary, as there is plenty of inventoried non-forested land available for development. Existing forest stands, as identified per National Forest Policy and all GOI, GOAP reservations, should be protected, and their productivity improved through active management. In addition, new forest patches and corridors should be established, and connected with larger forests. These forested green corridors can coincide with the greenway systems discussed later in this chapter.

Hilltop Preservation

The Konda landform, rising from the flat valley floor, is a unique feature of Andhra Pradesh that directly and indirectly contributes to the region's "green living" persona. The hills act as ecological preserves, recreational destinations, and cultural attractions. They enhance waterfront vistas along the coast, and frames Andhra Pradesh's coastal cities. The hills segment Vizag into discrete sections, breaking down the perceived scale of the city, and providing a continual green backdrop to the urban panorama. The resulting urban form is strikingly beautiful, with white cities nestled among green hills.

Recent development north of Vizag, such as the IT City west of Rushikonda beach, has gravitated towards the hill tops. While the views of the Bay from these locations is magnificent, their value does not justify the aesthetic and ecological losses associated with degrading this natural landform. The forested kondas throughout the region serve critical public purposes, not only by providing a pleasing aesthetic experience, but by maintaining forest cover and reducing dangerous landslide potential on the steep hillsides. Privatizing the hill tops not only reduces natural beauty and the collective value of the surrounding valleys, but also increases the risk of erosion and potentially hazardous landslides.

Hilltop development should be halted. Hospitality and innovation-industry uses are better integrated into mixed-use communities in the valleys clustered with residential opportunities. In this location, it is easier to serve the developments with utility and transportation infrastructure, and there is more opportunity for synergy between existing communities and new growth areas. Hilltops, their sideslopes, and a 50-meter buffer at the toe of slope should be preserved in vegetated cover to mitigate erosion and landslide risk, reinforce the "Green

Living" identity, and strengthen valley communities. These hilltops shall be accessible by pedestrian paths that provide the public with observation points and access to recreation.

Reservoir Protection

The region's water supply reservoirs are critical infrastructure that must be protected in order to ensure the quality of drinkable water. Each reservoir must have a buffer zone of 50 meters from the high water line to prevent stormwater runoff from impervious surfaces and encroachment from conflicting land uses. This buffer should be vegetated in a manner that protects water quality, filters run-off, and supports passive recreation and wildlife observation.

Regional Parks

Establishing regional parks at key locations can help conserve unique cultural and environmental features, and help inform the region's "Green Living" identity. These parks could be marketed as tourist attractions, contributing to the public's perception of the region's livability, through the preservation of sensitive habitats and visual resources. Regional parks could be designated and maintained by the state government and, like parklands in North America, maintain existing residential dwellings where needed. Strategic locations for regional parks include the Kambala Konda Mountains and Valleys North of central Vizag, and the riparian wetland system and floodplain south of Annakapalle and Southeast of Vizanagram. These three park locations frame the greater Vizag growth area, and protect ecosystems from the hilltop to the river valley.

Parkways + Greenways

National highways and state level routes currently provide the only connections between cities, towns, and rural areas for pedestrians and cyclists. These routes carry high-speed traffic, and as population increases, will create more and more challenges for multimodal connectivity. Additional capacity for slower-speed traffic could be accommodated by linear greenways that parallel new or enhanced roadway corridors. These greenways could support slower-speed traffic, provide designated space for vendors, manage stormwater runoff, and create linear vegetation corridors that provide valuable ecological services. Signature parkways could be developed within the Regional Parks to accentuate the landscape and draw additional tourism. Similar facilities could be constructed adjacent to canals that connect settlements throughout the VMR. Additionally, existing and proposed roadways through regional parks could be retrofitted or designed as parkways that limit access, provide scenic experiences, and become tourist attractions in their own right. Greenway and parkway corridors should be maintained at 500 meters wide to allow for the establishment of linear forests, connecting larger patches of forest preserve and Konda vegetation.

Oceanfront Venues + Amenities

The Vizag beachfront is a significant attraction for residents and visitors alike. To maximize its potential as an urban amenity, improved water, power, and sewer services are needed, as well as improved access, at key locations of high activity. These activity hubs must be developed to better support programmed events and regular usage throughout the year. In addition, these locations can be enhanced to support signature events and concessions that build Vizag's cultural identity and activate the beachfront.

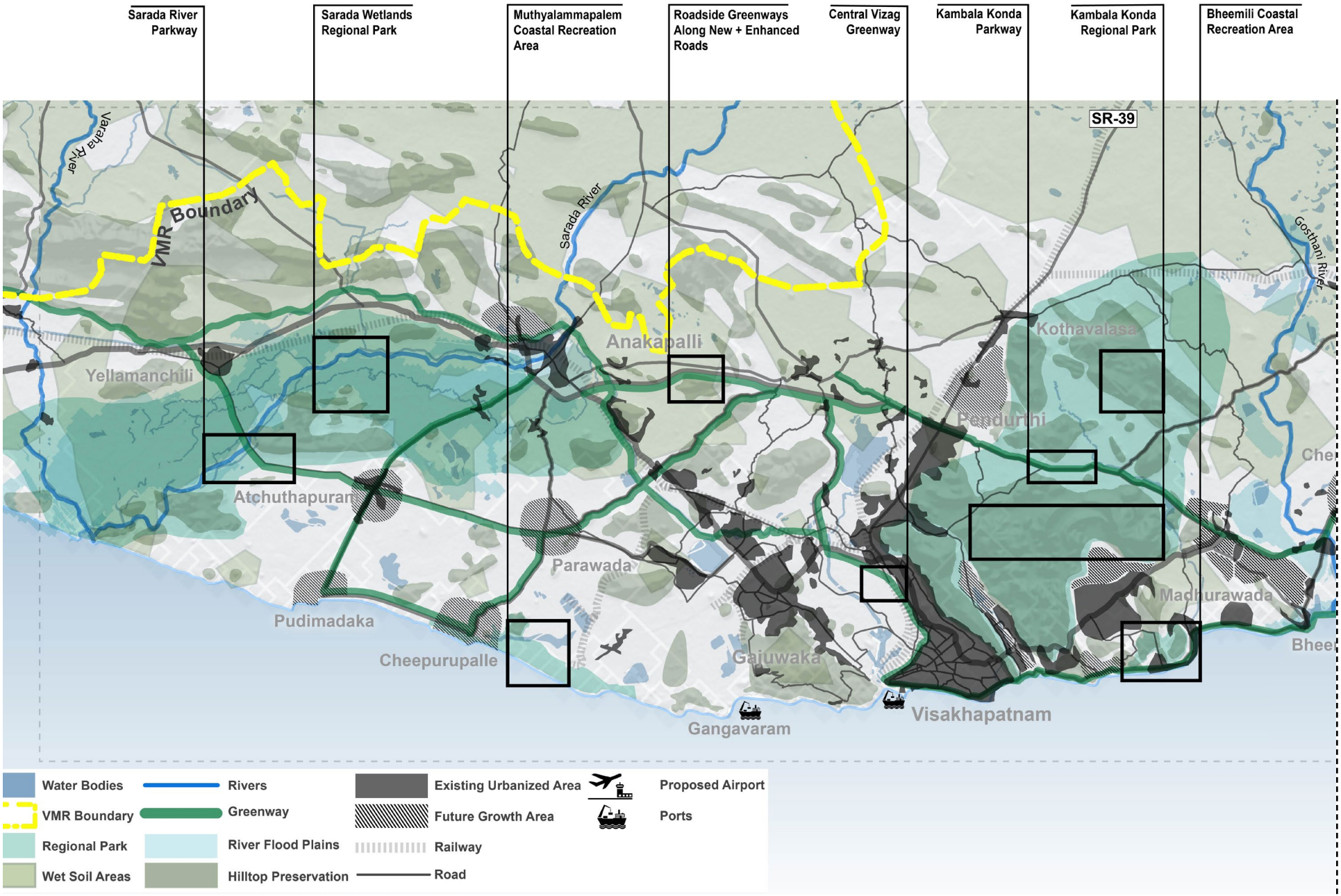
Urban Parks

Providing adequate park space within the GVMC and other urbanized areas is an important part of achieving "Green Living" aspirations. Access to properly-appointed urban parks can improve health outcomes and encourage social cohesion between neighborhoods. Urban parks can be larger-scale signature destinations or smaller neighborhood parks:

Signature destinations - support city-wide events and provide attractions and unique amenities. These parks are larger in size, appeal to tourists, can generate revenue, and can also provide significant ecological services, such as water filtration, flood protection, and habitat conservation. Example signature destinations already existing in the GVMC include Kailashgiri VUDA Park along the coast, and VUDA Central Park in the heart of the city.

Neighborhood parks - provide residents with both active and passive amenities like seating areas, playgrounds, and gardens. They provide focal points within the community, and are located at regular intervals throughout the city to minimize walking distance.

The GVMC today includes 1.2 acres of urban parkland and beachfront per 1000 residents. As a point of comparison, The Trust for Public Land's 2015 research on urban parks space found that the highest-density cities in North America had a median of 7.0 acres of urban parkland per 1000 residents within a range of 0.8 - 35.0 acres per 1000 residents.


Sarada River Parkway
Sarada Wetlands Regional Park
Muthyalammapalem Coastal Recreation Area
Roadside Greenways Along New + Enhanced Roads
Central Vizag Greenway
Kambala Konda Parkway
Kambala Konda Regional Park
Bheemili Coastal Recreation Area
SR-39
Jalada River
VMR Boundary
Sarada River
Gosthani River
Anakapalli
Kothavalasa
Yellamanchili
Pendurthi
Atchuthapuram
Parawada
Madhurawada
Pudimadaka
Cheepurupalle
Gajuwaka
Visakhapatnam
Gangavaram
Water Bodies
VMR Boundary
Regional Park
Wet Soil Areas
Rivers
Greenway
River Flood Plains
Hilltop Preservation
Existing Urbanized Area
Future Growth Area
Railway
Road
Proposed Airport
Ports

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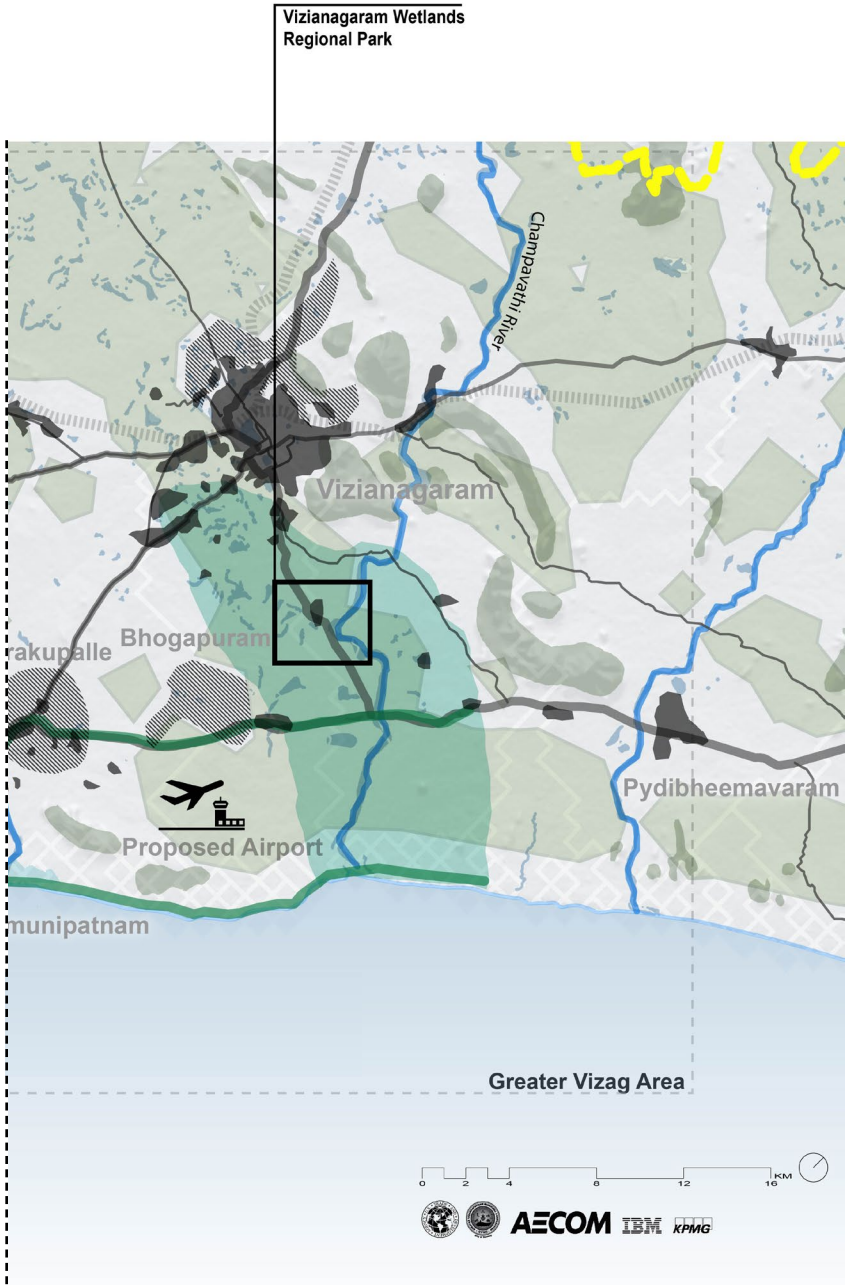

Figure 1.1 Expansion in City Centre, Urban Edge, and Satellite Typologies

Match **p. III-6**

Table 1.1 Summary of Open Space Projects

Open Space Type + Project	Proposed Project Description
Regional Parks	
Kambala Konda Regional Park	Combine the individual reserve forests north of Vizag to create a Kambala Konda regional park focused on mountain recreation and stewardship.
Anakapalle Wetlands Regional Park	Create a regional park to celebrate and conserve the wetlands and floodplains along the Sarada River between Anakapalle and the coast.
Vizanagaram Wetlands Regional Park	Create a regional park to celebrate and conserve the wetlands and floodplains along the Champavathi River between Vizanagaram and the coast.
Parks + Greenways	
Kambala Konda Parkway	Convert Route 38 between Pendurti and Vemulavasa into a limited-access beautified parkway through Kambala Konda Regional Park.
Anakapalle Wetlands Parkway	Convert the Lankelapalem – Simhadri road between Atchutapuram and Yellamanchili into a limited access beautified parkway through the Sarada River Valley.
Greenways paralleling arterial roads	Establish greenways for forestation and low-speed mobility parallel to new and enhanced major roadways within the Greater Vizag Area.
Greenways paralleling canals	Establish greenways for forestation and low-speed mobility parallel to canals within the Greater Vizag Area.
Oceanfront Venues + Amenities	
Varun Beach enhancements	Enhance the park space east of the beach road at Varun Beach to host signature events.
Rushikonda beach enhancements	Enhance the beachfront at the southern extent of Rushikonda beach to support more intense recreation and events programming.
Harbor Parks	Create linear parks along the oceanfront edge of the jetties extending out from the Beach road in the vicinity of the fishing harbor and expanded container terminal. These parks can facilitate fishing and public viewing of the ocean and the Vizag coast.
Urban Parks	
Lavender Canal wetland park	As part of the project to establish the new roads needed to convey container traffic through the Port, rebuild the lavender canal hydrology and wetland vegetation. The resulting linear park can become a better buffer between city and port, and anchor revitalization of the southwestern edge of old town.
Old Airport aquatic gardens	As part of the eventual redevelopment of the Vizag Airport site, create a series of aquatic gardens that manage flood waters and provide recreation space for new residents and employees.

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IV. ICT OVERVIEW STRATEGY

Introduction

The Government of Andhra Pradesh ("GoAP"), with the assistance of the Government of the United States of America ("USA"), Department of Commerce, United States Trade Development Agency ("USTDA") and United States Exim Bank, is keen on developing the City of Visakhapatnam (also referred to as "Vizag") as a "Smart City" under the 100 Smart Cities Project of the Government of India ("GoI").

The purpose of the "Mission Smart City" is to efficiently utilize Vizag's available assets, resources, and infrastructure to enhance the quality of urban life; provide a clean and sustainable environment for living; and increase focus on core infrastructure services. Like adequate clean water supply, power supply, sanitation, disaster management, solid waste management, wastewater treatment, efficient urban mobility and public transportation, public healthcare system, education, affordable housing, robust IT connectivity, e-governance, safety, and social security.

Conceptual Functional Architecture

In the information age, businesses cannot succeed without effective information sharing between employees, departments and customers. This is true for governments as well—operating in isolation, governments cannot deliver efficient protections and value-added services to citizens. The effectiveness of government services depends directly on the quality of their interaction with citizens, business partners, and employees in the context of agency and business processes.

The process of implementing a smarter city must be considered as the process of combining technology into the development process for starting, growing, and transforming the city as time progresses. Initiatives should also look at improving the efficiency and efficacy of city

operations. A city should go beyond instrumentation, and be an interconnected and intelligent place by integrating different service areas, such as energy, water, transportation, public safety, education, health care, etc. A common operations monitoring platform should examine the health of key city systems, and promote coordinated action to handle any disruptions or emergency situations. This model allows the use of data analytics to enable the city to predict and prevent issues that could impact quality of life, ranging from traffic congestion to real emergencies.

Smart appliances will become increasingly ubiquitous in consumer homes. Connected to the Internet, these appliances can be observed and controlled by consumers, as well as third parties (such as utilities), and can optimize demand response and energy efficiency. Sophisticated systems like affordable energy management systems, automated-demand response appliances, and mobile smartphone applications will offer greater control. In many cases, consumers can simply set their preferences, and these systems will respond and learn their patterns and additional preferences.

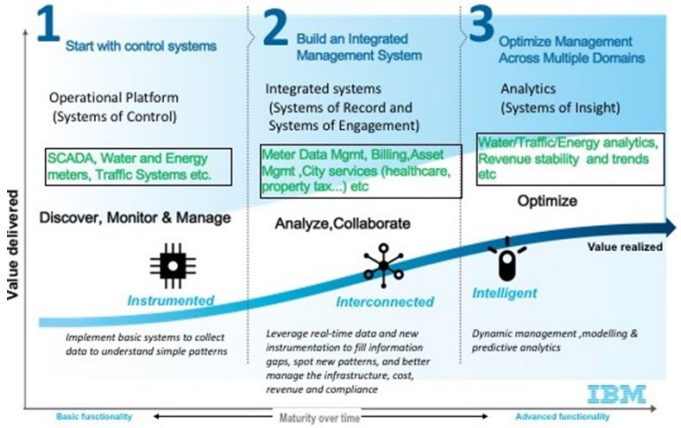
Agencies can effectively manage public transport, and reduce congestion, energy spending, and emission levels using the following strategies: (1) provide greater visibility of active transit vehicles and predict their arrival times, (2) analyze the performance and bottlenecks of the transit system through historical data analysis and predictive modeling, and (3) disseminate transit info through multiple channels such as web portals, mobile phones, kiosks, and vehicle management systems. If the residents are well informed about real time status, the satisfaction of public transport users can be significantly improved.

ICT can help governments, utilities, businesses, and organizations address water issues like loss, leaks, and aging infrastructure. ICT solutions are designed to enhance infrastructure visibility, and to deliver an advanced level of situational awareness, event and incident management, informed decision-making, and stakeholder collaboration.

The maturity model shown below is recommended based on discovery sessions held with various GVMC departments and stakeholders, and because of the current lack of availability of control systems, which form the foundation of a good city infrastructure.

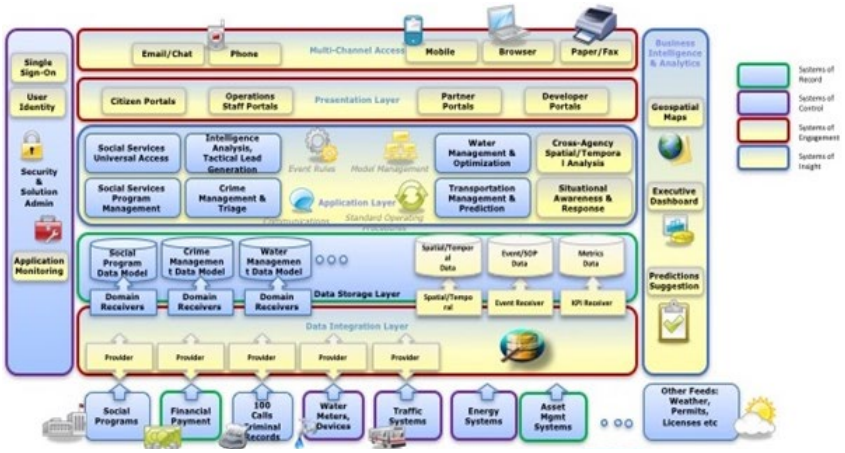
Figure 1.1 Maturity Model for Vizag

Shown below is the recommended logical architecture for Vizag, which would allow the city to follow industry best-practices as it adds new capabilities to its ICT platform



Source: IBM

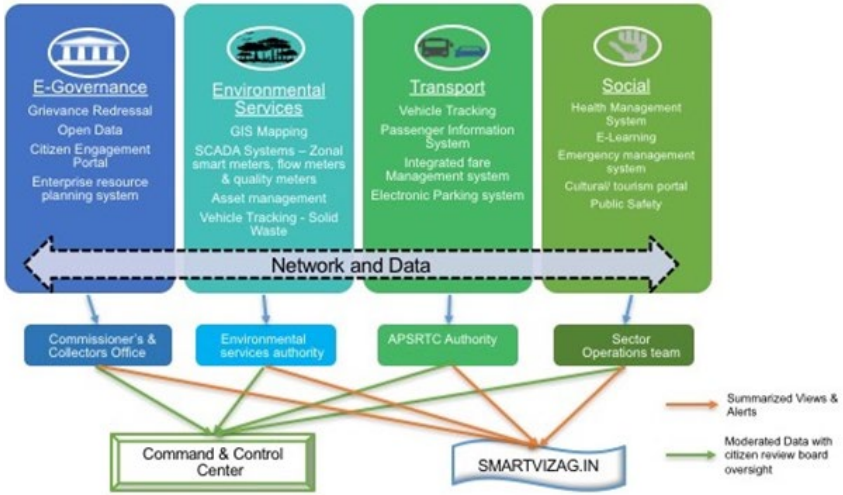
Figure 1.2 Smart City Logical Architecture



Source: IBM

The flow of data within GVMC and its stakeholders/citizens is shown below. Operational systems are controlled by various departments within GVMC, with summarized values and insight being offered to the Command and Control Center (CCC) as required, either on-demand or during an event. Data collected by GVMC systems can be correlated, analyzed and published/made available as appropriate to the citizens of Vizag and other third party entities as per GVMC policy.

Figure 1.3 Flow of Information to GVMC and Its Citizens



Source: IBM

Shown below is the proposed classification of ICT systems for the city of Vizag. Systems of control and record are the foundation. Systems of insight and engagement take performance to new levels

Table 1.1 Proposed Classification of ICT Systems for Vizag

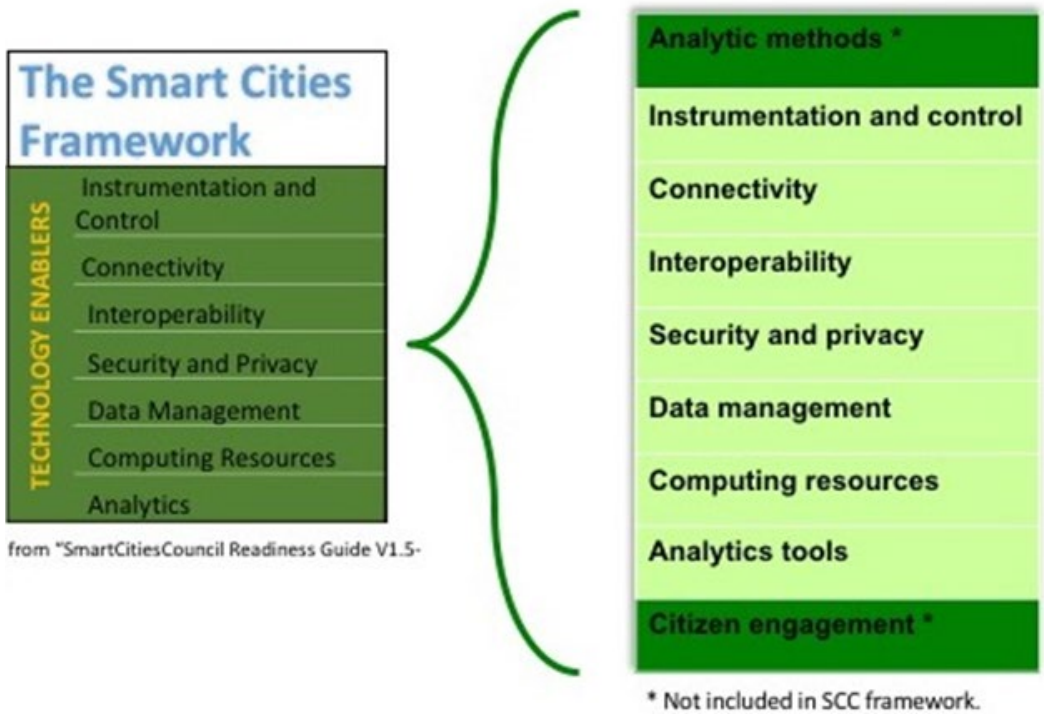
	Examples	Characteristics
"Systems of Record"	▪ Meter data management ▪ Billing and financial, incl. tax collection ▪ Asset management ▪ Hydraulic model (for a water system)	▪ Databases ▪ Transaction processing, "back office" ▪ Reference systems ▪ Frequently require optimization
"Systems of Control"	▪ SCADA, PLCs, sensors, meters, cameras ▪ Dashboards ▪ Emergency management ▪ Traffic management	▪ Operation of infrastructure systems ▪ Monitoring and observation ▪ Event response ▪ Increasingly – enabling devices to interact autonomously
"Systems of Engagement"*	▪ Additional consumption analysis provided with consumer bills ▪ City Services and other "My City" applications ▪ Public leak reporting tools ▪ Open data and reporting	▪ Designed to engage as well as inform ▪ Anywhere, any time (websites, smart-phone & mobile apps) ▪ Often cloud enabled – mobile device links to cloud-based system
"Systems of Insight"	▪ Analytics-based leak detection and pressure management ▪ Traffic pattern analysis ▪ Revenue stability and trends ▪ "Sentiment analysis"	▪ Analytics, often from large accumulations of data of many types. ▪ Models ▪ Simulations ▪ Integration of different models

Source: IBM

ICT Infrastructure

The proposed overarching ICT infrastructure would be the seamless merger of technology into the planning, execution, and operation of the city from all aspects. The recommendation is to consider the use of the new informatics toolkit in the context of the Smart City Council (SCC) framework, but with two additions, as shown below.

Figure 1.4 Proposed IT Strategy Framework for the City of Visakhapatnam



Source: IBM

Analytic Methods

The successful application of ICT for creating a “smarter” city starts with understanding the problems to be solved, and what the desired outcomes are for the city.. There are many analytic methods that have applicability to the design and management of smarter cities, but the preferred method for Vishakhapatnam is the Key Performance Indicator (KPI) method.

A city’s systems are highly heterogeneous, and have complex, sometimes intermittent interrelationships. Complex city systems may work in varying time and spatial scales.

KPIs function as “design points” - measures of what one might try to achieve with an implementation of ICT. KPIs can be linked to outputs, or linked to outcomes, and the outcomes should reflect the value of the output.

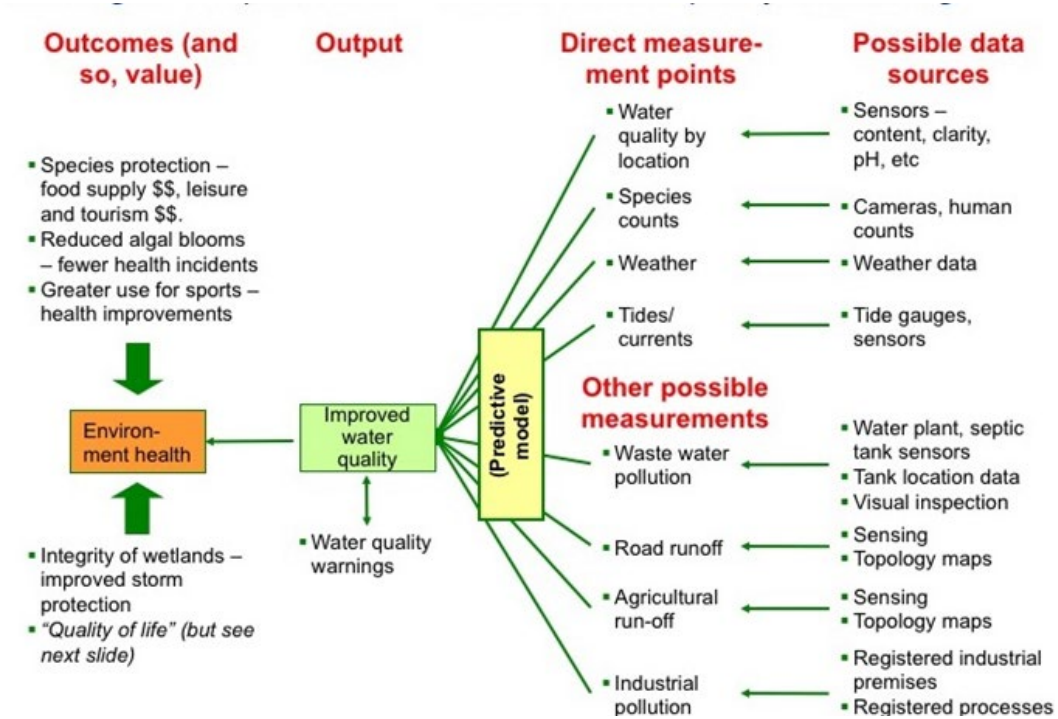
Figure 1.5 Distinction Between Output and Outcome

	Safety	Economic	Mobility and access	Environment/ Health
Possible *Output* Measures	▪ Accident rate per year. ▪ Average time to respond to, and clear accidents.	▪ People and volume of goods carried. ▪ User fee revenue generated.	▪ Km of transportation system per 100,000 population. ▪ Journey times by mode.	▪ GHG emissions from transportation. ▪ Particulate emissions from transportation.
Possible *Outcome* Measures	▪ Reduced traffic disruption. ▪ Vehicle-related hospitalization rates and costs. ▪ Vehicle-related mortality rates.	▪ Impact on economic location and tourist decisions. ▪ Impact of traffic on retail business levels.	▪ User satisfaction with access and performance. ▪ Modal split (% of commuters using travel mode other than a personal vehicle).	▪ Incidence rates of respiratory illness / disease. ▪ Impact on global warming. ▪ (Energy independence).

Source: IBM

Shown below is a sample of possible outputs and outcomes for a water quality model:

Figure 1.6 Sample KPIs for Water Quality Monitoring



Source: IBM

KPIs offer a value that can be measured, and therefore also offer the means to address the topic addressed by the KPI. KPIs are numerical constructs so they are therefore applied to whatever can be quantified. They may in turn drive incentives and behavior. While this may be acceptable, but may also be problematic since:

- Measures may be incomplete: cities or states may measure something because it's easier to measure (i.e. surface water) and ignore other dimensions (i.e. groundwater).
- Key items may also be excluded because they are too hard to measure or quantify (for example, "social cohesion").
- It may be possible to use proxies (for example, cell-phone calls within an area, for social cohesion), but these may or may not truly capture the phenomenon at issue.

KPIs must be analyzed carefully, as root causes may sometimes be misconceived. For instance, determining whether traffic is due to the volume of cars, or to people driving slowly looking for a parking spot would require further analysis.

Instrumentation and Control

Instrumentation forms the basis for data generation in any Smart City, and is the core component of the Internet of Things (IoT). Sensors come in a variety of shapes and sizes, and are geared for various functional domains. The City of Vizag can consider the addition of on-line sensors, which are a major focus for development, as an alternative to lab tests. The integration/instrumentation strategy should be designed to allow various types of sensors and devices to connect securely and easily, while following the appropriate standards. A good IoT strategy will allow users to quickly connect and capture data from a broad range of both new and legacy devices. The strategy should also allow for data to be analyzed and optimized, and should allow for data that has been collected to be developed as services for consumption by third party users as required.

Let's consider a scenario for instrumenting the Water domain. Water sensing initially covers the "basics":

- Quality: temperature, turbidity, salinity, pH, total dissolved solids, TOC, conductivity, oxidation reduction potential, hardness, chlorine/ chloramine, THM, nitrate, dissolved gases, free ammonia, fluoride, etc.

- Level, flow, pressure.
- Mechanical performance: vibration, noise, cavitation, energy use etc.

Once the city has the basic infrastructure in place, there are additional needs to be met. For example:

- Consider the use of multi-parameter quality sensors for “emergent contaminants,” such as drug decomposition byproducts.
- Consider unattended operation (not handhelds).
- Look at sensors with high accuracy, offering fewer false positives/negatives.
- Expand the number of installed sensors.

Table 1.2 High Level Taxonomy of City Sensing

Focus area	Examples	Example sensor types
Environ-mental status	▪ Air or water resource quality/pollution ▪ Noise ▪ Ecosystem or species extents ▪ River or sea levels, flood extents ▪ Weather	▪ (Water quality sensors), gas/particulate sensors ▪ Microphones ▪ Cameras, satellite images, trackers ▪ Flood/depth gauges, cameras ▪ Barometers, hygrometers, satellite
Resource usage	▪ Agriculture or habitation patterns. ▪ Groundwater or reservoir usage	▪ Satellite images ▪ Depth and flow gauges, satellite images, gravitational variations
Infra-structure & equipment usage	▪ Traffic ▪ Water or energy consumption ▪ Water flows and pressure (in-system) ▪ Location tracking (mobile assets) ▪ Occupancy	▪ Induction loops, cameras, cellphones ▪ Meters ▪ Pressure sensors, pump output measures ▪ GPS transponders, cameras, odometers ▪ Movement and heat sensors
Infra-structure performance and issues	▪ Response times, user experience ▪ Water leakage ▪ Energy system faults ▪ Duty cycles, wear rates, vibration, also malfunctions, outages ▪ Structural integrity	▪ Latency measurements, user feedback ▪ Acoustic or vibration sensors, moisture detection, “virtual” sensing by inference ▪ Current anomaly detectors, analytics ▪ Accelerometers, clocks, counters, many specific anomaly detection methods
People	▪ Presence (eg for lights, burglar alarms) ▪ City usage patterns – crowd accumulations, daily cycles ▪ Public safety, criminal activity ▪ Health	▪ Movement, heat sensors, microphones ▪ Cameras, cell phones ▪ Cameras, microphones

An instrumentation strategy should cover the key areas mentioned in the table below:

Table 1.3 Key Areas to be Covered by Instrumentation Strategy

Security	▪ Often absent. Most sensors (and meters) are open to cyber-attack. This is a growing concern and needs to addressed right from the get go and not as an after thought
Intelligence	▪ Changing sensing parameters and reporting thresholds in response to conditions sensed, or via downloaded instruction. ▪ Distribution of computing tasks, in effect, away from the central platform to the device. Example – water meters that detect leaks and collectively execute a water balance. ▪ Linkage with back-end analysis.
Fusion	▪ Integrating data of different scales – for example infilling for different spatial and time scales. ▪ Integrating data of different types – say, camera and induction loop data with GIS to infer existence of a traffic jam.
"Platform" value	▪ New capability added through software, not through re-engineering the device
Power consumption	▪ Driven by data volumes, transmission protocols and local processing.
Robustness	▪ Field deployability – can the sensor be left alone for 30-60 days? ▪ False positives and negatives
Sensor drift	▪ How to detect and manage drift over time? How to self-calibrate?
Standards	▪ OGC's Sensor ML, Common Alerting Protocol (CAP) and others

Lastly, there are a number of Supervisory Control and Data Acquisition (SCADA) Systems available on the market that allow users to monitor and manage sensors. SCADA systems are the operational destination for much sensor and meter data. SCADA data ("tags") are specific inputs or outputs. SCADA systems allow users to configure set-points--if reached, the SCADA issues alarms and/or actuates a response. All tag values are time-stamped and stored as sequenced data in a data historian. This is often a valuable source of data for analytics performed higher up in the systems value chain.

Connectivity

Network connectivity forms the backbone of the city, and should be designed to be adequate, reliable, and secure. The installed network should support voice, data, and video, should include security and redundancy, and should increase bandwidth while reducing latency.

The city of Vizag has shown foresight in this area by including a city-wide fiber grid, which is currently being installed.

Interoperability

Interoperability is about ensuring that all of the technologies deployed in the smarter city can work together, so that the city functions as a whole. Shown in the table below are some of the general interoperability layers that the City of Vizag should include in their ICT strategy.

Table 1.4 General Interoperability Levels

Physical	Consistent physical bores, diameters, shapes, connectors, voltages, modes of operation, materials etc
Process	Consistent process steps , governance, legislation and regulation
Network	Usually, but not always, TCP IP . Consistent messaging standards – eg Sensor ML
Security	Devices must not undermine each other's security (Module 8)
Data	Consistent data definitions, scale and frequency, quality and legal permission to use either alone or in combination with other data
Models	Consistent assumptions and constraints, emantics (input and output data, model operations) - output from one has to meets requirements for input to the next
Applications	Data interoperability, Consistent operating or run-time schedules
Autonomous	Consistent orchestration and recording

Security and Privacy

The city of Vizag should include the security standards specified by the Government of India, and should also include industry-standard security models based on the functional domain that is being addressed. Data privacy issues need to be addressed during the design phase, in order to ensure that privacy concerns are addressed.

Individuals' data that is collected by systems that are designed to reduce or price consumers' resource usage can have significant privacy implications. For example, monitoring individual's energy and water consumption might provide an insight into their lifestyle (asleep or awake, appliances purchased, who is at home when, etc). In some cases name, address, and bank account details maybe held. Privacy risks can emerge when seemingly disparate data elements are put together, and can pose a problem.

Data Management

Data is considered the “new natural resource” for cities, and the instrumentation of various devices can bring about data management issues that need to be addressed. Data may be held by multiple entities (agencies, departments, etc.) who have their own rules, standards, and accountabilities. Data integration has historically not been a priority, and thus has to be assembled and integrated from many sources to support some activity that may span different entities. Listed below are some of the data challenges that need to be addressed by cities ahead of time

- No data available
- Identifying the right set of data to be used
- Data is in the wrong scale for the decision or problem
- Data is fragmented between different stakeholders
- Conflicting ownership
- Data interoperability issues
- Too much data to use or analyze
- Incompatible or incomplete models lead to solutions that are partial and/or ineffective.
- Poor visualization of information impedes effective decision-making.
- Maintaining quality and applicability of data over time.
- Deriving additional value from data already assembled.
- Data privacy issues
- Always consider the “5Vs” of data management:
- Value → Why capture, keep or integrate data in the first place?
- Volume → How much data needs to be processed?
- Velocity → Required capture cycles and processing times?
- Variety → Range of data types, degree of structure in each?
- Veracity → Level of uncertainty in the data and its interpretation.

Computing Resources

IoT, Big Data, mobile data, and social data are creating new demands on IT infrastructure, and as a consequence, a city's computing platform often needs to be more distributed, dynamic, and "open."

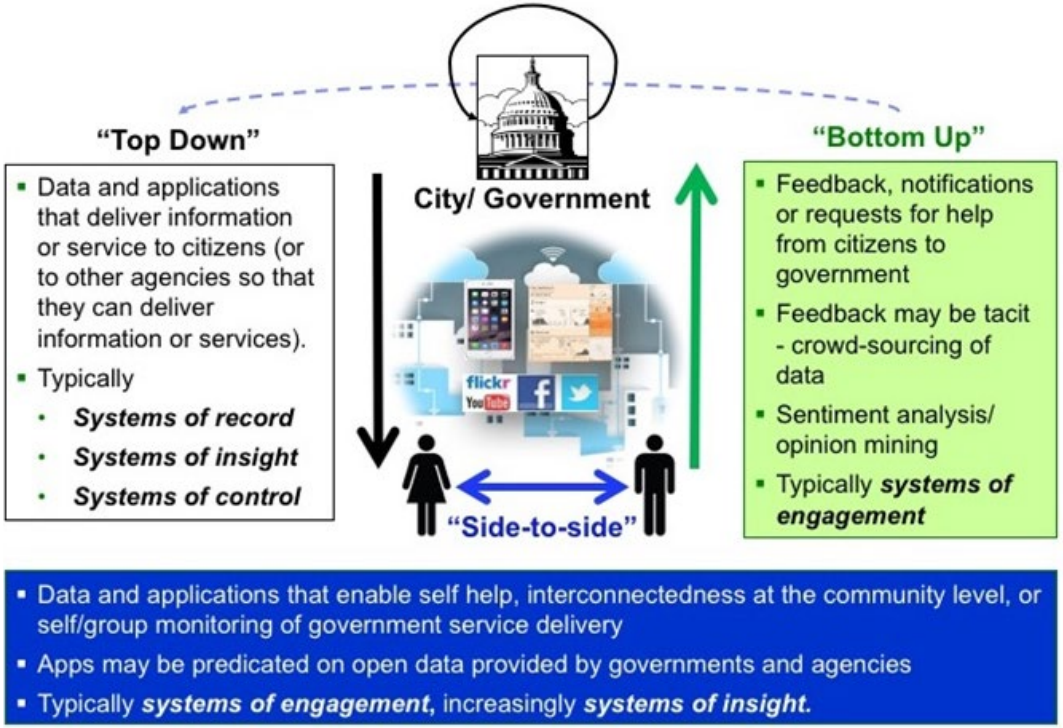
Analytic Tools

Analytic tools are a "System of Insight." Consider mining historical data for additional insights that can improve understanding of performance, environmental impact, or cost, and enable prediction. Modeling should be included as part of the decision stream; for example, traffic prediction, energy grid optimization modeling, water/energy optimization modeling, leak detection, etc.

Citizen Engagement

Citizen engagement involves "systems of engagement." Cities and communities rely upon the active engagement of their citizens, and for them to serve as human "sensors," in order to improve the efficiency & efficacy of systems, and to positively influence behaviors. The various principles discussed above enable the emergence of a fundamentally new relationship between a city/government and its citizens, the "U-Shaped" government.

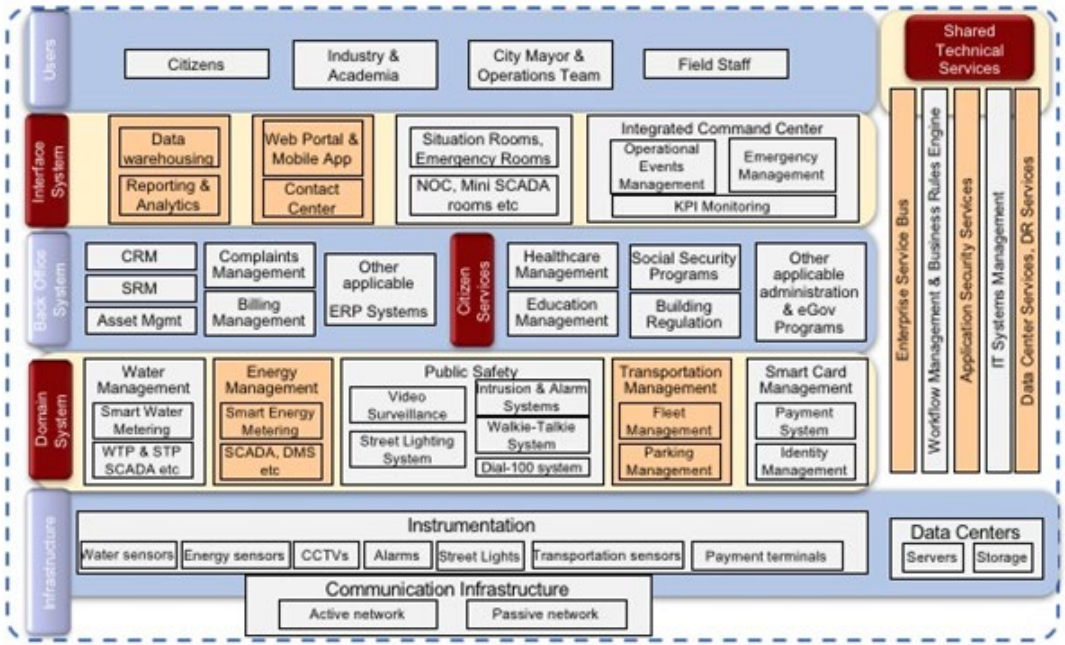
Figure 1.7 Figure 1.11: The "U Shaped" government



Source: IBM

Several interviews were conducted with various stakeholders, and the functional architecture that was developed, shown below, was based on those interviews. The functional architecture is aligned with the ICT system classification described earlier in the document.

Figure 1.8 Conceptual Functional Components of a Smart City



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V. MOBILITY

Introduction

As Visakhapatnam expands from a core city to a polycentric metropolitan area, providing alternative connections between employment and residential subcenters is becoming increasingly important. GVMC has taken the important initial steps towards developing a more comprehensive multimodal transportation system, which include the construction of new Bus Rapid Transit lines and a planned bypass of National Highway No. 5. Integrating pedestrian and bicycle facilities into the major arterial roads in the city center is also a priority under Vizag's Smart City Challenge program. In fact, based on a Household Survey conducted earlier this year, citizens of greater Visakhapatnam rated their transportation priorities as follows:

- 78% of respondents feel that public transportation needs to be improved, and 72% want bus information to be displayed at bus stops.
- 68% of respondents think that the City of Visakhapatnam is severely polluted.
- 53% of respondents reported that there are no adequate parking facilities available when they go shopping.
- The annual vehicular growth rate of 9% is seen as too high, and a direct factor to air pollution
- City of Visakhapatnam lacks a quality, safe pedestrian environment

From the perspective of the broader VUDA Metropolitan Region, additional mass transit lines are required to link the multiple subcenters, thereby facilitating the flow of goods and people among employment, service, and residential areas. Under the preferred development scenario (see section 8.1), VMR's center of gravity is anticipated to continue its shift northwards, with the development of Bhogapuram, Bheemilipatnam, and Madhurwada. A rapid light-rail line will be necessary to link Bhogapuram with these areas and the city center. Additional BRT lines will help connect satellite centers like Anakapalle and Madhurwada to employment areas.

Mobility priorities within the region include:

- Promoting Integrated Multimodal Systems
  - Smart Bus Stops
  - Public Information Systems
  - Bus Rapid Transit Lanes
  - Integrated Fare Collection System between transit modes
  - Defined Pedestrian Space
- Easing Traffic Congestion
  - Smart Travel Corridors
  - Improving transit and shifting people from cars to transit
- Enhanced Connectivity to Growth Destinations
  - New Airport Rail Link
  - Expanded Arterial Roadway
  - New BRT routes
- Reduced Transportation Related Emissions
  - Electrification of Transport
  - Improve average vehicle speeds on arterial roadways by reducing congestion

In the context of this ambitious transport service expansion, intelligent transport systems can help improve the efficiency of existing services, as well as enable future improvement plans, to achieve higher benefit-cost ratios. First, ICT would be used to upgrade the two existing BRT lines. Subsequently, real-time vehicle tracking systems and signal prioritization would be integrated into plans for new mass transit lines, including the MRT. Finally, major arterial roads in the city center could be redeveloped progressively as technology-enhanced multimodal corridors. Visakhapatnam would then be able to take advantage of Andhra Pradesh's electricity surplus, and set a national standard for electrification of transport of across all modes.

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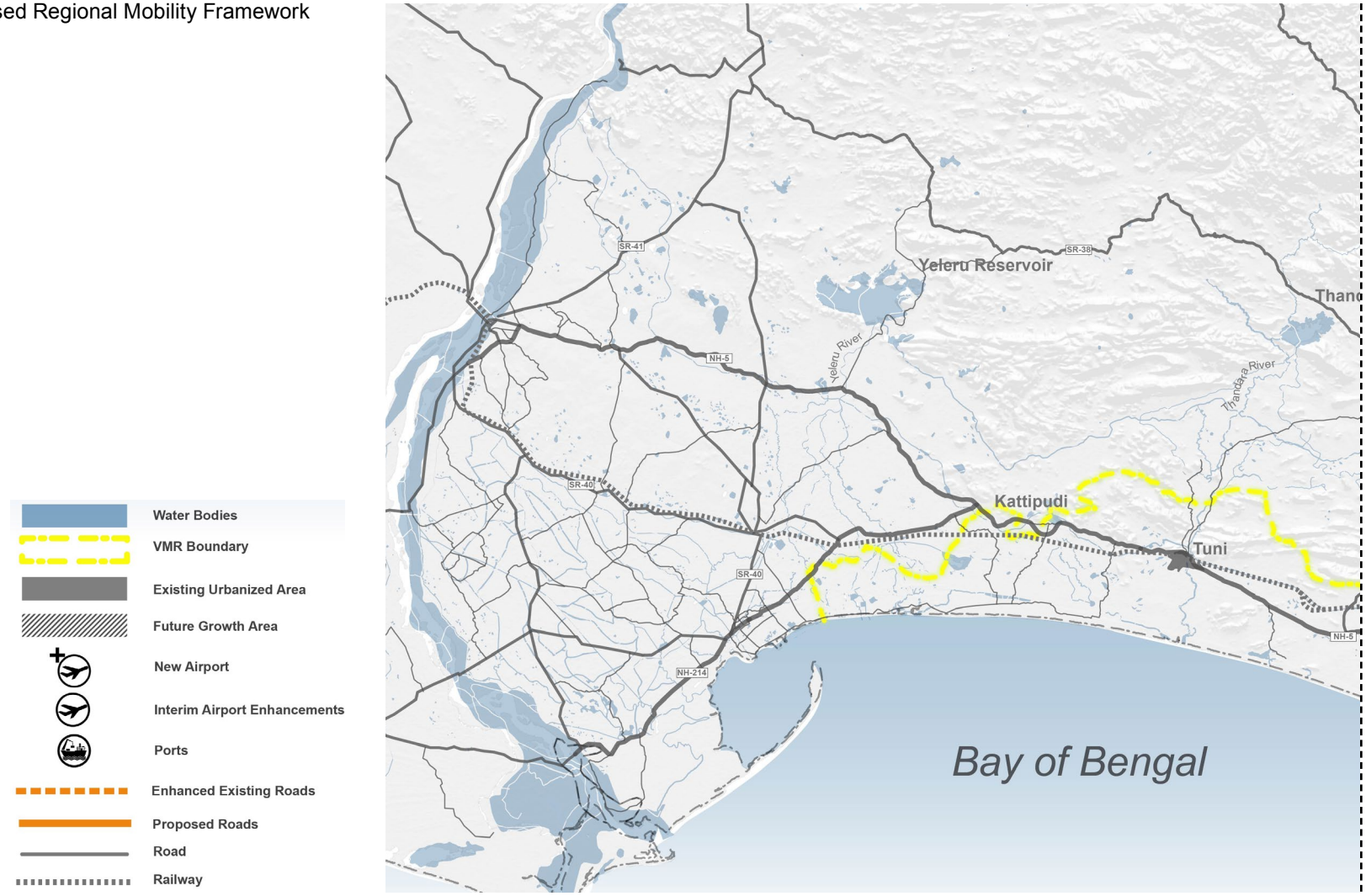
Figure 1.1 Proposed Regional Mobility Framework



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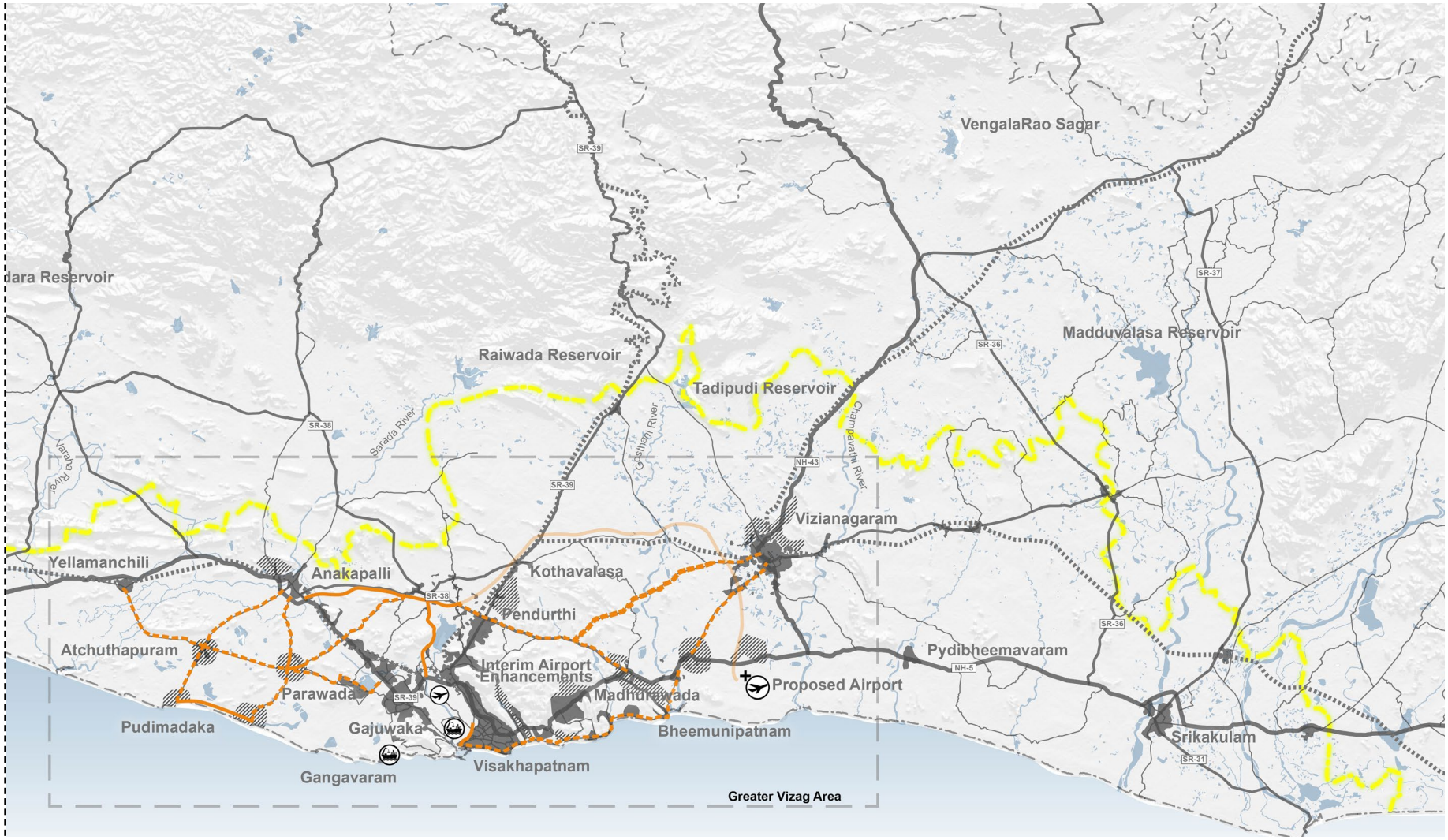
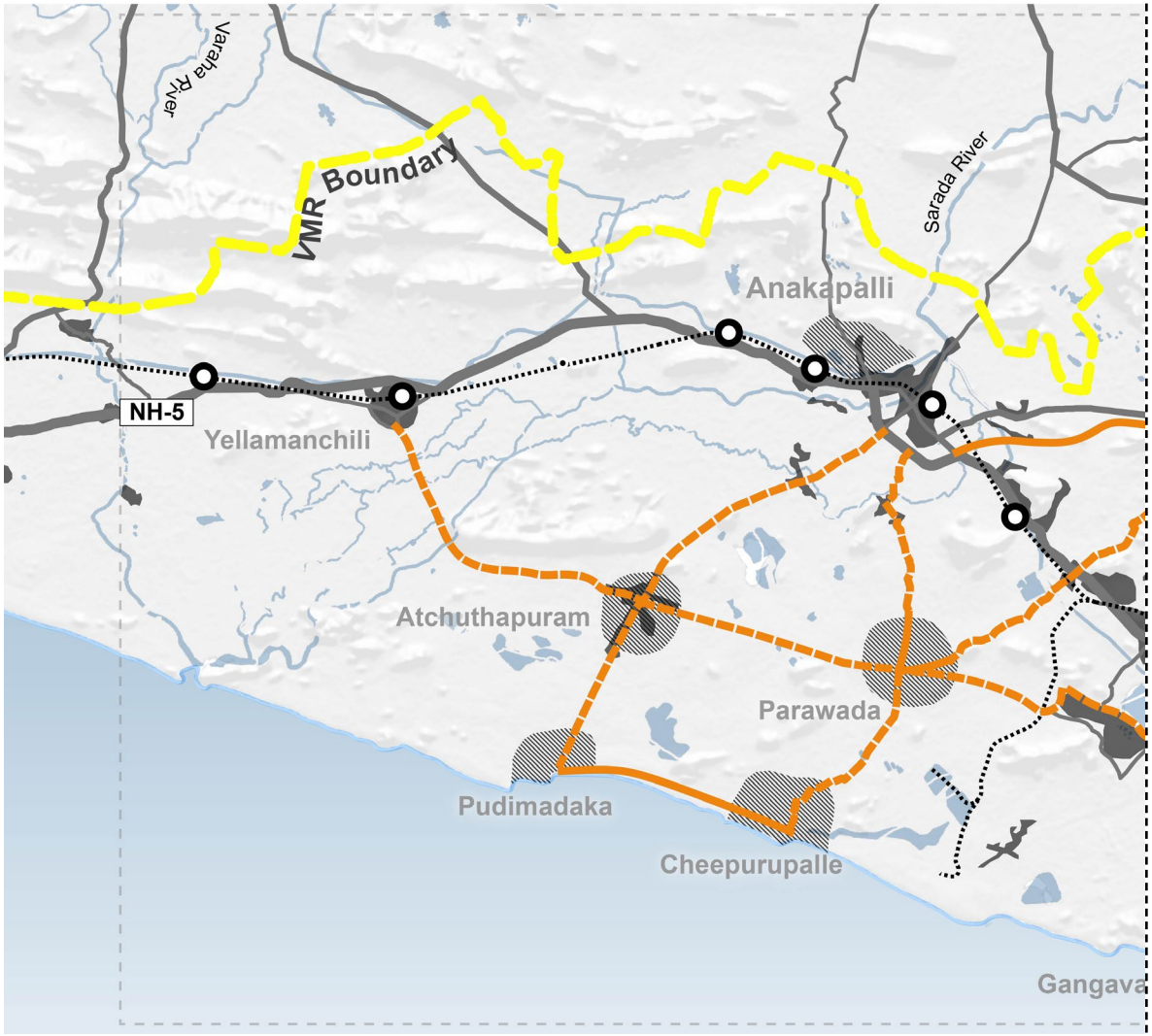

VengalaRao Sagar
Madduvalasa Reservoir
Raiwada Reservoir
Tadipudi Reservoir
Sarada River
Gosthani River
Champavathi River
Vizianagaram
Yellamanchili
Anakapalli
Kothavalasa
Pendurthi
Atchuthapuram
Interim Airport Enhancements
Parawada
Madhurawada
Proposed Airport
Pydibheemavaram
Pudimadaka
Gajuwaka
Bheemunipatnam
Srikakulam
Visakhapatnam
Gangavaram
Greater Vizag Area
SR-39
SR-38
SR-37
SR-36
NH-43
NH-5
SR-31

Match p. V-4

Figure 1.2 Enlargement of Greater Vishakhapatnam Mobility Framework



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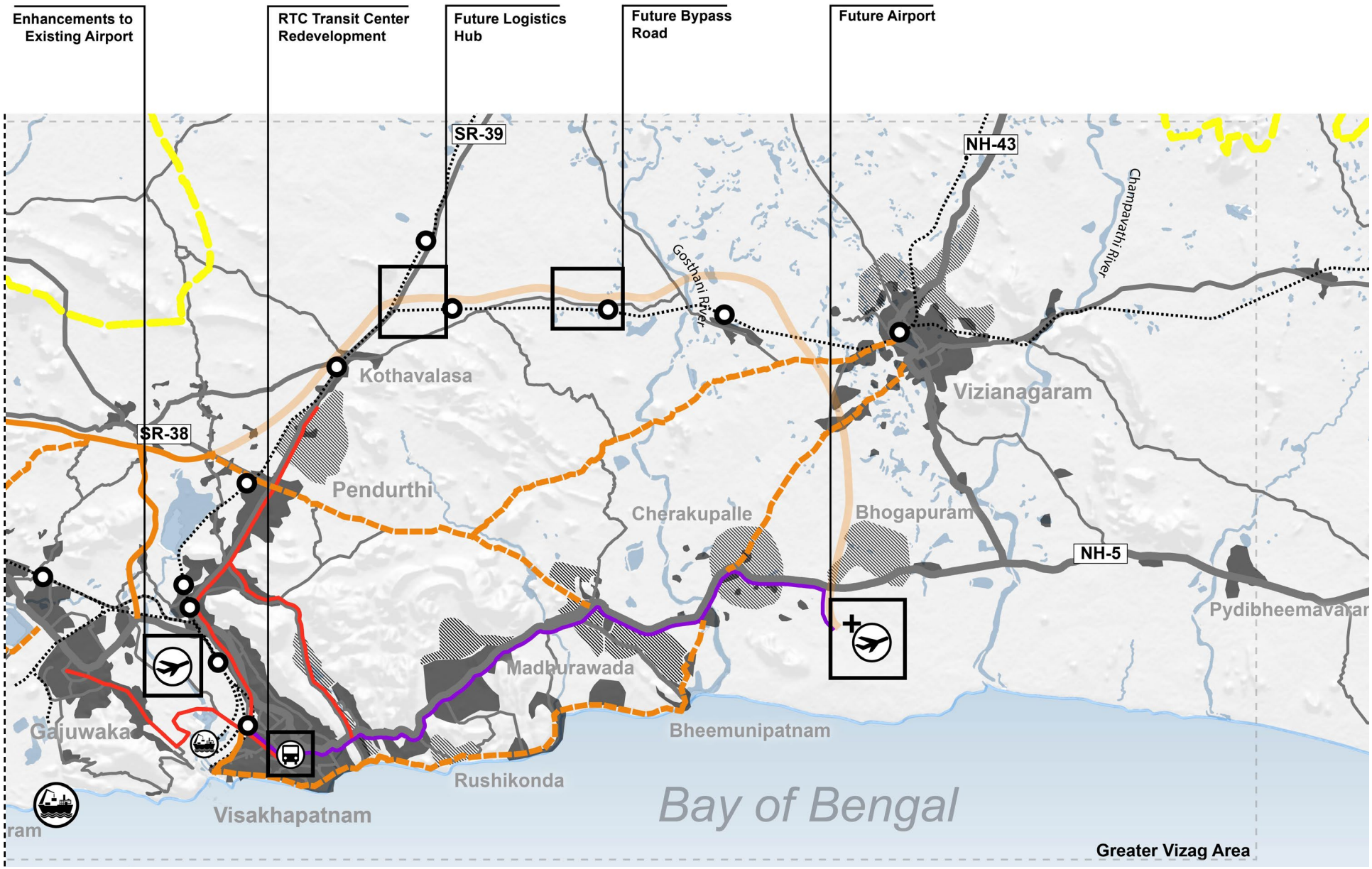

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Water Bodies
VMR Boundary
Existing Urbanized Area
Future Growth Area
Enhanced Existing Roads
Proposed Roads
Proposed BRT
Proposed Airport Link
Interim Airport Enhancements
Port
New Airport
Transit Center
Train Station
Road
Railway

Technical Approach

In response to the region's priority needs and goals, the overall approach to transforming Vizag's mobility system is based on a number of programs and subprograms. Each of the subprograms, in turn, includes one or more capital investment projects. The major programs are as follows:

Electrification of Transport

With an extensive network of thermal power plants, among other sources of energy, Andhra Pradesh is a net-power-exporter to other Indian states. VMR is also rich in power, with plans to double the output of the Simhadri NTPC power plant from 2,000 MW to 4,000 MW, and a proposal to build another 4,000 MW plant at Pudimadaka. While the use of solar power is expanding rapidly in the VMR, the large majority of electricity for industrial, institutional and domestic use is still generated from coal. Visakhapatnam has the opportunity to establish itself as a green-energy leader in India by using its power surplus to fuel electrified vehicles of all types, thus reducing the use of fossil-fuel powered vehicles. The support system for an electric car conversion program would include battery charging stations located around the city, a reliable electrical transmission service, and a potential increase in electrical substations in parts of the city that are currently under-served. This ambitious program would involve a number of sub-programs:

Visakhapatnam has the opportunity to establish itself as a green-energy leader in India by using its power surplus to fuel electrified vehicles of all types, thus reducing the use of fossil-fuel powered vehicles.

- **Electrification of two- and three-wheelers** — A mandatory, phased transfer from the use of vehicles that use combustion engines to electric scooters, bicycles, and three-wheelers. Local manufacturing of vehicles could be promoted, perhaps in partnership with multinational firms specializing in electric vehicles. The conversion of two- and three-wheelers from fossil fuel to electric power would preferably happen in stages. The initial stage would be located in a small area within central Vizag, which would be equipped with charging stations, additional substations, and improved transmission facilities. Charging stations typically use 240 volts of service or DC Fast Charge (DCFC), which is the fastest type of charger. DCFC facilities provide significantly faster charging times, but are significantly more expensive to install, and are often used where short-charging-time vehicles are required. This initial electrified zone (E-Zone) would be used to demonstrate the applicability of the concept for Vizag. The zone of electrification would then be expanded from this initial area. Within the E-Zone, residential, commercial and shopping areas would be retrofitted with 240-volt charging stations. Typically, these cars can be charged at a slower rate than ordinary house electric service, dependent on the power service and vehicle specifications. Due to the time needed for charging, multiple charging plug-ins must be provided at each station. For instances where time to stop is limited, like when driving on the highway, the DCFC installation could be used. For the initial E-Zone, it is recommended that the 240-volt charging stations be installed in new off-street parking facilities, or retrofitted to suit existing private off-street parking areas for employees. In residential areas, home-charging and community-charging stations for the overnight charging of the vehicles can be installed. It is important to provide sufficient charging stations in the initial E-Zone, so that drivers do not have to wait to charge a vehicle, or worse, run out of power due to an insufficient number of chargers. Charging stations should not be provided on-street, as this will only clog already over-burdened roadways and reduce the availability of short–term parking in commercial and shopping areas.
- Electrification of mass transit, including BRT and MRT — New, electric-powered rapid bus and metro service would replace existing buses with electric vehicles. The implementation of these services would include charging facilities in bus depots and/or at bus stops.

Each of these sub-programs would involve a combination of “hard-side” inputs (capital investment projects) and “soft-side” inputs (policies and regulations) in order to be successful. They are also require between 5 and 10 years to implement, necessitating a phased approach over time. The anticipated impacts would include a dramatic reduction in the emission of greenhouse gases related to transport, and a corresponding reduction of Vizag’s carbon footprint.

In the meantime, two discrete capital investment projects that could be implemented in the short term include:

- **Electric Circulator Bus along the Beach Road** — This new electric bus service would run along the beach road from Visakhapatnam Port to Rushikonda (and perhaps eventually to Bheemilipatnam). Demonstrating the feasibility of electric buses in Vizag, this project would help promote tourism along the urban coastline. The bus line could be integrated into the Area-Based Development project envisioned under the Vizag's Smart City Challenge.
- **Electrification of Pendurthi BRT Route** — New electric rapid bus service, replacing existing buses with electric vehicles. Includes charging facilities in bus depot and/or at bus stops.

Upgrading of Existing Bus Rapid Transit System – 'Connect Vizag'

The second major program for the development of VMR's mobility system is the upgrading of BRT lines. Along heavily traveled routes, congestion for all modes of traffic, including transit buses, is common. These delays often leave bus passengers at bus stations waiting, without any information as to the time of the next bus, the cause of the delay, or potential alternatives in the case of suspended service or extensive delay. Equally important, many potential passengers do not take bus transit because of the lack of information related to bus delay or schedule problems. Improving the transparency of information for passengers at bus stations, as well as providing advance information that potential riders can access before leaving their home/place of work will improve the passenger's trip and increase potential ridership. In times of emergency, the information system would provide vital information to people on the availability of buses and routes that are operating.

Improving the transparency of information for passengers at bus stations, as well as providing advance information that potential riders can access before leaving their home/place of work will improve the passenger's trip and increase potential ridership.

Two projects are proposed: **upgrading of the Pendurthi BRT** (in operation) and **upgrading of the Mudaslorva Valley BRT** (under construction). Both projects include the same components; namely, retrofitting of bus stops, a real-time bus tracking system, and bus priority signalization. GPS bus transmitters would be used, in conjunction with smartphone apps and passenger information displays on buses and at bus stops, to provide real-time information about bus arrival time to passengers. In addition, the transmitters on the buses would be used to trigger green traffic signals for buses approaching intersections, speeding up bus travel and reliability. The details of the projects are set out in the "Connect Vizag" project action plan submitted under Task 5 of this technical assistance.

New Mass Transit Development

In addition to upgrading the existing BRT system, new BRT and MRT/LRT lines should be developed. The smartest sub-program in support of new mass transit would be the advance acquisition of use and development rights for the land to be designated for future transit service. This is an ongoing, phased program that would include multiple land transactions for future BRT and MRT lines. Advance action in this area would lower development costs, and therefore improve the financial feasibility of these major public transport projects.

One proposed BRT route is from Gajuwaka via the Navy Base to the Vizag RTC station. Gajuwaka's center is highly populated, and therefore needs better connectivity with the Naval Base. Currently, that connectivity is limited. A proposed BRT service, in conjunction with a new river crossing east of the existing airport, would provide improved access to both the Navy Base and the RTC station. Additionally, the additional roadway resulting from implementation of BRT would relieve some of the severe recurring traffic congestion in the NH-5 corridor in that area.

The Vizag Smart City Team, as part of its mobility and land use efforts, recognized that the land use changes associated with the expanding subcenters within the VUDA area, and changes within the area of the GVMC, require a review of the previous MRT studies and identified alignments. For instance, the development of a new international airport at Bhogapapuram had not been part of any previous MRT study.

Transit access to airports has become a prerequisite around the world for providing reliable and efficient access for passengers, air crews, and ground-based personnel. Based upon peak hour peak (PHPD) direction passenger capacity, rail provides more capacity then non-rail transit, including BRT systems. If the MRT study indicates that ridership is sufficiently low for the extended future (15-20 years) after the opening of the airport, non-rail transit systems such as BRT could be implemented. The purpose of the MRT study should be to review and validate the assumptions previously made in the report, and update assumptions that have changed since the previous report. The report should focus on anticipated land use changes, updating ridership forecasts based on land use, and reviewing capital and operating cost estimates based on concept (5%) engineering.

As part of reviewing and updating the data, the study should assess whether MRT or LRT is the appropriate rail mode to be studied, and ultimately constructed. MRT or "heavy rail transit" refers to the passenger capacity that the system can provide hourly per direction of travel. Heavy rail transit systems have greater distances between stations stops and operate longer

trains then LRT, on dedicated and physically separated right-of-way. LRT or “Light Rail Transit” refers to the carrying capacity of a system similar to the MRT. At-grade LRT typically has lower passenger capacity then MRT systems. However, LRT vehicles can operate in mixed traffic on roadways, since LRT trains are much shorter than MRT trains, typically 1 to 3 vehicles. Another major distinction permitting LRT to operate along the roadway is that their source of electrical power is from overhead power lines, as compared to MRT trains, that typically receive electric power from a third rail along the ground immediately adjacent the tracks.

The changing conditions that can guide the study include the need to develop a convenient, rapid transit connection between downtown Vizag and the proposed airport at Bhogapapuram. This connection should be the initial section constructed for the Vizag MRT system. It is critical for the success of the airport, as well as the development of Vizag as a major business and tourist center, that fast public transit service be provided at the time of the airport’s opening. The recent changes in the use of the existing airport need to be reflected in the study, based on the proposed horizon year of 2035, and the year of the airport and rail connection, which should be concurrent. In addition, connecting the new MRT/LRT system with the current and proposed BRT and traditional bus services is vital. The USTDA Smart City framework plan imagines a new mixed-use growth corridor between Vizag and the new airport, with a combination of infill and greenfield development near Maduwarta, Rusikonda Beach, Bheemilli, Anandapuram, adjacent to the airport itself. The siting of the rail corridor and potential stations in this area will be an important factor for its success. In addition, the Smart City framework plan suggests multimodal and transit-oriented development enhancements to the current RTC complex that could become a key connection for new rail transit and bus services to the heart of the city. The framework Plan also calls for a new bypass road to be constructed, to connect the future airport to the center of Vizag via the future logistics center (westbound), and southbound to the junction with SR-38 just south of Pendurthi. Once that bypass road is completed, an MRT/LRT system is proposed to follow the current NH5 alignment. (See map Figure 1-3)

Given the proposed land use, which will impact the locations where people reside and work, coupled with the emerging emphasis on tourism and the relocation/ expansion of the existing airport to Bhogapapuram, the study of MRT must include a review of the previously-identified alignment, and how well it will interface with the changes in Vizag. If necessary, based on the metrics developed for the study, new alignments should be identified to form a total-system plan with the airport connection the initial alignment for construction.

The Metro Rapid Transit plans should also be revised to include a connection to the new Bhogapuram Airport. A rapid (<60 minutes) transit connection to Vizag's central business district is critical for the future success of the airport. The MRT development program would also include the analysis of discreet projects concerning the development and operationalization of individual lines (Bhogapuram to Maddilapalem, Maddilapalem to NAD Junction, railway station to Gajuwaka viz Scindia, etc.), as well as the construction of rolling stock and other equipment.

'Smart Streets' Corridors – Renovation of Major Arterial Roads within Central Vizag

A central component of Vizag's transformation into a "smart" city would be the redesign of its major arterial roads into multimodal corridors. The 6-km pilot project for this program is currently being designed under Vizag's Smart City Challenge. The pilot would be phased over a 4-8 year period, to eventually include all of the major arterials in Vizag's city center. The vision plan for the city center (see Component 8.3) shows the top-priority arterials that should be enhanced in the first phase.

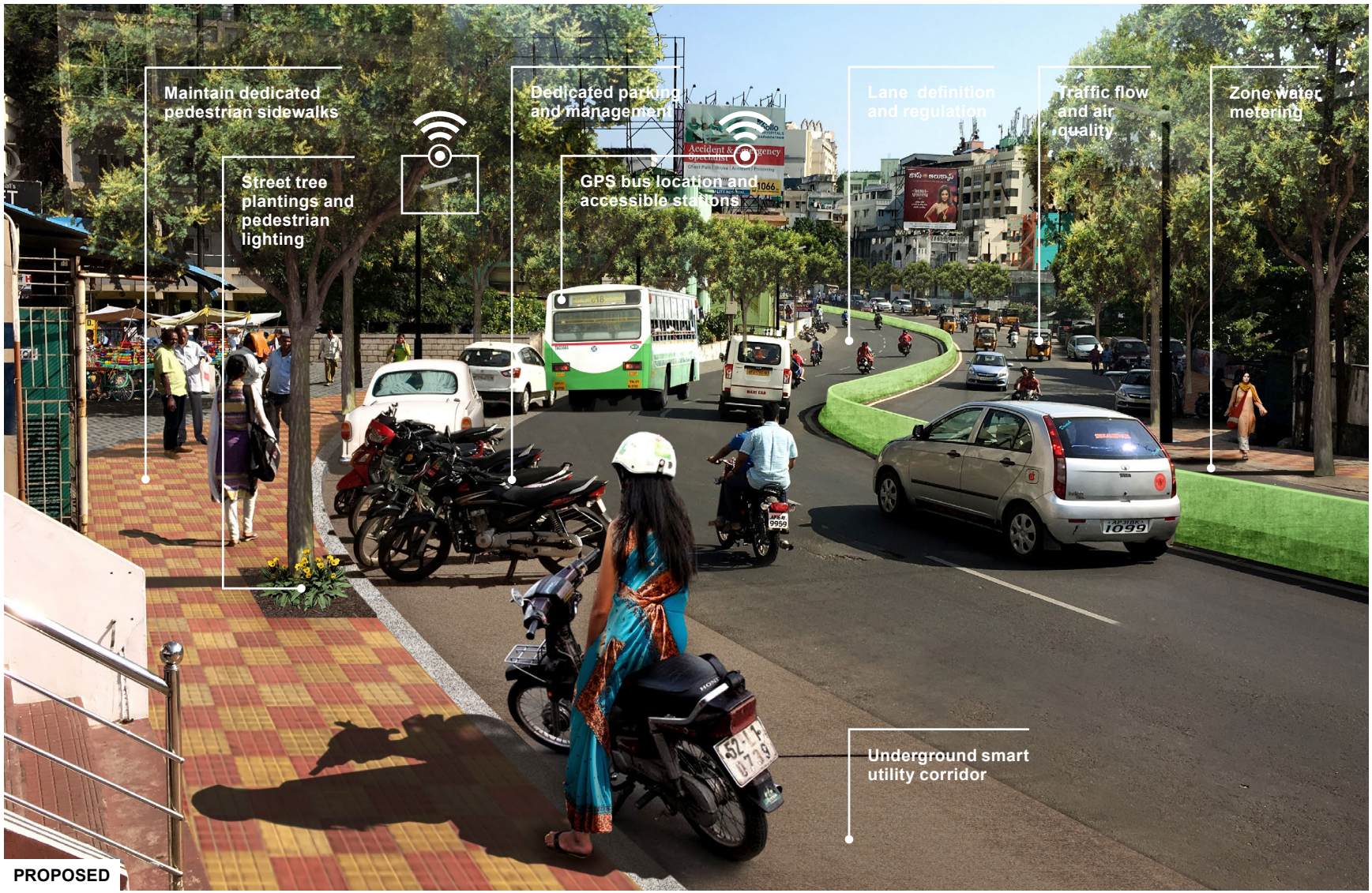
Recommended improvements include:

- Rationalized sidewalk widths, based on anticipated pedestrian flows;
- Geometric changes at intersections to improve pedestrian safety, including safety islands for wider street crossings, high-visibility marking of pedestrian crossings, and pedestrian signals;
- Urban design solutions to prevent vehicles from using sidewalks for parking, while maintaining safe sight distances for vehicles along the roadways and at intersections;
- Parallel on-street parking at key commercial locations;
- Planting areas to buffer pedestrian paths, where space permits;
- Improved bus stops that are secure, safe, convenient, and provide real-time bus information;
- Use of solar cells to provide electrical power for lighting at bus stops and electronic informational signage
- Dedicated full or peak-period BRT lanes;
- Electronic information signage that indicates parking locations and availability to drivers.

Figure 1.3 Arterial Roadway Existing Condition

EXISTING

Figure 1.4 Proposed Smart Street Enhancements to Arterial Road



New and Enhanced Highways Roadways Throughout the Greater Vizag Area

The highway network throughout the region surrounding Vizag will be enhanced to better connect existing and future communities. Both the existing and new roads will include integrated storm water management systems and electrical and sewer utilities within the right-of-way of the road. Between urban centers, roadways will have separate lanes for slower-speed vehicles, and greenways will be installed to provide separation between non-motorized vehicles and motorized vehicles (see illustration below). These improvements will improve travel times, reduce accidents, and increase the efficiency of the roads and the predictability of travel times for drivers. The image below is an artist's illustration of new and enhanced arterial roadways throughout Greater Vizag Area.

Existing Airport Expansion and Enhancement

The rationale for transforming the old airport over the medium-term into a vibrant, mixed-use urban community is set out in more detail in Component 8.3. This major, multi-year program includes transport projects, other infrastructure improvements, and real estate investments. In the short run, the existing passenger air terminal should be expanded to increase its capacity, allowing it to respond to passenger demand while the new airport at Bhogapuram is under development. Once Bhogapuram is in operation, the old airport could become a mixed-use urban center, which would include extensive parkland in this flood-prone area. The transport projects necessary to facilitate this transition would include rerouting the MRT to pass through the center of the area, constructing a local street network, and developing local public bus routes.

The programs, sub-programs and projects that comprise the mobility component are set out in the following table.

Summary of Projects

Program	Sub-program	Project	Project description
Electrification of Transport	Electrification of two- and three-wheelers	2 and 3 wheeler electrification pilot in E-zone within central Vizag.	E-Zone would include the installation of multiple charging stations for vehicles and upgrading (as necessary) electrical substations and transmission lines to increase reliability.
	Electrification of mass rapid transit, including BRT and Metro Rail	Electric circulator bus along beach road	New electric bus service, including electric vehicles and charging facilities in bus depots and/or at bus stops.
Upgrading of Existing Bus Rapid Transit System		Upgrading of Pendurthi BRT	Retrofitting of stations and bus priority signalization at all signalized intersections. Queue bypass lanes at intersections with no dedicated lanes; level loading of passengers at bus stops; PIDs on buses and at bus stops; new upgraded bus shelters with interior light, powered by solar cells; precision docking at stations and all-doors boarding.
		Upgrading of Mudaslorva Valley BRT	Retrofitting of stations and bus priority signalization at all signalized intersections. Queue Bypass Lanes at intersections with no dedicated lanes; level loading of passengers at bus stops; PIDs on buses and at bus stops; new upgraded bus shelters with interior light powered by solar cells; precision docking at stations and all-doors boarding.
		Upgrading of Simhachalam Valley BRT	Retrofitting of stations and bus priority signalization at all signalized intersections. Queue Bypass Lanes at intersections with no dedicated lanes; level loading of passengers at bus stops; PIDs on buses and at bus stops; new upgraded bus shelters with interior light powered by solar cells; precision docking at stations and all-doors boarding.
New Rapid Transit Development	New BRT to Gajuwaka	BRT planning study for new route	Study would develop and recommend a new BRT alignment between Gajuwaka, the Navy Base and the Vizag RTC station. Elements of the study would include ridership forecasts, 5% concept engineering, identification of station locations and depot locations, vehicle requirements, property requirements and environmental issues. Consider electrification of this route.
		BRT financing plan for new route	Development of a financing plan that includes potential revenues from ridership, advertising, property development, third-party financing, and the type of project procurement, including Design-Build-Operate-Maintain (DBOM), P3, DB, etc.
	New airport link	Revision of MetroRail plan to include connection to Bhogapuram Airport	Review and develop new ridership forecasts based on land use changes and new airport. Identify new alignments based on land use and ridership forecasts, including a direct connection from the Vizag RTC to the new airport. Concept engineering and Capital costs would also be identified.
		Advance acquisition of use and development rights to MRT/LRT routes	Initiate acquisition of property that would have a protracted acquisition time or would need to be acquired to avoid purchase by others in advance of project construction,
		Purchase of equipment, including rail cars	For the initial alignment to be constructed, develop specification for rail car procurement and other specification-driven equipment such as signals & communications and fare collection.

Program	Sub-program	Project	Project description
'Smart Streets' Corridors	Central Vizag Arterial Renovations	Renovation of Allipuram Main Road / Ramanagar Road / Nowrj Road Corridor	Develop 5% concept engineering, capital cost estimates, and environmental issues associated with implementing corridor upgrade of arterial for vehicle, pedestrian, non-vehicle, bus and BRT modes
		Waltair Station Approach Road / CBM Compound Road Corridor	Develop 5% concept engineering, capital cost estimates, and environmental issues associated with implementing corridor upgrade of arterial for vehicle, pedestrian, non-vehicle, bus, and BRT modes
		Renovation of Jail Road / Hanumanthawaka Road Corridor	Develop 5% concept engineering, capital cost estimates, and environmental issues associated with implementing corridor upgrade of arterial for vehicle, pedestrian, non-vehicle, bus, and BRT modes
		Renovation of Waltair Main Road	Develop 5% concept engineering, capital cost estimates, and environmental issues associated with implementing corridor upgrade of arterial for vehicle, pedestrian, non-vehicle, bus, and BRT modes
Existing Airport Expansion		Expand existing terminal at old airport	Expansion of existing terminal at old airport for short- to medium-term use, using low-cost, reusable construction materials


GK
PRINT
HOUSE
AADITYA
DENTAL CLINIC
SAI TOWERS 1
WOOD Park
The Furniture Shop
U-FOAM
vodafone

VI. SEWERAGE, WATER SUPPLY & STORMWATER

Introduction

As the population of greater Visakhapatnam continues to grow in the coming years, increasing pressure will be placed on the urban and social infrastructure that supports residents and visitors. Universal access to water and sewerage systems on a 24/7 basis is critical for improving the livability of the area for existing residents, and encouraging investment in the VUDA region over the long term.

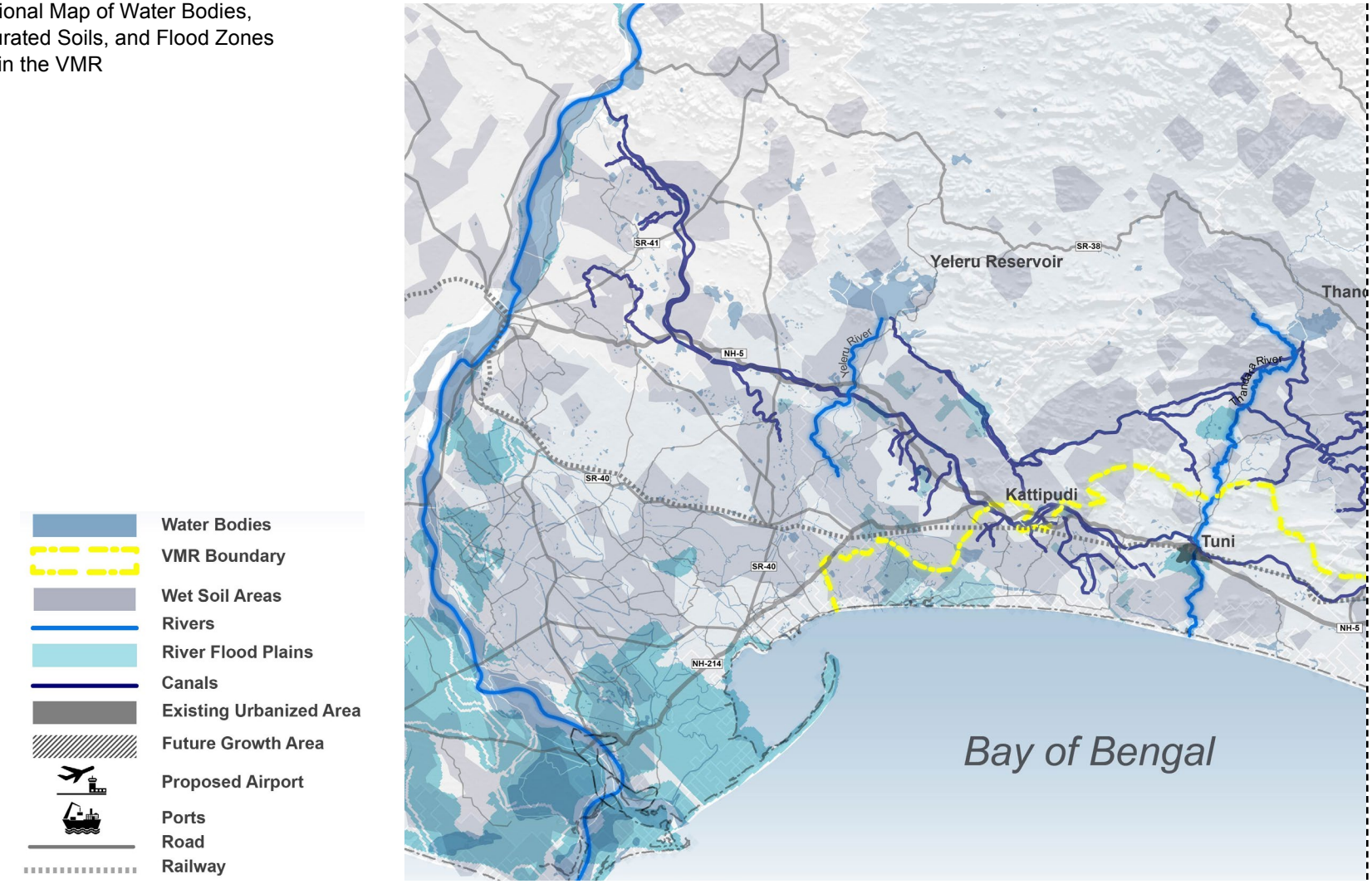
The many infrastructure projects needed to provide quality public services in the water supply, sewerage, drainage, and solid waste sectors fall into two general categories: traditional infrastructure/capital projects, and smart city projects. The GVMC has already identified and prioritized water-sector projects under various action plans, such as AMRUT, PMC for Smart City, other IFI programs, and their own initiatives. These plans include the undergrounding of sewerage infrastructure, stormwater network project expansion, and water supply projects under the Smart City Challenge “Area Based Development” in central Visakhapatnam.

While the approach outlined in this document was specifically developed to deliver smart city projects, some are also appropriate for procuring basic infrastructure improvement projects. The approach focuses on the implementation of large sector-wide smart city projects, rather than any of the related technical and operational activities. Numerous challenges to the delivery of adequate water supply, sewerage, and drainage services were identified during the Smart City planning process. The challenges are outlined as follows:

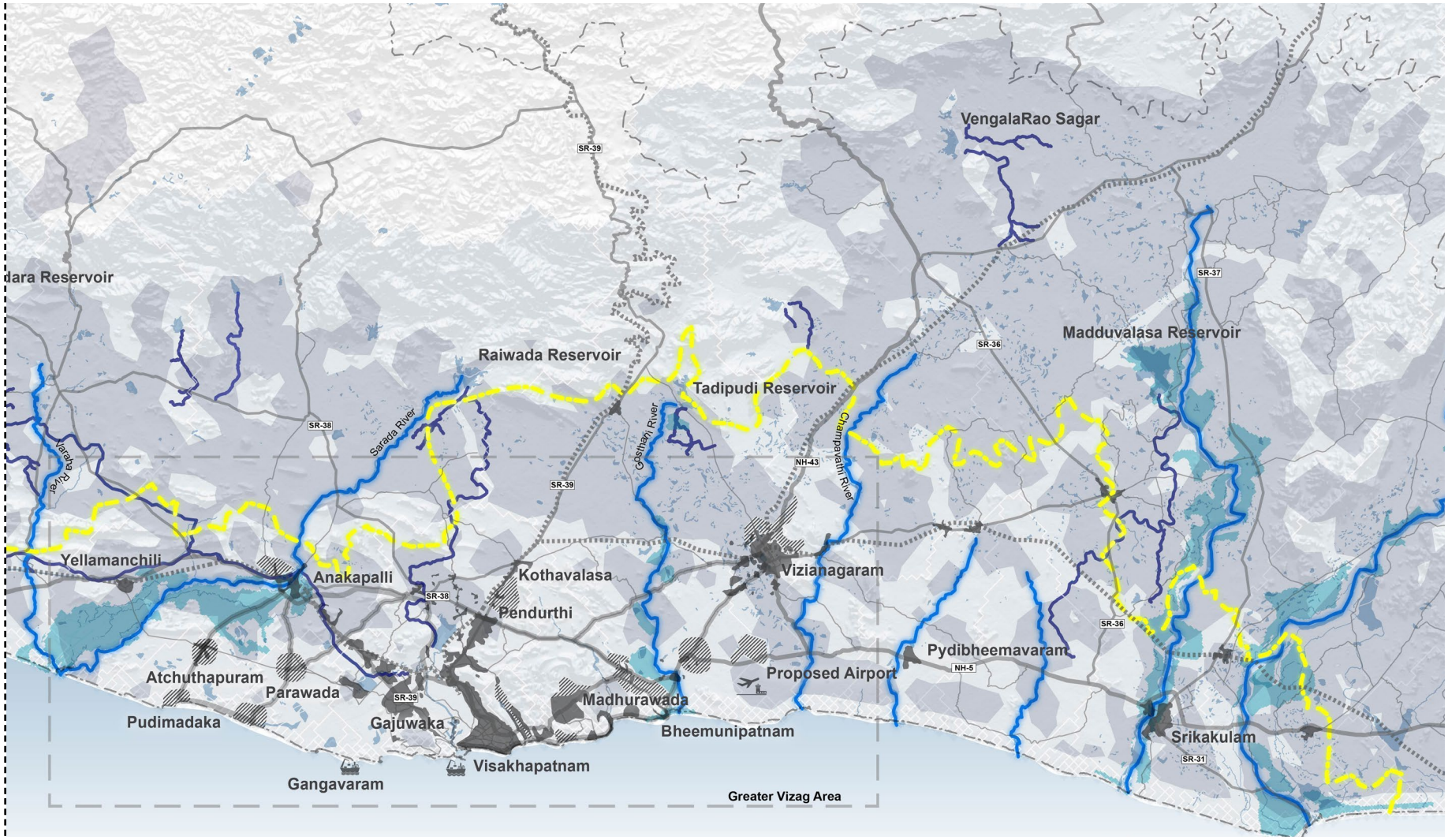
- **Greater coordination of planning and funding system development** – Holistic and coordinated master plans for water supply, sewerage, and stormwater systems would encourage efficient and effective system delivery of long-term supplies to existing residents, and to areas that will accommodate future population growth. Access to additional funding will be required to implement necessary projects.

- **Increasing water supply** – Additional water storage capacity is needed to store adequate water volumes from monsoon rains, in order to meet quantity and quality demands for a 24/7 water supply to existing and future residential, commercial, and industrial users.
- **Building resiliency in the water and wastewater systems** – Parallel transmission mains for critical service areas, backup connections between pressure zones, and backup power supplies for water and wastewater systems would build redundancy for water supply delivery throughout the region.
- **Improving asset monitoring and maintenance** – Maintenance based on asset condition and performance monitoring should be improved, in order to minimize outages.
- **Improving stormwater drainage** – Better stormwater drainage coverage and maintenance would reduce public health effects of vector-borne and sanitation-related epidemics due to water logging, especially during the monsoon months.

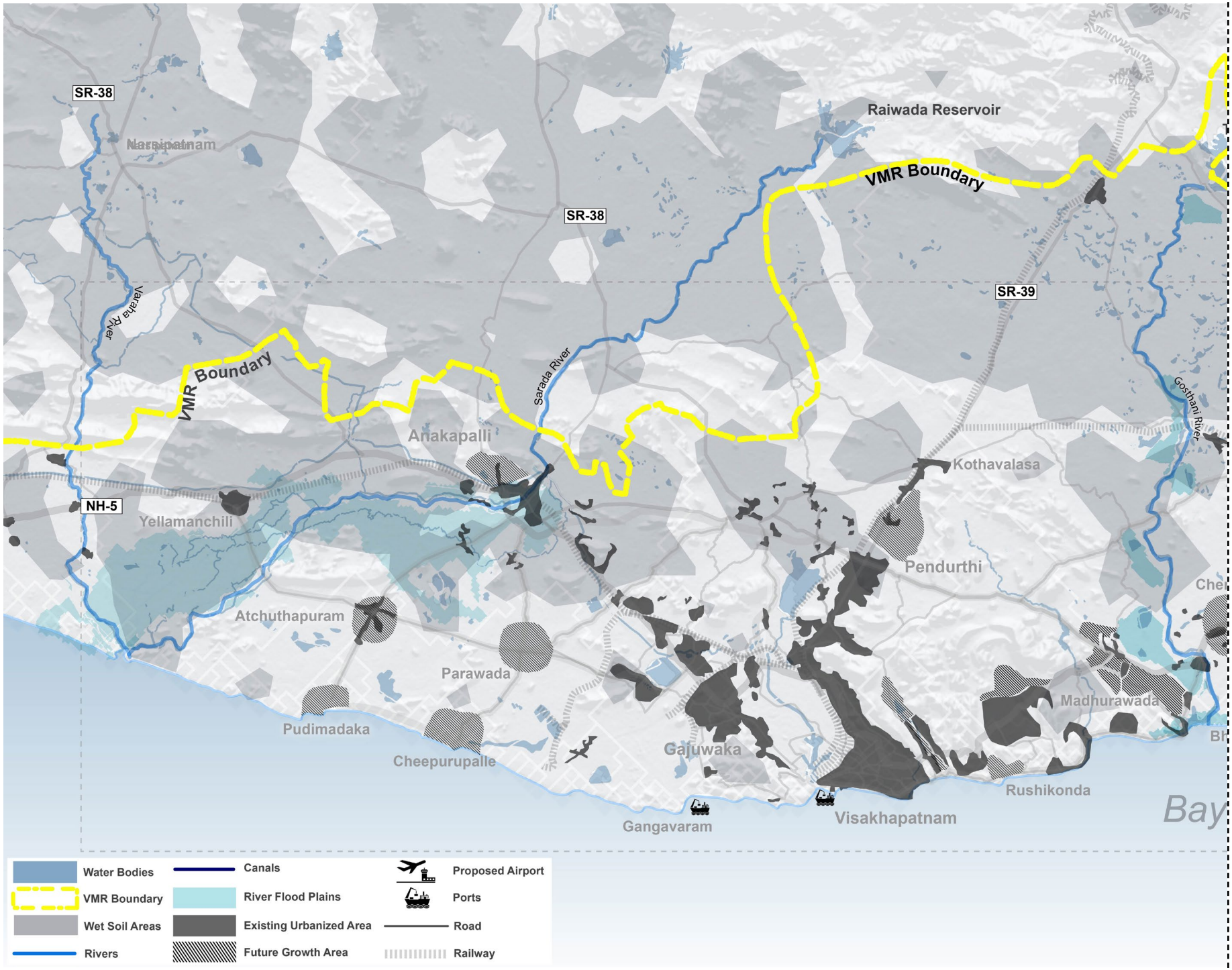
Figure 1.1 Regional Map of Water Bodies, Saturated Soils, and Flood Zones within the VMR



Match p. VI-5


VengalaRao Sagar
SR-39
lara Reservoir
SR-37
Madduvalasa Reservoir
SR-36
Raiwada Reservoir
Tadipudi Reservoir
Sarada River
SR-38
Yarala River
Gosthani River
Champavathi River
NH-43
SR-39
Yellamanchili
Anakapalli
Kothavalasa
Vizianagaram
SR-38
Pendurthi
SR-36
Pydibheemavaram
NH-5
Proposed Airport
Atchuthapuram
Parawada
SR-39
Madhurawada
Pudimadaka
Gajuwaka
Bheemunipatnam
Srikakulam
SR-31
Visakhapatnam
Gangavaram
Greater Vizag Area

Match p. VI-4


SR-38
Narsipatnam
SR-38
Raiwada Reservoir
VMR Boundary
SR-39
Varaha River
VMR Boundary
Sarada River
Gosthani River
Anakapalli
Kothavalasa
NH-5
Yellamanchili
Pendurthi
Atchuthapuram
Parawada
Madhurawada
Pudimadaka
Cheepurupalle
Gajuwaka
Rushikonda
Gangavaram
Visakhapatnam
Bay
Water Bodies
VMR Boundary
Wet Soil Areas
Rivers
Canals
River Flood Plains
Existing Urbanized Area
Future Growth Area
Proposed Airport
Ports
Road
Railway

Match p. VI-7

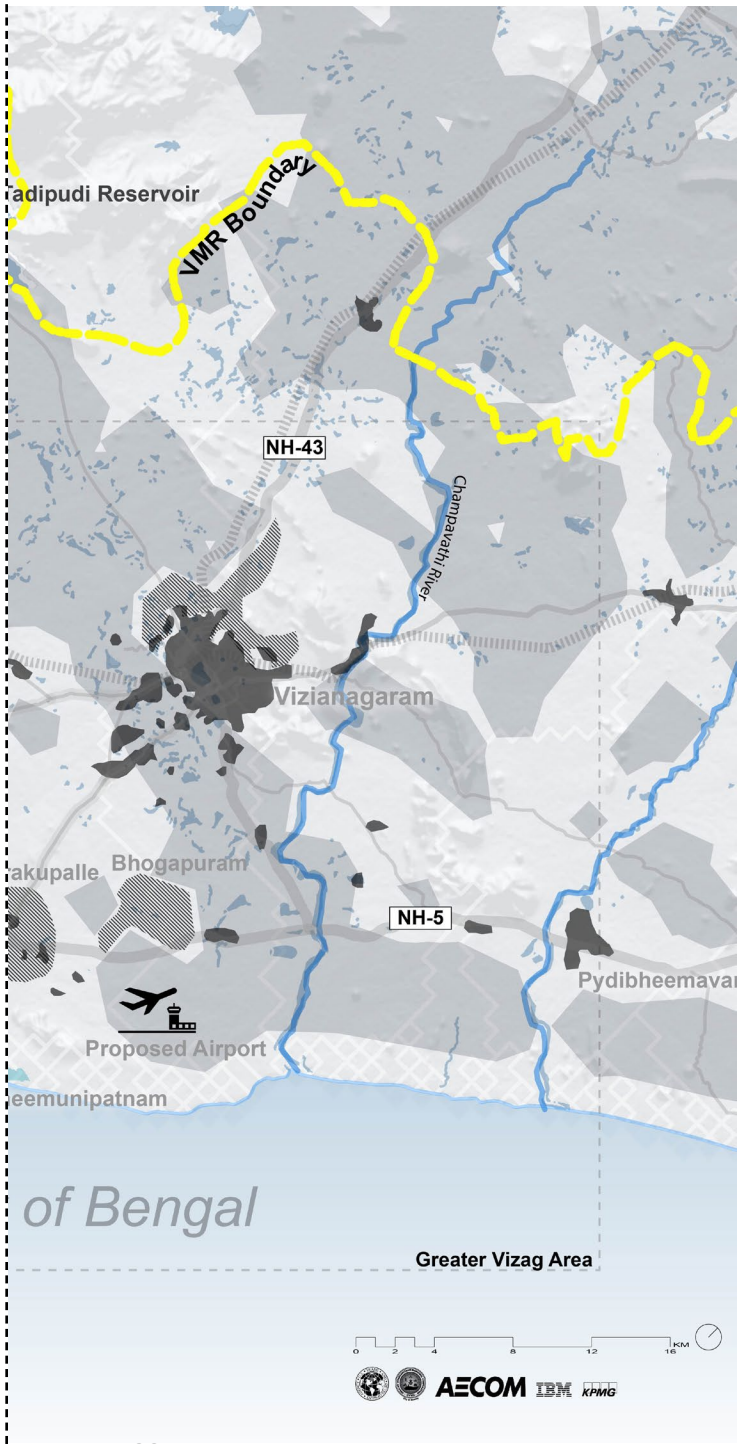


Figure 1.2 Enlargement map of Water Bodies, Saturated Soils, and Flood Zones within GVMC Study Area

Match p. VI-6

Stated System Goals, Metrics and Key Performance Indicators

GVMC's system goals are summarized for each part of the water supply, sewerage, and drainage sector.

Water Supply

- 24/7 water supply to homes and other customers
- Service to 100% of homes, businesses, and industry
- Meeting quality and quantity needs
- Eventually have 100% metered connections

Sewerage

- Extend sewer service to 100% of the GVMC area
- 100% coverage of peripheral areas through individual or community toilets
- Connect all households to the sewerage network
- No collection system overflows or backups
- Improve efficiency and adequacy of treatment systems

Stormwater Drainage

- 100% area coverage by stormwater drains
- No incidents of water logging
- 100% rainwater harvesting

Solid Waste

- 100% door-to-door collection of solid waste
- Citizen outreach to instruct on existing solid waste cycle, regulations and their role in waste segregation, door to door collection, and GPS-equipped collection of segregated waste
- 100% on site segregation of waste, household-level awareness about waste types

Approach to Smarter Water and Solid Waste Management

The proposed approach to strengthening Vizag's water and sewerage system is based on a number of programs and capital investment projects. The major programs are as follows:

Asset Management Framework

The Asset Management Framework program supports the GVMC in efficiently tracking water system and solid waste system assets over their lifecycles, including their installation, operations, and maintenance. A supervisory control and data acquisition (SCADA) system will integrate management and perform supervisory operations or the full array of proprietary assets within the water and sewerage system. Asset-management software will evaluate physical infrastructure performance to optimize water and solid waste systems performance, and when replacement of aging assets becomes necessary. Operational weight bridges to be installed at solid waste collection points as well as at entry points to disposal location, thereby allowing the operator to have a high-level view of the amount of waste through each part of the system. In addition, a SCADA system based on sensors and cameras will be installed to collect more detailed information about operating conditions at key points. The results of the waste movement with quantities in the zones of the city will be taken into account in designing this system-wide roll-out project. Asset-management software improves staff productivity, through better utilization of staff skills, certifications, labor and physical assets.

Increasing Water Supply Capacity

Existing reservoirs, which are the major water source for the GVMC area, have lost their designed capacity due to siltation, and thus, a smart initiative to increase the supply volume using existing assets is needed. Desilting and dredging will restore original capacity or provide increased capacity. Additional storage capacity can be obtained by installing variable crest gates on the existing dam spillways, which would allow continuous storage to the flood-water level. Bascule gates and fabric dams have been used throughout the world to maximize water supply storage in existing reservoirs. Additionally, water and sewerage services can be expanded to Anakapalle, Bheemilipatnam, and Madhurawada through financing, construction, and management on a concession basis in each area. Expanded services include new water-treatment and wastewater-treatment plants, rainwater harvesting, wastewater collection, and distribution piping to all buildings.

Expanding Coverage of Water and Sewerage Services

GVMC will introduce new institutional and financial delivery models for water and sewerage services, with a view towards achieving the medium- and long-term system goals listed above on a financially sustainable basis. First, GVMC will explore the possibility of creating a new Visakhapatnam Water and Sewerage Authority. The Authority will operate on a commercial basis, raising funds on capital markets, expanding water and sewerage systems, setting tariffs under municipal supervision, and collecting user fees from customers. At the same time, GVMC will deliver water supply and sewerage systems in satellite urban communities such as Anakapalle and Bheemilipatnam on a concession basis. Private firms will be tasked with financing, construction and management of these stand-alone systems over a 25- or 30-year period.

Expanding Segregation of Solid Waste

Only 40% of the city is covered under door-to-door collection. 100% door-to-door collection of waste is a top-priority goal for GVMC. This requires major capital improvements, which include the extension of collection networks, as well as the construction of transfer stations. To increase collection volume of solid waste, the number of community bins with provisions for different waste types should be placed at 50-meters intervals, and replaced after every two to three years. The most important components of integrated municipal solid waste management are the segregation of waste at its generation point into wet and dry garbage, and its collection into colour-coded plastic containers--green and red--separately. All residents should participate in segregating waste at primary storage locations by developing separate community bins (colour-coded), and existing secondary collection points (6 Nos) should be converted into closed bins. Citizen outreach programs can improve performance by providing instruction on the existing solid waste cycle and regulations, and their role in waste segregation, door-to-door collection, and GPS-equipped collection of segregated waste.

Expanding Collection and Transportation of Solid Waste

The entire chain can be made to be more effective, efficient, and sustainable, if aspects such as source segregation and processing at the generation level is enforced and practiced. The integration of technologies such as GIS, GPS, and IT can be used very effectively for various purposes, such as the route optimization and monitoring of the efficiency and effectiveness of the entire SWM system. A system could be introduced where each vehicle is fitted with a GPS instrument, and is tracked remotely for the quantity of waste it carries, the route it follows, etc. Similarly, the technology could be expanded and used in improving effectiveness at all levels. It is important to ensure that all collection and transportation vehicles have adequate arrangements for collecting segregated waste. An integrated system, combined with Radio Frequency Identification (RFID), Global Position System (GPS), General Packet Radio Service (GPRS) and Geographic Information System (GIS), is key. The built-in RFID reader in trucks would automatically retrieve all sorts of customer and bin information from the RFID tag mounted with each bin. GPS would give the location information of the collection truck. All the information in the center server would update automatically through the GPRS communication system. Within the system, a bin and truck database has been developed to store the bin and truck ID, date and time of waste collection, bin and

truck GPS coordinates information, bin status and amount of waste, which are then compiled into a data packet and stored,for the purposes of monitoring and management.

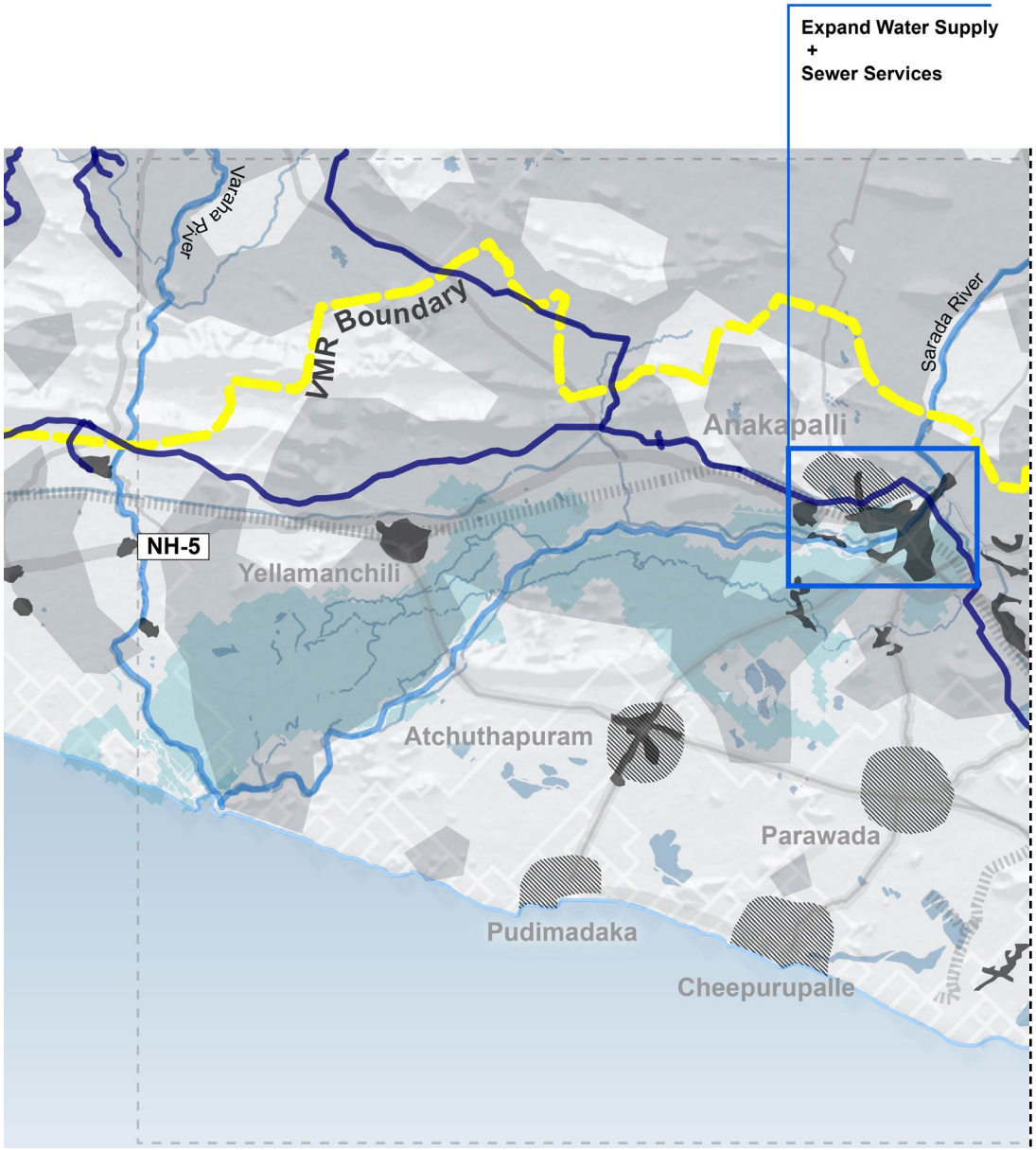
Secondary storage facilities should be designed to ensure hygiene, convenience, adequate capacity, in-time clearance, and the recovery of recyclables for reuse by the recycling industry. Currently, GVMC has only one transfer station, which is located in an old sewage farm, with plans to develop more than 5 transfer stations in different locations for the better management and transportation of waste. The design of modern transfer stations should be convenient and nuisance-free. Collection vehicles, including dumper placers, tippers, and tractors, will pick up the waste from the secondary open collection points and dumper bins, and transfer waste directly to the transfer stations. A ramp facility will also be provided for the unloading of vehicle or dumper-placed containers directly into large container trucks at the transfer station.

Since modern practices involve processing solid waste, rather than distancing and disposal, simple technologies like composting may be adopted at the household level, and at other decentralized sites like gardens, institutions, schools, etc. Modern landfill sites can be developed in accordance with the national and international standards set by CPHEEO, Government of India and Central Pollution Control Board. Since the composition of the waste generated would be homogeneous and in bulk quantity, treatment facility design should deploy waste to energy plants, composting facilities, etc. A Municipal Solid Waste Management Plan should be prepared for all waste types, in alignment with applicable policy mandates, to provide a cost-effective and ecologically-responsible system that ensures an adequate level of SWM services in the region.

Proposed Organic Waste Compost Plant

Organic solid waste would be sent to a compost unit, to be processed into manure for use in gardens and plantations within the city. A closed processing shed and covered shed compost yard are proposed, with adequate ventilation to ensure the filtration of outgoing air through bio-filters, and the circulation of fresh air. The waste ditch, pre-sorting area, composting plant, and curing shed are to be provided with a ventilation or air-collection system comprised of hoods, ducts/grilles and suction/centrifugal blowers. Collected air will be passed through a wet scrubber for dust separation, and biofilters for odour removal. A set of independently-operated biofilter modules will be provided for odour control, in order to process the leachate generated from different waste handling areas like the waste collection pit, window platforms, and pit washing, as well as the byproducts of natural process of the decomposition of organic waste. Preventative measures, such as concreting the compost pad, will be implemented to avert percolation of waste that would result in the pollution of soil and groundwater. The leachate conveyance system to be developed consists of perforations and an open drain pipe that collects the leachate and conveys it into a sump. The drainage network, including the spacing between the pipes, will be in accordance with the requirements of MSW Rules, 2000. Part of the leachate will be reused to maintain moisture at compost pits. The remaining leachate will be treated at a Leachate Treatment Plant, which will be based on the activated sludge process.

Figure 1.3 Summary of Water Projects



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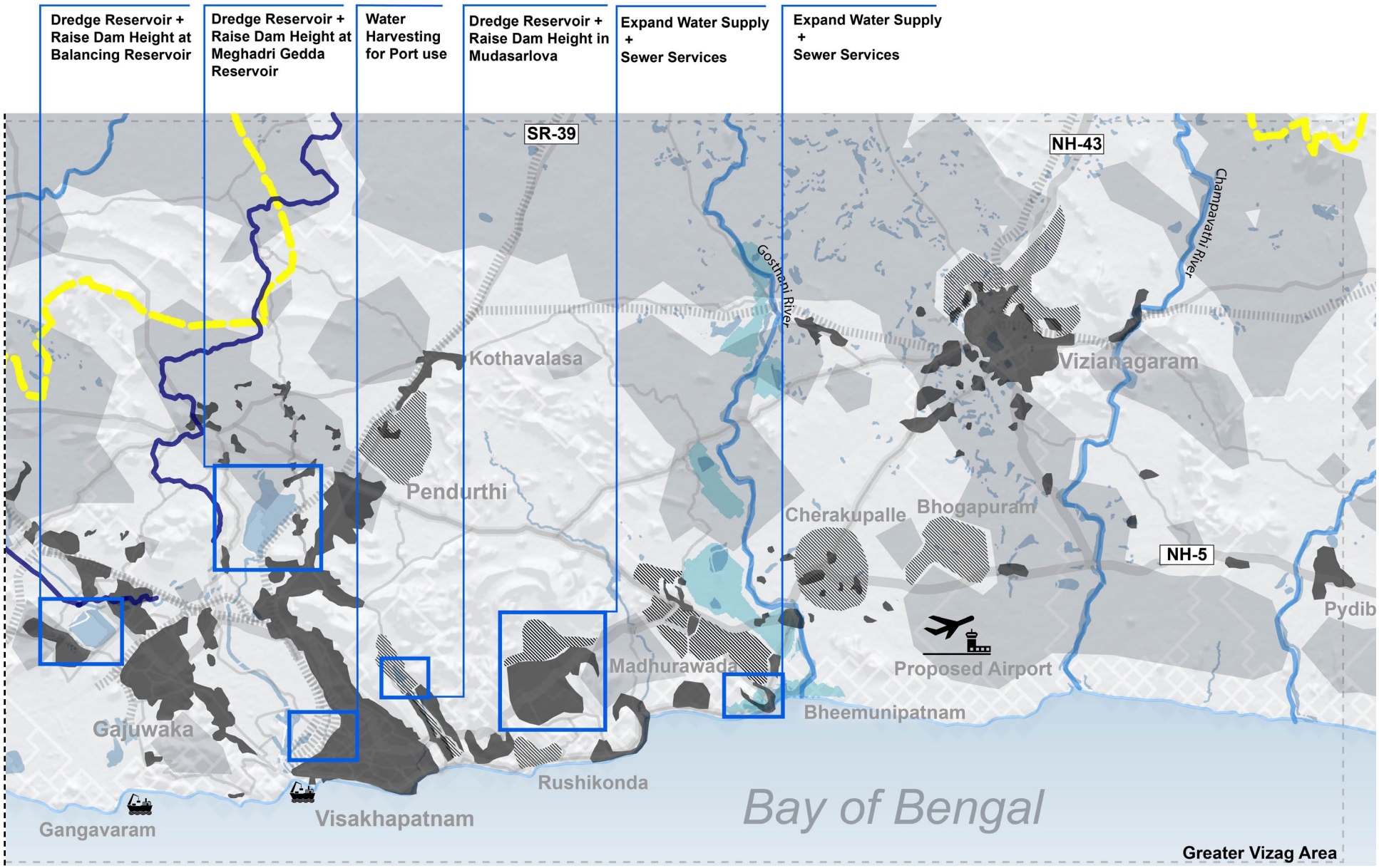

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Water Bodies
VMR Boundary
Wet Soil Areas
Rivers
Canals
River Flood Plains
Existing Urbanized Area
Future Growth Area
Proposed Airport
Ports
Road
Railway

Summary of Projects

Program	Project	Project description
Asset Management Framework	Zone Metering	Track water flows and distribution through water metering by zone. Provide the data required to increase water supply by locating and eliminating non-revenue water losses throughout the system and reduce energy consumption by optimizing system operation. Conditions assessments, detailed survey investigation, and prioritized improvements can now be performed.
	SCADA System	Design, install, and operate SCADA for water and sewerage system.
	Asset management software	Asset management system (including GIS).
	Strategic Pipe Replacement	Replacement of the 5-10% of pipes in water network that lose the most water through leakage each year.
Increasing Water Supply Capacity	Existing Reservoir Capacity Improvements	Bathymetric survey investigation, capacity assessment plan, dredging, and design of check dams for existing reservoirs; dredging of existing canals. Convergence with energy sector by installation of solar panels.
Expanding coverage of water and sewerage services.	Water Supply and Sewerage Services to Anakapalle	Financing, construction and management of water-supply and sewerage services on a concession basis. New WTP (Water Treatment Plant) and expanded distribution piping to all buildings. New wastewater collection system and new WWTP (Wastewater Treatment Plant).
	Water Supply and Sewerage Services to Bheemilipatnam	Financing, construction, and management of water-supply and sewerage services on a concession basis. New WTP and expanded distribution piping to all buildings. New wastewater collection system and new WWTP.
	Water Supply and Sewerage Services to Madhurwada	Financing, construction and management of water supply and sewerage services on a concession basis. Construct new sewerage system incorporating rainwater harvesting. Revise proposed WWTP at Kapuluppada from conventional treatment method to wetland treatment. Expand water supply distribution piping to all buildings.
Waste management System awareness Program	Environment and waste management Awareness programme	Conducting awareness programs to disseminate information to public to encourage segregation and recycling; promotion of recycling and reuse of segregated materials.
	Geographic Information System	Make use of GIS maps for fixing most suitable route, and GPS for tracking location of vehicles
Tracking waste System Movement	SCADA System	Track waste collection and transportation through bulk GIS and by zone. Design, install, and operate SCADA for waste management system.
Solid Waste Collection and Sorting	Neighborhood level sorting facilities	Establish neighborhood collection and sorting locations equipped with bins for different biodegradable waste and for dry waste, Secondary storage facilities and transfer stations.
	Develop transfer stations.	Locate and develop additional transfer stations equipped for sorting.
	Expand House-to-house waste collection	Study feasibility of expanding house-to-house collection through outsourcing to private firms.

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VII. ENERGY

Introduction

Too often, the energy sector is thought of as a system of segregated infrastructure that serves customers independently from other urban systems. In reality, all urban systems are energy systems of one kind or another, and either directly or indirectly impact the conversion of primary energy sources. For example, transportation-systems improvements that enable and encourage pedestrian and bicycle trips can reduce vehicle miles traveled and help avoid the associated conversion of fossil fuels. Similarly, in Vizag as in many other cities, the largest single consumer of electricity is the water system. Sourcing, treating, distributing, capturing, and re-treating water utilizes an enormous amount of electricity. Energy conversions are implicit in all infrastructure services and their processes, and therefore all systems should be considered when attempting to meet energy system goals. Smart City solutions to infrastructure challenges use these energy interdependencies to their fullest potential, in order to get the most out of any system, and also look for creative ways to harness available energy, or offset increased system loads, by managing behavior-based demand.

While all systems involve conversions of energy, the electricity system is the central focus, as it plays a particularly important role in supporting quality of life for residents as well as industry. The capacity, resilience, cost, and environmental profile of this system will become even more of a critical concern as the region continues to grow. While energy generation currently exceeds demand, the region is growing, and with the expected increases in industrial demand, and the increased desire for air conditioning and electrified systems in general, the prospect of increasing “cleaner” electricity generation must be considered now. The current system is dependent on the thermal conversion of coal, is subject to price volatility, and produces high levels of greenhouse gas emissions. The long term affordability and liveability of the system must be considered when planning for growth.

As energy prices fluctuate, finite fossil fuels are used, and the energy system’s impact on climate change comes into focus, the effective management of electricity systems becomes paramount to mitigating risks. Smart electricity management can address these issues by using sensors, advanced meters, renewable energy sources, digital controls, and analytic tools to automate, monitor, and optimize energy distribution and use. These systems optimize grid operation and usage by balancing the needs of the different stakeholders involved--consumers, producers, and providers.

Enhancements to the electricity generation, transmission, and distribution system shall meet the following goals:

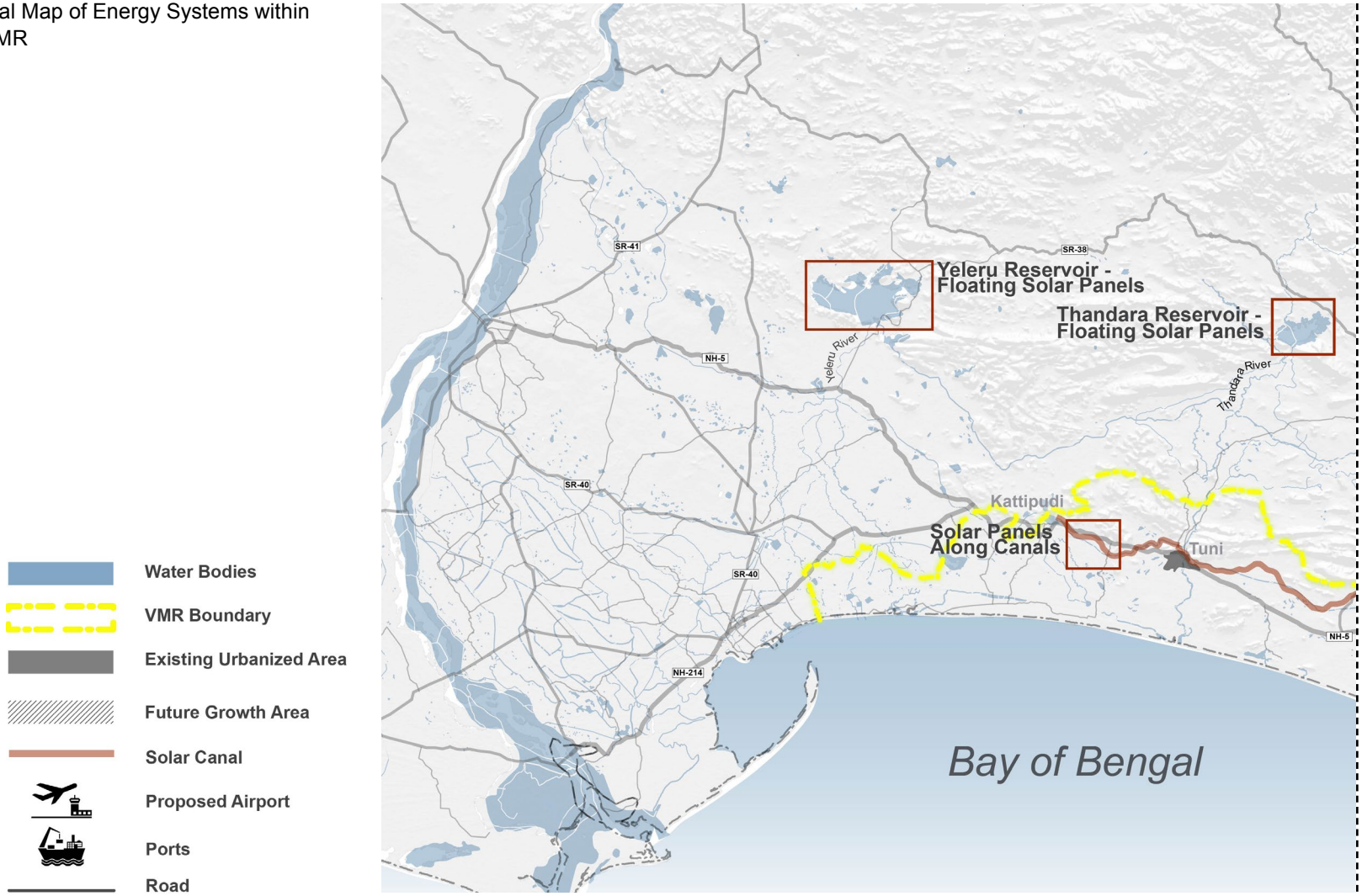
- **Improved System Resilience** – Wind and water damage can shut down electrical systems if they are not redundant and/or specifically designed to avoid downtime. Similarly, critical facilities will need back-up power systems to serve the public following disaster events.
- **Uninterrupted power supply** – Vishakhapatnam often experiences power outages due to system faults that result from salt deposits on line conductors, faulty equipment, etc. These may be overcome by having resources like redundant feeders and alternate or redundant power sources.
- **Improve quality of supply** – Reducing voltage fluctuations can help attract businesses and better support service for residents.
- **Minimization of transmission and distribution (T&D) losses** – Vishakhapatnam has about 8% T&D losses. This loss may be due to energy dissipated in conductors and equipment that is used for transmission, transformation, sub-transmission, and distribution of power; unauthorized extensions of loads, errors in meter reading, errors in estimating

unmetered energy supply, and improper meter calibration. These losses can be mitigated by upgrading transmission and distribution systems, coupled with a reduction in losses and theft, and by allowing redistribution of the load.

- **Quick fault detection and fast mitigation time** – Use of “smart meters,” linked by a Supervisory Control And Data Acquisition (SCADA) system,will improve the operation of the distribution system.
- **Diversify energy sources** – Using a variety of fuels and primary conversations will support a more reliable, resilient, and affordable system.
- **Incorporate distributed renewable generation & energy storage** – Increasing penetration of renewable energy generation and storage will improve environmental outcomes, and reduce the need for costly peak- generation facilities.
- **Increase use of grid-tied solar micro-grids** – Grid-tied solar systems are designed to run parallel to the utility grid. Grid-tied solar systems allow a home to use power from the utility grid as it would normally while utilizing the power from the solar system at the same time. If the solar array produces more power than the home can use, a grid-tied system pushing power back onto the grid banks the energy credit for later use, thereby providing sustainable energy.
- **Implement of Smart Grid technology** – Smart Grids use a high level of system integration with SCADA, and metering and automation to manage electricity flow and reduce peak pressure on the system.
- **Mitigate peak demand** – System peak-demands drive the capital invested in generation, and increase the sizing and costs of substation systems. Spreading the peak can allow more people to be served throughout the day by less infrastructure. Additionally, demand side management (DSM) through financial incentives and changing consumer behavior can influence when customers use energy.
- **Reduction of Green House Gas (GHG) emissions** – The energy sector contributes significant carbon and other GHG emissions. Cleaner energy systems are needed to meet global GHG reduction targets.

Advancements in the electricity system can also develop synergies with other infrastructure sectors, such as transportation and water systems. Projects that develop cross-sectoral co-benefits have the advantage of getting more out of a given investment.

Figure 1.1 Regional Map of Energy Systems within THE VMR



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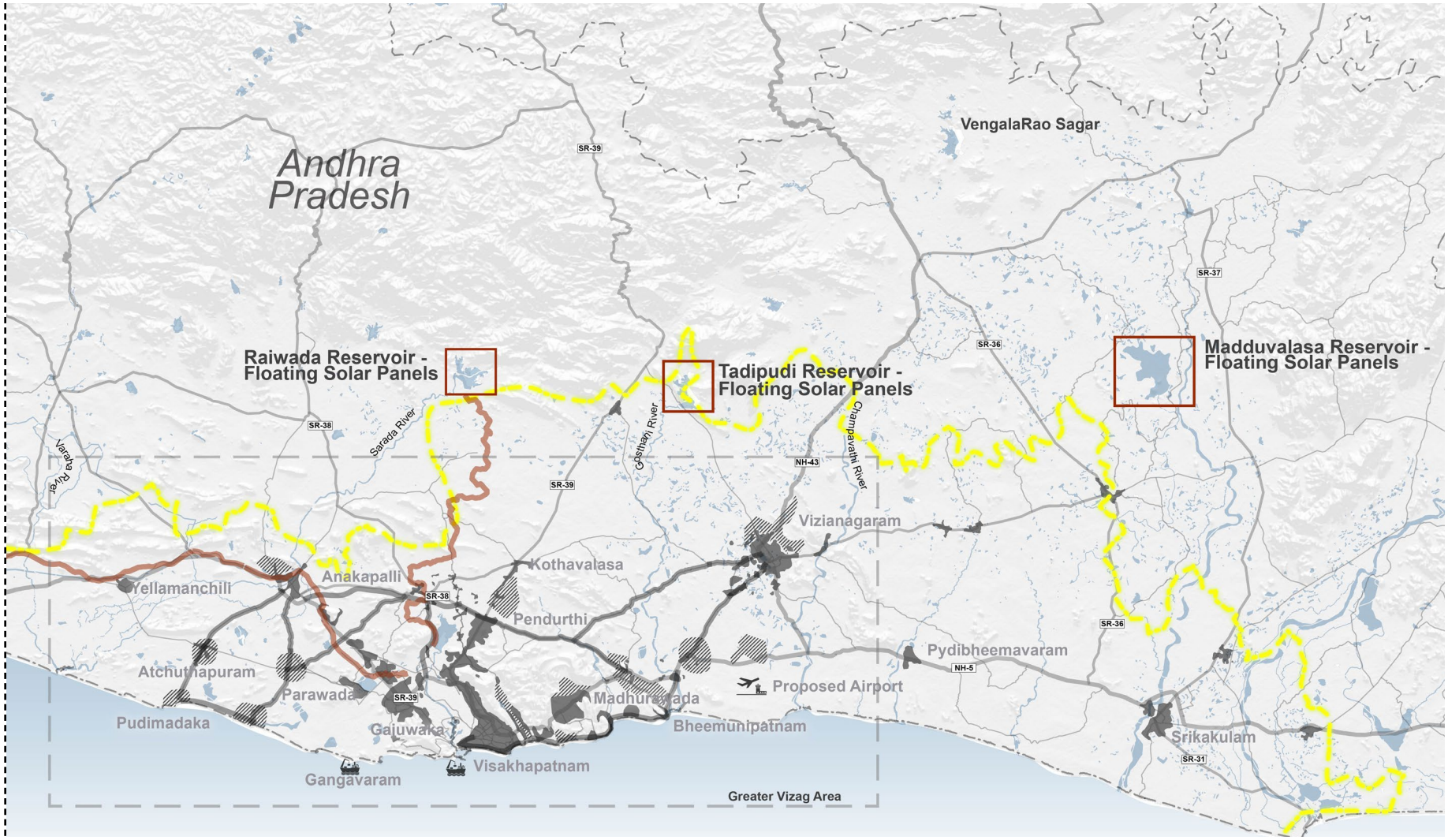

Andhra Pradesh
VengalaRao Sagar
Raiwada Reservoir - Floating Solar Panels
Tadipudi Reservoir - Floating Solar Panels
Madduvalasa Reservoir - Floating Solar Panels
Sarada River
Gosthani River
Champavathi River
Varaha River
SR-39
SR-38
SR-37
SR-36
SR-31
NH-43
NH-5
Vizianagaram
Kothavalasa
Anakapalli
Yellamanchili
Pendurthi
Atchuthapuram
Parawada
Pudimadaka
Gajuwaka
Madhurawada
Bheemunipatnam
Proposed Airport
Pydibheemavaram
Srikakulam
Visakhapatnam
Gangavaram
Greater Vizag Area

Match p. VII-4

Technical Approach

The approach to strengthening Vizag's energy system is based on a number of programs and sub-programs. Each of the sub-programs includes one or more capital investment projects. The major programs are as follows:

Smart Micro-grid Program

Building on the success of the APEPDCL, the greater Vizag area can advance the design and deployment of versatile micro-grid systems within in India. The program will seek to improve the reliability, resilience, and efficiency of the energy system through micro-grid system development, and improve the testing and operation of micro-grid systems for institutional partners as well as new developments. Pilot projects will be undertaken to explore retrofits as well as new construction in relevant growth areas. These demonstration projects will be used to test available technologies and develop institutional capacity to deliver micro-grid systems at larger scales. Initial projects to be undertaken include:

Andhra University Micro-grid – Design and deploy a "smart" micro-grid retrofit at Andhra University that allows for large-scale solar energy conversion and battery storage. The system should be sized to offset peak electricity usage, and reduce the university's emissions footprint. The project could become a training tool for the engineering school, and would include educational partnerships focused on monitoring and maintenance. The new grid would be configured to accept and store on-site renewable energy generation, as well as connections to currently available distribution lines. The systems will be managed through a Supervisory Control and Data Acquisition (SCADA) system connected to the University and APEPDCL.

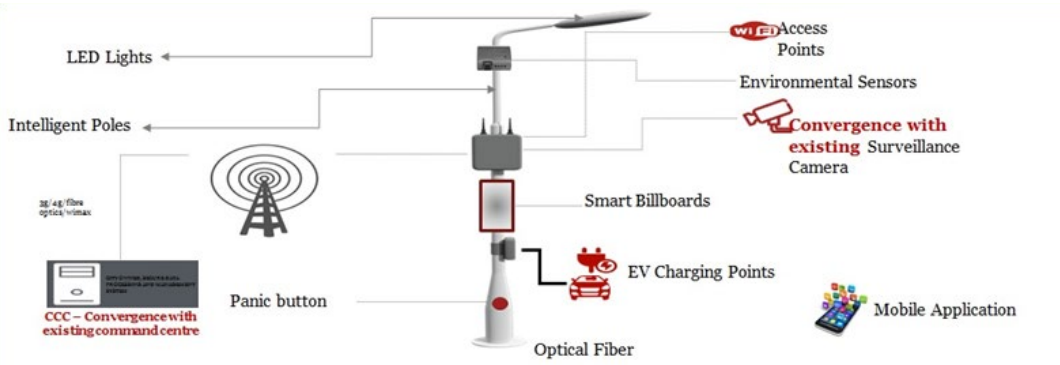
Andhra University is scattered over 440 acres of land. The total demand of Andhra University is around 1MW and the generation of this power can be done through the installation of solar panels on rooftops and over parking sheds, and by installing solar street lights. A well-maintained building-management system to adjust temperature, lighting, and other indoor environment settings, according to time of day, occupancy, season, and room use should also be implemented. The existing distribution system may be converted to a "smart" distribution system by shifting from existing switchgears to modern technologies. For example:

S.N.	Existing Network	Network proposed under Smart Grid Module
1	Outdoor conventional 11/0.415kV Distribution Substations	Use of Compact Substations
2	11kV & 415V overhead lines	Underground cabling of 11kV & 415V cables
3	Outdoor 11kV switchgears	Use of Ring main units with remote terminal Unit for communication between other switchgears.

As seen from site visits, and after discussion with various utility boards, it is understood that 33kV & 11kV lines are currently being laid underground, and the extensive use of ring main units is being proposed. With all this integration at larger scale may also be possible once the first module of Smart micro grid is implemented.

“Smart” streetlight poles can also be used in this smart-grid module. Battery storage facilities should be created in order to house and transfer excess energy to various other consumers. These poles should house security cameras; poles can also display advertisements, as seen in figure below.

Figure 1.2 Smart Streetlight Poles



Bhogapuram Micro-grid – The proposed project is located in the future airport area, and unlike the university campus demonstration, would be a Greenfield pilot project. The new grid would be configured to accept and store on-site solar generation, biomass conversion, and connections to APEPDCL distribution lines. The biomass plant should accommodate agricultural byproducts, such as sugar cane, rice husk, woody biomass, cotton stalk, chili stalk, coal, jute waste, casurina branches, waste dust, groundnut husk, corn cob waste and dust, leaves, cashew cuttings, and eucalyptus. The proposed capacity of the biomass energy plant is a 10MW plant. In the initial phase, solar firm capacity is considered 10 MW and can be increased. The storage battery stores power generated by the solar cells. The generation and storage systems would be managed through a Supervisory Control And Data Acquisition (SCADA) system.

Well-integrated building management systems should be utilized to adjust temperature, lighting, and other indoor environment settings, according to time of day, occupancy, season, and room use. Investments in state-of-the art electrical transformers and switchgears across campus, allow APEPDCL energy managers to track energy usage in real time. Smart-grid implementation would add a new level of sensors and controls to the electrical distribution systems at the building or equipment level. Benefits of these new features include the following:

Solar Water System Program

Similar to the systems of other cities, the GVMC water system consumes more electricity than any other user. Simultaneously, the water and sewer systems lack the critical back-up power supplies needed to rebound quickly following severe weather events or other APEPDCL power outages. The solar water system program seeks to offset peak energy demands, reduce the emissions footprint of the water system, limit water losses due to evaporation, and provide resilient back-up power to the water system. All of these outcomes can be achieved by overlapping PV solar arrays and battery storage with water system infrastructure. Individual subprograms and projects include:

Canal Energy Program – The region has hundreds of kilometers of major canals that connect distant water sources with supply reservoirs throughout the GVMC and other jurisdictions. These canals are flanked by rough access roads, and in many cases, electricity transmission infrastructure. The solar canal program seeks to build PV solar arrays over advantageous canal segments, with the aim of reducing evaporative water losses and building renewable generation capacity that can be tied to battery storage and grid distribution. The program could also consider mini-hydropower projects within the canals that use the canal's water flow to drive smaller turbines, further increasing the system's electricity yield. In this

way, water infrastructure can help generate the energy it uses. Additionally, the paths that follow the canals can be upgraded to better convey slower-speed vehicle, bicycle, and pedestrian traffic. Solar canals are similar to rooftop solar, in that they are installed over existing infrastructure, and do not require additional land development or land acquisition, which is a major factor. They also provide the additional benefit of reducing evaporative losses, and can help provide the energy needed to pump water throughout the country.

The same can be developed by considering the “thumb rule” of solar energy, which states that on average, modern photovoltaic (PV) solar panels will produce 8 – 10 watts per square foot of solar panel area. Thus, if we have a canal area of 1000 meter with average canal width of 15 meter is 15,000m² (161458 feet²), the panels would produce roughly 8 watts per square foot, or 161,458 square feet x 8 watts/square foot=1,291,664 watts (1,291.664 kW)(1.2MW) of electric power.

Figure 1.3 Smart Canal Energy Program

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Solar Reservoir Program – The regions' reservoirs also provide the opportunity for cross-sectoral projects that can have integrated benefits. PV solar arrays can be built to float on the reservoir's surface, shading the water, reducing evaporation, and generating clean power, therefore offsetting water system demands and/or providing back-up power when traditional centralized power is off line. However, floating solar panel installations, also called "floatovoltaics," have popped up as a feasible solution.

Unlike land-based solar plants, floating solar power plants are installed on water reservoirs, like dams, lakes, and rivers, which negate the issue of occupying land. The solar panels are mounted on floating platforms that are anchored tightly, in order to prevent damage in even the worst weather conditions. Moreover, research suggests that solar panels installed on land face a reduction in energy yield as the ground heats up and impacts the rear surface of the solar panel. When placed on top of water, solar panels can cool themselves more efficiently, which means that they will last longer and produce more energy.

Likewise, the installation of floating solar panels on water bodies is not expected to impact the water bodies' ecology. Rather, it proves beneficial to the water itself, as solar panels reduce water evaporation and discourage the growth of the algae, thus helping to preserve water levels during extreme summer conditions.

Building solar arrays over water allows for an installation of significant size, without the need to procure/occupy private land, and yields the co-benefit of reducing evaporation losses. The program would include installations at five GVMC reservoirs.

Below are examples of "Floatovoltaics" in India:

a. 10kWp Solar panel in Rajarhat Kolkata, by MNRE

b. 100kWp on Loktak Lake Manipur, by Manipur Renewable Energy Development Agency

c. 50MW Solar project in Kerela under planning by NHPC & Renewable energy college

District Cooling Pilot Program

District cooling is a superior alternative to conventional individual-unit air conditioning, as it reduces capital and operational costs per dwelling unit, and helps reduce energy consumption while also cutting carbon dioxide emissions. At present, most large hotels and building complexes utilize conventional heating and cooling systems. But future developments could capture the advantages of district cooling, using centralized evaporative cooling systems and/or ground-source or water-source heat exchange. District cooling pilot projects can be publicly or privately-owned, and can be incorporated into new infill growth areas like Rushikonda, and into projects like the redevelopment of the RTC complex.

Figure 1.4 Canal Existing Condition

Figure 1.5 Solar Water Resilience Program along Canals

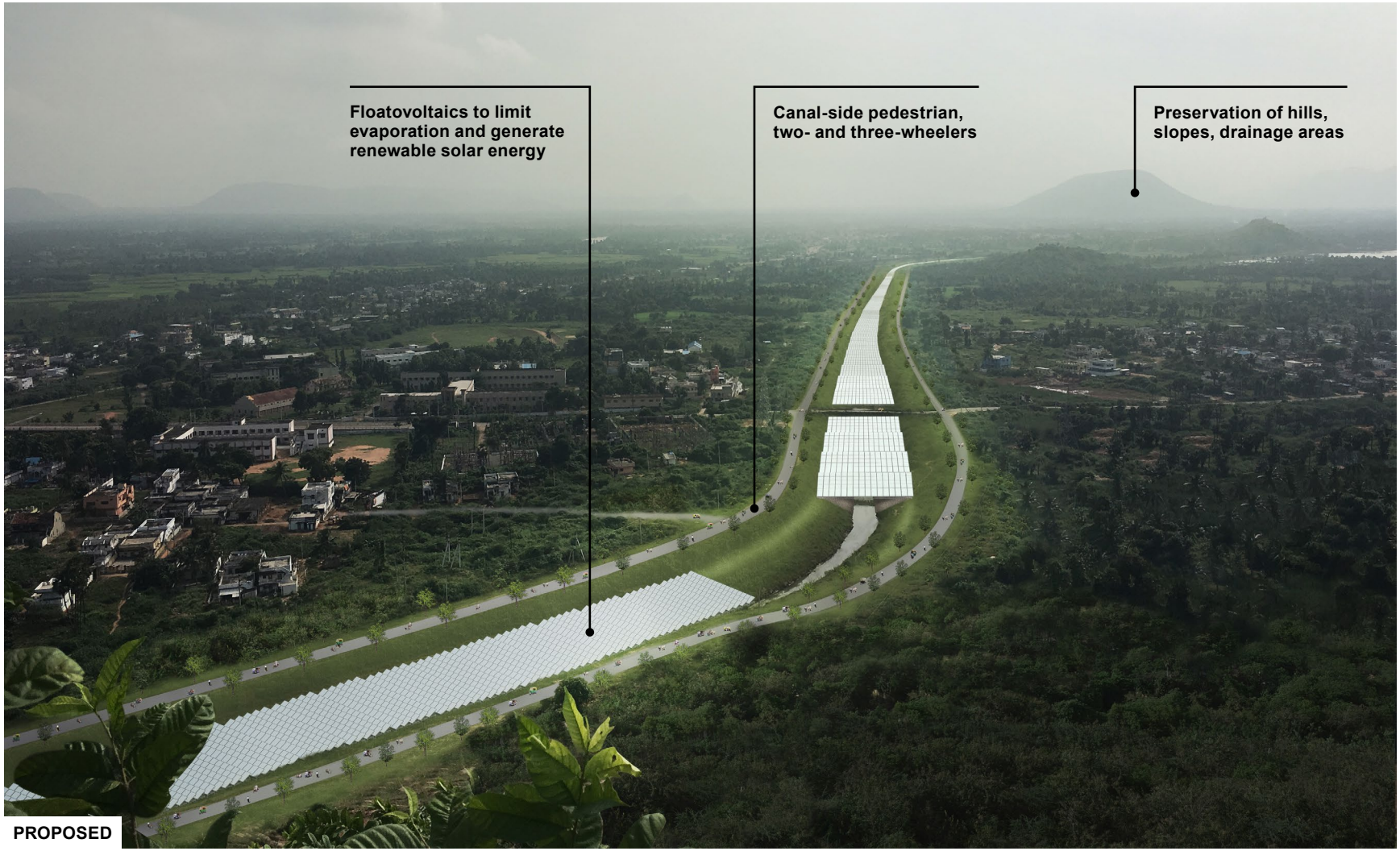
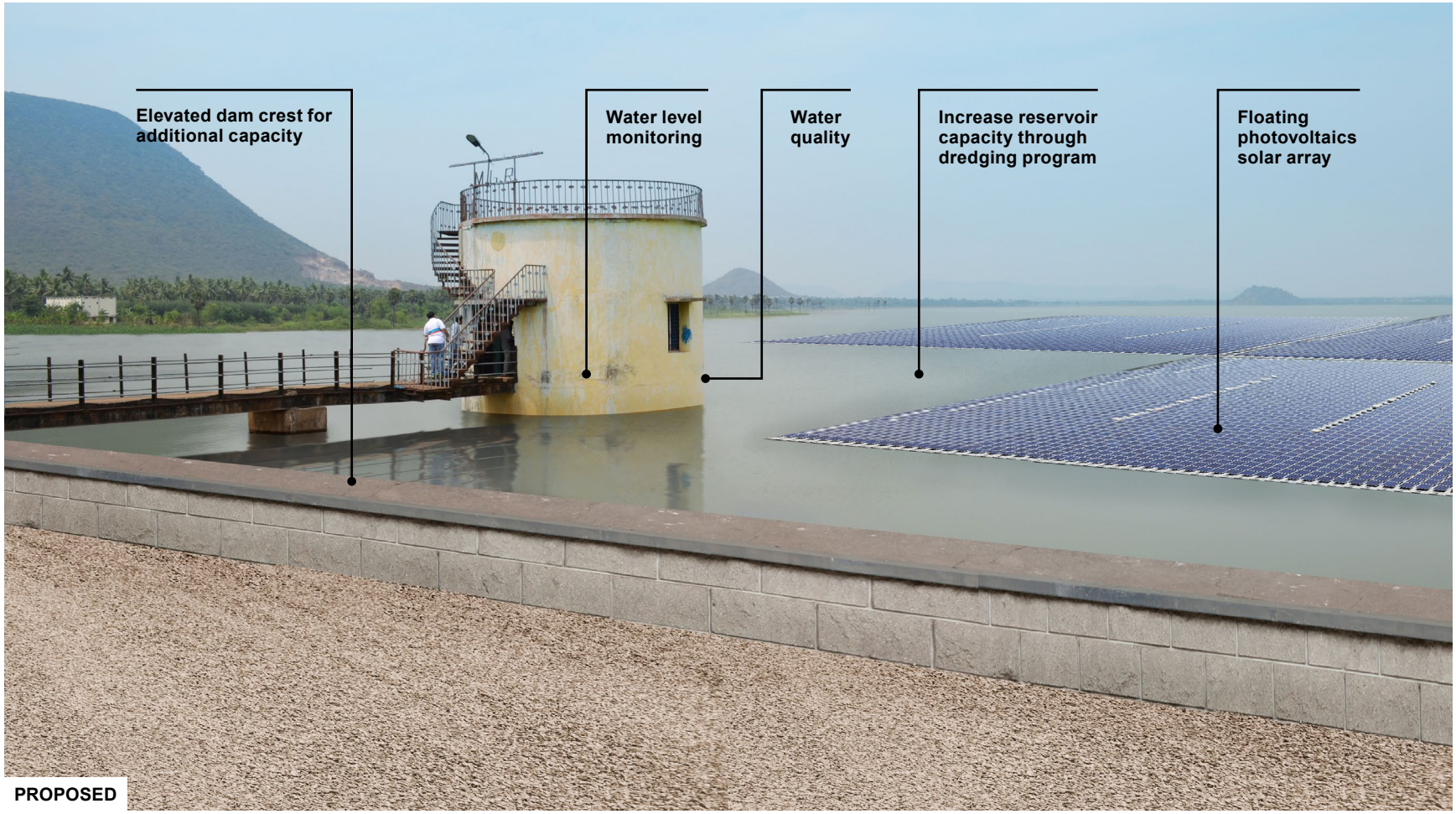
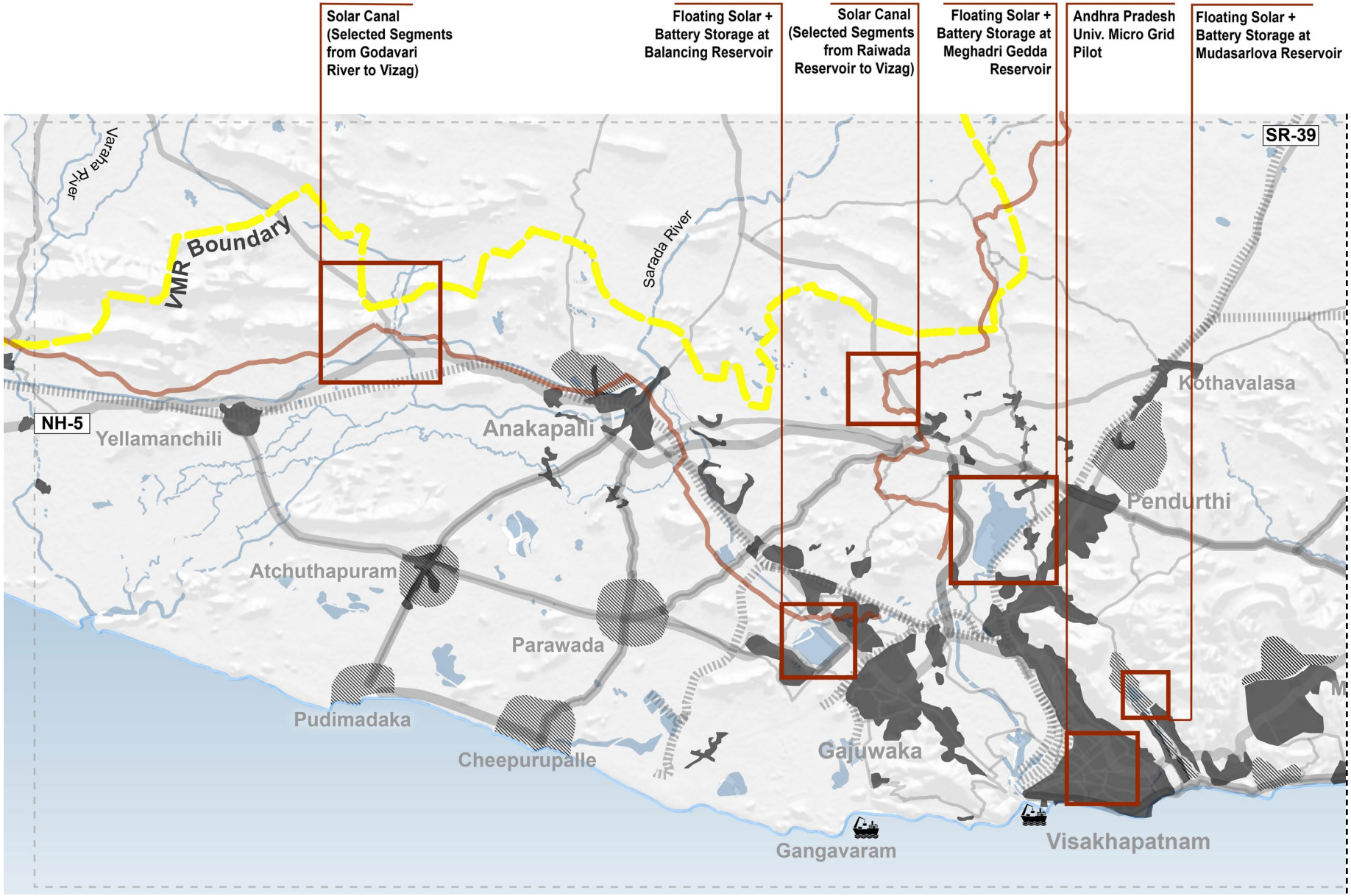


Figure 1.6 Existing Reservoir Conditions

EXISTING

Figure 1.7 Solar Water Resilience Program at Reservoirs





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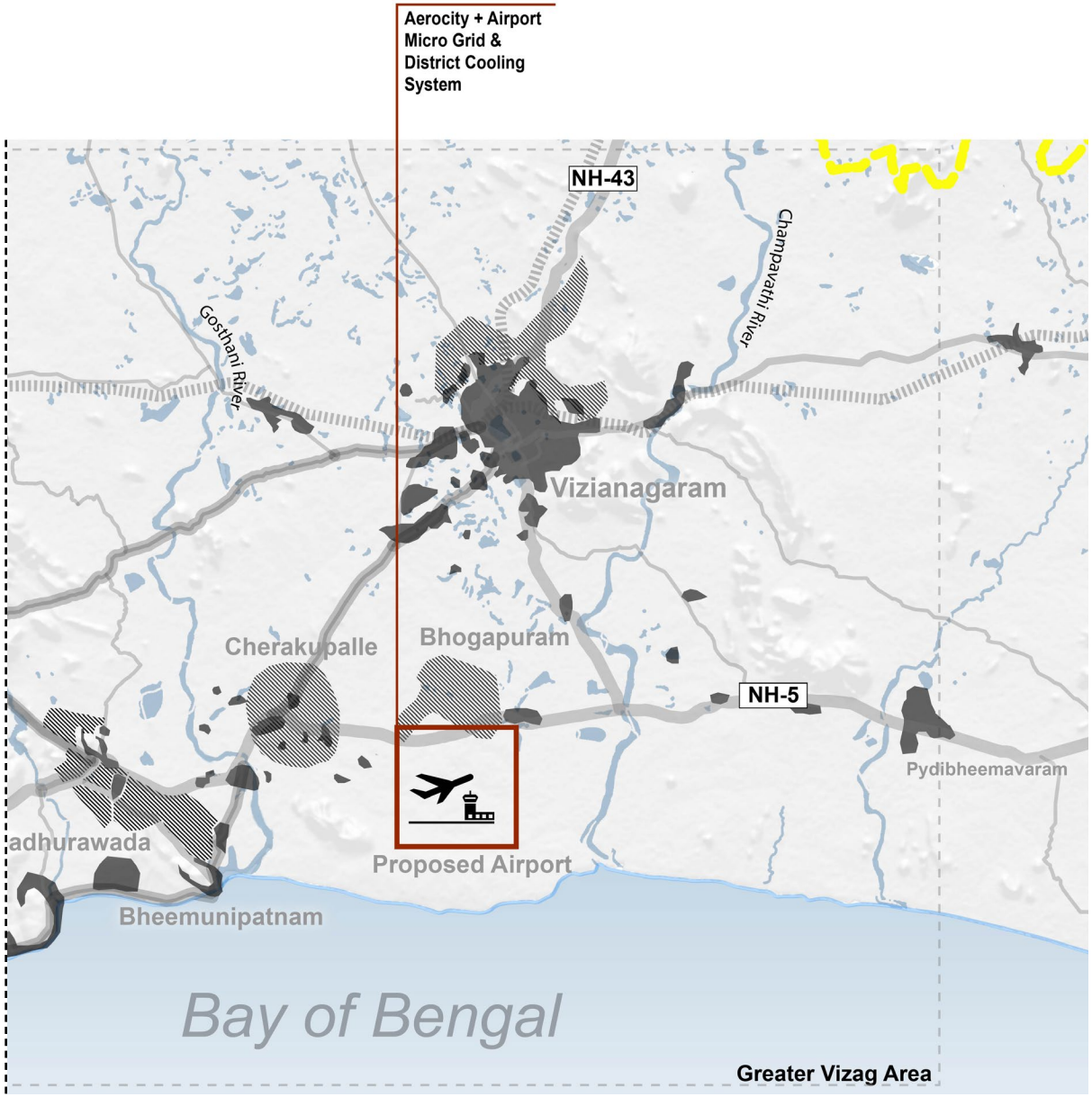

Figure 1.8 Summary of Energy Programs and Projects

Water Bodies
VMR Boundary
Existing Urbanized Area
Future Growth Area
Proposed Airport
Ports
Solar Canal
Road
Railway

Match p. VII-16

Summary of Programs and Projects

Capital Investment Program	Sub-program	Project	Project description
Smart Micro-Grid program	Smart Power grid Pilot projects	Smart Micro Grid at Andhra University	▪ Smart Micro-Grid with solar power generation, battery storage, and back-up-grid connection by APEPDCL, and district cooling for large buildings and hotels. ▪ The project can be implemented through Public Private Partnership on a DBFOM / concession basis; however, the financial and commercial viability of the project need to be further evaluated. Power tariff and related services could be potential revenue streams for the Concessionaire. Considering that AP is a power-surplus state, the financial viability of this project could be further improved if the public-sector sponsor contributes capital funding to make the project more attractive for private-sector bidders.
		Smart Micro Grid at Bhogapuram	▪ Smart Micro-Grid with solar power generation, battery storage, and back-up grid connection by APEPDCL. ▪ Same as above.
Solar water system program	Solar energy generation along significant canals	Solar Panels deployed over canal corridors: 1. Godavari River Canal 2. Raiwada Reservoir Canal	▪ Solar Panels deployed over canal corridors. Convert paths along water canals at opportune segments to slower-speed intercity traffic (three-wheelers, two-wheelers). ▪ The project can be implemented through public-private partnerships on a DBFOM (Design-Build-Finance-Operate-Maintain)/ concession basis. The state of AP has successfully entered into an agreement with a private sector developer to develop "Solar Parks" on a DBFOM basis. Similar projects are being considered or are under development by several states in India. AP can leverage this experience to attract private- sector investment for this project.
	Solar energy generation at reservoirs	Power generation and battery storage at: 1. Madduvalasa, 2. Madhurawada, 3. Meghadri Gedda, 4. Mudasarlova, 5. Raiwada, 6. Tadipudi, 7. Thandara, 8. Yeleru reservoirs and 9. Kanithi Balancing Reservoir	▪ Floating solar panels deployed over reservoirs to offset power consumption by the water system. Battery storage used at each site. ▪ The project can be implemented through Public Private Partnership on a DBFOM / concession basis; however, financial and commercial viability of the project must be further evaluated. Considering that AP is a "power-surplus" state, the financial viability of this project could be improved further if the public-sector sponsor could contribute capital funding, in order to make the project more attractive for private-sector bidders.
District cooling demonstration program	District cooling on large buildings or redevelopments	District cooling systems as part of infill development areas (see urban development component)	▪ Site to be determined ▪ The financial and commercial viability of the project would need to be evaluated further, prior to determining the procurement method, and the potential role of the private sector.

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VIII. SOCIAL INFRASTRUCTURE

Introduction

The Government of Andhra Pradesh ("GoAP") with the assistance of the Government of the United States of America ("USA"), Department of Commerce, United States Trade Development Agency ("USTDA") and United States Exim Bank is keen on developing the City of Visakhapatnam (also referred to as "Vizag") as a "Smart City" under the 100 Smart Cities Project of the Government of India ("GoI").

The purpose of the Mission Smart City is to efficiently utilize Vizag's available assets, resources, and infrastructure to enhance the quality of urban life; provide a clean and sustainable environment for living; and increased focus on core infrastructure services like adequate clean water supply, power supply, sanitation, disaster management, solid waste management, wastewater treatment, efficient urban mobility and public transportation, public healthcare system, education, affordable housing, robust IT connectivity, e-governance, safety, and social security.

Objectives of the Study

GoAP, acting through its Municipal Administration and Urban Development ("MA&UD") Department, and with the assistance of USTDA, has appointed a consortium of AECOM, IBM and KPMG (the "Project team") to provide advisory services for the Visakhapatnam Smart City Project in three phases:

- **Phase 1:** Baseline Analysis
- **Phase 2:** Integrated Smart City Master Plan
- **Phase 3:** Implementation Plan and Project Feasibility Analysis

Coverage of this Report

Key activities performed under Phase 1 of the assignment included: (i) defining Visakhapatnam Smart City Vision; (ii) review and analysis of existing conditions and corresponding leading practices; (iii) strategic planning for regulatory and infrastructure framework; (iv) sector-specific strategies; and (v) action planning for two Smart City projects.

Under Phase 2 of the assignment, the Project team is developing an Integrated Smart City Master Plan ("Integrated Master Plan"). The Integrated Master Plan will draw from the Smart City Vision statement, developed as part of Phase 1, with the goal of implementing the vision by the end of the planning period in 2030. The Integrated Master Plan will include sections on:

- Framework for Urban Development;
- Overarching ICT Infrastructure and Integrated Urban Management ("IUM") Section;
- Smart City Components of the Integrated Master Plan;
- Capital Investment Program; and
- Smart Planning Interface Website.

This document addresses the social infrastructure component of the Integrated Master Plan, and provides analyses and recommendations on capital investment programs that will increase and facilitate citizens' access to information about healthcare, cultural/entertainment districts, and emergency services, thereby broadening their choices and improving their ability to receive such services readily and efficiently.

Challenges and Opportunities in Social Service Delivery

Social infrastructure relates to the framework that supports the development of human and social capital, such as livelihoods, healthcare, entertainment, education, etc. It also includes performance and creative arts, sports, open spaces, parks and gardens. These are the structures which can help to bring socioeconomically disadvantaged members of the society(i.e., scheduled castes, scheduled tribes, socially and financially backwards, minorities, disabled and women) into the mainstream of development.

The section below describes the current situation in terms of key challenges and opportunities in the delivery of healthcare, entertainment and emergency services to the citizens in the greater Visakhapatnam region.

Social Infra Component	Challenges	Opportunities
Healthcare Services	▪ Existing healthcare programs are legacy systems, with information silos and data residing in multiple locations – results in a lack of access to timely and decision-useful information. ▪ Manual paper-driven processes often limit flexibility and impact the speed and consistency of the healthcare delivery. ▪ System complexities and information silos often result in situations where health benefits/programs for low income families (BPL families) go unclaimed. ▪ Unavailability or lack of adequate data/information results in situations where health-related subsidies / incentives do not reach the target group.	▪ Mobile and internet platforms can be one of the means used to address deficient healthcare facilities, through innovations in technology and telemedicine. ▪ Kiosks / Citizen Centers can be used for citizens to obtain information about available healthcare programs / services and make appointments. ▪ New technological solutions can help to deliver the right care, when and where it is needed, at lower costs, while enabling patients to play a more active role in managing their care. By adopting such solutions, the following can be achieved: – Information about health services would be more readily available, including information that helps people improve personal wellness. – Health threats and emergencies can be managed proactively, rapidly alerting the public, efficiently mobilizing resources and taking preventive measures. – More cost-effective, quality care can be delivered at local hospitals. – Collaboration among public and private hospitals and care providers can be supported.
Entertainment Services	▪ Citizens' survey conducted in Phase 1 indicated lack of recreation facilities in the greater Visakhapatnam region as a major concern. ▪ Adequate recreational facilities should be provided in the region, and should address the following considerations: – Expected objectives of the planned changes should take into account the real behavior of the stakeholders. – Services should be easily accessible and affordable. – New services and infrastructures should be usable by citizens of all ages and income groups. – Social and cultural values of citizens should be taken into account. – New services and infrastructure should help promote / protect unique selling point of Visakhapatnam.	▪ Improvements in cultural / entertainment infrastructure can boost tourism activities in the region, which can boost economic growth, as well as helping to attract new talent. ▪ A network of recreational spaces created along the beautiful waterfront through the use of clean technologies could radically improve the quality of life for the citizens, and could help to promote outdoor recreation for all age groups. ▪ Creation of culture/ entertainment zones can help spread new lifestyle, art and culture thereby providing an opportunity to reduce some of the lifestyle diseases that are afflicting citizens.

Social Infra Component	Challenges	Opportunities
Emergency Services	▪ Ordinary citizens are usually first on the scene in an emergency, and often play a vital role in responding to an emergency situation. Presently, there is no system with a single point of contact in place which can be used by citizens to coordinate their activities, which could increase the effectiveness of their efforts. ▪ Efficient and reliable communication is one of the key challenges during emergency response. ▪ Emergency transportation dispatch and restoration time require improvement.	▪ Comprehensive emergency solutions can be developed that provide increased collaboration between various emergency services. Such solutions can also provide ready access to historical data and best practices, which can help enable the prediction of the extent of damage, and better preparedness and response to similar situations in future. ▪ Real-time tracking of assets and rescue workers / first responders could enable efficient and effective deployment of limited resources, and help appropriately tailor the emergency response.
Skills Development	▪ Due to lack of effective counseling resources, it remains difficult for people – especially those growing up in rural areas – to get easy access to comprehensive information, understand the variety of opportunities that exist with respect to roles, training programs and jobs, and to determine the specific actions required to meet their personal career aspirations. ▪ Representative household survey found 14.5 % of households to be illiterate, 44.3% of heads of households have not attained '10th standard pass' status, and only the VUDA (including GVMC) region has a mean expenditure-to-income ratio of 87.5 %.	▪ Vizagites expressed that increased skills and additional higher-skilled employment opportunities were the leading priorities in the VUDA region. ▪ Residents desire better access to education, skills development, and technology training in order to reach these goals. ▪ To leverage Andhra Pradesh's demographic growth and drive economic development, young women and men will need training and gainful employment in the coming years. The absence of a large and highly skilled workforce can slow or derail Andhra Pradesh's economic development and the demographic dividend can over time, turn into a burden. ▪ Government of India (GOI) and Government of Andhra Pradesh (GOAP) initiatives have been launched to enhance local training capacity and to provide financial for enrollment into skill development programs and to improve employability. ▪ Vizag's workforce of tomorrow is posited to lead growth in key economic sectors; incubate entrepreneurship in the region; support the operations, maintenance and expansion of the region's smart infrastructure systems; and add value and market competitiveness for lower-income workers.

Approach to Smarter Social Services

The journey to achieve smarter Social Services is not a single path, but is a set of building blocks that can be applied based on the existing capabilities of the public sector. These building blocks would build on what is already in place, and add capabilities, while also using cognitive technologies to unlock the potential of data and analytics to improve service delivery.

The table below highlights the approach for smarter delivery of healthcare, entertainment, and emergency services to the citizens.

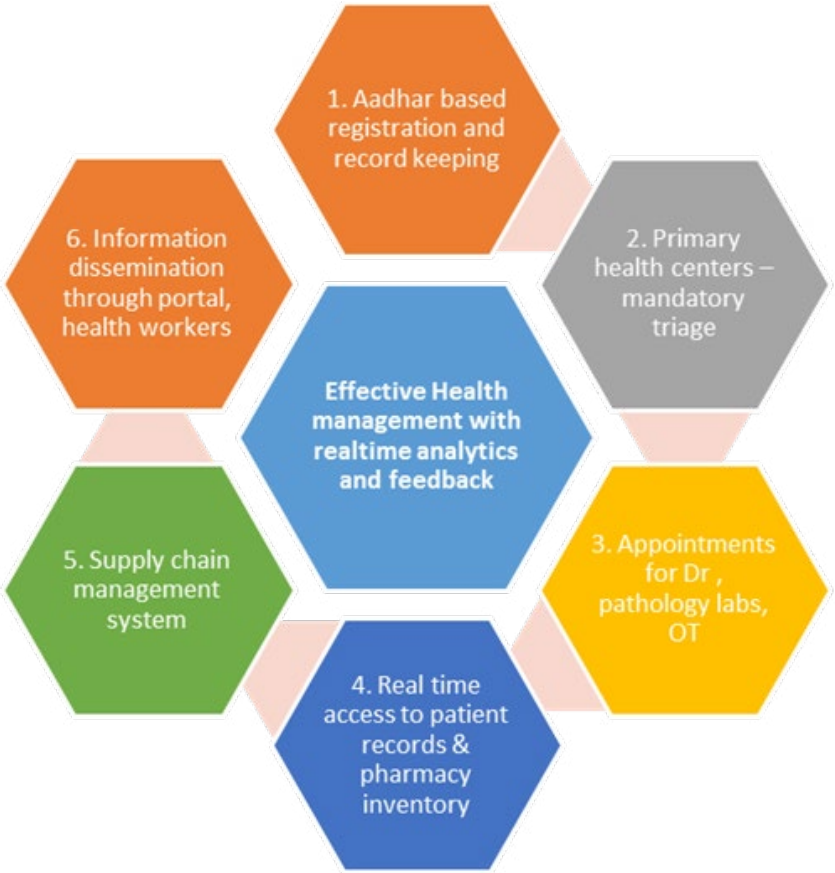
Social Infra Component	Approach to Smarter Social Services
Healthcare Services	▪ Transform the existing IT infrastructure that is composed of various discrete system silos into an integrated architecture that allows for data sharing and collaboration. ▪ Maximize the potential of existing technology investments (e.g. like e-Health, e-Vaidya, Mother and Child Tracking System ("MCTS"), Reproductive and Child Health ("RCH") program, Mahila Master Health Checkup ("MMHC") program, etc.) to focus more on individuals and families and evolving operations to meet tomorrow's challenges. ▪ Develop an application that provides citizens with a single point of access to inform them of healthcare programs they may not be aware of, and helping them to determine their eligibility for such healthcare programs. ▪ Create an IT-based solution to improve healthcare service delivery performance, and be able to quickly and cost-effectively respond to future changes to various healthcare programs. Such solutions will help the government in managing its "Big Data" challenges (i.e. migrating from a largely paper-based approach to a more open, automated platform to manage the healthcare service delivery).
Entertainment Services	▪ Create a landmark destination within the greater Visakhapatnam region, with a vibrant recreational environment that promotes the physical and mental well-being of citizens. Having an optimum blend of business and recreation activities would make the project financially and commercially viable. ▪ Create a zone that becomes a platform for recreational and cultural activities for the community. ▪ Create a facility that balances functionality with identity, accessibility with adaptability, and security with amenities. ▪ Create an opportunity for flexible and sustainable development that rewards the investor, inspires small scale industries and benefits the community.
Emergency Services	▪ Resilient transportation is essential to successful emergency planning, preparedness, response, and recovery. An accurate inventory of transportation assets and infrastructure is fundamental for matching needs to supplies during times of crisis. ▪ Leverage the Radio-Frequency Identification ("RFID"), Global Positioning System ("GPS") and Geographic Information System ("GIS") for real-time matching of available assets to critical needs, and efficiently deploy assets and supplies based on the inventory. ▪ Optimum utilization of existing infrastructure like the Central Command Center, which is currently used to monitor signalized intersections within the greater Visakhapatnam region. Leveraging its cognitive abilities, the Command Center provides alternatives on deployment of assets, and hence provides a balance between intuition and data-based decisions, leading to a more efficient and faster response.
Skills Development	▪ Provide training roadmaps, information, and access to training for workers and predictive workforce demand analytics for major industries/sector organizations and socio-economic communities through the virtual platform, in-person "Vizag One Centre," and regional outreach programs. ▪ Enhance training capacity by supporting residents to enroll in skill development programs to increase value in labor force; to attract, retain and absorb skilled workers in the region; to link individuals and partner educational institutions and industry across sectors to further develop supply and demand chains; to support employment across sectors and socio-economic communities, including vulnerable. ▪ Other key stakeholders such as government agencies/policy makers, industry bodies, financial institutions, content providers, training and certification agencies, employers etc. derive value from insights on skill availability, skill demand, training quality, in the region so that investments can be suitably channelized and the effectiveness of the overall ecosystem can be monitored and optimized with time.

Proposed Projects

Virtual Health Information System

Project Description and Implementation Details
The entire health services delivery can be mapped to the ICT framework below for effective health management

Figure 1.1 ICT Framework for Effective Health Management



The above initiatives/ programs/ projects are mandatory, and are also useful tools for enhancing the provision of health services and for mapping the ICT framework. To further enhance healthcare service delivery, citizen engagement, and access to all segments of the society, a two-part capital investment project has been proposed, in order to:

- Extend citizen's access to healthcare infrastructure;
- Efficiently utilize the existing healthcare infrastructure and processes designed to save time and cost for healthcare service providers and users;
- Ensure the optimal use of the existing infrastructure available. For example, Mee-Seva Kendras can be utilized to register citizens and capture their medical records and health related data; and
- Use data-based analytics to make informed decisions on how to provide preventive health care services that are targeted to the identified sections of the population.

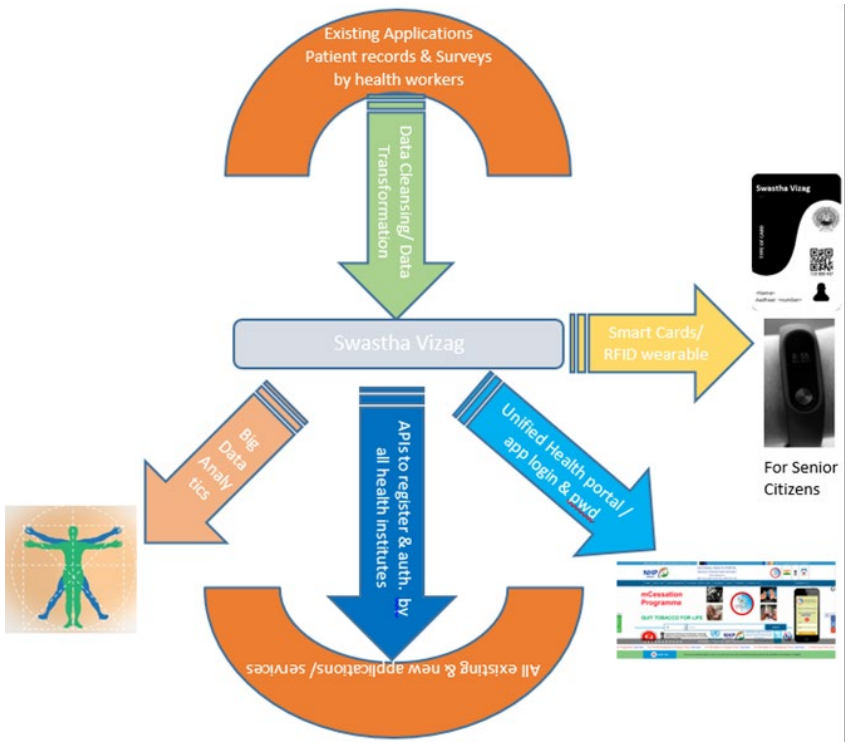
(a) Health Information System – 'Swastha Vizag': This project will create a unified healthcare database for local residents (it is envisioned that this project will initially start with the population residing within the greater Visakhapatnam region. At a later stage, consideration should be given to explore the feasibility of extending the program to visitors, including those visiting the greater Visakhapatnam region for medical tourism). Built incrementally over time, this database will be comprised of each patient's medical records, including transactions, diagnoses, and procedures. All medical providers will have access to, and participate in, the upkeep of the database. The database will enable a more personalized approach to healthcare.

For the purpose of this project, it is assumed that the necessary IT infrastructure and capabilities will be developed and maintained by GVMC, either by using its internal resources, or through contracted services. GVMC will be responsible for maintaining healthcare records and providing access to public and private healthcare providers in a safe manner.

Implementation Details:

- Starts with a single window (portal) for citizens and a primary health center where citizens can either self-register using their Aadhaar card (UIDAI – Unique Identification Authority of India), or can be registered by the primary health center staff at the time of the patient's visit. This would inform patients on how they could benefit from being part of the system. Also, health workers who visit households to capture any other data/perform surveys can open this application and complete the registration on any "smart" devices (e.g., smart phone, tablet, personal computer, etc.). The existing Mee-Seva Kendra can also be utilized for the registration. Citizens can view their own medical records and/or take a print out on as needed basis.
- Data from existing applications like e-Health, e-Vaidya, MCTS, MMHC, RCH, etc. can be updated, formatted and migrated to this unified citizen health information system. All the systems should then be connected to the Swastha Vizag, where each family will be given a unique ID, and each family member will be given a unique registration number. These could also be printed as smart cards, and distributed across the region to all the citizens, which would need to be carried with the patients when they visit the health care centers. These smart health cards should be personalized cards, coupled with Aadhaar. The greater Visakhapatnam region should also consider issuing a wearable device to senior citizens to track their well-being, which would be the first program of its kind in India.
- Once a minimum threshold of data coverage, which is received through existing applications or new survey, is achieved, the Swastha Vizag API (Application programming interface) should be made available to all health institutions (public and private), and health projects should be used for registration, as well as authentication, for all healthcare services. Also, APIs should be published, to allow the health institute to provide patient health records with a biometric validation of the patient's consent to share the medical record should be mandatory), so that the medical history of the patient is visible to the treating doctor for routine, as well as emergency, situations.

Figure 1.2 Swastha Vizag Solution Architecture



(b) Referral Management System: This system would facilitate referrals from primary healthcare centers to tertiary health care centers, thereby improving access to specialized healthcare. The system would match patient needs to availability at tertiary care facilities, and facilitate making doctor's appointments.

Implementation Details:

- Tertiary health care centers and diagnostic health centers would need to publish their availability calendars for patients referred by primary health centers.
- Primary health centers would give appointments to doctors, either for tele-medicine calls or for in-person consultations, at tertiary centers, based on the availability and specialization matrix.
- There would be a rescheduling provision to cater to any emergency cases/ situations at tertiary centers.
- Once a primary health center decides on a hospital/specialty, citizens can either ask them to book an appointment, or make an outpatient appointment themselves through the e-Referral Service. This service would let the patient choose a convenient date and time for the appointment.
- Primary health centers should provide a unique code, required for making the appointment, which should be valid for a specific time range during which appointments can be made.
- For the follow-up appointments, the consultants at tertiary service facility would generate the code.
- Both primary and tertiary health centers could generate code/book appointments at diagnostic centers.
- To fast-track a particular case, health centers would have the option to generate a code for urgent cases, based on their assessment.
- Appointment(s) could be made through multiple channels: at the health center, via a telephone call to the e-referral service line, or online.

Project Rationale

- Efficient utilization of existing healthcare infrastructure would be achieved, along with time and cost savings for the patients as well as healthcare providers.
- Optimum utilization of existing infrastructure, like MeeSeva Kendra for registration of citizens and capturing their medical records and health related data, would be achieved.
- The project would be coordinated with municipal Central Command Centre (CCC).
- Data-based analytics will help in taking informed decisions on providing preventive health care targeted to the identified sections of the populations.
- Such platforms would help to increase the reach and accessibility of doctors and other medical practitioners, which is essential to bridge the significant gap that currently exists in doctor-to-patient ratio.
- Timely and accurate diagnosis by doctors would be supported, and the history of patients would be made available on cloud platforms.

Business Model and Financing Strategy

Considering that the proposed project focuses on the delivery of social services, and does not have substantial revenue streams, the funding requirements for such projects could be met through the options listed below:

- Increasing the taxes by nominal value. Additional financial resources could be generated for an urban infrastructure fund. Such a fund could be used to fund the delivery of the social services within the greater Visakhapatnam region.
- Contributions from the Government/GVMC or by NGOs who may sponsor such initiatives, or major industries that are willing to contribute their Corporate Social Responsibility (“CSR”) funds.

Benefits

Key benefits include:

- Easy and secure access to patient health records, allowing providers to deliver better care.
- A reduction in healthcare costs - a robust IT solution portfolio for healthcare could help optimize business processes and operations to lower cost.
- Enhanced quality, care outcomes, and citizen health through data-driven insights.
- Application of advanced analytics to reduce response times and save lives.

Implementation Timelines
Implementation timelines will depend on the number and complexity of the systems to be integrated and implemented. IBM recommends a design-thinking and discovery workshop to better understand the greater Visakhapatnam region's healthcare processes, and to establish an accurate set of requirements, costs, and delivery timelines. Additionally, consideration should be given to access various on-going and planned web portal/smart services to ensure that the proposed solution(s) can fully leverage efforts under way.

Festival Promotion and Delivery Platform

Promoting Cultural/Entertainment Events at the Beachfront
The project will capture the entertainment and tourism potential of Visakhapatnam's beachfront, as well as other parts of greater Visakhapatnam region, by promoting cultural and entertainment events. The project would be part of a coastal strategy that links the beachfront areas as a distinguishing aspect of Visakhapatnam, and leverages the entire Ocean Drive, from Rushikonda ("RK") beach in the south to Bheemili beach in the north to support economic development.

The proposed project would include development of a hierarchy of performance sites/stages at various location along the Ocean Drive. These stages would be intended to provide a platform to showcase the music, dance, theater, and art, etc. performed by local and international artists. Ancillary components of this project should include tourist-friendly amenities like public toilets, formal hawking zones for food and beverages, retail, information kiosks, etc. The revenues accrued through commercial activities could be used for the operation and maintenance of the project sites. While the project's primary focus is to develop such facilities and related physical infrastructure, an integral part of the initiative will be the use of IT to connect, promote, and enhance the overall potential of the location and events. In addition to the performance stages and other physical infrastructure, this project could also involve the creation of an on-line web-portal/web-based application, which could serve dual purposes: (i) the artists / performers can book/reserve the performance platforms/stages; and (ii) the citizens/tourists can get information on the upcoming cultural events in the greater Visakhapatnam region, as well as have an option to provide their feedback on the events. Citizen feedback could be further utilized to plan forthcoming events.

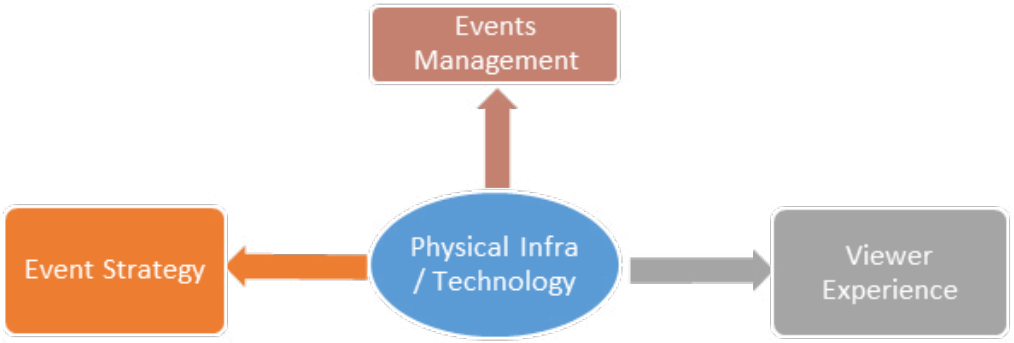
Implementation Details
This project could involve the creation of a next\-generation tourism and event portal, that would offer travelers/citizens an elevated and interactive user experience as a one-stop

solution for searching, planning, and booking their travel itineraries, getting information on multiple events, and providing feedback on those events through blogs, tweets, posts, and other forms of social media.

It would also serve as a region-wide event engagement tool where artists and performers can book/reserve the performance venues maintained by GVMC for this purpose throughout the beach road.

Considerations should be taken to ensure that the experience is consistent with the "Sunrise State" Andhra Pradesh and brand Vizag, and should deliver consistent interactions. The digital strategy and digital experience needs to be integrated, aligned, and consistent across all channels, including web portals, smart phone applications, and social media.

Figure 1.3 Technology Enabled



In addition to its required physical infrastructure, this project can be viewed from two perspectives:

1. The perspective of the performer/artist, typically classified as "amateur", "emerging," "professional," and "master/veteran, who should be able to reserve different categories of venues from across a broad range of available locations.

- An artist should be able to register, create a profile page, and select a few likely dates at least one month in advance of the performance

- The details of the registration should be published in the “Upcoming Events” section of the “Live Vizag” website.
- The category of venue can be selected based on the criteria listed below:
  - “likes”/“I will attend:” sentiment analysis from registered users of the portal;
  - Previous performance scoring at similar locations;
  - Government, i.e. Tourism and/or Cultural Department recommendations; and
  - Availability of the venue.
- The dates and venue for the performance could be provided to the artist for acceptance.
- On acceptance, the marketing/awareness for the event could be done via a variety of outlets, including the portal, social media, ads on internet, print media, broadcast, and/or podcast.
- Details of the events could be broadcast to entrepreneurs/registered hawkers / ad agencies for booking commercial spaces / billboards at rates pre-defined for each categories of venues / stages.
- The revenues generated through commercial activities could be used for operation, maintenance and upgrading the venues.
- Every performance should be scored on a scale of 1-100, based on the votes from visitors, hawkers, polls sent to registered users, views of performance clippings on the portal, and sentiment analysis on social media.
- Amateur artists would have a platform to showcase their talent and an opportunity to grow it to the next level.
- Emerging, Professional and Veteran masters would get a percentage (e.g., 10%, 20% or 30%) of the total revenue generated.
- Admission could only be charged for Professional and Veteran performers, and rates would be dynamic, based on the analytics.
- Options should be given to performers, crew, and visitors to book hotels and taxis near the venue at discounted rates.

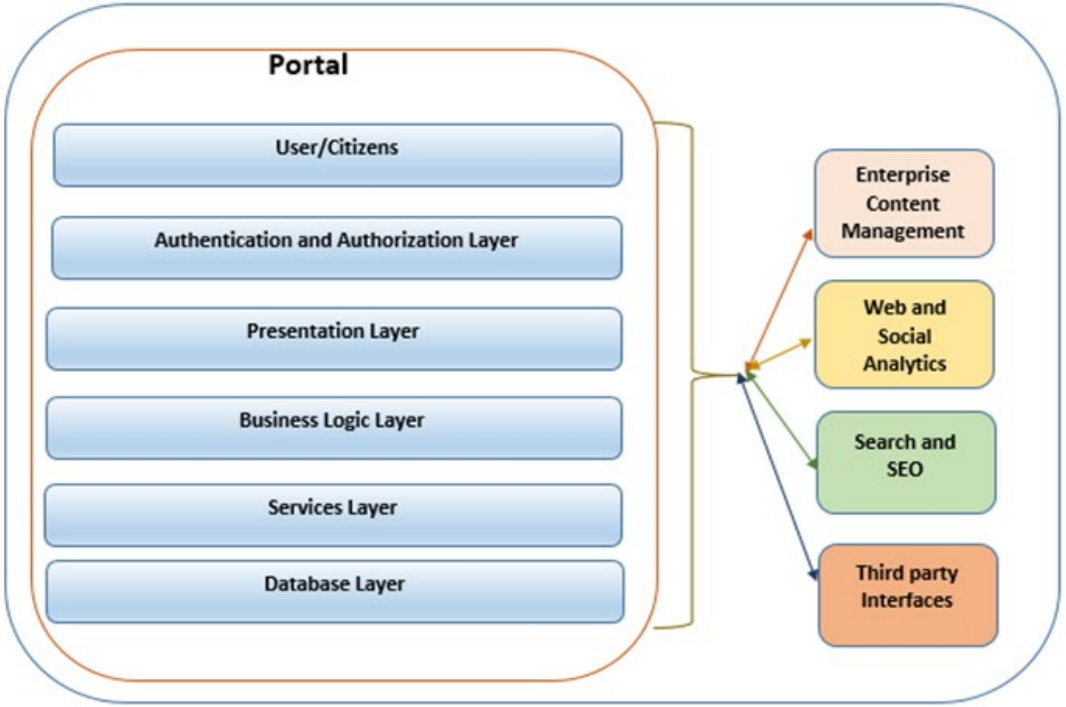
2. The perspective of local citizens or visitors to the greater Visakhapatnam region who are looking for entertainment, art, weekend destinations, and/or family oriented recreational activities.

- A user could browse the events happening in the city and view information displayed regarding Visakhapatnam as a preferred tourist destination.
- Users could be asked to register to participate, plan, and book events, etc. and use the Live Vizag social media site.
- Registered users could like, comment, and/or post on an upcoming event. Users could also confirm participation/attendance for free events or buy tickets online for a paid performance.
- Users could view performer's profile pages, which would also include event clippings of previous shows, social network pages, YouTube links, etc.
- Users could subscribe to a particular event, or follow a performer to allow related updates to be sent through e-mail, SMS, WhatsApp or other modes of e-communication.
- Users could participate in polls during or after the event to allow organizers to grade the quality of the product delivered.
- Users could also book hotels, taxis, site tours etc. through the portal.

The portal could be used to advertise or publish a list of certified event managers that could help manage events, including providing the necessary infrastructure. Published rate cards would indicate the charges of the event manager, and would allow performers traveling from outside the city to book an event manager online in advance.

To provide the users a unified experience, the portal would need to have the solution components listed below:

Figure 1.4 Live Vizag Solution Architecture



The third-party interfaces mentioned above could be delivered by local start-ups, creating the ecosystem for “Live Vizag” with the data exposed through the portal, based on open and industry-standards-based data policies.

Finally, this initiative would not only help Visakhapatnam preserve and promote its cultural heritage, but would also place Visakhapatnam ahead of many other tourist destinations on the world map.

Project Rationale

- Contributes to branding Vizag as a tourism destination.
- Aligns with a broader vision of diverse tourist-activity zones along the coastline.
- Preserves and promotes celebration of cultural heritage.
- Capitalizes on the unique locations on Vizag's beachfront.
- Helps create "destinations" and promote the waterfront.
- Enhances tourism potential of the beach, which could help further catalyze economic growth in the tourism sector.
- Provides employment opportunities for small-scale entrepreneurs.
- Sets the stage for future high-quality beachfront development.
- Supports the local talent by nourishing and advancing the arts and culture of the region. Provides spaces and low-cost performance venues for upcoming artists and talent groups.

Business Model and Financing Strategy

Possible revenue streams / project financing sources could be:

- Affordable user charges from the performers, in lieu of reserving the performance platforms/stages.
- Commercial utilization of land near the performance stages, to allow formal hawking zones for food, beverage, and retail options.
- Revenues generated through monetizing outdoor advertisement potential.
- Investment subsidies, available under the Andhra Pradesh Tourism Policy 2015, for amenities like beachside shacks, public conveniences, cloak rooms, parking facilities, etc.
  - Project Cost < INR 1 crore: 15% of value of Total Project Cost, excluding the cost of land.
  - Project Cost from INR 1-10 crore: 15% of value of Total Project Cost, excluding the cost of land, or INR 1.25 crore, whichever is less.
  - Project Cost from INR 10-20 crore: 15% of value of Total Project Cost, excluding the cost of land, or INR 2 crore, whichever is less.

Benefits
Key benefits include:

- Promoting local tourism.
- Identifying and promoting local talent by providing a platform to showcase their abilities.
- Providing the citizens of the greater Visakhapatnam region with a means to enjoy local cultural events.
- A revenue stream for the small businesses that would manage, operate and service the venue.

Implementation Timelines
The suggested project is at a conceptual stage, and additional discussion with the City of Vizag would be required in order to arrive at costs and timelines for the proposed project.

Emergency Response Dispatch Platform

Emergency Management System
This project envisions the creation of an integrated Smart City solution that combines sensor data from a variety of service providers to deliver a holistic view of Smart infrastructure for the purposes of remote monitoring, control, and optimization of movable assets. It is envisioned that the location of all the emergency management vehicles (ambulances, fire fighting vehicles, police vehicles, etc.) within the greater Visakhapatnam region could be monitored through a GPS enabled system at the Central Command Centre (“CCC”).

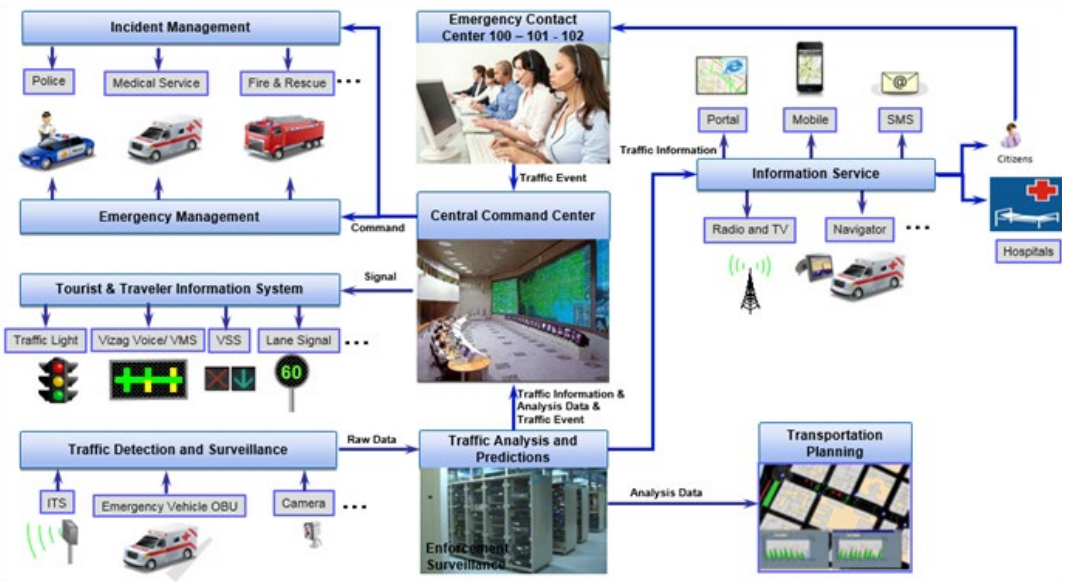
Consideration should be made to ensure that the proposed project is coordinated with on-going and planned efforts. For example, the project team understands that, as part of Vizag CCC (managed by the Project Management Consultant as part of the PAN City project), the procurement documents for the PAN City project are under preparation (the Request for Proposal for System Integrator(s) for e-governance and disaster management is under development). As such, several attributes of the proposed project can be coordinated from a design and implementation perspective as part of on-going efforts (e.g., the design and implementation of components such as sensors, integration of surveillance cameras, beachfront management announcements, street lighting, etc.). The design and implementation of other components of the emergency response system to be implemented on ground (for example vehicle tracking, occupancy of beds in any given hospital, etc.) can be coordinated as a part of the fully-integrated CCC system.

The CCC would receive notifications for updates, information, alerts and panic situations from citizens through a telephone call. These notifications would help the CCC take immediate action, with minimal response time. For example, when the CCC receives a notification of an accident, they would be able to quickly (i) designate the nearest emergency dispatch (e.g., ambulance, fire fighting vehicle, police vehicles, etc.) to reach the accident location; (ii) determine the quickest route possible, and change the traffic signals to provide a 'green-signal corridor' for the emergency dispatches; and (iii) inform the nearest hospital/ healthcare facility to prepare for the emergency situation.

Implementation Details

This project is an extension of the "Connect Vizag" project for the Bus Rapid Transit System ("BRTS") to the emergency services. The CCC would serve as the single point for handling all emergency situations.

Figure 1.5 Conceptual Architecture of the Recommended Solution for Emergency Response



- Incident Management and Emergency Response - Accident areas and road construction/ repair areas should be identified on the GIS map, based on incident reporting and repair schedules.
- Traffic analytics/monitoring should detect incidents and emergencies based on sensor data that records traffic speed and volume, and correlates information.
- The CCC should generate response plans by referencing standard operating procedures and real-time traffic status for event handling, demand response dispatch routing, setting the Variable Message Sign (VMS) message, initiating traffic control, adjusting the lane signals, etc.
- Emergency services should be quickly identified and deployed based on GPS locations. Updates would be provided regarding services, road closures, emergency shelters, and other special circumstances. Collaboration with other service providers, such as hospitals, etc. would occur.
- Traffic congestion and other data would be monitored and obtained from field devices mapped to a geo-spatial context based on location of the data capture.
- Video and surveillance feeds would be monitored and analyzed manually.

The Central Command Center could integrate, in near-real time, with the various systems mentioned above, including but not limited to: traveler information systems and vehicle tracking systems on emergency vehicles, with potential extensions to other means of transport.

Project Rationale

- Extends citizen access to region's resources for dealing with emergency situations.
- Reduces average emergency-response time, with decreased risk of injury and loss of life.
- Leads to higher citizen satisfaction at lower costs.
- Leverages the capabilities of the existing Central Command Centre.
- Enhances preparedness and responsiveness, with minimized loss and quicker restoration of normal daily life.
- Provides opportunities to predict, analyze and react more effectively to an emergency situation., and offers more effective evacuation and rehabilitation.
- Supports swift and accurate dispatch of emergency vehicles, which would ensure rapid distribution of available resources to the citizens.

Business Model and Financing Strategy
Considering that the project focuses on the delivery of social services, and does not have substantial revenue streams, the funding requirements for such projects could be met through below options:

- Increasing municipal taxes by a nominal value. Additional amounts thus generated could be credited to an urban infrastructure fund. Such a fund could be used to finance the delivery of the social services within the region.
- Contributions from the government/GVMC, from NGOs who may sponsor these types of initiatives, or from industries that are willing to contribute their CSR funds.

Benefits
Key benefits include:

- Provides situation awareness
- Offers all first responders (police, fire, and other law-enforcement units) and other government agencies a Common Operating Picture (COP), which is critical at a time of crisis.
- Allows correlation of data across various agencies, thus breaking down traditional silos and allowing for quicker and better collaboration across agencies
- Provides a single location/platform to view a wide variety of information.
- Provides modeling and simulation capabilities to allow agencies to plan, prepare, mitigate, and respond to various events.

Implementation Timelines
The suggested project is at a conceptual stage, and additional discussion with the City of Vizag would be required in order to be able to arrive at costs and timelines for the proposed project. However, it is anticipated that an initial set of capabilities could be delivered in about 3 months.

Smart Skill Vizag Workforce Training Platform

Project Summary
Smart Skill Vizag provides training roadmaps and predictive workforce-demand analytics for major industries/sectors and socio-economic communities through a virtual platform, in-person "Vizag One Centre," and through regional outreach and training programs.

Project Background and Justification
In a representative household survey conducted between May and July of 2016, Vizagites expressed that increased skills and additional higher-skilled employment opportunities were leading priorities in the VUDA region. Residents desire better access to education, skills development, and technology training in order to achieve these goals. The potential for improvement is great, as the survey found that 14.5 % of households are illiterate, 44.3% of heads of households have not attained "10th standard pass" status, and only the VUDA (including GVMC) region has a mean expenditure-to-income ratio of 87.5 %.

To leverage Andhra Pradesh's demographic growth and drive economic development, young women and men will need training and gainful employment in the coming years. A number of Government of India (GOI) and Government of Andhra Pradesh (GOAP) initiatives have been launched to enhance local training capacity, and to provide financial assistance for enrollment in skill-development to improve their employability. However, due to the lack of effective counseling facilities, it remains very difficult for some residents – especially those growing up in rural areas across Andhra Pradesh – to gain access to comprehensive information, understand the variety of opportunities that exist with respect to roles, training programs and jobs, and to determine the specific actions required to meet their personal career aspirations. As a result, these residents may end up making various sub-optimal training- and career-related choices, or continue to take up low-skilled jobs, mostly in non-state regulated sectors. The absence of a large and highly skilled workforce could slow or even derail Andhra Pradesh's economic development, and this demographic division, could over time, turn into a burden for the region.

Vizag's "workforce of tomorrow" is posited to lead growth in key economic sectors, incubate entrepreneurship in the region, support the operations, maintenance and expansion of the region's smart infrastructure systems, and add value and market competitiveness for lower-income workers. Most workers would benefit from personalized skills-development and career guidance that is based on deep insights drawn from real market data, and personalized to the needs, interests and constraints of each individual.

Project Location
Skills-development counseling is provided through multiple modes: an online virtual platform with web- and app-based interfaces for internet users, the in-person “Vizag One Centre” for local residents, existing training institutions, and outreach programs that extend awareness and access to training modules to peripheral and isolated communities.

Project Description
Smart Skill Vizag provides training roadmaps, information, and access to training for workers, as well as predictive workforce-demand analytics for major industry/sector organizations through the virtual platform, and access to the in-person “Vizag One Centre” and regional outreach programs.

Smart Skill Vizag enhances training capacity by encouraging residents to enroll in skill development programs that will increase their value in the labor force, and attracting, retaining and absorbing skilled workers in the region. It also links individuals and partner educational institutions with industry, to further develop supply and demand chains, and supports employment across sectors and socio-economic communities, including more vulnerable groups.

Other key stakeholders like government agencies/policymakers, industry leaders, financial institutions, content-providers, training and certification agencies, employers, etc. will derive value from insights on skill availability, skill demand, and training quality in the region, so that investments can be suitably channelized and the effectiveness of the overall ecosystem can be monitored and optimized with time.

Platform – Virtual:
The Smart Skill Vizag virtual platform consists of interactive web-based and app-based portals for free self-service access. The virtual platform leverages natural language-processing techniques on unstructured data, and advanced matching algorithms, to link user datasets with National Skills Qualifications Framework (NSQF) training pathways, training opportunities, and job postings.

The virtual platform's data processing toolkit should include these capacities:

- **Concept Insights:** offers a set of services that enable users to do content recommendation and exploration. For instance, Concept Insights will recommend related documents by recognizing high-level concepts within documents uploaded by employers. The service can help organizations find skilled staff for specific jobs and projects.
- **Personality Insights:** extracts and analyzes a spectrum of personality attributes from a body of text (at a 3,500 word minimum) to discover actionable insights about people and entities, in order to guide end users to highly personalized interactions.
- **Trade-Off Analytics:** helps users make decisions that involve balancing multiple objectives using the "Pareto Optimization" filtering technique, enabling users to see trade-offs when considering multiple criteria for a single decision.
- **Natural Language Classifier:** interprets the intent within a short body of English-language text (1,000 characters or less) and returns corresponding classifications with associated confidence levels. The service can be trained to function within any domain or application.
- **Statistical Package for the Social Sciences (SPSS):** used by an application to communicate the accuracy, confidence, or other qualitative evaluation of a trained predictive model as designed. SPSS is useful in predicting job types per skill for considered industries.
- **Document Conversion:** provides an Application Programming Interface (API) to enable developers to transform a document into other formats. The input of a single PDF, DOCX, or HTML document translates into outputs as HTML or text documents, or as answer units to be used with other API services.

The virtual platform is coded in English, and will integrate Telugu and Hindi language interface compatibility in the longer term. The virtual platform tailors training roadmaps for all industries (with emphasis possible on target market sectors), connects academic institutions and training providers, and supports Visakhapatnam-based job listings.

Vizag One Centre
The Vizag One Centre is a physical site within the GVMC that provides free in-person job, career, and training counseling. The center tailors training roadmaps for all industries, with an emphasis on target market sectors; connects users with academic institutions and training providers; and lists Visakhapatnam-based job listings.

Platform – Outreach:
Packaged training modules and teams work with peripheral, isolated, or otherwise marginalized communities to support tailored in-situ skills development programs. The programs rely upon visual materials with Telugu, Oriya, Tamil, Hindi, and English language support for use by resident and migrant workers, self-help groups (SHGs), non-governmental organizations (NGOs), community-based organizations (CBOs), and panchayats to connect their peripheral or isolated communities with desired educational and training programs through Smart Skill Vizag's portals. While many outreach programs are designed in accordance with funder mandates, others can be designed, facilitated, and led by constituents of the targeted communities as well, such as programs by the Self-Employed Women's Association.

Training sites:
Skills development training is delivered through the existing facilities of local academic institutions, and public and private training providers, throughout the GVMC and VUSA areas. When paired with public programs and existing public subsidies, Smart Skill Vizag extends and incentivizes more effective access to training through private investment in training delivery within the region.

Users:
The virtual platform, Vizag One Centre, and outreach programs are all designed to serve the full range of workers in the greater Visakhapatnam area. These workers are categorized into four broad user types:

- User Type One: workers (31.6% of surveyed heads of households) with English literacy and graduate and post-graduate educational attainment who can already secure knowledge-based employment within the key economic growth sectors of pharmaceuticals, logistics, health and wellness, digital / IT, and tourism within the Visakhapatnam region.
- User Type Two: workers (20+% surveyed heads of households) with English literacy and 10th/12th standard educational attainment who are at the threshold of accessing technical careers within the key economic growth sectors of pharmaceuticals, logistics, health and wellness, digital / IT, and tourism within the Visakhapatnam region.

- User Type Three: workers who are currently illiterate (14.5% of surveyed families) and without 10th/12th standard educational attainment but have good access to municipal transport and good access to ICT infrastructure services.
- User Type Four: workers (14.5% of surveyed families) who are illiterate without 10th/12th standard educational attainment and have limited access to municipal transport and limited access to ICT infrastructure services.

Table 1.1 Platforms are designed to extend access the four user type categories:

	User Type One	User Type Two	User Type Three	User Type Four
Virtual platform	X	X	X	
Vizag One Centre	X	X	X	
Outreach programs			X	X

Expansion potential:
The virtual platform can integrate structural modifications in the natural language processing techniques for higher-complexity Telugu language support.

Over time, additional connections with venture capitalists could be fostered to encourage idea-generation, entrepreneurship, and business incubation within Vizag. This innovation hub could provide online mentorship, community, and “matchmaking” between Vizag-based entrepreneurship mentoring/venture capital assets and universities to attract skilled entrepreneurs to build businesses in Vizag. An innovation hub supports business development and incubation through the launch of the business, and aligns with the Digital India and Startup India policy agendas.

Anticipated Project Benefits
The project would benefit all market sectors, and position Vizag well for economic growth, by accelerating skills development and attracting and retaining a highly skill-diverse workforce. A more skillful workforce in Visakhapatnam would be able to secure more sustainable, higher-income livelihoods, and would increase the purchasing power and disposable income of individuals within the region.

Business Model and Financing Strategy

The implementing agency could utilize multiple funding sources, depending on the platform and organization type. Some sources are identified in the table below. Capital investments would be required to initiate the three platforms, with partnerships needed for developing and delivering training programs for all four user types. Once operational, the virtual platform may be able to operate through advertising revenue generated through public private partnerships. The Vizag One Centre and outreach programs are unlikely to generate positive cash flow, and would likely require subsidization, based upon its anticipated economic benefits. The financing of skills-development training would depend upon a worker's ability to pay, as well as employers' needs and their ability to invest in anticipated benefits.

Table 1.2 Contribution by Platform and Organizational Type

Organizational Type	Virtual Platform	Vizag One Centre	Outreach Programs	Training
Government of India and Government of Andhra Pradesh	Digital India, NSDC, GOAP investment	GOAP investment, MSME programs, NSDC	MEPMA, MSME, NSDC	Digital India, MEPMA, MSME, NSDC, Skill India, Startup India
GVMC and VUDA		Facilities, staffing, programs		Subsidies or contracting for training existing staff; pre- or post-training reimbursements
Educational Institutions		Venue for training programs		Tuition based training; pre- or post-training employer reimbursements
NGOs		Venue for training programs	Foundation / grant-based funding	Foundation / grant-based funding
Self-help Organizations and Other CBOs			Full-service delivery including self-funding	Full-service delivery including self-funding
Private Entities	PPP, advertising revenue	Expertise under contract through MSDE Sector Skill councils; PPP (CSR)	Expertise through MSDE Sector Skill Councils; funding through MSME and Startup India	Digital India; Expertise through MSDE Sector Skill Councils; funding through MSME and Startup India; training provider and employer tariffs

In addition to these identified funding sources, the project sponsor/owner should:

- Explore the feasibility of leveraging assistance from various industry groups and education institutions;
- Explore the feasibility of marketing the data/information (user group, their education, career interest, location, etc.) generated to prospective employers who are interested in locating their businesses in the GVMC area;
- Explore the feasibility of “advertisements” within the virtual platform – i.e., banner tags, for web and mobile apps;
- Explore the feasibility of seeking “sponsorship” for the platform – i.e., “this information is brought to you by Rotary Club of GVMC.”

Operations and maintenance costs can be reduced by integrating existing land, building, training programs and provider information assets, as well as through outreach partnerships. Costs can be offset by assigning training information and job listing responsibilities to training providers and employers, and integrating available data from training provider portals into Smart Skill Vizag platforms via “push” and “pull” content transfer methods.

Institutional Arrangements for Project Implementation

Implementation of the three Smart Skill Vizag platforms, and Smart Skill Vizag training, would result in an environment where public and private sector entities would share phased responsibility for ensuring the long-term effectiveness for skills development advisement, training, and market absorption for residents. Government agencies should develop the virtual platform through its launch, after which leasing models could be explored with private entities to generate operational revenue. As they will likely not be self-financing, the Vizag One Centre and outreach programs could seek financial and in-kind contributions from government agencies, NGOs, and companies that emphasize corporate social responsibility (CSR). Operations and maintenance of the Vizag One Centre, training delivery, and outreach can be contracted to private entities, non-governmental bodies, and collectives.

Initial project management, development and launch must be guided by the public sector. However, once the project's capabilities are established, and commercial benefits are evident and sustainable, the public sector project sponsor/owner can invite private-sector actors to assume responsibilities for content development, coordination, operations and maintenance, etc. Coordination between various governmental, educational, private, and community bodies should be administered jointly by the GVMC and SPV, in order to gather insights into the functional and business requirements for the Virtual Platform, Vizag One Centre and Outreach components of Smart Skill Vizag. A project-implementation vendor, once on board, can further validate these requirements by working with various stakeholders.

Existing portals and resources developed by universities can also be pulled for use within the Smart Skill Vizag virtual platform. This method would also encourage greater private sector participation, by increasing the number of website "hits," and by securing trainees and employees and explicitly sharing profiles on the desired training of candidates. With oversight, training providers can adapt their programs to meet the certification requirements of NSQF pathways. Employers can also partner with training providers to reimburse training tuition and guarantee employment for residents who meet specific NSQF qualifications.

Summary of Projects

Project	Project description
Virtual Health Information System	Unified healthcare database comprised of each patient's medical records, including transactions, diagnoses, and procedures. The system grant access to all public and private healthcare providers as well as patients.
Emergency Response Dispatch Platform	Emergency Response Platform for police (exg), fire and emergency services. System will be a module operating within the CCC to determine best routing for emergency vehicles.
Festival Promotion and Delivery Platform	Promotion of cultural events along Vizag's coastline, including upgrading and revitalization of selected venues.
Smart Skill Vizag workforce training platform	Smart Skill Vizag provides training roadmaps, information, and access to training for workers, as well as predictive workforce-demand analytics for major industry/sector organizations through the virtual platform, and access to the in-person "Vizag One Centre" and regional outreach programs.


HYUNDAI

IX. HOUSING COMPONENT

Introduction

One advantage that Visakhapatnam has over competing “knowledge industry” cities in India is that housing in Vizag is generally more affordable. In Bangalore, Hyderabad, Delhi and other Indian cities with vibrant knowledge industries, housing is expensive, and the financial burden of housing is particularly onerous for young professional families at the beginning of their careers. Market prices for upper-middle and upper income housing in Vizag are comparatively affordable. The purpose of this housing component, as set out in the Smart City Framework Plan Terms of Reference, is to propose strategies and approaches to enable Vizag to maintain its comparative advantage in housing affordability as the local economy – and in particular the local knowledge industries – develop.

It is understood that rapid rise in house prices in India as in other countries is most often the result of sharp increases in demand while supply remains relative inelastic. Historically, the supply side in India has been fairly unresponsive to demand increases resulting from large-scale in-migration from rural areas, as well as from other cities. Typically in the face of population growth the amount of serviced land for residential use and built-for-sale or built-for-rent housing does not grow commensurately. This “supply-side responsiveness” lens has been used in preparing this analysis and arriving at proposals to increase the supply of affordable housing options.

This component was prepared following a review of existing secondary sources of information and conducting a series of key informant interviews.

Challenges and Opportunities

The main housing challenge in urban areas of GVMC is that housing production has not kept up with demand. While the population has in recent years grown slowly, the housing stock has grown even more slowly. Over the next five years, GVMC needs to produce about 100,000 “housing solutions” for future households and for current households that lack decent housing. This is equivalent to about 20,000 dwelling units per year. In the meantime, the public sector (in particular, the Housing Board) has produced 4,500 detached houses in the last five years. The current plan of the Housing for All 2022 program, which caters to Lower Income Group (LIG) and Economically Weaker Section (EWS) households, is to produce 4,000 units in Vizag over a two-year period, and about 11,000 units over the life of the program. While these contributions are valuable, they will not on their own fill the housing gap. Only an attempt to stimulate housing production broadly, including maximizing the contribution of private sector housing developers, will bring housing supply closer to being in line with housing demand.

In addition to a housing shortage, the quality of housing produced by the public sector is also a problem. As a result of little or no stakeholder consultation during the housing design process, the fit between housing projects and the preferences and priorities of beneficiary communities is weak. Fishermen have no place to hang their fish nets. Some families have been reluctant to move to new housing projects in peripheral areas because they are too far from employment areas. Beneficiaries should be consulted during the planning and design processes.

Another challenge is the lack of trust that slum dwellers place in local government housing initiatives. The Urban Community Development has proposed to some slum dwellers living on centrally located land to participate engage in densification projects. Given the high land values in these locations, such projects often distribute substantial financial windfalls. Nonetheless, the residents have often demurred, ostensibly because they do not trust the public sector developers to give them their fair share of the benefits.

Approach to Smarter Housing

International experience that housing production is rarely the most economically efficient way to fill a housing deficit (especially low-income housing deficit). Usually the total number of “housing solutions” — which refers not just to constructed units but also to rental vouchers, serviced residential land parcels, core housing, etc. — provided through direct construction is low, and the beneficiaries of that construction tend to be middle-income households with political connections. Providing access to serviced land and finance provides higher return on public investment in most cases, despite the challenges of fair allocation of plots.

- To increase the production of housing in Visakhapatnam, the most important thing is to enable the production of housing solutions by many different types of actors. Private housing developers and managers, public developers, non-governmental organizations all have the potential to generate housing solutions, whether built-for-sale housing, rental housing, serviced land plots… GVMC should take this as a starting point for a new housing policy, and then develop specific strategies for ramping up housing production by socioeconomic segment of the population.
- Relax zoning provisions with regard to setbacks, minimum unit size, and amenities. Allow the production of “accessory dwelling units” (ADU) and other types of small dwelling units that can increase density and enable greater housing affordability, to the extent that small units tend to cost less. The development of new “microunits” (small apartments) with some shared facilities may be appropriate for some low-income households as well as some young professionals.
- Set and enforce a minimum percentage of housing units set aside for EWS or LIG households in all new housing developments above a certain minimum size. For example, projects with more than 100 units should offer a minimum of 5% of all units to LIG families. Developers should be offered density bonuses for exceeding the minimum LIG percentage.
- Incentivize private real estate developers to move “downmarket,” building rental or built-for-sale housing for households in the 30th to 60th income percentile. Provide incentives such as free off-site infrastructure improvements. Consider providing rental vouchers to qualifying low/middle income families to fill any gap between the cost of housing production and maintenance plus normal profit, on the one hand, and the ability-to-pay of the target population.
- Adopt a demand-driven approach to housing production. Systematically consult beneficiaries as part of the planning and design process. Take into account lifestyle: design the housing to suit the lifestyle of the beneficiaries. Take into account livelihoods: do not locate projects in areas located far from employment areas and lacking public transit connections

- Catalyze the redevelopment and densification of informal settlements to add more units to the housing stock.
  - Communicate to landowners in “slums” that the city favors densification under the right conditions
  - Provide technical assistance to facilitate incremental redevelopment of individual properties over time (manuals, free counsel, site visits…)
  - Upgrade infrastructure to increase capacity so that more units can be built in the same settlement
- Coordinate housing delivery with urban planning.
  - Avoid a “scattershot” approach to locating housing projects. Wide distribution is fine (and preferable to concentrating all EWS households in a small number of locations), but sites should be integrated with other types of investments and land uses, such as employment areas, retail and services, community facilities, etc.
  - Coordinate the location of housing projects with the preparation of city-wide and local area land use plans.
  - Locate housing where infrastructure investments are existing or programmed in order to accommodate the resulting demand for water, sewer, transit, roads, schools, parks, etc.

Housing Projects

This housing approach can be applied in different ways in different “key urban centers” around the GVR.

For example, the “LIG set-aside” (minimum % of units set aside for LIG households) should be adjusted on a ward-by-ward basis. The cost of this set-aside will vary with the land prices in different parts of the city, the percentage can be adjusted on a ward-by-ward basis. For example, in upper-income areas such as R.K. beachfront Rushikonda, the percentage can go as low as 5-10%. In other middle income areas such as Pendurthi or the mixed-use areas north of RTC complex, the percentage can be in the 10-20% range.

In Rushikonda, a combination of housing interventions could be used to keep supply in line with demand and enable its emergence as a livable and desirable tech community.

- First, make it easy for private residential developers to enter the market initially. Keep the LIG set-aside low. Install trunk sewerage infrastructure in advance. Then, after the market heats up and more capital is attracted to Rushikonda, raise the LIG level (say, 10-15%).
- Second, use small units—or even “microunits” (apartments <300 square feet) to provide affordable rental housing to young professionals. These small units, popular among young professionals in many cities around the world, could accentuate Vizag’s housing affordability advantage for recent tech and other knowledge industry graduates deciding what city to live in early in their careers.

- Bring in Gitam University to develop some student housing in the tourist/student subcenter on the southwestern part of Rushikonda. GU can partner as required with private developers. In terms of housing typology, these apartment buildings may end up being similar to the microunits inhabited by the young professionals closer to the tech park.

In Parawada, a set of housing interventions could be adopted as a test case for other mixed use urban subcenters in the industrial south:

- A relatively high requirement for LIG/EWS housing production, such as 30%. The minimum size to which this requirement applies may have to be adjusted downwards, as projects will tend be small (e.g., one building, 10-50 units) in these towns.
- Rather than using the Housing for All funding to build separate LIG/EWS housing, partner with a private developer to do a series of small projects with mixed MIG/LIG housing in different industrial suburbs. This will serve as the incentive for the private developer to go downmarket to Parawada, which will generally not be an attractive destination, when compared to other locations around GVR.

To the north of National Highway 5 in the city center, adopt a more robust approach to slum redevelopment. Many of the squatter areas along the Highway 5 are already quite centrally located and will be even more convenient and attractive after the BRT is upgraded and operational.

- Identify 2-3 land pooling pilot projects
- Develop new regulations (municipal decree) that establish safeguards for slum dwellers participating in land pooling projects, e.g.:
  - Minimum percentage of economic benefits to be distributed to existing residents at the time of project planning = 50%. The balance 50% can go to landowners, GVMC and/or private developer partners
  - Financial penalties to be paid by GVMC/developer if project takes longer than planned.
  - Benefits in terms of serviced land parcels or finished dwelling units to be specified before formal contracts are signed among residents association and developer/GVMC
  - When 2/3 or local residents support a land pooling project, it can go forward, regardless of the preferences of the balance residents.
- In the case of land pooling projects that do not involve construction of units by a developer, establish a revolving fund to make loans to residents for construction of new units on their serviced residential plots.

X. RESILIENCE COMPONENT

Introduction

Resilient settlement patterns and resilient infrastructure systems will be increasingly necessary for maintaining a high quality of life as the region grows, and will also be critical for attracting the businesses and residents that will drive that growth. Cities that can provide continuous services and maintain a support network for businesses and residents in the face of threatening conditions will develop a significant competitive advantage.

Resilience and "Green Living" – Future residents will seek out Vizag because of its inherent quality of life, its transparent communication and governance, and the systems that have been built to protect and preserve its natural and cultural heritage.

Resilience and "Smart Business" – Future businesses will seek out Vizag due to the predictability of its infrastructure services and access to reliable critical facilities.

A resilient VMR will anticipate threats to public health and the economy, and mitigate and/or respond to these challenges.

Assessing Challenges

The resilience assessment completed in Task 3 of this effort examined the literature and current conditions associated with threats to Vizag's critical infrastructure from natural hazards and anticipated climate change impacts.

Natural Hazards

The primary natural hazards facing Visakhapatnam include cyclonic wind events, flooding, tsunami, and vector and water-borne diseases. The greatest risk for tsunami events to eastern India are a result of the major subduction earthquake zone in the Bay of Bengal and the Indian Ocean. Extreme rain events during the monsoon season (June to October) can also cause severe flooding, and while storm surge is not an issue during these events, damage from flooding to homes and infrastructure system can lead to direct and indirect impacts to the community.

An analysis by UNDP shows that major cyclonic wind events impact Visakhapatnam on average once every ten years, with 44 cyclones having passed within 150km of Visakhapatnam between 1877 and 2013. The direct impacts from major storms include injury to humans and livestock, damage to physical assets from high-velocity winds, flooding caused by extreme rainfall, and the impacts from storm surge and larger tides. In addition to the direct impacts, secondary and/or cascading effects from cyclones include the loss of access to infrastructure services, such as water, electricity, transport, healthcare, and communications services, resulting from damage to those systems. In addition, emergency-response times are longer, and demand is increased during and immediately after an event. Secondary and tertiary impacts also include an increased exposure to vector and water-borne diseases that result from damage to sanitation systems, clean water, refrigeration, and standing water.

The incidence and spread of disease in Visakhapatnam is driven significantly by weather conditions, population density, and limited access to healthcare. Environmental threats caused by the secondary impacts of flooding and limited access to clean water and sanitation are also significant factors. High temperatures in the summer months, along with heavy rains, can lead to vector-borne diseases such as dengue and malaria, and water-borne ailments such as diarrhea.

Projected Effects of Climate Change

The most recent data on projected changes in climate from the Intergovernmental Panel on Climate Change (IPCC AR5, Working Group II) suggests that Visakhapatnam, like most of the region, will experience increases in incidences of severe heat stress, an increase in the frequency and magnitude of extreme rain events, and sea level rise. Various studies and government reports have performed downscaling of the IPCC data for Andhra Pradesh and the Visakhapatnam region, and found no major variations in these anticipated impacts. Based on this data, increases in the maximum summer temperatures in Andhra Pradesh by more than 2 degrees Celsius could occur, and some models show maximum temperatures

exceeding this projection by a factor or two or three. Overall, the projected effect of climate change is to increase the vulnerability to cyclones, extreme rain events, flooding, tsunami, heat stress, and disease by accelerating and increasing the effects described above.

Critical Infrastructure Vulnerability

A comprehensive inventory of key infrastructure and services for Visakhapatnam was prepared in 2014 by TERI, The Energy Resources Institute, under a grant from the US Agency for International Development (USAID). This inventory covered 11 key sectors, including water, waste management, transport, energy, industry, housing, health and education, telecommunications, and tourism. Climate change and disaster management services are also addressed in the inventory. TERI created a database management system to compile, organize, and depict the data spatially. In developing an assessment of vulnerabilities and existing mitigation, TERI also created a resource for guiding future resilience planning. These GIS layers allow future plans or concepts to be incorporated and tested against the identified hazards. TERI also incorporated climate vulnerability into their assessment.

The TERI reports that vulnerable critical infrastructure assets in Visakhapatnam are at risk from sea level rise and storm surge. In the social infrastructure sector, two hospitals (Lata and APHB Colony Steel Plant) and five schools are identified as vulnerable to flooding from SLR and storm surge. Nearly half of the stormwater drains, the Appughar sewerage treatment plant, and Shanti Ashram pumping station, and major surface and air transport facilities are also vulnerable to flood damage. In the industrial sector, major facilities in and around the port are at risk, including steel, petroleum, chemical, and naval assets.

Disaster Management Coordination

The disaster management coordination function within Visakhapatnam rests with the District Collectors. GVMC and other operators of infrastructure and services support this effort under the direction of the Collector, and ultimately State officials, in Andhra Pradesh. However, the VUDA area includes all or part of four Districts, so incident coordination is not centrally coordinated across the entire region, except at the State level in Hyderabad.

Strategic Considerations

Building on the initial recommendations from the Task 3 assessment, the following considerations can inform future project development, and integrate “resilience thinking” into future initiatives.

Comprehensive Asset Management and Planning

The TERI database is comprehensive and very robust; however, we have found no evidence that it is being maintained as a dynamic planning tool that incorporates new plans and completed projects and modifications into the database. An update process to keep the database current would be a very effective tool for resilience planning. We recommend that the database is also expanded to address all hazards, not just the core climate hazards (SLR and storm surge) covered in the initial study. Consistent with the transport recommendation in the IBM report, a comprehensive database could be the basis of an asset-management system to assist in planning, and assess not only future hazards, but also the state of good repair (SGR) of existing assets. This aids in addressing both preventative-maintenance issues as well as emergency-response activities.

Downscaling of Climate Data for Use in Planning

In order to facilitate better planning for the impacts of climate change impacts on proposed and existing assets, we recommend that Visakhapatnam and Andhra Pradesh partner with academic and research organizations to develop and maintain downscaled climate impact assessments, based on the latest observation and modeling data developed by the GOI and IPCC. The downscaled data and assessments could be incorporated into the system described in Recommendation 1, and used to analyze proposed public investments and land use decisions to improve the resiliency of new projects.

Improved Situational Awareness and Devolution Capabilities Across Districts

Disaster-management coordination is housed within the office of the District Collector. As described in previous IBM recommendations, an Intelligent Integrated Command Centre will improve situational awareness across the District and improve the resilience of District assets. However, large incidents like cyclones and tsunamis tend to impact a larger area than the District boundary, and coordination and visibility across Districts could improve situational awareness and resource sharing. The Collectors report to the State, which coordinates across Districts, but State officials receive data from each District. If the systems are connected across Districts, there would be two major improvements in resilience. The first would be that State officials would have consistent visibility of assets and impacts across the

entire affected region, and could more effectively coordinate asset and resource sharing. The second would be that, if one District's command center is impacted or becomes unsafe, staff can relocate to another District, and still be able to access all of their systems and sensors remotely. In an extreme case, state officials could also devolve the functions of one District to another less-impacted District or to the State command center.

Leverage Broadband Infrastructure Investment to Improve Information and Healthcare Access (Telemedicine)

Access to timely healthcare services improves the prevention and treatment of disease threats to the population. In rural areas, this access is often greatly affected by the travel distance required to access these services, level of demand, and scheduling of limited resources within the local area. In less affluent areas, people tend to only seek medical attention when a crisis occurs, because it is difficult and time-consuming to access the providers. A lack of preventative assessment and timely attention to acute problems can lead to a lower standard of health in these populations. The statewide investment in broadband infrastructure allows for the opportunity to establish a comprehensive telemedicine program for those with limited access to healthcare. In addition to improving the frequency and timeliness of care from a health professional, the telemedicine program would allow a better balance of demand and resources across the greater area. Patients could theoretically access providers across Andhra Pradesh, or even across all of India, and beyond, using this technology. While telemedicine cannot address all medical needs, through the use of video, remote sensors, and biometrics, many routine screenings and triage assessments can be performed the would allowing patients to have to travel to a healthcare facility only when absolutely necessary.

Integrated approach to risk mitigation

Resilience in the face of threatening conditions is best achieved by integrating responsive practices and/or technologies into all urban systems. In Vizag, this can be achieved by insisting that proposed urban planning approaches and infrastructure systems contribute to geographically-specific resilience objectives. These fundamental objectives include:

Understanding the current and future flows of people, goods and services

Projects that build awareness of people's real-time behavior and/or measure the flow of vehicles, water, energy, waste, and the other externalities of urban life can help to better anticipate threats to urban services and public welfare. They can also assist in efficiently allocating resources before, during, and after threatening events.

Avoiding and or augmenting vulnerable locations and time periods

Locating growth areas to avoid vulnerable locations and/or limiting exposure during high-threat timeframes is the most efficient way to mitigate the influence of threatening events. Design elements that augment existing conditions can reduce vulnerability and/or increase response-time windows that limit damage or downtime.

Improving Information exchange

Means of communication are critical before, during, and after threatening events. Projects that improve reliable, efficient dialogue between municipal leadership and citizens can greatly reduce negative impacts.

Improving service reliability and consistency

Projects that build redundant means of service delivery, and/or integrate the storage of water, energy or necessary goods, reduce system downtime, or improve response times can also limit the negative impacts of threatening conditions.

Diversifying resource base

Dependence on a limited number of resources can inherently pose significant economic challenges, should conditions change and resources become scarce. Diversifying sources of water and energy, and improving transportation mode choice, act as a hedge against scarcity and improves reliability.

Distributing critical systems

While centralized infrastructure can be simpler to control and manage, it can also increase vulnerability. More complex networks of interconnected systems allow managers greater flexibility in isolating problems, adapting to changing conditions, and expanding system capacity.

Leveraging natural systems

Resilience goals can be more easily and consistently achieved by harnessing and working with natural systems, rather than against them. For example, it is far more efficient to protect an existing wetland that filters runoff and absorbs floodwater than it is to rebuild a flood wall that degrades with every storm. Similarly, it is more efficient to preserve or revegetate a forested hill side than it is to constantly remove eroded soil from adjacent drainage areas.

These objectives can work in combination to further strengthen urban systems. Projects and policies that meet multiple resilience objectives create co-benefits that can accelerate Green Living and Smart Business aspirations.

Integrating policy infrastructure & urban resilience

The various components of the Smart City Integrated Framework plan recommend polices, programs, and projects that were conceived to improve urban resilience by responding to the threats and achieving the objectives that were identified earlier. The following table illustrates the objectives addressed by the integrated policies and programs.

Table 1.1 Resiliency objectives addressed by the integrated policies and programs

Policy + Program Integration	Understanding the current + future flows of people, goods and services	Avoiding + augmenting vulnerable locations and time periods	Improving Information exchange	Improving service reliability and consistency	Diversifying resource base	Distributing critical systems	Leveraging natural systems
Urban Growth + Open space							
Poly-centric, compact growth areas clustered near employment centers, outside of flood plains and wet soils		■					
Economic foundation focused on logistics, pharmaceuticals, IT/digital systems, tourism + healthcare	■				■		■
Regional Park System		■					■
Hill Top preservation		■					■
Floodplain+ wetland preservation		■					■
Lavender canal revitalization		■					■
ICT							
Asset management platforms	■	■	■	■		■	
Command and Communication Center			■				
Monitoring and control of networked systems	■		■			■	
Social Infra							
Emergence response Platform	■		■			■	
Skills development Platform	■		■			■	
Festival promotion							■

Policy + Program Integration	Understanding the current + future flows of people, goods and services	Avoiding + augmenting vulnerable locations and time periods	Improving Information exchange	Improving service reliability and consistency	Diversifying resource base	Distributing critical systems	Leveraging natural systems
Water							
Asset management systems	■	■	■			■	
Water supply coverage expansion		■		■			
Reservoir upgrades				■			■
Sewer coverage expansion		■		■			
Lavender canal revitalization	■	■			■		■
Mobility							
Electrification of transport					■		
Expansion and completion of BRT			■	■	■		
Airport link	■		■	■	■		
Arterial road renovation	■			■	■		
Arterial road network expansion				■	■		■
Energy							
Solar reservoir	■			■	■		■
Solar Canal	■			■	■		■
Back-up power to critical facilities				■			
Micro-grid pilot		■	■	■	■	■	■
District cooling pilot		■	■	■	■	■	■