View of the railway bridge over the Krishna River from Barrage

3 EXISTING TRANSPORT AND INFRASTRUCTURE ANALYSIS

This chapter reviews the existing conditions, future projects and key issues of transportation and infrastructure in the Capital Region. The chapter covers the following:

Transport

- Roads
- Rail
- Aviation
- Water Transport
- Public Transport
- Non-motorized Transport

Infrastructure

- Water Supply
- Waste Water
- Storm Water
- Solid Waste
- Power Supply

3.1 GENERAL REVIEW

3.1.1 ANDHRA PRADESH INFRASTRUCTURE

In the state of Andhra Pradesh, the high growth due to economic liberalization has resulted in significant movement of goods and people, which in turn created problems such as congestion, pollution and overburden and deterioration of existing infrastructure.

A multi-pronged approach is needed to ensure that the economic growth and urbanization does not lead to further deterioration in mobility and accessibility in urban areas, while providing new infrastructure where necessary.

In 2001, the State Government enacted the Andhra Pradesh Infrastructure Development Enabling Act (APIDEA), providing a regulatory framework for attracting private sector investment and Foreign Direct Investment (FDI) into the infrastructure sector.

The framework enables the State Government to enable and encourage the private sector to invest in the development and maintenance of the infrastructure in the State of Andhra Pradesh.

Infrastructure development is therefore well-supported by legislation, however key strategies need to be developed to encourage such investments.

Prakasam Barrage

Photo Credit: Adarsh Gupta K.

Fig.3.1 Existing Roads in the Capital Region

3.1.2 Road network

Existing Conditions

Road transportation is the dominant mode of travel in India. In 2012, roads carried approximately 85% of the country's passenger traffic and 65% of its freight. Roads form the backbone of public transport and connectivity to other modes such as ports and airports.

About 40% of road traffic in India is carried by National Highways, however they only account for 2% of the country's road network. India has a national highway density comparable to that of United States, however most highways in India are narrow and congested.

More than 7% of the country's national highway (3144km) is located in Andhra Pradesh[1]. Two vital national highways, NH5 and NH9, intersect at Vijayawada, the current business capital of Andhra Pradesh.

Fig.3.1 illustrates the Existing Roads in the Capital Region .

NH5 connects the Capital Region with the two industrial centers of Chennai and Kolkata, whilst the NH9 connects the Capital Region with Hyderabad and Machilipatnam Port. Several large cities and towns in the Capital Region, such as Guntur, Gannavaram, Mangalagiri, Jaggayyapeta and Nandigama are also located along these two Nati onal Highways.

High traffic demand is expected along the National Highways, as they are the only roads that connect the Capital Region with other commercial centers.

The Krishna River separates the Capital Region into two parts. Presently the two-lane Prakasam Barrage road and the NH5 are the only highways across the Krishna River in the Capital Region, and are heavily congested.

1 Andhra Pradesh State Statistical Abstract, Planning Department, 2014

Table 3.1 Existing Road Lengths (by type) in Capital Region

Road Type	Length(km)	Percentage
National Highway	357	4%
State Highway	365	4%
Major District Road	1822	21%
Other District Roads	857	10%
Village Road	5391	61%

Source: R&B, CRDA, Panchayat raj

State Roads link cities in Guntur district, i.e. Guntur and Tenali, however State Roads are not prevalent in Krishna district due to few major settlements. Major district roads and local roads play a large role in connecting smaller villages in the Capital Region.

Development of rural roads in the Capital Region has been done mainly through the Prime Minister Rural Roads Scheme, which aimed to build all-weather single lane, paved asphalted roads to connect all habitations with a population of 500 or above (250 or above for hilly areas).

The roads were of indifferent quality constructed by unskilled labour. As the objective of the programme was provision of sustenance support to the rural people, the technical standards of asset quality were not insisted upon. As a result, roads constructed under the scheme were often not durable[2].

The National Highways Development Project (NHDP), managed by the National Highways Authority of India (NHAI), is upgrading, rehabilitating and widening major highways in India.

The Golden Quadrilateral project, which is one of the keystone projects of the NHDP, also includes the upgrading of NH5 from Kolkata to Chennai via Andhra Pradesh. This was completed in 2013.

2 India Infrastructure Report 2007

The NHDP is currently upgrading and improving the National Highways linking other cities to the Golden Quadrilateral to improve road connectivity and accessibility (Refer to Chapter 2).

The East Coast Economic Corridor (ECEC) links Kolkata to Chennai via Andhra Pradesh as shown in Fig.3.2. In compliance of the commitment made by the Central Government in the Andhra Pradesh Reorganization Act, 2014, Asian Development Bank will focus on the Vizag - Chennai Section in the first phase of the study[3]. The Capital Region is expected to benefit from the development of the ECEC.

Several state governments have been implementing a number of state highway projects since 2000. By 2010, state highway projects worth $1.7 billion had been completed, and an additional $11.4 billion worth of projects were under implementation. The state government of Andhra Pradesh had implemented the construction of 1230 km of state highways as of 2010.

Key Issues

- Heavy traffic congestion due to insufficient lane capacity
- Connections in the Capital Region depend on two National Highways
- Congestion at Prakasam Barrage due to high traffic demand across the Krishna River
- Poor road quality and under-funded existing road maintenance leading to deterioration of roads

3 Investment opportunities in Corridors, NIMZ and Cluster under IIUS, 2014

Opportunities

The expansion of National Highways and State Roads are expected to alleviate traffic congestion, however there is need to study projected demand in consideration of the new Capital City. Its central location makes it an ideal distribution hub to Chennai, Visakhapatnam and Hyderabad.

A comprehensive regional network of National Highway-level roads are required to ensure that road capacity is sufficient to support the projected growth. Bypass roads can be introduced to relieve congestion in the future Capital City and to allow bypass traffic to circulate around the region unimpeded.

A new road hierarchy (high capacity urban roads) will be introduced as an intermediary. Road hierarchy and cross-sections are crucial to safeguard land reserves necessary for the road network. Long term strategic plans can help to safeguard these reserves, and identify key alignments for development.

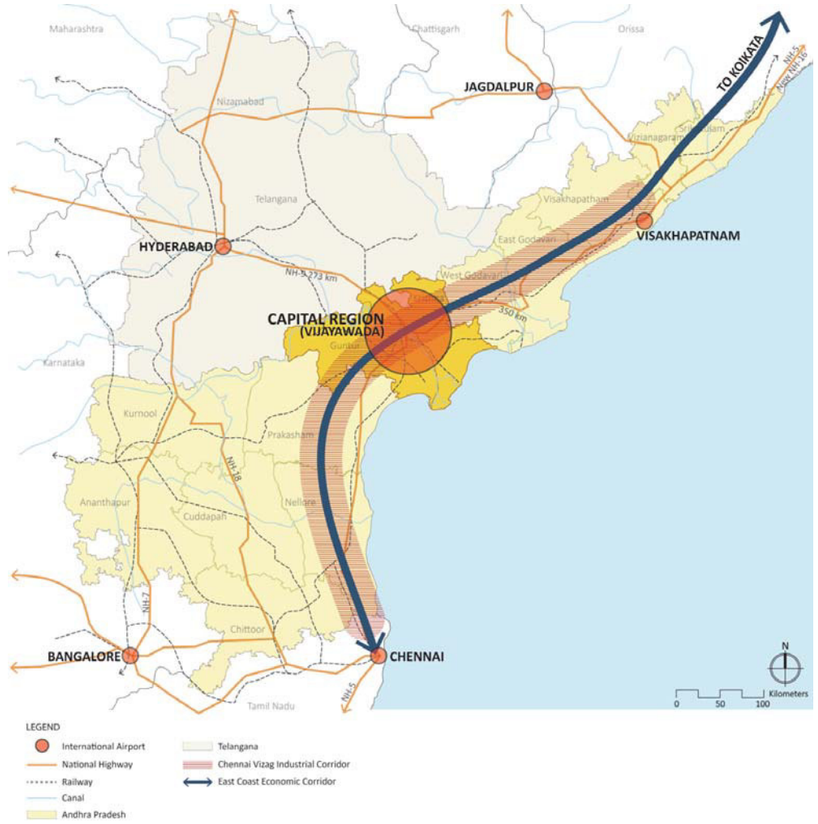

Fig.3.2 National Economic Corridor through Andhra Pradesh; Alignment not confirmed

NH5 at Mangalagiri

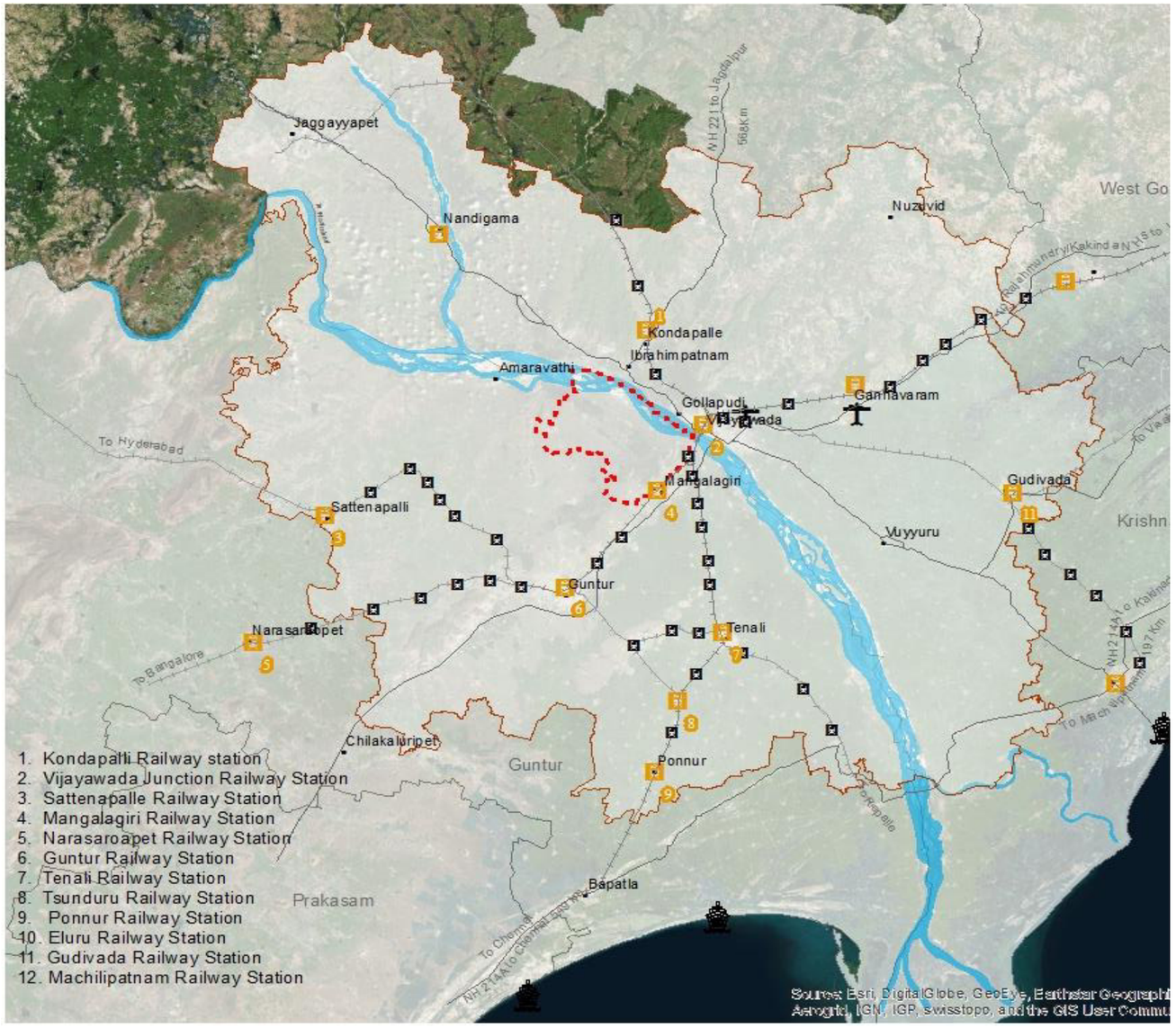

Fig.3.3 Existing Rail Network and Railways in Capital Region

3.1.3 Railway network

Existing Conditions

Indian railways provide an important mode of transport in India, transporting over 24 million passengers and more than 2 million tonnes of freight daily. The Indian rail network connects more than 7,000 stations over a total route length of more than 65,000 km and track length of about 115,000 km.

Vijayawada Junction, one of the busiest railway stations in India. More than 250 express and 150 freight trains pass through it daily. It serves over 50 million passengers per year.

LEGEND

- Railway Station (National)
- Railway Station (Local)
- Port
- Airport
- Railway
- National Highway
- Rivers
- Capital Region Boundary
- Capital City Boundary

Andhra Pradesh has 5,046 km of railway network. It plays a significant role in boosting the economy of the state, alongside developing the industrial and the tourism sectors. All the districts in the state are connected by rail. The Capital Region has 2 major stations in Vijayawada and Guntur. (Fig.3.3)
Two major commuting lines, Jammu-Delhi-Kanyakumar, which connects northern and southern India, and the Kolkata-Kanyakumar, which connects eastern and southern India, both intersect at Vijayawada Junction Station[1].

Overall freight movement by rail in India has grown by 35% between 2002 and 2006 and has been growing by 5.8% annually to 2013 (Fig.3.4). To support the growth, the Ministry of Railways is constructing new Dedicated Freight Corridors (DFC) to increase in productivity and reduce in freight transportation cost.

1 Approach to the 12th Five Year Plan of Andhra Pradesh, Centre for Economic and Social Studies, 2012

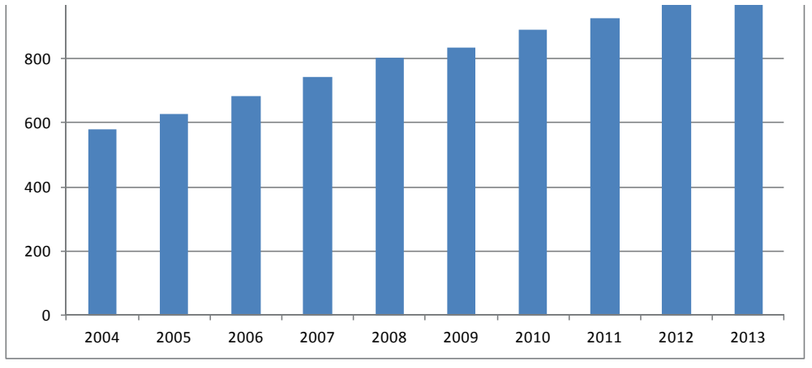

Fig.3.4 Total Freight Traffic moved by Rail (Indian Railways, 2013)

Two corridors have been constructed (Eastern and Western Corridors), with four additional Dedicated Freight Corridors being planned (Refer to Chapter 2).

The East Coast Corridor and North South Corridor identified intersect at Vijayawada. Machilipatnam Port is also connected to the Capital Region by rail, as shown in Fig.3.5. These freight corridors may introduce a significant portion of freight through-traffic, which may add to congestion at Vijayawada Junction.

The railway lines are undergoing standardization, and the Indian Railways are currently upgrading the rail tracks and converting the existing narrow gauge and meter gauge lines to broad gauge under Project Unigauge.

The Ministry of Railway plans to increase rail capacity by doubling and electrifying 14,000 km of the existing and potential overcrowded lines. Key rail sections with planned upgrades which benefit the state of Andhra Pradesh are:

- Vijayawada-Gudivada-Bhimavaram-Nidadavolu
- Gudivada-Machilipatnam, and
- Bhimavaram-Narsapur

The electrification of the Vijayawada - Machilipatnam port will also increase freight capacity, therefore supporting the Capital Region's role in the Industrial Corridor.

Indian Railways also plans to improve the existing conventional lines to semi-high speed rail handling speeds of up to 160 km/h, and are proposing high-speed rail on new tracks with improved technology. The Indian Ministry of Railways' white-paper "Vision 2020" proposed six potential high-speed rail corridors (HSR) connecting commercial, tourist, and pilgrimage hubs (Refer Section 2.1.1 in Chapter 2).

The main High Speed Rail Corridor which would benefit the Andhra Pradesh Capital Region is the Hyderabad - Chennai High-Speed Passenger Corridor, which passes through Vijayawada.

Commuting and freight traffic at Vijayawada Junction is expected to grow significantly due to the development of the new Capital Region.

As the sole rail crossing of Krishna River, congestion is currently occurring at Vijayawada Station, with delays of up to 90 minutes . The station is running at capacity, and will not be able to accommodate future growth.

Key Issues

- Development of dedicated freight corridors may introduce significant freight through-traffic at Vijayawada Junction
- Congestion at Vijayawada Junction
- Introduction of High-speed rail
- Need to separate freight and passenger traffic
- Need for additional rail crossing along Krishna River to alleviate pressure on Vijayawada Station

Opportunities

The provision of a bypass freight corridor would help to remove freight through-traffic from Vijayawada Junction. This can help Vijayawada Junction improve capacity for commuter traffic to and from the Capital City. These new corridors should provide alternatives to the existing crossing points across River Krishna to help alleviate the pressure on the existing crossing.

Transport/Logistics Hubs can also be introduced in the fringes of the new Capital City, so that commuter traffic can be dispersed without travelling to Vijayawada Junction first.

The High-Speed Rail station can also be located within the new Capital City instead of Vijayawada Junction, therefore improving the capacity of the station.

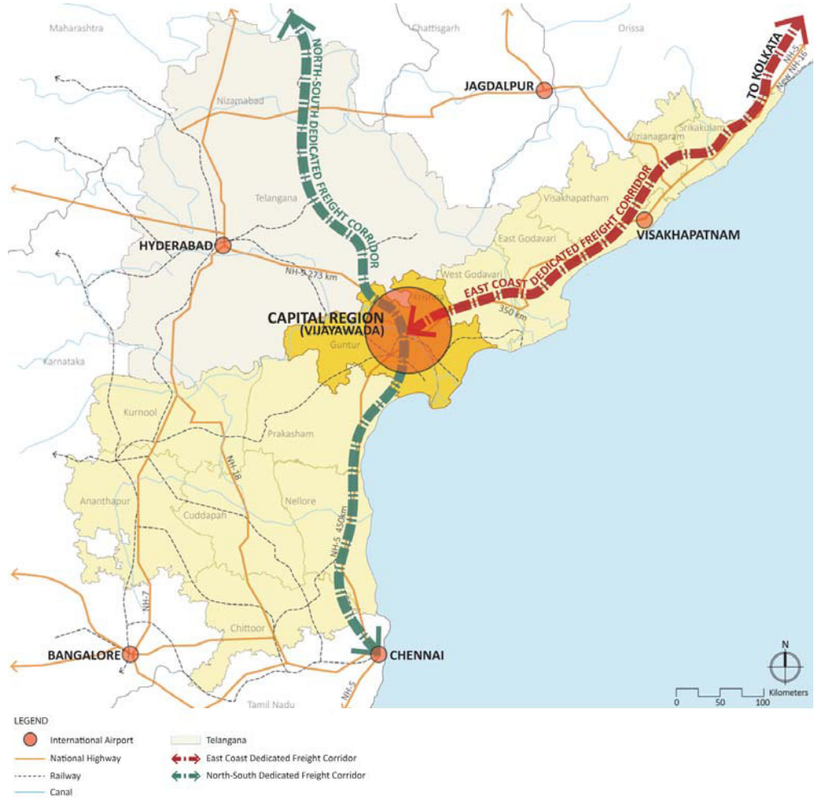

Fig.3.5 Existing and Planned DFC

Table 3.2 Status of Freight Corridors in 2014

Dedicated Freight Corridor	Route		Length (km)	Status
	Start Point	Termination Point		
Western Dedicated Freight Corridor	Dadri	JNPT, Nava Sheva	1483	Approved in Rail Budget 2014-15
Eastern Dedicated Freight Corridor	Ludhiana	Dankuni	1839	Approved in Rail Budget 2014-15
East-West Dedicated Freight Corridor	Kolkata	Mumbai	2000	Planned
North-South Dedicated Freight Corridor	Delhi	Chennai	2173	Planned
East Coast Dedicated Freight Corridor	Kharagpur	Vijayawada	1100	Planned
South-West Dedicated Freight Corridor	Chennai	Goa	890	Planned

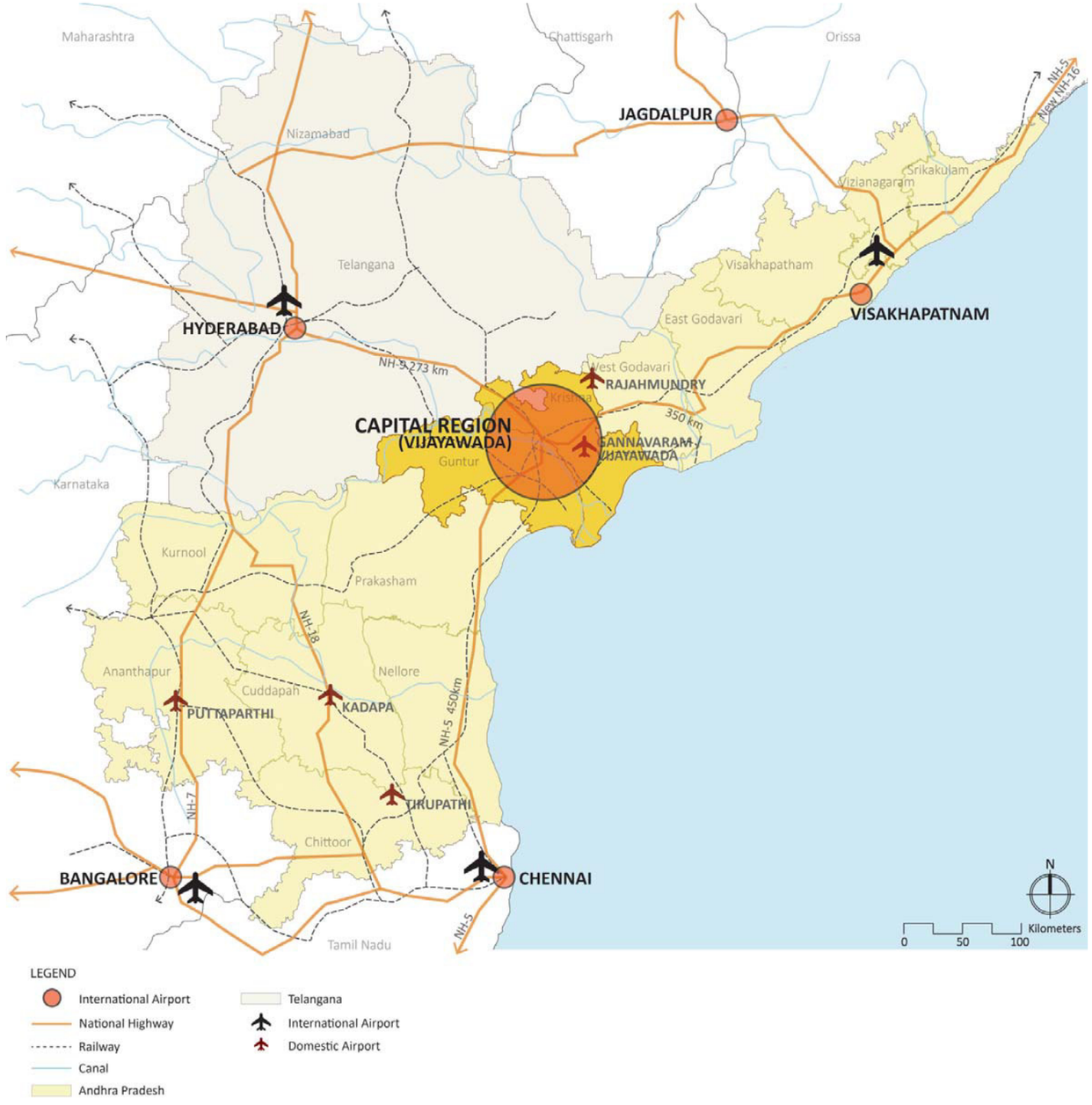

Fig.3.6 Existing Airports in the vicinity of the Capital Region

3.1.4 AVIATION

Existing Conditions

Increase in air traffic in India over the last decade has placed a heavy strain on the country's major airports.

Andhra Pradesh is well-connected to the aviation network via 1 international airport and 5 domestic airports. There are also 3 international airports in the adjacent states to Andhra Pradesh,namely Chennai, Bangalore and Hyderabad (Fig.3.6).

The closest airport to the Capital Region is Vijayawada Airport (IATA: VGA), 18 km east of Vijayawada. It is a mid-sized domestic airport and is currently served by four regular airlines with eight daily scheduled flights. Freight usage at the airport is currently limited.

Recent upgrades to the airport include a runway extension (2,285m), and acquisition of 169 hectares of land for future expansion, bringing its total area to 400 hectares.

The Airports Authority of India (AAI) is currently developing and making infrastructural improvements to the Vijayawada Airport to accommodate future increase in air traffic. There are plans to increase the length of the runway to 3,200m, improve existing facilities, security and operations and construction of a new runway for domestic services. [1].

Freight logistics is not a primary use of the existing airport, however the industrialization of Andhra Pradesh may increase freight share in the airport.

Vijayawada Airport is approximately 25 minutes away from Vijayawada by car, 30 minutes by train.

Key Issues

- Small land area may limit future airport expansion
- Inadequate facilities to handle freight
- Infrequent public transport services to and from Vijayawada, and other neighbouring cities

Opportunities

Additional land may be reserved for future expansion in the strategic plans. By doing so, runways capable of receiving larger planes may be built, therefore enabling international flights from Europe and the US.

Freight logistics facilities can be developed to accommodate cargo growth in the airport.

The airport can also be developed as a transport/logistics hub, in order to support better public transport connectivity to nearby towns and the new Capital City.

1 Deccan Chronicle, 2014

3.1.5 WATER TRANSPORT

Existing Conditions

Despite India's high density of rivers and canals, inland water transportation remains largely undeveloped. The total cargo transported by the inland waterways was just 0.1% of the total inland waterways traffic in India, compared to 21% for United States.

There is potential growth in the use of the canals for moving freight cargo. The Inland Waterways Authority of India (IWAI) has undertaken several projects to develop five National Waterways (Refer Section 2.1.1 in Chapter 2), where National Waterway 4 (Fig.3.10) runs through the Capital Region of Andhra Pradesh1.

National Waterway 4 is expected to form the backbone of water transport in the Capital Region.

1 Inland Waterways Authority of India, 2012

Visakhapatnam Port

The waterway connects Kakinada-Puducherry canals with Godavari and Krishna rivers and will provide a vital link for transporting agricultural products and industrial goods between rural areas and urban centers. It also connects the sea ports of Kakinada, Krishnapatnam, Ennore and Chennai and will facilitate inland import and export of cargo. The National Waterway 4 is expected to transport 11 million tonne cargo per annum.

Krishna River is not navigable; its primary purpose is to provide water for irrigation. It is fed by seasonal monsoon rains, and therefore its flow undergoes great fluctuation during the year, limiting its usefulness for irrigation and transportation.

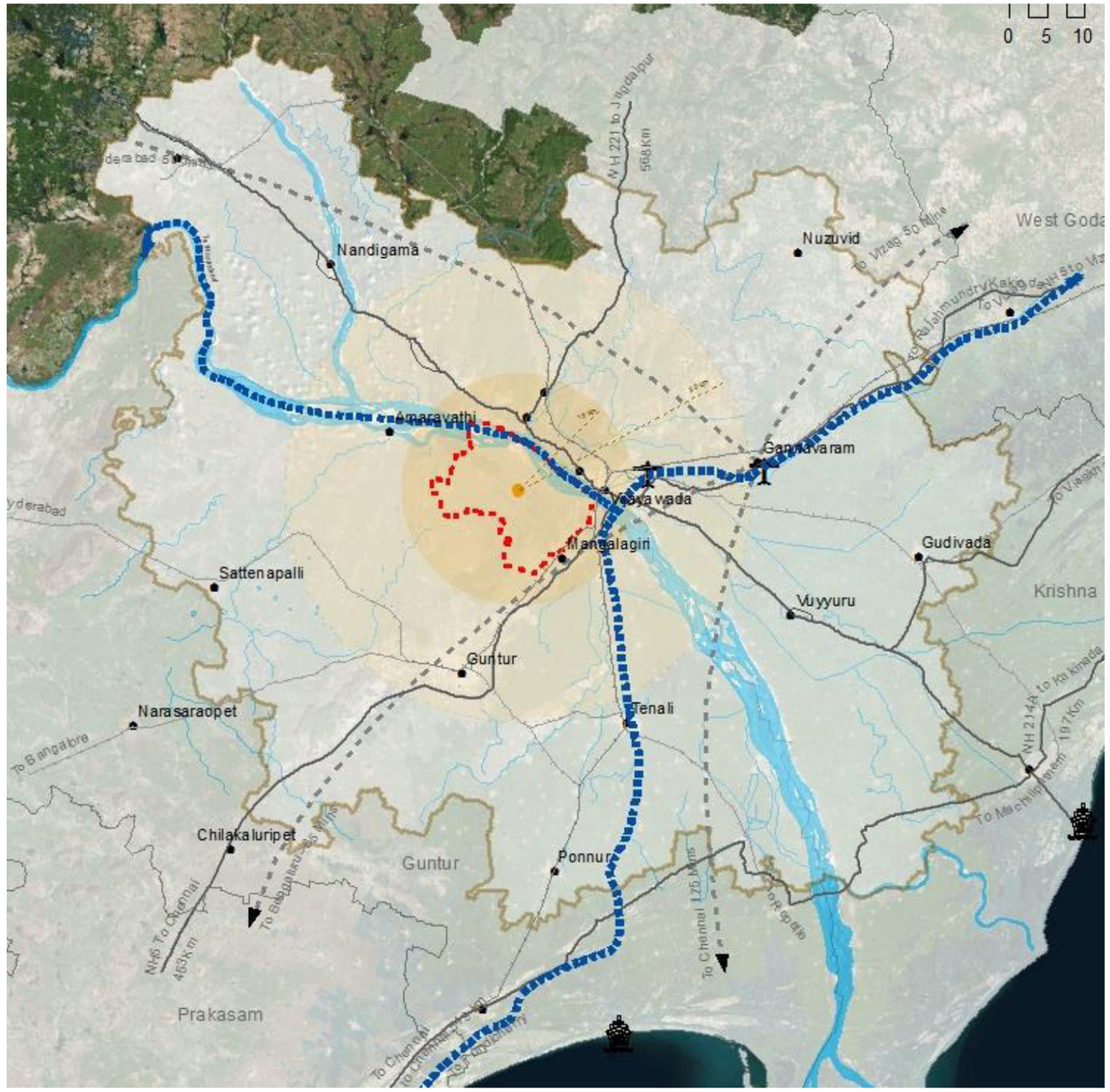

Fig.3.7 National Waterway and Air port within Capital Region

Fig.3.8 Ports in the vicinity of the Capital Region

The Capital City is located at the key intersection of National Waterway 4 and therefore is suitable for intermodal transport development.

In addition, Andhra Pradesh has 13 sea ports, along its coast line, and has the second-highest cargo-handling port in India. Visakhapatnam port (Fig.3.8) handled 67 million tonnes of freight in 2011-12.

Machilipatnam Port is a re-established port located at a distance of 72 km to the east of Vijayawada[2]. It is intended for freight transport to Vijayawada and Hyderabad. It is currently linked to Vijayawada by rail. An extension may also be implemented to connect the Capital Region of Andhra Pradesh to this port.

Key Issues

- Lack of strategies to utilize the under-developed canals and rivers
- Need to strengthen link between road, rail and water transport

Opportunities

The establishment of the National Waterways provides an opportunity for the Capital Region to develop a water-road/rail freight hubs.

There is potential for the freight traffic to be transported via canal to the Capital City, and then transferred to Machilipatnam for export, and vice-versa.

The use of transport/logistics hubs to maximize mode transfer from water to rail or road can be done where these intersect.

2 Department of Ports, Government of Andhra Pradesh, 2011

Koneru center, the business center of Machilipatnam

3.1.6 PUBLIC TRANSPORT

Existing Conditions

Public transport is the pre-dominant mode of motorized local travel in cities in Andhra Pradesh. This comes in the form of bus, auto and cycle rickshaws. These modes play a significant role in existing road congestion.

The Andhra Pradesh State Road Transport Corporation (APSRTC) runs thousands of buses connecting different parts of the state. APSRTC operates in all cities and towns of Andhra Pradesh and also operates from and to the neighbouring states, such as to Chennai, Hyderabad and Bangalore. APSRTC serves about 14 million passengers every day.

In addition, the Bus Rapid Transit System (BRTS), which has been successfully launched in Indian cities like Delhi, Pune, Ahmedabad, and internationally in Curitiba, Bogota, and Mexico, was launched in Vijayawada in 2008. Six BRTS corridors were proposed. Phase 1, as shown in Fig.3.9 has a total length of 15.5 km.

The BRTS was planned before the consideration of the new Capital City, and therefore there is opportunity to expand and/or incorporate the BRTS to the new Capital City, as well as to satellite cities in the Capital Region.

There is currently no integrated public transportation plan for the Andhra Pradesh Region.

Key Issues

- Congestion due to existing public transport systems may hinder efforts to successfully implement a BRTS system
- Need to introduce other modes of public transportation such as mass transit and light rail
- Need for an integrated public transportation plan for the region to link Capital City and Regional Centers

Opportunities

Obsolete public transport systems such as cycle rickshaws need to be phased out. By doing so, existing congestion may be reduced, thereby easing the implementation of BRTS.

Mass transit systems will be required in the long run to meet the projected public transport demand.

A comprehensive Public Transportation Plan needs to be prepared to guide the planning and development of public transport both at the regional and city level.

Transport hubs integrating these modes (BRTS, mass transit) with the other modes such as rail and roads can be established around the Capital City to ease modal transfer.

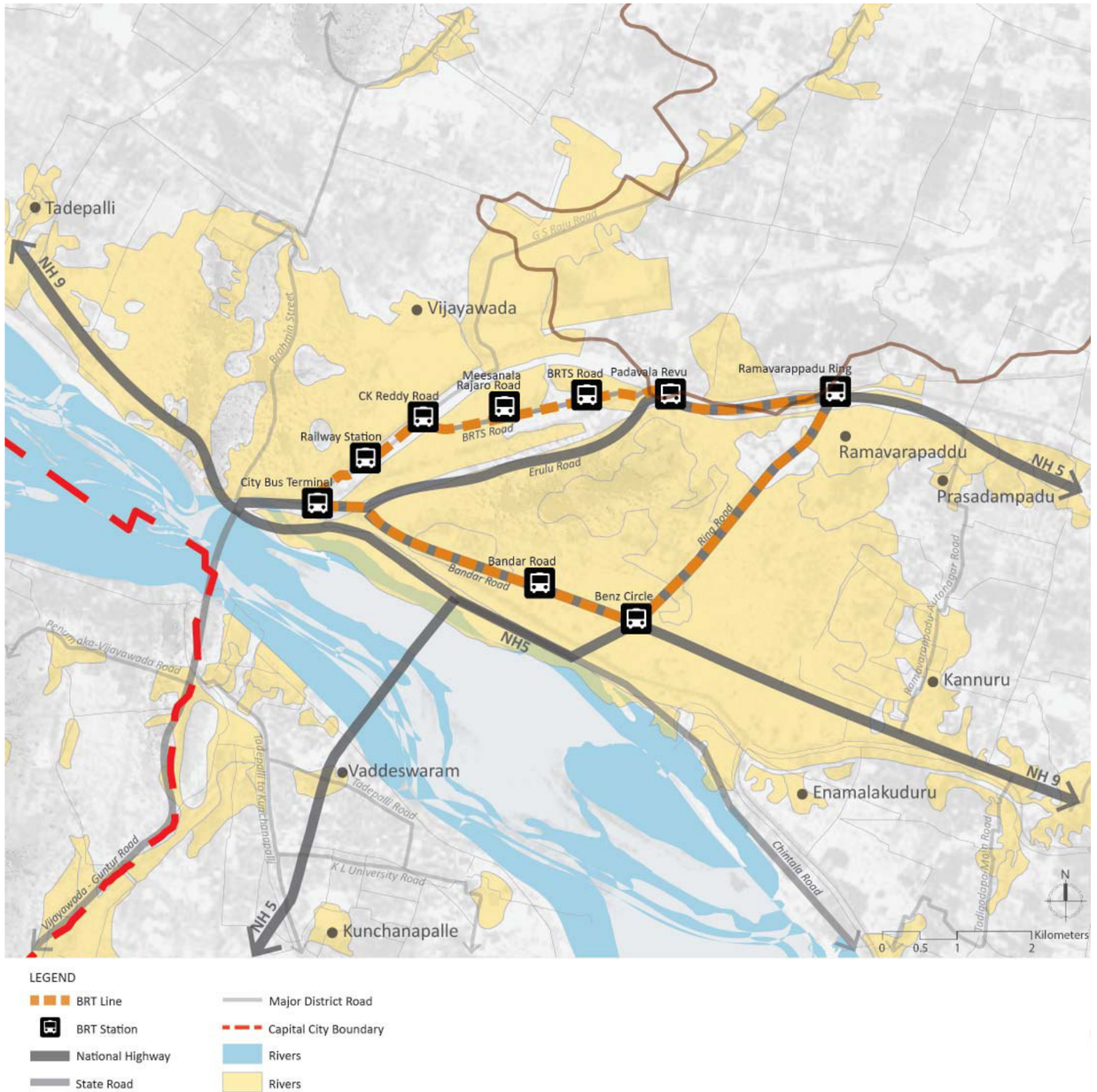

Fig.3.9 BRTS in Vijayawada Phase 1 (The Municipal Corporation of Vijayawada, 2014)

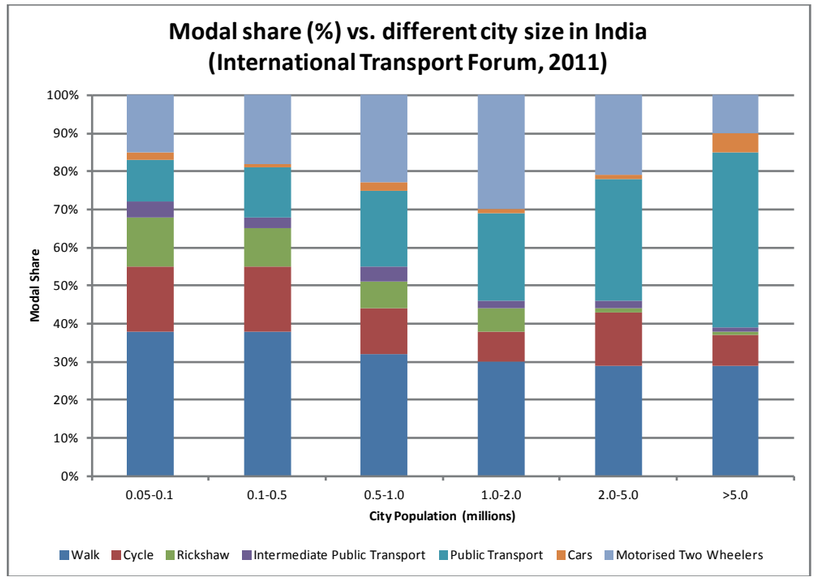

Fig.3.10 Modal Share in Cities of Different Sizes in India (International Transport Forum, 2011)

Existing Pedestrian Infrastructure in Vijayawada

3.1.7 NON MOTORIZED TRANSPORT

Existing Conditions

Non-Motorized Transport (NMT) modal share in the cities in India is the highest among all transport modes. Fig 3.14 shows that walking is the predominant mode for cities with population less than 2 million; however public transport share is higher for cities with population larger than 2 million.

Dedicated non-motorized transport facilities are not prevalent in the existing road infrastructure. Footpaths and pedestrian crossings are provided only in some of the urban areas.

A Wilbur Smith study for the Ministry of Urban Development has found that in most of the cities in India, less than 30% of the roads have pedestrian footpaths. As a result, many pedestrians currently walk along the road, while cyclists share the same road space as motorized vehicles.

The current engineering guidelines for pedestrian facilities do not meet the needs of pedestrians. Pedestrian and cycling network plans have not been produced for any city in Andhra Pradesh.

In a recent joint study of University of Michigan and Indian Institute of Technology, Delhi, shows that in India, road traffic fatalities have been increasing at about 8% annually for the last ten years. In Andhra Pradesh, pedestrians and cyclists accidents were the highest in 2006 and 2007. [1]

There is need to develop road design guidelines that cater not only for vehicular traffic, but for NMT traffic too.

There is also low awareness of pedestrian safety in Andhra Pradesh. There is need to promote pedestrian and cyclist safety, while providing road infrastructure with better safety features.

1 Transportation Research Board , 2010

Overflowing Footpath on Bandar Road in Vijayawada

Key Issues

- Traffic-related deaths are high
- Pedestrian and cycling links are not readily available city-wide
- No integration plans with other transport networks
- Need for campaigns and promotion of NMT
- Need to provide NMT safety features in new road design

Opportunities

In the new Capital City plan, greenfield conditions allow the design of NMT-friendly cross-sections which can be reproduced in the Capital Region.

A pedestrian and cycling network plan is to be produced at City-level to safeguard road reserves where necessary.

In addition, integration with other modes of transport (i.e. rail and public transport) can be provided by building NMT infrastructure along the infrastructure, for example cycle racks at bus stations etc.

3.1.8 KEY TRANSPORT ISSUES AND OPPORTUNITIES

Transport	Key Issues	Opportunities
Roads	• Heavy traffic congestion due to insufficient lane capacity • Connections within and outside the Capital Region depend solely on the two National Highways • Congestion at Prakasam Barrage due to high traffic demand across the Krishna River • Poor road quality and under-funded existing road maintenance leading to deterioration of roads	• Capital City's central location is ideal as a distribution hub to Chennai, Visakhapatnam and Hyderabad • Bypass roads to be introduced to relieve congestion in the future Capital City and to allow bypass traffic to circulate around the region unimpeded • Greenfield site allows adoption and implementation of comprehensive road hierarchy and controls in plot access • Long term strategic plans to help safeguard road reserves, and identify key alignments for development
Rail	• Development of dedicated freight corridors may introduce significant freight through-traffic at Vijayawada Junction • Congestion at Vijayawada Junction • Introduction of High-speed rail • Need to separate freight and passenger traffic • Need for additional rail crossing along Krishna River to alleviate pressure on Vijayawada Station	• The provision of a bypass freight corridor to remove freight through-traffic from Vijayawada Junction • New rail corridors crossing Krishna River to provide alternatives to the existing crossing • Transport Hubs to be introduced to disperse commuter traffic • The High-Speed Rail station to be located within the new Capital City
Aviation	• Small land area may limit future airport expansion • Inadequate facilities to handle freight logistics • Infrequent public transport services to and from Vijayawada, and other neighbouring cities	• Additional land may be reserved for future expansion in the strategic plans • Freight logistics facilities may also be developed to accommodate cargo growth • The airport may be developed as a transport hub to support better public transport connectivity to nearby towns and the new Capital City.
Water Transport	• Lack of strategies to utilize the under-developed shallow canals and rivers • Need to strengthen link between road, rail and water transport • Seasonal river flow	• Capital Region to develop a water-road/rail freight hubs. • Freight traffic to be transported via canal to the Capital City and then by rail to sea • Long-term strategic plans to encourage inland water transportation to relieve the busy road and rail network
Public Transport	• Congestion due to existing public transport systems may hinder efforts to successfully implement a BRTS system • Need to launch other modern modes of public transportation such as urban mass rapid transit and light rail • Need for an integrated public transportation plan for the region to link Capital City and Regional Centers	• Phasing out of obsolete public transport systems such as cycle rickshaws • A comprehensive Public Transportation Plan to be prepared to guide the planning and development of public transport both at the regional and city level • Mass transit systems to be planned to meet the projected public transport demand
Non-motorized Transport	• Pedestrian and cycling links are not readily available city-wide; • No integration plans of NMT with other transport networks; • Need for campaigns and promotion of NMT • Need to provide NMT safety features in new road design	• Design of NMT-friendly cross-sections in future road network • A pedestrian and cycling network plan to be produced at City-level to safeguard road reserves where necessary • Integration with other modes of transport (i.e. rail and public transport) can be provided by building NMT infrastructure

3.2 INFRASTRUCTURE

The following documentation have been reviewed to understand the existing conditions and key issues in Andhra Pradesh Capital Region:-

- National Disaster Management Guidelines: Management of Flood
- Report of Working Group on Flooding Management and Region Specific Issues FOR XII Plan
- National Rural Drinking Water Programme
- District Level Household and Facility Survey 2007-2008
- Vijayawada City Development Plan
- Guntur City Development Plan 2006

While many of the issues have been identified in these studies, there is no central authority to manage and implement the strategies identified in these documents.

As previously identified, the Andhra Pradesh Infrastructure Development Enabling Act has provided a framework to funding for these projects, however due to lack of focus many programmes may not be initiated. Additionally there are opportunities to obtain benefits for several aspects via a combined development plan, for example the National Waterways development plans can also be developed as part of the Flood Management Plan, as well as the Water Supply plan, by means of detention basins etc.

Krishna River during monsoon

3.2.1 WATER SUPPLY

Existing Conditions

Water supply is a state responsibility. There are three authorities sharing this responsibility for Andhra Pradesh Capital Region (Capital Region) currently:-

- Guntur Municipal Corporation (GMC), which supplies potable water to the Guntur city and two rural settlements Koritipadu and Pedakakani and part of surrounding villages as delineated by VGTM Urban Development Authority (VGTMUDA).
- Vijayawada Municipal Corporation (VMC), which supplies potable water to the Vijayawada city and the surrounding villages.
- Ministry of Drinking Water and Sanitation, which is in charge of the rural areas within Capital Region.

Water supply resource:

There are two main water sources in Capital Region as follows:

- Surface Water - Krishna River was dammed up to create the Prakasam barrage and the associated canals, such as Buckingham Canal and Bandar Canal.
- Ground Water - Ground water is commonly used in the upland areas in Guntur District. Most of the places in Guntur and Krishna Districts depend on Krishna River for their drinking water demand. As pointed out in Vijayawada City Development Plan, only 26% of water is ground water while the rest are extracted from Krishna River.

Water Supply network

Capital Region has a general water network for urban areas such as Guntur city and Vijayawada city, consists of water treatment plants, service reservoirs, pumping stations and water pipelines.

The piped water supply network is inadequate in Capital Region. As reported in the City Development Plan of both Guntur and Vijayawada, water network covers 88% of Vijayawada city area and 77% of Guntur city. Surrounding zones only have 30% network coverage. Although the water supply network coverage is more than 75% in urban areas, only 27 % of the city households are connected to piped water supply network.

The high un-accounted water loss is 25% in Guntur and 40% in Vijayawada, and up to 50% in rural township. These water loss are mostly caused by illegal tapping, leaking pipes due to aging water infrastructure and unrecorded usage as some houses are not installed with bulk meter. Portable water supply duration varies from one hour to 24 hours a day. Situation of rural areas is even worse. The uncovered area is being supplied through water tankers, or utilize boreholes, canal water, river water etc, for their water supply.

There are 4 recorded Water Treatment Plants (WTP) in Capital Region, build next to their sources. All WTPs mainly serve the urban area of Guntur city and Vijayawada city.

After primary treatment at source, surface water is pumped into the service reservoirs and water tanks. Ground water extracted from the bore wells is pumped into the Over Head Tanks (OHT) directly.

Water quality

Quality of the water supplied by the VMC is maintained as per specifications of CPHEEO manual as reported in the Vijayawada City Development Plan. Portable water supplied by GMC are treated through chlorination plants and tested by the Chloroscope apparatus at random places everyday, as reported in the Guntur City Development Plan. The water quality of the rest areas in Capital Region is unknown.

Key issues

- Lack of comprehensive master plan in Water Supply Scheme for Capital Region to implement.
- Lack of water supply network distribution in rural areas.
- High un-accounted water loss, 25-40% in the urban area and up to 50% in rural township.
- Inadequate water supply distribution. The supply duration varies from one hour to 24 hours a day.
- High level of illegal connections

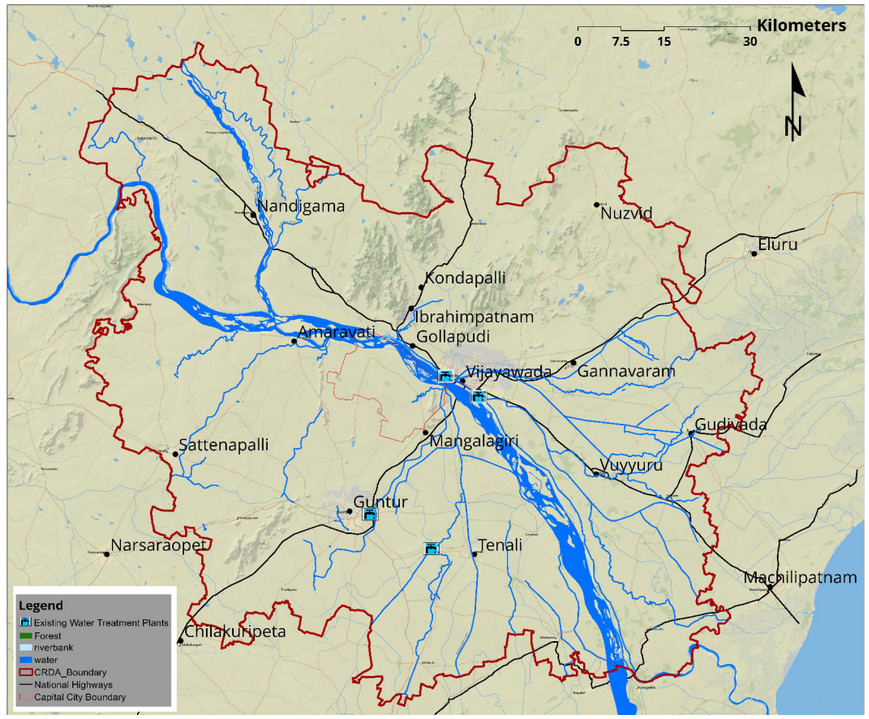

Fig.3.11 Krishna River, its Tributaries and Canal Systems, and Water Supply Sources

Table 3.3 Existing Water Works in Capital Region

No.	Name	Source	Capacity (MGD)	Capacity (MLD)	Owner
1	KL Rao Head Water Works	Krishna River	29	131.8	VMC
2	Ramalingeshwar Nagar	Krishna River	10	45.5	VMC
3	Takkellapadu Plant gravity filtration plant	Guntur Channel	10	45.5	GMC
4	Sangam Jagarlamudi Rapid gravity filtration plant	Kommamur Canal	6	27.3	GMC

3.2.2 WASTE WATER

Existing Conditions

Sanitation type

Base on the Household Facility Survey 2007-20008, in Andhra Pradesh State, 38.4% households have access to sanitation facilities, including improved source of sanitation, flush toilets not collected by sewers/septic pits/ twin pits, pits without slab and dry toilets. The rest 61.6% have no toilet and take the use of open space. Households in Capital Region has a better accessibility compare to the state, 52.2% household in Guntur district and 60.3% household in Krishna district have the access to sanitation facilities.

Under Ground Drainage System (UGD)

There is an existing UGD network in urban areas of Capital Region designed to collect the sewerage. However, the UGD network distribution is insufficient as it only covers partially in the urban area. In Guntur city, only 22% of the city area and 32% population is served by the existing UGD sewerage system. Within the UGD coverage area, only 13% households are connected to sewerage network. In Vijayawada, 40% of the city area is connected the existing UGD sewerage system while only 10% households can access to sewerage connection (City Development Plan).

In the areas without UGD, the sanitation is being maintained though individual septic tanks and open drains. Most of the waste water disposal is being transferred through open drains to the nearest water bodies directly. Open drains were designed to carry storm water and no separation is provided for the sewage and storm water. Untreated sewerage poses a major risk to human health since it contains waterborne pathogens that can cause serious illness. Therefore, an integrated master plan of sewerage treatment network is required in Capital Region.

Operation and Maintenance

Aging sewerage infrastructures, such as pipe incrustation and pumping corrosion, have been stated in the City Development Report of Vijayawada. It is not reported any authority is taking charge the maintenance of open drains.

Sewage Treatment Plants (STP)

There are 5 recorded STP's operating in Capital Region. VMC managed four STP's with a total capacity of 61.27 MLD. GMC owns and manages the Sudapalli Donka STP with capacity of 34 MLD. This STP has become almost defunct and the effluent standards after this plant are not as per standards and this plant is to be revamped immediately. Reported in the Vijayawada City Development Plan, the total sewage generation in VMC is estimated to be 148MLD, less than half sewage is treated properly. There is a necessity to commission additional STP to treat the remaining sewage before disposal.

Key Issues

- No comprehensive master plan in UGD scheme for Capital Region to implement.
- Suddapalli Donka STP is reaching its life span but no new STP is proposed to serve the GMC areas alternatively.
- Less than 40% of city area is covered by UDG system.
- Less than 15% of households can access to the sewerage connection.
- Not enough STP's are provided to treat the total generated sewerage.
- Potential risks to human health caused by untreated sewage.
- Lack of maintenance for UGD and open drains.

Table 3.4 Existing Sewage Treatment Plant Capacity in Capital Region

No.	Location of STP	Capacity (MLD)	Owner
1	Azithsinghnagar	27.27	VMC
2	Autonagar	10	VMC
3	Ramalingeswara Nagar	10	VMC
4	Poornanandampet	14	VMC
5	Suddapalli Donka	34	GMC

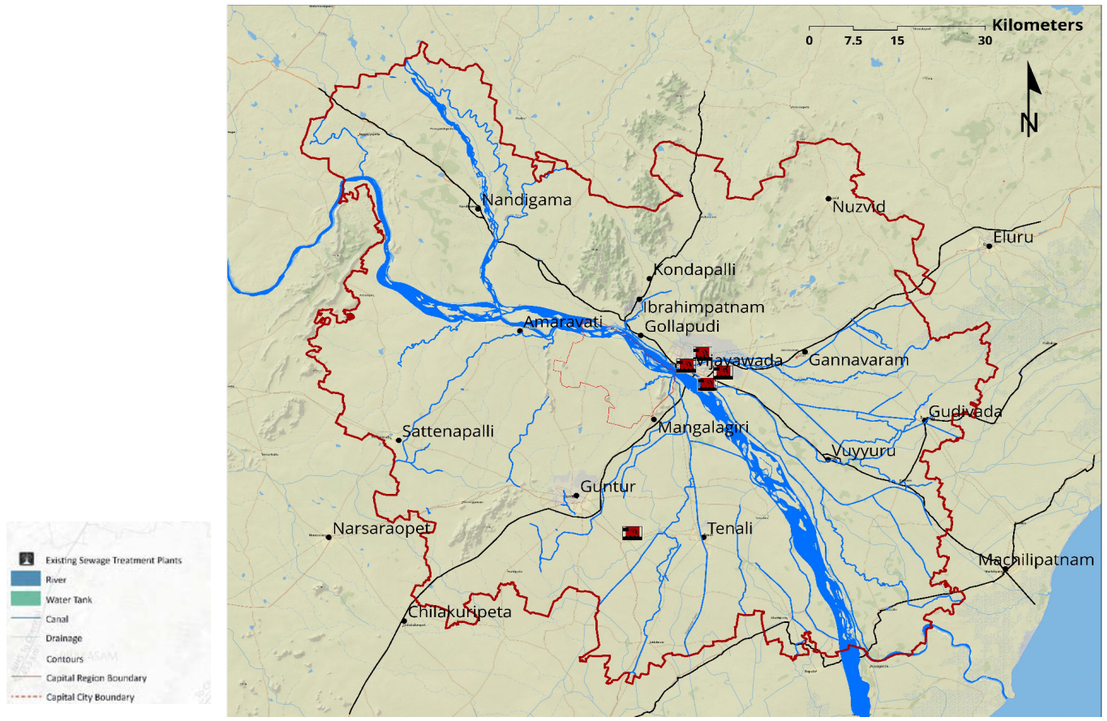

Fig.3.12 Existing Sewage Treatment Plant Locations in Capital Region

3.2.3 STORM WATER

Annual Rainfall

Rainfall varies considerably across the Andhra Pradesh. Annual rainfall of Capital Region ranges from 800 to 1200 mm. In Guntur district, the average rainfall is 830 mm, experienced mostly by both southwest monsoon and the retreating monsoon. Annual rainfall in Krishna district is 1028 mm, mainly contributed by the southwest monsoon.

Drainage Network

Capital Region is located at the downstream of the Krishna Basin. The catchment basin forms part of the Krishna River catchment area. There are several irrigation canals flowing across Capital Region from the Krishna River, such as Buckingham Canal, Eluru Canal, Ryves Canal, Bandar Canal, among others. These water canals contribute in draining the surface run-off, and are referred as the major drainage networks in Capital Region.

Primitive open drains and shallow ditches are used to carry storm water in both rural and urban areas of Capital Region. However, they are currently also used as sewers which collect the waste water disposal. No segregation is provided for sewage and storm water, except in some city areas where underground drainage exists. The polluted storm water discharge is threatening the water quality of water bodies as well as the surrounding environment.

Flood Prone Areas

As reported by the National Disaster Management department, Capital Region is vulnerable to heavy rains and floods. Flood prone areas are identified in Fig.3.13. 7% area in Capital Region is highly prone to flood, 31% is prone to flood and 43% is moderately prone to flood. By analyzing the moderate to high risk flooding areas in Capital Region, the factors that cause flooding are heavy rainfall, rise in river level, tidal water and problems of canals and drains. Cyclone is also a factor, but it occurs at very low frequency.

Existing Flood Management

Different methods have been adopted to reduce the flood losses and protect the flood plains. However, the current condition of integrated storm water management is unknown. Regarding to the Report of Working Group on Flooding Management, these measures can be classified as engineering method and non-engineering method.

1. Engineering methods, which are used in flood protection. It does not reduce the total flood volume but reduce spilling.

The existing Prakasam Barrage stretches 1223.5 m across the Krishna River connecting Krishna districts and Guntur district. This Barrage not only helps irrigating over 1.2 million acres of land, but also acts as a forecast station in terms of flooding control.
Nagarjuna Sagar Dam is an upstream dam of Krishna River, located outside the Capital Region. Nagarjuna Sagar Dam has an associated reservoir located 21km downstream, namely Nagarjuna Sagar tail pond. These two upstream dams can be used as flood control structure to control the total volume flow into Capital Region. Large amount of water can be stored at upstream dams during periods of high discharges in the river and released after the critical high flow condition is over.

2. Non-engineering methods, which are used to mitigate the flood damage.

In India, flood forecasting and warning is entrusted with the Central Water Commission (CWC). Krishna river systems have 3 Level Forecasting stations and 6 Inflow Forecasting stations, all issued by CWC. The Level forecasts help the relative agencies in deciding mitigating methods, such as evacuation of people and shifting people to safer locations. The Inflow Forecasting is used in optimum operation of reservoirs. It is also used to ensure adequate storage in the reservoirs for meeting demand during non-monsoon period.

Apart from CWC, Andhra Pradesh State owns a Flood Unit, which prepares rainfall maps and basin-wise volume estimation within the state during monsoon period.

National Disaster Management Guideline of Flood Management

This guideline is published by National Disaster Management Authority and Government of India in January 2008. It sets a direction to minimize vulnerability to floods and consequent loss of lives, livelihood systems, property and damage to infrastructure and public utilities.

Key Issues

- Lack of integrated storm water management and centralized coordination in the storm water drainage along Krishna River.
- Lack of proper storm water drainage network in both urban and rural area.
- No separation between sewage and storm water in the areas without underground waste water drainage.
- Insufficient open drains and canals in the flood prone area

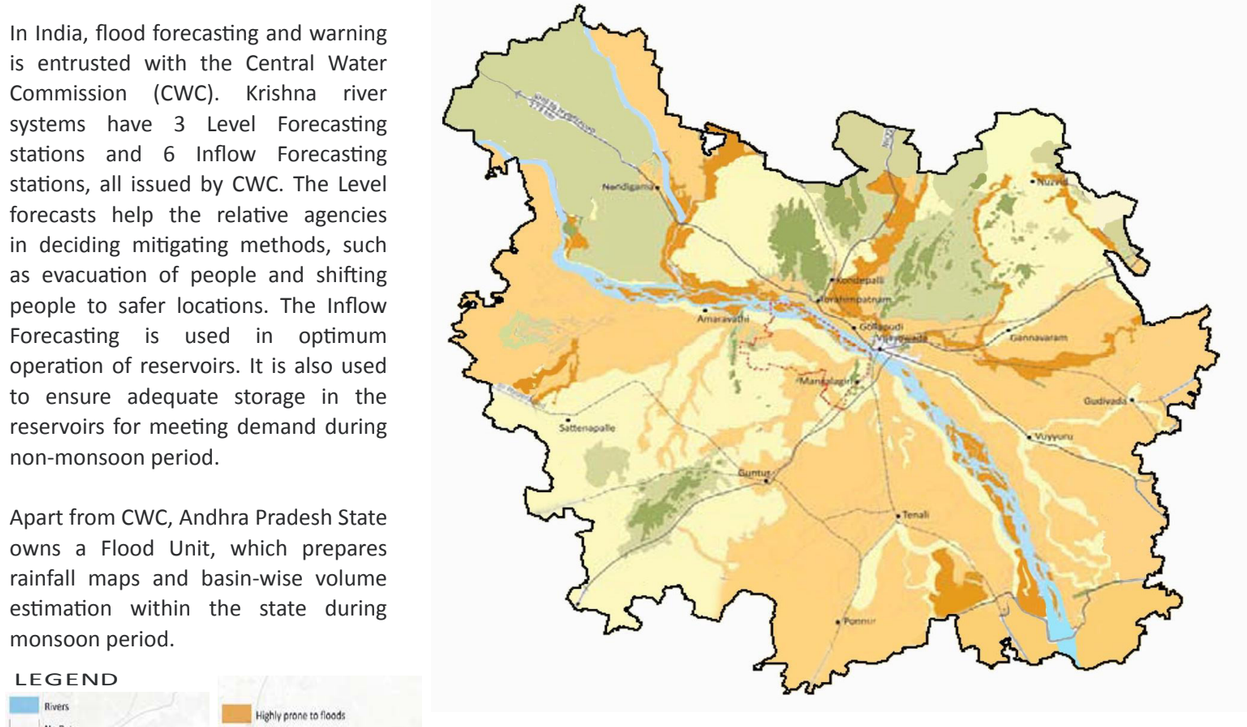

Fig.3.13 Flood Map of Capital Region

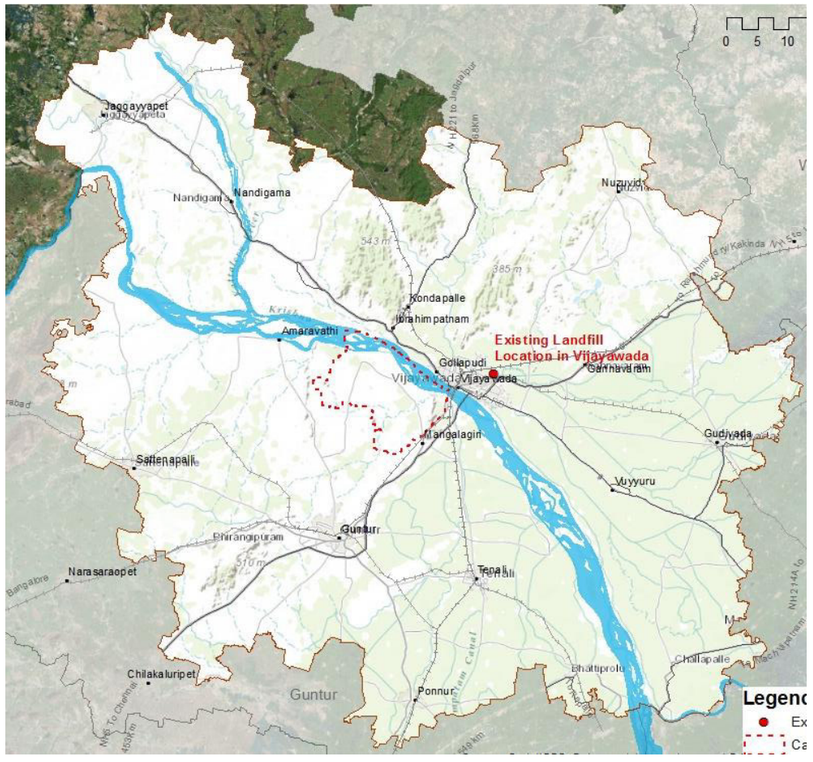

Fig.3.14 Location of known Sold Waste facilities in Capital Region

3.2.4 SOLID WASTE

Existing Condition

Waste Generation

The City Development plans for Vijayawada and Guntur reports a waste collection efficiency of over 87% in urban areas. 604.2 tons of solid waste is generated everyday. In Guntur city, 350 tons/d of solid waste is generated. The waste generation rate is about 600 gms/cap./day. Around 70% of the urban solid waste is bio-degradable. The remaining of waste after extracting the recyclable portion is disposed to open dump yard. Bio-degradable waste is transferred to relative industries for manure and power generation.

Waste Collection

The waste is collected from dust bins, street sweeping, cleaning of drains, and transfer through tricycles to reinforced concrete bins. Further transportation through tractors and dumper placers to the dumping yards located outside the city. The VMC has handed over the collection of solid waste in hilly areas to private parties in the city, i.e. DWACUA and CMEY.

Waste Disposal

Currently there is no landfill site in operation in Capital Region. The collected solid waste is dumped at villages on the fringes despite stiff opposition from the local residents. These dumping yards locate at Jakkampudi, Ajithsingh Nagar and Pathapadu[1]. It may cause serious health problems and groundwater pollution where the dumping yard is not treated properly.

Solid waste facilities were used to handle the municipal solid waste for a time. However, they were stopped due to both financial and technical issue. These facilities are listed in the following, and current conditions are unknown.

- Generation of Organic Manure Using Municipal Solid Waste (MSW) by Excel Industries Ltd - Excel plant was established in the year 1995 for manufacturing organic manure from municipal solid wastes. VMC used to transfer around 125 tons/day of waste to this plant, which was converted into organic manure. The compost plant can generate 30-40 tons of organic manure per day.
- 6MW Power Generation with MSW by Shriram Energy Systems Limited - The treatment plant operated by Shriram Energy Systems used to handle 225 tons/d. the solid waste was converted to RDF pellets which then loaded on to the boiler for burning along with other fuels to generate 6MW of power per day.
- Bio-Methanation Plant - 20 tons/day of vegetable waste and slaughterhouse waste is processed for Methane Gas and power generation at this Bio- Methanation Plant.

Future Plans

Solid Waste Management is one of the top priorities of the Government of Andhra Pradesh. The Commissioner & Director of Municipal Administration has submitted a draft Strategy on Andhra Pradesh Integrated Municipal Solid Waste Management, 2014 for approval.

This document outlines the strategies to be adopted by the Government to manage solid waste, and includes a framework such as 5Rs Hierarchy of Waste Management (Reduce, Reuse, Recycle, Recover and Remove) as the main approach to manage waste

Key Issues

- Lack of solid waste facilities serving the Capital Region.
- Potential contamination of ground water from non- engineering dumping yard.
- Inefficient collection and disposal in rural areas.
- Lack of rural waste generation data.

3.2.5 POWER SUPPLY

Existing Power Supply System in Andhra Pradesh

The state of Andhra Pradesh is located in the southern part of India and forms a major constituent of the southern grid.

Major electricity generation are via thermal and the hydro power plants, operated by Andhra Pradesh Power Generation Company (APGENCO).

In 2013, Andhra Pradesh was the fourth largest power generating state in the country and also had the largest hydro power generation capacity in India

At present, Andhra Pradesh has a total installed power generation capacity of 16,817 MW from all the sources. Of these, 11,771 MW is from thermal, 3,737 MW is from Hydro, 1,036 MW is from Renewable energy sources and 276 MW is from Nuclear.

Private players also have considerable presence in Andhra Pradesh. Private power plants operating in the state use transmission lines managed by Andhra Pradesh Transmission Company (APTRANCO) that looks after the transmission of electricity in the state.

The power generated by all power plants in Andhra Pradesh is being fed to the Southern Grid, which is accessible to all states linked to the grid.

The institutional structure of the electricity sector in Andhra Pradesh can be categorized into four main domains i.e. Regulation, Generation, Transmission and Distribution.

In Andhra Pradesh, Andhra Pradesh Electricity Regulatory Commission (APERC) look after regulation related matters, APGENCO is engaged in power generation, APTRANCO is mainly responsible for transmission and there are four electricity distribution companies, Eastern Power Distribution Corporation of AP Ltd , Southern Power Distribution Corporation of AP Ltd, Central Power Distribution Corporation of AP Ltd and Northern Power Distribution Corporation of AP Ltd managing distribution in four zones. of the State.

The major transmission lines in India are 500kV (HVDC), 765kV, 400kV, 220kV, 132kV. The local distribution lines are 11kV and 33kV.

Table 3.5 indicates the existing thermal power plant at Andhra Pradesh.

Table 3.5 Existing Power Plant and Capacity in Andhra Pradesh

Power Station	Location	District	Capacity (MW)
Ramagundam B TPS	Ramagundam	Karimnagar	62.5
Kothagudem TPS	Paloncha	Khammam	720
Kothagudem V Stage TPS	Paloncha	Khammam	500
Dr Narla Tatarao TPS	Ibrahimpatnam	Krishna	1760
Rayalassema TPS	Cuddapah	YSR Kadapa	840
Kakatiya TPS	Chelpur	Warangal	500
Ramagundam STPS	Jyothi Nagar	Karimnagar	2600
Simhadri STPS	Simhadri	Visakhapatnam	1000

Future Plans

There are 25 planned power generation projects in Andhra Pradesh, with capacity ranging from 70MW to 4000MW to serve the region and the surrounding states.

Key issues

The key issues of power sector are as follows:

- Increase in installed generation capacity was not commensurate with the increase in demand.
- Plant Load Factor of thermal stations was decreased to 78% by FY 2013-14 leading to frequent outages particularly during monsoon season.
- Loss of power generation due to low coal stock in Thermal Power Plants
- Improper maintenance of Distribution Infrastructure such as Substations. Feeders, Distribution Transformers, Poles and Wires.
- Untapped renewable energy sector

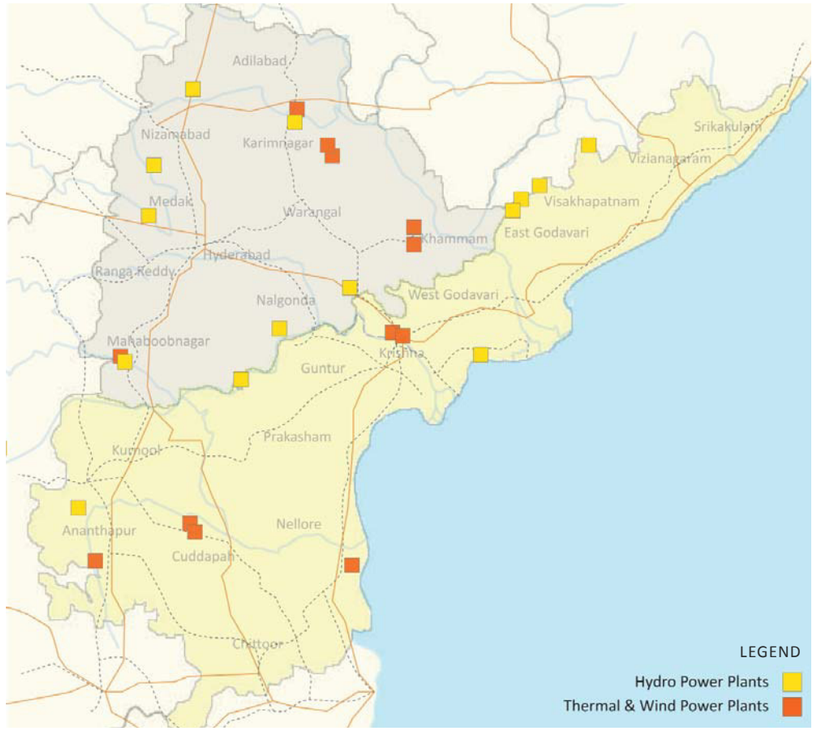

Fig.3.15 Location of Thermal Power Plants in Andhra Pradesh and Telangana

Kakatiya Thermal Power Plant, Andhra Pradesh

3.2.6 KEY INFRASTRUCTURE ISSUES AND OPPORTUNITIES

	Key Issues	Opportunities
Water Supply	• Lack of comprehensive master plan in Water Supply Scheme for Capital Region to implement. • Lack of water supply network distribution in rural areas. • High un-accounted water loss, 25-40% in the urban area and up to 50% in rural township. • Inadequate water supply distribution. The supply duration varies from one hour to 24 hours a day. • High level of illegal connections	• An integrated water supply scheme for Capital Region, including water conservation and water demand management strategies. • Opportunity for expansion and upgrading of water supply infrastructure, to enhance the water supply network, and to reduce high un-accounted water losses in the new capital. • Introduce alternative water sources, including treated waste water effluent and storm water from rainwater harvesting.
Waste water	• No comprehensive master plan in UGD scheme for Capital Region to implement. • Suddapallis Donka STP is reaching its life span but no new STP is proposed to serve the GMC areas alternatively. • Less than 40% of city area is covered by UDG system. • Less than 15% of households can access to the sewerage connection. • Not enough STP's are provided to treat the total generated sewerage. • Potential risks to human health caused by untreated sewage. • Lack of maintenance for UGD and open drains.	• Opportunity for expansion and upgrading the existing waste water collection infrastructures, to provide sufficient sanitation facilities and STP's in both rural and urban areas. • Introduce the concept of Environmental Treatment Zone (ETZ), isolate and treat all the unwanted waste far from the residential area and minimize contact between the residents and the waste.
Storm Water	• Unknown condition of integrated storm water management and centralized coordination in the storm water drainage planning amongst Guntur district and Krishna district. • Lack of proper storm water drainage network in both urban and rural area. • Potential water pollution caused by polluted discharge since no separation between sewage and storm water in the areas without UGD. • Insufficient open drains and canals in the flood prone areas.	• Opportunity for improving and expanding drainage network, including provide roadside drains for all roads and enhance the operation and maintenance for all canals. • Use of the Flood Protection Zone concept, green buffer such as grass land and woodland should be provided at the banks of the existing water bodies. • Implement the National Disaster Management Guideline of Flood Management, to minimize the vulnerability to floods. • Develop the Water Sensitive Urban Design (WSUD), to achieve a sustainable storm water system.
Solid Waste	• Lack of solid waste facilities serving the Capital Region. • Potential contamination of ground water from non- engineering dumping yard. • Inefficient collection and disposal in rural areas. • Lack of rural waste generation data.	• Implement the framework Andhra Pradesh Integrated Municipal Solid Waste Management, including the hierarchy of waste management (5R: reduce, reuse, recycle, recover and remove). • Opportunity to identify proper landfill site base on the ETZ concept in the Landuse Master plan.
Power Supply	• Increase in installed generation capacity was not commensurate with the increase in demand. • Plant Load Factor of thermal stations was decreased to 78% by FY 2013-14 leading to frequent outages particularly during monsoon season. • Loss of power generation due to low coal stock in Thermal Power Plants • Improper maintenance of Distribution Infrastructure such as Substations. Feeders, Distribution Transformers, Poles and Wires. • Untapped renewable energy sector	• Opportunity to develop renewable energy in the region • Solid Waste Management integration by developing biofuels etc in the ETZ • Introduce renewable energy power supply to the rural areas

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