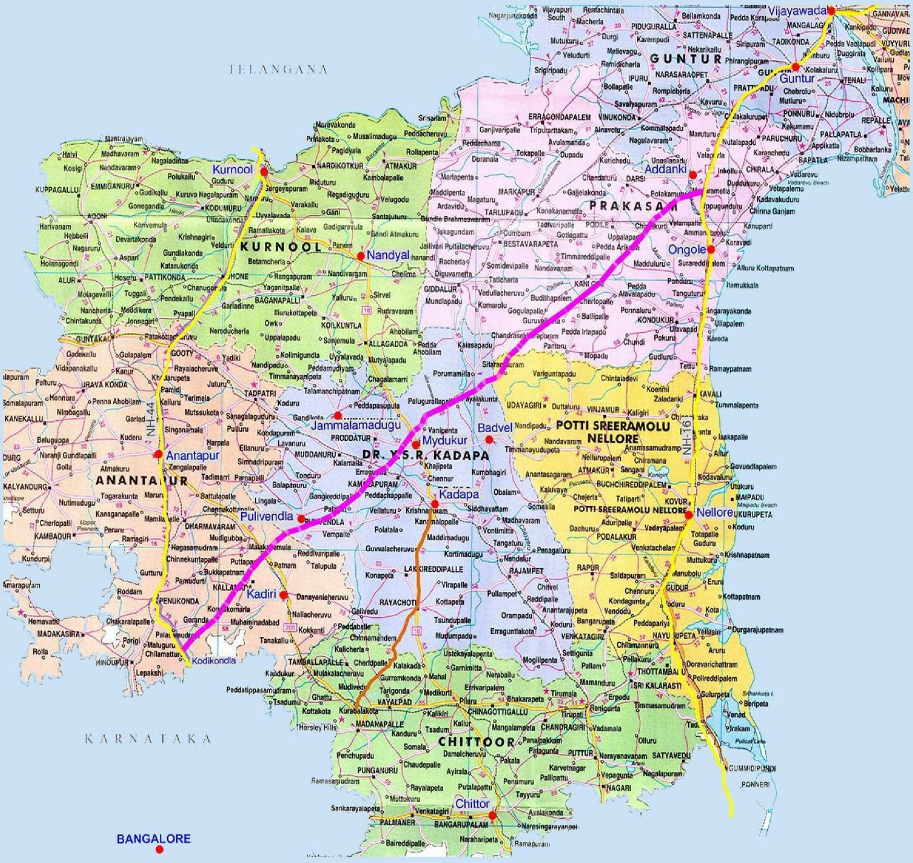
NATIONAL HIGHWAYS AUTHORITY OF INDIA
(MINISTRY OF ROAD TRANSPORT & HIGHWAYS)

CONSULTANCY SERVICES FOR PREPARATION OF DPR FOR DEVELOPMENT OF EXPRESSWAYS, ECONOMIC CORRIDORS AND INTER CORRIDORS UNDER BHARATMALA PARIYOJANA PHASE-II (LOT-10, PKG-4)

BANGALORE - MYDUKURU (KADAPA) - VIJAYAWADA (EXPRESSWAY)

&

KADAPA - MADANAPALLE (ECONOMIC CORRIDOR)



FEASIBILITY REPORT
(MAIN REPORT)

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1.0 Introduction

1.1 General

The ***National Highway Authority of India*** (herein after referred to as the "Authority" or "NHAI") is engaged in the development of the National Highways under the scheme of Bharatmala Pariyojana.

Bharatmala Pariyojana is a new umbrella program for the highways sector that focuses on optimizing efficiency of freight and passenger movement across the country by bridging critical infrastructure gaps through effective interventions like development of Economic Corridors, Inter Corridors and Feeder Routes, National Corridor Efficiency Improvement, Border and International connectivity roads, Coastal and Port connectivity roads and Green-field expressways.

A total of around 24,800 kms are being considered in Phase-I of Bharatmala. In addition, Bharatmala Pariyojana phase -I also includes 10,000 kms of balance road works under NHDP, taking the total to 34,800 kms. Bharatmala Phase I - is being implemented over a period of five years i.e. 2017-18 to 2021-22.

The second phase of the Bharatmala programme has been announced on 21st January 2021. In this phase it has been aimed that 5,000 km of projects are planned to be constructed and Detailed Project Reports (DPRs) are being prepared prior to the approval of the projects so as to speed up the implementation process.

As part of this endeavour, NHAI has decided to undertake the project namely "Consultancy services for preparation of DPR for development of Expressways, Economic Corridors and Inter Corridors under Bharatmala Pariyojana - Phase II (Lot-10/Package -4: Bengaluru – Kadappa - Vijayawada)".

In order to fulfil the above task, the National Highway Authority of India has appointed *M/s Aarvee Associates Architects Engineers & Consultants Pvt. Ltd.* to provide services for the above-mentioned project. The agreement was signed on 07th July 2021 and commencement of services was issued on 22nd July 2021.

1.2 Project Location

As per ToR, the scope of the consultancy services comprises of two stretches. Madanepalle – Kadappa section and the other Bangalore – Vijayawada (Amaravati). The first one will be developed as Economic Corridor and the later one will be developed as expressway standards. Details of the same as per RFP are furnished in ***Table-1.1***.

Table-1.1: List of Project Stretches

S. No	Name of Stretch	Name of Corridor	State	Type of Corridor
1	Madanpalle - Kadappa	Bengaluru - Kadappa - Vijaywada	Andhra Pradesh	BM-2 EC
2	Mydukur (Kadappa) - Amravati - AAE Part 1/2			BM-2 EXP

The stretch from Madanapalle to Kadapa will make use of the existing alignment with bypasses and realignments wherever necessary. On the other hand, the stretch from Mydukuru to Amaravathi has been reviewed by the Client based on different alternatives presented to them and the same has been revised as green field expressway with starting point near Kodikonda (Andhra / Karnataka border) on NH-44 and transiting via Myudukur and Porumamilla and terminating at Addanki / Medarametla on NH-16.

Table-1.2: List of Modified Project Stretches

S. No.	Name of Stretch	Name of Corridor	State	Type of Corridor
1	Madanpalle - Kadappa	Bengaluru - Kadapa - Vijaywada	Andhra Pradesh	BM-2 EC
2	Kodikonda - Pulivendula - Mydukur - Mallepalli - Vangapadu - Kanigiri - Addanki			BM-2 EXP

Location Map of the project corridors are shown in **Figure-1.1**.

Figure-1.1: Location Map of the Proposed Greenfield Project Corridor (Bengalore-Kadapa-Vijayawada Expressway)

1.3 Objective of the Study

The main objective of the consultancy service is to establish the technical, economical and financial viability of the project and prepare detailed project reports of the greenfield expressway by considering the investment requirements and financial return through toll and other revenues. The List of Objectives is Listed hereunder:

- Conducting the detailed Engineering surveys & Investigations
- Study of alternative alignment options to finalize the alignment by taking into account the applicable geometric standards, ecology & environment, drainage pattern etc.
- Forecast the traffic demand on project stretch by conducting necessary volume count and origin-destination studies giving due weightage to the future development proposals along the project stretch
- Design the pavement along the project stretch using respective IRC codes
- Design of Bridges/ Cross drainage structures and grade separated structures
- Develop General Arrangement Drawings (GAD's) of structures for assessment of quantities
- Identify the Initial Social Impact Assessment by broadly identifying and assessing the extent of private lands to be acquired and the government lands/ forest land to be proposed for division
- Identifying the Initial Environmental Impact Assessment based on available reports and by assessing the levels of pollution from projected traffic on the project highway
- Preparation of BOQs, Rate analysis and cost estimates based on prevailing market rates and SSR
- Prepare the economic and financial analysis of the project by bringing out the project packaging and various feasible procurement alternatives
- Preparation of Land Acquisition Plans, Utility relocation plans along with strip plans
- Obtain necessary forest and environmental clearances
- Submission of necessary Bid/ Contractual documents

1.4 Intent of the Report

Final Detailed Project Report is the next milestone, after Draft Detailed Project Report, among the agreed deliverables of the project. The key objective of the Final Detailed Project Report is to finalize the development proposals, their cost and viability of the project.

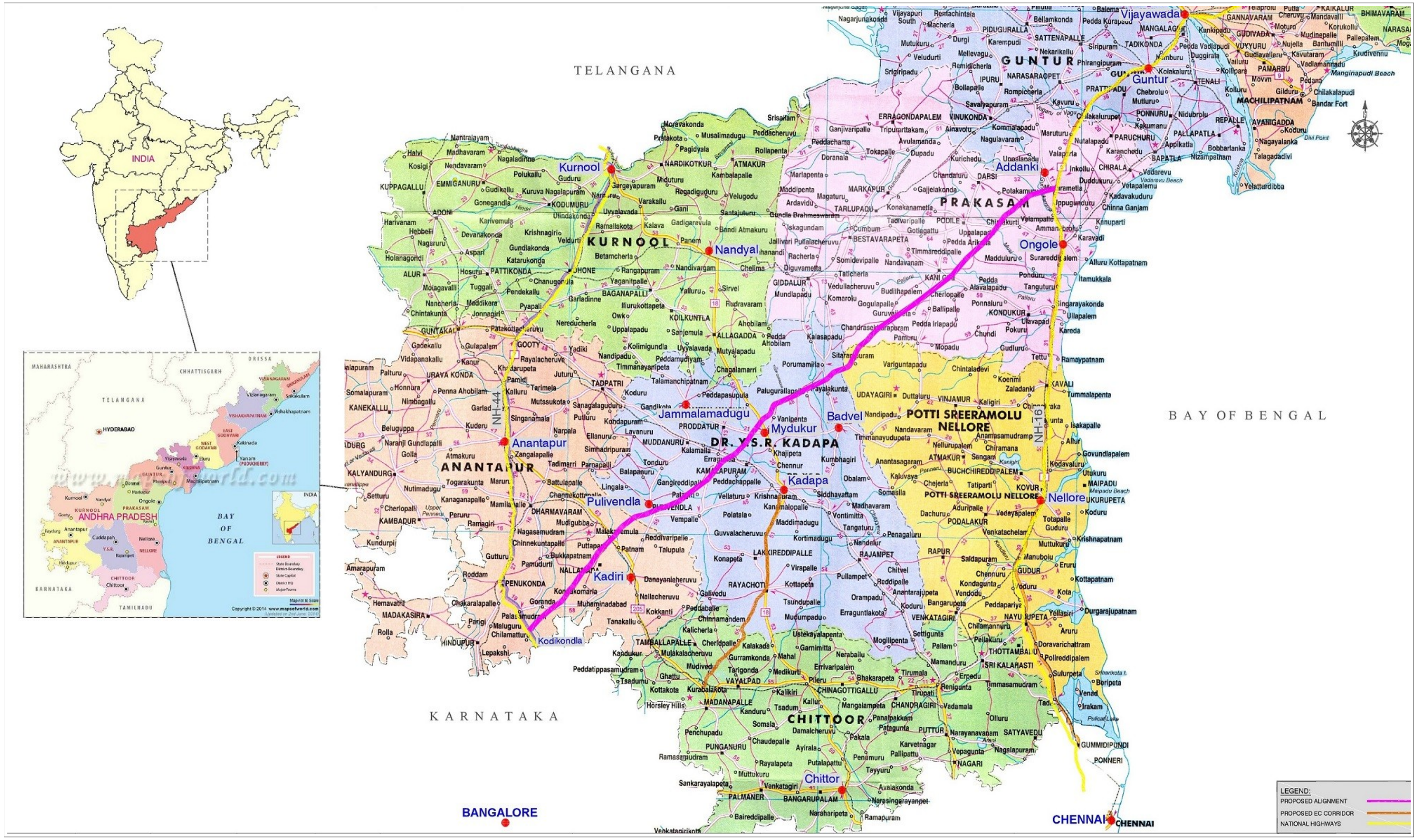


Figure-1.2: Index Map of the Proposed Greenfield Project Corridor (Bengalore-Kadapa-Vijayawada Expressway)

1.5 Benefits of Proposed Expressway

A quick connection is formed, in the form of an expressway, between Rayalaseema and coastal Andhra Pradesh regions. Travel time from Bengalore to Medarametla will get reduced thus providing a faster connectivity to the people of the region to reach the Vijaywada city.

- Bengaluru to Vijayawada: Distance reduces by 120 km, Travel time reduces 4.30 hrs
- Strategically located between Bengaluru and Amaravathi, Rayalaseema region benefits hugely in terms of attracting industrial/ commercial investments and promoting tourism. This in turn will change the economic face of the region from scratch to prosperity.
- The backward Rayalaseema region will be ready for a rapid industrialization owing to the industrial corridor along the Bengaluru - Chennai & Bengaluru - Vijayawada national highways. In the long run, the corridor will support the region's growing population and will spur the creation of huge employment in the region as well as the economic development of Andhra Pradesh.
- The project falls in line with the iconic goal of Andhra Pradesh to become Gateway of India on East coast.
- The project would be a signal that Andhra Pradesh is open to innovative partnerships that are beneficial for both the government and for private sector interests.

1.6 Scope of the Study

The scope of the services to be rendered essentially involves detailed designs based on field visits and engineering surveys. As per ToR, the scope of the current study is listed as under:

- ✔ Engineering surveys and investigations
- ✔ Highway & Structural design
- ✔ Environmental and Social Impact Assessment
- ✔ Estimation of Project Cost
- ✔ Economic & Financial Analysis
- ✔ Preparation of Feasibility study report and Detailed Project Report
- ✔ Preparation of Land Acquisition Plans
- ✔ Preparation of Bid Documents
- ✔ Obtain necessary Forest/ Environmental and Utility Clearances, etc.

- Review of all available reports and published information about the project road and the project influence area.
- Possible locations and design of toll plaza shall be studied. Wayside amenities required on tolled highway shall also be planned. The local and slow traffic may need segregation from the main traffic and provision of service roads and fencing may be considered, wherever necessary to improve efficiency and safety.
- All ready to implement 'good for construction' drawings shall be prepared.
- Environmental Impact Assessment, Environmental Management Plan and Rehabilitation and Resettlement Studies shall be carried out by the Consultant meeting the requirements of the lending agencies like ADB/ World Bank/ JICA etc.
- Public consultation, including consultation with communities located along the road, NGOs working in the area, other stake holders and relevant Government Departments at all the different stages of assignment.

- Liaison shall be carried out with concerned authorities and arrange all clarifications. Approval of all drawings including GAD and detail engineering drawings shall be got done from the Railways. However, if Railways require proof checking of the drawings prepared by the consultants, the same shall be got done by NHAI.
- Traffic studies including traffic surveys and Axle load survey and demand forecasting for next thirty years.
- Detailed topographic surveys using LIDAR equipped with minimum engineering grade system or any other better technology having output accuracy not less than

  (a) Specified in *IRC:SP-19*

  (b) Total Station

  (c) GPS/ DGPS

The use of conventional high precision instruments i.e, Total Station or equivalent can be used at locations such as major bypasses, water bodies etc. where it may not be possible to survey using LIDAR.

- Investigation of required sub-grade and subsoil characteristics and strength for road and embankment design and sub soil investigation.
- Identification of sources of construction materials.
- Detailed design of road, its cross-sections, horizontal and vertical alignment and design of embankment and also in poor soil conditions and where density consideration require, even lesser height embankment. Detailed design of structures preparation of GAD and construction drawings and cross-drainage structures and underpasses etc.
- Identification of the type and the design of intersections.
- Identification and design of grade separated interchanges
- Economic and financial analysis.
- Contract packaging and implementation schedule.
- To find out financial viability of project for implementation and suggest the preferred mode on which the project is to be taken up.
- Preparation of detailed project report, cost estimate, approved for construction Drawings, rate analysis, detailed bill of quantities, bid documents for execution of civil works through budgeting resources.
- Preparation of social plans for the project affected people as per policy of the

lending agencies / Govt. of India R&R Policy.

- Final approval shall be obtained from Ministry of Environment and Forest for all applicable clearances.
- Estimates for shifting of utilities of all types involved from concerned local authorities as well as NHAI shall be incorporated.
- All Land Acquisition plans (i.e, all necessary schedules as per L.A. act) shall be prepared for acquisition of land either under NH Act or State Act.
- Bid Documents, based on the feasibility report, shall be prepared due to exigency of the project for execution.
- All types of necessary clearances, which are required for implementation of the project on the ground, shall be obtained from the concerned agencies. The client shall provide the necessary supporting letters and any official fees as per the demand note issued by such concerned agencies from whom the clearances are being sought to enable implementation.
- Separate documents for BoT as well as EPC contracts at Feasibility stage/ DPR stage shall be prepared. The studies for financing options like BoT, Annuity, EPC shall be undertaken in feasibility study stage.
- Bid documents including required schedules (as mentioned above) shall be prepared as per EPC/ PPP documents.
- Furthermore, assistance shall be extended to the NHAI and their Financial Consultant and Legal Advisor by furnishing clarifications as required for the financial appraisal and legal scrutiny of the Project Highway and Bid Documents.
- The authority shall be supported in responding to all technical queries, and shall ensure participation of senior team members during all interaction with potential bidders including pre-bid conference, meetings, site visits etc. In addition, support shall be extended for preparation of detailed responses to the written queries raised by the bidders.
- During field studies, investigations and designs, the development plans being implemented or proposed for future implementation by the local bodies/ authorities concerned with the proposed expressway, shall be taken into account. They shall be duly reflected in the reports and drawings.
- All activities related to field studies, design and documentation shall be done as per the latest guidelines/ circulars of MoRT&H and relevant publications of IRC & BIS, in consultation with NHAI as desired.
- The details of utility services and other physical features shall be documented

in detail in the Feasibility report.

- New technologies and construction materials for the design and construction of the project with respect to economic consideration, shall be proposed.

1.7 Approach

The consultant's approach towards the project is in accordance to the ToR in lines with the project objectives. The prescribed engineering surveys and investigations will be carried out on project stretch conforming to MoRT&H/IRC/BIS specifications/Codes/Bharatmala guidelines as per ToR to generate adequate database for preparing the most appropriate proposal for the proposed expressway.

1.8 Outcome of Current Study

The Final Detailed Project Report assists in predicting the workability and effectiveness of highway after its implementation. The viability of the project will be established taking into account the requirements with regards to rehabilitation, upgrading and improvement based on highway design, pavement design, provision of service roads wherever necessary, type of intersections, structures, road safety features, quantities of various items of works and cost estimates and economic analysis.

1.9 Schedule of Deliverables

As per Terms of Reference (ToR) of Contract Agreement the following documents have to be prepared and submitted to the NHAI

S. No	Stage	Type of Reports/Submission
1	Stage-I	Draft Inception Report including QAP document
		Final Inception Report including QAP document
		Preliminary Alignment Report
2	Stage-II	Final Alignment Report
		Draft Feasibility Report
		Final Feasibility Report
3	Stage-III	Strip Plan & Clearances
		Land Acquisition Report-I
		Utility Relocation Plans
		Clearances Report-I
4	Stage-IV	Draft Detailed Project Report (DDPR) including Drawings
		Final Detailed Project Report (FDPR) including Drawings

S. No	Stage	Type of Reports/Submission
5	Stage-V	Bid Documents & Technical Schedules
6	Stage-VI	LA & Clearances II Report
7	Stage-VII	Award Determination Report
8	Stage-VIII	Land Possession Report

1.10 Structure of the Reports

The Draft Feasibility Reports has been presented in Volumes to cover all the details on road design, social and environmental aspects etc. These are as follows:

Volume-I : Main Report	
E	Executive Summary
1	Introduction
2	Overview about NHAI
3	Project Background
4	Alignment Alternatives Report
5	Methodology
6	Socio-Economic Profile of the Project Corridor
7	Indicative Design Standards, Methodologies and Specifications
8	Traffic Surveys & Analysis
9	Pavement Design Report
10	Environmental Screening and Preliminary Environmental Assessment
11	Initial Social Assessment and Preliminary Land Acquisition/ Resettlement Plan
12	Improvement Proposals
13	Cost estimates based on preliminary rate analysis and bill of quantities
14	Cost analysis of all alternate identified alignments
15	Economic analysis
16	Financial analysis
17	Technical Specifications
18	Conclusions and Recommendations
	Annexures

Volume-II : Investigation Reports	
1	Introduction
2	Road Inventory Report
3	Structural Inventory
	Annexures
Volume-III : Material Investigation Report	
Volume-IV : Technical Specifications	
Volume-V : Rate Analysis	
Volume-VI : Cost Estimates	
Volume-VII : Bill of Quantities	
Volume-VIII : Drawings (Highway Standard Drawings and PnPs	

Note:-

(i) Terminologies like *"Project road", "Project stretch", "Project corridor", "greenfield alignment", "greenfield expressway"* and *"Proposed expressway"* may be treated as synonyms to the proposed Bengaluru-Kadapa-Vijayawada Expressway road

(ii) Terms like "Main Line" may be considered as synonym for Bengaluru-Kadapa-Vijayawada corridor

(iii) Terms like *"Ananthapuramu"* and *"Anantapur"* may be considered as synonyms to each other

(iv) LHS & RHS, with respect to individual corridors, shall be considered from Kodikonda to Medarametla

(v) All Chainages mentioned in this report refer to Design Chainage unless otherwise specified

2.0 Overview of NHAI

VISION STATEMENT OF NHAI

"To meet the nation's need for the provision and maintenance of National Highways network to global standards and to meet user's expectations in the most time bound and cost effective manner, within the strategic policy framework set by the Government of India (GoI) and thus promote economic well being and quality of life of the people."

2.1 Introduction

National Highways Authority of India (NHAI) is an autonomous organization under the Ministry of Road Transport & Highways and was constituted by an act of Parliament, the National Highways Authority of India Act, 1988. NHAI is responsible for the Development, Maintenance, and Management of National Highways and for matters concerned thereto. The authority was made operational with the appointment of full time Chairman and other Members in the year 1995.

The first and foremost mandate for NHAI was the construction and development of five road stretches in the states of Haryana, Rajasthan, Bihar, West Bengal and Andhra Pradesh under loan assistance from Asian Development Bank(ADB). Subsequently, development works for other highway stretches were entrusted to NHAI. Its main objective is to ensure that all contract awards and procurement's conform to the best industry practices with regard to transparency of process, adoption of bid criteria to ensure healthy competition in award of contracts, implementation of projects conform to best quality requirements and the highway system is maintained to ensure best user comfort, safety and convenience.

NHAI is mandated to implement National Highways Development Project (NHDP) which is India's largest ever Highways Project. Presently National Highway network of about 1,15,435 km serve as the main road network of the country. Even though National Highways constitute only about 2% of the length of all roads, they carry about 40% of the road traffic. Rapid expansion of passenger and freight traffic makes it imperative to improve the road network in the country.

Accordingly, Government of India(GoI) launched major initiatives to upgrade and strengthen National Highways through various phases of NHDP. Recently, the government of India has planned to end the NHDP program in early 2018 and consume the ongoing projects under a gigantic Bharatmala project.

NHAI along with the Government of India and other institutions and authorities are working towards implementing the changes and reforms to achieve the target of building 20km per day.

2.2 Organization Chart

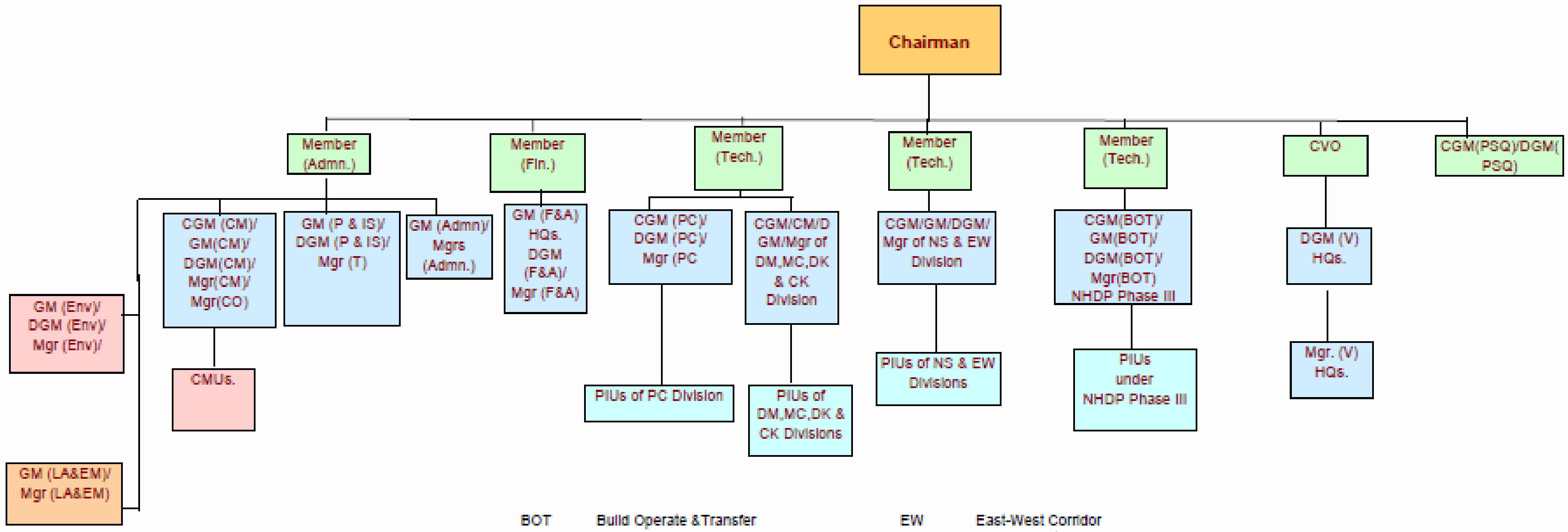
As per the National Highways Authority of India Act 1988, the Authority shall consist of a Chairman, not more than five full-time Members and not more than four part time Members, to be appointed by Central Government.

The Organizational Structure of the Authority is as shown below. The total manpower strength of the Authority under various categories, as on 31.03.2017 is as under:

Table-2.1: Total Manpower of the Authority

Group Post	Total No. of Employees	Regular	Deputation	Contract
A	556	286	260	10
B	259	21	6	232
C	161	11	0	150
D	1	1	0	0
Total	977	319	266	392

Organizational Structure of the NHAI



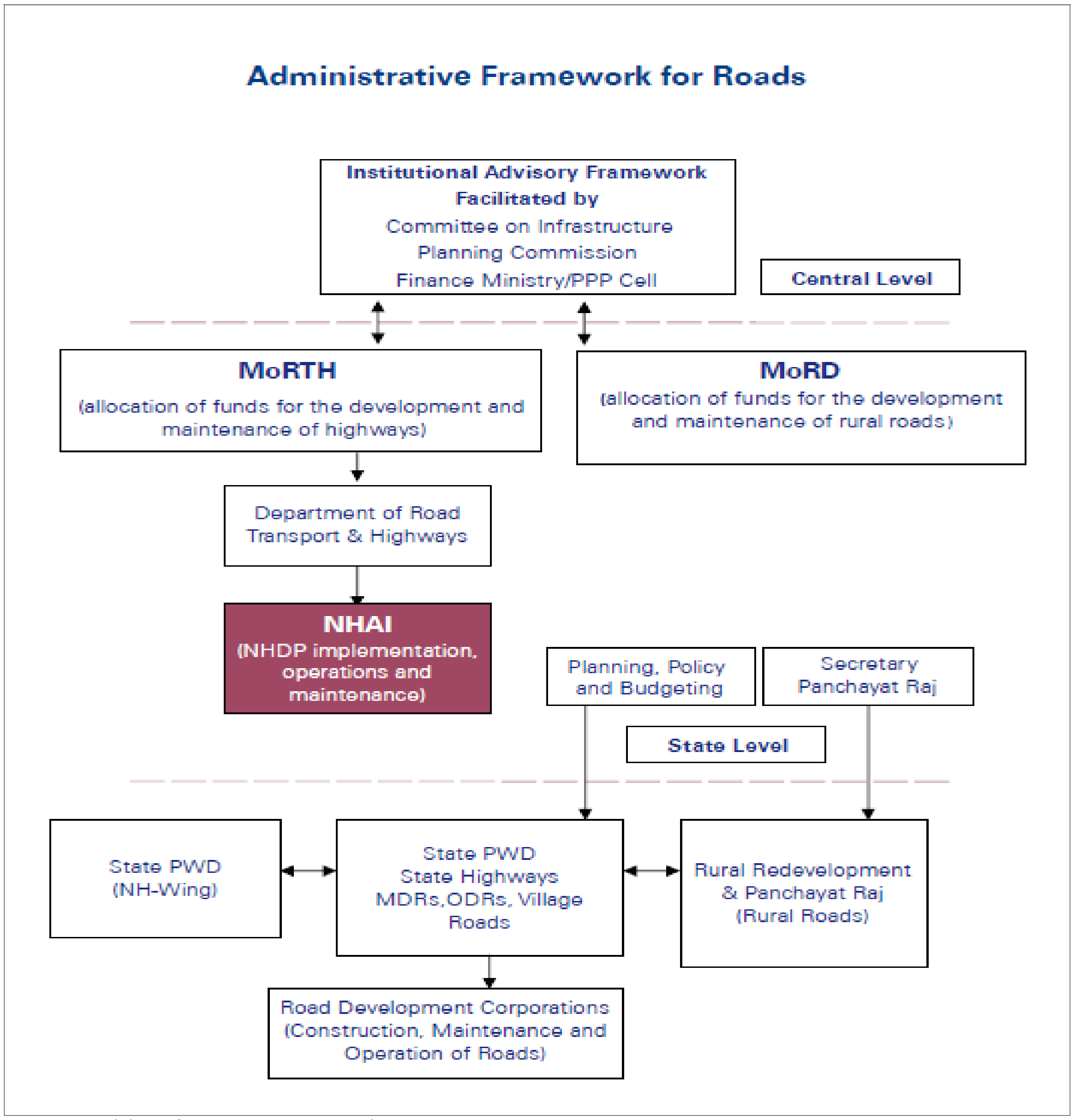
BOT	Build Operate &Transfer	EW	East-West Corridor
CGM	Chief General Manager	Env	Environment
CK	Chennai-Kolkata Section of GQ	F&A	Finance and Account
CM	Corridor Management	GM	General Manager
CMU	Corridor Management Unit	GQ	Golden Quadilateral
CO	Commercial Operations	L&EM	Land Acquisition & Estate Management
CVO	Chief Vigilance Officer	MC	Mumbai-Chennai Section of GQ
DGM	Deputy General Manager	P&IS	Planning and Information Systems
DK	Delhi-Kolkata Section of GQ	PC	Port Connectivity
DM	Delhi Mumbai Section of GQ	NS	North-South Corridor
PIU	Project Implementation Unit		

2.3 National Highways

National Highways (NH) are the main highways which traverses through the overall length and width of the country connecting the National and State capitals, major ports and rail junctions and link up with border roads and foreign highways and serve as arterial roads for movement of passengers and goods. The total length of NH (including expressways) in the country is 1,15,435 km. While National Highways constitute only about 2% of the length of the country's road network, they carry about 40% of the road traffic. The first and the foremost task mandated to the NHAI is the implementation of NHDP – comprising of the Golden Quadrilateral and North-South & East-West Corridors.

As on March 31, 2017, out of the total 55,886 Km (7097 Km with Ministry of Road Transport & Highways) of National Highways that are planned to be developed and upgraded by NHAI, 39,581 Km of National Highways contracts have been awarded. Out of this 28,479 Km have been completed and work on 11,102 Km is in progress. Projects with a length of 9,208 Km are yet to be awarded for which the project preparations are in progress. About 65% of freight and 80% passenger traffic is carried by the roads.

NHAI is responsible for the implementation of National Highways Development Project (NHDP) and other agencies implement the Non – NHDP projects. The administrative framework for the road sector in India is given in the below figure:



Source: Guidelines for Investment in Road Sector – NHAI

2.4 Institutional Changes

The following are the major landmark changes in the institutional framework that facilitated the faster development of National Highways in India:

- National Highways Authority of India Act, 1988
- The National Highways (Collection of fees by any person for the use of section of National Highways / Permanent Bridge / Temporary Bridge – Public funded project) Rules, 1997
- The National Highways (Rate of fee) rules, 1997
- The National Highways Laws (Amendment) Act, 1997 to the National Highways Act, 1956 that facilitated Land acquisition under NH Act, 1956

- The control of National Highways (Land and Traffic) Act, 2002
- Duty waiver for import of equipment used in highway construction
- Tax concessions for private entrepreneurs, investments in Highway sector.

2.5 Funds for Highway Development and Maintenance

Traditionally, financing for development of National Highways in India was from the budgetary resources of the Government of India. In order to augment the available resources, loans have also been raised from multilateral agencies like World Bank, Asian Development Bank (ADB) and Japan Bank of International Cooperation (JBIC). Around 80 percent of the external assistance is provided to NHAI as a grant by the Central government. The balance is made available as long-term loans to NHAI, with the Centre bearing the foreign exchange risk. Such loans are usually provided for 15-25 years with a moratorium of 5 years. Total cost of NHDP has been estimated to be Rs. 54,000 Crores or US$ 13.2 billions whose components are as below:

Table-2.2: Likely sources of income of the Authority

Likely sources	Rs. Cr. (1999 prices)	US$ Billions (1999 prices)
Cess on Petrol and Diesel	20000	4.9
External assistance	20000	4.9
Market borrowings	10000	2.4
Private Sector Participation	4000	1

2.5.1 Central Road Fund (CRF)

In a historic decision, the Government of India introduced a cess on both Petrol and Diesel. This amount at that time (at 1999 prices) came to a total of approximately Rs. 2,000 crores per annum. Further, Parliament decreed that the fund so collected were to be put aside in a CRF for exclusive utilization for the development of a modern road network. The developmental work that it could be tapped to fund and the agencies to whom it was available were clearly defined as

- Construction and Maintenance of State Highways by State Governments
- Development of Rural Roads by State Governments
- Construction of Rail over- bridges by Indian Railway
- Construction and Maintenance of National Highways by NHDP and Ministry of Road Transport & Highways.

Today, the cess contributes between Rs 5 to 6 thousand crores per annum towards NHDP. The annual accruals on account of this increase are approximately Rs. 5,800 Crores and this amount is distributed among National Highways, State Roads, Roads of Economic Importance and Railways for taking up safety works such as ROBs, manning of level crossings etc. The share of the National Highways from the Central Road Fund is Rs. 2,000 Crores per annum.

2.5.2 Highway Infrastructure Bonds

Highway Infrastructure bonds are issued with benefits of tax savings for raising funds for NHAI.

Policy Initiatives for Attracting Private Investment:

- Government will carry out all preparatory work including land acquisition and utility shifting. Right of way (ROW) to be made available to concessionaires free from all encumbrances.
- NHAI / GOI to provide capital grant up to 40% of project cost to enhance viability on a case to case basis 100% tax exemption for 5 years and 30% relief for next 5 years, which may be availed of in 20 years.
- Concession period allowed up to 30 years
- Arbitration and Conciliation Act 1996 based on UNICITRAL provisions.
- In BOT projects entrepreneur is allowed to collect and retain tolls.
- Duty free import of specified modern high capacity equipment for highway construction.
- Foreign Direct Investment up to 100 % in road sector. Declaration of the road sector as an industry (Infrastructure as defined in section 18(1) (12) of the Infrastructure Act includes Roads).
- Easier external commercial borrowing norms.

2.5.3 Modes of Procurement

Broadly, modes of procurement adopted for implementation of highway projects may be classified into Public Private Partnership (PPP) and public funded projects. The details of modes of procurement's are given below: -

PPP PROJECTS: PPP projects are categorized into two types, namely, BOT (Toll) and BOT (Annuity).

BOT (TOLL) MODEL: Concessionaire is procured through steps of Request For Qualification (RFQ) and Request For Proposal (RFP). Construction, operation, maintenance and tolling responsibility rests with the Concessionaire during entire concession period, which is normally, between 20 to 30 year.

- In a BOT (Toll) Model, the concessionaire (private sector) is required to meet the upfront/construction cost and the expenditure on annual maintenance.
- The Concessionaire recovers the entire upfront/construction cost along with the interest and a return on investment out of the future toll collection.
- The viability of the project greatly depends on the traffic (i.e., toll). However, with a view to bridge the gap between the investment required and the gains arising out of it, i.e., to increase the viability of the projects, capital grant is also provided (up to a maximum of 40% of the project cost has been provided under NHDP).

BOT (ANNUITY) MODEL: Concessionaire is procured through steps of RFQ and RFP. Construction, operation and maintenance rest with the Concessionaire during the concession period. While toll is collected by the Authority through a bidding process, the developer receives annuity payments through the concession period.

(i) In an BOT (Annuity) Model, the Concessionaire (private sector) is required to meet the entire upfront/construction cost (no grant is paid by the client) and the expenditure on annual maintenance.

(ii) The Concessionaire recovers the entire investment and a pre-determined cost of return out of the annuities payable by the client every year.

(iii) The selection is made based on the least annuity quoted by the bidders (the concession period being fixed).The client (Government/NHAI) retains the risk with respect to traffic (toll), since the client collects the toll.

PRIVATE SECTOR PARTICIPATION:

- Major policy initiatives have been taken by the Government to attract foreign as well as domestic private investments. To promote involvement of the private sector in construction and maintenance of National Highways, Some Projects are offered on Build Operate and Transfer (BOT) basis to private agencies. After the concession period, which can range up to 30 years, this road is to be transferred back to NHAI by the Concessionaires
- NHAI funds are also leveraged by the setting up of Special Purpose Vehicles (SPVs).The SPVs will be borrowing funds and repaying these through toll revenues in the future. This model will also be tried in some other projects. Some more models may emerge in the near future for better leveraging of funds available with NHAI such as Annuity, which is a variant of BOT model.

PUBLIC FUNDED PROJECTS: The traditional mode of executing public funded projects was Item Rate Contract. This was prone to time and cost overruns. This mode has been replaced by New Engineering Procurement and Construction (EPC) contracts.

The projects which are not viable under BOT (Toll) mode, such as those in far flung areas would have to be done under EPC mode. Model EPC Contract Agreement has been finalized and implemented all across highway projects. Model EPC agreement relies on assigning the responsibility for investigations, design and construction to the contractor for a lump sum price determined through competitive bidding. Model EPC agreement incorporates international best practices and provides a sound contractual framework that specifies the allocation of risks and rewards, equity of obligations between Government and the Contractor, precision and predictability of costs, force majeure, termination and dispute resolution, apart from transparent and fair procedures.

2.6 Borrowings from Multi-Lateral Agencies

Borrowing from multi – lateral funding agencies such as ADB, World Bank and JBIC (OECF) is also one of the major sources for funding of Highway projects.

2.7 Cost Recovery Mechanisms and Finance Mechanism

The investments are being recovered either directly through tolls or indirectly through cess on petrol and diesel.

CESS: In a historic decision, the Government of India introduced a cess on both Petrol and Diesel. This amount at that time (at 1999 prices) came to a total of approximately Rs. 2,000 crores per annum. Further, Parliament decreed that the fund so collected were to be put aside in a Central Road Fund (CRF) for exclusive utilization for the development of a modern road network.

The current cess imposed on petrol and diesel to finance road projects is likely to stay at least for the next two decades. At least that is the recommendation of the special committee formed by Prime Minister Manmohan Singh to look into the problems of the Road Transport and Highways Ministry that had impeded the construction of national highways during the past five years in particular.

Set up under the Planning Commission, the B. K.Chaturvedi Committee, with secretaries of the Finance Department and the Road Transport and Highways Department as members, has come out with a suggestion that a written undertaking should be given to the National Highways Authority of India (NHAI) assuring that the fund received from the cess imposed would be continued. The Finance Ministry will be issuing a letter of comfort assuring the availability of cess-related funds till at least 2030-31. At present the cess imposed by the Finance Ministry on petrol and diesel is Rs. 2 and Re. 1, respectively. The money so raked in is used for financing road projects across the country.

The Centre also intends to guarantee cover to the borrowing plan of the NHAI. In principle it has approved the issuance of tax exempted bonds by the NHAI to raise finances, besides directing the Indian Infrastructure Finance Corporation Ltd. to set aside at least Rs. 10,000 crore for road projects from the Rs. 30,000-crore it has been permitted to borrow under the fiscal stimulus package.

It has also been decided to provide back-to-back support where necessary to the NHAI to avail itself of multilateral loans from the World Bank, the Asian Development Bank and the Japan Bank for International Cooperation (JBIC). The developmental work that it could be tapped to fund and the agencies to whom it was available were clearly defined as:

- Construction and Maintenance of State Highways by State Governments.
- Development of Rural Roads by State Governments
- Construction of Rail over- bridges by Indian Railways
- Construction and Maintenance of National Highways by NHDP and Ministry of Road Transport & Highways
- Today, the cess contributes between Rs 5 to 6 Thousands crores per annum towards NHDP

LOAN ASSISTANCE FROM INTERNATIONAL FUNDING AGENCIES: Loan assistance is available from multilateral development agencies like Asian Development Bank and World Bank or Other overseas lending agencies like Japanese Bank of International Cooperation.

MARKET BORROWING: NHAI proposes to tap the market by securities cess receipts.

PRIVATE SECTOR PARTICIPATION: Major policy initiatives have been taken by the Government to attract foreign as well as domestic private investments. To promote involvement of the private sector in construction and maintenance of National Highways, Some Projects are offered on Build Operate and Transfer (BOT) basis to private agencies. After the concession period, which can range up to 30 years, this road is to be transferred back to NHAI by the Concessionaires.

NHAI funds are also leveraged by the setting up of Special Purpose Vehicles (SPVs).The SPVs will be borrowing funds and repaying these through toll revenues in the future. This model will also be tried in some other projects. Some more models may emerge in the near future for better leveraging of funds available with NHAI such as Annuity, which is a variant of BOT model.

2.8 National Highways Development Project (NHDP)

The Government launched the National Highways Development Project (NHDP) to upgrade and strengthen National Highways through the various phases of NHDP being implemented by NHAI. The project-wise details NHDP all Phases as on 31.03.2017, is as follows:

Table 2.3: Project-wise details of the NHDP programme

Phase	Total length (Km)	4/6 laning completed	Under implementation	Balance for award
Golden Quadrilateral	5,846	5,846	0	0
North-South & East-West	7,142*	6,563	305	274
Port Connectivity & other Projects	2,479	2,117	362	0
NHDP Phase III	12,109#	7,507	2,357	1,945
NHDP Phase IV	20,000^	3,773	6,373	3,057
NHDP Phase V	6,500	2,544	1,424	2,532
NHDP Phase VI	1,000	0	184	816
NHDP Phase VII	700	22	94	584
SARDP-NE	110	107	3	0
TOTAL	**55,886**	**28,479**	**11,102**	**9,208**

* The original approved length of Corridors is 7300 km. The variation in the actual length of 7142 km from the original approved length of 7300 km is mainly on account of variation in the design length after preparation of DPRs.

11,809 Km is assigned to NHAI.

^ 13,203 Km is assigned to NHAI.

2.9 Bharatmala Pariyojana

2.9.1. Program at a glance: Bharatmala Pariyojana is a new umbrella program for the highways sector that focuses on optimizing efficiency of freight and passenger movement across the country by bridging critical infrastructure gaps through effective interventions like development of Economic Corridors, Inter Corridors and Feeder Routes, National Corridor Efficiency Improvement, Border and International connectivity roads, Coastal and Port connectivity roads and Green-field expressways. A total of around 24,800 kms are being considered in Phase I. In addition, Phase I also includes 10,000 kms of balance road works under NHDP. Estimated outlay for Phase I is Rs 5,35,000 crores spread over 5 years. The objective of the program is optimal resource allocation for a holistic highway development/improvement initiative.

2.9.2. Background: The NHDP has reached a certain level of maturity. It is now important to re-define road development and have a macro approach while planning expansion of the national highways network. The focus has to be on recasting road development by bridging critical infrastructure gaps. Hence Bharatmala has been launched as a new umbrella program whose primary focus is on optimizing the efficiency of the movement of goods and people across the country. This program envisages a corridor approach in place of the existing package-based approach which has, in many cases, resulted in skewed development. For instance, in areas of high traffic, even upto 30,000 Passenger Carrying Units (PCUs), there are NH stretches of single and even intermediate lane.

These have naturally become an impediment to seamless freight and passenger movement. Bharatmala will give the country 50 national corridors as opposed to the 6 we have at present. With this, 70 – 80 percent of freight will move along NH as against the 40 percent at present. The programme will help to connect 550 Districts in the country through NH linkages. Currently, only around 300 Districts have NH linkages. Bharatmala will also have a positive impact on the Logistic Performance Index (LPI) of the country. NHDP had aggregate length of 55,792 Km. Out of this, 30,108 Km have been completed already and another 4,900 Km will be completed this year.

The balance is 20,784 km against which projects for 6,399 Km are under implementation. Of the remaining 14,385 Km, 4,385 Km are a part of Bharatmala Component like Corridors/Expressways. Unfinished outstanding stretches of 10,000 Km will be subsumed in Bharatmala and implemented as an integrated program. The extensive experience gathered by MoRTH and its implementing agencies like NHAI in implementing NHDP shall be utilized in implementing Bharatmala.

2.9.3. Identification of project stretches under Bharatmala

Bharatmala focuses on enhanced effectiveness of already built infrastructure, multi–modal integration, bridging infrastructure gaps for seamless movement and integrating National and Economic Corridors. Identification of the project stretches under the components of the proposed program has been done based on detailed O-D(Origin-Destination) study, freight flow projections and verification of the identified infrastructure gaps through geo mapping, using data from Bhaskaracharya Institute for Space Applications and Geo-Informatics (BISAG) as well as from other sources. This O-D study has also taken into account integration of economic corridors with the ongoing projects under NHDP and infrastructure asymmetry in major corridors.

2.9.4. Bharatmala Phase I – components and outlay

Phase-I of Bharatmala shall be implemented over a period of five years i.e. 2017-18 to 2021-22. Summary of Phase I components and approved outlay are shown in **Table-2.1**. Components of Phase one are as follows:

ECONOMIC CORRIDORS: Economic corridor development program focuses on developing new corridors, in addition to existing Golden Quadrilateral (GQ) and North South-East West corridors (NS-EW). It is planned to develop these corridors end to end to ensure seamless and speedy travel and to ensure uniformity in standards in terms of speed, design of various elements of roads, control of accesses, way side amenities, road safety features, etc.

Once upgraded it will ensure substantial increase in speed and time of travel for both freight and passenger traffic at large across the country. Identified Highways Corridors of Economic importance are expected to carry 25% of freight in the coming years.

Once built, the National and Economic corridors along with their inter-corridor and feeder routes would be able to carry 80% of our freight traffic. Around 26,200 km of Economic corridors have been identified to be developed as Economic corridors out of which 9,000 kms are being taken up in Phase-I of Bharatmala.

INTER-CORRIDOR AND FEEDER ROADS TO NATIONAL AND ECONOMIC CORRIDORS: Stretches of roads connecting more than 2 corridors are classified as inter-corridors routes, while other routes connecting to 1 or 2 corridors are termed as feeder routes. Around 8,000 km of inter-corridors and around 7,500 km of feeder routes have been identified out of which 6,000 kms are being taken up in Phase-I of Bharatmala.

NATIONAL CORRIDORS EFFICIENCY IMPROVEMENT: The Golden-Quadrilateral and NS-EW, corridors carry 35% of India's freight and would be declared as National corridors. The average traffic in the 6 national corridors is >30,000 PCU. The 6/8 laning of these corridors would be done as per need. The National Corridors have developed choke points impacting logistics efficiency.

There is a requirement to build Ring Road and bypasses/ elevated corridors in addition to lane expansion to decongest these National Corridors. Further, Logistics Parks would also be developed at strategic locations to enhance logistics efficiency. A list of such identified locations of Logistics Parks is attached. Around 5,000 kms are being taken up under this category in Phase-I of Bharatmala.

BORDER AND INTERNATIONAL CONNECTIVITY ROADS: Around 3,300 km of border roads have been identified to be built along the international border for their strategic importance. Around 2,000 km of roads are required for connecting India"s major highway corridor to International trade points so as to facilitate Export-Import (EXIM) trade with our neighbors: Nepal, Bhutan, Bangladesh and Myanmar. Around 2,000 kms are being taken up under this category in Phase-I of Bharatmala.

COASTAL AND PORT CONNECTIVITY ROADS: Around 2,100 km of coastal roads have been identified to be built along the coast of India. These roads would boost both tourism and industrial development of the coastal region. Around 2,000 km of port connectivity roads have been identified to facilitate EXIM trade with an emphasis to improve connectivity to non-major ports. The roads identified have been synergized with the Sagarmala program. Around 2,000 kms are being taken up under this category in Phase-I of Bharatmala.

GREEN-FIELD EXPRESSWAYS: Certain sections of National and economic corridors have traffic exceeding 50,000 PCUs and have also developed several choke points. About 1,900 km of these stretches have been identified for development of green-field expressways. Around 800 kms are being taken up under this category in Phase-I of Bharatmala.

Table-2.4: Summary of Phase-I Components and Approved Outlay

S.No	Components	Length (Km)	Outlay (Rs crore)
a.	Economic corridors development	9,000	1,20,000
b.	Inter-corridor & feeder roads	6,000	80,000
c.	National Corridors Efficiency improvements	5,000	100,000
d.	Border & International connectivity roads	2,000	25,000
e.	Coastal & port connectivity roads	2,000	20,000
f.	Expressways	800	40,000
	Total	**24,800**	**385,000**
	Balance road works under NHDP	**10,000**	**1,50,000**
	Total	**34,800**	**5,35,000**

3.0 Inventory & Condition Surveys

The proposed project corridor is completely greenfield/ New alignment.
There were no existing structure/ corridor is being utilised.

4.0 Alignment Option Study Report

4.1 OVERVIEW OF BANAGALURU-KADAPA-VIJAYAWADA EXPRESSWAY

The project alignment starts near Kodikonda Check post (Settipalle village) on NH-44 at Km 452.000 (Bangalore-Hyderabad Road) and traverses through Anantapur, YSR Kadapa, SPS Nellore and Prakasham districts and ends on NH-16 (Chennai - Vijayawada Road) near Addanki. The proposed alignment is passing nearby towns are Pulivendula, Yerraguntla, Proddutur, Mydukur/Kadapa, Porumamilla, Darsi, Chendrasekhara Puram, Kanigiri, Podili, Chemakurthi and Addanki. The project alignment is controlled by the existing reserved forest stretches, namely Amagondapalem, Kottakota, Errokota, Nagidi, Kokkarajukonda and Dorigallu and High/Extra High Voltage lines by the Power Grid Corporation of India Limited (PGCIL) and AP TRANSCO all along the proposed alignment.

4.1.1 Preliminary Studies on the Proposed Expressway

The proposed project corridor is a part of Bengalore – Vijayawada greenfield expressway, which starts near to Kodikondla (near KA/AP border) check post on NH-44 in Ananthpur district and transiting via Mydukuru and Mallepalli and terminates at Addanki / Medarametla on NH-16 in Prakasam district in the state of Andhra Pradesh.The proposed Greenfield expressway traverses through Ananthapur, Kadappa, Nellore and Prakasham districts in the state of Andhra Pradesh.

Table-4.1: Project Stretch Details

S.No.	Stretch	Districts
1	Kodikonda on NH-44 traverses towards Pulivendula, Mydukuu, Pormamilla, Kanigiri, Chimakurthy and terminates near Addanki / Medarametla on NH-16	Ananthapur, Kadappa, Nellore & Prakasham

The proposed expressway project is intended to augment the transport infrastructure in the new state of Andhra Pradesh and to boost the industrial and tourism sectors by providing faster inter-region connectivity. The corridor provides avenues for a wide variety of tourist attractions, logistic hubs, industrial developments – manufacturing and services etc. Provision of complete access control facilitates road users in reaching their destinations quicker and safer.

The proposed green-field corridor has been proposed as an expressway for entire length of project alignment.

Proposed Alignment:

There are two existing popular routes has been identified between Bangalore – Vijayawada, details as given below:

Route	Towns/Cities along the Route	Length (*) (km)
I	Bangalore - Anantapuram – Nandyala – Giddalur – Narsaraopet – Guntur – Vijayawada	635
II	Bangalore – Chittor - Renigunta – Naidupeta – Nellor – Ongole – Guntur – Vijayawada	647

* Route Length is calculated from STRR near Bangalore and Varadhi (existing bridge on River Krishna) in Vijayawada. While planning for proposed green field alignment, due considerations have been given to the following:

a. Better connectivity between the Bangalore and Vijayawada cities

b. Ensuring shortest possible distance between two major cities

c. Connecting important towns Pulivendula, Mydukuru/Kadapa, Produturu, Porumamilla, Kanigiri, Chimakurthi.

d. Optimum utilization of existing NH 44 on Bangalore side (Start point) and existing NH 16 on Vijayawada side (End point)

e. Avoiding the existing wild life sanctuaries Gundla Brahmashweram WLS on north side of alignment and Lanka Malleswaram WLS on South side of alignment.

f. Avoiding long tunnels while crossing the mountains

g. Avoiding the existing habitations and irrigation tanks

h. Optimum length of crossing at Forest stretches

i. Future development of existing NH road network and proposed green filed expressways i.e. Bangalore – Hyderabad Expressway and Surat Chennai Expressway

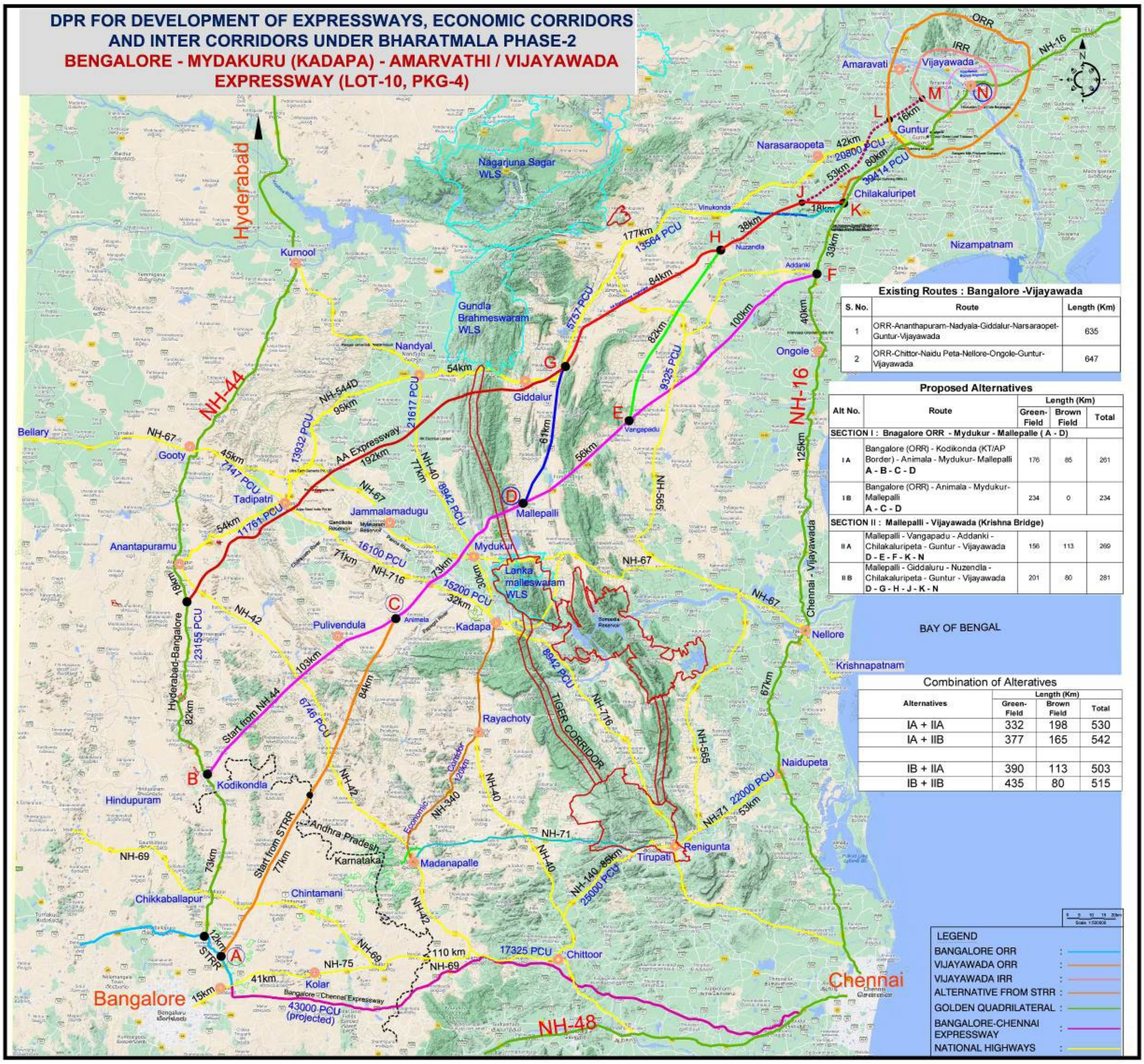
j. Better connectivity to existing industries in the vicinity of the project corridor.

k. It provides Hinter land connectivity for Rayalasema region.

Keeping above considerations, alignment map has been prepared with proper marking from A to K and is presented here under. Proposed corridor is divided into two sections for better presentation/comparison of alternatives.

SECTION-I: Bangalore STRR - Mydukur – Mallepalli (Porumamilla) (A - D)

SECTION-II: Mallepalli (Porumamilla) - Vijayawada (Bridge on river Krishna) (D-N)



aarvee associates
architects engineers & consultants pvt.ltd.

Alt No.	Route	Length (Km)		
		Green Field	Brown Field	Total
SECTION I : Bangalore STRR - Mydukur – Mallepalli (Porumamilla) (A - D)				
I A	Bangalore (STRR) - Kodikonda (KT/AP Border) – Pulivendula - Animala - Mydukur- Mallepalli (A - B - C – D)	176	73	249
I B	Bangalore (STRR) - Animala - Mydukur- Mallepall (A - C – D)	234	0	234
SECTION II : Mallepalli (Porumamilla) - Vijayawada (Bridge on River Krishna) (D-N)				
II A	Mallepalli - Vangapadu - Addanki - Chilakaluripeta - Guntur – Vijayawada (D - E - F - K – N)	156	113	269
II B	Mallepalli - Giddaluru - Nuzendla - Chilakaluripeta - Guntur – Vijayawada (D - G - H - J - K – N)	201	80	281

Alternatives with possible combinations are presented in table below

Final Alt	Combination	Nearby Towns Connectivity between Bangalore and Vijayawada	Length (Km)		
			Green Field	Brown Field	Total
Option 1	IB + IIA	Mydukur- Addanki - Chilakaluripeta - Guntur	390	113	503
Option 2	IB + IIB	Mydukur - Giddaluru – Vinukonda - Nuzendla - Chilakaluripeta - Guntur	435	80	515
Option 3	**IA + IIA**	**Pulivendula - Mydukur- Addanki - Chilakaluripeta - Guntur**	**332**	**186**	**518**
Option 4	IA + IIB	Pulivendula – Mydukur - Giddaluru – Vinukonda Nuzendla - Chilakaluripeta - Guntur	377	153	530

SECTION I: Bangalore STRR - Mydukur – Mallepalli (Porumamilla) (A - D)

- **Alternative IA:** it uses the existing NH 44 for a length of 73km and connects the Pulivendula town.
- **Alternative IB:** Though it is short in length and it requires more in land acquisition. It does not connect the major town Pulivendula. It requires additional development of Spur to connect the town.

SECTION II: Mallepalli (Porumamilla) - Vijayawada (Bridge on river Krishna) (D-N)

- **Alternative IIA:** Though it is short in length, but it do not connects the important towns Giddaluru, Vinukonda.
- **Alternative IIB:** It connects the towns Giddalur, Vinukonda and also facilities traffic from Kurnool/Nandyala. Though it is more in length, it is considered as feasible alternative.

- Option-1: Bangalore (STRR) – Animela – Mydukuru – Mallepalle (Porumamilla) – Vangapadu – Kanigiri – Addanki – Chilakaluripet – Guntur – Vijayawada having a total length of about 503 Km comprising of 390 km greenfield component and 113 km brownfield component.
- Option-2: Bangalore (STRR) – Animela – Mydukuru – Mallepalle (Porumamilla) – Giddaluru – Nuzendla – Chilakaluripet – Guntur – Vijayawada having total length of about 515 km comprising of 435 km greenfield component and 80 km brownfield component.
- Option-3: Bangalore (STRR) following Bangalore-Hyderabad Expressway / NH-44 – Kodikonda (KT/AP Border) – Pulivendula – Animela – Mydukuru – Mallepalli – Vangapadu – Kanigiri – Addanki – Chilakaluripet – Gunture – Vijayawada having total length of about 518 km comprising of 332 km greenfield component and 186 km brownfield component (out of which about 73 km would become part of Bangalore – Hyderabad Expressway).
- Option-4: Bangalore (STRR) following Bangalore-Hyderabad Expressway / NH-44 – Kodikonda (KT/AP Border) – Pulivendula – Animela – Mydukuru – Mallepalli – Giddaluru – Nuzendla – Chilakaluripet – Guntur – Vijayawada having total length of about 530 km comprising of 377 km greenfield component and 153 km brownfield component (out of which about 73 km would become part of Bangalore – Hyderabad Expressway).

Considering all the above and subsequent discussions with the Authority, Option-3 (IA+IIA) has been recommended for the proposed expressway as it would utilise the alignment of proposed Bangalore – Hyderabad Greenfield Expressway/existing NH-44 till Kodikonda (about 73 kms), serve identified Hindupur Industrial Node, more economical due to lesser LA cost and shortest greenfield length and also open hinterland for economic development. The Proposed Option-3 is shorter by about 117km in comparison with the existing road network.

The preliminary alignment proposals have been presented during the review meeting held at Transport Bhavan, New Delhi under the chairmanship of Secretary, MoRTH on

07.09.2021, during the meeting proposed alignment by considering the "Option 3" has been in principally approved. The Minutes of the same has been enclosed as Annexure to this report. Subsequently, Authority has directed the DPR Consultants to proceed for detailed alignment study for the preferred/approved alternative. Accordingly, detailed alignment study has been carried-out and same has been explained in the subsequent paragraphs.

On the other hand, the preferred alignment has been reviewed by the Authority and few observations on them have been provided. Further, site visit along with the Regional officer, Vijayawada has been conducted on 13th & 14th of November 2021 for the proposed alignment few modifications has been made. Accordingly, the alignment report has been prepared.

For easy of understanding, the Proposed alignment has been divided in to five homogeneous sections by considering the terrain, Forest and geometrics considering the and same are presented in the table below

Table-4.2 Alignment Sections

Section	Description	Chainage		Length (km)
		From (Km)	To (Km)	
I	Kodikonda to Pulivendula	0.00	87.000	87.000
II	Pulivendula to Mydukur	87.000	150.000	63.000
III	Mydukur to Pourmamilla	150.000	189.500	39.500
IV	Pourmamilla to Kanigiri	189.500	269.500	80.000
V	Kanigiri to Addanki	269.500	344.450	74.950

Note: The design chainage mentioned above is corresponds to Chainage shown in alignment drawings (Pink/Voilet)

4.2 SECTION I: KODIKANDA TO PULIVENDULA (FROM KM. 0.000 TO KM. 87.000)

The section starts at NH-44 (Bangalore – Hyderabad highway) near Kodikanda Check post/ Settipalle villages and ends near Pulivendula. In this section, the alignment traverses through plain, rolling and hilly terrain.

4.2.1 Land Use and habitation: The land use pattern along the alignment is mix of Commercial, agricultural, Forest and barren. Mandals/Towns/Habitations close to the alignment are Gorantla, Puttaparthi, Nallamada, Kadiri, Mudigudda, Pulivndula and

Vemula. The details of Land-use pattern is given below:

S.No	Land Use	Percentage (%)
1	Agricultural	42.50
2	Barren	49.00
3	Forest	7.50
4	Commercial	1.00

4.2.2 Connectivity to Existing Highways: The proposed alignment in this section crosses the Kodur – Gorentla - Dharmavaram road (New NH), Hindupur-Gorentla-Kadiri road (NH-716G), Bukkapatnam-Nallamada-Pulagampalli road (SH-369). Madanepalle-Kadiri-Anantapuram Road NH 42, Kadiri - Pulivendula (NH-716G) and Pulivendula – Vempalli - Kadapa Road (SH-51).

4.2.3 Forest stretches and wildlife: In this section, the project alignment is traversing along/adjacent to the existing reserved forest stretches, namely Amagondapalem (Dokklakonda), Kottakota, Errokota, Nagidi, Kokkarajukonda and Dorigallu. The proposed alignment is designed in such a way that, no or minimum affect existing forest cover without compromising the geometric standards. However, there are some locations, the forest cover spread is too wide to avoid completely. After avoiding the maximum extent of forest cover, the proposed alignment passing through reserved forest of Amagondapalem (Dokklakonda) for a length of 2.66km and Dorigallu for a length of 3.80 km. Total length of the forest land is about 6.46km. There is no wild life/ eco-sensitive areas falling in this section.

4.2.4 High Tension lines along the Alignment: There are HT lines running parallel/crossing the proposed alignment. As far as possible, HT line running parallel to the alignment is avoided, unless there are other constraints which may demanding the proposed alignment running parallel/close to the HT lines

4.2.5 Railway line crossing: The proposed alignment crossing the existing railway line (Dharmavaram – Kadiri line) near Malakavemula village. The existing railway line and NH 42 (Anathapuram – Kadiri section) are running parallel at an offset of 100m for a length of 1km on either side of proposed crossing location. Suitable, interchange will be planned to provide entry and exit to NH 42.

4.2.6 River Crossings: The proposed alignment crossing the River Chitravati in Settipalle village and River Madduleru in Patnam village. Alignment was designed in such a way that, crossing is normal to river flow to have minimum length of bridge.

4.2.7 Alternative alignments

Alternative alignments have been prepared for following locations.

I. *Take-off/Start point of the project corridor near Kodikonda on NH-44*

II. *Alignment alternatives at Palakonda Hills (Dorigallu RF)*

4.2.8 Take-off/Start point of the project on NH-44

At the start point of the project, the land falls in Kodur and Settipalli revenue villages. The type of land abutting to NH 44 for a width of 1km to 1.5km is commercial land as per revenue records. Cost of commercial land in Kodur village about 70 to 80% higher than land in Settipalli village. Further, during the site visit, there was a notice board by the Enforcement Directorate (ED) that the land plots belongs to Lepakshi Knowledge Hub Pvt Ltd are attached in money laundering case.

Three alternative alignments have been studied and details of the same are given below:

Alternative I: Take-off point of the project corridor is at Km 454.400 on NH 44 (Hyderbad – Bengalore) in Kodur village in Ananthapur district. The total length of the alternative is 7.00km, out of which 1.40km length of commercial land and remaining 4.60km length is of Non-commercial land. Further, the alignment is crossing the existing HT line and it requires raising / relocation.

Merits:

- short in length compared with other alternatives.

Demerits:

- Shifting/raising of HT line
- High in project cost due to acquisition of high cost commercial land in Kodur village for a length of 1.4km.
- The alignment may passing through the land attached in money laundering case.

Alternative II: The take-off point is at Km 453.200 on NH 44 (Hyderabad – Bangalore) near Kodur village in Ananthapur district. The total length of the alternative is 7.27km, out of which 0.9km length of commercial land and balance 6.37km length is of non-commercial land.

Merits:

- Short in length of commercial land in comparison to Alternative I
- Avoids the shifting of HT lines.

Demerits:

- Alignment is passing through land belongs to M/s Leepakshi Knowledge Hub Pvt. Ltd which is attached in money laundering case by Enforcement Directorate.
- Total length of alignment is more than the Alternative I

Alternative III: The take-off point is at Km 452.000 on NH 44 (Hyderbad – Bengalore) in Settipalle village in Ananthapur district. The total length of the alternative is 7.20km, out of which 0.9km length of commercial land and remaining 6.20km length is of Non-commercial land.

Merits:

- Short in length of commercial land in comparison to Alternative I&II
- Avoids the shifting of HT lines.
- Avoids LA in Kodur village. Hence, the proposal avoids LA in court litigation lands.

Demerits:

- Total length of alignment is more than the Alternative-I

Comparison of above three alternatives as given below:

S. No.	Description	Alternatives		
		I	II	III
1	Total Length	7.00 km	7.27km	7.20km
2	Commercial land	1.40km	0.9	0.9
3	Non-Commercial	4.60km	7.27	7.20
4	Cost Civil (Rs Crores)	**280.00**	**290.80**	**288.00**
5	LA Cost (Rs Crores)	83.84	44.56	44.28
6	Cost for HT line shifting (Rs Crores)	6.82	0	0
Total Cost		**370.66**	**336.36**	**333.28**
7	Merits	• Short in length	• Avoids Commercial land • Avoids HT line shifting	• Less length commercial land • Avoids Court litigation land • Avoids HT line shifting
8	Demerits	• HT lines shifting • Commercial land	• Passing through Court litigation land	• Minor increase in length

Recommended alternative: Alternative III is recommended, since it avoids the commercial land and HT line shifting and least in project cost among all other alternatives. Moreover, the Regional Officer, NHAI, Vijayawada has conducted the site visit for finalization of start/takeoff point of the project on 13th November 2021 and it is found in order. A Map with proposed alternatives is attached as annexure to this report.

4.2.9 Alignment alternatives at Palakonda Hills (Dorigallu RF)

At this location, there is a wide opening in the hill where an existing stream and NH 716G crossing the hill. There was a temple on south side of existing NH-716G near bridge, hence any future widening would be feasible on north side of existing bridge. The DPR Consultants were informed that there was a proposal for four laning of NH-716G by Ministry. It was also noticed that adequate width is not available between the existing bridge on NH and hill face to accommodate future 2 lane bridge for NH-716G and current 4/6 lane cross section for proposed expressway.

Considering the above, four alternatives have been prepared for this location.

- Following the existing stream/hill opening on North of NH-716G (SH-60)
- In between above both with tunnel and via-duct
- Following the existing NH-716G (SH-60)

Alternative I: is following the existing NH 716G on southside. Due to existence of old temple, huge hill cutting, this alternative was discarded in the proposals.

Alternative II: This alternative cross the existing Palakonda Hills in Dorigallu reserved forest on North of NH-716G (SH-60). This alternative has least forest among the other alternatives. The total length of the alternative is 23.78km out of which forest stretch is about 3.10km. In this alternative there is a requirement of Viaduct of 1.70km due to drop in level from west side to east side of hillock.

Merits:

- ease of construction since it is away from the existing NH 716G
- less in length of forest diversion and
- at par with civil construction cost among the other alternatives.

Demerits:

- Shifting of HT lines required
- Elevation/Height of viaduct will be very high compared to other alternatives.

Alternative III: This alternative is in between Alternative II and IV with straight alignment with provision tunnel and viaduct combination. The total length of the alternative is 22.13km out of which forest stretch is about 4.90km. In this alternative there is a requirement of Viaduct of 1.83km and tunnel for a length of 2.90 km.

Merits:

- shorter in length among the other alternatives
- ease of construction in comparison to Alternative II, since it will not have interference with existing NH NH 716G.
- Good geometry (straight line) compared to other alternatives
- Least disturbance to forest cover due to prosed tunnel

Demerits:

- Civil construction cost is more compared with other alternatives due tunnel and viaduct
- Construction time and maintenance cost will be more due proposed tunnel.

Alternative IV: This alternative traverses adjacent to the existing Kadiri – Pulivendula Highway (NH 716G/SH 60). On the existing stream Kadiri – Pulivendula highway has about 650m length 2 lane bridge.

The total length of the alternative is 23.46km out of which forest stretch is about 3.80km which requires forest diversion. In this alternative there is a requirement of Viaduct of 1.90km and balance on normal embankment.

Merits:

- less in construction time as well maintenance cost in comparison Alterative III
- Strata is known as exposed rock is visible.
- There is no tunnel requirement for this alternative.

Demerits:

- It requires hill cutting and adequate safety measures to be followed due to traffic on existing NH.
- Adequate hill slope protection is required

Comparison of above three alternatives as given below:

S. No.	Description	Alternatives		
		II	III	IV
1	Tunnel (km)	-	2.90	-
2	Viaduct (km)	1.70	1.83	1.90
3	Total Length (km)	23.78	22.13	23.46
4	Cost (Rs Crores)	1047	1742	1044
5	Forest	3.10km	4.90Km	3.80km
6	Shifting/rising of HT Lines/Gas required	Yes	No	No
7	Merits	• Ease of construction since it is away from the existing NH 716G. • Less in project cost	• Shorter among the other alternatives • Away from the existing NH. • Less disturbance to forest cover.	• Fast in construction • Near to existing NH 716G. • Known strata
8	Demerits	• HT lines diversion required • Tall piers in via-duct portion.	• Construction duration is more • Project cost is high among other alternatives	• Hill cutting is required • Adequate safety measures to protect the hill slope

Recommended alternative: Alternative IV, though there is marginal increase in project civil cost, height/clearance viaduct from Ground level is less among other alternatives. Hence, it is recommended.

A Map with proposed alternatives is attached as annexure to this report.

4.2.10 Proposed Structures

The proposed structures with the recommended alternative in this section are given below:

S.No	Description	Proposed Nos.
1	Major Bridges	4
2	Minor Bridges	67
3	Vehicular Underpasses (VUP)	11
4	Light Vehicular Underpasses (LVUP)	24
5	Interchanges	4 (1 – Trumpet & 3- Double Trumpet)

4.3 SECTION II: PULIVENDULA TO MYDUKUR (FROM KM. 87.000 TO KM. 150.000)

The section starts near near Pulivendula on – Vempalli - Kadapa Road (SH 51), and ends on NH-40 (Mydukur – Nandyal road) near Mydukur. This section of the alignment traverses through plain terrain.

4.3.1 Land Use and habitation: The land use pattern along the alignment is mix of agricultural and barren. Mandals/Towns/Habitations close to the alignment are Pulivendula, Vemula, Veerapunayunipalle, Yerraguntla, Kamalapuram, Proddatur, and Mydukur. The details of Land-use pattern in this section are given below:

S.No	Land Use	Percentage (%)
1	Agricultural	76
2	Barren	24
3	Forest	Nil

4.3.2 Connectivity to Existing Highways: The proposed alignment connects the Pulivendula – Vempalli - Kadapa Road (SH-51), Pulivendula – Alavapadu – Vempalli road (SH-69), Pulivendula – Genumukulapalle (SH-68), Yerraguntla – Vempalli (SH-430), Yerraguntla – Kadapa (NH 716), Proddatur – Mydukur (NH-67) and Nandyal – Mydukur (NH-40).

4.3.3 Forest stretches and wildlife: There is no forest or wild life falling in this section.

4.3.4 High Tension lines along the Alignment: There are HT lines running parallel/crossing the proposed alignment. As far as possible, HT line running parallel to the alignment is avoided, unless there are other constraints which may demanding the proposed alignment running parallel close to the HT lines

4.3.5 Railway line crossing: There are two existing railway line crossings i.e Gooty – Kadapa main line and Yerragunta - Bharathi Cement in the proposed corridor. The alignment has been designed for the allowable/permissible skew angle.

4.3.6 River crossings: The proposed alignment crosses the River Penna near Kokatam village, River Kundu near Budidapadu and Creak of river Papagni near Muthukuru. Alignment was designed in such a way that, crossing is normal to river flow to have minimum length of bridge.

4.3.7 Proposed Structures

The proposed structures in this section are given below:

S.No	Description	Proposed Nos.
1	Major Bridges	5
2	Minor Bridges	62
3	Vehicular Underpasses (VUP)	9
4	Light Vehicular Underpasses (LVUP)	22
5	Interchanges	3 (Double Trumpet)

4.4 SECTION III: MYDUKUR - PORUMAMILLA (FROM KM. 150.000 TO KM. 189.500)

The section starts at NH-40 (Mydukur - Nandyal road) near Mydukur and ends on SH–56 (Porumamilla – Badvel road) near Boppapuram/Porumamilla. In this section, the alignment traverses through plain, rolling and hilly terrain.

4.4.1 Land Use and habitation: The land use along the alignment is partly agricultural, partly barren and forest areas. Mandals/Towns/Habitations close to the alignment are Mydukur, Onipenta, Mallepalle Virabrahamgarimattam and Porumamilla.

The details of Land-use pattern in this section are given below:

S.No	Land Use	Percentage (%)
1	Agricultural	38
2	Barren	51
3	Forest	11

4.4.2 Connectivity to Existing Highways: The proposed alignment in this section crosses Nandyal – Mydukur (NH 40), Mydukur – Porumamilla (NH 167B) and Porumamilla – Badvel (SH 56).

4.4.3 Forest stretches and Wildlife: In this section, the project alignment is traversing though existing reserved forest stretches, namely Kotha Kota Dasari Palli (Nallamala) Reserve Forest. The alignment is designed in such a way that, no or minimum affect existing forest cover without compromising the expressway geometric standards. However, there are some locations, the forest cover spread is too wide to avoid completely. After avoiding the maximum extent of forest cover, the proposed alignment passing through reserved forest of Kotha Kota Dasari Palli (Nallamala) for a length of 4.35km in this section.

The existing wildlife sanctuaries **Gundla Brahmeswaram WLS** and **Sri Lankamalleswaram WLS** on north and south side of proposed alignment respectively. There is proposal of habitat corridor of 3km wide between Nagarjun Sagar Sri Sailam Tiger Reserve and Sri Venkestwara NP is mostly through forested habitat and passes through three protected area Gundla Brahmeswaram WLS, Sri Lankamalleswaram WLS and Sri Penusila Narasimha WLS. Suitable proposals shall be proposed in consultation with the National Tiger Conservation Authority (NTCA).

4.4.4 High Tension lines along the Alignment: There are HT lines running parallel/crossing the proposed alignment. As far as possible, HT line running parallel to the alignment is avoided, unless there are other constraints which may demanding the proposed alignment running parallel /close to the HT lines. At certain locations, HT Line is running very close to the proposed centerline of the project corridor, where shifting of HT line is unavoidable due to terrain and geometry conditions.

4.4.5 High petroleum pipeline (HP) along the Alignment: There is an existing high pressure petroleum pipe line (HP) from Vijayawada to Dharmapuri running parallel to the existing NH 167B in the Kotha Kota Dasari Palli (Nallamala) Reserved forest area. The proposed alignment also running parallel to the NH 167B in this section. As far as possible, HP pipe line and its ROU in the proposed alignment will be be avoided, unless there are other constraints.

4.4.6 River crossings: The proposed alignment crosses the River Sagileru near Vankamarri/Munnelli villages. Alignment was designed in such a way that, crossing is normal to river flow to have minimum length of bridge.

4.4.7 Alignment alternatives for Kotha Kota Dasari Palli (Nallamala) Reserved Forest:

As discussed above, there was a high-pressure petroleum pipeline (dia. 16”) of HPCL running parallel to the existing NH-167B on north side. There was also a HT line also running parallel to NH-167B on north side.

There was an existing water pipeline starting from SPVB reservoir to Muddanaur Thermal Power Plant in between Design chainage from km.161.00 to Km.177.00 on south side of NH-167B along the road. Therefore, the alignment would be proposed in such a way that the water pipeline line on the other side of the NH-167B was avoided.

After detailed study of the location and above-mentioned constraints, following alternatives have been prepared for this location:

- Partially following the NH-167B with Viaduct
- Following NH-167B with multiple crossing of NH-167B
- Crossing through Tunnel on north side of NH-167B
- Parallel to NH 167B by avoiding multiple crossings of HT and Gas pipe lines

Alternative I: This alternative of the project corridor starts near Kottapelle village and ends near Chinnayyapalle village. The proposed alternative crosses the existing Kotha Kota Dasari Palli (Nallamala) reserved forest and within it proposed tiger corridor. In the forest location, the alignment partly runs parallel to the existing Mydukur – Porumamilla (NH 167B).

The total length of the alternative is 16.00km out of which forest stretch is about 4.80km which requires forest diversion. The proposal along this alternative will have Viaduct of 2.12km length & tunnel of 340m.

Merits:

- Shorter in length among the other alternatives
- Majority of the length in viaduct portion.

Demerits:

- Requires shifting of HT lines at multiple locations
- May requires larger spans to overpass the HPCL gas line at many locations.

Alternative II: This alternative of the project corridor also starts near Kottapelle village and ends near chinnayyapalle village. The proposed alternative crosses the existing Kotha Kota Dasari Palli (Nallamala) reserved forest and within it proposed tiger corridor. In the forest location, the alignment partly runs parallel to the existing Mydukur – Porumamilla (NH 167B).

The total length of the alternative is 16.36km out of which length of the project road traverses through the forest area is about 4.20km which requires forest diversion. The proposal along this alternative requires a Viaduct of 2.80km length with partial cutting of hill slopes to accommodate the cross section. There is no requirement of Tunnel for this alternative.

Merits:

- Avoids tunnel
- Most of the length on viaduct, which will comply to NTCA norms in tigor corridor.

Demerits:

- it requires shifting of HT lines at multiple locations,
- curved alignment and hence length of the alignment is more in comparison with other alternatives.

Alternative III: This alternative of the project corridor also starts near Kottapelle village and ends near chinnayyapalle village. The proposed alternative crosses the existing Kotha Kota Dasari Palli (Nallamala) reserved forest and within it proposed tiger corridor.

The total length of the alternative is 16.360km out of which forest stretch is about 4.10km which requires forest diversion. The proposal along this alternative requires Viaduct of 1.18km length & tunnel of 1.15km.

Merits:

- most of the length is tunnel in Tiger corridor stretch
- Avoids HT lines shifting
- No interference with HPCL GAS line

- No interference with water pipe line running on south side of the NH167B

Demerits:

- Civil construction cost is more compared with other alternatives
- NTCA may object, since partial cutting in tiger corridor stretch in approaches to tunnel.

Alternative IV: This alternative of the project corridor also starts near Kottapelle village and ends near chinnayyapalle village. The proposed alternative crosses the existing Kotha Kota Dasari Palli (Nallamala) reserved forest and within it proposed tiger corridor. The alignment runs o south side of the existing Mydukur – Porumamilla (NH 167B).

The total length of the alternative is 16.94km out of which forest stretch is about 4.35km which requires forest diversion. The proposal along this alternative requires Viaduct of 2.04km length & tunnel of 700m.

Merits:

- Majority of the length on either via-duct or tunnel in tiger corridor.
- Avoids shifting/raising of HT lines at multiple locations
- Avoids multiple crossings of HPCL Gas Pipeline
- Avoids in water pipeline relocation

Demerits:

- it has more in length compared with other alternatives.
- Cost is more compared to other alternatives

Comparison of above four alternatives as given below:

S. No.	Description	Alternatives			
		I	II	III	IV
1	Tunnel (km)	0.340	-	1.150	0.700
2	Viaduct (km)	2.12	2.80	1.180	2.040
3	Total Length (km)	16.00	16.360	16.360	16.940
4	Cost Civil (Rs Crores)	**848**	**812**	**1020**	**854**
5	Forest diversion	4.80km	4.20km	4.10km	4.35km
6	Shifting/rising of HT Lines/Gas required	Yes (Multiple)	Yes (Multiple)	No	Yes (one)
7	Merits	• Shorter among the other alternatives • Most of the length on Viaduct	• Fairly straight • Utility crossing at many locations • Mostly on viaduct	• longer among the other alternatives • Away from the existing NH. • Less disturbance to forest cover.	• Fairly straight • Utility crossing at one location only • Mostly on viaduct and tunnel
8	Demerits	• Relocation of utilities at many places	• Curved alignment • Length is more	• Construction duration is more due to longer tunnel • Project cost is high among other alternatives	• Curved alignment • Length is more

Recommended alternative: Alternative IV, though there is marginal increase in project civil cost, minimum interference with existing utilities, hence, it is recommended.

A Map with proposed alternatives is attached as annexure to this report.

4.4.8 Proposed Structures

The proposed structures with the recommended alternative in this section are given below:

S.No	Description	Proposed Nos.
1	Major Bridges	3
2	Minor Bridges	46
3	Vehicular Underpasses (VUP)	5
4	Light Vehicular Underpasses (LVUP)	8
5	Interchanges	1 (Double Trumpet)

4.5 SECTION IV: PORUMAMILLA - KANIGIRI (FROM KM. 189.500 TO KM. 269.500)

The section starts at SH–56 (Porumamilla – Badvel road) near Boppapuram/Porumamilla and ends at SH–35 (Kanigiri – Kandukuru – Singarayakonda road) Near Kanigiri. In this section, the alignment traverses through plain, rolling and hilly terrain.

4.5.1 Land Use and habitation:

The land use pattern along the alignment is mix of agricultural, barren and few of the forest areas. Mandals/Towns/Habitations close to the alignment are Porumamilla, Seetarampuram, Chandrasekaharapuram, Pamuru, Vangapadu, Veligandla and Kanigiri.

The details of Land-use pattern in this section are given below:

S.No	Land Use	Percentage (%)
1	Agricultural	46
2	Barren	41
3	Forest	13

4.5.2 Connectivity to Existing Highways: The proposed alignment in this section crosses Porumamilla – Badvel (SH-56), Porumamilla – Pamuru (NH-167B), Yerpedu – Venkatagiri – Atnakur – Dattalur - Pamuru – Markapur – Macherla (NH 565) and Kanigiri – Kandukuru – Singarayakonda (SH-35).

4.5.3 Alignment at Forest stretches and wildlife: In this section, the project alignment is traversing along existing reserved forest stretches, namely Kalavakunta Extension A and Seetaramapuram Reserve Forests of Cumbum Forest range and Bhyravanikonda reserved forest. The alignment is designed in such a way that, no or minimum affect existing forest cover without compromising the geometric standards. However, there are some locations, the forest cover spread is too wide to avoid completely. After avoiding the maximum extent of forest cover, the proposed alignment passing through reserved forest of Kalavakunta Extension A for a length of 2.6km, Seetaramapuram reserved forest for a length of 2.95km and Bhyravanikonda reserved forest for a length of 4.25km Total length is about 9.80km of forest land in this section. There is no wild life/ eco-sensitive areas falling in this section.

4.5.4 High Tension lines along the Alignment: There are HT lines running parallel/crossing the proposed alignment. As far as possible, HT line running parallel to the alignment is avoided, unless there are other constraints which may demanding the proposed alignment running parallel close to the HT lines. At certain locations, HT Line is running very close to the proposed centerline of the project corridor, where shifting of HT line is unavoidable due to terrain and geometry conditions.

4.5.5 River crossings: The proposed alignment crossing the River Paleru near Manamadugu village. Alignment was designed in such a way that, crossing is normal to river flow to have minimum length of bridge.

4.5.6 Alternatives:

4.5.6.1 Alignment alternatives for Velikonda Range Hills (Sitarampuram Reserved Forest):

During the site visit, it was observed that there are 765 KV HT line (PGCL) and anther 500KV HT line running parallel/cross the proposed alignment. Since, both 765 KV and 500 KV HT are running Nort-South direction, crossing of these utilities are inevitable in all the alternatives. The Regional Officer (RO), NHIA, Vijayawada suggested to explore suitable proposals such as lowering the Expressway with adequate drainage measures, so that shifting of HT lines may be avoided.

The RO also suggested that, at any location, either forest diversion or HT line sifting is required for proposed project corridor, it would be better to pass through forest area to avoid unnecessary shifting of HT lines shifting.

Existing NH 167B traverse through the Velikonda hills with substandard curves/hair pin bends and steep gradients near proposed project corridor.

Due to existence of mountain with a height about 300m and spanning in north-south direction, all four alternative will have tunnel. All alternatives for the project corridor starts from SH–56 (Porumamilla – Badvel road) near Boppapuram/Porumamilla and ends near Abbavaram village in Prakasham District. Details of each alternative is given below:

Alternative I: Length of the alternative is 29.00km out of which forest stretch is about 6.50km (4km in the Kalavakunta Extension A & 2.5km in the Seetaramapuram reserved forests) which requires forest diversion. The proposal in this alternative will be of 4.0 km tunnel in existing Kalavakunta Extension A and Seetaramapuram reserved forests.

Merits:

- Short in length of alignment.
- Avoids nearby irrigation tanks

Demerits:

1. it requires shifting of multiple HT lines.
2. Relocation of existing NH 167B or underpass/overpass is required

Alternative II: The total length of the alternative is 30.980km out of which, forest stretch is about 7.60km (out of which 3km in the Kalavakunta Extension A & 4.6km in the Seetaramapuram reserved forests) which requires forest diversion. The project proposal in this alternative requires a tunnel of 4.99km length in existing Kalavakunta Extension A and Seetaramapuram reserved forests.

Merits:

- avoids most of the near-by irrigation tanks
- avoids multiple HT line crossings.

Demerits:

- More in length of tunnel in comparison to all other alternatives
- overall length is more
- Higher civil construction cost due to more in tunnel length and total.

Alternative III: The total length of the alternative is 28.440km out of which length of the project road traverses through the forest area is about 7.0km (out of which 4.2km in the Kalavakunta Extension A & 2.8km in the Seetaramapuram reserved forests) which requires forest diversion. The project proposal in this alternative requires a tunnel of 4.36km length in existing Kalavakunta Extension A and Seetaramapuram reserved forests.

Merits:

- Shorter in length of tunnel in comparison with other alternatives.
- Avoids the nearby irrigation tanks.

Demerits:

- It requires shifting/raising of multiple HT lines.

Alternative IV: The total length of the alternative is 31.810km out of which length of the project road traverses through the forest area is about 4.50km (out of which 2.60km in the Kalavakunta Extension A & 2.95km in the Seetaramapuram reserved forests) which requires forest diversion. The project proposal in this alternative requires a tunnel of 3.59 km length in existing Kalavakunta Extension A and Seetaramapuram reserved forests .

Merits:

- Shorter tunnel length in comparison with other alternatives.
- Avoids multiple crossing of HT lines.
- Avoids nearby irrigation tanks

Demerits:

- it has nearby irrigation tank
- it has curved approach on east side of tunnel

Comparison of above four alternatives as given below:

S.No.	Description	Alternatives			
		I	II	III	IV
1	Tunnel (km)	4.00	4.99	4.36	3.590
2	Viaduct (km)	0.0	0.0	0.0	0.0
3	Total Length (km)	29.000	30.980	28.440	31.810
4	Cost (Rs Crores)	**2200**	**2537**	**2271**	**2206**
5	Forest diversion required?	Yes	Yes	Yes	Yes
6	Shifting/rising of HT Lines required	Yes (Multiple)	Yes (one)	Yes (Multiple)	Yes (one)
7	Merits	• Avoids near by tanks	• Avoids near by tanks. • Avoids multiple HT lines crossings	• Shorter in project length. • Avoids near by tanks.	• Shorter in tunnel length • Avoids multiple crossings of HT lines
8	Demerits	• Multiple HT lines crossings	• Tunnel length is more	• Multiple HT lines crossings	• Near by irrigation tank • Curved approach on east side

Recommended alternative: Though there is marginal increase in project civil cost in Alternative IV over Alternative I, it has minimum interference with existing utilities, hence it is recommended. A Map with proposed alternatives is attached as annexure to this report.

4.5.6.2 Alignment alternatives for Sandarakonda, Bhyravanikonda and Pulimikonda Reserved Forest:

The proposed alignment presented to Member (P) on 09.11.2021 was running parallel/crossing HT lines to avoid the forest stretches. However, the HT lines are high-capacity (765KV and 500KV) lines owned by the PGCIL and their shifting or raising will take longer time and huge cost involved. Hence, during the site visit on 14th November 2021, the RO Vijayawada suggested to avoid these lines, even if the alignment requires to pass through the forest land. For the purpose of presentation of alternatives for this stretch, the project road start near Abbavaram village in Prakasham District and ends near Kanigiri is considered. Three alternative alignments have been prepared for this stretch and details of the same are presented below:

Alternative I: This alternative traverses in between Sandarakonda and Bhyravanikonda reserved forests, North side of the Pulimikonda RF, Nallakonda gidda RF and ends near Kanigiri with junction of Kanigiri – Kandukur (SH 35) road. There are existing HT lines running parallel/crossing many locations for the proposed alignment. Total length of the alternative is 41.20km.

Merits:

- Avoids forest blocks/diversion.

Demerits:

- It requires shifting/raising of multiple HT (PGCL) lines
- Longer in length among the other alternatives.

Alternative II: This alternative traverses through Bhyravanikonda reserved forest for a length of 4.25km, and it takes South side of the Pulimikonda RF and ends near Kanigiri with junction of Kanigiri – Kandukur (SH 35) road. Avoids HT lines in this section. Total Length of the alternative is 44.00km.

Merits:

- Avoids HT lines of high capacity (765KV/500KV) of PGCL

Demerits:

- it requires forest diversion of for a length of 4.25km in the Bhyravanikonda reserved forests.

Alternative III: This alternative follows the alignment of the Alternative I and traverses in between Sandarakonda and Bhyravanikonda reserved forests then it takes South side of the Pulimikonda RF and ends near Kanigiri. There are existing high capacity HT lines running parallel/crossing many locations in this alternative. Total Length of the alternative is 40.57km.

Merits:

- Avoids forest blocks/diversion.

Demerits:

- it requires shifting/raising of multiple HT (PGCL) lines
- longer in length in comparison with Alternative I.

Comparison of above three alternatives as given below:

S. No	Description	Alternatives		
		I	II	III
1	Tunnel (km)	0	0	0
2	Viaduct (km)	0	0	0
3	Total Length (km)	41.20	39.50	40.57
4	Cost (Rs Crores)	**1648**	**1580**	**1623**
5	Forest diversion required?	Yes	No	No
6	Shifting/rising of HT Lines/Gas required	Yes (Multiple)	Yes (one)	Yes (Multiple)
7	Merits	• Avoids forest area	• Avoids HT lines multiple crossings • Shorter among all	• Avoids forest area.
8	Demerits	• Multiple HT lines (PGCL) crossings • Longer among all	• Forest diversion is required	• Multiple HT lines (PGCL) crossings

Recommendation: Though there is requirement of forest land in Alternative II, it is economical and avoids shifting/raising of HT lines. Hence, Alternative II is recommended. A Map with proposed alternatives is attached as annexure to this report.

4.5.7 Proposed Structures

The proposed structures with the recommended alternative in this section are given below:

S.No	Description	Proposed Nos.

1	Major Bridges	7
2	Minor Bridges	78
3	Vehicular Underpasses (VUP)	8
4	Light Vehicular Underpasses (LVUP)	16
5	Interchanges	2 (Double Trumpet)

4.6 SECTION V: KANIGIRI - ADDANKI (FROM KM. 269.500 – KM. 344.450)

The section starts at SH–35 (Kanigiri – Kandukuru – Singarayakonda road) near Kanigiri and ends on NH–16 (Chennai - Kolkata GQ Highway) near Muppavaram/Addanki. In this section, the alignment traverses through plain, rolling terrain.

4.6.1 Land Use and habitation: The land use pattern along the alignment is mix of agricultural, barren and few of the de-notified forest areas. Mandals/ Towns/Habitations close to the alignment are Kanigiri, Marripudi, Podili, Chimakurthy, Darsi, Thallur, Mundlamuru, Addanki and Janakavarampanguluru.

The details of Land-use pattern in this section are given below:

S.No	Land Use	Percentage (%)
1	Agricultural	58
2	Barren	42
3	Forest	-

4.6.2 Connectivity to Existing Highways: The proposed alignment in this section crosses Kanigiri – Kandukuru – Singarayakonda (SH 35), Podili – Marripudi – Kuchipudi – Kondpai – Tangutur (SH 37), Podili – chimakurthy – Ongole (SH 39), Darsi – Chimakurthy (SH 295), Narketpalli – Miryalaguda – Addanki – Medarametla (NH 167A and SH 36) and Chennai - Kolkata GQ Highway (NH 16).

4.6.3 Alignment at Forest stretches and wildlife: In this section, the project alignment is completely avoids the existing reserved forest stretches. But traverses through De-notified Nagambotlapalem Reserved forest (length of 3.6km).

4.6.4 High Tension lines along the Alignment: There are HT lines running parallel/crossing the proposed alignment. As far as possible, HT line running parallel to the alignment is avoided, unless there are other constraints which may demanding the proposed alignment running parallel close to the HT lines. Only one alternative has been recommended for this section. Since proposed alignment is being a completely access controlled expressway, Trumpet interchanges has been proposed where major NH/SH crosses the project highway.

4.6.5 River crossings: The proposed alignment crosses the River Makeru near Kanchipuram village, River Atleru near Tippala Devi Palli village, River Moosy near Boddikura Padu Village and River Gundlakamma near Addanki town. Alignment was designed in such a way that, crossing is normal to river flow to have minimum length of bridge.

4.6.6 Alternatives for end point on NH-16

At this location Emergency landing facility (ELF) was under construction on NH-16 in between Km. 1211 to Km 1216. The alignment approved in principle by the Secretory, MORTH falling on ELF under construction. To avoid the ELF stretch of NH 16, two alternatives were proposed for this location i.e. landing point at Km.1209 and at Km.1207 of NH 16

For the purpose of alignment alternatives preparation, the alignment starting from Narketpally – Addanki – Medarmetla road (SH 36) near Addanki and ends on NH-16 near Jagarlamudi vari palem/Reningavaram villages in Prakasham District. Three alternatives have been prepared and details of same are given below:

Alternative I: The total length of the alternative is 9.35 km (7.18km green field and 2.17km brown field). The landing point is nearer to the ELF under construction on NH-16.

Merits:

- Green filed length is less among the alternatives.
- Uses the existing NH 16 for a length 2.17km

Demerits:

- Closer to proposed ELF

There are existing cold storage and IOC petrol pump near landing location.

Alternative II: The total length of the alternative is 8.97km. The landing point is about 4km away from the proposed Emergency landing facility on NH-16.

Merits:

- Away from the ELF
- Shorter among the alternatives

Demerits:

- Falling on existing Substation

- Length of green filed alignment increases by 2km (approx.)

Alternative III: The total length of the alternative is 9.23km. The landing point is about 4.2km away from the proposed Emergency landing facility on NH-16.

Merits:

- Away from the ELF
- Avoids existing 32kv Sub-Station

Demerits:

- Length of green filed alignment increases by 2km (approx.)

Recommended alternative: Though there is marginal increase in green field alignment length, overall travel length is less than the Alternative I. The alternative III is most feasible in comparison to Alternative I and II, hence it is recommended.

Map showing all the alternative have been attached as annexure to this report.

4.6.7 Proposed Structures : The proposed structures with the recommended alternative in this section are given below:

S.No	Description	Proposed Nos.
1	Major Bridges	9
2	Minor Bridges	46
3	Vehicular Underpasses (VUP)	11
4	Light Vehicular Underpasses (LVUP)	11
5	Interchanges	3 (2 - Double Trumpet & 1 - Trumpet)

4.6.8 Proposed Structures

Proposed structures along the finalized/recommended alignment for the entire project corridor are given below:

S.No	Description	Proposed Nos.
1	Major Bridges	28
2	Minor Bridges	299
3	Vehicular Underpasses (VUP)	45
4	Light Vehicular Underpasses (LVUP)	81
5	Interchanges	13 (11 - Double Trumpet & 2 - Trumpet)

4.7 Preliminary Cost Estimate for the Finalised/Recommended Alignment:

The Preliminary cost estimate along the finalized/recommended alignment for the entire project corridor is given below:

Preliminary Cost Estimate	
Item Description	**Total Cost in Rs. Cr**
BILL NO 1 : SITE CLEARANCE AND DISMANTLING	48.22
BILL NO 2 : EARTH WORKS	3,686.77
BILL NO 3 : BASE COURSES	1,170.88
BILL NO 4 : PAVING COURSES	1,061.16
BILL NO 5a : REPAIR AND REHABILITATION OF STRUCTURES	-
BILL NO 5b : BRIDGES	2,154.86
BILL NO 5c : CULVERTS	414.35
BILL NO 5d : UNDERPASSES	1,944.75
BILL NO 5e : ROB	61.43
BILL NO 5f : DRAINAGE, PROTECTIVE WORKS AND OTHER SERVICES	942.83
BILL NO 5g : REINFORCED EARTH AND TOE WALLS	-
BILL NO 5h : INTERCHANGES INCLUDING APPROACH ROADS	1,168.84
BILL NO 6 : TUNNEL	1,587.00
BILL NO 7 : JUNCTIONS	8.35
BILL NO 8 : TOLL PLAZA - EXCLUDING PAVEMENT	26.76
BILL NO 9 : USER AMENITIES	0.06
BILL NO 10 : TRAFFIC SIGNS, MARKINGS AND APPURTENANCES	228.80
BILL NO 11 : MISCELLANEOUS	89.64
BILL NO 12 : MAINTENANCE OF ROAD DURING CONSTRUCTION	-
CONSTRUCTION COST INCLUDING GST	**14,596.70**
LENGTH OF THE PROPOSED ROAD (Kms)	**344.450**
CONSTRUCTION COST (Crores per Km)	**42.25**

4.8 Preliminary Cost Estimate for Land Acquisition:

Based on the proposed/recommended alternative, the tentative Land acquisition cost for the entire project corridor is given below:

Total Estimated LA Cost (Rs Cr.): 3462

Total Additional Land to be acquired with 90m RoW: 3434 Ha

Detailed village wise LA cost is given as annexure to this report.

5.0 METHODOLOGY

5.1 General Approach

Various engineering surveys and investigations have been carried out on the Project Road strictly following the relevant specifications mentioned in MoRTH/ IRC/ BIS Codes to generate adequate database for preparing the most appropriate proposal for the proposed greenfield alignment of Bengaluru-Kadapa-Vijayawada stretch.

Various engineering surveys and investigations carried out are listed below:

- ✔ Reconnaissance & Alignment Study
- ✔ Topographic Surveys
- ✔ Road Inventory and Condition Survey
- ✔ Traffic Surveys
- ✔ Inventory and Condition Survey of Bridges and Culverts
- ✔ Hydraulic and Hydrological Investigations
- ✔ Pavement Investigations
- ✔ Soil and Material Investigations
- ✔ Sub-Soil Investigations

5.2 Reconnaissance and Alignment Study

In-depth study of the available land width (RoW), study of topographic maps of the project area was made and other available relevant information have been collected concerning the existing alignment and the vicinity of the project corridor.

The detailed ground reconnaissance has been taken up immediately after the study of maps and other data. The primary tasks of reconnaissance survey include:

- Topographical features of the area.
- Typical physical features within the RoW for understanding land use pattern along the project stretch.
- Possible alignment alternatives, vis-à-vis, scheme for the construction of additional lanes or paved shoulders parallel to the existing road to the left or right or central widening.
- Provision of the interchanges and underpasses for vehicle/pedestrian/animal crossing
- Traffic pattern and preliminary identification of traffic homogeneous sections.
- Identification of sections passing through congested areas.
- Critical areas requiring detailed investigations
- Requirement for carrying out supplementary investigations.

- Soil (textural classifications) and drainage conditions.
- Type and extent of existing utility services along the alignment (within RoW).
- Identification of various agencies of the Govt. from whom the concerned project clearances for implementation are to be sought.
- General observations of the condition of existing pavement.

5.3 Topographical Survey

The basic objective of the topographic survey is to collect the essential ground features along the greenfield alignment and develop Digital Terrain Model (DTM). The equipment used for this purpose is Drone. This data forms the basis for all the designs to be carried out, so as to take care of design requirements of new carriageway, possible improvements in highway geometrics, identifying areas of restriction and their remedies and relocation of utilities. The data collected will result in the final design and for the computation of earthwork and other quantities required. The detail methodology including the various intermediate quality check procedures, control points and pillars, horizontal and vertical controls etc. have been described in detail, in the QAP, document submitted to NHAI.

5.3.1 Scope of Work

The detailed scope of services is enclosed in the contract agreement.

(a) Topographic Surveys along the Proposed Right of Way (RoW):

- Running a continuous open traverse along the proposed greenfield alignment.
- Fixation of Horizontal Intersection Points (HIP's), centre points, transit points etc.
- Fixing reference pillars on either side of centre line at safe places within the RoW.
- Establishment of Height Control by Auto Level.

(b) Detailed Topographical Survey to generate Digital Terrain Model of the defined corridor of the project road.

(c) Additional survey as required for geometric improvements like designing of Interchanges

5.4 Traffic Studies and Analysis

The methodology and details of traffic studies and analysis are mentioned in detail, in Chapter-8 of Volume-I : Main Report.

5.5 Hydraulic and Hydrological Investigations

5.5.1 Requirements for Hydraulic and Hydrological Investigation

The hydrological study aims at estimating the peak discharge of the flood generated by the run-off of rainfall within the catchment area. The hydrological study requires:

- Knowledge of the characteristics of peak rainfall in the regions
- Knowledge of the characteristics of the catchment areas
- Topographic data about the stream, upstream and downstream
- Survey of India topo sheets maps to a scale of 1:50,000 for identification of catchment area and its characteristics.

5.5.2 Data Collection

Topographic Survey Data: Topographic surveys will be done at all the major and minor river crossings with a view to obtain the cross section of the rivers at the centre line of the road and up to a reasonable distance at upstream and downstream. The High Flood Levels (HFL) will be obtained from existing flood marks/flood marks on Railway bridges or ascertained from enquiry with local knowledgeable persons.

Catchment Areas: The characteristics of the catchment areas will be ascertained from Survey of India topo sheets, to a scale of 1:50,000 from which, catchment area at the proposed bridge site, length of the stream and fall in elevation from originating point to the point of crossing, could be determined. Slope of the stream will be determined from the contours on the topo sheets.

Rainfall Data: For rivers/streams having catchment area more than 25 sq km, CWC Report No. C/16/1988 – Flood Estimation Report for Chambal sub zone 1(b), Flood Estimation Report for Upper Indo-Ganga Plains sub zone 1(e) in which the project site lies will be obtained. These Reports will be referred for determining the characteristics of peak rainfall regimes. These reports have been jointly prepared by CWC, MOST, Ministry of Railways and IMD and contain all the rainfall data required for estimation of design discharge of 25, 50 and 100 year returns periods by applying the Synthetic Unit Hydrograph approach, the parameters of which have been indicated in the above report. For streams having catchment area less than 25 sq km, IRC:SP-13 and RBF-16 have been referred to.

5.5.3 Hydrologic Design

The following methods will be used to estimate the peak discharge for bridge sites on major and minor streams:

- Rational Method
- Synthetic Unit Hydrograph Method

- Area-Velocity Method or Slope Area Method

(i) Discharge estimation for the catchment areas less than 25 Sq. Km (rational method) (ref: IRC:SP-13 and bridges & Floods wing report no. RBF- 16) This is a well known method given in IRC:SP-13 and has been suitably improved as per report RBF-16 and is in use from many years.

Here, 50 year Peak Discharge is calculated by following formula

$$\mathbf{Q_{max} = 0.28fCIA}$$

Where,

Q_{max} = design flood (m^3/s) for 50-year return period

f = Areal Distribution Factor

C = runoff coefficient between 0 and 1.0

A = catchment area (sq.km)

I = mean intensity of rainfall in mm/h during the time of concentration (the time required for the most distant part of the catchment to Contribute to the outflow at bridge site)

Time of concentration has been taken from Bransby- Williams' formula as suggested in RBF-16:

$$\mathbf{t_c = 0.615\ L\ /\ (A^{0.1}\ S^{0.2})}$$

Where,

t_c = time of concentration (h)

L = mainstream length (km)

S = mean slope of mainstream (%)

A = catchment area (Km^2)

Intensity of rainfall has been determined from formula I = 2*R/ (tc+1)

(ii) Synthetic Unit Hydrograph (SUH) Approach for Bridges having Catchment Area More than 25 Sq. Km.

This method has been used for those bridges, which cater for more than 25 sq km of catchment area. In this method 1 hour Synthetic Unit Hydrograph is determined for an ungauged catchment. Following steps have been followed as suggested in CWC report for determination of discharge by this method.

- Physiographic parameters of the ungauged catchment viz. A, L and S will be determined from toposheets or field observations.

- SUH parameters will be computed using the equations set out in subzone manuals.
- The values calculated will be plotted to arrive at a unit hydrograph.
- The design storm duration is taken as equal to base period of unit graph (T_B =1.1* tp).
- Point rainfall is available in the given plate in CWC report for 50 year 24 hr rainfall.
- The areal rainfall of design storm duration is split into 1-hour rainfall increments using time distribution coefficients.
- Estimation of effective rainfall excess unit will be done after taking design loss rate into account.
- Base flow will be estimated based upon the catchment area.
- Finally, for 50 year peak discharge, the effective rainfall excess after removing the losses from rainfall increments are arranged against unit hydrograph ordinates such that the maximum of effective rainfall is placed against the maximum UG ordinate, next lower value of effective rainfall against next lower value of UG ordinate and so on. Sum of the product of the above two added together with base flow gives peak discharge.

(iii) Area Velocity Method/Slope Area Method

This method can be utilised to calculate the discharge from the stream cross-section and stream slope/bed slope at the proposed bridge sites, for both major and minor bridges. After plotting the cross section of the river, and marking the observed HFL, the cross-sectional area (A) and wetted perimeter (P) will be computed.

The velocity and Discharge are calculated using the Manning's formula:

$$V = 1/n\ R^{2/3}\ S^{1/2}$$

$$Q = A \times V$$

Where,

V = Velocity in m/sec

R = Hydraulic mean depth in m

S = Flood slope/bed slope

n = Co-efficient of rugosity

Q = Peak Discharge in cumecs

A = Area of cross section in sq.m

5.5.4 Fixing of Design Discharge

In general, the design discharge is taken as highest of the discharges obtained from above methods. However, the general condition laid down in IRC:SP-13 will be used to fix the design discharge, that is, if the discharge obtained by one method is greater than 1.5 times the discharge obtained from the other, the design discharge should be limited to 1.5 times of the smaller one. In the case where Average discharge obtained by Area Velocity method is higher than 1.5 times the discharge obtained by the other method, design discharge has been taken as that of from previous method. Accordingly, the design discharge has been established for all the bridges. Also in the case where area velocity method is governing case (i.e. discharge by catchment area method is lesser than the area velocity method) and the average discharge by area velocity method has been found lesser as compared to discharge by same at proposed bridge site, the discharge calculated at proposed bridge site has been considered as design discharge.

5.5.5 Afflux Calculation

Since some of the bridges in the alignment will have less clear waterway as compared to natural stream width and also velocities at bridge sites high due to steep bed slopes, this combined effect causes afflux at bridge sites during flood. Afflux for the bridges will be calculated using Weir and Orifice formulae as described in IRC:SP-13.

5.5.6 Vertical Clearance

The vertical clearance for each structure will be calculated as per the standards set out in IRC:SP-13.

5.6 Material and Geo-Technical Investigations

5.6.1 Material Investigations

It has been ensured that all Geo-technical investigations confirm to IRC, BIS codes and MoRT&H specifications. The Geo-technical investigation scheme has been prepared in accordance with the "Terms of reference".

The Material investigations for road construction have been carried out to identify the potential source of construction materials and to assess their general availability, nature and quantum of materials available for the project. This is one of the most important factors for stable, economic and successful implementation of the project within the stipulated time frame. The investigation and testing of materials is carried out in accordance with MoRT&H, IS and IRC specifications.

Objectives:

The investigation on these material sources was carried out with the following basic objectives.

- Material investigation was carried out based on information collected from local PWD, Panchayat office, Zilla parishad office and from material suppliers along with public enquiry.
- Investigations have been carried out to identify and assess potential sources for bulk procurement of the following materials.
- Embankment fill material
- Gravel for sub-grade
- Natural Gravel for GSB, if any
- Stone quarry for aggregate to be used for bituminous & non bituminous layers and GSB in case of non-availability of natural GSB
- Sand to be used for Cement Concrete
- Demarcating the location of source indicating place, kilometer stone and lead distance from the project road and the status whether it is in operation or new source.
- Identify the ownership of land/quarry, (Government or Private).
- Testing of materials to indicate the quality, classification and suitability of materials.
- To asses probable use of materials at various stages of construction activities, i.e. embankment fill, sub-grade, sub-base, wearing course and structures.
- During the process of investigation, due consideration has been given such that no material shall be selected from the right of way, at the same time locally available materials were selected for reducing the cost of construction.

5.6.2 Material Testing

The samples from various identified sources have been collected for laboratory testing as per IS & AASHTO standards.

(i) Interpretation of Test Results

The test results of soil samples have been presented as per IS:1498-1959. In addition to the tests already mentioned, soil samples to be used for sub-grade purpose shall be tested for soaked CBR in the laboratory on remoulded specimen compacted to 97 per cent Modified Proctor Density at Optimum Moisture Content.

For this purpose, three individual specimens are subjected to different blows (10, 30 and 65) and CBR for each of the soaked specimen is determined. Actual CBR value corresponds to 97% of MDD is determined from a graph plotted between CBR and corresponding dry density.

a) The following tests have been performed on stone aggregate collected from various quarries:

- Aggregate Impact Value
- Specific Gravity
- Water Absorption

b) Granular sub-base materials have been tested for its grading and Atterberg Limits. In addition, a soaked CBR test has been carried out following the standard procedure at 98% of modified Proctor Density. The sub-base material could be either natural granular material available in the quarries/borrow areas or shall be designed using crushed aggregates to meet the specific requirements of sub-base material as per MoRT&H specifications. The LL and PI of such material shall not be more than 25% and 6% respectively and soaked CBR value shall not be less than 30%.

c) For proper identification, index map and quarry charts, showing the following details will accompany the tables: Approximate Quantities and type of material available from each quarry source.

d) Location of each quarry and the distance up to the nearest link point of the Project Highway. The coarse aggregate for Wet Mix Macadam sub-Base/Base shall be crushed stone and confirm to MORT&H specification. Potential quarries have been identified in consultation with Forest/Mining departments. and shown in quarry charts. In case crushed gravel/shingle has to be used for advantage of availability and economy, not less than 90 percent by weight of the gravel/shingle pieces retained on 4.75mm sieve shall have at least two fractured faces.

5.6.3 Methodology For Conducting Sub-Soil Investigations

Geotechnical investigations are carried out with a view to furnish the Detailed Technical Information of the nature of sub-soil strata for foundation design and assessment of stability of high embankments.

5.6.4 Objectives And Scope Of Work

The objectives of Geo-Technical Investigation is to evaluate the following:

a) To ascertain the sub-soil strata at structure locations.
b) To study standing Ground Water Level.
c) To study the physical and engineering properties of soil strata.
d) To evaluate allowable safe bearing capacity of soils to design foundations.

e) To recommend type and depth of foundation.
f) To recommend improvements to the weak soil strata if any.
g) To evaluate the stability of high embankment.

The Scope of Geotechnical Investigations includes the following field and Laboratory Tests.

(i) Field Investigations

The scope of Field investigations is as follows:

- Boring of 150-mm dia holes in all kinds of soils up to refusal strata (N>100 Blows for 30 cms penetration) using Auger equipment.
- Boring of 150-mm dia Boreholes in all kinds of soils in Hard Rock whichever encounter early using Calyx operated Rotary Boring Rig with Wash Boring Method.
- Collecting Disturbed / Representative samples (DS / RS) during drilling and also during SPT Tests. Disturbed samples using the split spoon sampler and UDS samples using 100 mm thin walled Shelby tubes shall be collected. The samples recovered will be packed in polythene bags, labelled and sent to the laboratory for testing.
- During field investigations, the standing Water Table levels will be studied and recorded in the Borehole log.

(ii) Laboratory Testing

The scope of Laboratory Testing is as follows:

(a) For Samples Obtained from SPT

- Grain Size Analysis as per IS 2720 part 4.

(b) For samples Obtained from UDS tube:

- Specific Gravity as per IS 2720- part 3-Section 1 and IS 2720 – part 3
- Grain Size Analysis as per IS 2720 part-4
- Atterberg Limits as per IS 2720 part 5, IS 2720 part 2.
- Determination of natural moisture content as per IS 2720 part 2.
- Determination of natural density as per IS 2720
- Determination of Tri-axial Shear Strength tests by UU and CU method as per IS 2720-part 10

(c) For samples Obtained from Rock Cores:

- Determination of Specific Gravity and Water Absorption of Rock Core Samples.
- Determination of Unit Weight and Classification of Rock Core Samples.
- Determination of Unconfined Compressive Strength of Rock Core Samples.

5.6.5 Contents Of Geo-Technical Report

The report shall include in brief, the following contents:

1. The test procedure employed
2. The sample calculation with reference to formula used to evaluate various parameters.
3. Summary of various soil parameters evaluated.
4. Type and character of soil.
5. Procedure of Investigation
6. Detailed bore logs, sub-soil strata, laboratory and field-test results.
7. Results obtained and their interpretation.
8. Recommendation for type and depth of formulation. Safe bearing capacity and settlement of the foundations adopted.
9. All recommendations shall be supported by a set of sample and back up calculations.
10. Any other information of special significance encountered during investigations shall be brought out in the Geo – Technical report.

6.0 Socio-Economic Profile

6.1 General

Generally, the area which contributes to the total traffic plying on the road is called the project influenced area (PIA). PIA is further classified into broad and immediate influence area depending on its proximity from project corridor. The immediate influence area for the current study comprises of Ananthapuramu, YSR Kadapa, SPS Nellore and Prakasham districts Andhra Pradesh state.

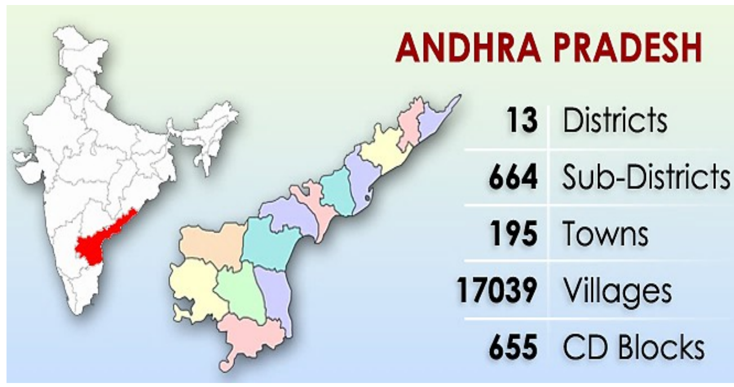
The districts through which the project road passes are considered to be the primary project influence area. The Andhra Pradesh state highways facilitate most important traffic movement for the various important towns of the state. Therefore, the influence area of the project corridor, for the purpose of socio economic study is considered with prime importance. The primary purpose of Socio-economic analysis is to provide an overview of the state's socio-economic setup and the relative status of the project influence area within the state. Data to be considered include demographic aspects, macro economic indicators and sectoral production of agriculture and allied activities, manufacturing, mining and service sectors including infrastructure. The profile provides the present scenario, the past performance and the prospective growth of the economy, population and urbanization. The profile depicts the spatial distribution of economic activities and provides basic inputs for estimating future growth in transport demand, on the basis of prospective economic growth rates and transport demand elasticity. Secondary data available with different state government departments have been collected and analyzed for preparation of socio-economic profile.

6.2 Andhra Pradesh State at a Glance

With a geographical area of 1,60,205 sq. km., Andhra Pradesh ranks as the 8th largest state in the country. The state is bound on the North by Odisha and Chhattisgarh, on the West by Telangana and Karnataka, on the South by Tamilnadu and on the East by the Bay of Bengal. Situated in a tropical region, the state has the second longest coastal line in the country with a length of 974 km. The state has a forest area of 34,572 sq.kms, which accounts for 21.58% of the total geographical area. Andhra Pradesh is the 10th largest state in the country, in terms of population. As per 2011 Census, the state accounts for 4.10% of the total population of the country. The decadal growth of population rose from 18.88% during 1961-71 to 21.13% during 1981-91.

Subsequently a significant decline was observed in the rate of growth of population and decline is even more prominent at 9.21% during 2001-11, lower than the All-India's growth rate of 17.72% in the same period.

The density of population for Andhra Pradesh is 308 persons per square kilometer, as against 368 persons per square kilometer at all India level in 2011. The sex ratio in the state was up from 983 in 2001 to 997 in 2011 and is higher than all India figure of 943. The literacy rate of the state is 67.35% which is lower than the all India literacy rate at 72.98%. Literacy in Andhra Pradesh increased over 37% points from 29.94% in 1981 to 67.35% in 2011. Female literacy rate has been at 59.96%.



Urbanization has been regarded as an important component for growth realization. The percentage of urban population to the total population in the state is 29.59%. The land utilization has been 38.31% of the state geographical areas which is under net area sown (62.35 lakh hectares), 22.51% under forest (36.63 lakh hectares), 8.61% under current fallow lands (14.01 lakh hectares), 12.30% under land put non-agricultural uses (20.02 lakh hectares), 8.30% under barren and uncultivable land (13.51 lakh hectares) and remaining 9.97% is under other fallow land, cultivable waste lands like permanent pastures and other grazing lands and land under miscellaneous tree crops and groves are not included in the net area sown.

6.3 Economics of Andhra Pradesh

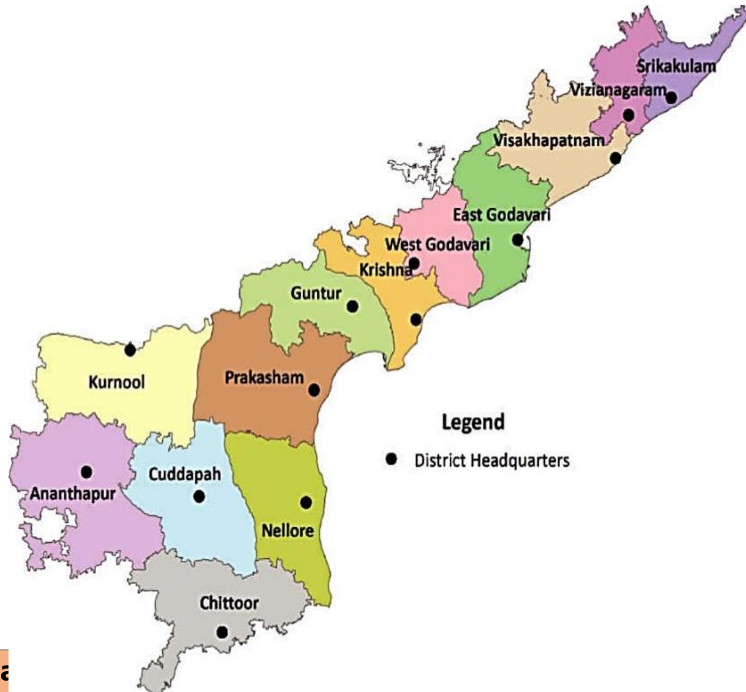
Andhra Pradesh has a very diverse geography that supports an eclectic economy. As many as 9 out of the 13 districts are along the sea coast of the Bay of Bengal that resulted in a flourishing manufacturing-and-export-centric industry. The fertile river plains in the delta regions of major peninsular rivers of Godavari and Krishna are rich with agriculture-based industries. The mineral deposits found in the districts of Rayalaseema, Eastern Ghats and neighbouring states contribute to large-scale ore exports.

The GSDP at Current Prices for the year 2015-16 (Estimates) stands at ₹6,03,376 crore. the GSDP at constant (2011-12) Prices for the year 2015-16 is estimated at ₹4,93,641 Crores as against ₹4,44,752 crores for 2014-15 (First Revised Estimates) indicating a growth of 10.99

percent.

The GVA at Constant (2011-12) Basic Prices for the year 2015-16 is estimated at □4,55,484 crore as against □4,12,188 crore of 2014-15 (FRE), registered a growth rate of 10.50%. The sectoral growth rates of GVA of Andhra Pradesh at constant (2011-12) prices are Agriculture: 8.4%, Industry: 11.13% and Services sector: 11.39%. The Per Capita Income (NSDP) of Andhra Pradesh at current prices increased to □1,07,532 from □95,689 in 2014-15 registering a growth of 12.38%.

The economy of the state is mainly based on agriculture and livestock, as it is an exporter of many agricultural products. Hence the state is also known as "*The Rice Bowl of India*". Four important rivers of India, *viz.*, Godavari, Krishna, Penna and Thungabhadra flow through the state and provide beautiful water resources for irrigation. Agriculture is the main occupation and about 60% of the population is engaged in agriculture and related activities. Rice is the major food crop and the staple food of the state. Livestock and poultry are also other profitable businesses that involve rearing cattle in enclosed areas for commercial purposes. The state is also the largest producer of eggs in the country and hence it is nicknamed as "*The Egg Bowl of Asia*".



Pa	h	India
Capital	Amaravati	New Delhi
Geographical Area (sq. km.)	1,60,205	31,66,414
Administrative Districts (No.)	13	640
Population Density (persons / sq. km)	308	382
Total Population of Combined State (Lakhs)	845.80	12105
Total Population Not Including Telangana (Lakhs)	493.86	-
Male Population (Lakhs)	424.4 (50.1%)	6231 (51.5%)
Female Population (Lakhs)	421.4 (49.9%)	5874 (48.5%)
Sex Ratio (Females per 1,000 males)	996	943
Literacy Rate (%)	67.41%	73%

Source: *www.ap.gov.in*

Coastal Andhra Pradesh, as per 2011 census, has an area of 92,906 km^2 which is 57.99% of the total state area and a population of 3,41,93,868 which is 69.20% of Andhra Pradesh state population. This area includes the coastal districts of Andhra Pradesh between the Eastern Ghats and the Bay of Bengal, from the northern border with Odisha to south of the delta of the Krishna

River. The coastal line of this region is the second largest in India, extending 960 km. Vijayawada, Vishakapatnam, Tirupati, Guntur and Kakinada are the notable cities in this region. Rayalaseema, which includes the four southern districts of Anantapur, Chittoor, Kadapa and Kurnool, is located in the southern region of Andhra Pradesh. As of 2011 census of India, the region with four districts has a total population of 15,184,908 and covers an area of 67,526 km^2. The region borders the state of Tamil Nadu to the south, Karnataka to the west and Telangana to the north.

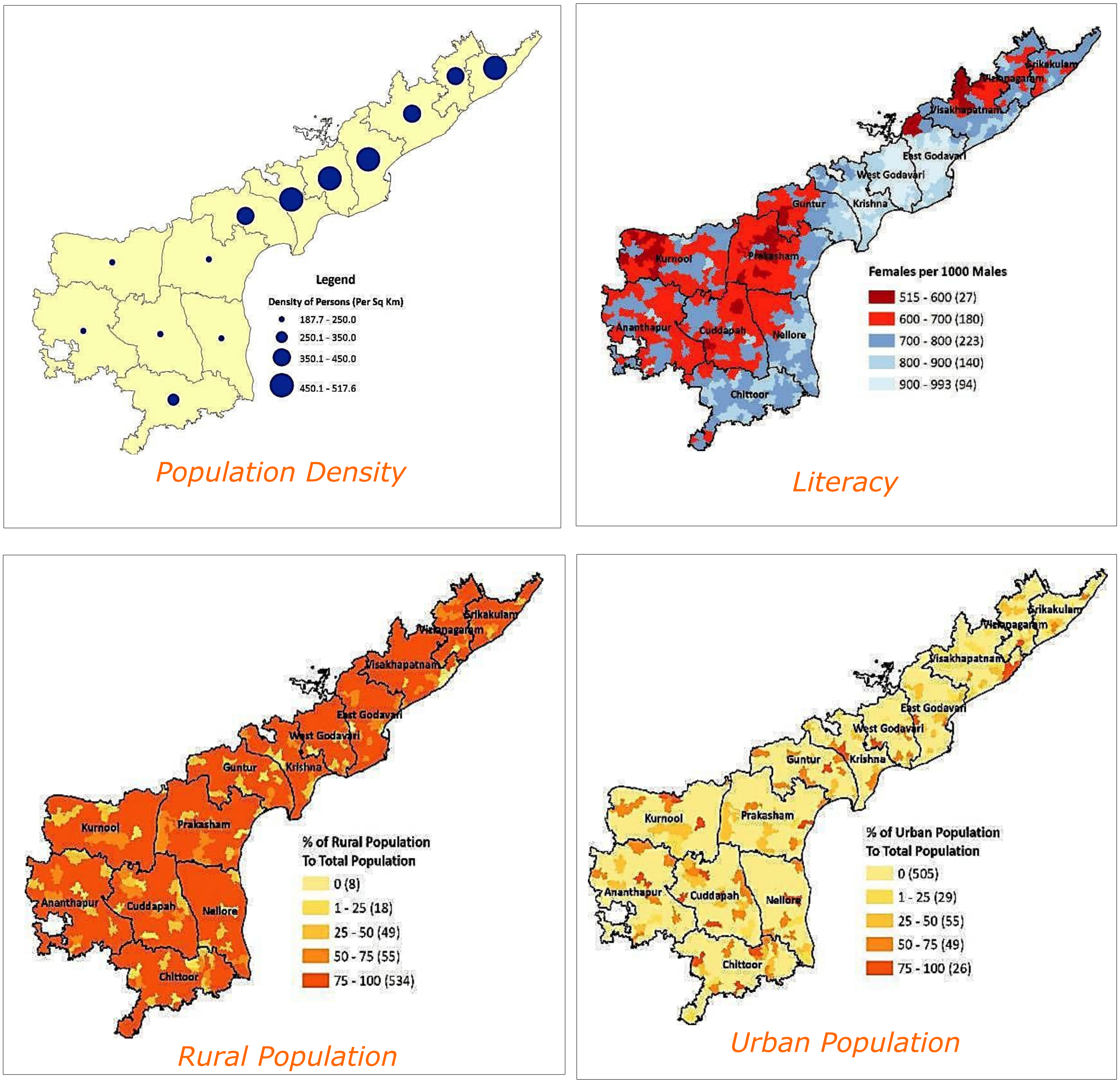


Figure-6.1: Demographics of Coastal Andhra Pradesh and Rayalaseema

The industrial sector of the state includes some of the key sectors like pharmaceuticals, automobiles, textiles, etc. The state is also emerging in Information Technology and Biotechnology. The IT/ITES revenue of the district of Visakhapatnam alone was at ₹14.45 billion ($230 million) in the FY 2012–13. The development of IT in Tier-II and Tier-III cities is also increasing very rapidly. Fisheries contribute to 10% of total fish and over 70% of the shrimp production of India. The geographical location of the state allows marine fishing as well as inland fish production. The most exported marine goods include Vannamei shrimp that crossed revenue of $1 billion in the FY 2013-14. The exports from the state have recorded as Rs.19,183.74 crore in the first half of the year 2015-16.

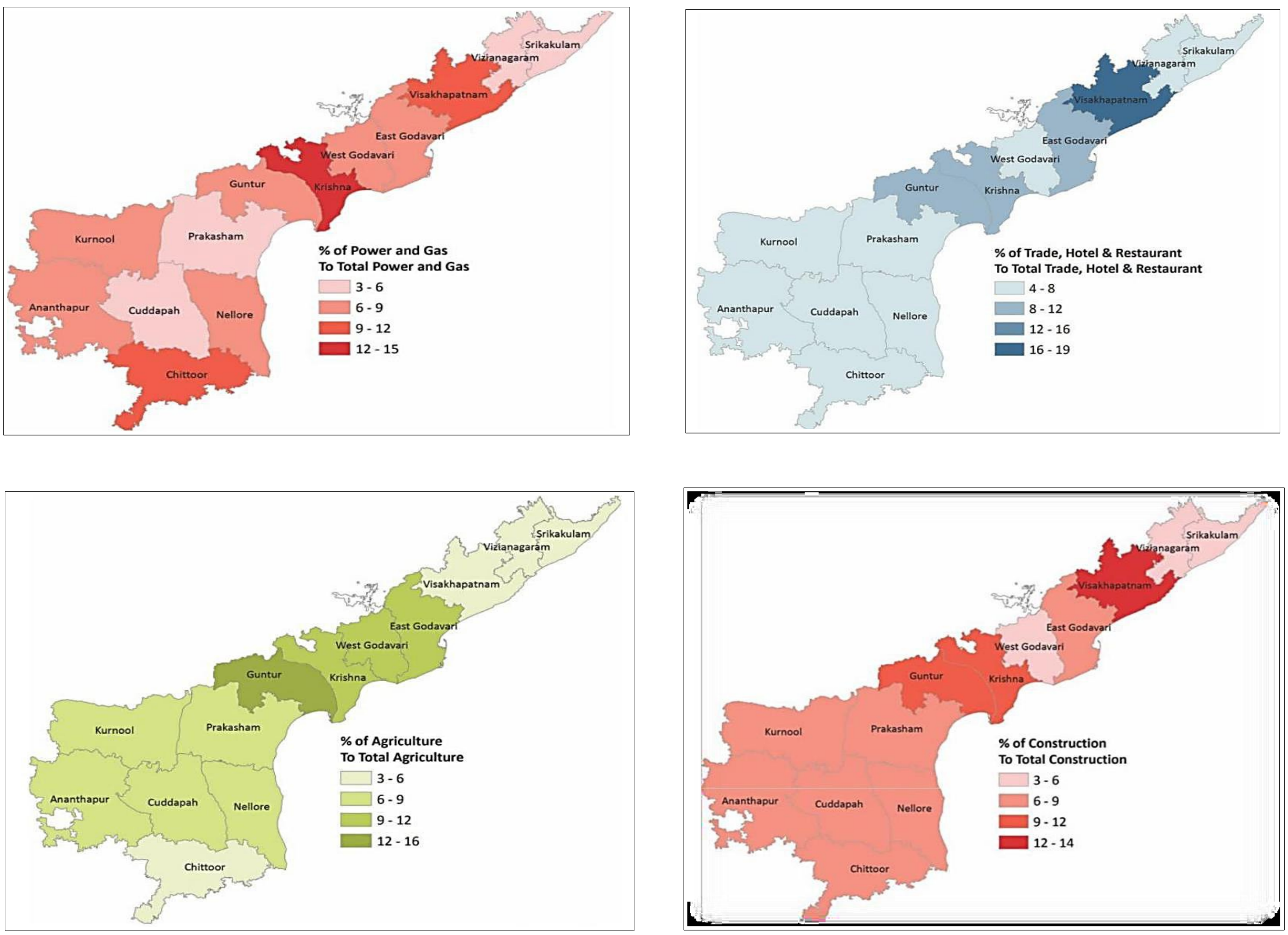


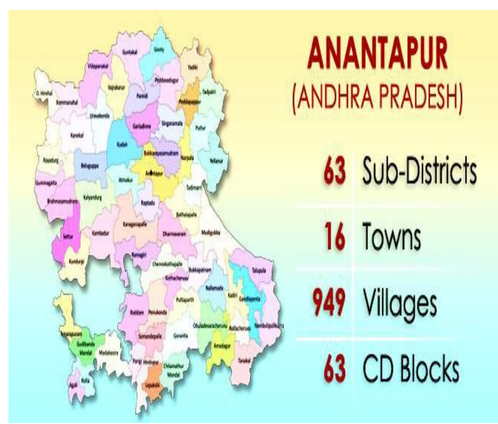
Figure-6.2: Economics Abstract of Andhra Pradesh

6.4 Profile of Project Influenced Districts

The proposed expressway passes through the districts of Anantapur, YSR Kadapa, SPS Nellore and Prakasham. The demographic and economic features of project districts are briefly explained below:

6.4.1 Anantapur District

Ananthapur district lies in the Rayalaseema region of Andhra Pradesh state with the administrative headquarters located in the city of Ananthapur. As of 2011 Census, the district had a population of 40,81,148, of which 28.07% is urban and a literacy rate of 63.57%. It is the largest district in terms of area in Andhra Pradesh and 7th largest district in India respectively. It is bounded on the north by Kurnool district, on the east by Kadapa district, on the southeast by Chittoor district, and on the southwest by Karnataka state. It is part of Rayalaseema region on the state. Its northern and central portions are a high plateau, generally undulating, with large granite rocks or low hill ranges rising occasionally above its surface. In the southern portion of the district the surface is more hilly, the plateau there rising to 2,000 ft (610 m). above the sea. Six rivers flow within the district viz., the rivers of Penna, Chithravathi, Vedavathi, Papagni, Swarnamukhi and Thadakaleru.



The district receives an average annual rainfall of 381 millimeters. Anantapur has a major potential for development of industry due to its strategic location between Bangalore -Chennai, Bangalore - Hyderabad routes and availability of vast tracts of land. In 2006 the Indian government named Anantapur one of the country's 250 most backward districts (out of a total of 640).

It is one of the thirteen districts in Andhra Pradesh currently receiving funds from the Backward Regions Grant Fund Programme(BRGF). The economy is principally agrarian with a developing industrial sector. Anantapur receives very less rainfall due to its location in the rain shadow area of Indian Peninsula.

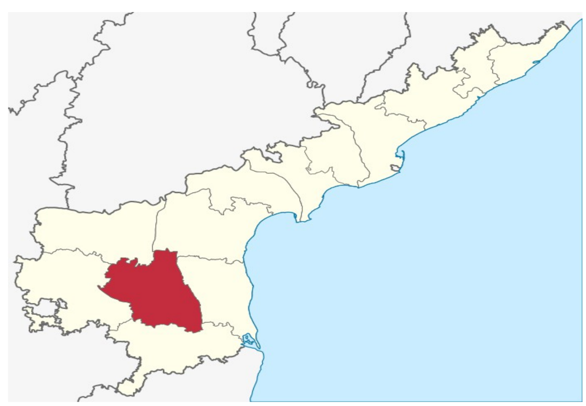
Table-6.1: Demographic Features of Ananthapur District

Total Area (sq. kms)	19,130	Male Population	20,64,495
Population density (persons/sq. km)	213	Female Population	20,16,653
Population Growth Rate (%)	11.77	Rural Population (%)	71.93
Literacy Rate (%)	63.57	Urban Population (%)	28.07
Total Population	40,81,148		

Source: *www.anantapuramu.ap.gov.in*

Anantapur town is known as Groundnut city in reference to the neighbouring Bangalore being called as Garden City. The economy is principally agrarian with a developing industrial sector. Anantapur Receives very less rainfall due to its location in the rain shadow area of Indian peninsula. Prominent crops include groundnut, sunflower, rice, cotton, maize, chillies, sesame and sugarcane. Silk trade, limestone quarrying, iron and diamond mining are common industrial practices in the district. The district has five revenue divisions viz. Anantapur, Dharmavaram, Kadiri, Kalyandurg and Penukonda. Kadiri and Kalyandurg divisions were formed recently in the year 2013. These revenue divisions were further divided into 63 mandals.

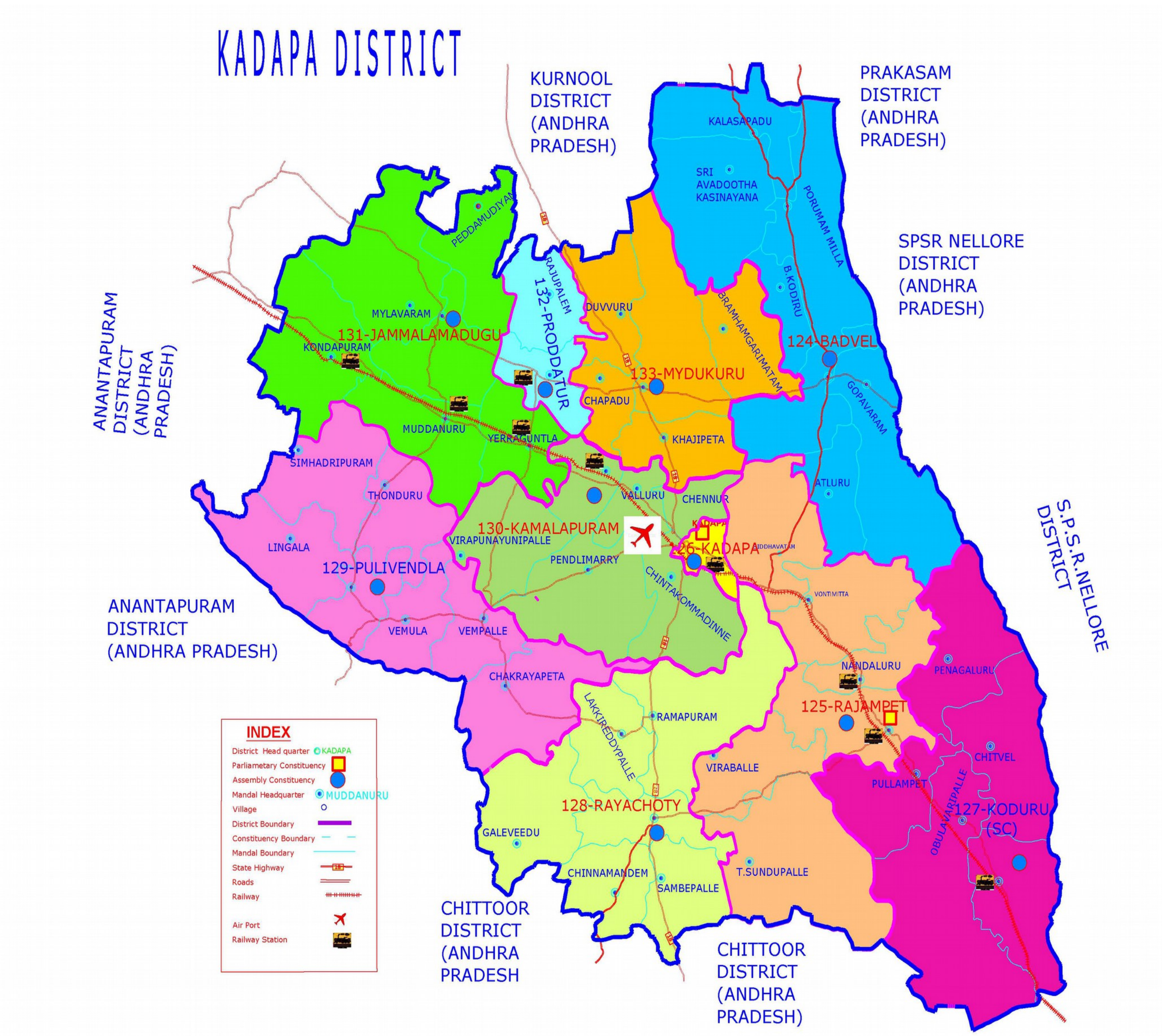
6.4.2 YSR Kadapa District



YSR Kadapa district lies in the Rayalaseema region of Andhra Pradesh state with the administrative headquarters located in the city of Kadapa. As of 2011 Census, the district had a population of 28,82,469, of which 33.97% is urban and a literacy rate of 67.30%. This district was renamed as YSR Kadapa in honour of Dr. Y. S. Rajasekhar Reddy, commemorating former Chief Minister of combined Andhra Pradesh. It is the 4th largest district in terms of area in Andhra Pradesh. YSR Kadapa district is said to be the heart of the Rayalaseema region as it is centrally located and well connected with the 4 districts of Rayalaseema. This district has a glorious history and rich in cultural heritage. It is bounded on the north by Kurnool district, on the west by Anantapur district, on the northeast by Prakasham district, on the east by Nellore district, and on the south by Chittoor district.

YSR Kadapa district is the extreme south eastern district of Andhra Pradesh situated within the geographical co-ordinate of 13° – 43° and 15° – 14° of northern latitude and 77° – 29° of eastern longitude. The latitude varies from 269 to 3787 metres above sea level. The district is bounded on north by Kurnool, on the south by Chittoor, on the west by Anantapur and on the east by Nellore districts. The district spreads north-wards beneath the western slopes of the eastern ghats as a rough parallelogram dented deeply in its southern, western and northern boundaries. The main rivers that flow in this district are Penna, Chitravathi, Kunderu, Papaghni, Sagileru and Cheyeru. The district receives an average annual rainfall of 700 millimeters. YSR Kadapa has a major potential for development of industry due to its strategic location between Kadapa-Kurnool-Chittoor, Kadapa-Vempalle, Kadapa-Sindout, Bangalore - Chennai, Bangalore - Hyderabad, Bangalore - Vijayawada routes and availability of vast tracts of land.

A major irrigation sources in the district are K-C canal, the Mydukur and the Chapadu Project, the upper Sagileru and lower Sagileru and the Pincha Projects. Paddy, Groundnut, Red gram, Cotton, Bengal gram are the major Agricultural crops. Mango, Citrus, Banana, Melons and Papaya are the fruit crops. Turmeric, Onion, Chillies, Coriander, Vegetables and Chrysanthemum are other commercial crops grown in the district.



In 2006 the Indian government named Kadapa district as one of the country's 250 most backward districts (out of a total of 640). It is one of the thirteen districts in Andhra Pradesh currently receiving funds from the Backward Regions Grant Fund Programme (BRGF). The Gross District Domestic Product (GDDP) of the district is ☐26,342 crore and it contributes 5.0% to the Gross State Domestic Product (GSDP). For the FY 2013–14, the per capita income at current prices was ☐70,821. The primary, secondary and tertiary sectors of the district contribute ☐6,204 crore, ☐6,935 crore and ☐13,203 crore respectively.

Table-6.2: Demographic Features of YSR Kadapa

Total Area (sq. kms)	15,359	Male Population	14,51,777
Population density (persons/sq. km)	188	Female Population	14,30,692
Population Growth Rate (%)	10.79	Rural Population (%)	66.03
Literacy Rate (%)	67.30	Urban population (%)	33.97
Total Population	28,82,469		

Source: *www.anantapuramu.ap.gov.in*

6.4.3 SPS Nellore District

Nellore district, officially Sri Potti Sriramulu Nellore district, is one of the thirteen districts of Andhra Pradesh. According to the 2011 Census, the district's population was 29,63,557, of which 28.94% was urban population. Its administrative headquarters are located in Nellore city. Located in the Coastal Andhra region, the district is bordered by the Bay of Bengal to the east, Kadapa district to the west, Prakasam district to the north, and Chittoor district and Tiruvallur district of Tamil Nadu to the south. The island of Sriharikota, the site where most Indian spacecrafts of ISRO are launched, is located in Nellore district.

The district's average elevation is 19 metres. Eastern Nellore consists of an area of low-lying land extending from the base of the eastern hhats range to the Bay of Bengal, while the western side is comparably more mountainous and is separated from neighbouring Cuddapah district by the Velikonda hills, part of the Eastern Ghats. 25.96% of districts land area is cultivated, while 17.75% is cultivable but fallow. The remainder consists of land used for non-agricultural purposes (18.68%), forested land (20.09%) and barren land (10.56%) unsuitable for human cultivation. The Pennar, Swarnamukhi and Gundlakamma are the main rivers that flow through the district.

These rivers, in addition to the Penna's tributaries, including the Kandaleru and Boggeru rivers, are not navigable and mainly serve to irrigate nearby farmland. Nellore is rich in a particular type of flint known as quartzite, which prehistoric humans used to make weapons and implements.

The average annual rainfall of the district is 1,080 mm, and reaches its peak during the southwest and northeast monsoons. Nellore is subjected to both droughts and floods, depending on the seasons.

The Gross District Domestic Product (GDDP) of Nellore district is ☐30,482 crore (304.82 billion rupees) and makes up 5.8% of Andhra Pradesh's Gross State Domestic Product (GSDP). For the fiscal year 2013–14, Nellore's per capita income at current prices was ☐80,782 (US$1,100). The primary, secondary and tertiary sectors of the district contribute ☐9,729 crore, ☐6,320 crore and ☐14,433 crore (97.29 billion, 63.2 billion and 144.33 billion rupees), respectively. The major agricultural contributors to the district's gross value added (GVA) include: paddy, sugarcane, lemon, tomato, milk, meat and fisheries. The major industrial and service contributors to the district's GVA include: construction, electricity, manufacturing, transport and education. Nellore district produces most of the crude mica in India.

The soils of the district are classified as black, red and sandy. The red soil is predominant with 40% of the area in the district whereas a belt of sand runs along the sea coast. The black cotton soil and sandy loams occupy 23% and 34% of the area respectively. 20.80% of the total area of the district is occupied by forest. Some of the notable places of Nellore district are Krishnapatnam port, Ranganadha Swamy temple, Penchalakona, Narasimhakonda, Jonnawada, Ayyappa swamy temple, Kasumuru mastanvali dargah, A.S Pet Mosque, Mypadu beach, Somasila, Pulicat lake, Nelakattu birds sanctuary and Sriharikota Rocket Launching Station.

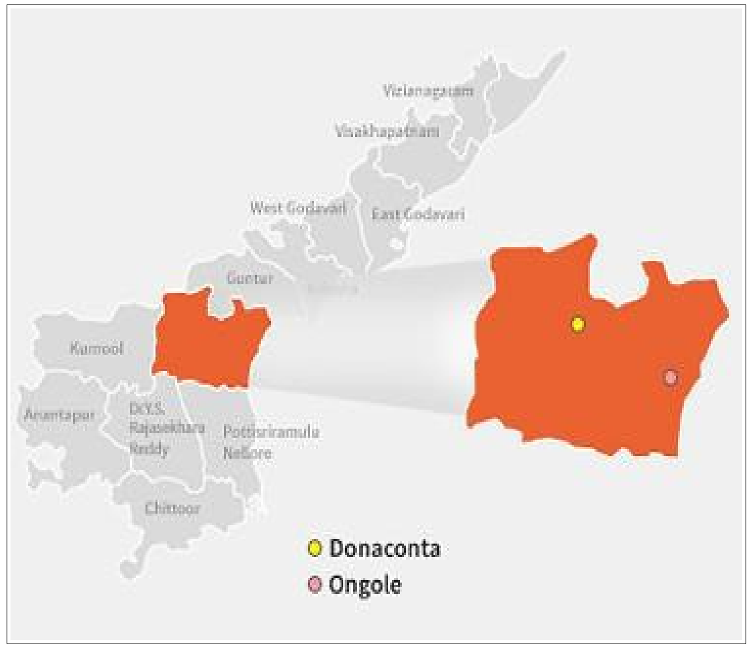
Table-6.3: Demographic Features of SPS Nellore District

Total Area (sq. kms)	13,076
Population density (persons/sq. km)	227
Population Growth Rate (%)	11.05
Literacy Rate (%)	68.90
Total Population	29,63,557

Male Population	14,92,974
Female Population	14,70,583
Rural Population (%)	71.06
Urban population (%)	28.94

Source: *www.anantapuramu.ap.gov.in*

6.4.4 Prakasham District

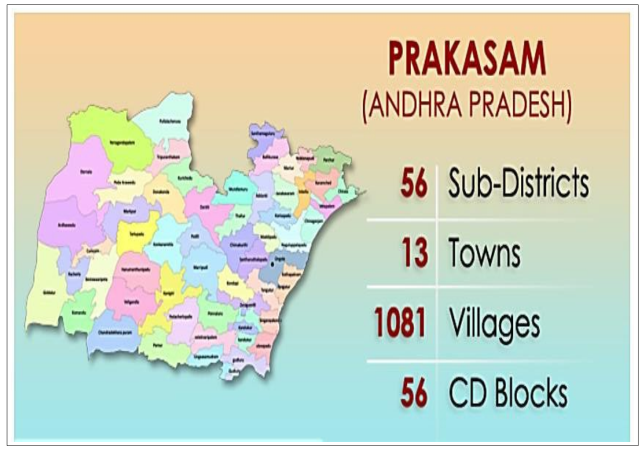


Prakasam district is an administrative district in the Coastal Andhra region of the Indian State of Andhra Pradesh. The headquarters of the district are located at Ongole. It is located on the west coast of Bay of Bengal and is bounded by Guntur district on the north, Kurnool district on the west, Kadapa and Nellore districts on the south. A part of north west region also borders the Mahabubnagar district of Telangana. It is the 3rd largest district in the state with an area of 17,626 square kilometer and had a population of 33,97,448 as per 2011 census.

The only Municipal Corporation in Prakasam is Ongole. Some of the main towns in Prakasam district are Singarayakonda, Addanki, Inkollu,Markapur, Yerragondapalem, Podili, Darsi, Donakonda, Chirala, Kandukur, Pamuru, Parchur, Giddaluru, Dornala, Cumbum, Kanigiri,Chimakurthy and Martur. Markapur is India's main slate manufacturing town where the historic temple of Lord Chennakesava is situated. Chimakurthi is world-renowned for its granite reserves. Dornala is also known as Diguva Srisailam, since it is very near to the historic pilgrimage center of Srisailam.

Cumbum lake also known as Gundlakamma lake built on Gundlakamma rivulet upon Nallamala hills is one of the oldest and largest man made lakes of Asia. The anicut was built by the Gajapati kings of Orissa in 15th Century A.D. when the area was under their control. It was subsequently renovated by the Vijayanagar princess Varadharaj Amma.

The lake in its present form is about 7 km long and on average, about 3.5 km wide as per the Imperial gazette of India at the turn of the 20th century the height of the dam was 57 feet (17 m) and the drainage area was 430 square miles (1,100 km^2). The direct irrigation land is about 10,300 acres (42 km^2) in all. Cumbum lake is accessible both by the rail Guntur-Nandyal railway line and by road 108 km from Ongole.



There are 1081 Villages in 2011 Census of which (96 Uninhabited and 985 habited), 56 Mandals (Rural) 3 Revenue Divisions, 13 towns (4 Statutory as Municipalities and 9 census towns) and 2 urban Agglomerations. As per 2011 census, Prakasam district has a population of 33,97,448. It is the 98th most populous district in India (out of a total of 640). The district had a population density of 192 inhabitants per square kilometre (500/sq mi). Its population growth rate over the decade 2001–2011 was 11.05%.

Prakasam has a sex ratio of 981 females for every 1000 males and a literacy rate of 63.53%. Prakasam district has highest SC population than any other district of the state standing at 7,87,861 (this is 23.2% of districts population). Cumbum mandal showed very good growth indicators in the 2011 census. According to census of India, Cumbum mandal has been recognized as the second highest in literacy in Praksam district having 73.55% literates after Ongole Mandal. Also Cumbum mandal is the third highest in sex ratio in Prakasam district having 1031 female population per 1000 males.

Table-6.4: Demographic Features of Prakasam District

Total Area (sq. kms)	17,626
Population density (persons/sq. km)	193
Population Growth Rate (%)	11.05
Literacy Rate (%)	63.08
Total Population	33,97,448

Male Population	17,14,764
Female Population	16,82,684
Rural Population (%)	80.44
Urban population (%)	19.56

6.5 Comparision of Demographic Profile/Statistics of Project Influenced Districts with State

S.No	Particulars	Anantapur	YSR Kadapa	SPS Nellore	Prakasham	Andhra Pradesh
1	**Geographical Area (Sq. Km)**	19,130	15,359	13,076	17,626	1,60,205
2	**Population as per 2011 Census**					
(a)	Total Population	40,81,148	28,82,469	29,63,557	33,97,448	4,93,86,799
(b)	Male Population	20,64,495	14,51,777	14,92,974	17,14,764	2,47,38,068
(c)	Female Population	20,16,653	14,30,692	14,70,583	16,82,684	2,46,48,731
3	**Sex Ratio**	977	985	985	981	992
(a)	Rural	971	983	985	977	988
(b)	Urban	991	990	985	1,001	990
4	**Total Rural Population**	29,35,437	19,03,337	21,05,927	27,32,866	3,47,76,389
(a)	Male Rural Population	14,89,157	9,59,693	10,60,810	13,82,641	1,75,38,000
(b)	Female Rural Population	14,46,280	9,43,644	10,45,117	13,50,225	1,72,41,389
(c)	% of Rural Population to Total Population	71.93	66.03	71.06	80.44	70.41
5	**Total Urban Population**	11,45,711	9,79,132	8,57,630	6,64,582	1,46,10,410
(a)	Male Urban Population	5,75,338	4,92,084	4,32,164	3,32,123	72,92,000
(b)	Female Urban l Population	5,70,373	4,87,048	4,25,466	3,32,459	73,18,410
(c)	% of Urban Population to Total Population	28.07	33.97	28.94	19.56	29.59

S.No	Particulars	Anantapur	YSR Kadapa	SPS Nellore	Prakasham	Andhra Pradesh
6	**Density of Population**	213	188	227	193	308
8	**Growth Rate over the previous census**	11.77	10.79	11.05	11.05	11.10
9	**Child Population (0-6)**					
(a)	Total Population	4,45,956	3,31,586	3,04,309	3,78,261	52,22,384
(b)	Male Population	2,31,369	1,72,902	1,56,907	1,95,753	26,86,453
(c)	Female Population	2,14,587	1,58,684	1,47,402	1,82,508	25,35,931
10	**Literates**					
(a)	Total Literates	23,10,960	17,16,766	18,32,189	19,04,435	3,32,62,009
(b)	Male Literates	13,38,474	9,94,699	10,11,922	11,07,686	2,48,70,004
(c)	Female Literates	9,72,486	7,22,067	8,20,267	7,96,749	83,92,005
11	**Literacy Rate**					
(a)	Total Literacy Rate	63.57	67.30	68.90	63.08	67.35
(b)	Male Literacy Rate	73.02	77.78	75.74	72.92	74.77
(c)	Female Literacy Rate	53.97	56.77	61.99	53.11	59.96
12	**Scheduled Caste Population**					
(a)	Total Population	5,83,135	4,65,794	6,66,588	7,87,861	81,04,374
(b)	Male Population	2,92,379	2,32,123	3,32,673	3,97,242	42,14,274
(c)	Female Population	2,90,756	2,33,671	3,33,915	3,90,619	38,90,100
(d)	% of SC population to Total Population	14.28	16.16	22.49	23.19	16.41

S.No	Particulars	Anantapur	YSR Kadapa	SPS Nellore	Prakasham	Andhra Pradesh
13	**Scheduled Tribe Population**					
(a)	Total Population	1,54,127	75,886	2,85,997	1,51,145	34,57,045
(b)	Male Population	78,573	38,571	1,45,168	76,677	17,63,093
(c)	Female Population	75,554	37,315	1,40,829	74,468	16,93,952
(d)	% of ST population to Total Population	3.77	2.63	9.63	4.45	7.00
14	**Workers**					
(a)	Total Workers (Main+Marginal)	20,36,166	13,20,404	13,14,561	17,00,567	3,48,93,859
(b)	Male	12,08,544	8,23,886	8,59,880	9,91,842	2,16,62,192
(c)	Female	8,27,622	4,96,518	4,54,681	7,08,725	1,32,31,667
15	**Non Workers**	20,44,982	15,62,065	16,48,996	16,96,881	1,44,92,940
(a)	Male	8,55,951	6,27,891	6,33,094	7,22,922	8424751
(b)	Female	11,89,031	9,34,174	10,15,902	9,73,959	60,68,189
16	**Agriculture Workers (Cultivators+Agrl.labour)**	12,92,790	7,86,062	790775	11,69,247	2,16,91,686
(a)	Male	6,72,717	4,24,589	453646	5,90,800	1,16,55,305
(b)	Female	6,20,073	3,61,473	337129	5,78,447	1,00,36,381

S.No	Particulars	Anantapur	YSR Kadapa	SPS Nellore	Prakasham	Andhra Pradesh
17	**Non Agricultre Workers (Household Industries+Others)**	7,43,376	5,34,342	523786	5,31,320	1,32,02,173
(a)	Male	5,35,827	3,99,297	4,06,234	4,01,042	1,00,06,887
(b)	Female	2,07,549	1,35,045	1,17,552	1,30,278	31,95,286
18	**Total Number of Households**					
(a)	Normal	9,64,522	7,03,823	7,73,722	8,58,151	1,27,19,000
(b)	Institutional	1,924	930	1,656	1,226	25,371
(c)	Houseless	1,714	1,451	1,476	1,086	21,894
19	**Rainfall (mm)**	594	710	1,080	799	1094 (Coastal Andhra) 680 (Rayalaseema)
20	**Rivers**	Pennar, Jayamangali, Chitravathi, Vedavathi, Papagni & Maddileru.	Penna, Chitravathi, Kunderu, Papaghni, Sagileru & Cheyeru	Pennar & Swarnamukhi	Kandaleru, Chilamaleru & Dornapuvagu	Major rivers: Godavari, Krishna, Penna & Thungabadra
21	**Mandals/sub-districts/taluks**	63	51	46	56	671
22	**Total No. of Villages**	949	919	1177	1,081	17,398
(a)	Inhabited	921	830	1093	985	16,450
(b)	Un-inhabited	28	89	84	96	948

S.No	Particulars	Anantapur	YSR Kadapa	SPS Nellore	Prakasham	Andhra Pradesh
23	**Total No. of Towns**	16	18	10	13	195
(a)	Statutory	7	7	4	4	69
(b)	Census	9	11	6	9	126
24	**Revenue Divisions**	5 (Anantapur, Penukonda, Kadiri, Kalyandurg & Dharmavaram)	3 (Kadapa, Jammalamadugu & Rajampet)	5 (Kavali, Nellore, Gudur, Atmakur & Naidupet)	3 (Ongole, Kandukur & Markapur)	51
25	**Municipal Corporations**	1 (Anantapur)	1 (Kadapa)	1 (Nellore)	1 (Ongole)	17
26	**Municipalities**	9	6	6	3	79
27	**District Headquarters**	Anantapur	Kadapa	Nellore	Ongole	Amaravati

Source: *Districts Census Handbooks of Andhra Pradesh, 2011*

6.6 Growth of Registered Vehicles

The growth in vehicle registrations in any region is mostly used in comparing the rate at which the demand for the road infrastructure is growing on one hand and the rate at which the infrastructure is growing (supply). The larger the gap between the two indicators (vehicle registration growth – road infrastructure growth) more critical is the situation. Apart from this the vehicle registration data is also generally a good indicator, as it is found to correlate reasonably well with traffic growth. Thus, it is possible to establish a definite trend and correlation between traffic growth and vehicle registration. To establish future traffic on the project corridor, the trend in vehicle registrations of the Andhra Pradesh and PIA states (Telangana, Karnataka, Tamilnadu and Odisha) is studied. The vehicle registration data for the state of Andhra Pradesh is as presented below. These figures are based on the individual vehicle registration data taken from the Road Transport year book published by MoRT&H from time to time.

Table-6.5: Vehicles Registered in the State of Andhra Pradesh

Date as on	Cars	Trucks	Bus	Tractors & Trailers	Transport Vehicles	Non-Transport Vehicles
31-Mar-2013	388304	224967	11978	156594	832302	5452074
31-Mar-2014	434516	245774	12225	170114	922583	6079560
31-Mar-2015	486307	260438	13041	186330	1013986	6868276
31-Mar-2016	533542	281933	14245	203651	1115430	7612128
CAGR	8.27%	5.81%	4.43%	6.79%	7.59%	8.70%

Source: *www.aptransport.org*

It can be observed from the above table that there is significant growth in the cars in Andhra Pradesh while Trucks are also showing a reasonable growth of 5.81% per annum.

6.7 Growth in Economies

Socio-economic parameters including population, employment, vehicle ownership, per capita income have all been used to study the trend of past development in any region. Also, the growth of traffic on the project road depends on existing development and future growth prospects of the connecting regions. The time series data of economic indicators at constant (2011-12) prices for the state of Andhra Pradesh are as presented below.

Table-6.6: Economic Indicators of Andhra Pradesh

S.No	Year	GSDP (Rs. Crores)	Per-Capita Income (Rs.)	Population (Million)
1	2011-12	3,78,,402	69,000	48.60
2	2012-13	3,80,629	68,865	49.70
3	2013-14	4,01,115	72,254	50.30
4	2014-15	4,41,741	78,039	51.20
5	2015-16	4,90,134	8,61,180	51.90
6	2016-17	5,47,021	95,566	52.50
CAGR		6.33%	5.58%	1.29%

***Source**: www.desap.cgg.gov.in*

₹35,838 crore
(US $ 5.9 billion)
GDDP

6.8%
Percentage contribution to GSDP

₹69,562
(US $ 1,150)
Per capita income
at current prices (2013-14)

₹9,944 crore
(US $ 1.6 billion)
Agriculture
contribution to GDDP

₹7,752 crore
(US $ 1.3 billion)
Industries
contribution to GDDP

₹18,142 crore
(US $ 2.97 billion)
Services
contribution to GDDP

The state has attracted Foreign Direct Investment (FDI) equity inflows worth US$ 14.524 billion during the period April 2000 to December 2017, according to data released by Department of Industrial Policy and Promotion (DIPP). As of December 2017, the state had 20 operational SEZs in the state across diversified sectors which include textiles and apparel, food processing, footwear and leather products, multi-product, pharma, IT SEZs etc. It is the first state in the country to have enacted the Industrial Single Window Clearance. The state also has separate acts for development in sectors such as solar power, electronic hardware and food processing. The presence of rich climatic and soil conditions make Andhra Pradesh a major agricultural belt. Few of the leading crops produced in the state include rice, chilly, oilseeds, cotton, pulses and gram. Foodgrain production in the state reached 15.759 million tonnes in 2017-18. Andhra Pradesh is home to many global and national pharma players and various companies have set up their manufacturing hubs in different cities of the state.

As of December 2017, the state had a total of four Pharmaceutical SEZs. The ITE&C (Information Technology, Electronics & Communication) department of the state has established a new IoT policy within the state with a view to attain a substantial market share in India's IoT market by 2020.

6.8 Industrial Development

Government of Andhra Pradesh accords high priority to industrial growth as a means to mitigate poverty and reduce unemployment. Industrial development in Andhra Pradesh is predicated on robust infrastructure, including land banks, 24x7 power supply and providing conducive environment for innovation and industry to thrive. Andhra Pradesh is strategically located on the Southeast coast of India and is a natural gateway to East & Southeast Asia. The State has a population of 4.93 crore (as per population census - 2011), accounting for 4% of Country's population, residing in 4.9% of country's geographical area. Andhra Pradesh has abundant natural resources (Barytes, Limestone, Bauxite, and a number of minor minerals), fertile land and river basins, water resources, extensive canal system and conducive agro-climatic conditions.

The State has the second longest coastline in India and is also one of the largest producers of marine products. At current prices, the Gross State Domestic Product (GSDP) of Andhra Pradesh was Rs. 4,75,859 crore in 2013-14. Between 2004-05 and 2012-13, the average annual GSDP growth rate of Andhra Pradesh was 7.25% while the average per capita income at (current prices) increased from Rs. 46,345 in 2008-09 to Rs. 88,876 in 2013-14. Andhra Pradesh, over the years, has established a strong presence in agro and food processing, textiles, chemicals & petrochemicals, pharmaceuticals, metallurgy, electronics and electrical engineering sectors. Industrial development promotes higher capital formation, raises wage incomes and absorbs surplus workforce to bring about equitable development. Therefore, the state government has accorded top priority to industrial growth as a means to mitigate poverty and unemployment. Andhra Pradesh intends to be the most preferred destination for investors by providing favorable business climate, excellent infrastructure, good law and order and peaceful industrial relations.

Government of Andhra Pradesh (GoAP) lays utmost emphasis on sustainable industrial development anchored by capacity building at the grassroots level.

6.8.1 INDUSTRIAL ESTATES

As of June 2013, the state had 39 operational special economic zones (SEZs). There are 272 Industrial estates and industrial development areas in the State, covering an area of 14700 hectares. The State Government is in the process of developing Industrial Parks at different places, for specific groups of industries like Visakhapatnam Export Processing Zone. Food parks, one each in the 2 regions of Coastal Andhra (value added rice products, dairy, horticultural, marine etc.) and in Rayalaseema region (processing of vegetables, edible oils and export oriented industry).Tentative estimates reveal that the total exports from AP during the year 2003–04 were to the tune of Rs.15,306 crore. The share of software was 30%, and that of food products was 20%. The value of exports during 2002–03 was Rs.13,614 crore and that during 2001–02 was Rs.12,400 crore. GoAP plans to set up the industrial hubs/parks etc in the following districts as a part of 2020 policy:

(1). ***Pharma Hub*** - Srikakulam, Guntur & Visakhapatnam

(2). ***Integrated Textiles*** - Visakhapatnam, Guntur, Krishna, Anantapur & Kurnool

(3). ***Automobile Hub*** - Nellore & Chittoor

(4). ***Cement Plants*** - Guntur, Anantapur, Kurnool & Kadapa

(5). ***Electronic Clusters*** - Visakhapatnam, East Godavari, Anantapur & Chittoor

(6). ***Petro-chemical Complex*** - Krishna, East Godavari, Visakhapatnam

(7). ***Smart Industrial Townships*** - All districts

(8). ***Aerospace & Defence*** - Visakhapatnam / Chittoor/ Anantapur

(9). ***Food Processing Parks*** - All districts

6.8.2 PLANNED INDUSTRIAL DEVELOPMENT

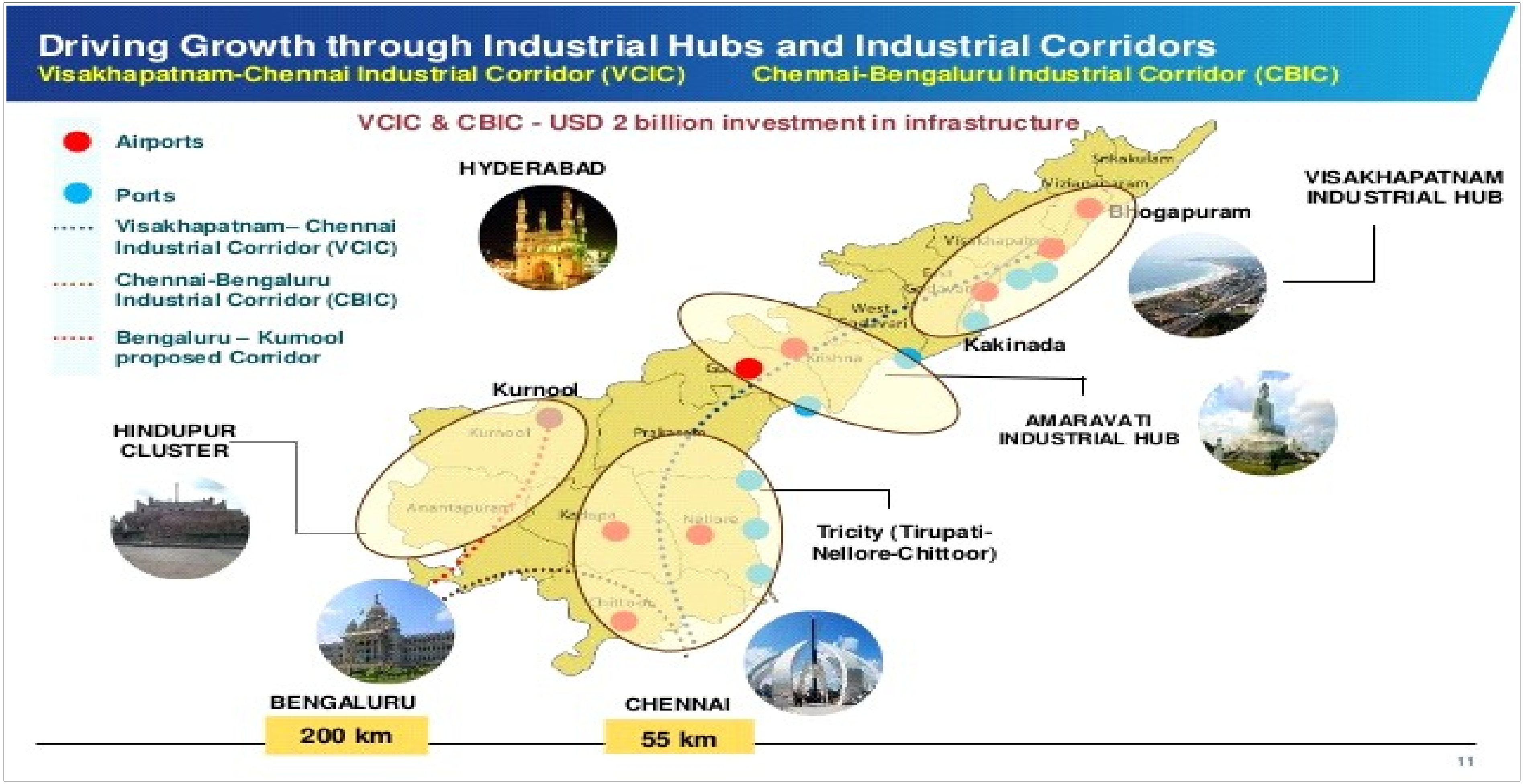
GoAP plans to set up Industrial Area Development Authorities under the aegis of article 243Q of the constitution to facilitate and encourage investment into specific investment zones like SIRs, industrial parks, industrial corridor nodes etc.

(a) Industrial Corridors

There are several industrial corridors already taken up in the state viz., the Vizag – Chennai Industrial Corridor (VCIC) and the Petroleum, Chemical & Petrochemical Investment Region (PCPIR) in the Visakhapatnam – Kakinada region. The Vizag – Chennai Industrial Corridor (VCIC) is a key part of the planned East Coast Economic Corridor (ECEC). VCIC is aligned with the Golden Quadrilateral and is poised to play a critical role in driving India's new "Act East Policy."

The corridor between Vizag and Chennai has an influence area across Andhra Pradesh and Tamil Nadu, and already makes a significant contribution to India's GDP and total manufacturing output. The strategy to develop VCIC is a part of the plan to achieve accelerated development and regional industry agglomeration in the focus states. Regional industry agglomeration could be achieved by attracting companies in the value chain of other companies already based in the corridor, attracting particular industries that the corridor provides with geographical advantages, or building and maintaining advanced infrastructure to support industries.

The Chennai – Bangalore Industrial Corridor project is an upcoming mega infrastructure project along Chennai, Sriperambudur, Chittoor, Bangarupalem, Hoskote and Banaglore. It is expected to boost commerce between south India and east Asia by enabling quicker movement of goods from these places to the Chennai and Ennore ports. Two major backbone infrastructure projects will be created for the corridor. Both Road and Rail connectivity for Freight movement will be upgraded in this corridor.


Driving Growth through Industrial Hubs and Industrial Corridors
Visakhapatnam-Chennai Industrial Corridor (VCIC)
Chennai-Bengaluru Industrial Corridor (CBIC)
VCIC & CBIC - USD 2 billion investment in infrastructure
Airports
Ports
Visakhapatnam– Chennai Industrial Corridor (VCIC)
Chennai-Bengaluru Industrial Corridor (CBIC)
Bengaluru – Kurnool proposed Corridor
HYDERABAD
VISAKHAPATNAM INDUSTRIAL HUB
Bhogapuram
Kakinada
Kurnool
AMARAVATI INDUSTRIAL HUB
HINDUPUR CLUSTER
Tricity (Tirupati-Nellore-Chittoor)
BENGALURU
200 km
CHENNAI
55 km
11

VK-PCPIR is one of the six Petroleum Chemical Petrochemical Investment Regions (PCPIRs) planned to be promoted in India. Visakhapatnam-Kakinada PCPIR is seen to be a catalyst, to position Andhra Pradesh as having the largest petrochemical hub of India. Andhra Pradesh Industrial Infrastructure Corporation (APIIC) is the nodal agency for managing implementation of VK-PCPIR. VK-PCPIR SDA spreads over an area of 640 sq km, encompassing 97 revenue villages across parts of 10 mandals of Visakhapatnam and East Godavari districts. The project area is well connected by all possible modes of transport including road, rail, air and sea ports. It is on the 'Golden Quadrilateral' with the NH-16 connecting it to Kolkata in the North and Chennai in the South.

(b) National Investment and Manufacturing Zones (NIMZ)

The Government of India (GoI) has announced a National Manufacturing Policy, 2011, with the objective of enhancing the share of manufacturing in GDP to 25% within a decade and creating 100 million jobs. As per the Policy, "NIMZs will be developed as integrated industrial townships with state-of-the art infrastructure and land use on the basis of zoning; clean and energy efficient technology; necessary social infrastructure; skill development facilities, etc." Govt. of India has accorded in-principle approval for setting up two NIMZs in Chittoor and Prakasam districts.

These NIMZs would be developed as world class industrial regions with each spread over a minimum of 5,000 hectares. These regions will act as growth nodes for industrial development and employment generation in the state. The estimated investment flow into each of the two National Investment and Manufacturing Zones (NIMZ) coming up in Chittoor and Prakasam districts is expected to be around Rs.30,000 crore and the employment potential about three lakh.

The Government of India (GoI) has accorded in-principle approval for setting up two NIMZ in the two districts in an extent of 5,000 to 6,000 hectares, according to Socio-Economic Survey 2013-2014. NIMZ will be developed as integrated industrial townships with the state-of-the-art infrastructure and land use on the basis of zoning, clean and energy efficient technology, necessary social infrastructure and skill development facilities. The land acquisition in Chittoor district is under process. NIMZ will be created as combined industrial townships along with the modern facilities and also land use on the foundation of zoning, well-maintained and also electricity effective innovation, important social infrastructure as well as capability progression facilities. For Industrial Framework System, top priority was provided create clusters having little market concentration.

The plan carried out on a public-private partnership project received 51 set development proposals along with an expenditure of Rs.252.57 crore. In this, 20 clusters along with a quantity of Rs.5.09 crore were approved through GoI.

Details	Chittoor NIMZ	Prakasam NIMZ
Location/ Materials	Falls within Valmikipuram (Vayalapad), Kalikiri and Gurramkonda mandals, Chittoor district (Close to Chennai – Bangalore Industrial Corridor – CBIC)	Falls within Pamaru and Pedacherla Palli mandals, Prakasam district (Falls in Vizag-Chennai Industrial Corridor – VCIC)
Extent Proposed	12,818.51 acres (51.875 sq.km/ 5187.467 ha)	14,231 acres (57.59 sq.km/ 5759 ha)
Estimated Project Cost (External and Internal Infrastructure)	Rs. 11,693 Cr.	Rs. 10,859 Cr.
Economic Benefits (Expected)	Investments: Rs. 40,000 Cr., Employment: 1.92 Lakh (Direct & Indirect), Exports: Rs 20,300 Cr.	Investments: Rs 4,37,000 Cr., Employment: 205 Lakhs (Direct & Indirect), Exports: Rs 24,000 Cr.

(c) Information Technology Investment Regions (ITIR)/ Electronic Management Clusters (EMC)

To promote investment in the Information Technology (IT) / Information Technology Enabled Services (ITES)/ Electronic Hardware Manufacturing (EHM) units, the Government of India had notified policy on Information Technology Investment Regions (ITIRs) in May 2008. ITIRs will be self-contained integrated township to accelerate growth of IT/ITeS/EHM industry. As per the policy, minimum area of 40 sq km should be delineated for ITIR.

Out of the total delineated area, 40% should be earmarked for processing zone and remaining area for non-processing zone. Processing zone would comprise of Information Technology/ Information Technology Enabled Services and Electronic Hardware Manufacturing Units, along with associated logistics and other services and required infrastructure. Non-processing area, to include residential, commercial and other social and institutional infrastructure The State Government would play the lead role in setting up of the ITIR.

ITIRs have been proposed in Visakhapatnam and Chittoor districts of Andhra Pradesh. The Information Technology Investment Region (ITIR) project, planned by the Government of Andhra Pradesh, may generate employment to approximately, up to 15 lakh IT professionals and also it can generate revenue for the economy, of up to ₹3.11 crore.

(d) Smart Industrial Township (SIT)

GoAP plans to facilitate setting up of SITs across various districts with local self-government status. The external infrastructure for SIT will be provided by the government will be four lane road to the nearest national highway, dedicated feeder for uninterrupted power supply, dedicated water supply and Right of way to create a connectivity to the nearest railway line and or port and fibre connectivity with no bandwidth constraints.

(e) Special Economic Zones (SEZ)

SEZs aim to provide simplified clearances and controls, world class infrastructure and a stable fiscal regime to attract foreign investments in the state. Currently there are 16 functional SEZs in AP and additional 4 SEZs with in-principle approval.

APSEZ is a Multi-Product SEZ developed over an area of 5595.47 acres of land at Atchutapuram and Rambilli mandals of Visakhapatnam district. The Government of India notified the SEZ on 12/04/2007 in the Gazette. It is the major SEZ in the State of Andhra Pradesh. Road connectivity to APSEZ is made available by a 4-Lane Road connectivity to a length of 7.5 Kms from State Highway which is being extended to NH-5. AP PCPIR Expressway from Gangavaram Port to Atchutapuram junction is being planned. Water Supply to APSEZ is made readily available by 75 MLD of water from Godavari / Yeluru source. Power to APSEZ is made available from 220/132 & 33 KV Sub-stations. Salient features of SEZs of Andhra Pradesh are given below.

APIIC Notified SEZs:

S. No	Developer	Type of SEZ	Location	District	Total Extent (Acres)
1	APIIC Ltd.	IT / ITES	Hill-3, Madhurawada	Visakhapatnam	88.92
2		Multi Product	Atchutapuram	Visakhapatnam	3213.03
3		IT / ITES	Hill-2, Madhurawada	Visakhapatnam	39.52
4		IT / ITES	Sarpavram (V), Kakinada (M)	East Godavari	25.71
5		IT / ITES	Kurukalva(V), Renigunta (M)	Chittoor	80.45
6		IT / ITES	Putlampalli (V)	Kadapa	52.76
7		Multi Product	Dwarakapuram, Pallepalem, Menkuru, Konetrajupalem & Palluchuru (V), Naidupet (M)	Nellore	2550.05
8		IT / ITES	Gmbheeram (V)	Visakhapatnam	51.25
9		Biotech	Pulivendula	Kadapa	77.02
10		Building Product	Annangi (V), Maddipadu (M)	Prakasham	262.96
	APIIC Notified Total				**6,441.7**

Assisted by APIIC (Formal Approval):

S. No	Developer	Type of SEZ	Location	District	Total Extent (Acres)
1	Assisted by APIIC – Formal	Biotech	Hindupur	Anantapur	70
2		Multi Product	Chillakur, Kota(M)	Nellore	2526.81
3		Biotechnology	Chillamaturu & Gorantla (M)	Anantapur	29.34
4		Aerospace & Precision Engineering	Chillamaturu (M)	Anantapur	285.06
5		Free Trade Warehousing Zone	Chillamaturu (M)	Anantapur	98.8
Assisted by APIIC Formal Approval- Total					**3,010.01**

(f) Industrial Parks

Andhra Pradesh Industrial Infrastructure Corporation (APIIC) has developed over 300 industrial parks (including SEZs) spread over an extent of about 1,21,655 acres. GoAP plans to develop new industrial parks and upgrade/maintain the existing ones. The Industrial Areas ranges from 15 acres to 2500 acres. The Corporation has presence in each and every Mandal Head Quarters of the district. A large number of leading industrial houses have their presence in these Industrial Areas. Some of them are BPL Engg., Kirby Building Products, Asian Paints, GVK, ITW Signode, Aurobindo Pharma, Widia India, Raasi Refractories, Lanco Kondapally Power Corporation, BSES Andhra Power etc.

(g) PPP for Regional Integrated Development Enterprises (Prides)

PPP for Regional Integrated Development Enterprises (PRIDE) scheme promoted by the Department of Economic Affairs (DEA), Government of India aims to provide an infrastructure enabled backbone in a secure and connected area for attracting businesses, manufacturing, as well as for people to live and work. The goal is development of modern, cost competitive and world class business centres of excellence which can become hubs for a well spread economic growth across the country. In pursuit of taking forward the GoI initiative, Government of Andhra Pradesh (GoAP) proposed to develop PRIDEs at SPS Nellore, Kurnool (within proposed Kurnool Mega Industrial Hub) and Prakasam (within proposed Donakonda Mega Industrial Hub) districts.

Location/ Materials	Falls within Ozili Mandal, SPS Nellore district. (Falls in Vizag-Chennai Industrial Corridor (VCIC)
Extent Proposed	3728.22 acres (1508.76 ha)
Estimated Project Cost (External and Internal Infrastructure)	Rs. 4762 Cr.
Economic Benefits (Expected)	Investments: Rs 17000 Cr., Employment: 93000 (Direct & Indirect), Exports: Rs 8000 Cr.

Note: Information pertaining to Industrial development in Andhra Pradesh has been collected from web source of Andhra Pradesh Industrial Infrastructure Corporation, www.apiic.in

6.9 Tourism

Apart from industries and agriculture, tourism in Andhra Pradesh also contributes to its economy. Andhra Pradesh is blessed with an exotic landscape: the rolling hills, beautiful plateaus, sparkling rivers, etc. that largely contribute towards tourism. Besides, the national parks, wildlife sanctuaries, holy shrines and museums, etc. largely attracts tourists in the state.

(a) Ananthapur District

Dharmavaram: Exquisite silk sarees and leather puppets.

Lepakshi: The village is famous for its three historical shrines, which are dedicated to Lord Vishnu, Lord Shiva and Lord Veerabhadra.

Puttaparthi: Major pilgrimage centre

Ahobilam: Penna Ahobilam is renowned for its Lord Narasimha Swamy Temple.

ISKCON Temple,Anantapur: ISKCON Temple is situated at Somaladoddi village, on the outskirts of the city. This temple is dedicated to Lord Krishna.

Bugga Ramalingeswara Swami Temple : Dedicated to Lord Shiva, it is also known as Ramalingeswara Swami Temple.

Penukonda, Gooty & Rayadurg Forts

Veerabhadra Temple

Hanuman statue at Mounagiri &

Tadipatri

(b) YSR Kadapa District

Gandikota Fort, The Grand Canyon of India (Gandikota Camping) & Tents,

Gandi Anjaneya Swami Temple,

Ameer Peer Dargah Shrine,

Devuni Kadapa Sri Venkateswara Swami Temple,

Kodandarama Temple,

Sri Chenna Kesava Swami Temple,

Siddavatam Fort,

Sri Kamakshi Vaidyanadha Swami Temple &

Mailavaram Dam.

(c) Prakasam District

Chennakesawa Swamy temple: 18th century temple,

Singarayakonda: Double storied Buddhist stupa dating back to 2nd century BCE,

Markapur Lakshmi Chennakesava Temple: 15th century temple with beautiful carvings,

Bhairavakonda: Rock-cut temples from 7th and 8th century,

Ramapuram, Ramayapatnam, Kothapatnam, Pakala and Vodarevu Beaches,

Mallavaram Dam,

Kasi Visweswara Swami Temple,

Ravi Priya Mall,

Sri Malyadri Lakshmi Narasimha Temple,

Rangaswami Temple,

Sri Bala Tripurasundaridevi Temple- Tripurantakam,

Chandavaram Buddhist Site,

Nemaligundam Ranganayaka Swamy Temple and Waterfalls,

Gundlakamma and Rallapadu Reservoirs &

Nallamala Forest

(d) SPS Nellore

Kondaveedu fort: 14th century fort of the Reddy kings; trekking trails,

Undavalli caves: 4th century caves with Jain, Buddhist and Hindu carvings,

Uppalapadu: Nature conservation,

Talpagiri Ranganadha Swami Temple- Nellore,

Sri Mallikarjuna Swamy kamakshi tai temple- Jonnawada,

Kandaleru & Somasila Dams,

Udayagiri Fort, Venkatagiri Fort & Penchalakona Waterfalls,

Pulicat Lake, Flemingo Festival at Pulicat Lake & Nelapattu Bird Sanctuary,

Rottela Panduga at Bara Shaheed Dargah in Nellore,

Mypadu & Kodur Beaches,

Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota,

Krishnapatnam Port and thermal &

The Pinakini Satyagraha Ashramam (Gandhi Ashramam) - Indukurpet

7.0 Indicative Design Standards, Methodologies and Specifications

7.1 General

The Preliminary Design has been carried out on the selected alignment so as to have optimum Construction and Operation & maintenance cost and Vehicle Operation Cost; minimum Social Impacts and Social Costs and Environmental Impacts and Environmental Mitigation Costs. The preferred alignment would definitely have minimum Rehabilitation and Resettlement i.e. it would utilize to the maximum possible barren / agriculture / government land to minimize Land Acquisition in villages / habited areas. A thorough consultation with stakeholders including industries, relevant government agencies, NGOs, project affected persons (including farmers & people having property) and other consultants working in the region will be made. The detailed design for geometric elements covers, but not limited to the following major aspects:

1. Horizontal alignment
2. Longitudinal profile
3. Cross-sectional elements
4. Interchanges

Different options for providing grade separated interchanges and at grade intersections were examined and the geometric design of interchanges has taken into account the site conditions, turning movement characteristics, level of service, overall economy and operational safety.

7.2 Indicative Design Standards for Geometric Design

The indicative design standards for geometric design of road are illustrated in the **Tables-7.1, 7.2 & 7.3** for main carriageway, geometric standards for Interchange elements and Length of speed change lanes. Ruling design speed is adopted for designing the Project Highway in conformity with the provisions of the Guidelines for Expressway Manual, IRC:SP:99-2013. The following Design Parameters are used:

Table-7.1: Design Parameters

S.No	Description	Particulars
1	Design Speed	120 Kmph
2	Lane width	3.75 m
3	Depressed Median	19.50 m
4	Median side paved strip (Shy distance)	0.75 m
5	4-Lane carriageway	15.00 m

S.No	Description		Particulars
6	Paved Shoulder (Plain and Rolling Terrain)		3.00
7	Earthen Shoulder		2.00 m
8	Camber	C/W & PS	2.50%
9		Earthen shoulder	3.50%
10	Width of Service Road		Not Applicable
11	Utility Corridor		2.00 m
12	Maximum super-elevation		5.00%
13	Safe Stopping Sight Distance (SSD)		250 m
14	Desirable Minimum Sight Distance (ISD)		500 m
15	Absolute minimum radius of horizontal curve		670 m
16	Minimum radius of horizontal curve without transition		2560 m
17	Min. longitudinal slope for Drain	Lined	0.5 %
		Unlined	1 %
18	Limiting gradient		3.0%
19	Minimum grade change requiring vertical curve		0.50%
20	Minimum length of vertical curve		100 m
21	Minimum Height of Embankment		Bottom of Subgrade is minimum 1.0 m above the High Flood Level/Water Table/Pond Level.
22	**Vertical Clearance**		
	Vertical clearance for SVUP/LVUP		4.0 m
	Vertical clearance for VUP		5.5 m
	Vertical clearance for Rail		6.625 m
23	K-Value for Sag-curve		62
	K-Value for Hog-curve		260
24	**Radius of Horizontal curve (m)**	**Min. transition length (m)**	**Super-elevation (%)**

S.No	Description		Particulars
	670	210	5.00
	700	210	5.00
	800	210	5.00
	900	210	5.00
	1000	150	5.00
	1100	150	5.00
	1200	150	5.00
	1300	150	4.90
	1400	140	4.60
	1500	130	4.30
	1600	120	4.00
	1700	115	3.80
	1800	110	3.60
	Radius of Horizontal curve(m)	**Min. transition length (m)**	**Super-elevation (%)**
	1900	105	3.40
	2000	100	3.20
	2100	100	3.00
	2200	100	2.90
	2300	100	2.80
	2400	100	2.70
	2500	100	2.60

Table-7.2: Geometric Design Standards for Interchange Elements

Design Elements		Unit	Ramp way Desired Values		
			Direct Connection	Loop	Semi- Direct Connection
Horizontal Alignment	Design speed	Kmph	80	70	40
	Radius of curvature	m	230	180	60
	Stopping Sight Distance	m	130	105	45
Vertical	Maximum Gradient	%	3	3	3

Design Elements		Unit	Ramp way Desired Values		
			Direct Connection	**Loop**	**Semi- Direct Connection**
Alignment	Minimum vertical curve length	m	50	45	20
Cross Section	Carriageway width	m	7.5	7.5	7.5
	Shoulder width (PS+ES)	m	2.0	2.0	2.0
	Camber	%	2.5	2.5	2.5

Table-7.3: Length of Speed Change Lanes (Acceleration/Deceleration)

Type of Lane	Speed on Entry/Exit curve (Kmph)	Length including Taper(m)
Acceleration lane	40	490
Deceleration lane	40	175

7.2.1 Design Speed

Design speed is the basic parameter which determines the geometric features of the road. The proposed design speeds for different terrain categories as per IRC:SP:99-2013 are as follows:

Table-7.4: Design Speed

Nature of terrain	Cross slope of the ground	Design Speed (kmph)
Plain	Less than 10 percent	120
Rolling	Between 10 and 25 percent	100

In general, the ruling design speed of 120 kmph is adopted for geometric design of the project highway. Only in exceptional circumstances, minimum design speed of 100 kmph is adopted where site conditions are extremely restrictive and adequate land width is not available. The need for warning signs is carefully considered whenever reduction in design speed becomes unavoidable.

7.2.2 CROSS-SECTIONAL ELEMENTS

7.2.2.1 Right of Way (RoW)

As per Guidelines for Expressway the minimum right of way (RoW) for up to 8 lanes expressways is 90m for plain and rolling terrain. However, ROW of 100 m has been adopted for the proposed expressway.

The RoW at ROBs and flyovers/interchange sections may vary depending on their respective layout and requirement. A 2m wide utility corridor inside the boundary fencing has been taken into account within the proposed RoW width.

7.2.2.2 Lane Width

As per Guidelines for Expressway the width of a lane in Plain and Rolling terrains has been taken as 3.75 m. The kerb shyness of 0.75 m shyness on median side has been provided.

7.2.2.3 Paved Shoulder

Paved shoulders shall be designed as an integral part of the pavement for the main carriageway. Width of these shoulders has been taken as 3m. This will provide for better traffic operation conditions, lower maintenance and facility of directly using these as part of carriageway when the road is subsequently widened on these sides.

7.2.2.4 Service Road

As the expressway is designed as completely access-controlled, service roads are not provided on either side throughout the project stretch.

7.2.2.5 Sight Distance

Safe stopping sight distance, both in the vertical and horizontal directions will apply in design. The sight distance values as per IRC:SP:99-2013 recommendations are as follows:

Table-7.5: Safe Stopping Sight Distance

Design Speed (km/h)	Safe Stopping Sight Distance (m)
120	250
100	180
80	120

7.2.3 HORIZONTAL ALIGNMENT

7.2.3.1 Radii of Curve

The horizontal curves on the project road are designed for a minimum radius as per Guidelines of Expressway manual. Adopting a maximum value of 7% for super elevation and 0.10 for side friction factor, the minimum radius for horizontal curves works out to be as follows as per IRC:SP:99-2013.

Table-7.6 : Radius of Horizontal Curve

Design Speed (Kmph)	Radius of horizontal curves (m)	
	Minimum	Desirable
120	670	1000
100	440	700

7.2.3.2 Super–Elevation

The super elevation at curves is arrived at as per the following equation:

$$v^2 = (e + f) *gR$$

Where, v = Vehicle speed in m/sec.

g = Acceleration due to gravity in meters/sec^2

e = Super elevation ratio in meter per meter

f = Coefficient of side friction between vehicle tyre and pavement (taken as 0.15)

R = Radius in meters.

The super elevation is calculated keeping in view the horizontal radii and gradient at curves at different locations.

Method for attaining super-elevation

Dual – inner edge pivot of both carriageways at different chainage is used for attaining super-elevation. This method pivots the dual carriageway about the inner edge strings of both carriageways using different chainage, so that the central reservation levels are not changed. The application of super-elevation to the left and the right carriageways will start (or end) at different chainage, to ensure that the rate of change remains the same for both. The method is explained in the following figure.

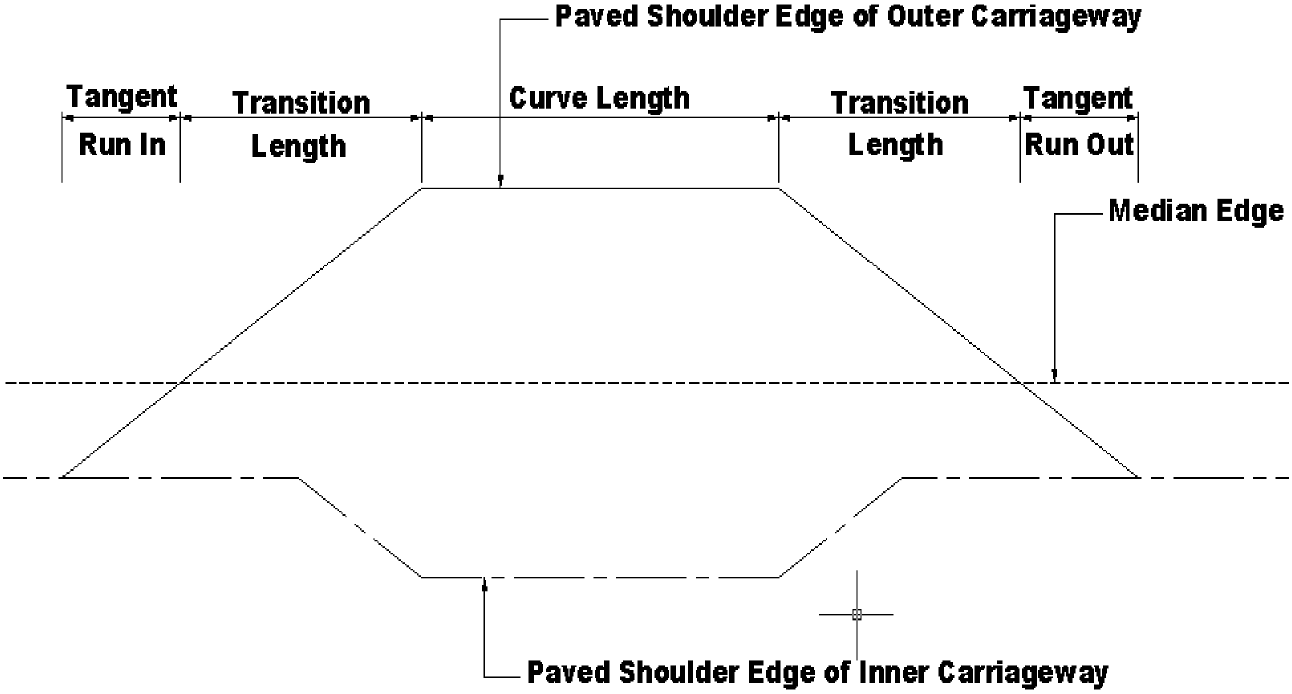


Figure-7.1 : Method for attaining super-elevation

7.2.3.3 Transition Curves

The rate of change of super elevation is being considered not steeper than 1 in 200 for roads in plain and rolling terrain and 1 in 150 for roads in Mountainous terrain. The following three formulae are used for calculating the transition lengths and the maximum value is being adopted for design:

(a) Rate of change of centrifugal acceleration:

$$L_s = 0.0215\ V^3/CR$$

(b) Rate of change of super elevation:

- if pavement is rotated about outer edge

$$L_s = eN(W+W_e)$$

- if pavement is rotated about centre line

$$L_s = 0.5N(W+W_e)$$

(c) Empirical formulae (As per IRC)

$$L_s = 2.7\ V^2/R \text{ (for plain and rolling terrain)}$$

Where:

R = Radius of curve in meters

V = Vehicle speed in Km / hour

L_s = Length of transition in meters

C = Rate of change of acceleration.

W = Normal width of pavement

W_e =extra widening on circular curve

1 in N =Rate of change of super elevation

The length of transition shall be greater of the three values derived from the above criteria.

Design Speed (km/h)	Min. Length of transition curve (m)
120	100
100	85

7.2.3.4 Cross Fall

Each carriageway will have unidirectional cross fall. The cross-fall for the flexible pavement and paved shoulders is 2.5%. For earthen shoulders, the corresponding value is 3.5%.

7.2.4 VERTICAL ALIGNMENT

The vertical alignment of the carriageway is generally compatible with the guidelines given in IRC:SP:99-2013.

- Desirably, there shall be no change in grade within a distance of 150m.
- At locations of sight deficiency, at least stopping sight distance (SSD) is being provided.

7.2.4.1 Vertical Curves

Vertical curves are designed to provide for visibility at least corresponding to the safe stopping sight distance. More liberal values are adopted wherever this is economically feasible. Valley curves are designed for headlight sight distance. Maximum vertical gradient is limited to 3% in plain and 4% in rolling sections.

7.2.4.2 Vertical Clearance

The vertical clearances is being adopted as per IRC:SP:99-2013.

- Vertical clearance at underpasses
  - Rural areas : 5.5 m minimum
  - Urban areas : 5.5 m minimum

However, the vertical clearance shall be confirmed by Railways / other authorities as required.

7.2.4.3 Lateral and Vertical Clearance at Underpasses

Wherever a cross road is proposed to be taken below the Project Expressway, minimum clearances adopted at underpasses shall be as follows:

Lateral Clearance

i. Full roadway width of the cross road shall be carried through the underpass. For vehicular underpass, the lateral clearance will not be less than 12m (7m carriageway + 2 x 2.5 m shoulder width on either side)
ii. For Light Vehicular Underpasses, the lateral clearance shall not be less than 12.0m
iii. The width of cattle and/ or pedestrian underpass will not be less than 7 m.
iv. Guardrails / crash barriers will be provided for protection of vehicles from colliding with the abutments and piers and the deck of the structures.
v. Vertical clearance at underpasses shall not be less than the values given below

1.	Vehicular underpass	5.5 m
2.	Light Vehicular Underpass	4.0 m

7.2.4.4 Lateral and Vertical Clearance at overpasses

Lateral Clearance: Full roadway width of proposed expressway has been carried through the overpass structure. The abutments and piers are provided with suitable protection against collision of vehicles. Crash barriers have been provided on abutment side and on sides of piers for this purpose. The ends of crash barriers are turned away from the line of approaching traffic.

Vertical Clearance : A minimum of 5.5m vertical clearance has been provided from all points of the carriageway of the project expressway.

7.2.5 ACCESS CONTROL

7.2.5.1 Access : Project Expressway has been designed for fast motorized traffic with full control of access. Access to the expressway has been provided with grade separators at locations of intersections.

7.2.5.2 Location of Interchange

- At crossing or nearest points of other expressways, National Highways, State highways and important arterial roads.
- At crossing or nearest points of major roads to important ports, material transport facilities, commercial and industrial areas, and places of tourist interest.

7.2.5.3 Connecting Roads

Connecting roads where required to maintain proper circulation of traffic, continuity of travel and to facilitate crossing over to the other side of the project expressway through an underpass/overpass shall be constructed on the land acquired within the ROW of the project expressway. The width of the connecting road shall be 7.0m. The construction and maintenance of connecting roads shall be part of the project expressway.

7.2.5.4 Grade Separators

Interchanges have been provided at the intersection of the Project expressway with the National Highways, State Highways. The vehicular underpass/overpass shall be so located that no vehicle is required to travel more distance on connecting road for crossing over.

7.2.5.5 Cattle and pedestrian underpass/overpass

The crossing facilities have been provided for the pedestrians and animals as and where required along the project road.

- A PUP/CUP may not be necessary within a distance of 2km from vehicular underpasses/overpasses and Light vehicular underpasses
- Pedestrian underpass/foot over bridge shall also be provided within a distance of 200m from a school or hospital or factory/industrial area.

7.2.5.6 Median openings

Median opening with detachable barrier shall be provided for traffic management for maintenance works and vehicles involved in accidents. Such barriers shall be located at ends of interchanges and rest areas. It is desirable to provide median openings with detachable barriers at about 5km spacing.

7.2.6 FENCING AND BOUNDARY STONES

Fencing along with boundary stones have been provided all along the expressway on inner side of the utility corridor. Prefabricated sheet of 3.0m high is proposed in cut section of forest along the ROW.

7.3 Grade Separators and Interchanges

The geometric design standards for various elements of Grade Separators will be as given in IRC:SP:99-2013. Gradient for approaches shall not be steeper than 2.5 percent (1 in 40).

7.3.1 Interchanges

There are two broad categories of Interchanges, based on traffic exchange:

- Service Interchange
- System Interchange

Service interchange

- This refers to an interchange of the Expressway with a road less in importance than Expressway.
- For this category, it is considered that Expressway shall be a toll road, and the other intersecting road shall be a "non-tolled" road or a road with open system of tolling with the toll plaza on the other road minimum 2 km away.
- Generally, Trumpet-type and T-type Interchanges are the preferred configuration.

System Interchange

- This refers to an interchange between two Expressways.

For this category, since both the intersecting routes are toll roads under closed system, toll booths on ramps are not required.

- For Three Leg Interchanges, the T-type configuration would require larger loops and semi directional ramps of larger radius based on traffic volumes.
- For Four Leg Interchanges, the forms may be Diamond, clover leafs directional and semi directional interchanges and composite interchanges requiring combinations of straight, curved or with loops and weaving.

7.3.2 Ramp types

Ramps are provided at interchanges for desired turning movements. Based on movement requirements, the connecting ramps may be classified as Direct, Semi-direct and Loop ramps.

7.3.3 Spacing between Interchanges

- Interchange spacing is based upon demand for access from the important cross roads, adequate distance to provide for signing and weaving and permit sufficient lengths of speed change lanes for respective adjacent interchange to operate safely and efficiently at a desired level of service.
- For expressways, a spacing of 3 km is absolute minimum from deceleration, weaving and acceleration consideration.
- For spacing less than 3 km, both the interchange shall be considered as a combined one. For expressways, a spacing of 20-30 km is desirable.

7.3.4 Ramp Design Speed

Recommended design speeds for interchange ramps are given in *Table–7.7*.

Table-7.7 : Recommended Design Speeds for Ramps

Configuration	Type of Ramp	Range of Expressway Design Speeds (km/h)	
		100-120	80-100
		Range of Ramp Design Speeds	
System Interchange	Semi-Direct	50-70	40-60
	Loop	70-90	60-80
	Direct	80-100	70-90
Service Interchange	Semi-Direct	40-60	40-60
	Loop	60-80	60-70
	Direct	60-90	60-80

7.3.5 Acceleration/deceleration lanes

Each entry and exit ramp shall have acceleration/deceleration lane for the Project Expressway. Typical requirements of Acceleration length and Deceleration length and speed change length adjustment factors are as given below in *Table–7.8* and *Table-7.9*.

Table-7.8 : Minimum Acceleration Lengths for Entry(Grades of 2 % or Less)

Design Speed (kmph)	Acceleration Length L (m)				
	V' Speed on Entry Curve at A (km/h)				
	40	50	60	70	80 or more
100	285	255	205	110	40
120	490	460	410	325	245

Table-7.9 : Minimum Deceleration Lengths for Exit(Grades of 2% or Less)

Expressway Design Speed V (km/h)	Deceleration Length L (m)				
	V' Speed on Exit Curve at A (km/h)				
	40	50	60	70	80 or more
100	145	135	120	100	85
120	175	170	155	140	120

7.4 Embankment

The design and construction of the road in embankment and in cutting has been carried out in accordance with section 300 of MORTH specifications and standards. The height of the embankment shall be measured with respect to the finished road levels. The following principles have been followed for fixing the road level:

No section of the road is over topped. The finished road level shall be at least 0.5 m above the general ground level.

The bottom of sub-grade is at least 1.0 m above the high flood level/high water table/pond level. The HFL should be decided by intelligent inspections, local observations, enquiries and studying past records.

7.4.1 Structural Features and Design of Embankment

The slopes should be designed from stability considerations and to provide a reasonable opportunity for a driver to recover control of an errant vehicle. Embankment slopes 1 V :4 H or flatter are recoverable slopes. Fixed obstacles such as culvert headwalls shall not extend above the fill slope within the clear zone distance.

Embankment slopes between 1 V : 3 H and 1 V : 4 H are traversable but non-recoverable and a clear run-out area at the base is desirable. Embankment with height 6.0 m or above shall be designed in accordance with IRC-75 taking into account slope stability, bearing capacity, consolidation, settlement and safety considerations based on geotechnical and investigation data. Where the embankment is to be supported on a weak stratum, appropriate remedial/ground improvement measures shall be taken.

The side slopes shall be protected against erosion by providing a suitable vegetative cover, kerb and channel, chute, stone/cement concrete block pitching or any other suitable protection measures depending on the height of the embankment and susceptibility of soil to erosion. Where pond ash is used for embankment construction in pursuance of the instructions of the Ministry of Environment and Forests or otherwise, the embankment shall be designed and constructed in accordance with IRC:SP:58.

7.4.2 Roadway in Cutting

The road level is fixed, keeping in view the provisions of relevant IRC Codes, and the side slopes of the cut section are governed by the type of soil met with. Generally, the side slopes are as given below in ***Table–7.10*.**

Table-7.10: Slopes and Cut Sections

Type of Soil	Slope (H:V)
Ordinary Soil	3:1 to 2:1
Rock	1/2:1 to 1/8:1 (depending upon quality of rock)

7.5 Soil Investigations and Design Report

Soil Surveys, field and laboratory investigations were conducted for selecting appropriate borrow pits, identifying and treating problematic ground locations.

7.5.1 Soil Investigations for Embankment

Soil Investigations and tests were done in accordance with the requirements specified in IRC:SP-19.

In respect of Embankments with height more than 6m, additional investigations and soil tests were conducted as per IRC-75 and IRC:SP-19.

Information collected regarding the topography, high flood level, natural drainage conditions, highest sub-soil water level, and the nature and extent of inundation.

The characteristics of embankment foundation were studied including the presence of any unsuitable/weak strata, marshy areas, water logged areas, etc.

Along the alignment of the road, where unstable strata, soft material or poor subsoil conditions have been met with at the foundation level, the soil profile was drawn after determining through borings, the type of soil at different levels. The Borings were at maximum interval of 100m to a depth of 2 m or more below the existing ground. In the case of high embankment, the borings were taken down to a depth equal to twice the height of the embankment.

7.5.2 Soil Investigations for Cut Section

Soil Investigations and tests were carried out in accordance with the requirements specified in IRC:SP:19.

Following information/data is examined and furnished:

- Depth of water table
- Seepage flow
- Presence of any weak, unstable or problematic strata

7.6 Roadway Width at Cross Drainage Structures

7.6.1 Culverts

The culverts are built to the full formation width of the road and have been designed using latest IRC:SP-13 and IRC:112.

7.6.2 Embankment Side Slopes

For earthen embankments the side slopes recommended from consideration of safety of traffic as per IRC:36–2010, are as follows:

- Up to 1.5m height - 1: 2 (V:H)
- 1.5m to 3.0m height - 1: 2.5 (V:H)
- 3.0m to 4.5m height - 1: 3 (V:H)
- 4.5m to 6.0m height - 1: 4 (V:H)

However, where costs of construction and land forbid the use of such liberal slopes, the slope is generally kept as 1V:2H. This slope is considered adequate from stability point of view. For design of embankments of more than 6.0 m height, the guide lines of latest IRC-75 are followed.

7.7 Highway Signs and Marking

The road signs conforming to latest IRC-67 have been proposed. Location of route marker signs are as per the latest IRC-2; the provision for highway kilometre stones and 200 m stones are as per latest IRC-8 and latest IRC-26 respectively. The boundary stones are as per latest IRC-25. Road Delineators are as per latest IRC-79. All road signs are considered as retro-reflective sheet of high intensity grade with encapsulated lens fixed over aluminium substratum and conforming to MoSRT&H Specifications for road and bridge works. Provisions for Road markings have been considered as latest IRC-35.

7.8 Pavement Design

The project road has been sub divided into traffic homogeneous sections. From the obtained MSA of all homogeneous sections, maximum MSA in all homogenous sections is considered. The cumulative Equivalent Standard Axle has been made available from the traffic forecast model. Flexible pavement is designed by using IRC:37-2018 and rigid pavement is designed as per the provisions contained in latest IRC:58-2015. Besides the above, designs for service roads, toll plaza, bus bays, truck lay byes etc. have been carried out.

7.8.1 Design Life

The design life for flexible pavement has been taken as 20 years instead of 30 years. According to IRC:58-2015,for rigid pavement a design life of 30 is considered.

7.8.2 Design Traffic

The Design traffic has been estimated in terms of cumulative number of standard axles (8160kgs) to be carried by the Pavement during the design period. Any likely change in traffic due to proposed improvement of the facility and/or future development plans, land use, shall be duly considered in estimating the Design Traffic. The Growth rates mentioned in the Traffic Studies chapter has been considered while calculating the Million Standard Axle loads.

7.8.3 Rigid Pavement Design

7.8.3.1 Design of Concrete Slab

Once the parameters are decided, actual stresses developed in the concrete slab due to design wheel load is computed by the Westergaard's Equation modified by Teller and Sutherland. The maximum stress occurs in the corner and the minimum in the interior. The edge load condition gives an intermediate value. Temperature stresses at the edge are calculated by using Bradbury's formula.

The temperature stresses in the corner region is negligible as the corners are relatively free to wrap and may be ignored. The design wheel load stress and the temperature stress at the edge are then added up together and this summation shall be less than 28 days flexural strength of concrete for the assumed thickness to be adequate from design point of view.

Once the assumed slab thickness is found adequate for the combined stresses developed due to temperature and design wheel load, its adequacy needs to be checked from the view point of its consumption of fatigue resistance. In this case also, edge stresses are computed as discussed earlier for various axle load classes.

Then stress ratio (SR) is calculated as ratio of stress due to wheel load and the 28 days flexural strength of concrete for all axle load class. Consumption of fatigue resistance is computed for this stress ratio for each axle load class. Summation of this consumption of fatigue resistance should not exceed the allowable limit for the assumed thickness to be adequate from the view point of fatigue consideration.

7.8.3.2 Design of Joints

Once the concrete slab thickness is designed based on particular spacing and location of joints, the remaining job is the design of dowel bars and tie bars with the provision of adequate sealants.

7.8.3.3 Dowel Bars

The design of dowel bar at joints is carried out on the basis of its load transfer capacity. It is recommended that 40% of wheel load can be transferred through dowel bar system. It is observed that failure of dowel bar occurs due to the crushing of concrete below the dowel bar and hence bearing stress shall be considered for its design.

Generally, 500 mm long 32 mm diameter M.S. bar at a spacing of 250 - 300 mm is used as dowel bar for concrete slab of 200 -350 mm thick. No dowel bar is required for slab thickness less than 150 mm. However separate calculation has been made for present situation for dowel bar design.Tie bars are provided to prevent the adjoining slabs from separating. Longitudinal joints are provided with tie bars. It does not increase the structural capacity of the slab and are not designed as load transferred devices.

7.9 Hydrological Design

7.9.1 Design Standards

The hydrological & hydraulic design for cross drainage structures conform to the following codes:

- IRC:SP:13-2004 - Guidelines for the design of small bridges and culverts
- IRC:5-2015 - Code of practice for Road Bridges, Section I (General features of Design)
- IRC:78 - Code of practice for Road Bridges, Section VII (Design of Foundation and Substructure)
- IRC:SP:99-2013 - Manual of Specifications and Standards for Expressways

7.9.2 Design Approach

The hydrological & hydraulic design of bridges is an important aspect to determine the minimum required waterway; design highest flood level (HFL) and minimum scour levels of piers & abutments of the bridges proposed on the new alignments. The various design standards (latest) which have been adopted for the hydrological & hydraulic design of bridges are given below.

Area of catchment, length of longest stream & parameters for determining equivalent slope has been obtained from topographical sheets of Survey of India (SoI). All other parameters, such as, equations for obtaining synthetic unit hydrograph, 100-year 24-hr point rainfall, conversion factor for 100-year 24-hr point rainfall to design storm duration, areal reduction factor for finding areal rainfall from point rainfall, time distribution of areal rainfall, loss rate, base flow, etc. are obtained from flood estimation.

River/stream bridges whose length is less than or equal to 30m, Area Velocity method have been adopted. Also, the area-velocity method has been used for the bridges on tributary & minor canals. The Gauge and discharge data have been collected from CWC or from the nearest CWC gauging site. If the observed discharge data from nearest CWC gauging site is not of good use, then data from nearest reservoirs can be considered.

The peak discharge at a given location in a stream depends, among other things, mainly upon the catchment area, rain fall, watershed characteristics like shape, topography, infiltration characteristics. These parameters are measured from Survey of India topo sheets where ever possible. The drainage area for each structure is delineated along the ridge dividing the water sheds using CAD tools.

Other shape parameters like longest stream distance from source to bridge/structure location (L) and length of the stream from a point opposite the CG of the drainage basin upto the stream crossing (Lc) are measured. The topographical parameter namely, the equivalent slope (s) is assessed from the contours and the distances between them**.**

Return Period:

100 years return period has been adopted to calculate the discharge as per Manual of Specifications and Standards for Expressways.

Bed Slope:

The energy slope has been taken equal to the bed slope, measured over a reasonably long reach. Bed slope of the river has been obtained from topo survey data. The longitudinal section of the river has been generated using MX-Road software.

Rugosity Co-efficient:

Rugosity coefficient, n has been taken as per Table 5.1 of latest IRC:SP-13. However, judgment and experience are also used for selecting proper value of n.

7.9.3 Discharge Computations

Discharge calculations for river bridges whose length is more than 30m have been done based on Flood Estimation Reports of CWC. Discharge calculations for river/stream bridges whose length is less than or equal to 30m and for canal (on tributary/minor) bridges, Area-Velocity method have been used.

Area–Velocity Method: Cross section has been taken at proposed bridge location or at nearby location. The bed slope of the river/stream/canal has been determined over a reasonably longer reach. The HFL / FSL at the structure location have been fixed based on local inquiry. For calculating the discharge the following method has been used.

Manning's Formula:

$$Q = A \times V$$

Where:

Q = the discharge in cumec

A = Area of the cross section in sq.m

V = Velocity in m/sec = $(1/n)*(R)^{2/3}*(S)^{1/2}$

Where:

R = Hydraulic mean depth = A / P in m.

P = Wetted perimeter in m.

S = Bed-slope of the stream.

n = Roughness co-efficient.

Scoured Bed Line: Depth of normal scour has been ascertained. The average scoured bed line that is likely to prevail during the high flood has been obtained (Refer: Cl. 5.2 of latest IRC:SP:13) based on normal scour as a guide.

Vertical Clearance: The vertical clearance between HFL (including afflux) and Soffit is a function of design discharge as specified in Table 12.1 of IRC-SP-13-2004.

Free Board: For major bridges having longer spans (>400m), free board is considered as 1.5m whereas for major bridges having shorter spans and other minor bridges the free board adopted as 0.9m between the HFL (including afflux) and road formation level.

Linear Waterway: The linear water way for each structure has been decided as per the guidelines given in Article 7 of IRC-SP-13-2004.

7.9.4 Flood Assessment

IRC:5-1998 specifies the methods to be adopted for the assessment of design flood. IRC:SP-13-2004 gives the procedures for calculating design flood using different methods. IRC:5-2015, vide clause 106.3.2, specifies that the design flood (Maximum discharge) shall be assessed based on the flood estimation reports published by CWC if the catchment area for the bridge is covered in the report. The Flood Estimation Reports of CWC are recommended to be used for deriving the Unit Hydrographs for catchment areas ranging from 25 sq km to 5000 sq km.

7.9.5 Design HFL

HFLs (without afflux) for river/stream bridges whose length is more than 30m have been obtained after applying the corresponding design discharge to the bridge cross-section. For river/stream bridges whose length is less than or equal to 30m and for canal (on tributary/minor), HFLs / FSLs have already been obtained from local inquiry. The HFLs (without afflux) is added with the value of afflux (as given below) for obtaining Design HFL.

7.9.6 Afflux

Afflux for river/stream bridges whose length is more than 30m have been obtained as per the following method. When the waterway area of the opening of a bridge is less than the unobstructed natural waterway area of the stream, i.e., when bridge contracts the stream, afflux occurs. The afflux is calculated by using the Orifice formula.

Orifice formula: Discharge through the bridge is calculated by,

$Q = C_0 (2g)^{0.5} L D_d \{h + (1 + e) u^2/2g\}^{0.5}$ (1)

Where:

C_0 = a coefficient, to account for losses of head through bridge

g = acceleration due to gravity in m/s^2

L = linear waterway in m

D_d = downstream depth in m

h = afflux in m

e = a coefficient

u = velocity of flow in m/sec

Discharge just upstream of the bridge is calculated by,

$Q = W (D_d + h) u$ (2)

Where:

W = unobstructed width of stream in m

Combining (1) & (2),

$[Q / \{C_0 (2g)^{0.5} L D_d\}]^2 - (1 + e) u^2/(2g) - Q / (W u) + D_d = 0$ (3)

By trial & error, ‘u’ could be obtained from (3), with known values of remaining parameters. Substituting ‘u’ in equation (2), afflux, $h = Q/(W u) – D_d$.

However, when the value of afflux is more than the one-fourth of average depth at downstream side of the bridge (D_d), then the Weir formula is used.

Weir formula: Discharge through the bridge is calculated by,

$Q = 1.706 C_w L \{D_u + u^2/2g\}^{(3/2)}$ (4)

C_w = a coefficient, to account for losses in friction

D_u = upstream depth in m

Discharge just upstream of the bridge is calculated by,

$Q = W D_u u$ (5)

Combining (4) & (5),

$[Q / \{1.706 C_w L\}]^{2/3} - u^2/(2g) - Q / (W u) = 0$ (6)

By trial & error, ‘u’ could be obtained from (6), with known values of remaining parameters. Substituting ‘u’ in equation (5) & deducting D_d from it, afflux, $h = D_u – D_d = Q/(W u) – D_d$.

The afflux for river/stream bridges whose length is less than or equal to 30m and for canal (on tributary/minor), afflux values have suitably been assumed.

7.9.7 Scour Depth : Scour depth can be calculated as per Clause 703.2 of latest IRC-78 and as explained in latest IRC:SP-13. The mean depth of scour, d_{sm} below the highest flood level is given by the following equation:

$d_{sm} = 1.34\ (D_b^2/K_{sf})^{1/3}$

Where, D_b = the design discharge for foundation in cumec per meter width. The value of D_b shall be the total design discharge divided by the effective linear waterway width between abutments.

As per latest IRC-78, for the design of piers and abutments located in a straight reach and having individual foundations without any floor protection works, the maximum depth of scour from the highest flood level is given by:

- For piers: $d_{max} = 2 \times d_{sm}$
- For abutments: $d_{max} = 1.27 \times d_{sm}$ (having retained approach)

Minimum Founding Level: The foundation has been taken to a level to safeguard against scour. In case of bridges, where the mean scour depth (d_{sm}) is calculated by using the equation given in Clause 703.2 of latest IRC-78, the depth of foundation has not been taken less than that of existing structures in the vicinity. The hydrological & hydraulic design has been done at Feasibility Level. The outcome of various dimensions of proposed bridges would be established by detailed hydraulic designs.

7.9.8 Drainage and Protection Works

The drainage requirements for the project road and adjoining areas are assessed through the DTM prepared from topographical survey data. Pavement internal and external drainage is ensured by providing drainage layer and camber respectively. Longitudinal slopes in roadside ditches and central drain are generally equal to generate self-cleaning velocity at the time of storm. Small catchment analysis with project specific unit hydrograph is undertaken for the hydraulic design of the drain channel. The shape of the channels is fixed to facilitate easy and economical construction and easy maintenance. Suitable drainage system is planned for the high embankment, super-elevated carriageway and other key areas, with a view to ensure easy collection and disposal of storm water. A network has been conceptualized from runoff till final disposal and its continuity is ensured at each critical point.

7.10 Structural Design

7.10.1 General

- All structures have been designed in accordance with the relevant Codes, Standards and Specifications, Special Publications and Guidelines of the Indian Roads Congress. Construction of all culverts, bridges and grade separated structures shall conform to MORTH Specifications for Road and Bridge Works.

- For the initial 4-lane configuration of the Expressway, the structures are of 4-lane Standards.
- All bridges and grade separated structures shall have independent structure for each direction of travel.
- All bridges shall be of high level type.
- The width of median in the culvert and bridge portion shall, as far as possible, be kept same as that in the approaches. In case width of median is different from that of approach section due to site constraints, transition of 1 in 50 shall be provided near approaches for guiding vehicular traffic. Duct for utility service shall be provided on all the structures.

7.10.2 Cross Sectional Elements

- The overall deck width for all bridges, underpasses, ROBs and the median width is as per IRC:SP:99-2013. Please refer *Volume-V* for GADs of structures
- **Material Specification:**

(a) <u>Concrete</u>: The grades of concrete are confirming to section-14 as per IRC-112.

(b) <u>Steel</u>: This conforms to the provisions given in IS: 1786, IS: 432 (Part Reinforcement steel:

- High yield strength deformed bars conforming to Fe 500 / TMT.
- Mild steel not to be used.
- Pre-stressing steel

(c)<u>Bearings</u> :Bearing has been provided as per latest IRC-83 and shall conform to clause 2005 of MoSRT&H specification for Road and Bridge Works.

(d)<u>Expansion Joints</u>: Elastomeric strip seal type expansion joints are provided on all the bridges and ROBs as per Clause No. 2607 of MoRT&H specification for road and bridge works.

- **Loads and Forces to be considered in Design**

<u>Vertical Loads</u>

a) Dead Loads : Following unit weights are assumed in the design as per latest IRC Codes.

- Pre-stressed Concrete: 2.5 t / m^3
- Reinforced Concrete: 2.5 t / m^3
- Plain Cement Concrete: 2.2 t / m^3
- Structural steel: 7.85 t / m^3
- Dry Density of Backfill Soil: 2.0 t / m^3
- Saturated Density of Backfill Soil: 1.8 t / m^3

b) Superimposed Dead Loads

Wearing coat: 65mm thick with 40mm Bituminous concrete overlaid + 25mm thick bituminous mastic layer.

c) Live Loads : Carriageway live loads: The following load combinations are considered in the analysis and whichever produces the worst effect is considered.

- One / Two / Three / Four lanes of IRC Class A
- One lane of IRC Class 70R (tracked) with two lane of IRC Class A
- One lane of IRC Class 70R (wheeled) with two lane of IRC Class A
- Class 70R for first two lanes with Class 70R on another two lane
- SV loading

Resultant live load stresses are reduced by 20% in case all the four lanes are loaded. Impact factor is as per latest IRC-6 for the relevant load combinations.

d) Horizontal Forces

- **Longitudinal Forces due to live load:** Following effects are considered in the design:
  - Braking forces as per the provision of latest IRC-6
  - Distribution of longitudinal forces due to horizontal deformation of bearings/frictional resistance offered to the movement of bearings as per latest IRC-6.

- **Horizontal forces due to water currents**

The portion of bridge, which may be submerged in running water, is designed to sustain safely the horizontal pressure due to force of water current as per the stipulations of latest IRC-6.

- **Earth load**

i. Earth forces are calculated as per the provisions of latest IRC-6 assuming the following soil properties:

Type of soil assumed for backfilling: As per latest IRC-112

Angle of Internal Friction: $\Phi = 30^{\circ}$

Angle of Wall Friction: $\delta = 20^{\circ}$

Coefficient of Friction 'μ' at base: tan (2/3 Φ), while Φ is the angle of internal friction.

ii. Live load surcharge is considered as per the provisions of latest IRC-6.

-Centrifugal forces

Centrifugal forces are calculated as per the provisions of latest IRC-6 for a design speed applicable at horizontal curves.

-Wind effect : Structures are designed for wind effects as stipulated in latest IRC-6. the wind forces are considered in the following two ways and the one producing the worst effect shall govern design.

1. With L L,
2. Without L L

-Seismic Effect : The road stretch is located in Seismic Zone-III as per the revised seismic map of India (IS:1893-2002).

The seismic forces will be coefficient method as suggested by the modified clause for the interim measures for seismic provisions in latest IRC-6.

- Other Forces / Effects

Temperature effects: The bridge structure / components i.e. bearings and expansion joints, are designed for a temperature variation of +25°C considering extreme climate. The superstructures are also designed for effects of distribution of temperature across the deck depth as given in latest IRC-6, suitably modified for the surfacing thickness. Temperature effects considered are as follows:

- Effects of non-linear profile of temperature combined with 50% live load and full value of 'E' is considered.
- Effects of global rise and fall of temperature combined with 100% live load and full value of 'E' is considered.

Differential shrinkage effects: A minimum reinforcement of 0.2% of cross sectional area in the longitudinal direction of the cast-in-situ slab is provided to cater for differential shrinkage stresses in superstructures with cast-in-situ slab over precast girders as per Clause 605.2 of latest IRC-22. However, effects due to differential shrinkage and / or differential creep are duly accounted for in the design.

Construction stage loadings / effects: A uniformly distributed load of 3.6 KN /m^2 of the form area is considered to account for construction stage loadings in the design of superstructure elements, wherever applicable, as per Cl. 4.2.2.2.2 of IRC:87-1984.

Buoyancy: 100% buoyancy is considered while checking stability of foundations irrespective of their resting on soil/weathered rock / or hard rock.

-Load Combinations to be considered in Design

All members are designed to sustain safely the most critical combination of various loads and forces that can coexist. Various load combinations as relevant with increase in permissible stresses considered in the design are as per latest IRC-6. In addition, the stability of bridge supporting two superstructures (with an expansion joint) is checked under one span dislodged condition also.

- Exposure Condition : Moderate exposure conditions are considered while designing various components of the bridge.

-Design Codes : The main design criteria adopted is to evolve design of a safe structure having good durability conforming to the various technical specifications and sound engineering practices.

- Load combinations : The various load combinations considered are as per provisions of latest IRC-6.

ROB : The design of ROB will be based on the guidelines of Ministry of Railways. As per the latest Railways Guidelines, a vertical clearance of 6.625m is being imposed for electrified track.

CD structures & HO/Grade separators : The GAD of CD structures is based on hydraulic and hydrological studies. The GAD of flyovers/Grade separator is based on the traffic surveys and guidelines as contained in relevant IRC codes.

7.10.2 Design Loads and Stresses

- The design loads and stresses shall be as per IRC-6 appropriate for the width of carriageway, velocity of stream, location, altitude, environment, etc.
- All structures shall be designed for the condition when paved shoulder and edge strip on median side is also used as carriageway.
- All the components of structures shall be designed for a service life of 100 years except appurtenances like crash barriers, wearing surface, expansion joints and bearings. All the requirements to achieve durability and serviceability shall be implemented in design, construction and maintenance.

7.10.3 Width of Structures

Width of the culverts, bridges and grade separated structures have been adopted as below:

Culverts

- Box culverts have been proposed along the green-field alignment. The outer face of the left crash barrier on the structure is in line with the outer edge of the earthen shoulder. On the inner side, the culvert extends upto full width of median. Joint between the structures of two sides is provided at the middle of median.
- The slope of the adjoining embankment is suitably graded to merge with the top level of culvert with longitudinal slope not steeper than 6H:1V.

Bridges and Grade Separated Structures/ROB

The overall width of structures shall be such that the outer face of left crash barrier on the structure is in line with outer edge of earthen shoulder and inside crash barrier is located at a clear distance of 0.75 from the edge of outermost carriageway of adjoining road (the paved edge strip of 0.75 m on median side shall continue on the structure also).

7.10.4 Reinforced Earth Retaining Structures

The design and construction of reinforced earth structures shall conform to section 3100 of MoRT&H Specifications. Reinforced earth retaining structures shall not be provided near water bodies. Such structures should be given special attention in design, construction, ground improvement where necessary, maintenance and selection of system/system design. Local and global stability of the structure shall be ensured.

7.10.5 Road-Rail Bridges

Road over bridge

- If the alignment of road at the existing railway crossing has skew angle more than 45°, the alignment of road or of pier/abutment is suitably designed to reduce skew angle up to 45°.
- Railways normally do not allow construction of solid embankment in their right of way. The horizontal and vertical clearances to be provided on the railway land are as per requirement of the Railway authorities.
- The approach gradient shall not be steeper than 1 in 40.
- Outside the railway boundary, one additional span conforming to the requirements of Vehicular Underpass shall be provided on either side of ROB to cater for the local traffic, inspection, and pedestrian movement.

7.10.6 Drainage

An effective drainage system for the bridge deck shall be planned, designed and installed so as to ensure that water from the deck is taken down to ground level/drainage courses by adequate size of drainage spouts and pipes.

7.10.7 Safety Barriers

- Reinforced Cement Concrete crash barriers shall be provided on the edges of all slab/box type culverts bridges and grade separated structures.
- The design loading for the crash barriers is as per Clause 209.7 of IRC-6.
- The type design for the crash barriers are adopted as per IRC-5. High Containment type crash barrier have been provided on the Road Over Bridges and Vehicle crash barrier type have been provided on all other structures.

7.11 Tunnels

7.11.1 General

The proposed expressway shall be constructed in tunnel to carry the alignment through the natural obstacle.

7.11.2 Geometrics

The proposed tunnel sections have the same geometric standards as on the expressway carriageway outside the tunnel except as and conform to IRC:SP-91.

7.11.2.1 Cross section

Suitable tunnel cross sections have been developed in accordance with the methodology of construction, e.g., mining or cut-and-cover method, geo-technical conditions and structural consideration as per IRC:SP:99-2013.

7.11.2.2 Horizontal clearance

The tunnel shall cater for carriageway, paved shoulder, edge strip as on the adjoining carriageways outside the tunnel, and space to be provided for ventilation ducts, escape foot way, emergency lay-bye where necessary, lighting, drainage, fire and other services.

7.11.2.3 Vertical clearance

A minimum vertical clearance of 5.5 m over the full width of carriageway and paved shoulders has been maintained in tunnel sections. Vertical clearance over foot way is 3.0 m minimum. Additional vertical clearance has been provided for accommodating tunnel ventilation and lighting fixtures.

7.11.2.4 Number of traffic lanes

Twin tubes of 2 - lane configuration each have been provided.

7.11.2.5 Paved shoulder

Tunnels have paved shoulder of 3.0 m on left side and edge strip of 0.75 m on the right side. In case of tunnels having more than 500 m length, provisions are made for 10 m long and 1.5 m wide emergency lay bye beyond the left most lane at 750 m intervals to facilitate refuge for break down/damaged vehicles and also for maintenance vehicles. Proper transitions, line of sight and informatory signs is ensured for such lay-bye.

7.11.2.6 Tunnel spacing

The clear distance between the twin tubes has been kept depending upon the type of strata and structural stability of the tunnel. Guidance in this regard has been taken from IRC:SP-91 and IRC:SP:99-2013.

7.11.2.7 Tunnel passage

The twin tunnels of more than 500 m length are connected by a cross passage at an inclination to facilitate diversion of the traffic from one tube to other tube in the event of an incident/accident in one of the tubes at a spacing of 300 m. The cross passage is at an angle of 30 degrees with the direction of flow. The cross passage has the provision for one traffic lane, edge strip of 0.75 m, crash barriers and walkways on either side.

7.11.2.8 Vertical Alignment

The vertical gradient is not more than 3 percent for tunnels of length more than 500 m. In short tunnels, the gradient is limited to 6 percent.

7.11.2.9 Horizontal Alignment

- The horizontal alignment is straight as far as practicable. However, the straight stretch shall not be more than 1500 m to avoid the effect of monotony and induction of an unconscious increase in speed.
- The curves provided are gentle and meet the minimum radius requirements for design speed of the tunnel.
- In case of twin tunnel, the crossing of central median has been provided at suitable locations at approaches of both tunnel tubes so as to allow emergency services gain immediate access to either tube and also to send back diverted traffic to proper traffic lanes.

7.11.2.10 Tunnel approach

Tunnel approach has smoothly aligned tunnel walls without any sudden narrowing to avoid a shift from the tunnel wall and a good day/night visibility of the edge lines.

7.11.2.11 Tunnel portals

Tunnel portals should, apart from providing protection at entry and exit, convey drivers about the presence of the tunnel, reduce the luminance effacing walls and be in harmony with the surrounding environment from aesthetics considerations.

7.11.3 Geo-Technical Investigations and structural design

Geotechnical investigations and structural design of tunnels have been carried out in accordance with IRC:SP:91-2010 and IRC:SP:99-2013.

7.11.4 Structural Design

7.11.4.1 General

Assessment of applicable loads is based on structural properties of the ground likely to be met during tunneling as arrived from detailed Geo-technical investigations. The design caters to the most adverse combination of load conditions including only those loads which have reasonable probability of simultaneous occurring with due consideration for the methodology of construction particularly in case of soft strata and soils. The design has been checked for loading conditions during the stages of construction, operation and maintenance.

7.11.4.2 Tunnels in Rock : IRC:SP-91 and IRC:SP:99-2013 have been followed for the structural design of tunnels passing through rock.

7.11.4.3 Tunnels Through Soft Strata and Soils

Structural design of tunnel system passing through soft strata and soils has been carried out by suitable standards, specialist literature and best engineering practices.

8.0 TRAFFIC SURVEY AND ANALYSIS

1.1 INTRODUCTION & PROJECT LOCATION

M/s Aarvee Associates were awarded package 4 of Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve efficiency of freight movement in India under Bharatmala Pariyojana (Lot-10) vide agreement signed on 7th July 2021.

The scope of the consultancy services includes the stretches stated in Table-9.1

Table-9.1: List of Project Stretches

S. No	Stretch Name	Corridor Name	State	Corridor ID
1	Madanpalle - Kadappa	Bengaluru – Kadappa - Vijayawada	Andhra Pradesh	BM2 - EC
2	Mydukur (Kadappa) – Amaravati – AAE part 1/2			BM2 – Exp.

The stretch from Madanapalle to Kadapa will make use of the existing alignment with bypasses and realignments wherever necessary.

On the other hand, the stretch from Mydukuru to Amaravathi has been reviewed by Client based on different alternatives presented to them and the same has been revised as green field expressway with start point near Kodikondla Check post (Andhra / Karnataka border) on NH 44 and transiting via Mudukur and Porumamilla and terminating at Addanki / Medarametla on NH 16.

The Consultants have undertaken reconnaissance and map study of the project influence area of the above stretches for identifying the existing road network, land use pattern and industrial activities along the project corridor. Based on the reconnaissance, map studies and consultations with Client, locations for conducting traffic surveys have been identified along existing road network.

Index Map of the project corridor is given in Figure-9.1.

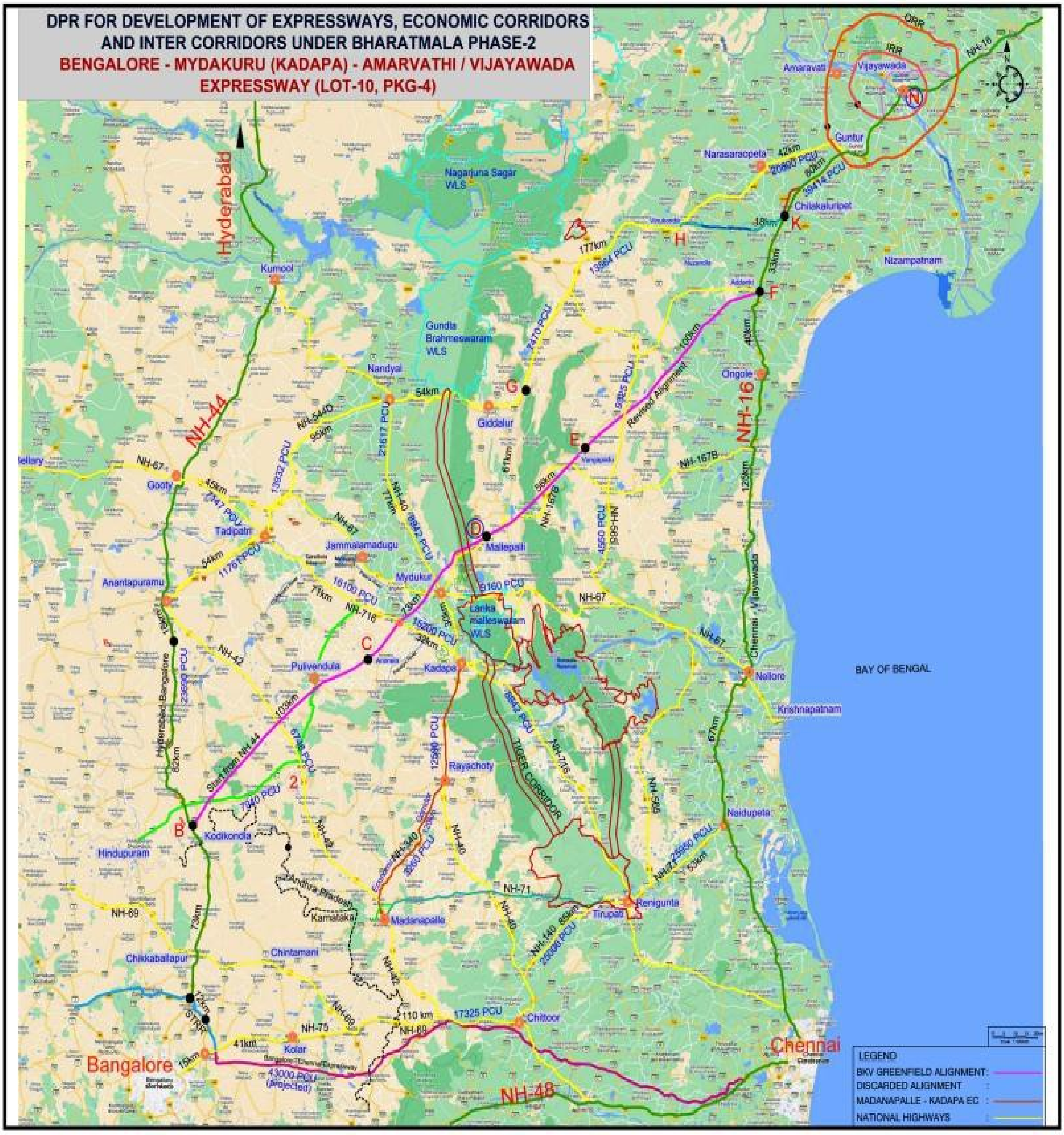


Figure-9.1 : Index Map of the Project stretch

Table-9.2: Location and Chainage of the Project stretch

S.No	Stretch Name	Length (km)	Geographic Coordinates	
			Start	End
1	Madanpalle - Kadappa	120	13°33'21.74"N 78°30'3.75"E	14°26'38.46"N 78°48'20.94"E
2	Kodikondla Checkpost (KA/AP border)– Mydukur – Porumamilla - Addanki/Medarametla	337	13°52'42.46"N 77°43'4.19"E	15°46'39.15"N 80° 2'8.10"E

1.2 SCOPE

The scope of the traffic study is listed as under:

- Study of available traffic flow data on existing National Highways and State Highways along the project stretch including traffic census data being collected by the Ministry.
- Collection of inter-regional traffic flow data by carrying out Origin-Destination study at selected locations.
- Gather supplementary data, as required, through primary surveys or secondary sources, to fill the existing data gaps to establish traffic benchmarks, modal splits, and traffic diversion curves.
- Estimate the growth of traffic on expressway for different time horizons and forecast the traffic volume for a period of 30 years.
- Estimate the modal split of traffic to be carried by the proposed expressway network.
- Carry out axle load study to determine the loading spectrum.

1.3 NEED FOR TRAFFIC STUDY FOR PROPOSED EXPRESSWAY

A comprehensive traffic and transportation study for an expressway involves traffic surveys as an integral component. Appreciation of existing traffic and travel characteristics is extremely important for the development of an effective traffic and transportation plan for the proposed expressway. An accurate estimate

of the traffic that is likely to use the project road is very important as it forms the basic input in planning, design, operation and financing. It provides the basis for determining and justifying the number of traffic lanes to be provided for different road sections having regards to volume, composition and other parameters of traffic.

For existing road networks along the project corridor, traffic analysis provides a means of assessing the traffic conditions. Traffic analysis thus helps further in the evaluation of investment needed for the future expressway improvements. A thorough knowledge of the travel characteristics of the traffic likely to use the project stretch as well as other major roads in the influence area of the study corridor is essential for future traffic estimation. The estimation of revenue through toll collection plays a pivotal role in assessing the financial viability of the project and finalize the financial covenants for the concession agreement. Thus, accurate assessment of the existing traffic and forecasting attains utmost importance in the development of Expressway.

1.4 OBJECTIVE

The objectives of the current traffic study are listed as under:

- Establish the base year traffic characteristics of existing road networks in and around the project influence area.
- Identify zones of influence for the project stretch and extent of influence based on O-D Survey.
- Determine travel pattern as well as type and weight of commodities carried by goods vehicles.
- Estimate potential traffic diversion from existing road network to project stretch.
- Estimate the induced as well as future developmental traffic.
- Project the traffic demand on the proposed expressway for a horizon period of 30 years.
- Forecast traffic levels for developing tolling strategies.
- Determine load distribution along proposed expressway and arrive at Vehicle Damage Factors (VDF) to aid in pavement design.
- Benefit-Cost Analysis (BCA) of proposed expressway along with Sensitivity Analysis.

1.5 OUTCOME

The following outcome will be derived from the current report:

- Base year traffic demand of existing road network along the project stretch.

- Potential traffic diversion from existing road network to project stretch
- Traffic forecast along the project stretch considering the generated as well as developmental traffic for a horizon period of 30 years
- Projected traffic on section-wise breakup of project stretch to provide inputs for tolling strategy
- Vehicle Damage Factor(s) to provide input for pavement design
- Justification on provision of 4 lane/ 6 lane Expressway

1.6 METHODOLOGY

Traffic Surveys were carried out strictly as per TOR and within the time frame given for submission. In general, the Specifications and Standards primarily based on the Guidelines for Expressway by Ministry of Road Transport and Highways (MORT&H) have been followed. Specific Codes and Guidelines of the IRC and publications of the MORT&H including circulars & general/special publications, technical Specifications & Standards have been kept in view.

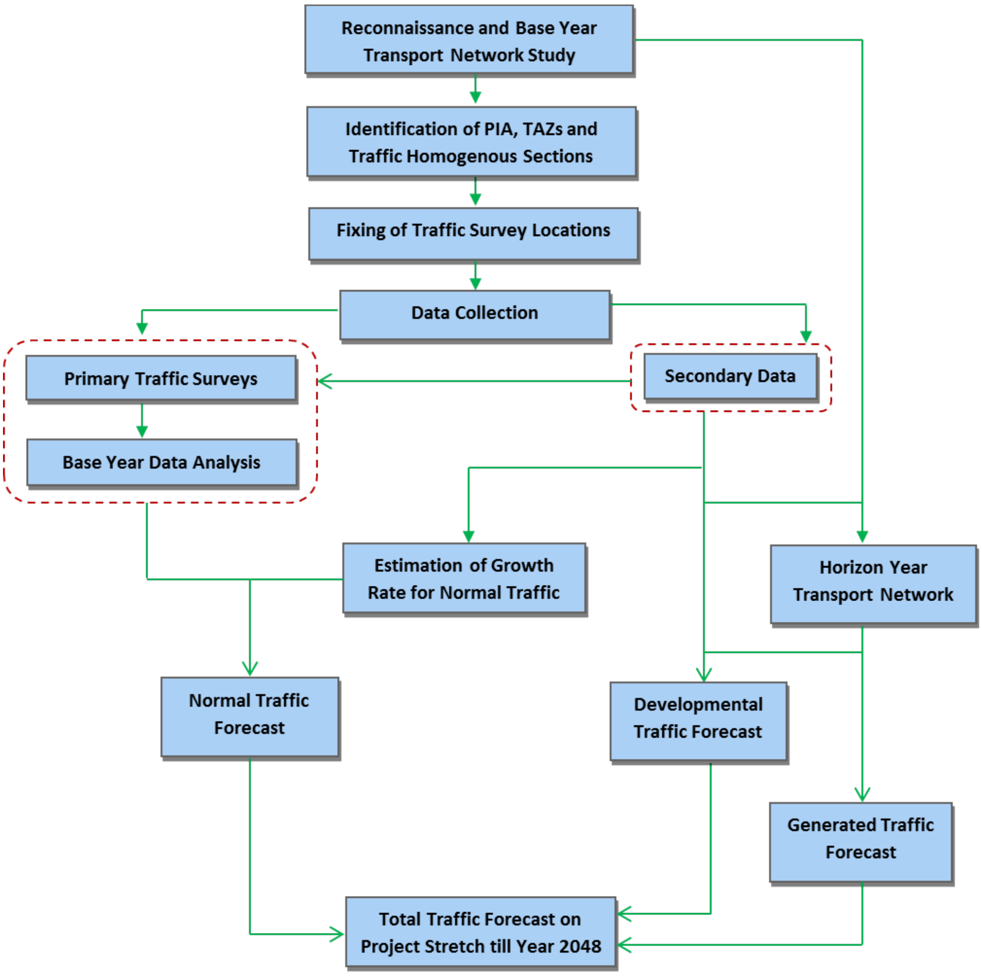
1.6.1 Socio-Economic Profile

Socio-economic profile of the influence area is prepared, after study of data on growth of population and density, human settlement pattern, land use, sub-profiles of agriculture and industries, economic base, trends in socio-economic indicators, development scenarios for various sectors, transport infrastructure and its uses such as use of rail transport etc. The relevant data helpful is collected from the following sources:

- State Statistical Abstracts
- State Year Books
- Census Publications – Districts and State
- Hand Books of Statistics of Districts in the area of influence
- Economic Surveys of the State constituting the zone of influence
- Directorate of Economics & Statistics of Andhra Pradesh

1.7 FLOW CHART OF WORK PLAN

The work plan adopted for the current study is represented in the form of flow chart as shown below.



1.8 TRAFFIC SURVEYS

To achieve the desired objectives, the Consultant thoroughly studied the road network during the reconnaissance stage. Keeping in view the requirements of the TOR, the consultants undertook surveys to assess typical traffic, travel, socio-economic and transport characteristics within the influence area of each survey location. The following traffic surveys were conducted:

- The Automatic Classified Traffic Volume Count (ATCC) surveys were conducted at 11 strategic points for 7 days. The surveys were conducted using ATCC(Video graphic) methods.

- Origin-Destination & Commodity Movement Survey by Road Side Interview (RSI) method were conducted at eight locations i.e., at Kodikondla Checkpost on NH-44, at Pulagampalle on SH-61, at Sambepalli on NH-40, at Basapuram Toll Plaza on NH-67, at

Mokshagundam on NH – 544D, at Kothuru on NH-71, at Pamuru on NH- 565, at Podili -Chimakurthy road and at Tanguturu Toll Plaza on NH-16 for 24 hrs.

- Axle load Survey were conducted at Five locations i.e., at Kodikondla Checkpost on NH-44, at Sambepalli on NH-40, at Basapuram Toll Plaza on NH-67, at Mokshagundam on NH – 544D and at Kothuru on NH-71 for 24 hrs.

Locations for carrying out these surveys were selected in consultation with the Authority and also based on the following factors:

- Each location being selected near the point from where the possibility of diversion of traffic on the proposed alignment of the expressway is expected
- The survey location should be outside urban influence
- The survey location is located in a reasonably level terrain with good visibility
- The location is located in a straight section of road and shall facilitate in reducing the speed of vehicles for easy enumeration of data

Mid-block sections were identified for carrying out traffic surveys and all locations of traffic surveys are finalized in consultation with the Authority. The map of the same is presented in ***Figure-9.2***. The survey schedule is given in ***Table-9.3***.

The following key activities were performed before commencement of actual surveys:

- Reconnaissance and an extensive study of existing traffic characteristic were made before finalizing the survey locations
- Survey formats were prepared keeping in view of guidelines specified in *IRC:SP:19-2001*
- Necessary permissions were obtained from police personnel of respective districts before commencing the surveys
- Automatic Traffic Counter and Classifier (ATCC) system was deployed at site to record the mode wise traffic data.
- Trained enumerators were deployed to capture the OD survey data accurately

All necessary precautions were exercised during surveys for the safety of enumerators. Enumerators were provided with traffic cones, reflective jackets, electronic gadgets and accurate measuring equipment(s).

Figure-9.2: Index Map showing Traffic Survey Locations

Table-9.3: Traffic Survey Schedule

S.No.	Location	Classified Traffic Volume Count Survey			Origin - Destination Survey		Axle Load Survey	
		From	To	Duration	Date	Duration	Date	Duration
1	Kodikondla Checkpost on NH 44	06.09.2021	12.09.2021	7 days	08.09.2021	1 day	08.09.2021	1 day
2	Pulagampalle near Kadiri on SH 61	06.09.2021	12.09.2021	7 days	09.09.2021	1 day	09.09.2021	1 day
3	Sambepalli on NH 40	06.09.2021	12.09.2021	7 days	07.09.2021	1 day	07.09.2021	1 day
4	Ramiganivari Palle on NH 340	06.09.2021	12.09.2021	7 days	-	-	-	-
5	Basapuram Toll Plaza on NH 67	06.09.2021	12.09.2021	7 days	09.09.2021	1 day	-	-
6	Akkalreddipalle	06.09.2021	12.09.2021	7 days	-	-	-	-
7	Kothuru on NH 71	12.09.2021	18.09.2021	7 days	16.09.2021	1 day	16.09.2021	1 day
8	Mokshagundam on NH 544D	13.09.2021	19.09.2021	7 days	13.09.2021	1 day	13.09.2021	1 day
9	Podili-Chimakurthy	13.09.2021	19.09.2021	7 days	15.09.2021	1 day	-	-
10	Pamuru on NH 565	13.09.2021	19.09.2021	7 days	14.09.2021	1 day	-	-
11	Tanguturu Toll Plaza on NH 16	13.09.2021	19.09.2021	7 days	17.09.2021	1 day	-	

Note: *Description of survey locations is briefly presented in subsequent chapters*

1.9 CLASSIFIED TRAFFIC VOLUME COUNTS

The classified traffic volume count survey was carried out at 11 locations, each location being selected near the point from where the possibility of diversion of traffic on the proposed alignment of the expressway was observed. The survey was done continuously for seven consecutive days for 24 hours using Automatic Traffic Collection and Classifier (ATCC) System. For carrying out the counts, the vehicles were grouped under different categories as indicated in ***Table-9.4*****.** The identified locations of classified traffic volume count for 7 days are given in ***Table-9.3.***

Figure-9.3: TVC survey using ATCC at various survey locations

Location wise photographs of ATCC surveys is given in *Annexure - I*

9.10 ORIGIN-DESTINATION SURVEY

The origin-destination survey was carried out with the primary objective of studying the travel pattern of goods and passenger traffic along the study corridor. The results will also be useful for assessing the divertable traffic on to the proposed road, identifying the influence area of the project road, estimating the growth rates of traffic, planning for tolling strategies and identification of the toll plazas on the project road. The O-D survey was carried out for one-day. Roadside interview method was adopted for the survey. The vehicles were stopped on random sample basis with the help of police, and information pertaining to origin and destination of the trip, trip length, frequency, return trip commodity types, loading pattern and trip purpose as applicable for various vehicle types were recorded. This trip frequency will be used in the estimation of Tollable vehicles. The origin–destination survey was carried out at all locations where Classified Volume Count was conducted as described above.

Figure-9.4: O-D Survey at survey locations

Location wise photographs of Origin – Destination surveys are given in Annexure - II

1.11 AXLE LOAD SURVEY ANALYSIS

Axle Load surveys provide load spectrum information which facilitates in pavement design. As the loading pattern along the existing roads is not available, the surveys were conducted at seven locations along existing roads, where diversion of traffic is expected on project stretch, to arrive at damaging effect due to heavy vehicles. The vehicle weights are manually captured using portable weigh scales by stopping the vehicle and making it pass on the axle pad. The survey was conducted for two days. Processing of combined information enables the calculation of average pavement loading results. The identified locations for axle load survey are given in *in the below table.*

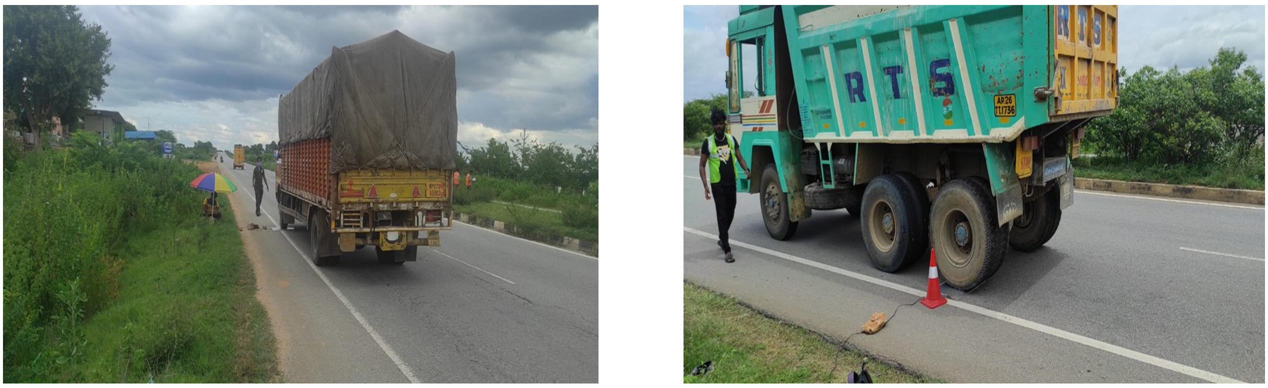


Figure-9.5: Axle load Survey at survey locations

Location wise photographs of axle load surveys is given in *Annexure – III*

Mode	Sambepalli	Basapuram	Kodikonda	Mokshagundam	Kothuru
LCV	0.94	0.85	1.10	0.82	1.05
2A	1.98	1.75	2.25	1.48	1.70
3A	2.98	3.05	3.78	2.78	3.18
MA	5.66	5.42	6.82	5.78	5.42

9.12 TRAFFIC VOLUME COUNT SURVEY ANALYSIS

The various vehicle types having different sizes and characteristics were converted into a standard unit called passenger car unit. Passenger Car equivalents for various vehicles are adopted based on recommendations of Indian Road Congress prescribed in "Guidelines for Capacity of Roads in Rural areas", IRC:64-1990. The passenger car unit values (PCU) which were adopted are presented in ***Table-9.4.*** The information derived from the surveys was utilized to obtain traffic intensity, traffic composition, hourly variation and daily variations and peak hour characteristics.

Table-9.4: Passenger Car Unit Factors for Various Vehicle Types

<table>
<tr><th>S.No</th><th>Vehicle Type</th><th>PCU factors</th><th>S.No.</th><th colspan="2">Vehicle Type</th><th>PCU factors</th></tr>
<tr><td>1</td><td>Two Wheelers</td><td>0.5</td><td>12</td><td colspan="2">Two Axle</td><td>3.0</td></tr>
<tr><td>2</td><td>Three Wheelers</td><td>1.0</td><td>13</td><td colspan="2">Three Axle</td><td>3.0</td></tr>
<tr><td>3</td><td>Car / Jeep / Van</td><td>1.0</td><td>14</td><td colspan="2">Multi Axle</td><td>4.5</td></tr>
<tr><td>4</td><td>Car (Yellow Board)</td><td>1.0</td><td>15</td><td colspan="2">Heavy Earth Moving</td><td>4.5</td></tr>
<tr><td>5</td><td>Tata Magic</td><td>1.0</td><td>16</td><td colspan="2">LCV/ LGV</td><td>1.5</td></tr>
<tr><td>6</td><td>RTC Bus</td><td>3.0</td><td>17</td><td colspan="2">Mini LCV</td><td>1.0</td></tr>
<tr><td>7</td><td>Private Bus</td><td>3.0</td><td>18</td><td colspan="2">Tractor</td><td>1.5</td></tr>
<tr><td>8</td><td>School Bus</td><td>3.0</td><td>19</td><td colspan="2">Tractor with trailer</td><td>4.5</td></tr>
<tr><td>9</td><td>College Bus</td><td>3.0</td><td>20</td><td rowspan="3">Non Motorised</td><td>Cycle</td><td>0.5</td></tr>
<tr><td>10</td><td>Mini Bus</td><td>1.5</td><td>21</td><td>Cycle Rickshaw</td><td>2.0</td></tr>
<tr><td>11</td><td>Three Wheeler (Goods)</td><td>1.0</td><td>22</td><td>Animal Drawn</td><td>8.0</td></tr>
</table>

Source: *IRC:64-1990*

9.12.1 Average Daily Traffic (ADT)

The Average Daily Traffic (ADT) is obtained from the Classified Traffic Volume Counts to determine the characteristics of traffic movement and to establish base year traffic demand. The data collected from primary and secondary sources were recorded in worksheets, compiled, checked and corrected before further proceeding for analysis. Traffic data analysis was carried out, to understand the traffic characteristics and travel pattern in the study area and to provide basic input for pavement design. ADT has been worked out in terms of vehicles per day (VPD) and Passenger Car Units (PCU) by averaging 7 days volume counts. ***Table-9.5*** gives the average daily traffic at 11 survey locations based on average of 7 days traffic volume count.

Table-9.5: Average Daily Traffic at Survey Locations

Survey Location No	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Name of the Location	**Kodikondla Checkpost**	**Pulagam palle**	**Sambepalli**	**Ramiganivari Palle**	**Basapuram Toll Plaza**	**Akkalreddi palle**	**Kothuru**	**Mokshagunda m**	**Podili-Chimakurthy**	**Pamuru**	**Tanguturu Toll Plaza**
Type of Road	**NH-44**	**SH-61**	**NH - 40**	**NH - 340**	**NH-67**	**SH - 54**	**NH - 71**	**NH – 544D**	**SH - 53**	**NH-565**	**NH-16**
Two Wheeler	3,944	6,466	3,126	1,293	2,615	1,523	2,525	2,039	7,727	1,298	9,171
Three Wheeler (Passenger)	407	1,094	571	140	330	189	447	201	1,352	155	994
Car (White board)	5,196	1,086	2,161	758	1,191	421	3,645	1,548	1,956	808	7,256
Car (Yellow Board)	15	21	24	1	4	18	36	20	0	10	81
Tata Magic	2	43	10	3	2	25	4	38	15	22	28
RTC Bus	342	205	286	191	123	67	488	186	412	126	705
Private Bus	210	31	101	23	45	17	147	64	4	39	294
Mini Bus	28	10	12	3	4	6	45	16	12	12	41
School/ College Bus	0	2	8	3	9	3	4	9	10	12	12
2 Axle	732	55	209	31	115	58	521	119	156	240	1,002
3 Axle	719	30	266	45	143	114	832	172	681	81	1,241
Multi Axle	1,562	118	1,033	227	893	276	2,034	410	136	99	4,426
HEM	7	4	3	14	4	4	3	19	25	2	3
LCV	1,278	106	234	71	219	101	821	195	72	37	1,159
Mini LCV	844	246	401	187	297	150	529	534	352	104	1,106
Tractor	12	17	6	14	22	8	24	9	34	13	34
Tractor with Trailer	18	80	21	28	54	38	110	18	185	13	126
Three Wheeler (Goods)	41	89	27	14	53	13	40	61	117	10	108
Bicycle	4	0	0	2	3	27	7	1	14	0	15
Cycle Rickshaw	0	0	0	1	0	0	0	0	4	0	0
Animal Drawn	3	0	3	0	0	0	6	0	0	0	3
Government Exempted	9	13	13	0	1	1	7	6	14	0	27
Vehicles Motorised	15,365	9,717	8,511	3,049	6,125	3,035	12,261	5,666	13,264	3,081	27,815
Non Motorised	7	0	3	3	3	27	13	1	18	0	18
Total Traffic	15,372	9,717	8,514	3,052	6,128	3,062	12,274	5,667	13,282	3,081	27,833
Tollable Traffic	10,935	1,957	4,748	1,557	3,049	1,260	9,109	3,330	3,831	1,592	17,354

Survey Location No		1	2	3	4	5	6	7	8	9	10	11
Name of the Location		Kodikondla Checkpost	Pulagam palle	Sambepalli	Ramiganivari Palle	Basapuram Toll Plaza	Akkalreddi palle	Kothuru	Mokshagunda m	Podili-Chimakurthy	Pamuru	Tanguturu Toll Plaza
Type of Road		NH-44	SH-61	NH - 40	NH - 340	NH-67	SH - 54	NH - 71	NH – 544D	SH - 53	NH-565	NH-16
PCU	Motorised	23,620	7,913	12,525	3,974	9,142	3,963	22,949	7,424	13,215	3,862	46,324
	Non Motorised	26	0	24	3	2	14	52	1	16	0	32
	Total Traffic	23,646	7,913	12,549	3,977	9,144	3,977	23,001	7,425	13,231	3,862	46,356
	Tollable Traffic	21,088	3,089	10,239	3,025	7,172	2,813	20,657	6,038	6,965	2,968	39,965

Location wise detailed analysis along with graphs are presented in Annexures – I.

9.12.2 Peak Hour Traffic

The peak hour traffic based on AADT at all survey locations is presented in ***Table-9.6.***

Table-9.6: Peak Hour Traffic Composition at Survey Locations

Survey Location	Peak Hour Volume	Total Volume	Peak Hour Composition(%)	Time
1	1,361	24,495	5.56	17:00 – 18:00
2	608	7,977	7.62	10:00 – 11:00
3	713	12,371	5.76	17:00 – 18:00
4	230	3,961	5.81	16:00 – 17:00
5	457	8,813	5.19	17:00 – 18:00
6	208	3,936	5.28	11:00 – 12:00
7	1,190	23,279	5.11	15:00 – 16:00
8	387	7,374	5.25	09:00 – 10:00
9	904	13,177	6.86	17:00 – 18:00
10	275	4,514	6.09	16:00 – 17:00
11	2,472	46,466	5.32	09:00 – 10:00

9.12.3 Traffic Composition (ADT)

The composition of passenger and goods vehicles at all survey locations is presented in ***Table-9.7.*** Mode wise composition of total traffic is shown from ***Figure-9.6*** to ***Figure-9.10.***

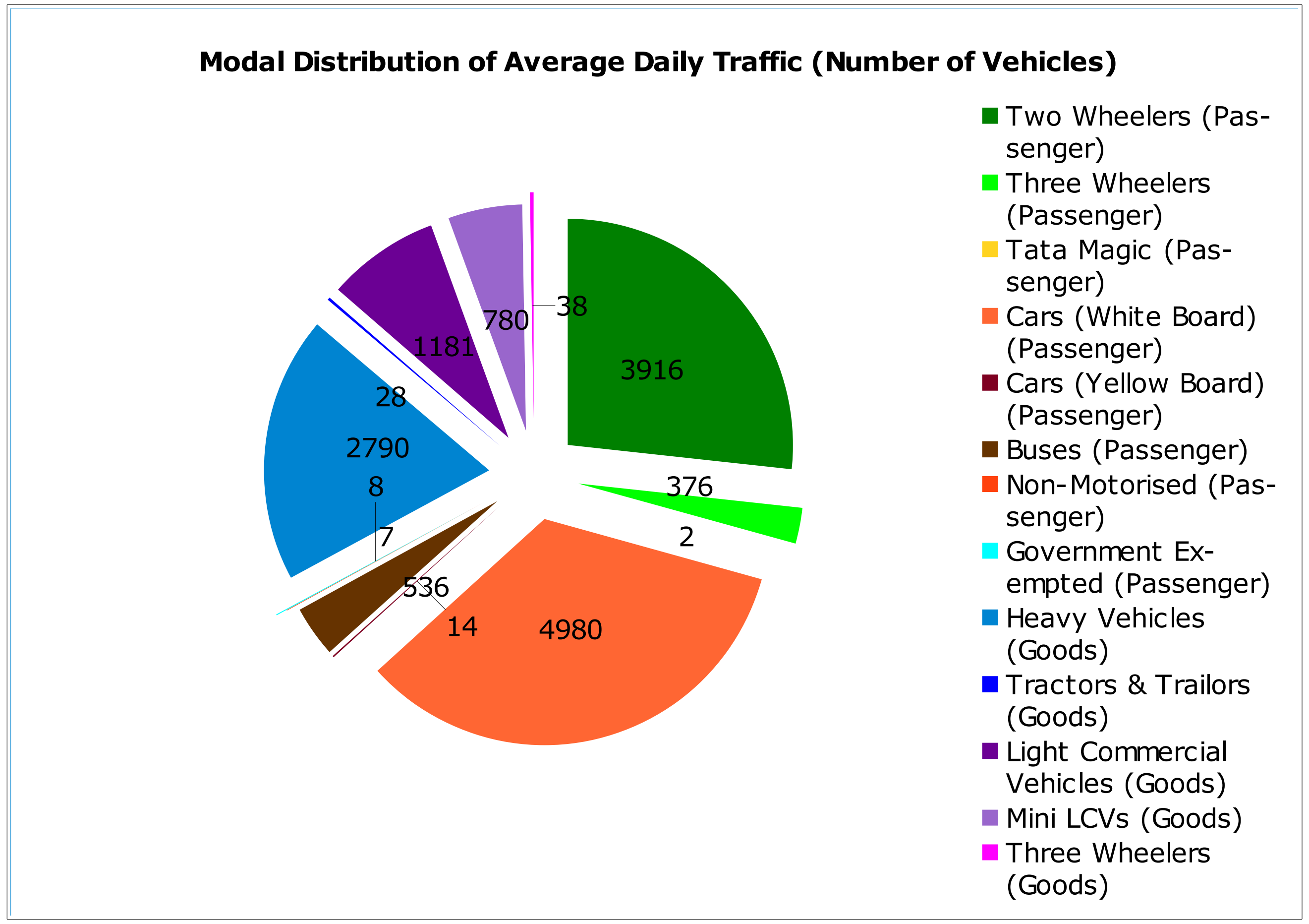
Table-9.7: Total Traffic Composition at Survey Locations

Survey Location	Passenger Vehicles			Goods Vehicles			Slow Moving Vehicles	Tractors
	Car	2 W	Buses	LCV	Trucks	3 W		
1	5,213	3,944	580	2,122	3,013	448	7	30
2	1,150	6,466	248	352	203	1,183	4	97
3	2,195	3,126	407	635	1,508	598	3	27
4	762	1,293	220	258	303	154	14	42
5	1,197	2,615	181	516	1,151	383	4	76
6	464	1,523	93	251	448	202	4	46
7	3,685	2,525	684	1,350	3,387	487	3	134
8	1,606	2,039	275	729	701	262	19	27
9	1,971	7,727	438	424	973	1,469	25	219
10	840	1,298	189	141	420	165	2	26
11	1,971	7,727	438	424	973	1,469	25	219

9.12.4 Variation of Traffic

Mode wise graphical representation of daily variation of traffic at survey locations is shown from ***Figure-9.6 to 1.20. Figure-9.21 to 1.27*** displays the mode wise average hourly variation of total traffic volume.

LOCATION-1



LOCATION-2

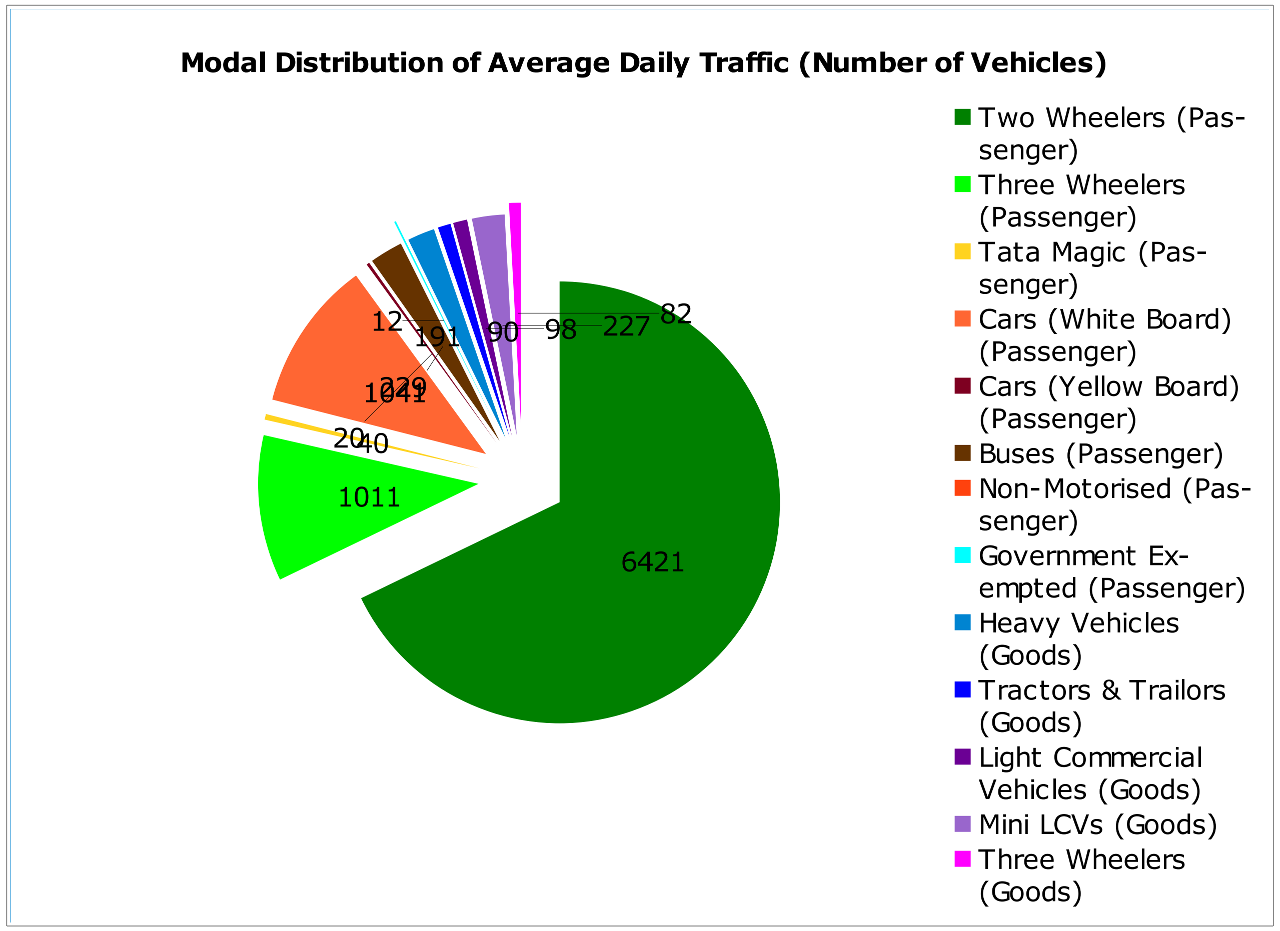
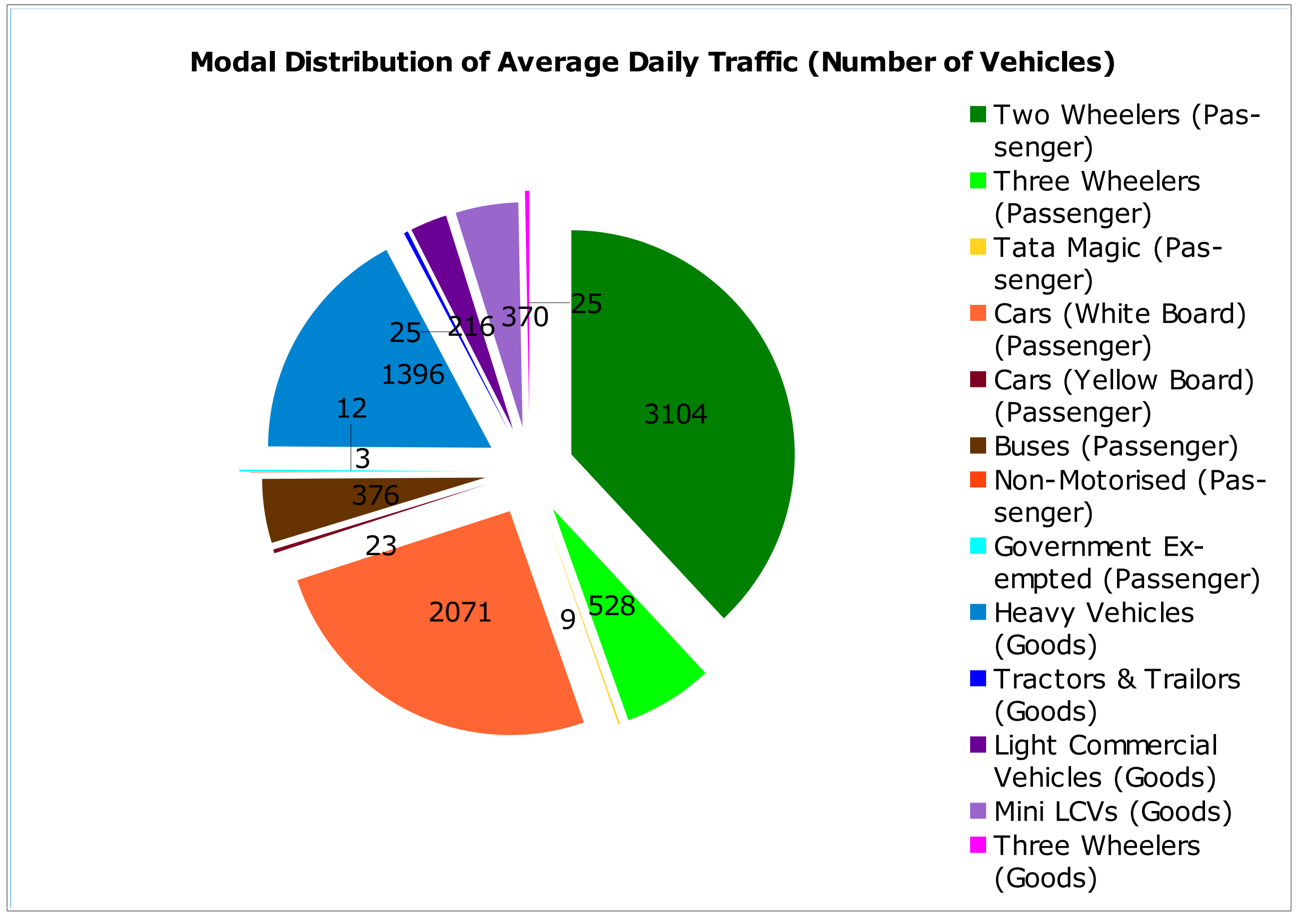


Figure-9.6: Mode wise average daily traffic composition at Locations 1 & 2

LOCATION-3



LOCATION-4

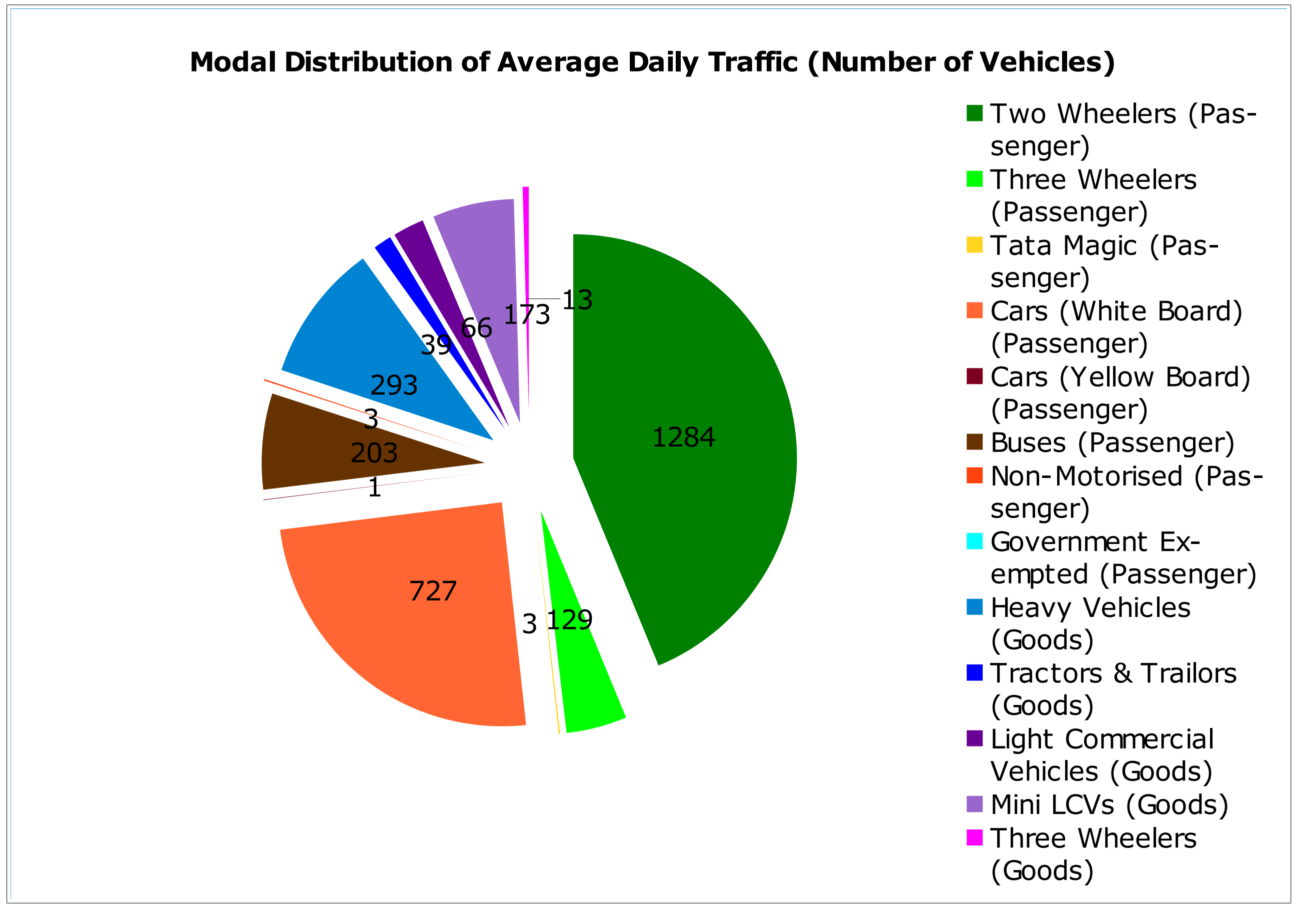
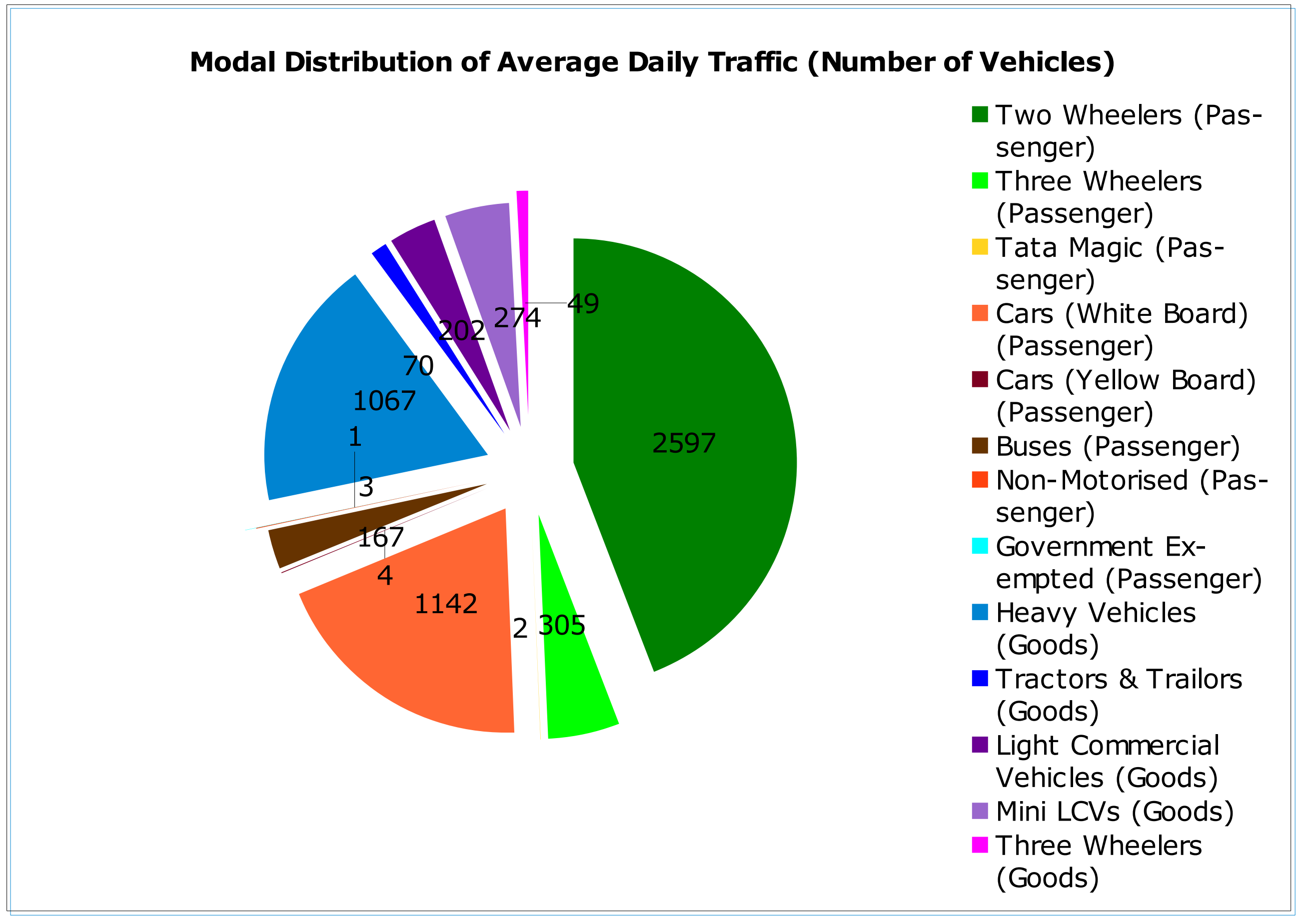


Figure-9.7: Mode wise average daily traffic composition at Locations 3 & 4

LOCATION-5



LOCATION-6

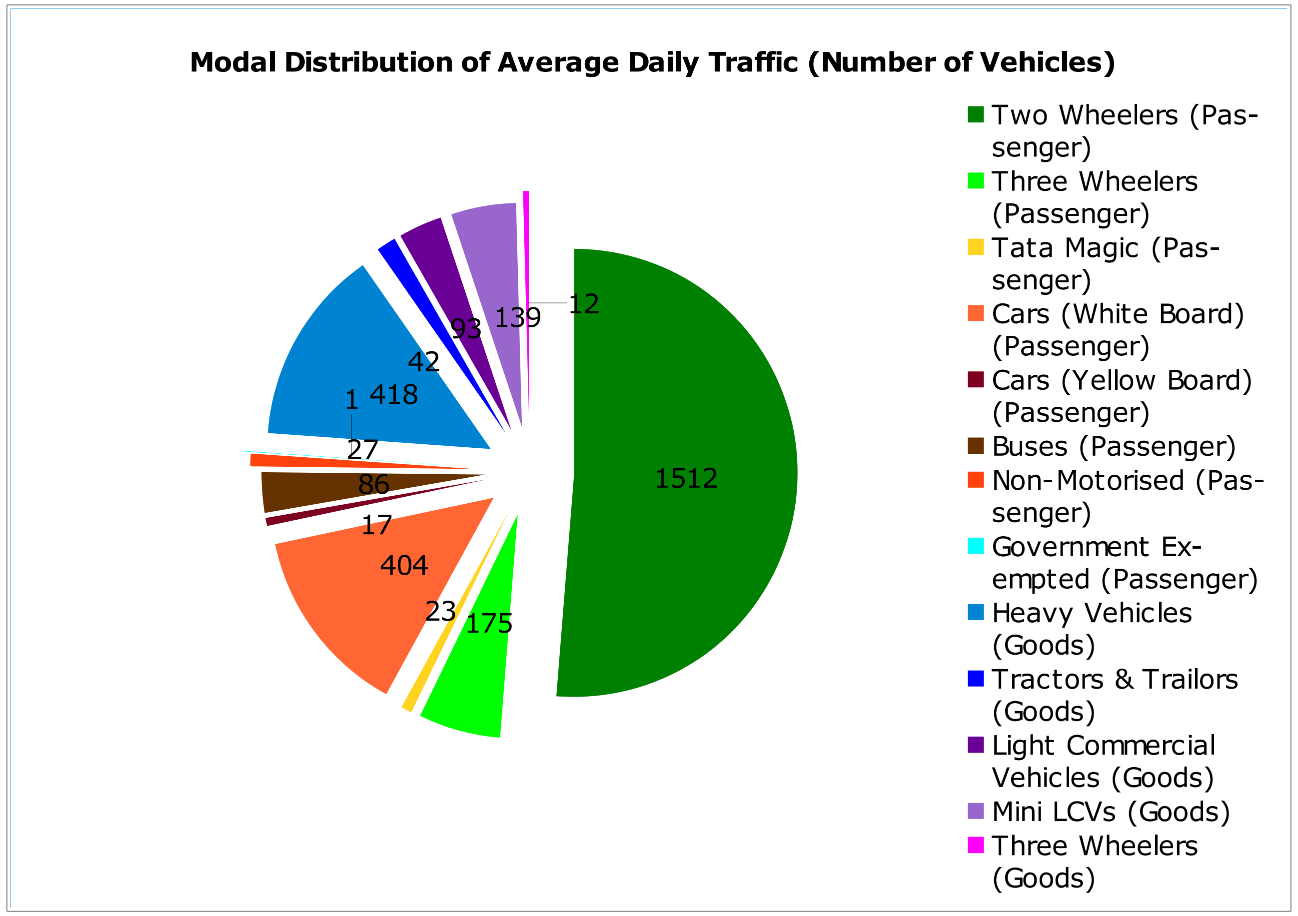
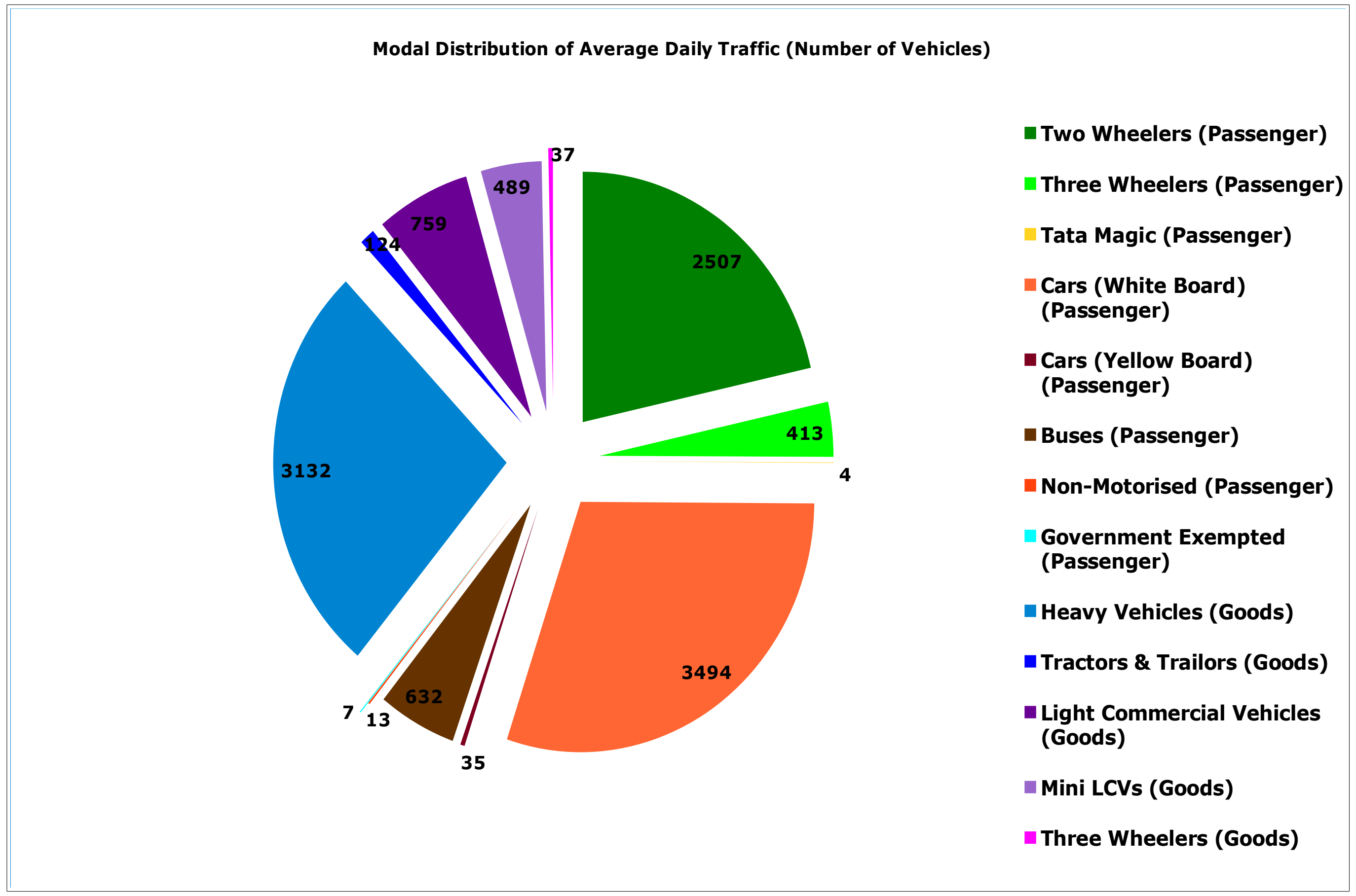


Figure-9.8: Mode wise average daily traffic composition at Locations 5 & 6

LOCATION-7



LOCATION-8

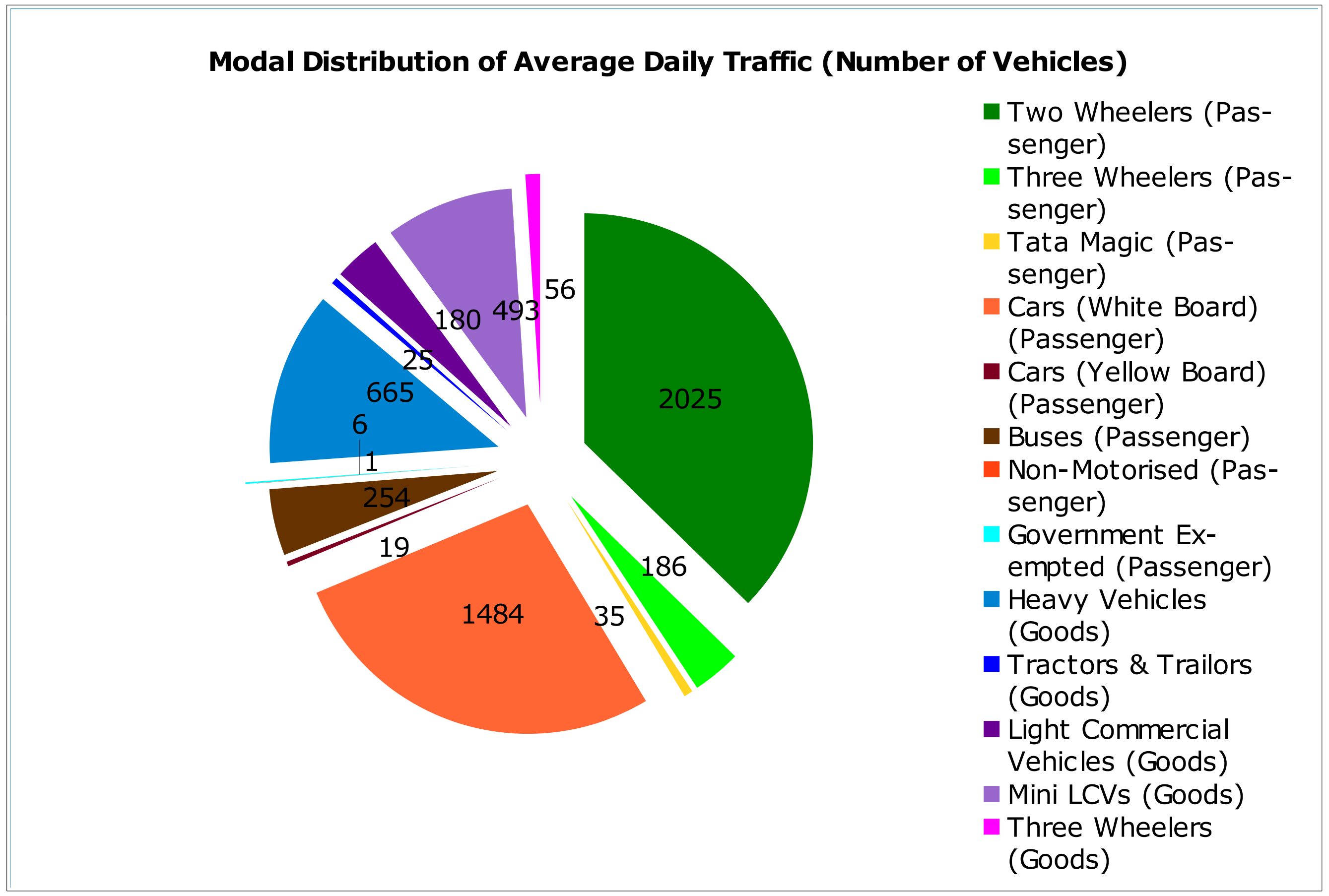
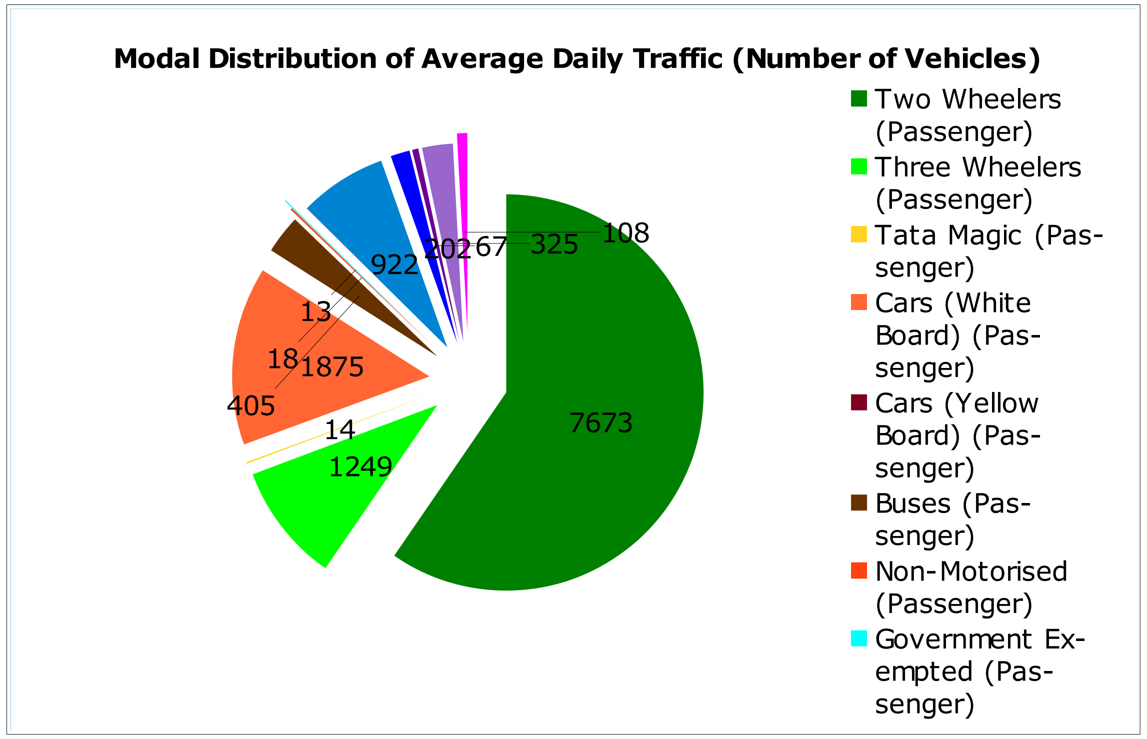
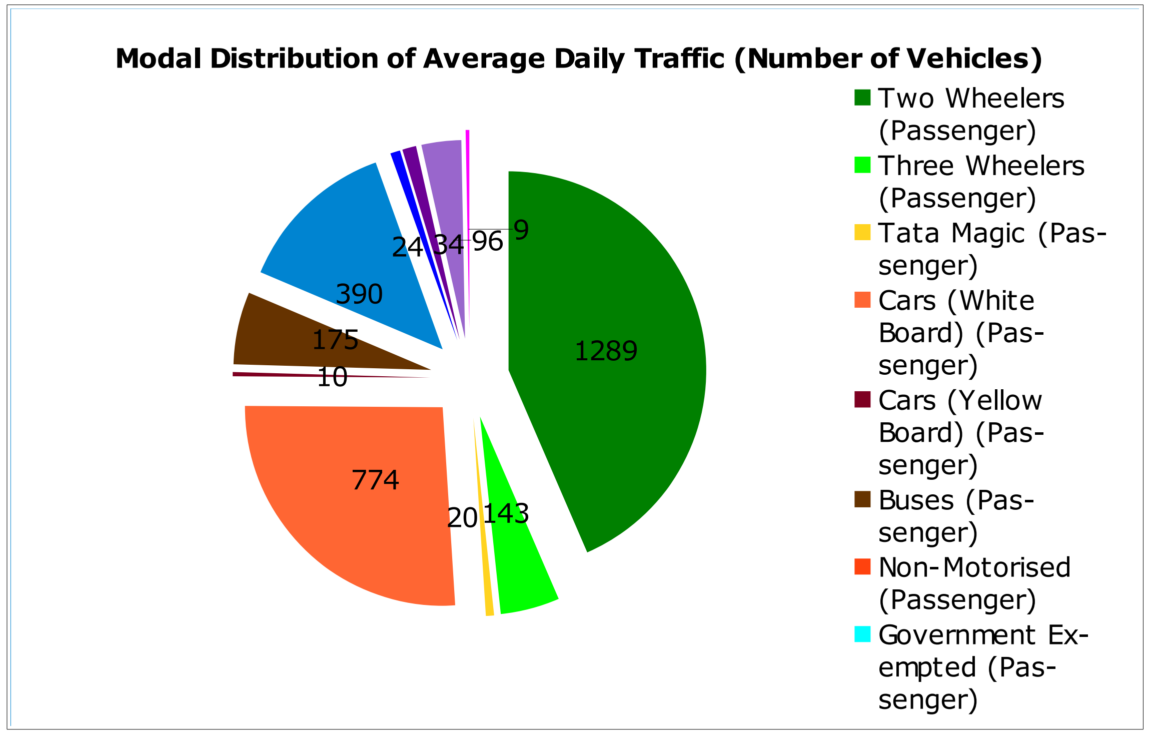


Figure-9.9: Mode wise average daily traffic composition at Locations 7 & 8

LOCATION-9



LOCATION-10



LOCATION-11

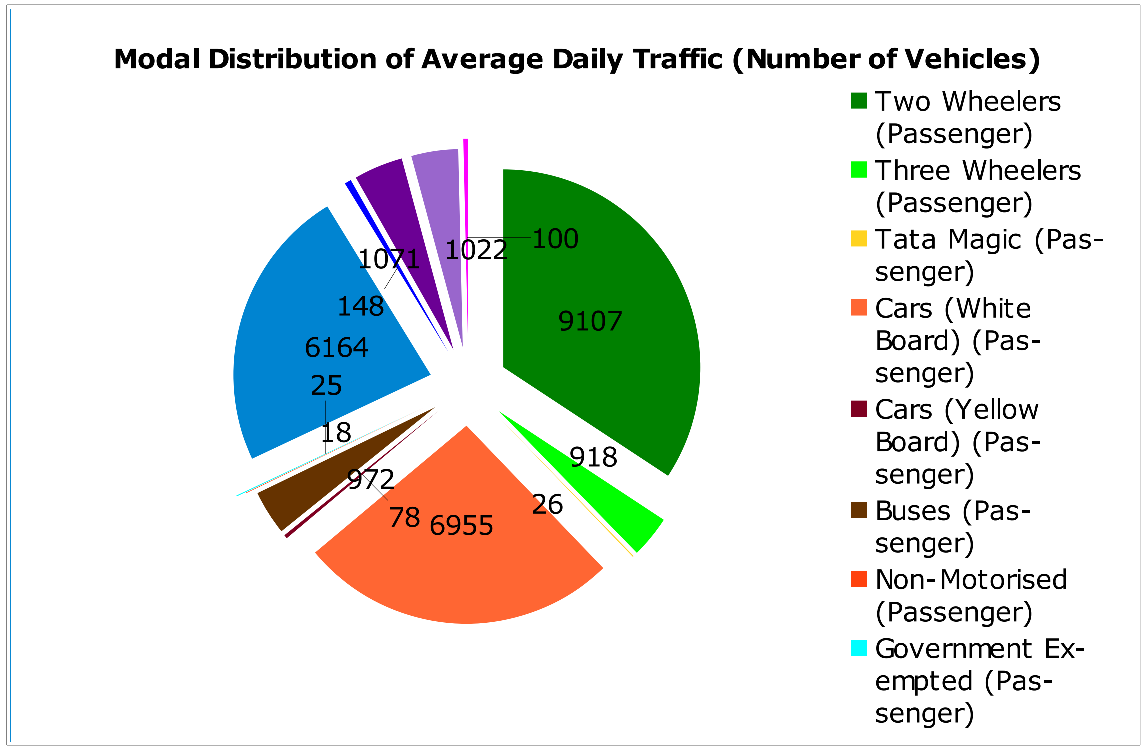
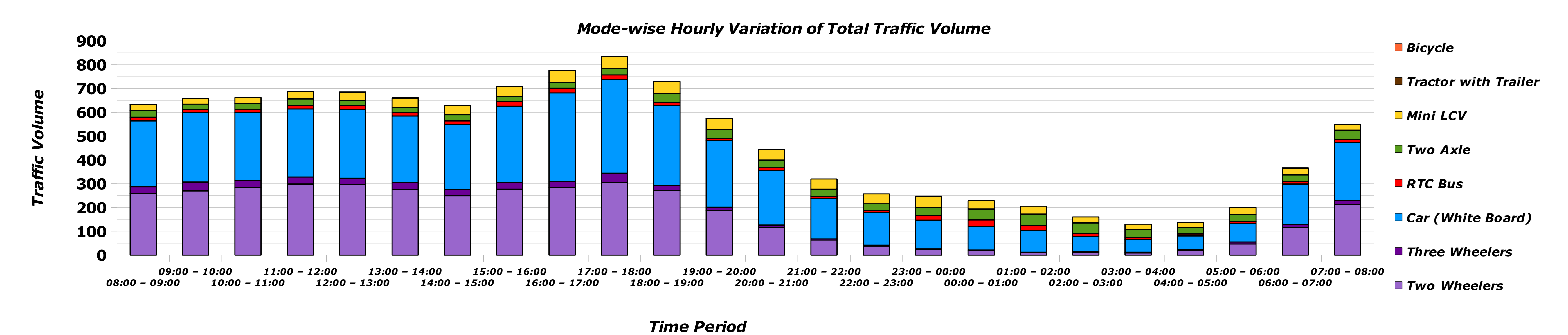


Figure-9.10: Mode wise average daily traffic composition at Locations 9, 10 & 11

LOCATION-1



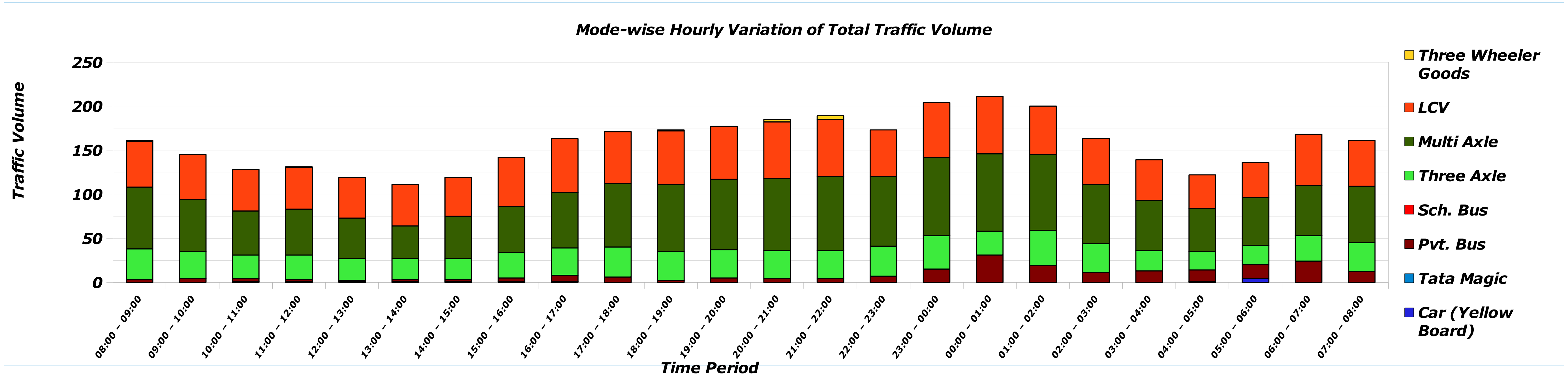
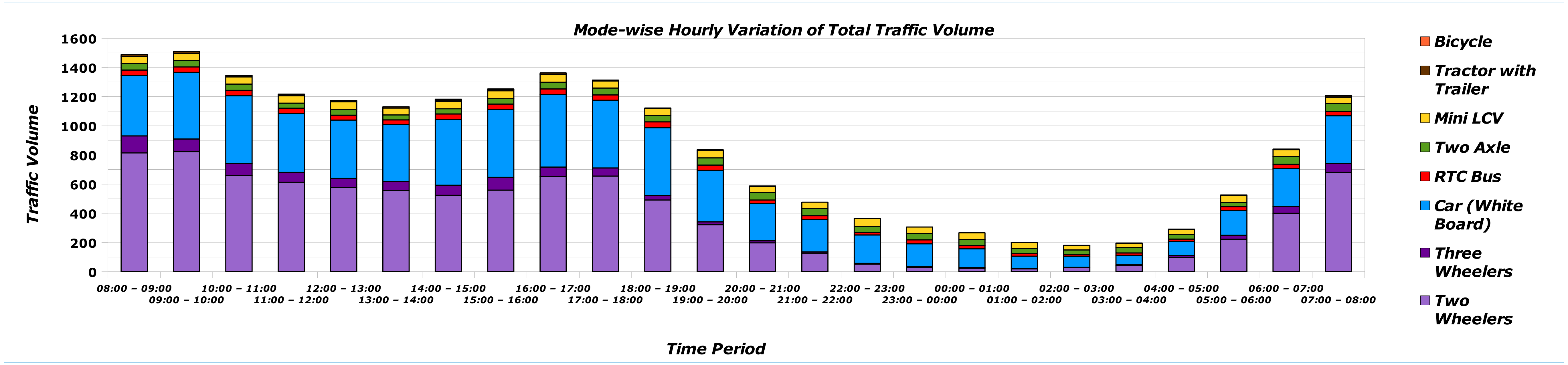


Figure-9.11: Mode wise hourly variation of Traffic at Location- 1

LOCATION-2



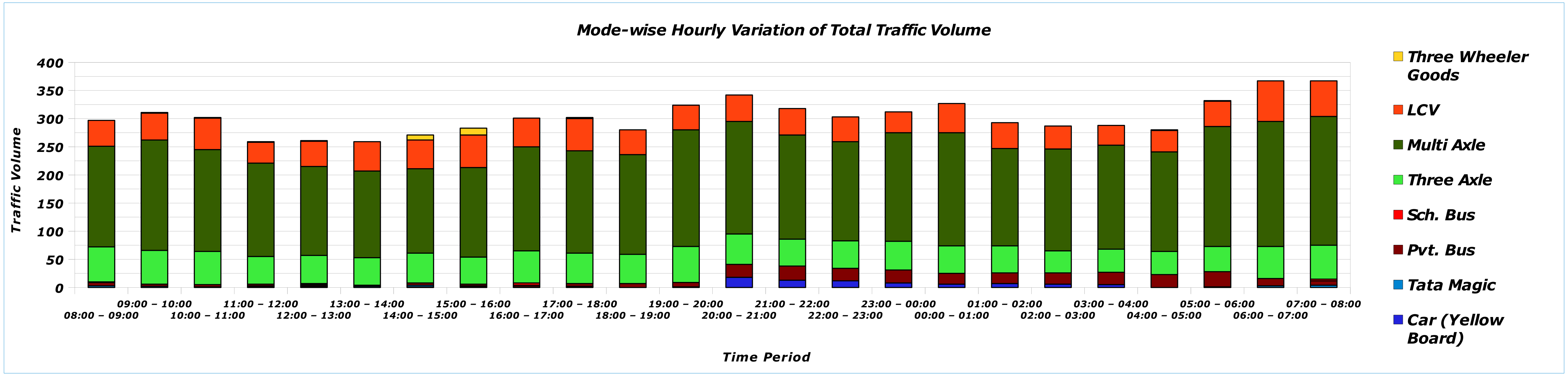
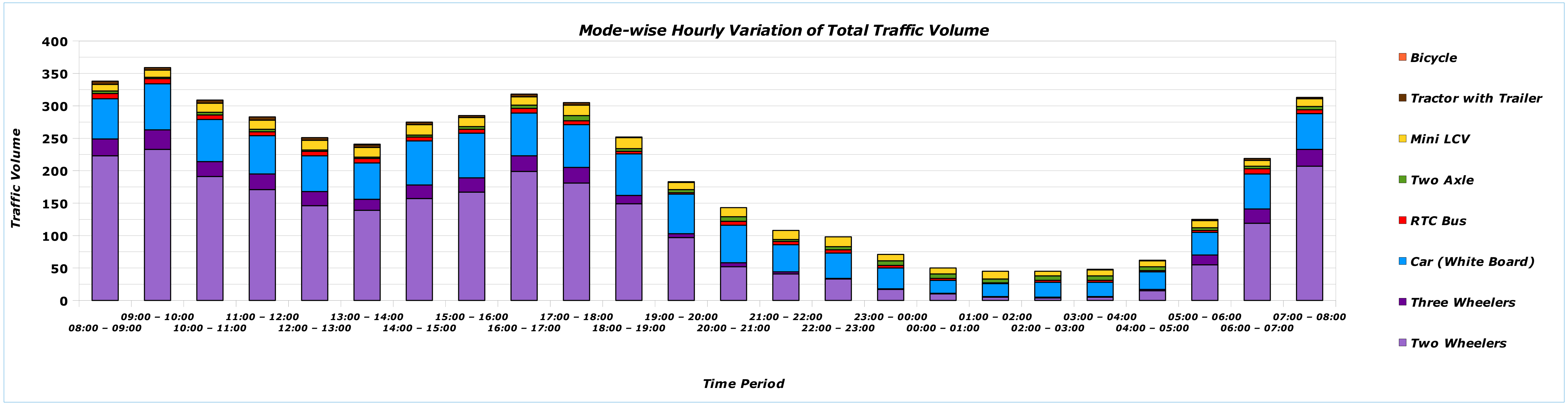


Figure-9.12: Mode wise hourly variation of Traffic at Location- 2

LOCATION-3



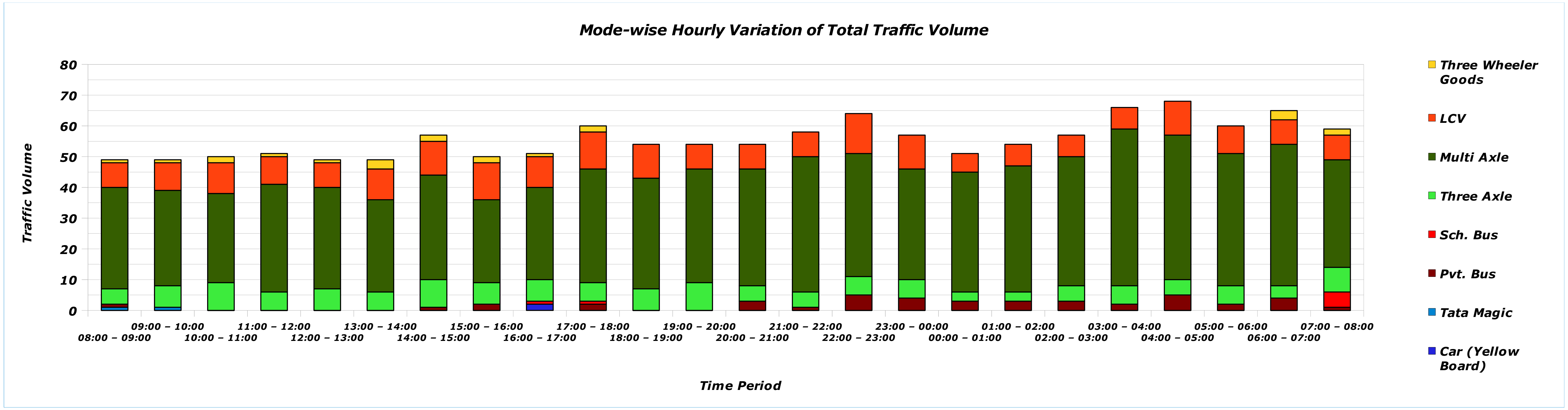
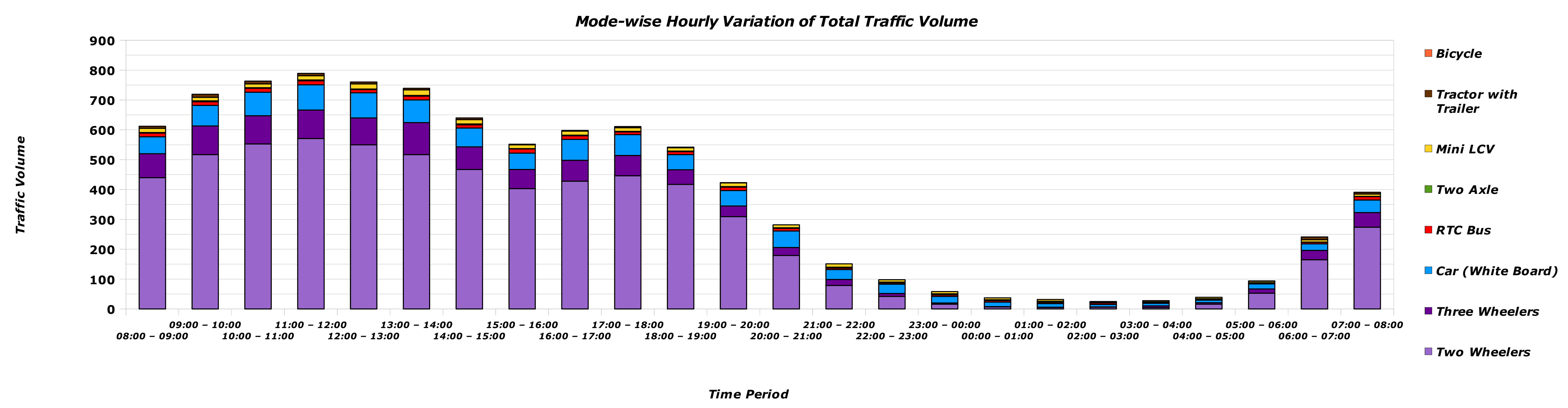
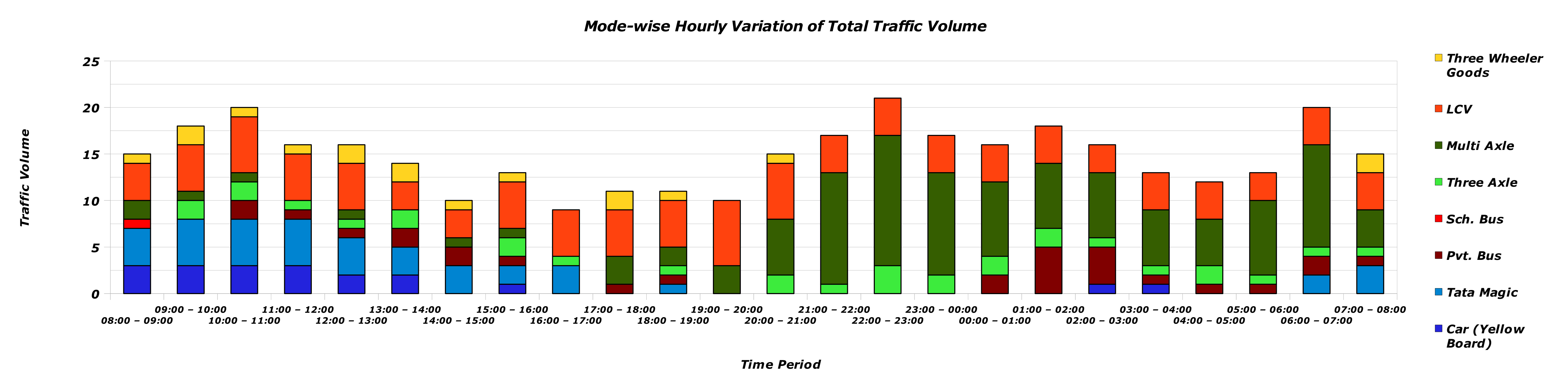


Figure-9.13: Mode wise hourly variation of Traffic at Location- 3

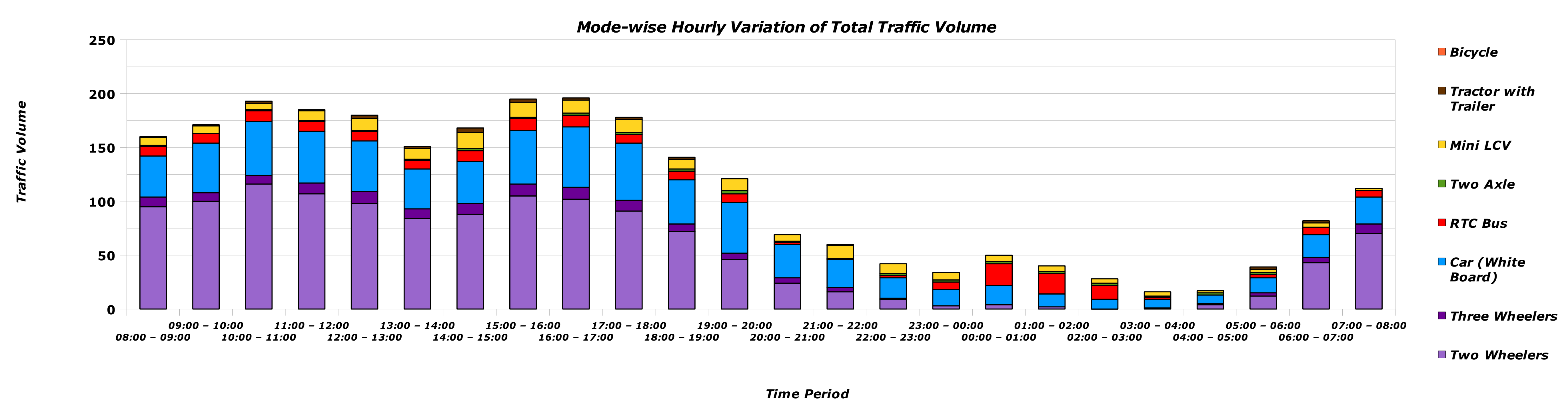
LOCATION-4


Mode-wise Hourly Variation of Total Traffic Volume
Traffic Volume
0
100
200
300
400
500
600
700
800
900
08:00 – 09:00
09:00 – 10:00
10:00 – 11:00
11:00 – 12:00
12:00 – 13:00
13:00 – 14:00
14:00 – 15:00
15:00 – 16:00
16:00 – 17:00
17:00 – 18:00
18:00 – 19:00
19:00 – 20:00
20:00 – 21:00
21:00 – 22:00
22:00 – 23:00
23:00 – 00:00
00:00 – 01:00
01:00 – 02:00
02:00 – 03:00
03:00 – 04:00
04:00 – 05:00
05:00 – 06:00
06:00 – 07:00
07:00 – 08:00
Time Period
Bicycle
Tractor with Trailer
Mini LCV
Two Axle
RTC Bus
Car (White Board)
Three Wheelers
Two Wheelers


Mode-wise Hourly Variation of Total Traffic Volume
Traffic Volume
0
5
10
15
20
25
08:00 – 09:00
09:00 – 10:00
10:00 – 11:00
11:00 – 12:00
12:00 – 13:00
13:00 – 14:00
14:00 – 15:00
15:00 – 16:00
16:00 – 17:00
17:00 – 18:00
18:00 – 19:00
19:00 – 20:00
20:00 – 21:00
21:00 – 22:00
22:00 – 23:00
23:00 – 00:00
00:00 – 01:00
01:00 – 02:00
02:00 – 03:00
03:00 – 04:00
04:00 – 05:00
05:00 – 06:00
06:00 – 07:00
07:00 – 08:00
Time Period
Three Wheeler Goods
LCV
Multi Axle
Three Axle
Sch. Bus
Pvt. Bus
Tata Magic
Car (Yellow Board)

LOCATION-5

Figure-9.14: Mode wise hourly variation of Traffic at Location- 4



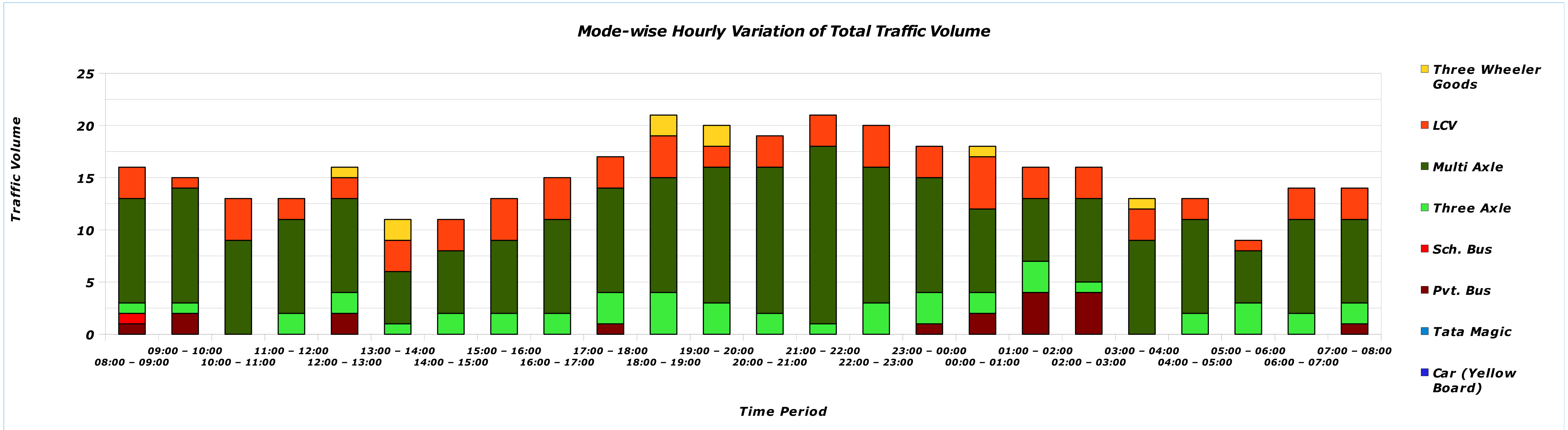
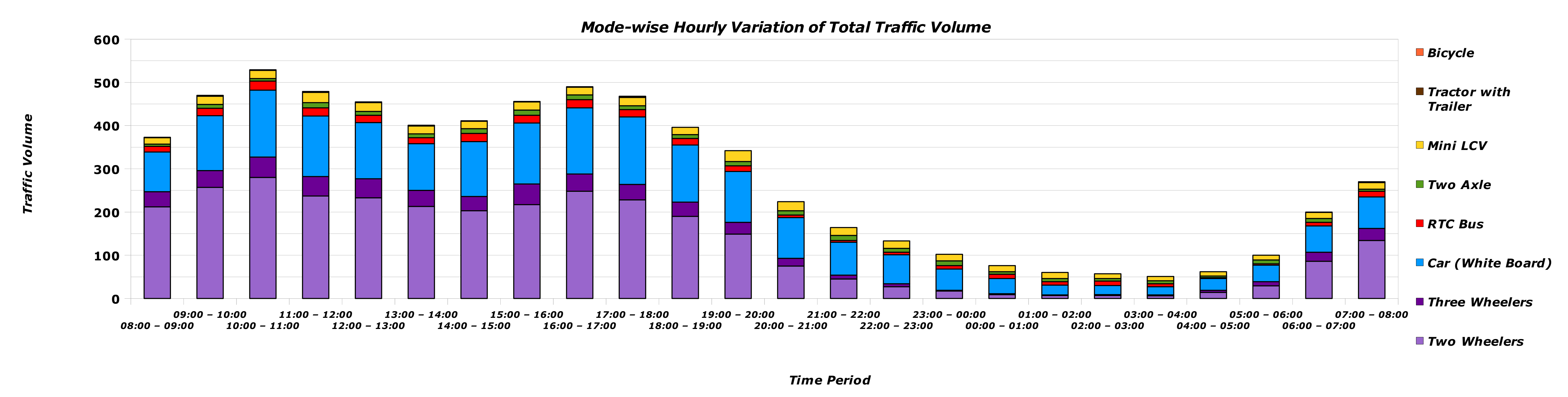


Figure-9.15: Mode wise hourly variation of Traffic at Location- 5

LOCATION-6



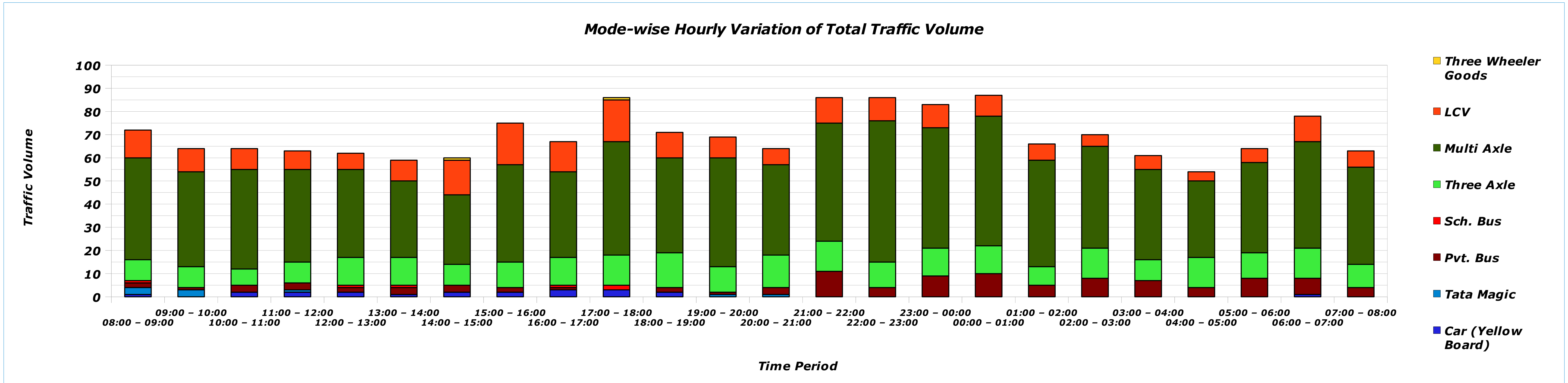
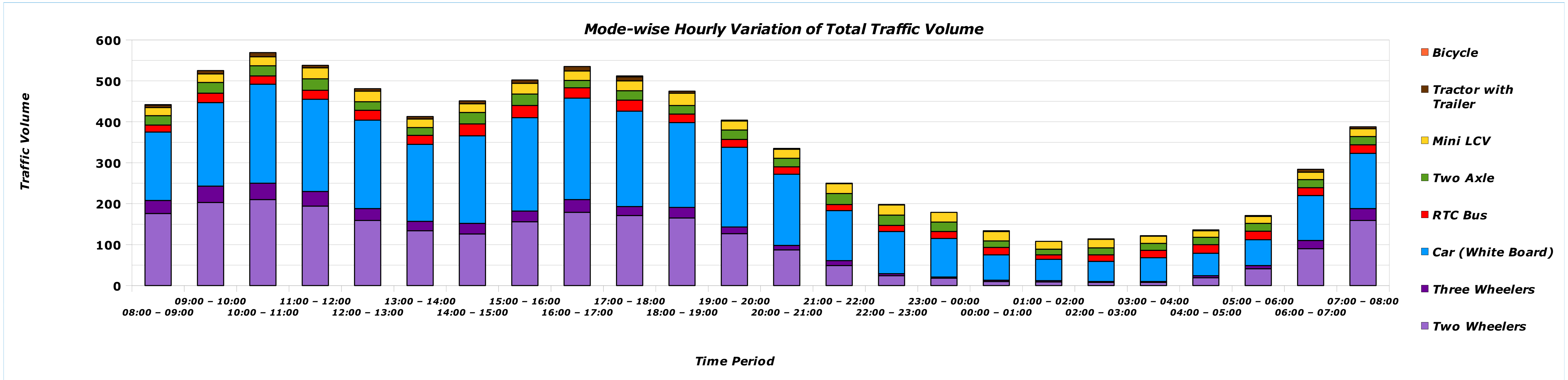


Figure-9.16: Mode wise hourly variation of Traffic at Location- 6



LOCATION-7

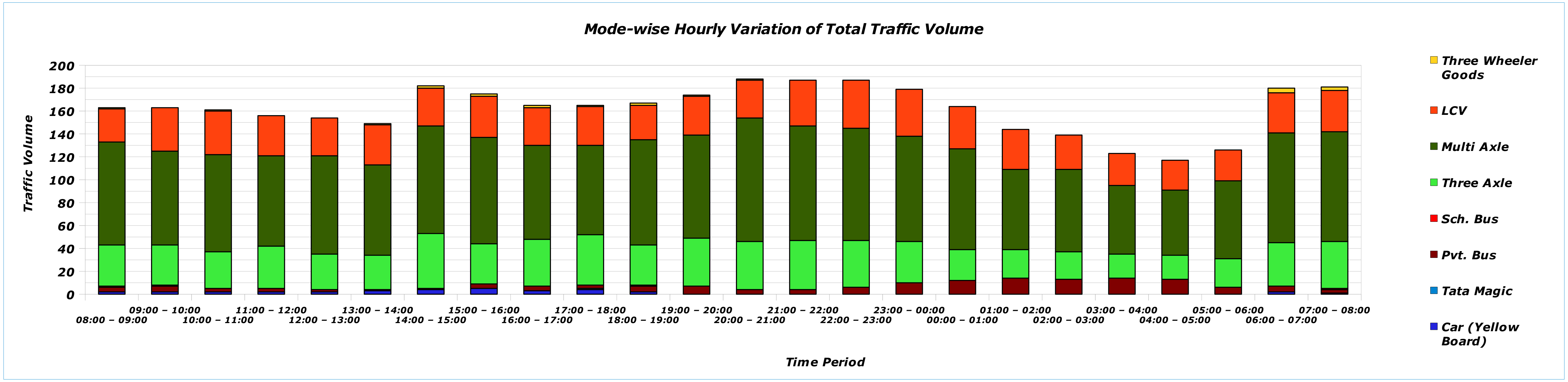
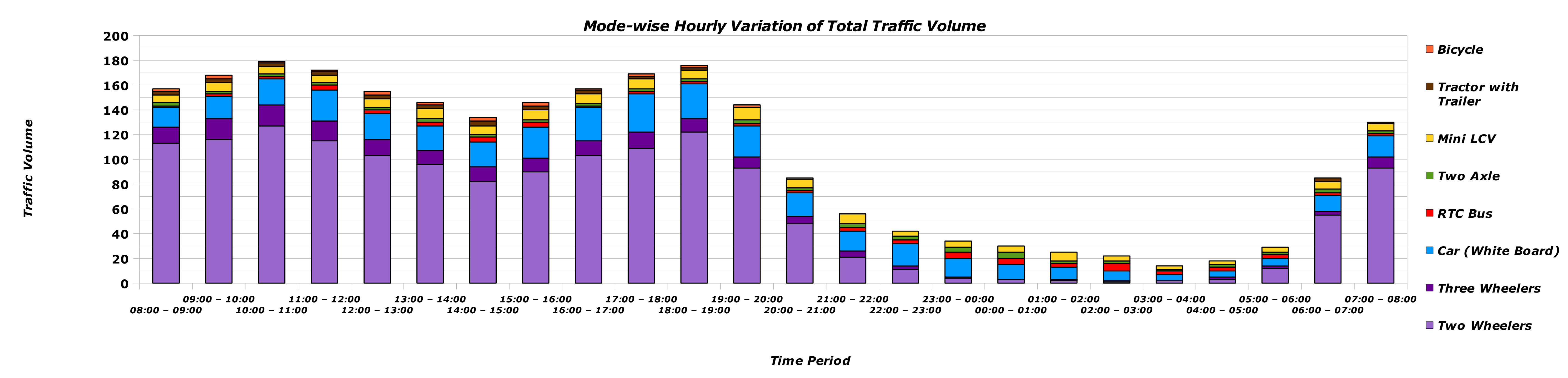
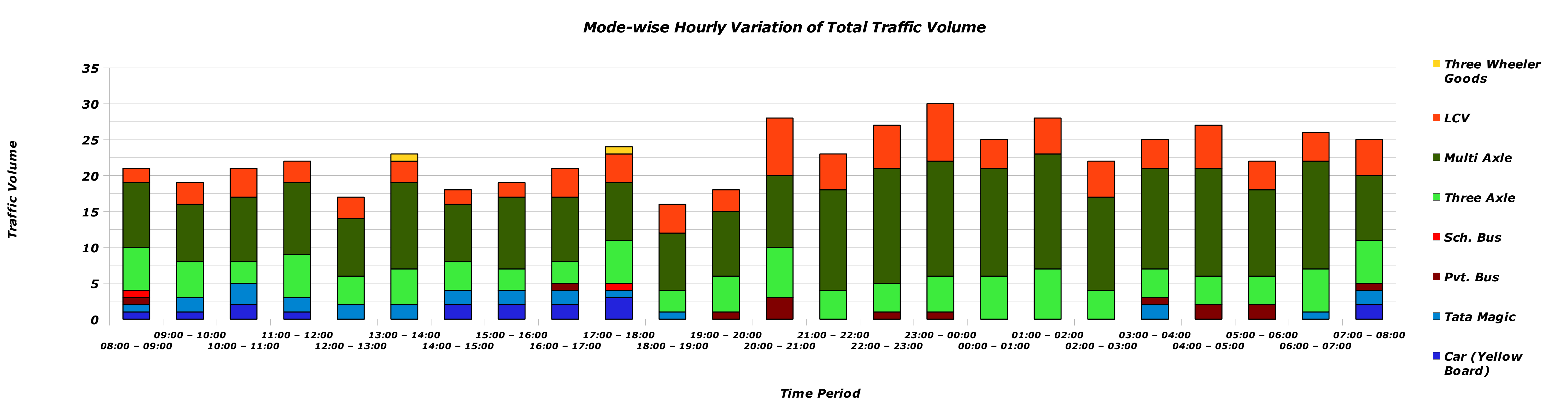


Figure-9.17: Mode wise hourly variation of Traffic at Location- 7

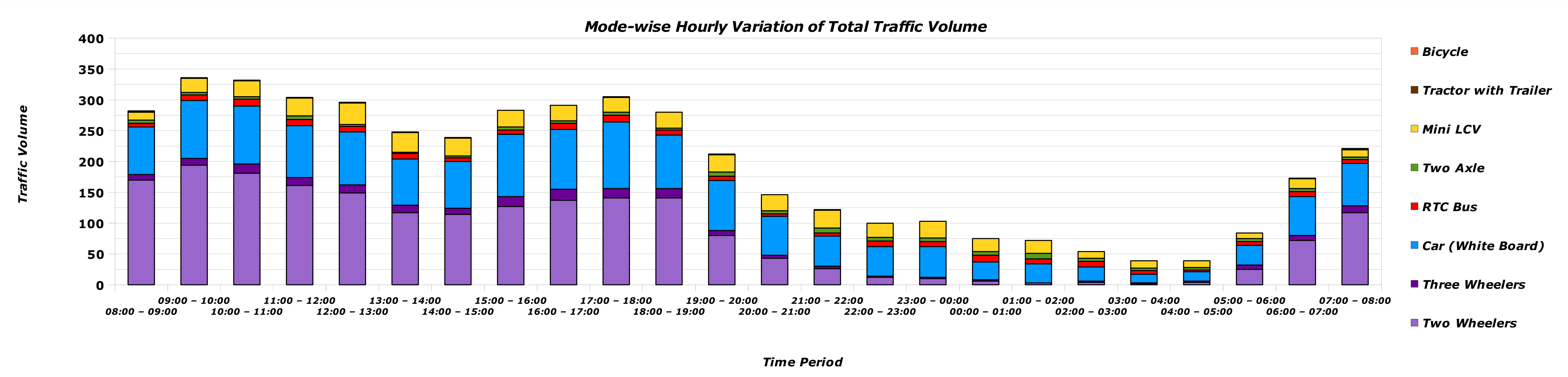
LOCATION-8


Mode-wise Hourly Variation of Total Traffic Volume
Traffic Volume
Time Period
Bicycle
Tractor with Trailer
Mini LCV
Two Axle
RTC Bus
Car (White Board)
Three Wheelers
Two Wheelers


Mode-wise Hourly Variation of Total Traffic Volume
Traffic Volume
Time Period
Three Wheeler Goods
LCV
Multi Axle
Three Axle
Sch. Bus
Pvt. Bus
Tata Magic
Car (Yellow Board)

LOCATION-9

Figure-9.18: Mode wise hourly variation of Traffic at Location- 8



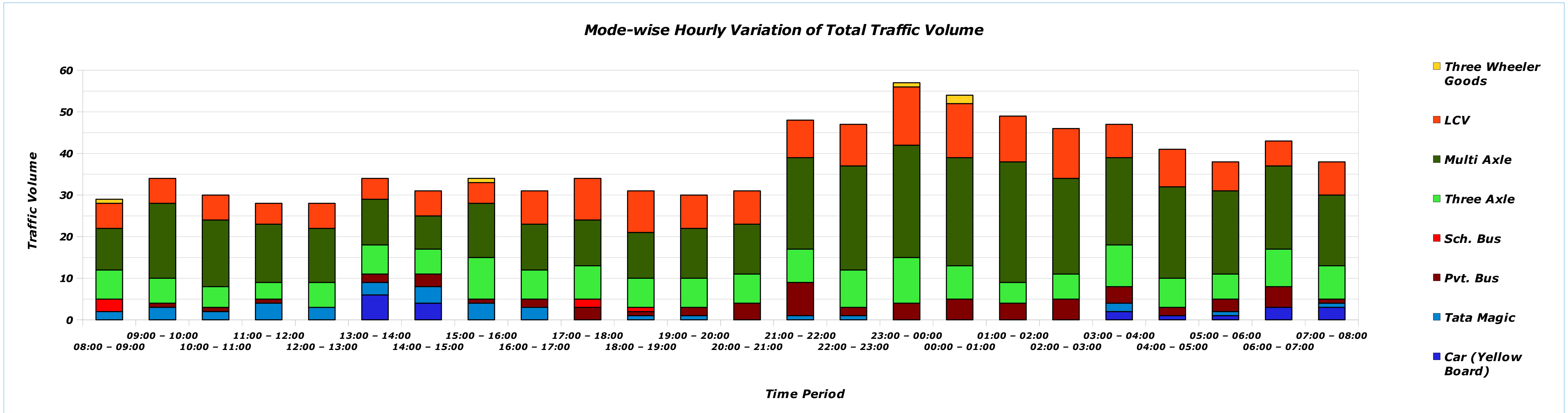
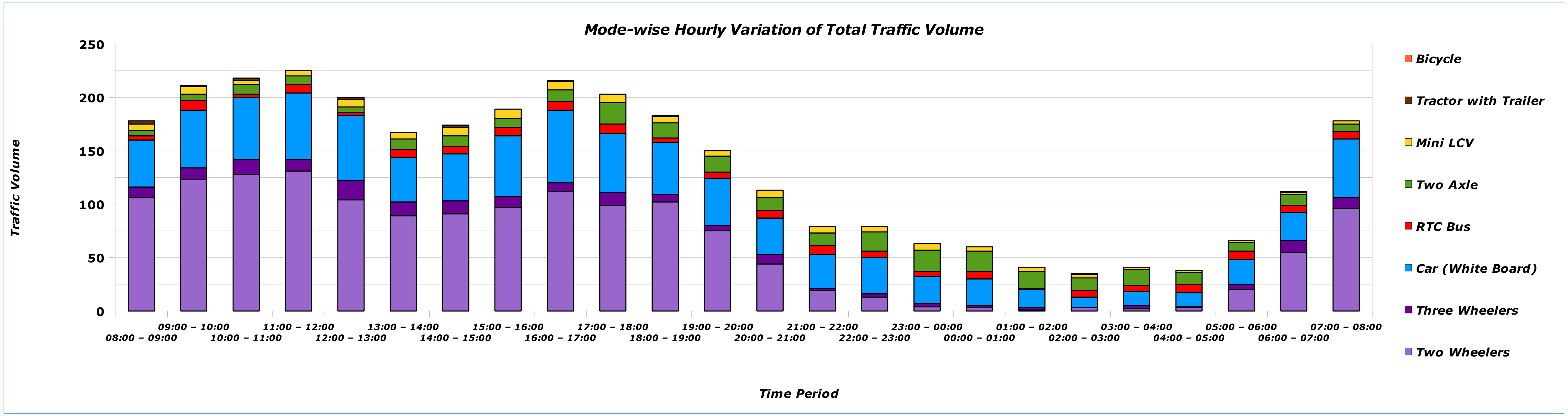


Figure-9.19: Mode wise hourly variation of Traffic at Location- 9



LOCATION-10

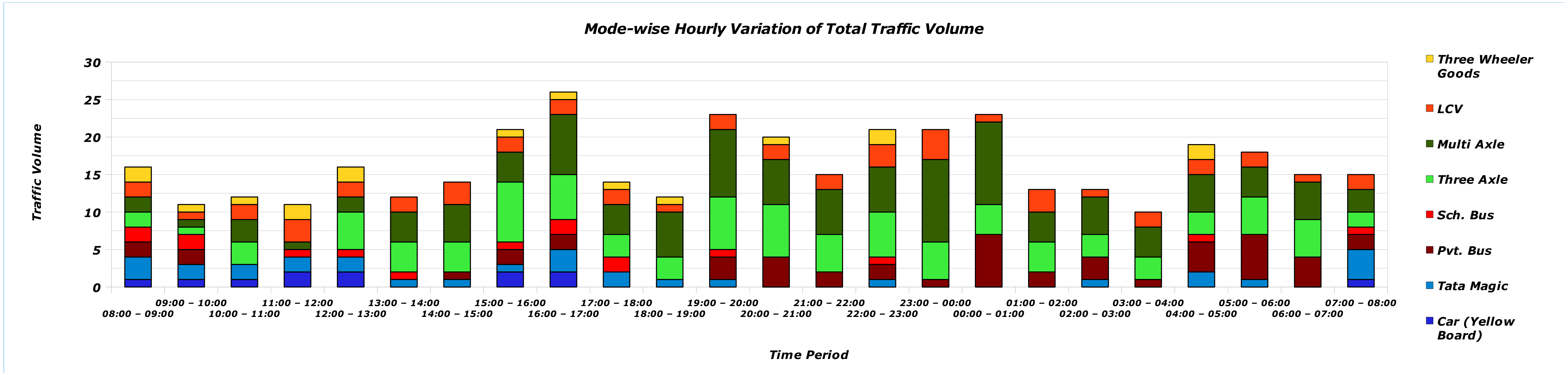
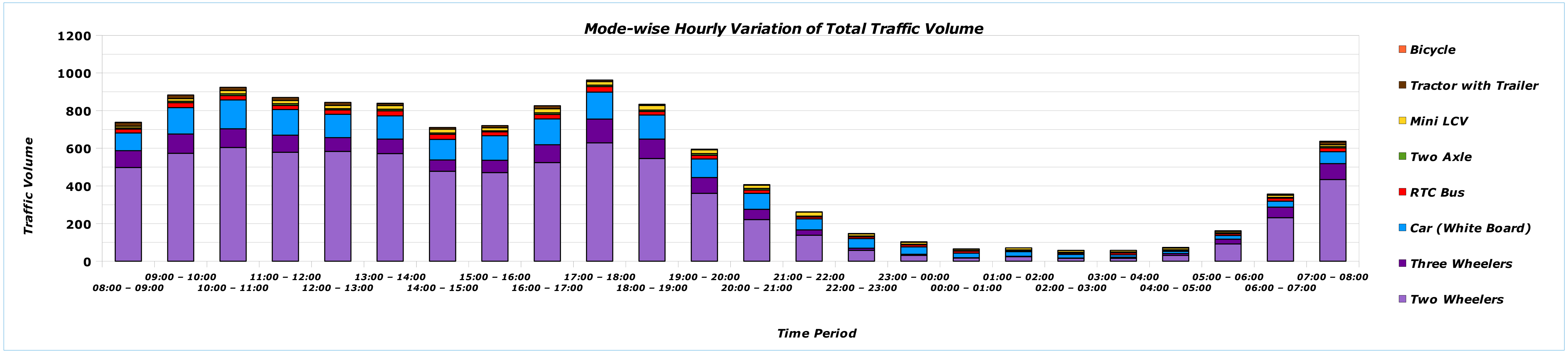


Figure-9.20: Mode wise hourly variation of Traffic at Location- 10

LOCATION-11



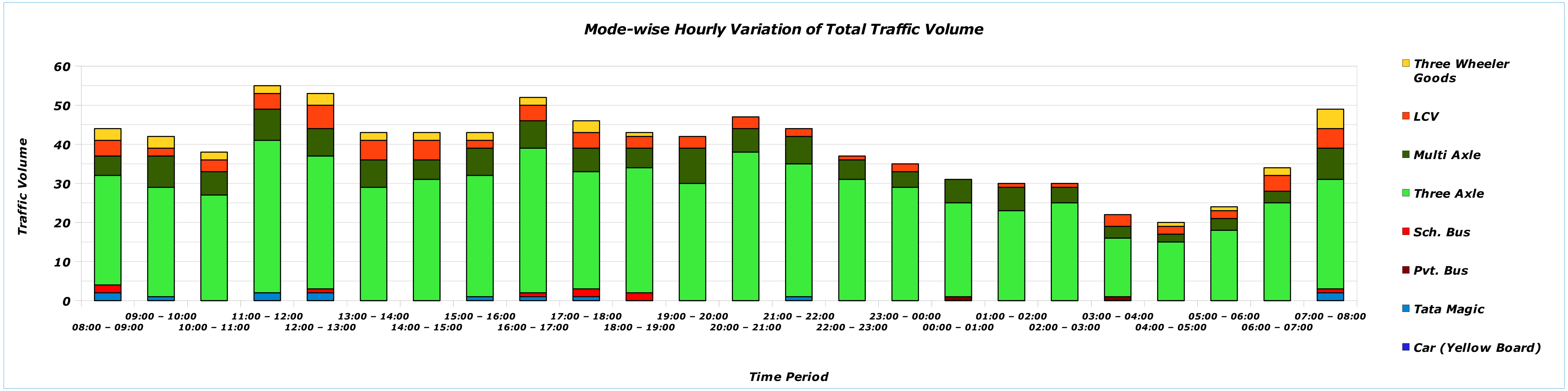
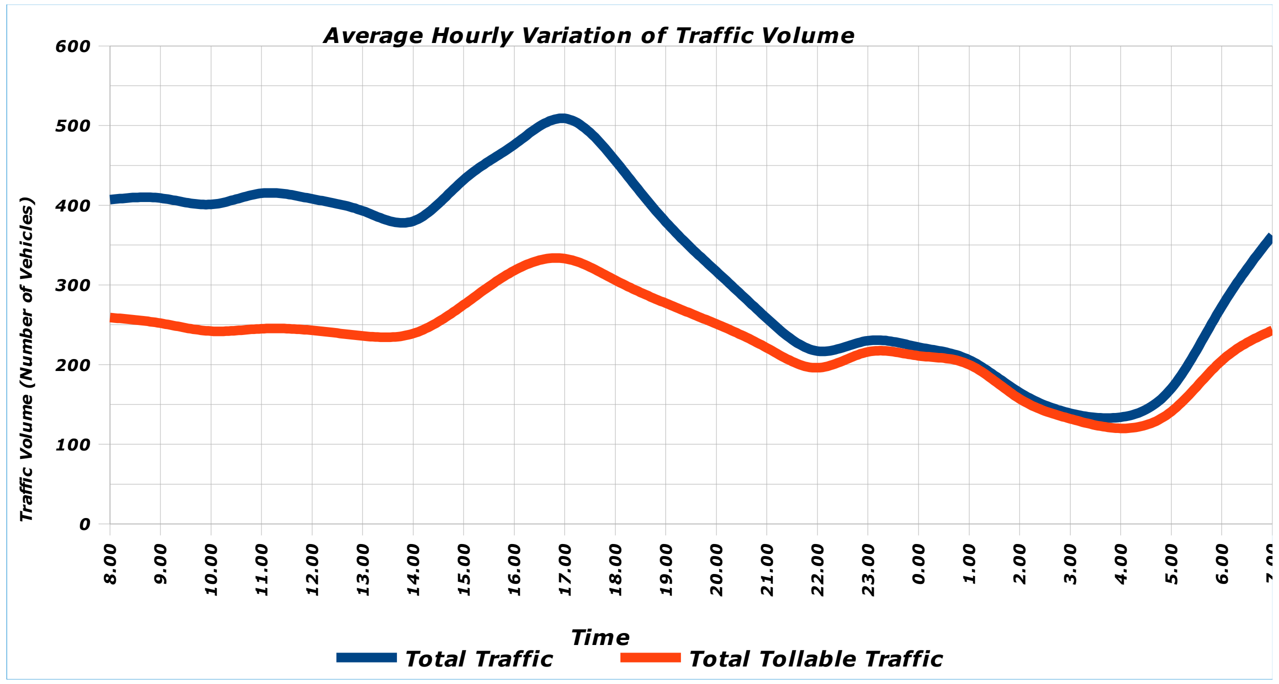


Figure-9.21: Mode wise hourly variation of Traffic at Location- 11

LOCATION-1



LOCATION-2

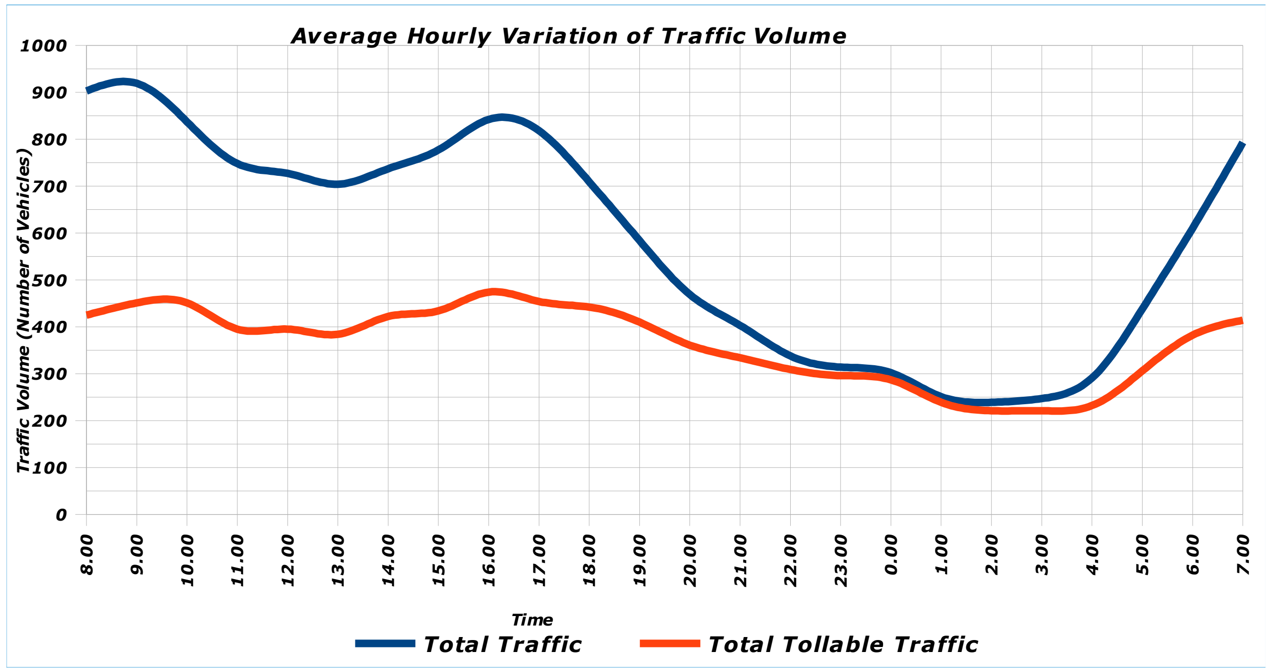
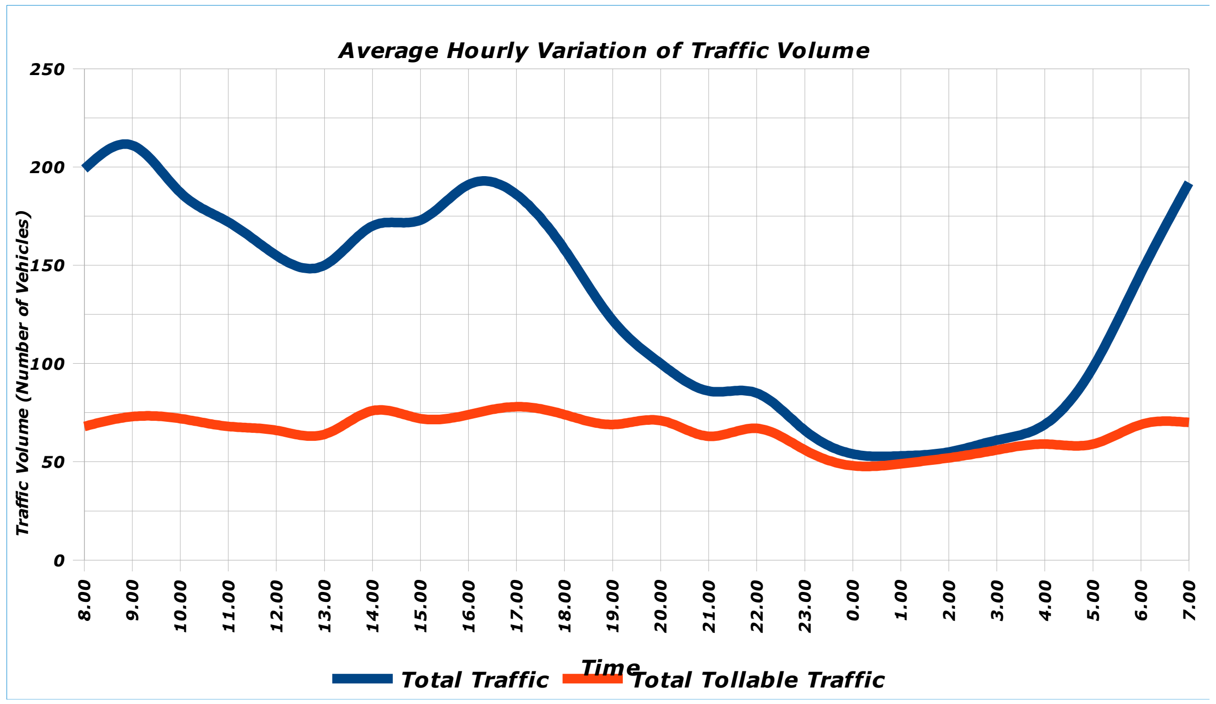


Figure-9.22: Average hourly variation of Traffic at Locations 1 & 2

LOCATION-3



LOCATION-4

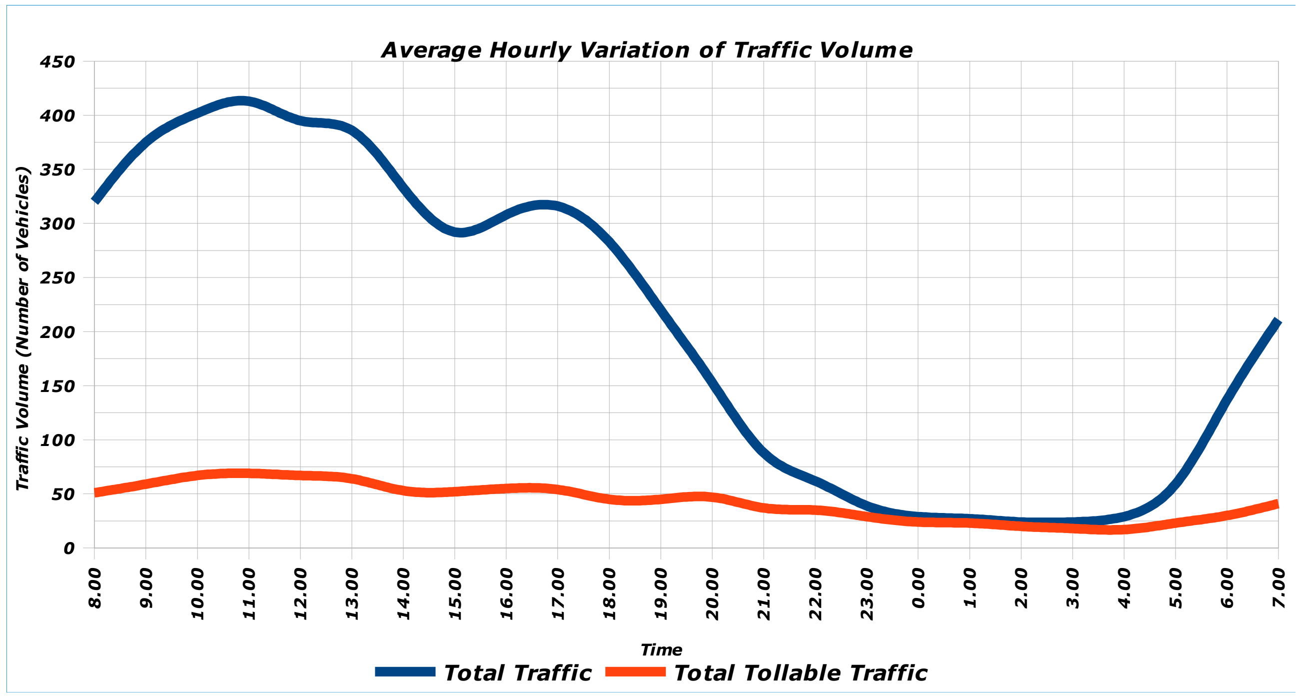


Figure-9.23: Average hourly variation of Traffic at Locations 3 & 4

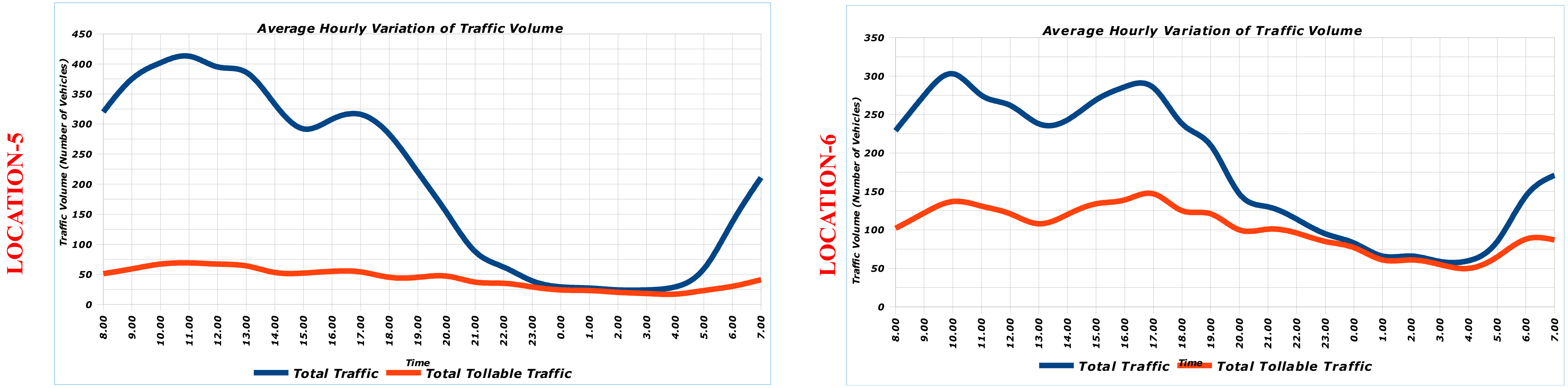


Figure-9.24: Average hourly variation of Traffic at Locations 5 & 6

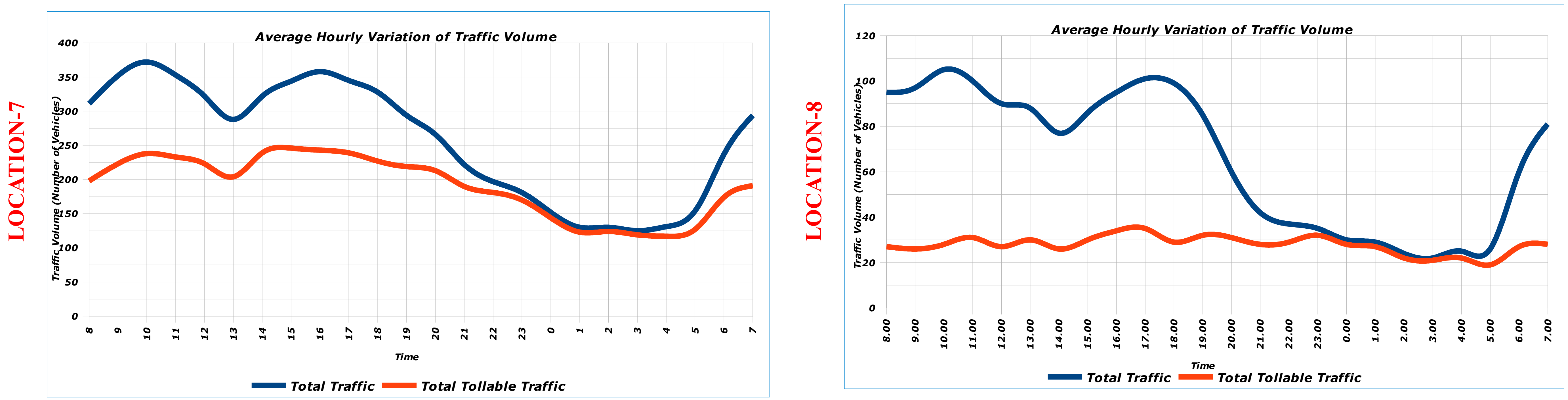
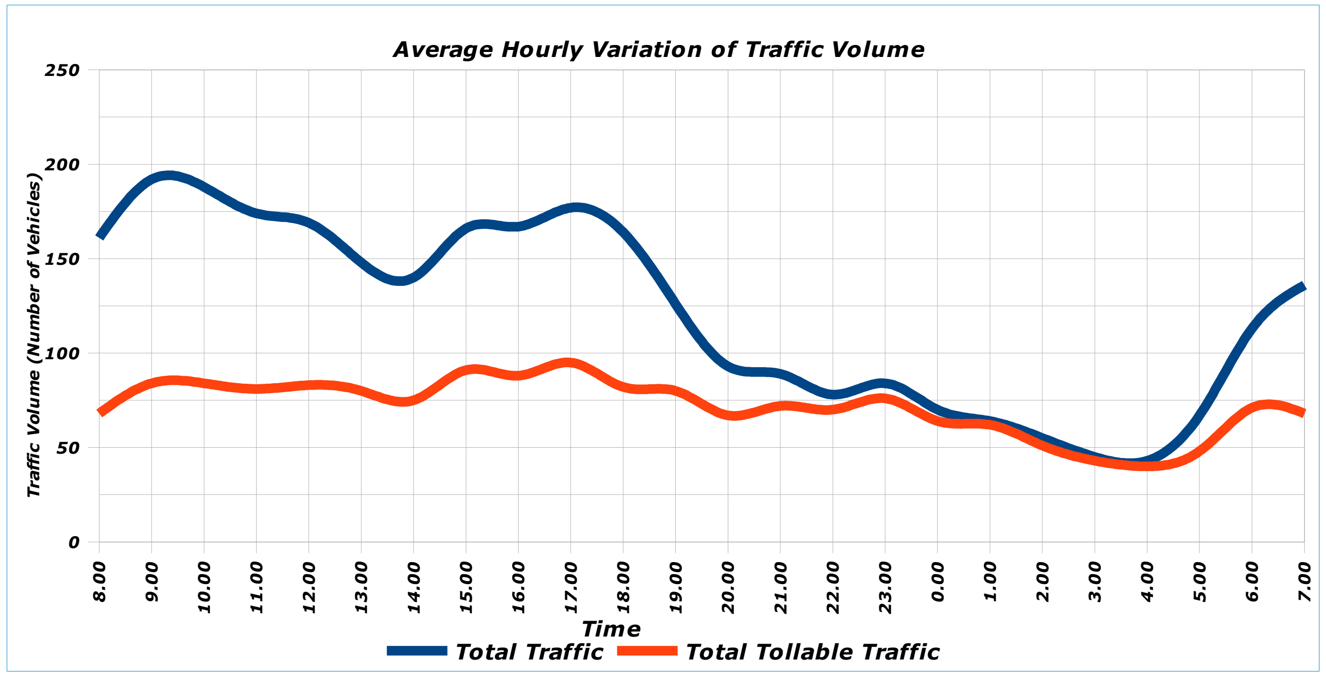


Figure-9.25: Average hourly variation of Traffic at Locations 7 & 8

LOCATION-9



LOCATION-10

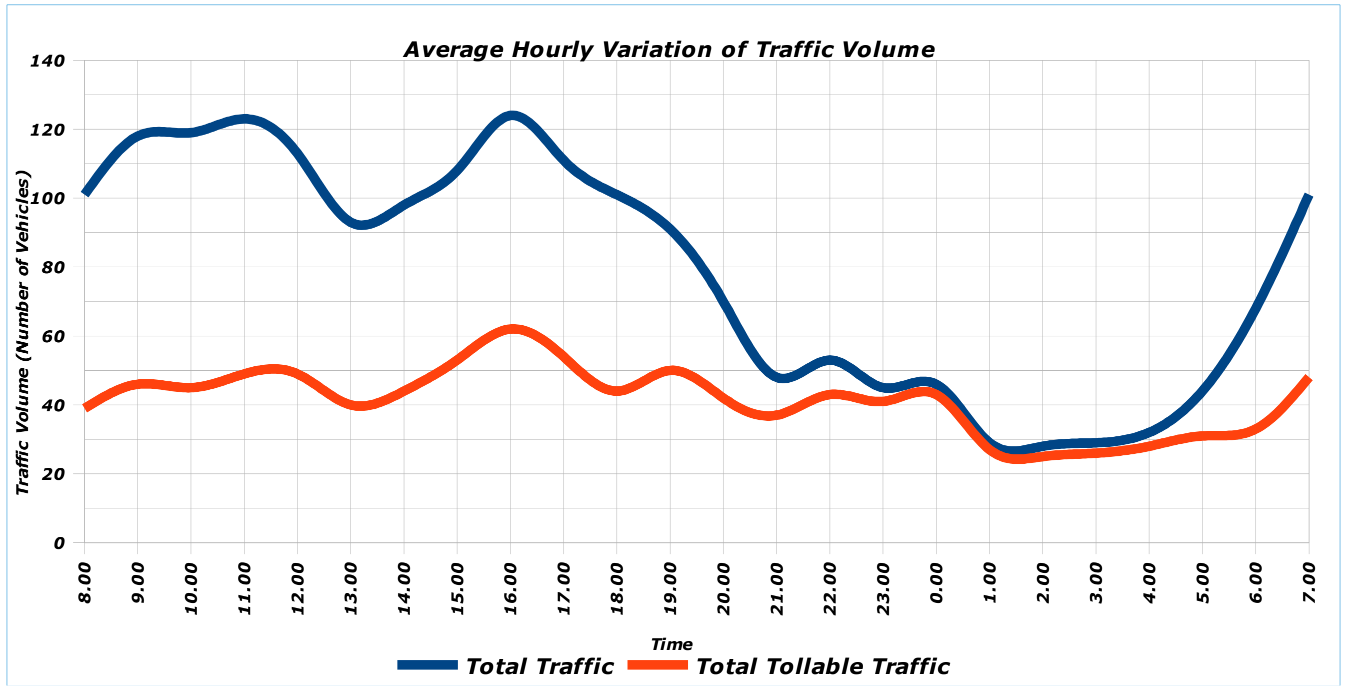


Figure-9.26: Average hourly variation of Traffic at Locations 9 & 10

LOCATION-11

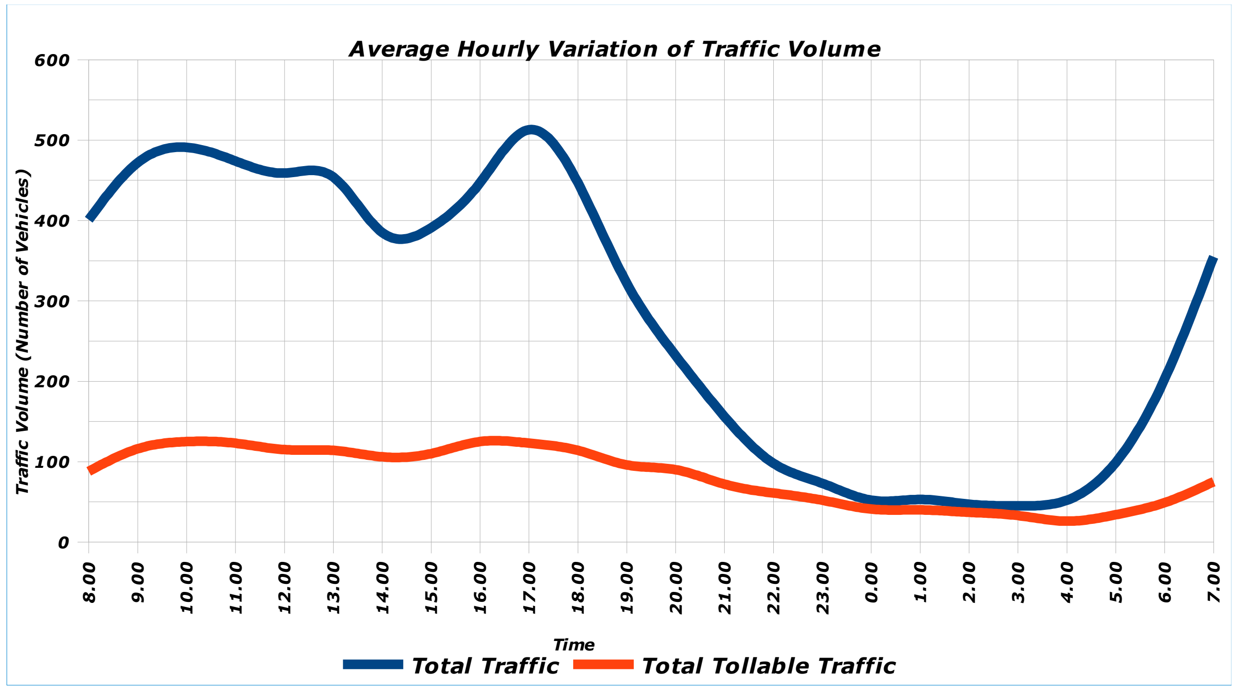


Figure-9.27: Average hourly variation of Traffic at Location 11

9.12.5 Inferences (ADT)

- Maximum ADT was observed on NH-16 at Tanguturu Toll Plaza between Vijayawada and Nellore (46356 PCU/ 27833 Vehicles) followed by traffic on NH-44 between Ananthapur and Bangalore (23646 PCU/ 15372 Vehicles). Minimum Traffic has been observed on NH-340 (3977 PCU/ 3052 Vehicles) and on SH-54(3977 PCU/ 3062 Vehicles).
- Survey locations 11 I.e, Tanguturu Toll Plaza location attains a peak hour volume of 2329 PCU followed by location 1 I.e, Kodikondla locations (1238 PCU). Location 6 i.e, Akkalreddipalle location records a very low peak hour volume of 201 PCU.
- Goods traffic was observed to be maximum at location 11 (10036 Vehicles) followed by Location 1 (5583 Vehicles). Goods traffic was observed to be very low at location 4 (715 Vehicles).
- Passenger traffic was observed to be high at location 11 (17588 Vehicles) followed by location 9 (10136 Vehicles) and location 1 (9737 Vehicles). It was observed to be very low at location 6 (2080 Vehicles).
- Proportion of non-motorized vehicles was observed to be high at location 6 (27 Vehicles) and least at location 2 & 10 with no non-motorized vehicular movement.
- Average hourly variation indicates that peak traffic varies throughout the day time but the total traffic takes a dip from 22:00 hrs and rises again from 04:00 hrs, the segment which can be considered as off-peak time.
- Maximum tollable traffic was seen at location 11 (39965 PCU/17354 vehicles) followed by location 1 (21088 PCU/10935 vehicles) and location 7 (20657 PCU/9109 vehicles). It was observed to be low at location 6 (2813 PCU/1260 vehicles)

9.12.6 Seasonal Variation Factor

Monthly sales data from the fuel stations located on the project corridor were collected to estimate the Seasonal Correction Factor (SCF). The SCF was applied to the vehicular traffic volume of ADT to obtain the Annual Average Daily Traffic (AADT) and it was later converted to PCU's. The factor is calculated based on the month of survey conducted, i.e., September 2021, was applied to the ADT to determine the AADT. The vehicle wise seasonal correction factors adopted are presented in ***Table-9.8***.

9.12.7 Annual Average Daily Traffic (AADT)

The Annual Average Daily Traffic (AADT) at each of the survey location was obtained by multiplying the Average Daily Traffic (ADT) with the Seasonal Correction Factor. The AADT for the year 2021 at survey locations are calculated and tabulated in the below ***Table-9.9*** The AADT values represented in the following table are actual values obtained from the survey.

Table-9.8: Seasonal Correction Factors

Survey Location No	1	2	3	4	5	6	7	8	9	10	11
Mode	Kodikondla Checkpost	Pulagam palle	Sambepalli	Ramigani vari Palle	Basapuram Toll Plaza	Akkalreddi palle	Kothuru	Mokshagund am	Podili - Chimakurthy	Pamuru	Tanguturu Toll Plaza
Petrol driven	1.03	1.01	0.97	0.99	0.97	0.97	0.98	0.96	0.96	0.96	0.97
Diesel driven	1.04	1.03	0.99	1.01	0.96	1.02	1.02	1.01	1.02	0.98	1.01

Location wise seasonal variation factor analysis along with graphs are presented in Annexures – I.

Table-9.9: Section wise AADT

Survey Location No	1	2	3	4	5	6	7	8	9	10	11
Name of the Location	Kodikondla Checkpost	Pulagam palle	Sambepal li	Ramiganivar i Palle	Basapuram Toll Plaza	Akkalreddi palle	Kothuru	Mokshagunda m	Podili - Chimakurthy	Pamuru	Tanguturu Toll Plaza
Type of Road	NH-44	SH-61	NH - 40	NH - 340	NH-67	SH - 54	NH - 71	NH – 544D	SH – 53	NH-565	NH-16
Two Wheeler	4062	6531	3032	1280	2537	1477	2475	1957	7418	1246	8896
Three Wheeler (Passenger)	423	1127	565	141	317	193	456	203	1379	152	1004
Car (White board)	5352	1108	2118	758	1155	417	3645	1533	1936	784	7183
Car (Yellow Board)	15	21	24	1	4	18	36	20	0	10	80
Tata Magic	2	44	10	3	2	23	4	38	15	22	28
RTC Bus	356	211	283	193	118	68	498	188	420	123	712
Private Bus	218	32	100	23	43	17	150	65	4	38	297
Mini Bus	29	10	12	3	4	6	46	16	12	12	41
School/ College Bus	0	2	8	3	9	3	4	9	10	12	12
2 Axle	761	57	207	31	110	59	531	120	159	235	1012
3 Axle	748	31	263	45	137	116	849	174	695	79	1253
Multi Axle	1624	122	1023	229	857	282	2075	414	139	97	4470
HEM	7	4	3	14	4	4	3	19	26	2	3
LCV	1329	109	232	72	210	103	837	197	73	36	1171
Mini LCV	878	253	397	189	285	153	540	539	359	102	1117
Tractor	12	18	6	14	21	8	24	9	35	13	34
Tractor with Trailer	19	82	21	28	52	39	112	18	189	13	127
Three Wheeler (Goods)	43	92	27	14	51	13	41	62	119	10	109

Survey Location No		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Name of the Location		**Kodikondla Checkpost**	**Pulagam palle**	**Sambepal li**	**Ramiganivar i Palle**	**Basapuram Toll Plaza**	**Akkalreddi palle**	**Kothuru**	**Mokshagunda m**	**Podili - Chimakurthy**	**Pamuru**	**Tanguturu Toll Plaza**
Type of Road		**NH-44**	**SH-61**	**NH - 40**	**NH - 340**	**NH-67**	**SH - 54**	**NH - 71**	**NH – 544D**	**SH – 53**	**NH-565**	**NH-16**
Bicycle		4	0	0	2	3	27	7	1	14	0	15
Cycle Rickshaw		0	0	0	1	0	0	0	0	4	0	0
Animal Drawn		3	0	3	0	0	0	6	0	0	0	3
Government Exempted		9	13	13	0	1	1	7	6	14	0	27
Vehicles	Motorised	15889	9867	8342	3043	5917	3001	12333	5587	13003	2985	27578
	Non Motorised	7	0	3	3	3	27	13	1	18	0	18
	Total Traffic	15896	9867	8345	3046	5920	3028	12346	5588	13021	2985	27596
	Tollable Traffic	11320	2005	4679	1565	2939	1270	9218	3332	3849	1552	17381
PCU	Motorised	24489	8070	12341	3990	8796	3986	23280	7413	13182	3763	46454
	Non Motorised	26	0	24	3	2	14	52	1	16	0	32
	Total Traffic	24515	8070	12365	3993	8798	4000	23332	7414	13198	3763	46486
	Tollable Traffic	21877	3169	10111	3046	6895	2853	20994	6066	7041	2901	40216

Location wise detailed analysis along with graphs are presented in Annexures – I.

9.13 ORIGIN-DESTINATION SURVEY ANALYSIS

The origin – destination survey was carried out at the following locations:

- **Location 1:** NH-44 near Kodikondla Checkpost at AP/ Karnataka border (Anantapur Dist.)
- **Location 2:** SH-61 near Pulagampalle (Ananthapur Dist.)
- **Location 3:** NH-40 near Sambepalli (YSR Kadapa Dist.)
- **Location 4:** NH-67 near Basapuram Toll Plaza (YSR Kadapa Dist.)
- **Location 5:** NH-71 near Kothuru (Nellore Dist.)
- **Location 6:** NH-544D near Mokshagundam (PrakasamDist.)
- **Location 7:** Chimakurthy-Podili road Budavada near Marrichetlapalem (Prakasam Dist.)
- **Location 8:** NH-16 near Tanguturu Toll Plaza (Prakasam Dist.)

A well-formatted questionnaire was framed containing information regarding origin, destination, distance, purpose and other various details. Separate queries were made for passenger vehicles and goods vehicles. The analysis of daily flow of classified volume counts has been the basis for fixing the sample size of vehicles by type and direction. At all the survey locations, the number of vehicles interviewed are around 20% - 30% as sample size. The expansion factors have been worked out based on the average daily volumes to the sample size at each location separately. Sample size collected at each O-D location is shown in ***Table-9.10***.

Table-9.10: Sample size at each location

Survey Location	1	2	3	4	5	6	7	8
Vehicle Type	NH-44 - Kodikondla checkpost	SH-61-Pulagampalle	NH-40 Sambepalli	NH-67-Basapuram Toll Plaza	NH-71-Kothuru	NH-544D-Mokshagundam	Chimakurthy-Podili road-Budavada	NH-16 Tanguturu Tollplaza
Car	16%	66%	15%	27%	5%	30%	23%	10%
Bus	18%	79%	11%	7%	6%	26%	30%	21%
LCV	10%	57%	19%	23%	10%	27%	18%	16%

Survey Location	1	2	3	4	5	6	7	8
Vehicle Type	NH-44 – Kodikondla checkpost	SH-61-Pulagampalle	NH-40 Sambepalli	NH-67-Basapuram Toll Plaza	NH-71-Kothuru	NH-544D-Mokshagundam	Chimakurthy-Podili road-Budavada	NH-16 Tanguturu Tollplaza
2 Axle	10%	69%	24%	34%	19%	49%	15%	15%
3 Axle	5%	73%	25%	18%	16%	48%	16%	13%
MAV	9%	78%	17%	15%	15%	64%	16%	14%

Commercial and passenger traffic traversing between Bengaluru and Vijayawada by using the existing road networks are captured and same has been assigned on to the proposed Bengaluru-Kadappa-Vijayawada section.

Traffic assignment is a process of capturing all the possible traffic in the existing corridor which will utilise the proposed greenfield expressway due to saving in travel length/time between Bengalore – Vijayawada and same are assigned to proposed corridor. OD data forms basic input for the traffic assignment. Traffic that diverts on to the proposed green field expressway from the conventional route is studied in detail between origin and destinations. Accordingly they are divided into various project influencing zones. Zones of influence are identified in Andhra Pradesh, Karnataka, Telangana, Maharashtra and Tamil Nadu states. The conventional routes which commuters adopt between Bengaluru and Vijayawada are identified viz. 1. Bengaluru – Anantapur – Nandyala – Giddalur – Narsaraopet – Guntur – Vijayawada (635 kms) and 2. Bengaluru – Chittor – Renigunta – Naidupeta – Nellore – Ongole – Guntur – Vijayawada (647 kms). Consultants have done traffic surveys on these roads to assess the traffic that may use the proposed BKV road.

In addition to the through traffic, influence of local traffic was identified by conducting traffic surveys on NH-44, SH 61, NH 40, NH 67, NH 71, NH 544D, SH 39 and NH 16. The OD data along with TVC collected on these roads are used in assigning traffic on AK road. Proper care has been taken such that no vehicle is duplicated or captured twice at any locations.

9.13.1 Zoning System

For analysis of O-D data collected from the field, it is required to code it for origin and destination of trip. The zoning was done at four levels. In first level, all-important towns located along the proposed project stretch were assigned a zone code. Secondly, immediate influence areas of project road were considered and nearby areas/towns were defined as zones. In the next level, all nearby districts were grouped in zones. Finally, states beyond the influence area were aggregated broadly in terms of direction of project road. Total 54 traffic zones were considered for the project stretch. List of zone numbers and corresponding zone areas are mentioned in the below ***Table-9.11***. Zonal Maps are shown from ***Figure-9.28*** to ***Figure-9.39***.

Table-9.11: Zones Derived from Origin–Destination studies

Zone No	Name of Village/Town/City District/State
1	Hindupuram, Lepakshi, Penukonda, Gorantla
2	Kadiri, Puttaparthi, Nallamada, Galiveedu, Balasamudram
3	Kurnool, Nandhyal, Adoni, Yemiganoor, Kodumur, Atmakur, Mantralayam, Banaganpalli, Allagadda, Ahobilam, Mahanandi
4	Rest of Kurnool District
5	Dharmavaram, Anantapuram, Kalyandurg, Raidurg
6	Plamaner, Punganur, Madanapalle, Anagallu, Kalikiri
7	Rayachoti, Kalakada, Chinnamandem
8	Mudigubba, Pulivendula,
9	Uravakonda, Guntakal, Gooty, Pamidi, Dhone
10	Jammalamadugu, Proddatur, Mydukur, Chagalmarri, muddanur, Yerraguntla, Onipenta
11	Badvel, Mallepalle, Nandyalampeta, Sankavaram
12	Kadapa city
13	Rest of Kadapa District
14	Rest of Anantapuram District
15	Cumbum, Giddaluru, Markapuram, Domlapenta
16	Donakonda, Darsi, Podili, Vinukonda
17	Kanigiri, Pamuru, Duttalur, Kaligiri
18	Kandukur, Tanguturu, Singarayakonda, Kondapai
19	Addanki, Medaramatla, Maddipadu, Ongole Town, Chimakurthy

Zone No	Name of Village/Town/City District/State
20	Martur, Chilakaluripet, Narsaraopet
21	Guntur City, Vijayawada city, Amaravathi
22	Rest of Krishna District
23	Rest of Guntur District
24	Rest of Prakasham District
25	Rest of Nellore District
26	Rest of Chitoor District
27	Nellore, Gudur, Naidupeta
28	Tirupati, Srikalahasti, Pakala, Chittor city, Puttur, Renigunta
29	Districts of Visakhapatnam, Vijayanagaram, Srikakulam, East Godavari, West Godavari
30	Bengaluru, Bengaluru Rural, Chikkballapura, Chintamani, Kolar
31	Districts of Devangare, Chitradurga, Haveri, Shimoga, Uttara Kannada in the state of Karnataka
32	Districts of Gadag, Belgaum, Dharwad, Bellary, Koppal in the state of Karnataka
33	Districts of Bagalkot, Raichur, Bijapur, Yadgiri, Gulbarga, Bidar in the state of Karnakata
34	Districts of Udipi, Chikamangalur, Tumkur, Hasan, Dakshin Kannada in the state of Karnataka
35	Districts of Kodagu, Mysore, Charmarajanagar, Mandhya, Ramanagara, Kolar in the state of Karnataka
36	Districts of Kanyakumari, Tirunelvelli, Tenkasi, Toothukodi, Ramanthapuram, Virudhunagar, Theni, Shivaganga, Madhurai, Pudukottai, Thanjavur,Tiruvarur, Nagapatnam, Mayiladuthurai, Thiruchurapalli, Perambalur, Ariyalur, Cuddalore, Villupuram, Chengalpattu, Kanchepuram, Kallakurachi in the State of Tamilnadu
37	Chennai
38	Districts of Thiruvallur, Ranipet, Tiruvannamalai, Karur, Nammakal, Dindigul, Tirupattur in the state of Tamilnadu
39	Districts of Salem, Dharmapuri, Krishnagiri, Vellore, the Nilgiris, Erode, Coimbatore, Tiruppur in the state of Tamilnadu
40	Districts of Medchal, Hyderabad, Yadadri, Rangareddy, Vikarabad in the state of Telanagana
41	Districts of Mahabubnagar, Narayanpet, Wanaparthy, Nagarkurnool, Jodugulamba Gadwal in the state of Telangana

Zone No	Name of Village/Town/City District/State
42	Districts of Nalgonda, Suryapet, Khammam, Bhadradi Kothagudem, Mulugu, Jangaon, Warangal Urban, Warangal Rural in the state of Telangana
43	Districts of Adilabad, Kumaram Bhem, Nirmal, Mancherial, Nizamabad, Jagityal, Peddapalle, Jayashankar Bhupalapally, Karimanagar, Kamareddy, Medak, Siddipet, Sangareddy in the state of Telangana
44	Districts of Ratnagiri, Kolhapur, Sindhudurg in Maharashtra
45	Districts of Solapur, Osmanabad, Raigad, Satara, Sangili in the state of Maharashtra
46	Mumbai, Pune, Thane
47	Districts of Nanded, Hingoli, Washim, Akola, Jalgaon, Dhule, Nandurbar, Aurangabad, Jalna, Buldana, Ahmednagar, Latur, Parbhani, Beed, Phalghar in Maharashtra
48	Districts of Gadchiroli, Chandrapur, Gondia, Bhandara, Nagpur, Wardha, Amaravathi, Yavatmal in Maharashtra
49	State of Kerala
50	State of Uttarpradesh, Haryana, Rajasthan, Madhya Pradesh, Gujarath, Delhi
51	State of Ladakh, Jammu & Kashmir, Himachal Pradesh, Panjab, Uttarakhand
52	States of West Bengal, Orissa, Jharkhand, Bihar, Chhattisgarh
53	State of Assam, Arunachal Pradesh, Meghalaya, Tripura, Mizoram, Manipur, Nagaland
54	State of Goa

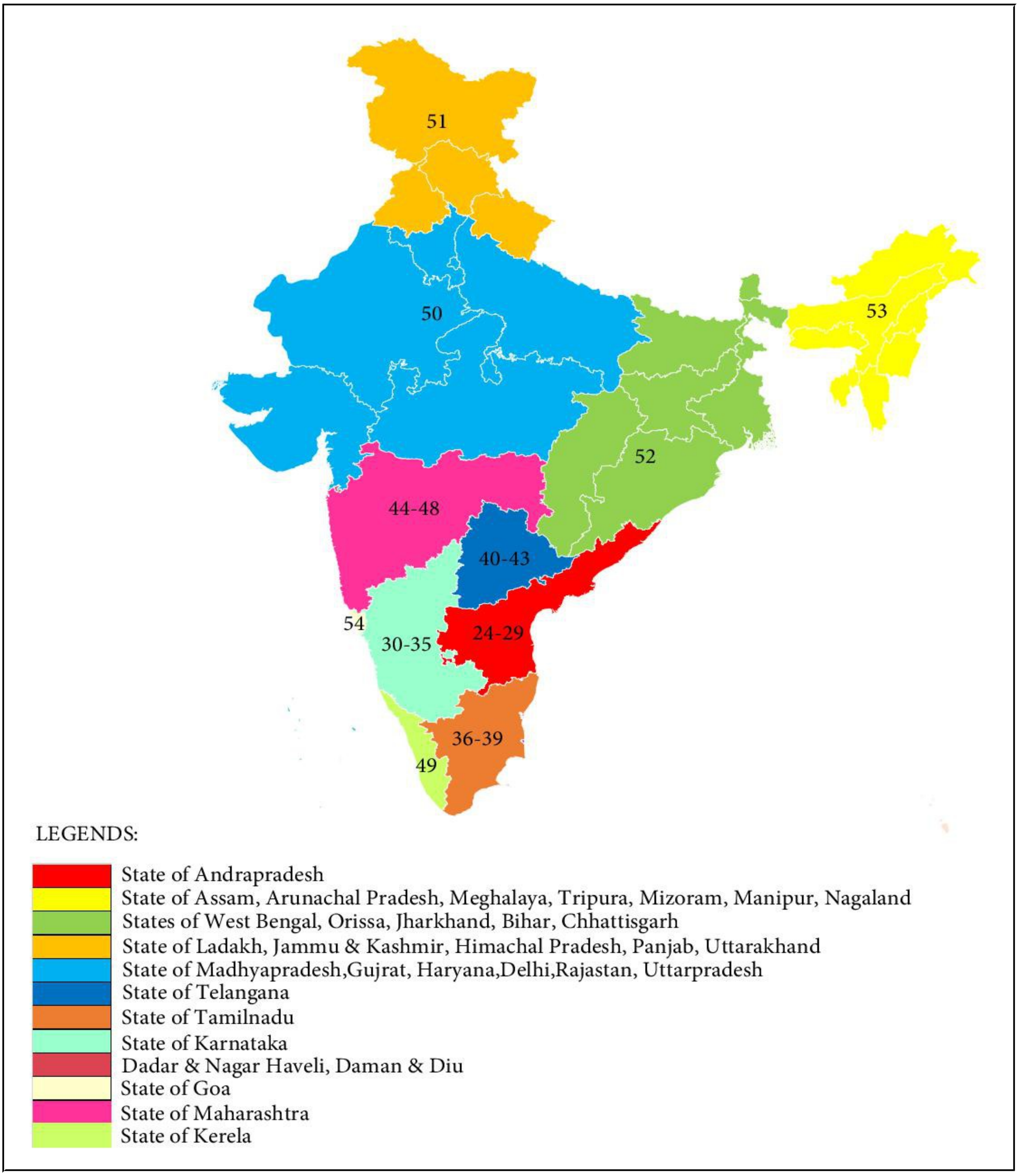


Figure-9.28: Adopted Zonal Map of India

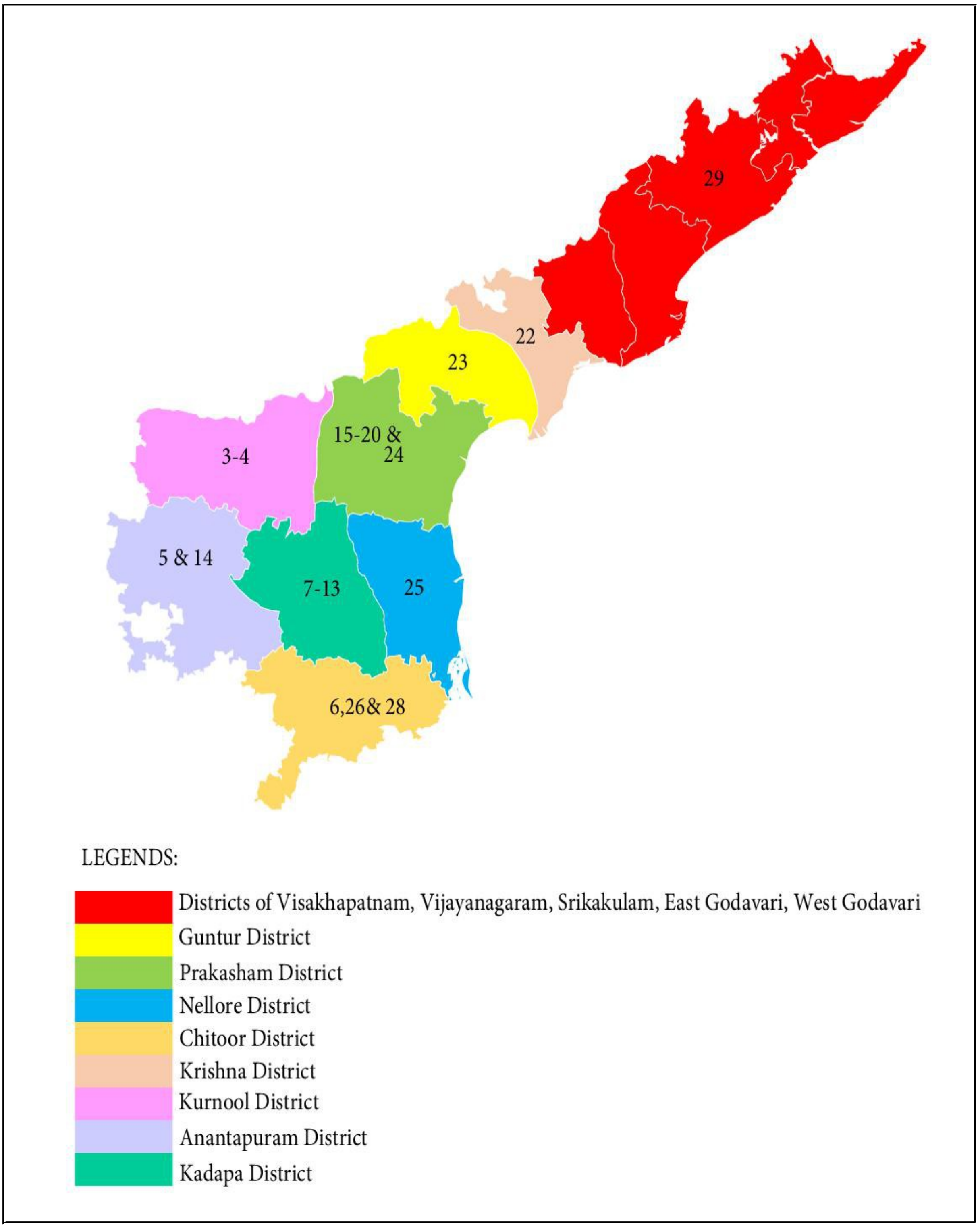


Figure-9.29: Adopted Zonal Map of Andhra Pradesh

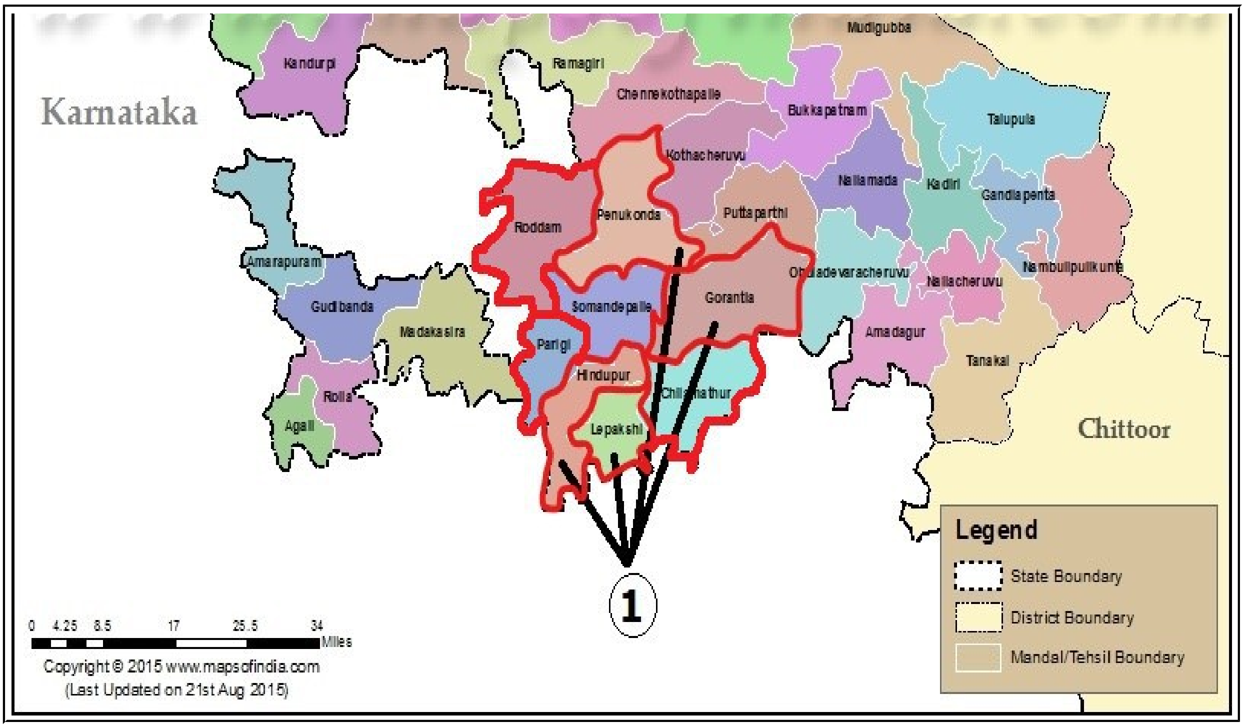


Figure-9.30: Adopted Zonal Map of Zone 1 in Anantapur District

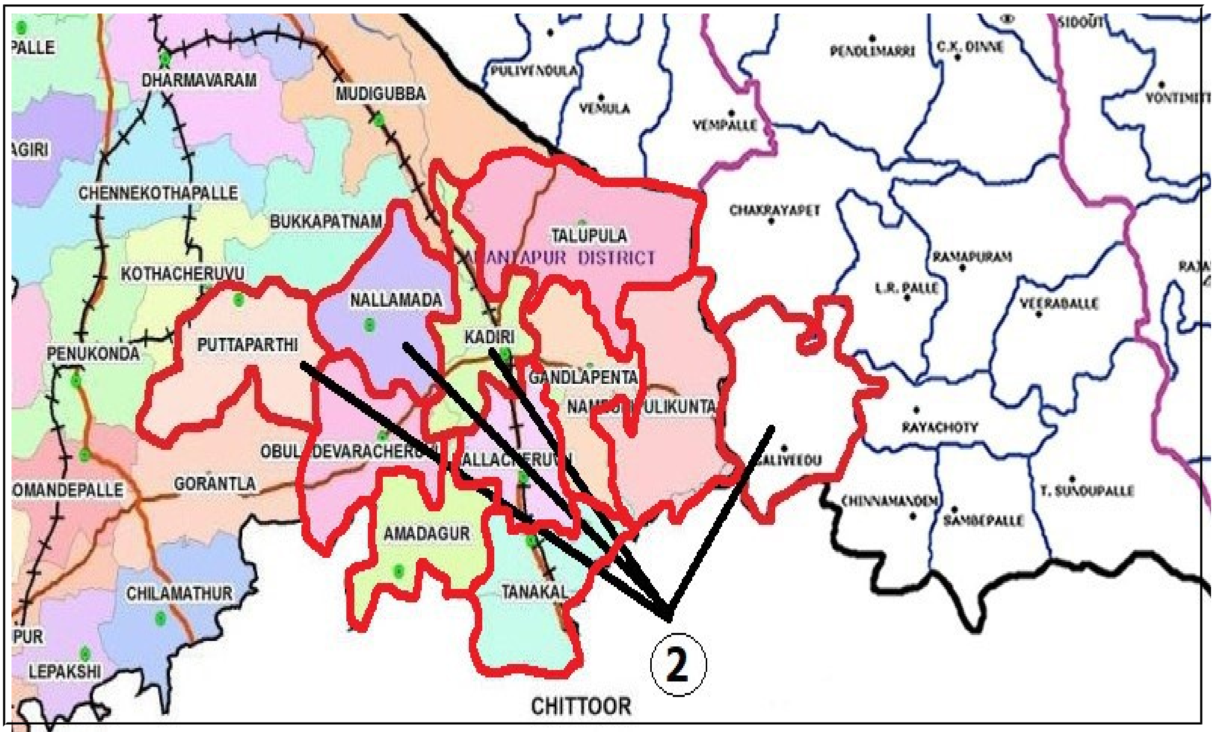


Figure-9.31: Adopted Zonal Map of Zone 2 in Anantapur & Kadapa Districts

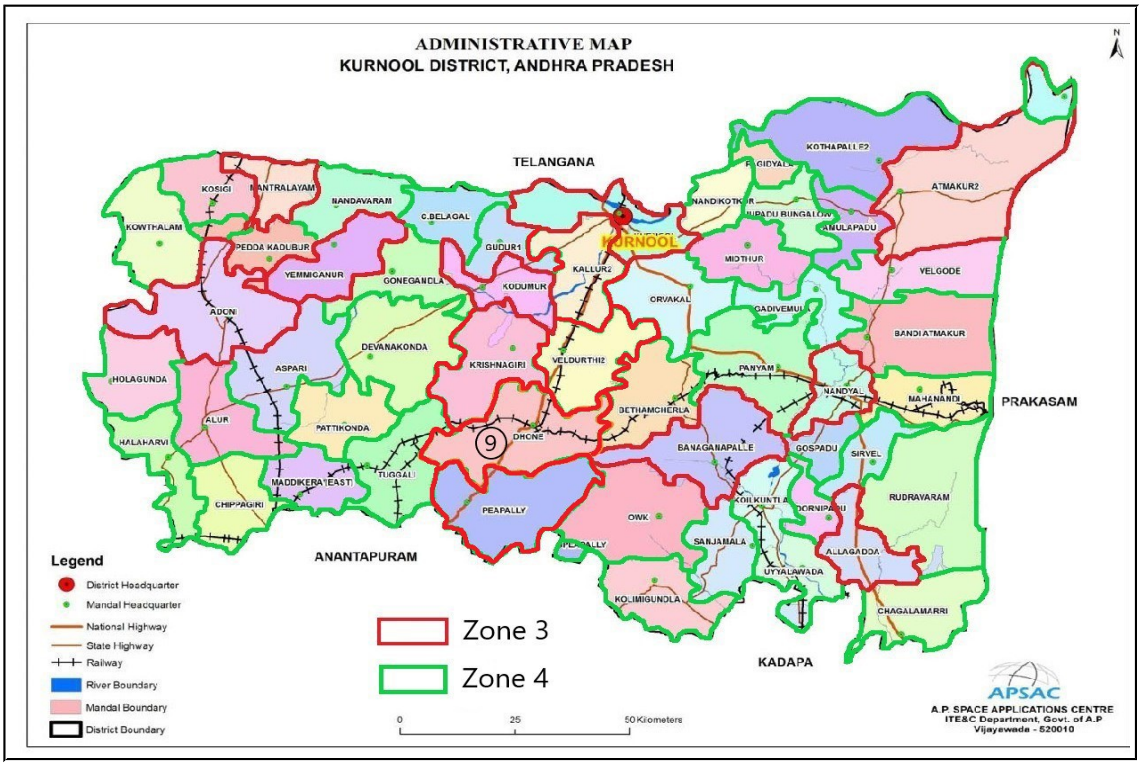


Figure-9.32: Adopted Zonal Map of Kurnool District

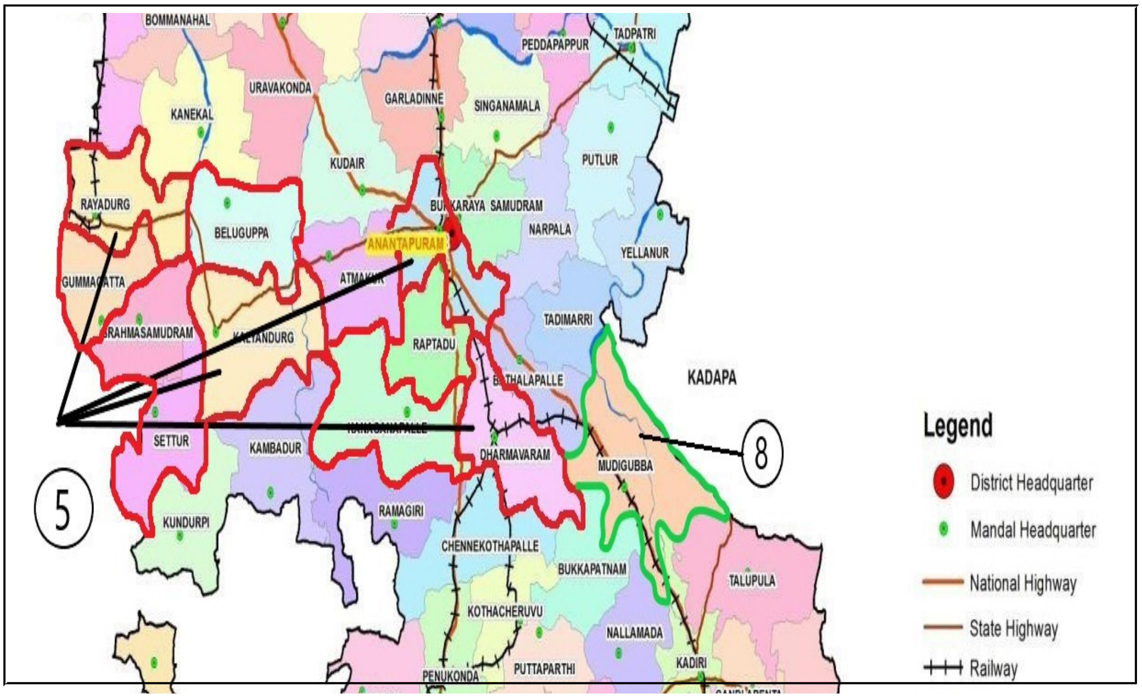


Figure-9.33: Adopted Zonal Map of Zone 5 & 8 in Anantapur District

Figure-9.34: Adopted Zonal Map of Zone 6 & 7 in Chittoor District

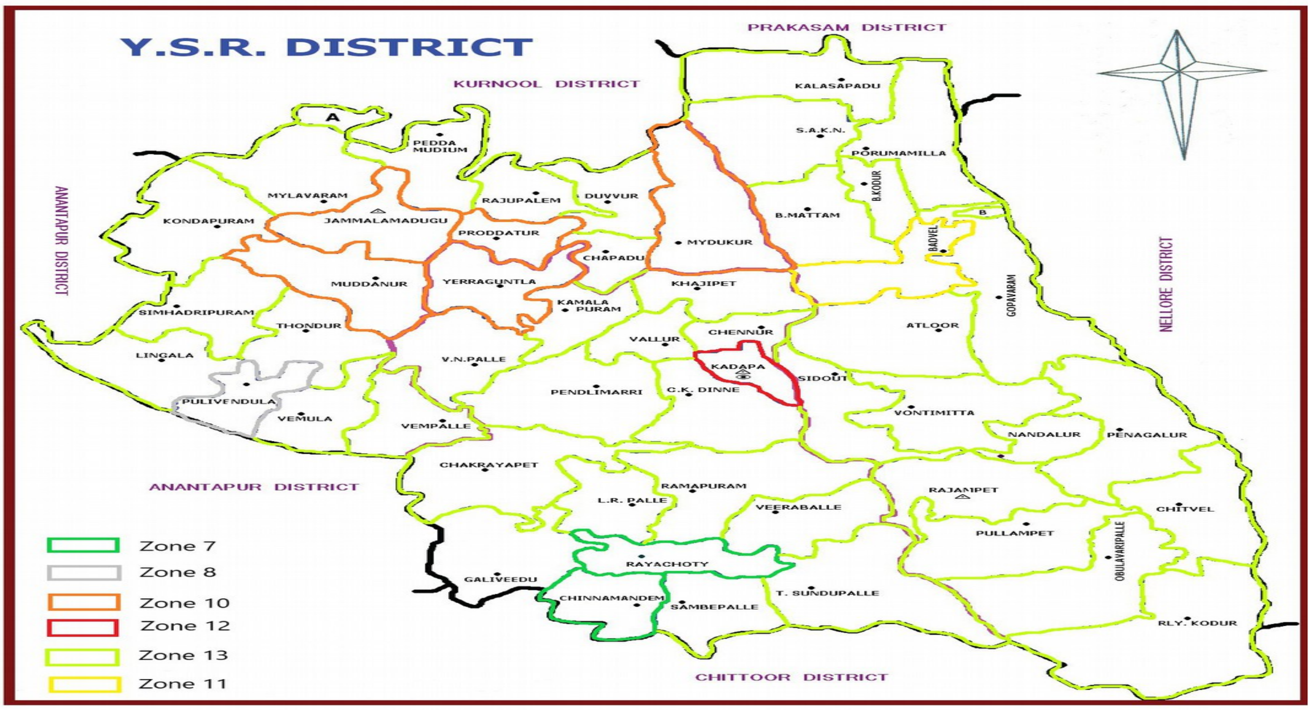


Figure-9.35: Adopted Zonal Map of YSR Kadapa District

Figure-9.36: Adopted Zonal Map of Anantapur District

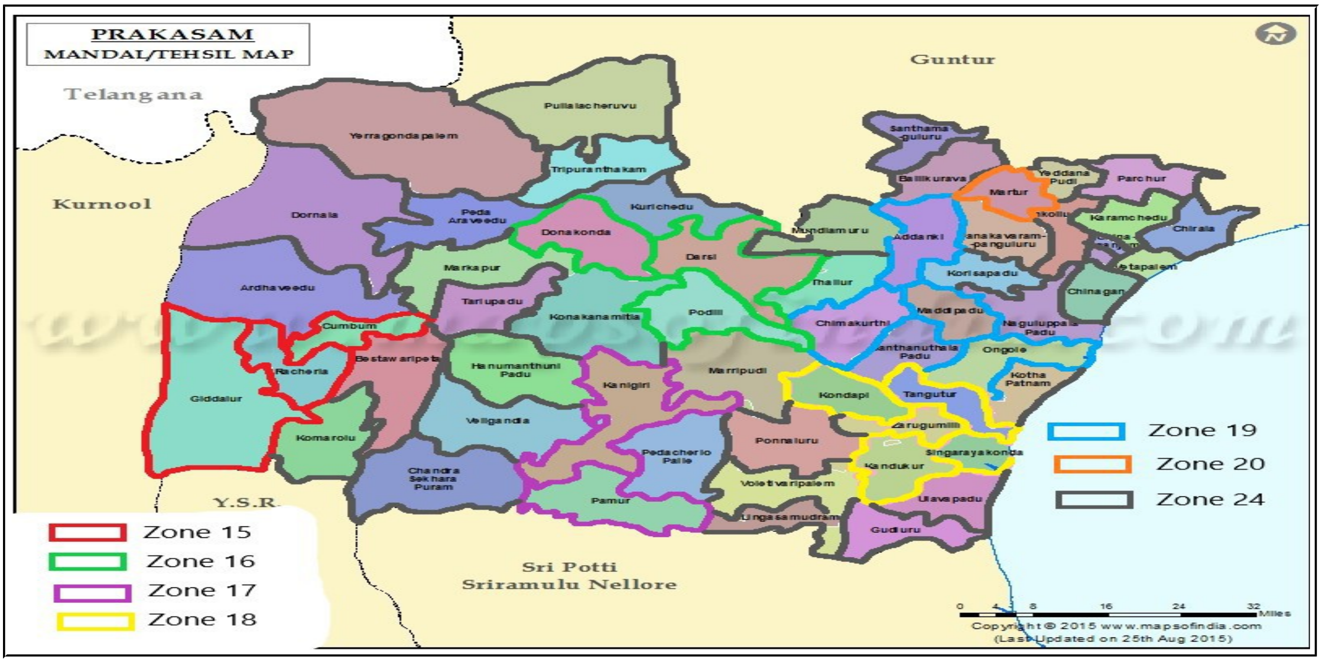


Figure-9.37: Adopted Zonal Map of Prakasam District

Figure-9.38: Adopted Zonal Map of Karnataka

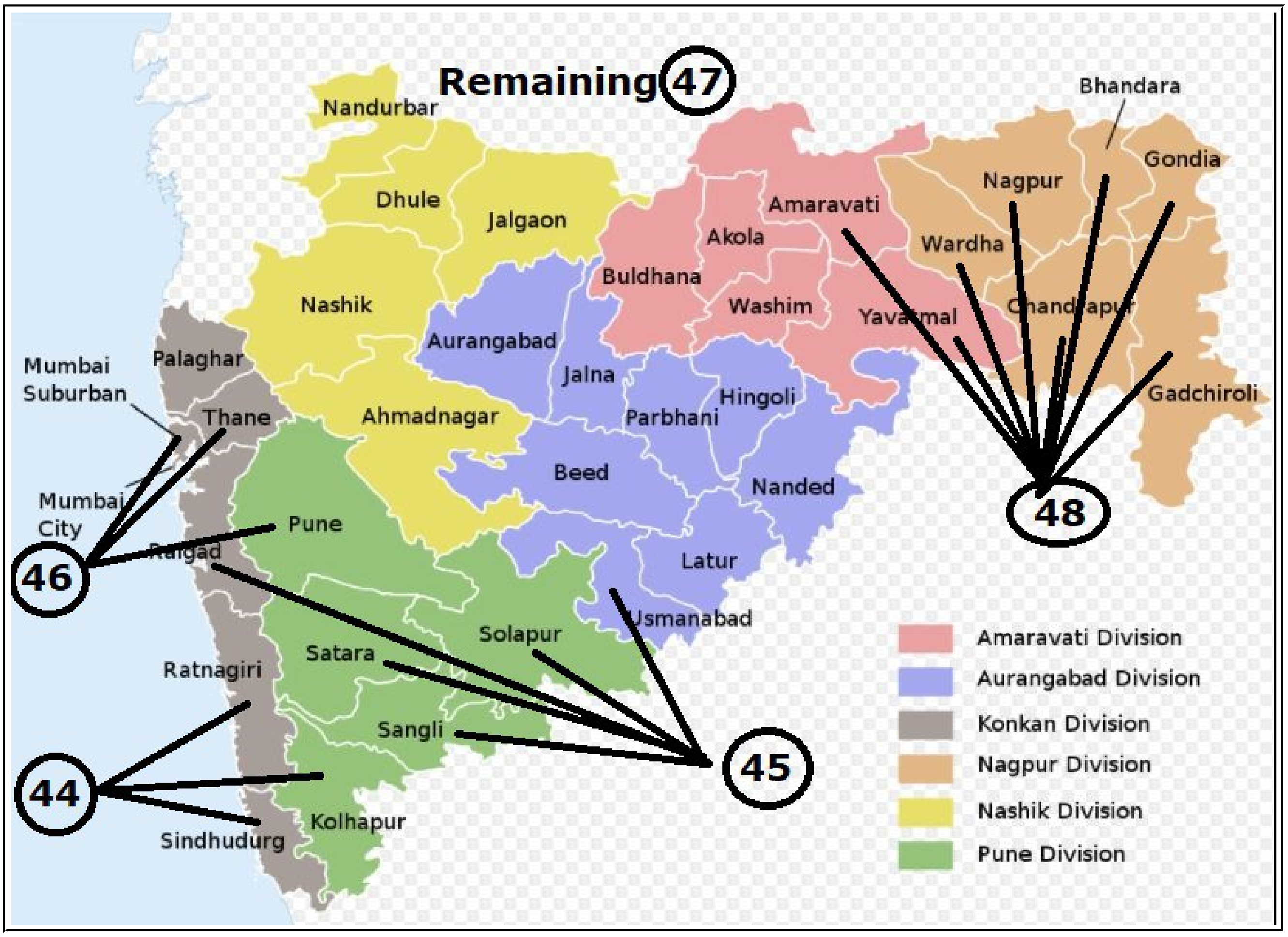


Figure-9.39: Adopted Zonal Map of Maharashtra

9.13.2 OD Matrix

The O-D data collected has been analyzed to study the OD matrix over the entire project stretch at each survey location. The OD matrix of Location 6 is presented below as sample in ***Table-9.12*** to ***Table-9.13.***

Table-9.12: Origin–Destination Matrix of Location 6 (in nos)

Origin	Destination																		
	3	5	8	10	11	12	13	14	15	19	21	24	26	27	28	29	30	37	40	Total Result
3	-	-	-	-	-	-	-	-	82	69	50	56	-	-	-	1	-	-	1	259
5	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2	-	-	-	4
8	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-	-	-	-	3
10	-	-	-	-	-	-	-	-	24	3	16	4	-	-	-	-	-	-	-	47
11	-	-	-	-	-	-	-	-	4	-	2	2	-	-	-	1	-	-	-	9
12	-	-	-	-	-	-	-	-	19	22	36	24	-	-	-	1	-	-	-	102
13	-	-	-	-	-	-	-	-	18	1	7	11	-	-	-	-	-	-	1	38
15	86	8	-	5	2	33	7	2	297	31	35	78	-	4	9	2	2	6	-	607
19	28	-	-	1	1	23	-	-	20	-	-	10	-	2	2	-	1	1	-	89
21	52	2	-	5	2	20	3	3	24	-	-	11	-	-	3	-	2	4	-	131
23	5		-		1	3	3		3	-	-	5	-	-	1	-	-	2	-	23
24	60	8	-	8	2	26	9	1	113	6	19	67	3	3	8	2	2	6	-	343
25	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
27	-	-	-	-	-	-	-	-	6	2	6	7	-	-	-	1	-	-	1	23
28	-	-	-	-	-	-	-	-	6	2	3	9	-	-	-	2	-	-	-	22
29	2	1	1	-	-	1	-	-	1	-	-	1	-	-	1	-	1	-	-	9
30	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	2
37	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
39	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	2
40	1	-	-	-	-	1	1	-	-	-	-	1	-	-	-	-	-	-	-	4
42	1	-	-	-	2	-	1	-	1	-	-	1	-	-	1	-	-	-	-	7
49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Total Result	**235**	**19**	**1**	**19**	**10**	**107**	**24**	**6**	**620**	**139**	**178**	**288**	**3**	**9**	**25**	**14**	**8**	**19**	**3**	**1,727**

Table-9.13: Origin–Destination Matrix of Location 6 (in %)

Origin	Destination																			
	3	5	8	10	11	12	13	14	15	19	21	24	26	27	28	29	30	37	40	Total Result
3	-	-	-	-	-	-	-	-	4.75%	4.00%	2.90%	3.24%	-	-	-	0.06%	-	-	0.06%	**15.00%**
5	-	-	-	-	-	-	-	-	-	-	0.12%	-	-	-	-	0.12%	-	-	-	**0.23%**
8	-	-	-	-	-	-	-	-	-	-	0.12%	0.06%	-	-	-	-	-	-	-	**0.17%**
10	-	-	-	-	-	-	-	-	1.39%	0.17%	0.93%	0.23%	-	-	-	-	-	-	-	**2.72%**
11	-	-	-	-	-	-	-	-	0.23%		0.12%	0.12%	-	-	-	0.06%	-	-	-	**0.52%**
12	-	-	-	-	-	-	-	-	1.10%	1.27%	2.08%	1.39%	-	-	-	0.06%	-	-	-	**5.91%**
13	-	-	-	-	-	-	-	-	1.04%	0.06%	0.41%	0.64%	-	-	-		-	-	0.06%	**2.20%**
15	4.98%	0.46%	-	0.29%	0.12%	1.91%	0.41%	0.12%	17.20%	1.80%	2.03%	4.52%	-	0.23%	0.52%	0.12%	0.12%	0.35%	-	**35.15%**
19	1.62%	-	-	0.06%	0.06%	1.33%	-	-	1.16%	-	-	0.58%	-	0.12%	0.12%	-	0.06%	0.06%	-	**5.15%**
21	3.01%	0.12%	-	0.29%	0.12%	1.16%	0.17%	0.17%	1.39%	-	-	0.64%	-	-	0.17%	-	0.12%	0.23%	-	**7.59%**
23	0.29%	-	-		0.06%	0.17%	0.17%	-	0.17%	-	-	0.29%	-	-	0.06%	-	-	0.12%	-	**1.33%**
24	3.47%	0.46%	-	0.46%	0.12%	1.51%	0.52%	0.06%	6.54%	0.35%	1.10%	3.88%	0.17%	0.17%	0.46%	0.12%	0.12%	0.35%	-	**19.86%**
25	-	-	-	-	-	-	-	-	0.06%	-	-	-	-	-	-	-	-	-	-	**0.06%**
27	-	-	-	-	-	-	-	-	0.35%	0.12%	0.35%	0.41%	-	-	-	0.06%	-	-	0.06%	**1.33%**
28	-	-	-	-	-	-	-	-	0.35%	0.12%	0.17%	0.52%	-	-	-	0.12%	-	-	-	**1.27%**
29	0.12%	0.06%	0.06%	-	-	0.06%	-	-	0.06%	-	-	0.06%	-	-	0.06%	-	0.06%	-	-	**0.52%**
30	-	-	-	-	-	-	-	-	0.06%	0.06%	-	-	-	-	-	-	-	-	-	**0.12%**
37	-	-	-	-	-	-	-	-	-	0.06%	-	-	-	-	-	-	-	-	-	**0.06%**
39	-	-	-	-	-	-	-	-	-	0.06%	-	-	-	-	-	0.06%	-	-	-	**0.12%**
40	0.06%	-	-	-	-	0.06%	0.06%	-	-	-	-	0.06%	-	-	-	-	-	-	-	**0.23%**
42	0.06%	-	-	-	0.12%	-	0.06%	-	0.06%	-	-	0.06%	-	-	0.06%	-	-	-	-	**0.41%**
49	-	-	-	-	-	-	-	-	-	-	-		-	-	-	0.06%	-	-	-	**0.06%**
Total Result	**13.61%**	**1.10%**	**0.06%**	**1.10%**	**0.58%**	**6.20%**	**1.39%**	**0.35%**	**35.90%**	**8.05%**	**10.31%**	**16.68%**	**0.17%**	**0.52%**	**1.45%**	**0.81%**	**0.46%**	**1.10%**	**0.17%**	**100.0%**

Based on the above table and trip pattern of vehicles at this location, the number of deliverable traffic on the proposed Bengaluru – Kadappa – Vijayawada corridor has been identified in vehicles (mode wise) based on the zoning pattern and also based on the least travel distance / time from the origin and destinations of each vehicle. The mode wise trip pattern has been discussed in detail in the subsequent chapters.

9.13.3 Trip Frequency Distribution

The O-D data collected has been analyzed to study the trip frequency distribution over the entire project stretch. The mode wise trip frequency distribution at all survey locations is presented from ***Table-9.14*** to ***Table-9.21*** and from ***Figure-9.40*** to ***Figure-9.55***.

Table-9.14: Trip Frequency Distribution at Location 1

Vehicle Type	NH-44 near Kodikondla Checkpost at AP/ Karnataka border (Anantapur Dist.)										
	Daily Once	Daily Twice	> Daily Twice	Weekly Once	Weekly Twice	> Weekly Twice	Monthly Once	Monthly Twice	> Monthly Twice	Yearly Once	>Yearly Once
Car	1%	3%	0%	9%	2%	2%	47%	10%	2%	22%	2%
Bus	0%	0%	0%	42%	0%	3%	29%	0%	6%	13%	7%
2 Axle	2%	0%	0%	12%	9%	0%	30%	26%	0%	21%	0%
3 Axle	6%	0%	0%	0%	13%	0%	6%	13%	0%	62%	0%
M Axle	4%	2%	0%	4%	12%	0%	39%	16%	2%	21%	0%
LCV	0%	0%	0%	6%	12%	0%	6%	23%	24%	29%	0%

Table-9.15: Trip Frequency Distribution at Location 2

Vehicle Type	SH-61 near Pulagampalle (Ananthapur Dist.)										
	Daily Once	Daily Twice	> Daily Twice	Weekly Once	Weekly Twice	> Weekly Twice	Monthly Once	Monthly Twice	> Monthly Twice	Yearly Once	>Yearly Once
Car	7%	7%	1%	15%	5%	2%	44%	12%	1%	1%	5%
Bus	40%	32%	19%	0%	0%	8%	1%	0%	0%	0%	0%
2 Axle	26%	6%	9%	12%	23%	0%	15%	6%	3%	0%	0%
3 Axle	4%	0%	4%	26%	18%	0%	35%	9%	4%	0%	0%
M Axle	12%	3%	6%	13%	16%	5%	15%	16%	14%	0%	0%
LCV	9%	16%	12%	21%	12%	2%	16%	9%	3%	0%	0%

Table-9.16: Trip Frequency Distribution at Location 3

Vehicle Type	NH-40 near Sambepalli (YSR Kadapa Dist.)										
	Daily Once	Daily Twice	> Daily Twice	Weekly Once	Weekly Twice	> Weekly Twice	Monthly Once	Monthly Twice	> Monthly Twice	Yearly Once	>Yearly Once
Car	0%	10%	0%	4%	0%	0%	31%	38%	13%	2%	2%
Bus	3%	7%	0%	2%	0%	0%	20%	32%	34%	2%	0%
2 Axle	2%	0%	0%	22%	17%	0%	53%	6%	0%	0%	0%
3 Axle	3%	0%	0%	26%	5%	0%	66%	0%	0%	0%	0%
M Axle	0%	0%	0%	9%	4%	0%	76%	9%	1%	1%	0%
LCV	0%	0%	0%	9%	18%	0%	73%	0%	0%	0%	0%

Table-9.17: Trip Frequency Distribution at Location 4

Vehicle Type	NH-67 near Basapuram Toll Plaza (YSR Kadapa Dist.)										
	Daily Once	Daily Twice	> Daily Twice	Weekly Once	Weekly Twice	> Weekly Twice	Monthly Once	Monthly Twice	> Monthly Twice	Yearly Once	>Yearly Once
Car	44%	1%	0%	16%	0%	0%	15%	0%	21%	3%	0%
Bus	56%	0%	0%	25%	0%	0%	19%	0%	0%	0%	0%
2 Axle	15%	2%	0%	29%	13%	2%	35%	4%	0%	0%	0%
3 Axle	9%	0%	0%	27%	9%	9%	27%	19%	0%	0%	0%
M Axle	14%	0%	0%	22%	4%	1%	43%	15%	1%	0%	0%
LCV	12%	2%	0%	22%	18%	2%	40%	2%	2%	0%	0%

Table-9.18: Trip Frequency Distribution at Location 5

Vehicle Type	NH-71 near Kothuru (Nellore Dist.)										
	Daily Once	Daily Twice	> Daily Twice	Weekly Once	Weekly Twice	> Weekly Twice	Monthly Once	Monthly Twice	> Monthly Twice	Yearly Once	>Yearly Once
Car	2%	2%	0%	9%	3%	0%	57%	9%	0%	7%	11%
Bus	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
2 Axle	0%	0%	0%	1%	7%	1%	61%	30%	0%	0%	0%
3 Axle	0%	0%	0%	5%	1%	1%	83%	10%	0%	0%	0%
M Axle	0%	0%	0%	1%	1%	0%	82%	15%	1%	0%	0%
LCV	0%	0%	0%	9%	0%	0%	55%	36%	0%	0%	0%

Table-9.19: Trip Frequency Distribution at Location 6

Vehicle Type	NH-544D near Mokshagundam (PrakasamDist.)										
	Daily Once	Daily Twice	> Daily Twice	Weekly Once	Weekly Twice	> Weekly Twice	Monthly Once	Monthly Twice	> Monthly Twice	Yearly Once	>Yearly Once
Car	10%	0%	0%	54%	0%	0%	29%	1%	0%	3%	3%
Bus	58%	0%	0%	0%	42%	0%	0%	0%	0%	0%	0%
2 Axle	2%	0%	0%	10%	19%	16%	19%	30%	4%	0%	0%
3 Axle	4%	0%	0%	26%	9%	15%	27%	15%	4%	0%	0%
M Axle	1%	0%	0%	28%	4%	8%	35%	17%	4%	2%	1%
LCV	9%	3%	2%	20%	5%	18%	25%	17%	1%	0%	0%

Table-9.20: Trip Frequency Distribution at Location 7

Vehicle Type	Chimakurthy-Podili road Budavada near Marrichetlapalem (Prakasam Dist.)										
	Daily Once	Daily Twice	> Daily Twice	Weekly Once	Weekly Twice	> Weekly Twice	Monthly Once	Monthly Twice	> Monthly Twice	Yearly Once	>Yearly Once
Car	16%	8%	1%	18%	13%	3%	29%	10%	2%	0%	0%
Bus	25%	45%	22%	0%	0%	8%	0%	0%	0%	0%	0%
2 Axle	3%	17%	14%	20%	26%	14%	3%	3%	0%	0%	0%
3 Axle	1%	31%	16%	12%	24%	13%	0%	2%	0%	0%	0%
M Axle	0%	18%	6%	18%	20%	32%	0%	6%	0%	0%	0%
LCV	0%	22%	33%	17%	11%	6%	11%	0%	0%	0%	0%

Table-9.21: Trip Frequency Distribution at Location 8

Vehicle Type	NH-16 near Tanguturu Toll Plaza (Prakasam Dist.)										
	Daily Once	Daily Twice	> Daily Twice	Weekly Once	Weekly Twice	> Weekly Twice	Monthly Once	Monthly Twice	> Monthly Twice	Yearly Once	>Yearly Once
Car	7%	1%	1%	16%	8%	3%	39%	13%	6%	4%	2%
Bus	51%	34%	8%	0%	0%	7%	0%	0%	0%	0%	0%
2 Axle	3%	1%	0%	20%	11%	3%	31%	20%	8%	1%	2%

Vehicle Type	NH-16 near Tanguturu Toll Plaza (Prakasam Dist.)										
	Daily Once	Daily Twice	> Daily Twice	Weekly Once	Weekly Twice	> Weekly Twice	Monthly Once	Monthly Twice	> Monthly Twice	Yearly Once	>Yearly Once
3 Axle	2%	0%	1%	28%	9%	4%	31%	16%	7%	1%	1%
M Axle	3%	2%	0%	31%	7%	2%	25%	20%	9%	0%	1%
LCV	0%	5%	0%	37%	12%	2%	28%	9%	7%	0%	0%

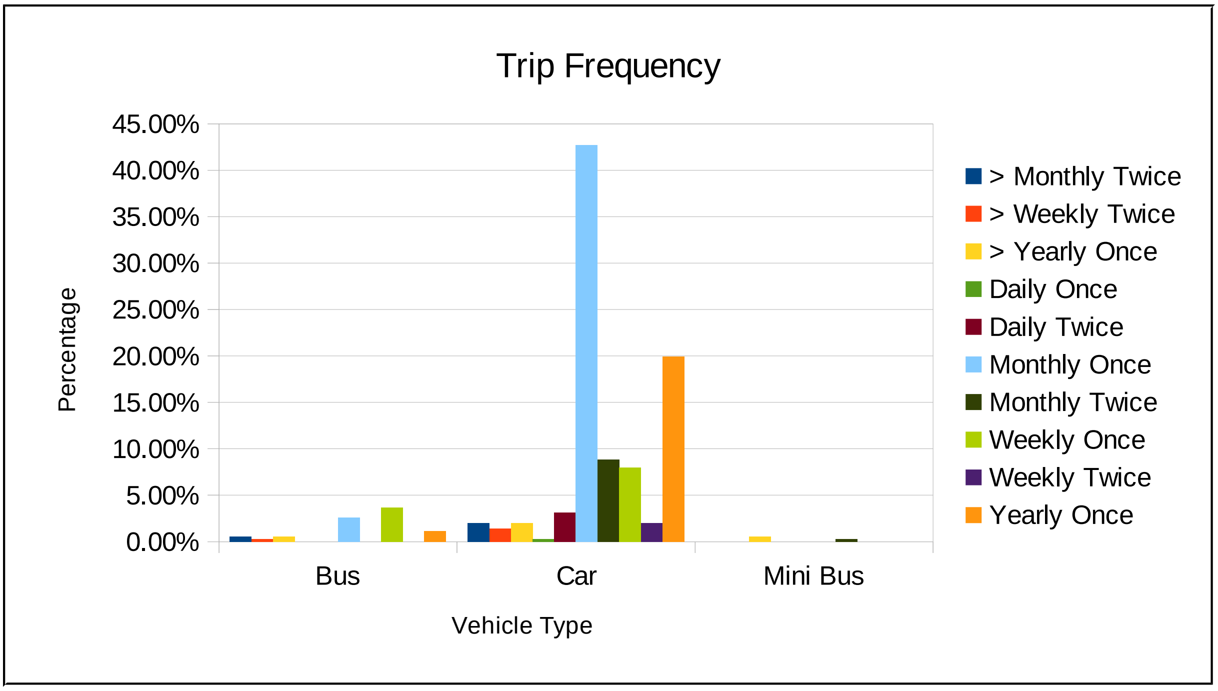


Figure-9.40: Trip frequency pattern for Passenger vehicles at Location 1

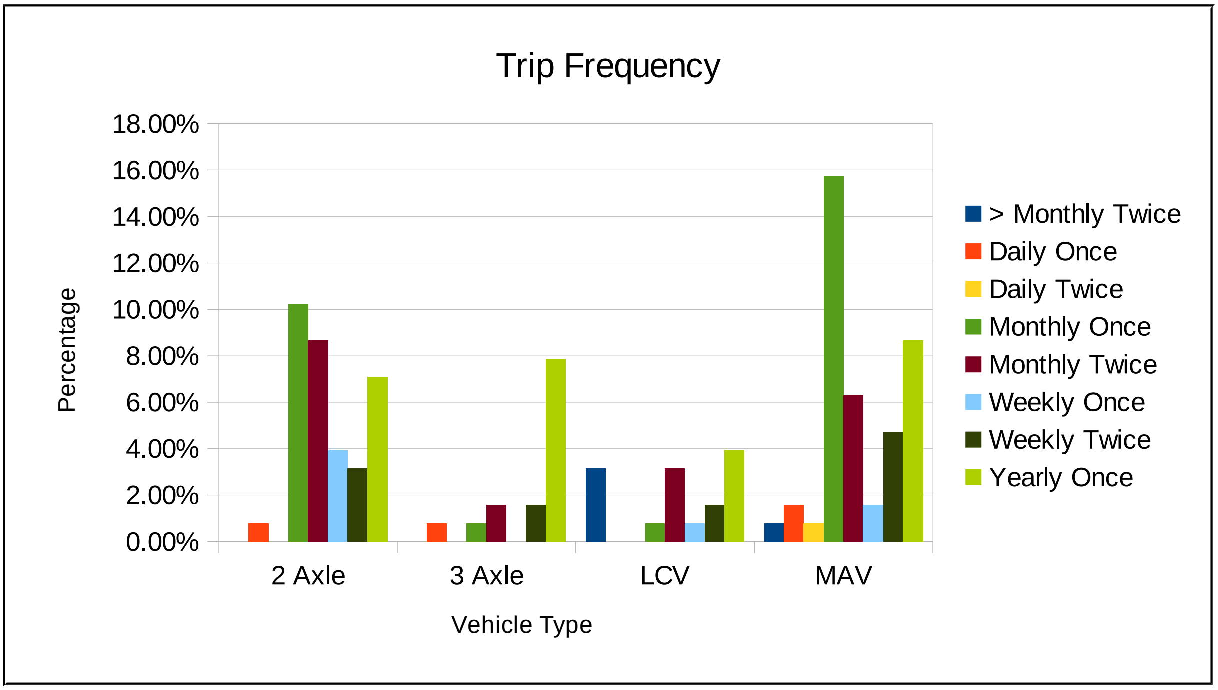


Figure-9.41: Trip frequency pattern for Goods vehicles at Location 1

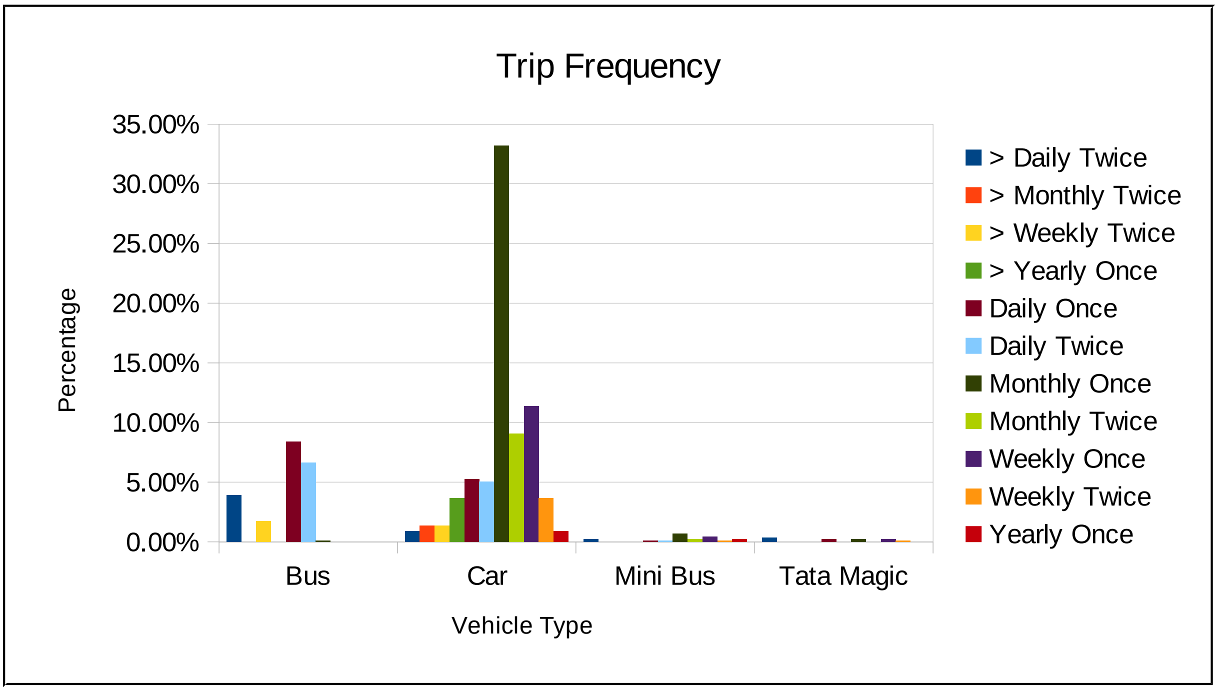


Figure-9.42: Trip frequency pattern for Passenger vehicles at Location 2

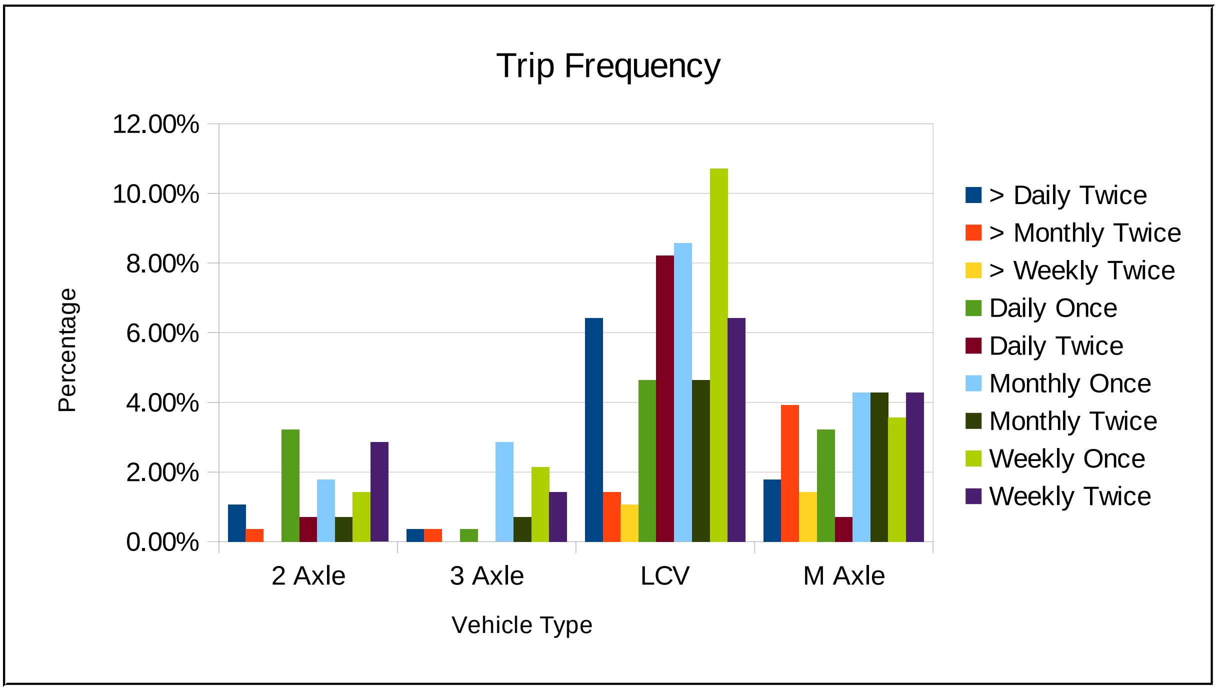


Figure-9.43: Trip frequency pattern for Goods vehicles at Location 2

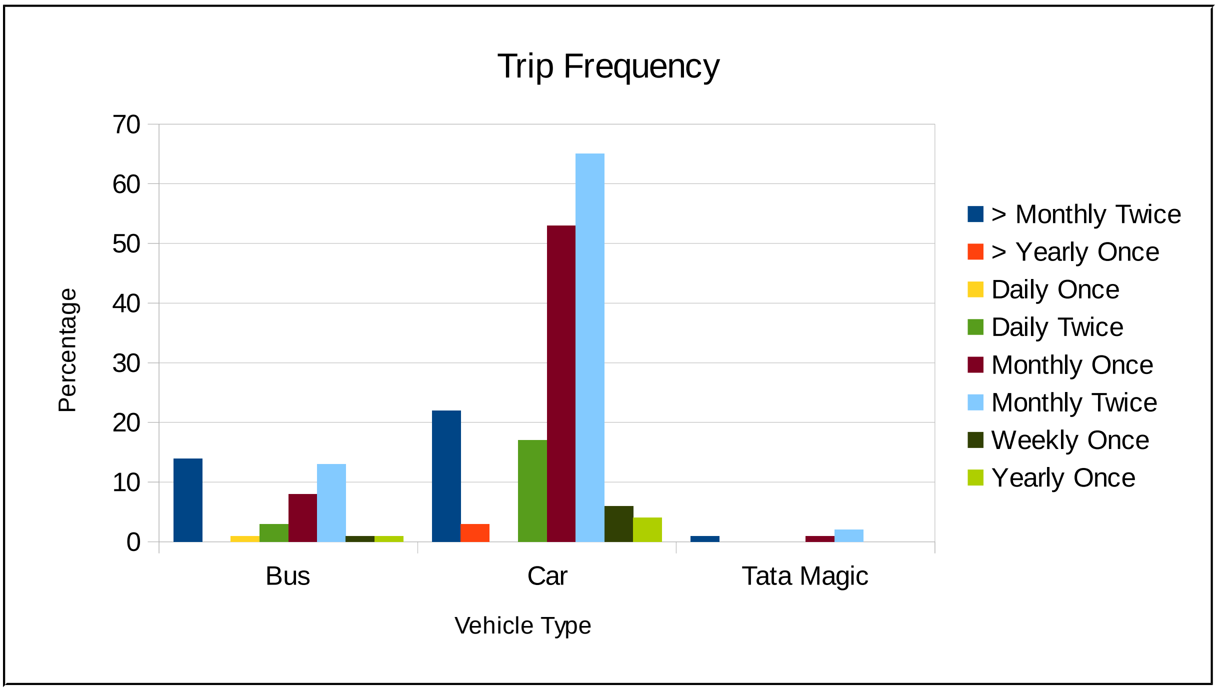


Figure-9.44: Trip frequency pattern for Passenger vehicles at Location 3

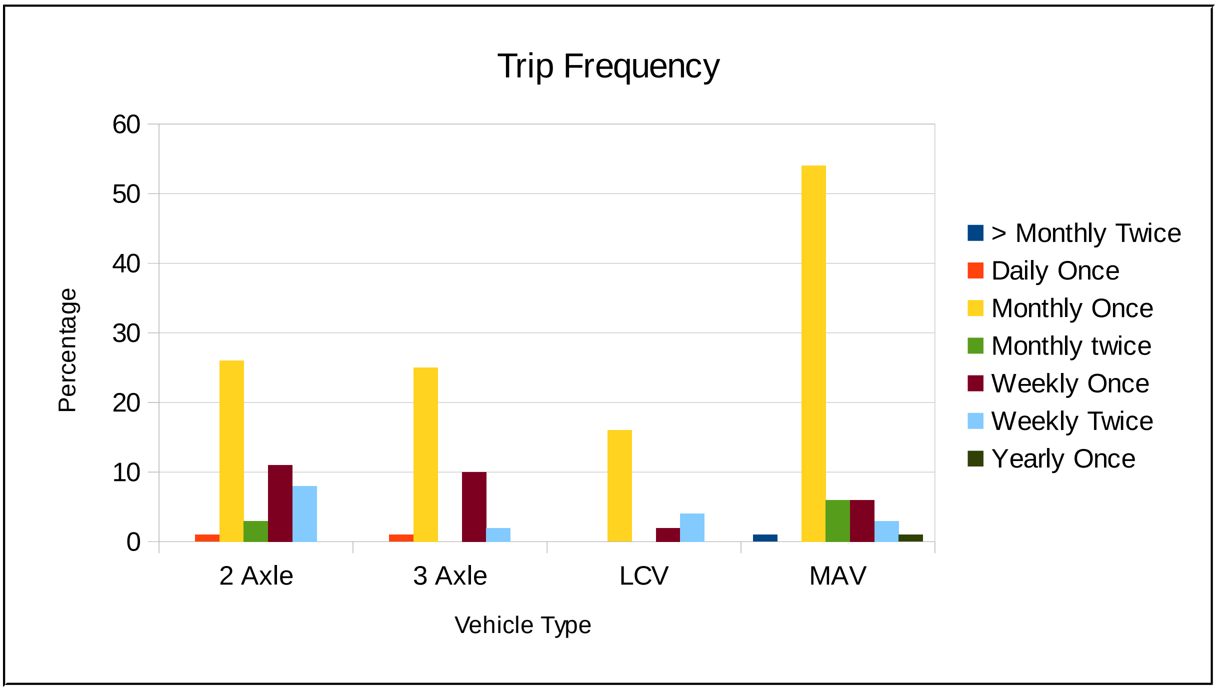


Figure-9.45: Trip frequency pattern for Goods vehicles at Location 3

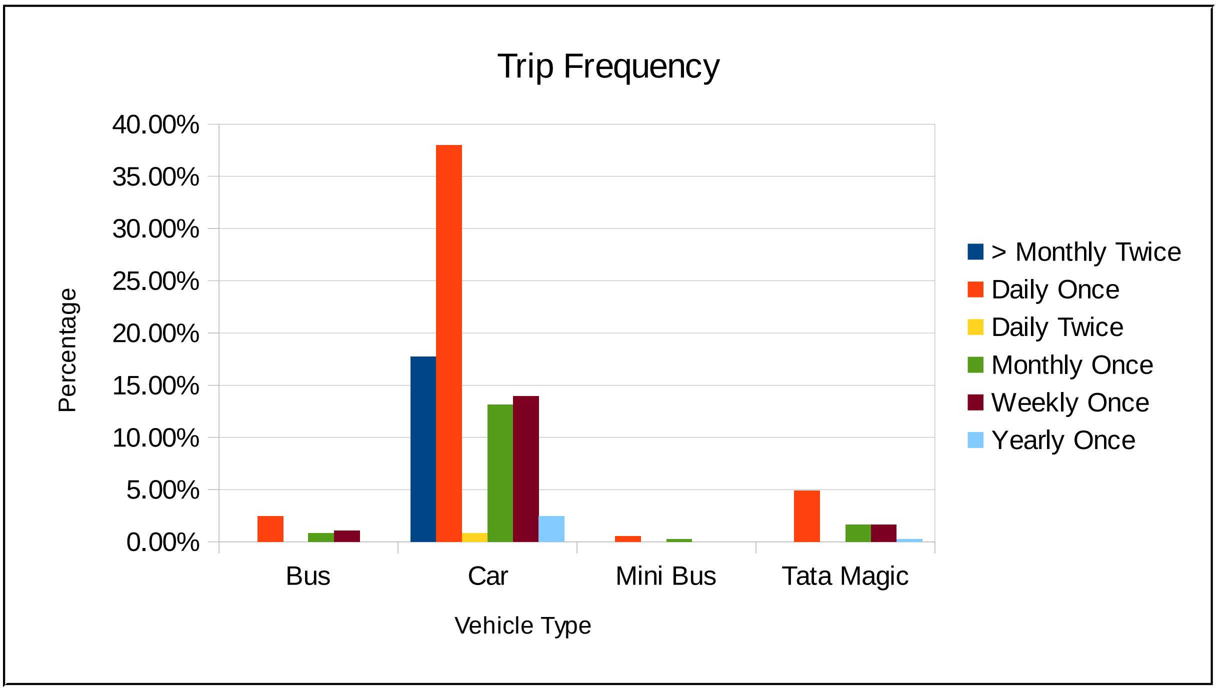


Figure-9.46: Trip frequency pattern for Passenger vehicles at Location 4

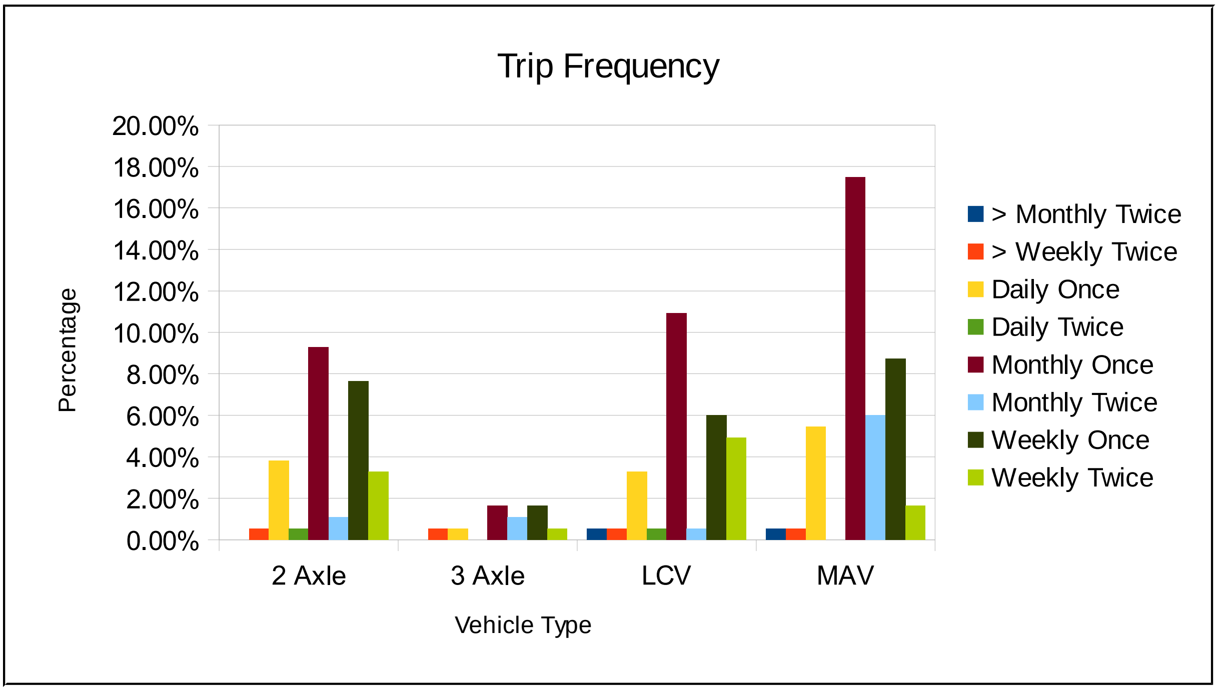


Figure-9.47: Trip frequency pattern for Goods vehicles at Location 4

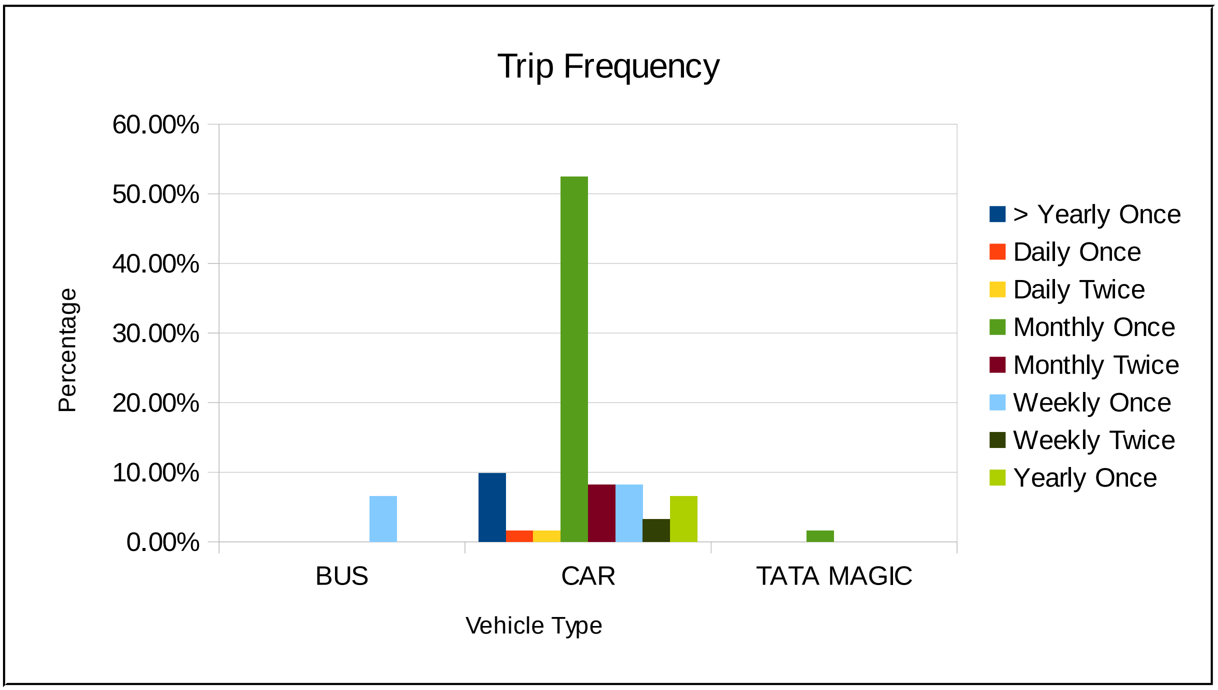


Figure-9.48: Trip frequency pattern for Passenger vehicles at Location 5

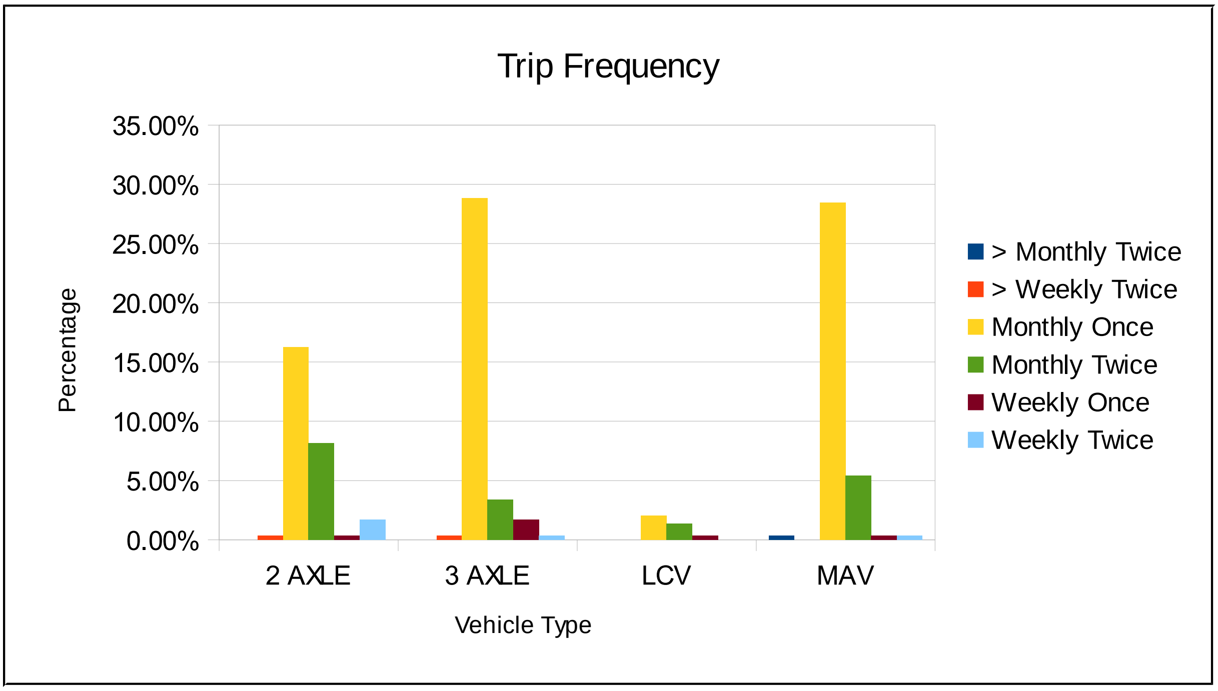


Figure-9.49: Trip frequency pattern for Goods vehicles at Location 5

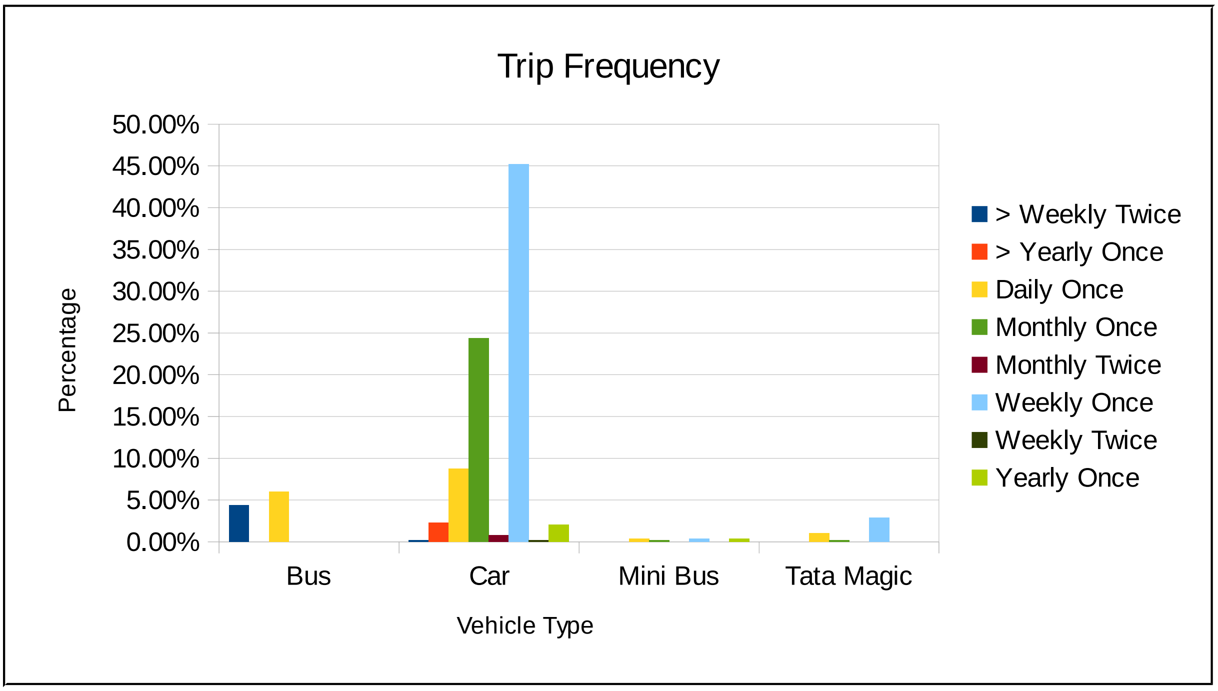


Figure-9.50: Trip frequency pattern for Passenger vehicles at Location 6

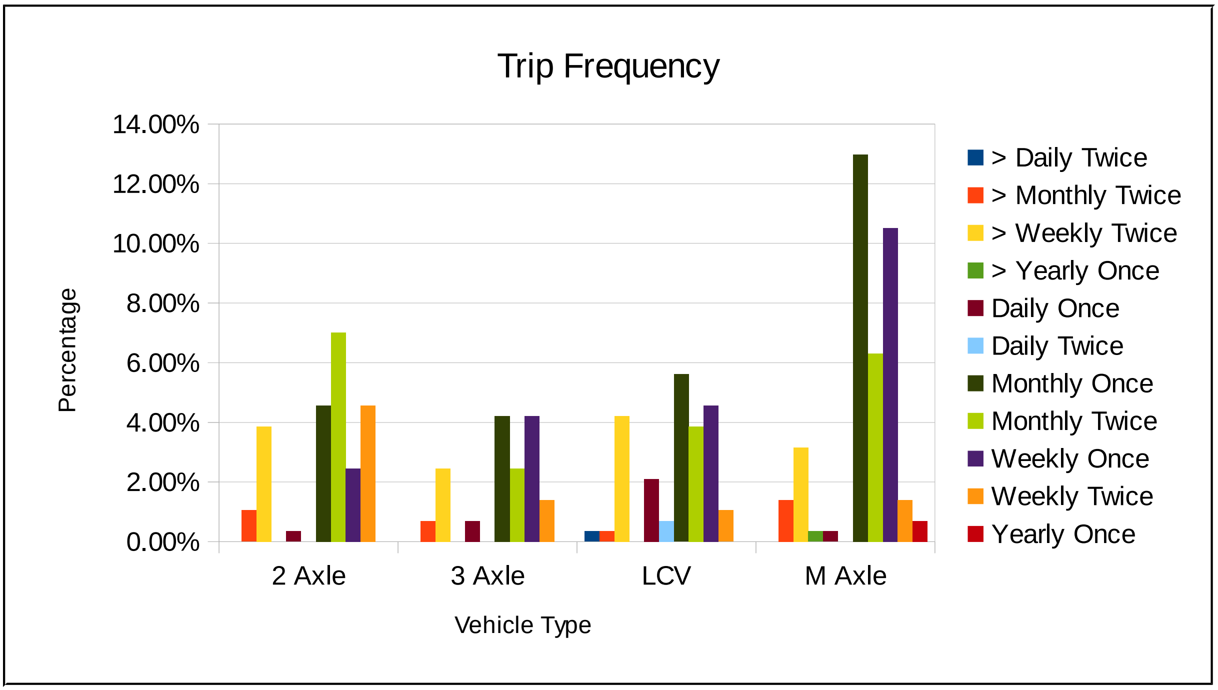


Figure-9.51: Trip frequency pattern for Goods vehicles at Location 6

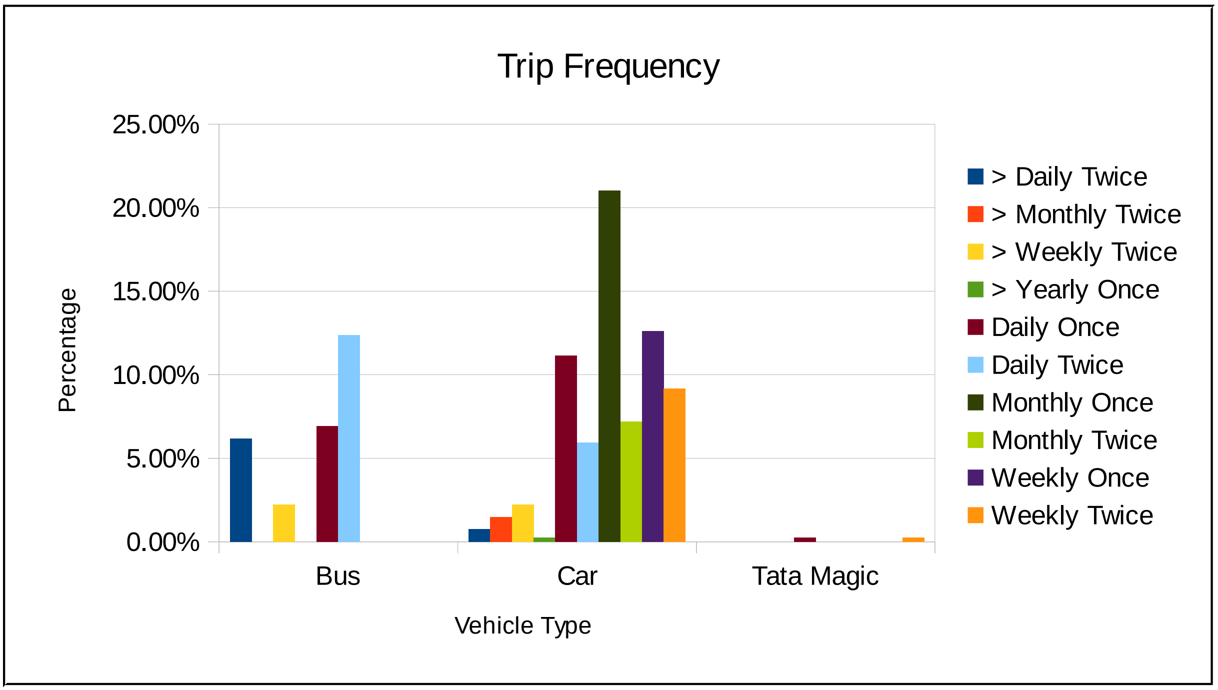


Figure-9.52: Trip frequency pattern for Passenger vehicles at Location 7

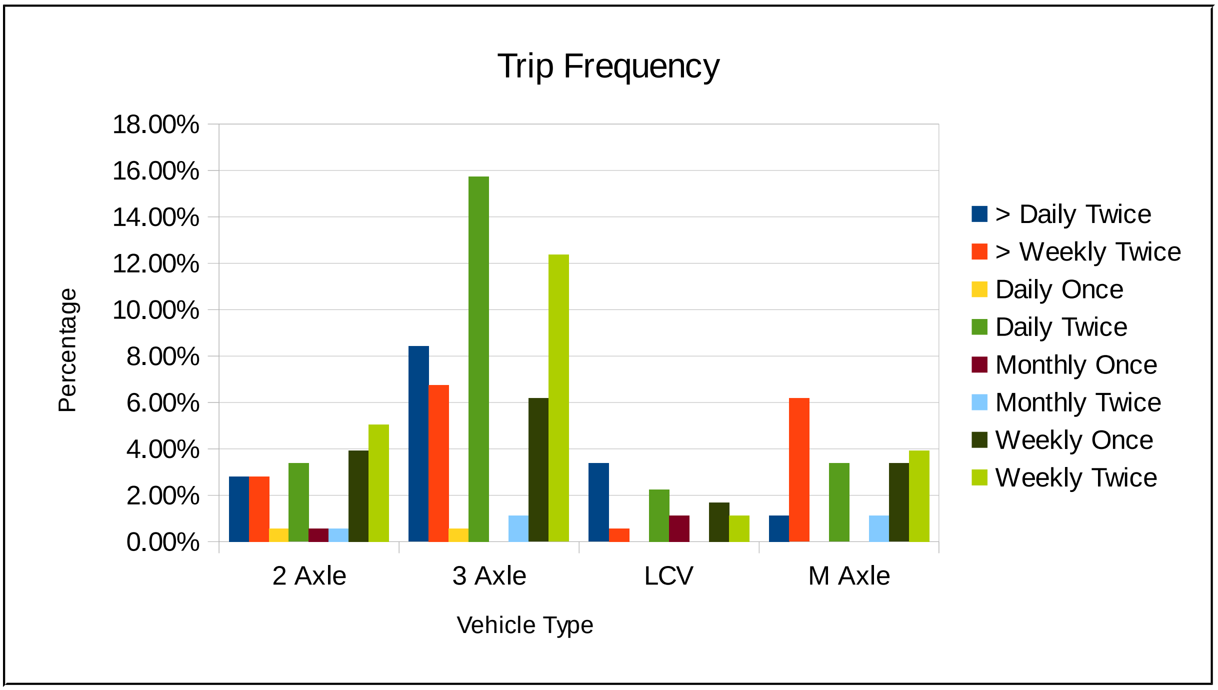


Figure-9.53: Trip frequency pattern for Goods vehicles at Location 7

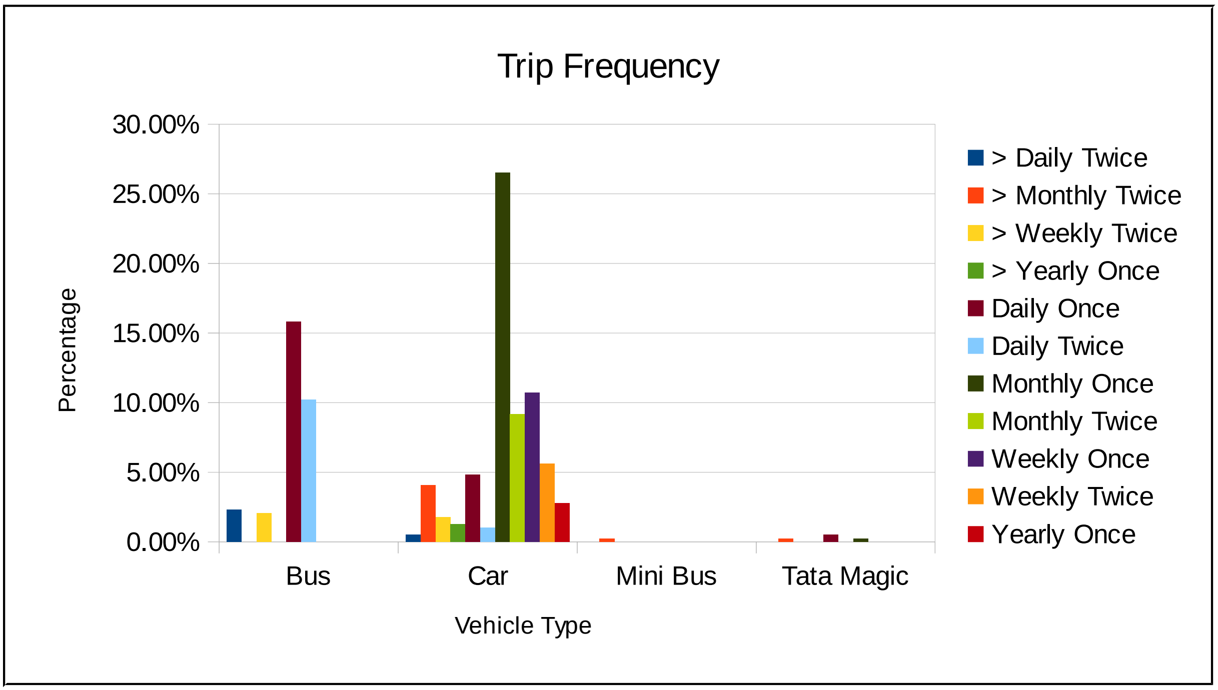


Figure-9.54: Trip frequency pattern for Passenger vehicles at Location 8

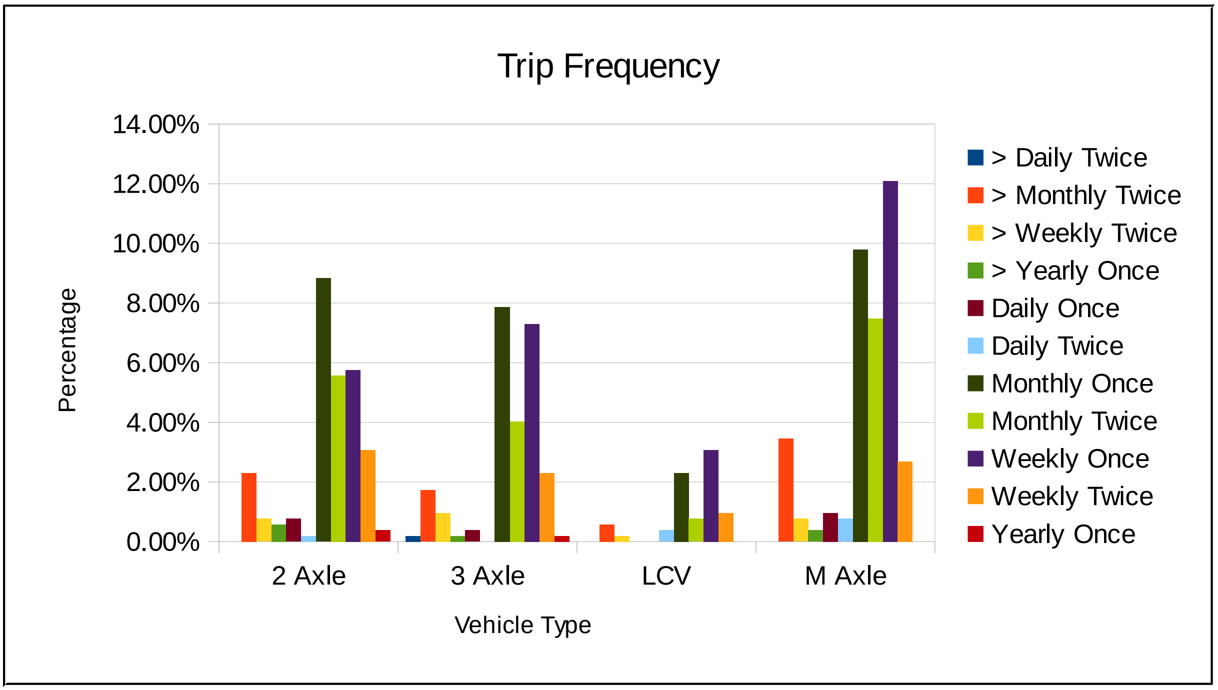


Figure-9.55: Trip frequency pattern for Goods vehicles at Location 8

1.13.4 Commodity Distribution

The O-D data collected was analyzed to study the type of commodities carried by the commercial vehicles along the entire project stretch. The proportion of each type of commodity carried by each mode of commercial vehicle along the project stretch at different survey locations is presented from ***Table-9.22*** **to** ***Table-9.29*** and from ***Figure-9.56 to Figure-9.63*****.**

Table-9.22: Commodity Distribution at Location 1

S.No	Commodity	LCV	2 Axle	3 Axle	MAV
1	Food grains and pulses	0%	0%	0%	0%
2	Cash crops	0%	2%	0%	0%
3	Vegetables and Fruits	29%	16%	6%	4%
4	Processed Food Items	12%	3%	0%	4%
5	Packed Food Items	0%	0%	6%	2%
6	Fishery, Poultry and Animal Feed	0%	0%	0%	0%
7	Building Materials	5%	12%	6%	18%
8	Industrial Raw Materials	0%	2%	0%	2%
9	Consumer Goods	0%	0%	0%	4%
10	Fertilisers, chemicals and Pharmaceuticals	0%	0%	0%	0%
11	Machinery and Automobiles	0%	7%	6%	8%
12	Petroleum Products	0%	0%	0%	4%
13	Parcel Goods	24%	37%	50%	22%
14	Empty	24%	16%	13%	24%
15	Industrial Outputs	0%	0%	0%	0%
16	Liquor, Cold drinks	0%	0%	0%	2%
17	Others	6%	5%	13%	6%

Table-9.23: Commodity Distribution at Location 2

S.No	Commodity	LCV	2 Axle	3 Axle	MAV
1	Food grains and pulses	1%	0%	4%	3%
2	Cash crops	0%	0%	0%	0%
3	Vegetables and Fruits	3%	6%	0%	1%
4	Processed Food Items	1%	6%	0%	1%
5	Packed Food Items	3%	0%	0%	0%

S.No	Commodity	LCV	2 Axle	3 Axle	MAV
6	Fishery, Poultry and Animal Feed	1%	3%	0%	0%
7	Building Materials	7%	12%	22%	47%
8	Industrial Raw Materials	4%	9%	13%	4%
9	Consumer Goods	2%	3%	0%	3%
10	Fertilisers, chemicals and Pharmaceuticals	1%	0%	0%	1%
11	Machinery and Automobiles	3%	0%	4%	1%
12	Petroleum Products	3%	0%	0%	1%
13	Parcel Goods	3%	6%	13%	3%
14	Empty	53%	50%	39%	29%
15	Industrial Outputs	0%	0%	0%	0%
16	Liquor, Cold drinks	1%	0%	0%	0%
17	Others	14%	6%	4%	6%

Table-9.24: Commodity Distribution at Location 3

S.No	Commodity	LCV	2 Axle	3 Axle	MAV
1	Food grains and pulses	0%	0%	3%	7%
2	Cash crops	0%	0%	0%	0%
3	Vegetables and Fruits	9%	41%	16%	7%
4	Processed Food Items	0%	0%	5%	0%
5	Packed Food Items	5%	0%	0%	0%
6	Fishery, Poultry and Animal Feed	0%	0%	0%	0%
7	Building Materials	26%	20%	15%	54%
8	Industrial Raw Materials	0%	4%	8%	8%
9	Consumer Goods	5%	3%	5%	8%
10	Fertilisers, chemicals and Pharmaceuticals	0%	0%	0%	0%
11	Machinery and Automobiles	5%	2%	8%	1%

S.No	Commodity	LCV	2 Axle	3 Axle	MAV
12	Petroleum Products	0%	2%	3%	0%
13	Parcel Goods	5%	8%	3%	0%
14	Empty	40%	18%	34%	14%
15	Industrial Outputs	0%	0%	0%	0%
16	Liquor, Cold drinks	0%	0%	0%	0%
17	Others	5%	2%	0%	1%

Table-9.25: Commodity Distribution at Location 4

S.No	Commodity	LCV	2 Axle	3 Axle	MAV
1	Food grains and pulses	6%	2%	0%	1%
2	Cash crops	0%	0%	0%	1%
3	Vegetables and Fruits	6%	29%	9%	0%
4	Processed Food Items	0%	0%	0%	0%
5	Packed Food Items	2%	0%	0%	0%
6	Fishery, Poultry and Animal Feed	0%	0%	0%	0%
7	Building Materials	6%	17%	36%	42%
8	Industrial Raw Materials	4%	0%	0%	16%
9	Consumer Goods	8%	2%	9%	4%
10	Fertilisers, chemicals and Pharmaceuticals	0%	0%	0%	0%
11	Machinery and Automobiles	24%	15%	10%	2%
12	Petroleum Products	2%	2%	0%	3%
13	Parcel Goods	2%	4%	0%	0%
14	Empty	40%	29%	36%	30%
15	Industrial Outputs	0%	0%	0%	0%

S.No	Commodity	LCV	2 Axle	3 Axle	MAV
16	Liquor, Cold drinks	0%	0%	0%	0%
17	Others	0%	0%	0%	1%

Table-9.26: Commodity Distribution at Location 5

S.No	Commodity	LCV	2 Axle	3 Axle	MAV
1	Food grains and pulses	0%	1%	1%	3%
2	Cash crops	0%	1%	3%	3%
3	Vegetables and Fruits	0%	0%	0%	1%
4	Processed Food Items	0%	3%	2%	0%
5	Packed Food Items	0%	1%	0%	7%
6	Fishery, Poultry and Animal Feed	0%	1%	0%	1%
7	Building Materials	18%	8%	12%	15%
8	Industrial Raw Materials	18%	10%	14%	6%
9	Consumer Goods	0%	13%	4%	11%
10	Fertilisers, chemicals and Pharmaceuticals	10%	0%	1%	0%
11	Machinery and Automobiles	0%	4%	5%	3%
12	Petroleum Products	0%	1%	0%	3%
13	Parcel Goods	27%	28%	23%	31%
14	Empty	18%	23%	28%	8%
15	Industrial Outputs	0%	0%	0%	1%
16	Liquor, Cold drinks	0%	0%	0%	0%
17	Others	9%	6%	7%	7%

Table-9.27: Commodity Distribution at Location 6

S.No	Commodity	LCV	2 Axle	3 Axle	MAV
1	Food grains and pulses	0%	0%	2%	2%
2	Cash crops	0%	3%	0%	0%
3	Vegetables and Fruits	49%	29%	2%	7%
4	Processed Food Items	0%	0%	0%	0%
5	Packed Food Items	0%	0%	9%	0%
6	Fishery, Poultry and Animal Feed	0%	0%	0%	1%
7	Building Materials	2%	9%	13%	43%
8	Industrial Raw Materials	0%	1%	4%	11%
9	Consumer Goods	0%	6%	7%	3%
10	Fertilisers, chemicals and Pharmaceuticals	2%	2%	2%	0%
11	Machinery and Automobiles	0%	3%	4%	8%
12	Petroleum Products	0%	2%	4%	1%
13	Parcel Goods	0%	3%	2%	1%
14	Empty	41%	32%	42%	12%
15	Industrial Outputs	0%	0%	0%	0%
16	Liquor, Cold drinks	0%	0%	0%	0%
17	Others	6%	10%	9%	11%

Table-9.28: Commodity Distribution at Location 7

S.No	Commodity	LCV	2 Axle	3 Axle	MAV
1	Food grains and pulses	6%	0%	0%	0%
2	Cash crops	0%	0%	0%	0%
3	Vegetables and Fruits	0%	0%	0%	3%
4	Processed Food Items	0%	0%	0%	0%
5	Packed Food Items	6%	17%		3%
6	Fishery, Poultry and Animal Feed	0%	0%	0%	0%

S.No	Commodity	LCV	2 Axle	3 Axle	MAV
7	Building Materials	0%	14%	8%	9%
8	Industrial Raw Materials	11%	11%	24%	24%
9	Consumer Goods	0%	6%		3%
10	Fertilisers, chemicals and Pharmaceuticals	0%	0%	0%	0%
11	Machinery and Automobiles	0%	0%	0%	3%
12	Petroleum Products	0%	6%	0%	0%
13	Parcel Goods	11%	3%	3%	15%
14	Empty	56%	40%	63%	32%
15	Industrial Outputs	0%	0%	0%	0%
16	Liquor, Cold drinks	0%	0%	0%	2%
17	Others	10%	3%	2%	6%

Table-9.29: Commodity Distribution at Location 8

S.No	Commodity	LCV	2 Axle	3 Axle	MAV
1	Food grains and pulses	2.00%	1.00%	5.00%	3.00%
2	Cash crops	0.00%	0.00%	1.00%	1.00%
3	Vegetables and Fruits	5.00%	5.00%	3.00%	7.00%
4	Processed Food Items	0.00%	0.00%	0.00%	0.00%
5	Packed Food Items	0.00%	0.00%	0.00%	0.00%
6	Fishery, Poultry and Animal Feed	3.00%	1.00%	1.00%	2.00%
7	Building Materials	7.00%	9.00%	16.00%	24.00%
8	Industrial Raw Materials	6.00%	14.00%	12.00%	18.00%
9	Consumer Goods	3.00%	6.00%	4.00%	5.00%
10	Fertilisers, chemicals and Pharmaceuticals	3.00%	0.00%	2.00%	1.00%
11	Machinery and Automobiles	1.00%	2.00%	2.00%	1.00%

S.No	Commodity	LCV	2 Axle	3 Axle	MAV
12	Petroleum Products	2.00%	7.00%	5.00%	2.00%
13	Parcel Goods	25.00%	23.00%	19.00%	10.00%
14	Empty	32.00%	21.00%	12.00%	20.00%
15	Industrial Outputs	0.00%	0.00%	0.00%	0.00%
16	Liquor, Cold drinks	0.00%	0.00%	0.00%	0.00%
17	Others	11.00%	11.00%	18.00%	6.00%

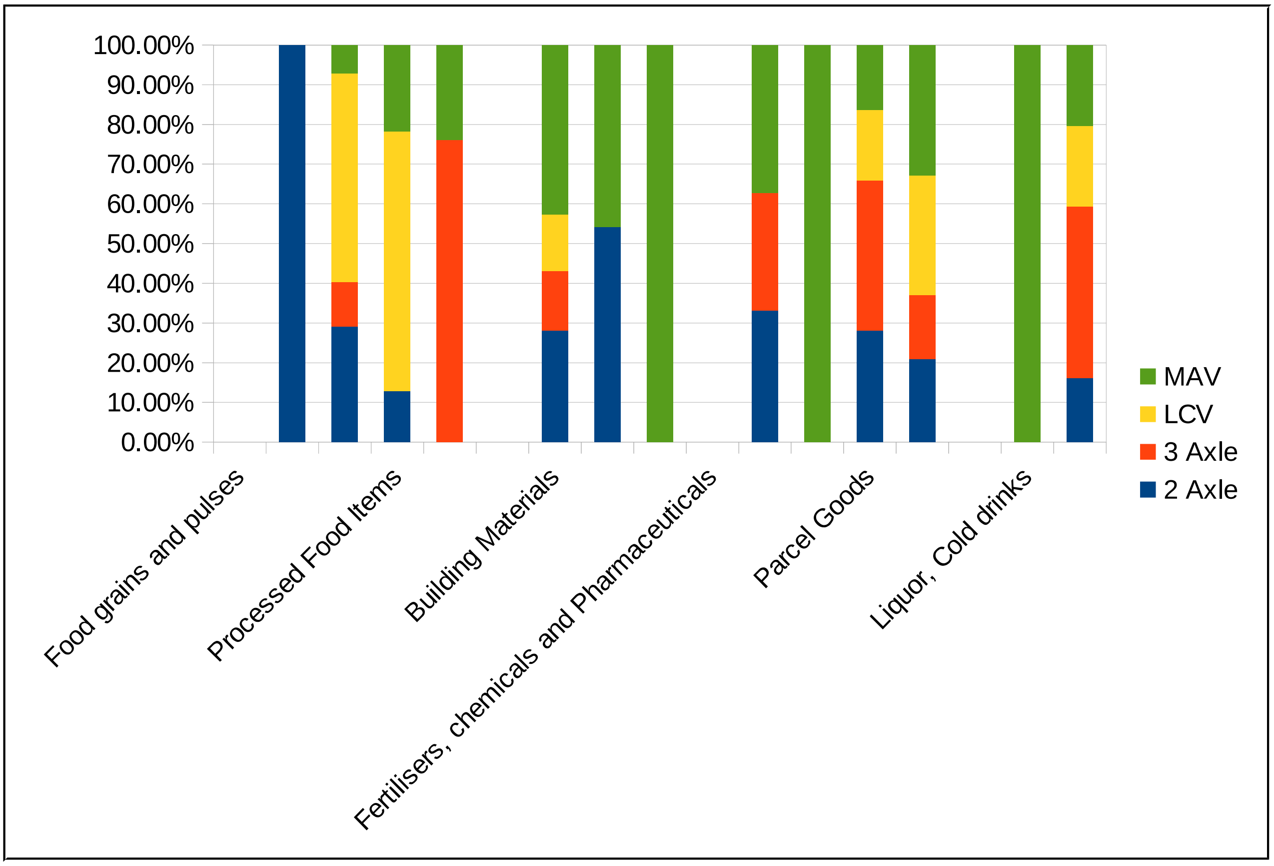


Figure-9.56: Composition of Commodity of Goods Vehicles at Location 1

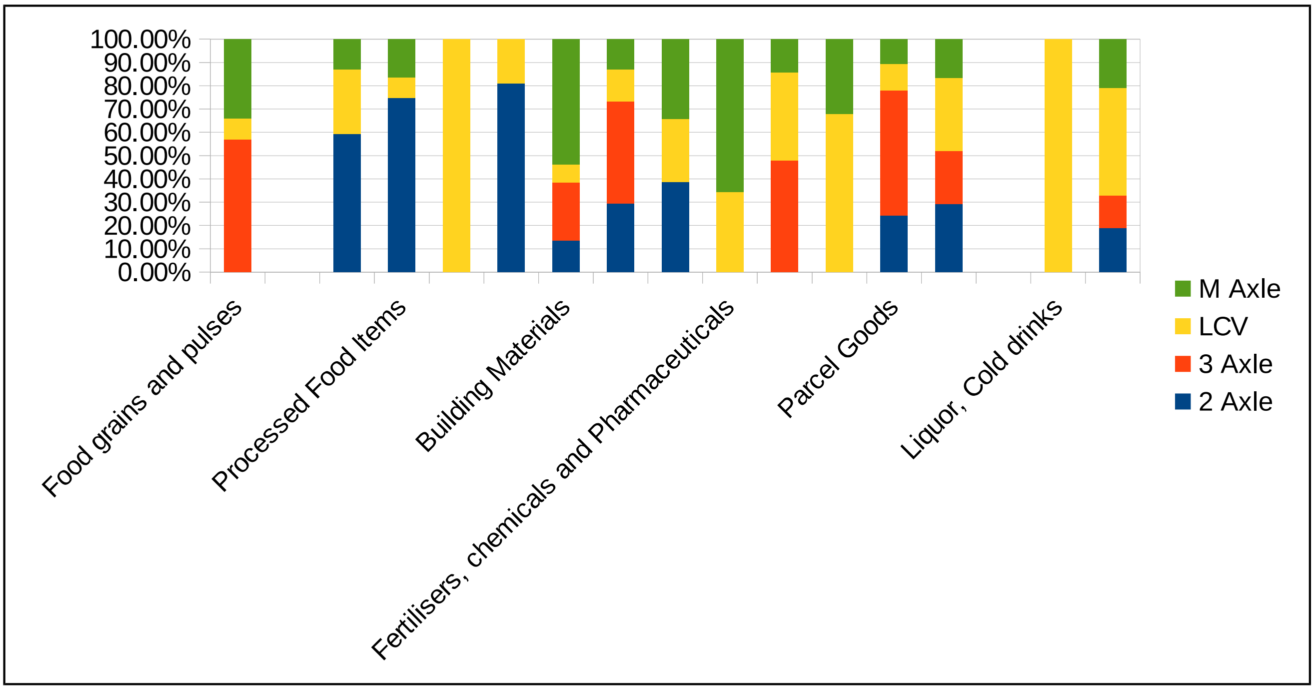


Figure-9.57: Composition of Commodity of Goods Vehicles at Location 2

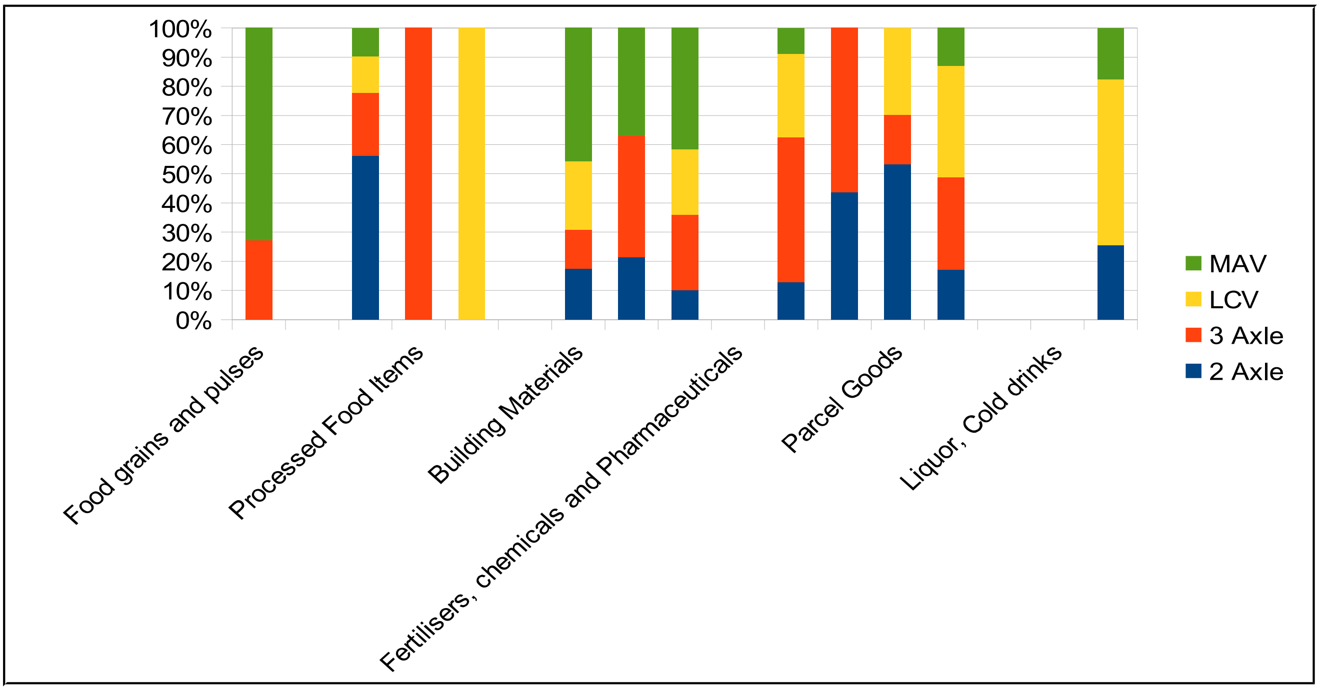


Figure-9.58: Composition of Commodity of Goods Vehicles at Location 3

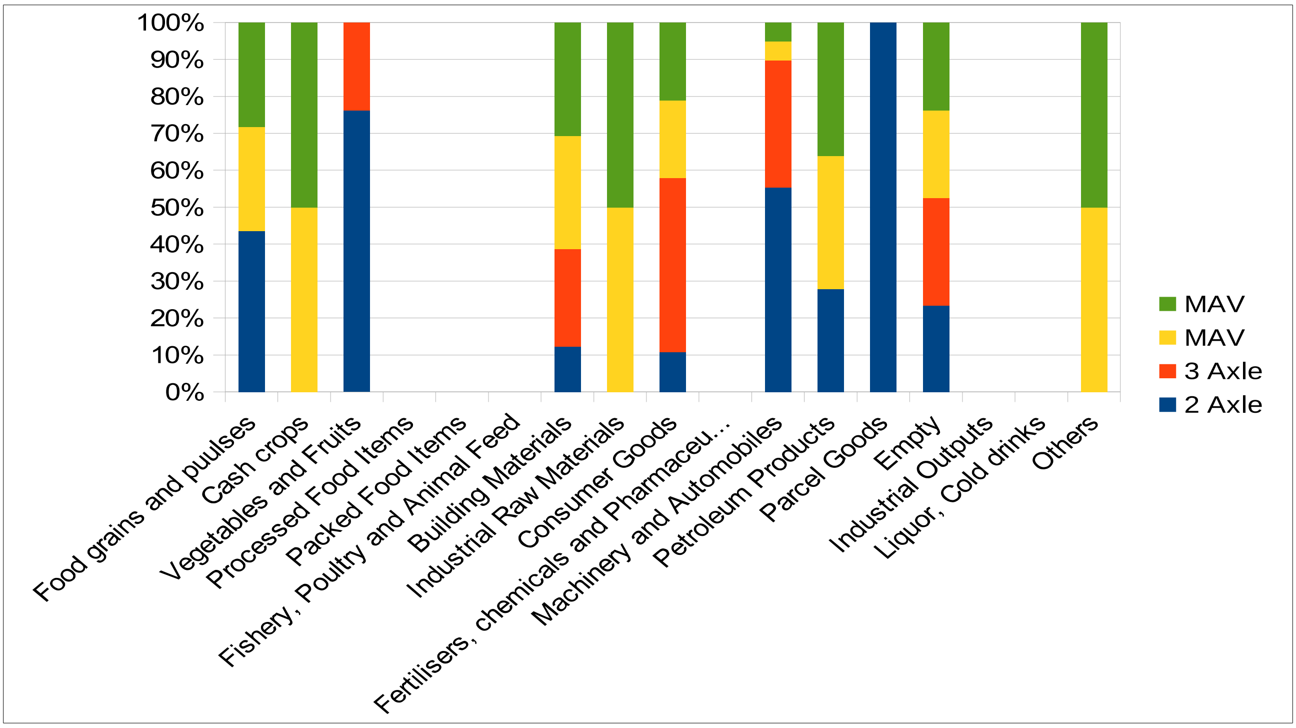


Figure-9.59: Composition of Commodity of Goods Vehicles at Location 4

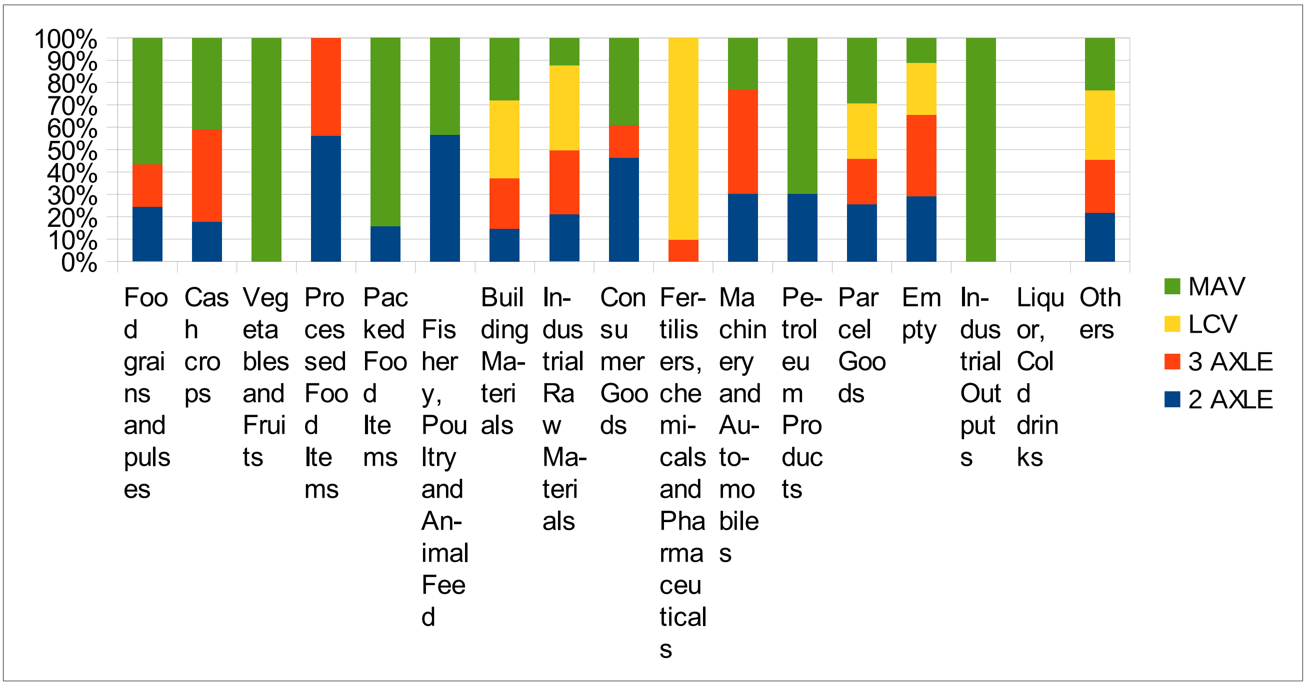


Figure-9.60: Composition of Commodity of Goods Vehicles at Location 5

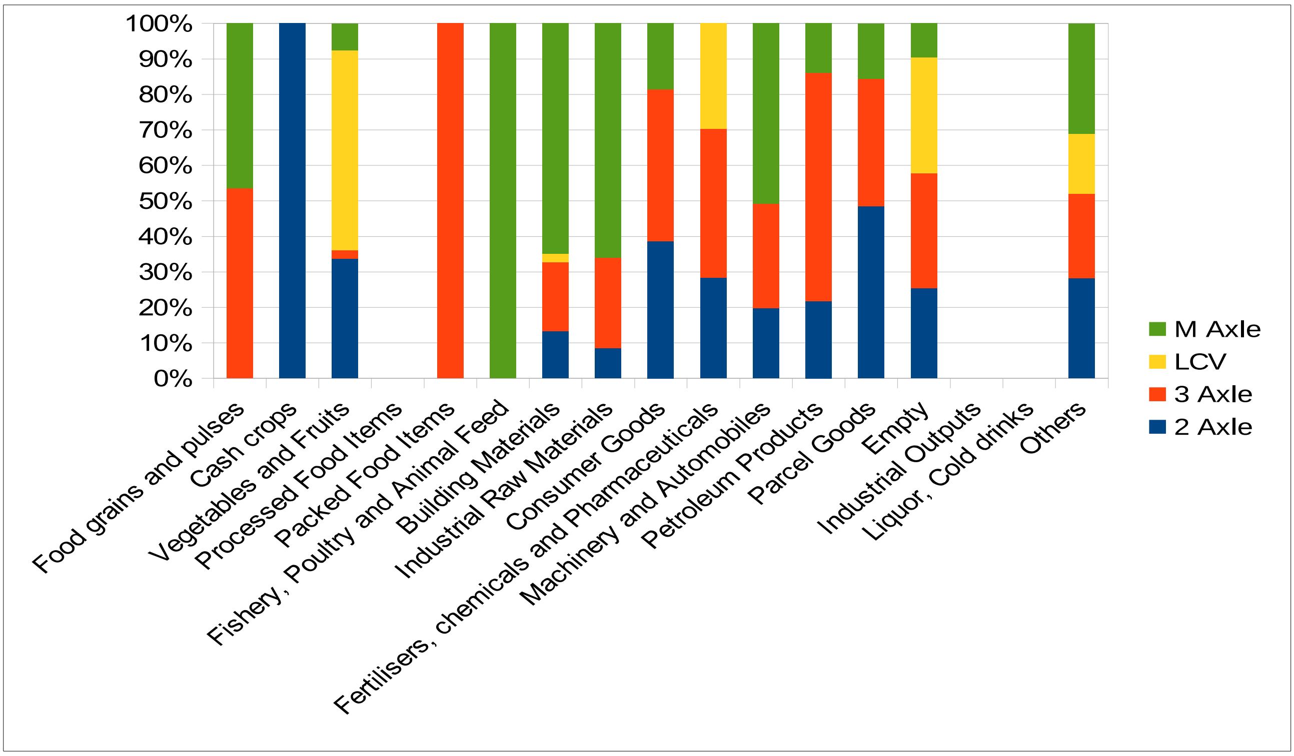


Figure-9.61: Composition of Commodity of Goods Vehicles at Location 6

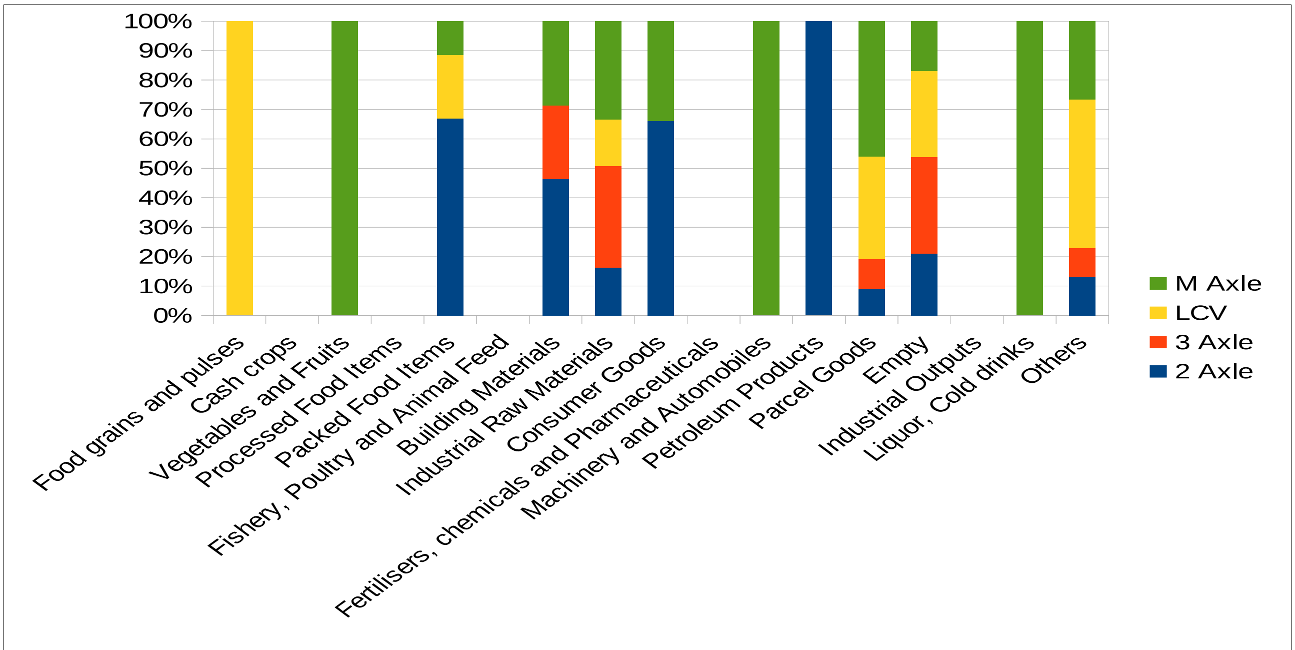


Figure-9.62: Composition of Commodity of Goods Vehicles at Location 7

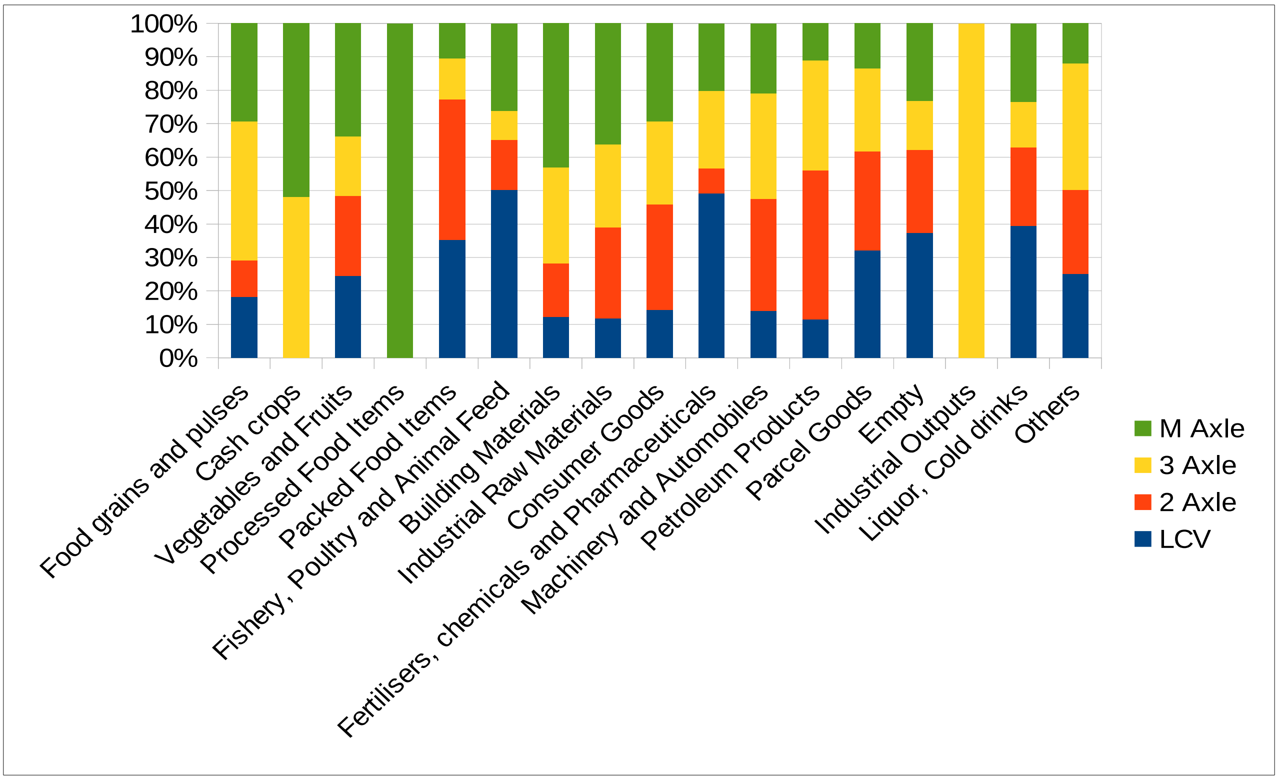


Figure-9.63: Composition of Commodity of Goods Vehicles at Location 8

9.14 Zones Of Influence

The data collected from the O-D survey has been analysed to assess the project influencing zones for different categories of goods vehicles. It is observed from RSI data that districts of Ananthapuramu, Kurnool, Kadapa, Chittoor, Nellore, Prakasam, Ongole, Krishna and Guntur in the state of Andhra Pradesh as well as fewer places from the states of Karnataka/ Tamilnadu are the major influencing zones in terms of trip generation and attraction. The level of attraction at all survey locations is given from ***Table-9.30*.**

9.14.1 Development of Origin-Destination Matrices

The origin-destination details were collected from the trip makers during the O-D survey on sample basis as stopping and interviewing all the vehicles was not possible. The sample size varied for different survey locations depending upon the quantum of traffic volume moving on the road. Sampling rate varied with the changes in traffic flow during different parts of the day at the same location as well. Care had been taken to eliminate any element of bias in the sampling method.

Since the data was collected on the sample basis expansion factors are required to replicate the pattern as reflected in the sample to the total number of vehicular trips made during the day. These expansion factors are calculated separately for each class of vehicle. For Example if "x_c " is the number of cars interviewed and "X_c" is the total number of cars counted during the day, then "X_c/x_c" is the expansion factor for Cars.

OD Matrices are developed to assess the traffic movement pattern. These matrices actually provide distribution of trips for each zone as various inter-zonal movements. Multiplying the sample O-D matrix obtained from the survey data with the expansion factor develops the vehicle wise O-D matrices for both the survey locations.

Table-9.30: Major Influential Zones for Survey Locations 1,2,3,4,5,6,7 and 8

Vehicle Type	Location 1		Location 2		Location 3		Location 4		Location 5		Location 6		Location 7		Location 8	
	Zone of Influence	% attraction	Zone of Influence	% attraction	Zone of Influence	% attraction	Zone of Influence	% attraction	Zone of Influence	% attraction	Zone of Influence	% attraction	Zone of Influence	% attraction	Zone of Influence	% attraction
Car	30	44.28%	2	38.82%	12	38.62%	11	29.37%	28	42.32%	15	31.87%	19	28.97%	19	21.46%
	30	43.49%	2	36.93%	12	38.18%	11	21.35%	28	39.38%	15	32.39%	19	30.68%	19	24.37%
Bus	30	36.00%	1	45.00%	12	52.89%	10	50.00%	28	67.48%	15	61.14%	19	59.32%	19	55.11%
	30	53.71%	2	61.15%	12	38.16%	11	55.56%	25	46.34%	15	50.26%	19	28.81%	24	30.30%
Mini Bus	5	36.36%	1	54.24%	7	66.67%	10	33.33%	28	100.00%	15	41.94%	3	50.00%	19	29.03%
	30	63.64%	2	83.05%	12	83.33%	11	66.67%	27	60.00%	24	54.84%	19	50.00%	27	54.84%
Tata Magic	-	-	1	51.52%	12	30.00%	11	60.00%	28	66.67%	3	37.58%	19	82.14%	24	54.39%
	-	-	2	81.82%	12	50.00%	10	60.00%	25	50.00%	15	48.41%	16	53.57%	19	96.49%
LCV	30	25.55%	2	40.74%	12	25.45%	10	33.33%	28	29.06%	15	38.00%	19	31.46%	19	19.12%
	30	39.65%	2	31.28%	12	30.00%	11	24.56%	25	24.79%	15	30.40%	19	46.07%	37	20.69%
2 Axle	30	38.96%	2	34.00%	12	18.00%	10	22.30%	28	27.25%	15	23.31%	19	35.94%	37	24.15%
	30	34.17%	2	36.00%	12	28.50%	11	19.42%	25	21.80%	21	15.79%	19	29.17%	21	22.01%
3 Axle	30	31.48%	30	36.36%	12	12.24%	10	33.33%	30	18.56%	15	27.08%	19	40.53%	37	15.33%
	30	36.51%	2	27.27%	12	23.81%	11	26.67%	28	19.04%	19	22.92%	19	39.20%	37	25.84%
M Axle	30	30.58%	30	37.11%	12	16.43%	27	37.45%	30	19.76%	21	12.57%	19	36.42%	37	23.87%
	30	38.35%	30	22.68%	37	14.32%	32	27.33%	25	13.98%	29	21.56%	16	34.57%	21	16.79%

It is observed that bulk of the trips are originating/destined from/to Andhra Pradesh respectively followed by fewer proportions from Telangana, Tamilnadu and Karnataka. Hence influence of Andhra Pradesh alone has been considered while arriving at traffic growth rate for future.

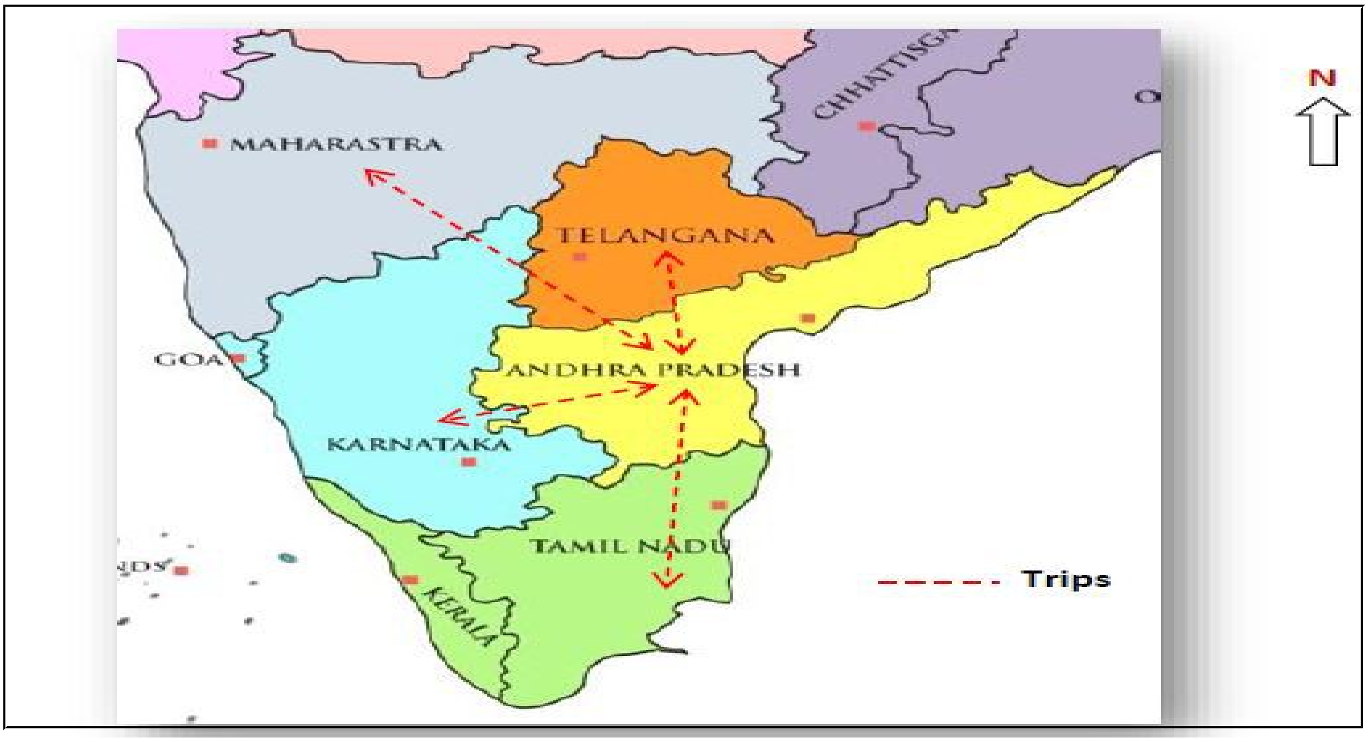


Figure-9.64: Representational Image of Trips Pattern in Project Influence Area

9.15 TRAFFIC FORECAST FOR THE PROPOSED EXPRESSWAY

For forecasting the traffic in future, it is essential to estimate different components of traffic *viz*., normal traffic, induced traffic, diverted traffic and developmental traffic.

Normal Traffic: Normal traffic is that traffic which would pass along the proposed expressway. The growth of traffic is normally estimated based on past and envisaged future growth trend of traffic around the project influence area. However, as the proposed expressway is a green field project, this component of traffic on project stretch is considered as nil and can be ignored.

Diverted Traffic: Generated traffic is defined as auxiliary traffic that occurs in response to the road investment. The proposed expressway will attract trips from other routes and modes. Diverted traffic is the proportion of traffic on existing road network, around the project influence area, which tends to make a shift in route as well as mode to the proposed expressway. As the project stretch provides more attractive options to commuters along the existing roads in the form of reduced travel distance, reduced travel time, savings in vehicle operating costs, savings in toll and value of time, significant segment of traffic opts to ply on proposed expressway. This component of attracted traffic is considered as Diverted traffic.

Developmental Traffic: Provision of an expressway provides immense opportunities for development of influential areas. Development is augmented by investment in various sectors like industrial, commercial, real estate, tourism etc. This in turn generates notable quantity of traffic volume which is often termed as Developmental traffic. Such component contributes significantly to the future traffic volumes along the project corridor.

Induced Traffic: In addition to the diverted traffic there is a possibility of additional traffic/trips / generated trips on to the proposed Expressway due to easy access to the existing / proposed roads and development of Industrial activities.

"*The projected traffic on project stretch is arrived by summing up the different components of traffic as discussed above giving due diligence to future investments and respective developments for different time horizons*"

9.15.1 TRAFFIC ASSIGNMENT METHODOLOGY

The proposed expressway is assumed to come into operation in the year 2025. It is expected that due to construction of access-controlled expressway, traffic on existing roads will completely utilize the facility. Hence the traffic that is most likely to use the project stretch is completely diverted on to the expressway. Methodology adopted for assigning the traffic on expressway is explained as under:

Step 1: The entire project stretch has been divided into 9 homogenous traffic sections based on entry and exit points in the form of interchanges proposed. The entry/ exit points along the project stretch have been chosen at such locations where possible diversion of existing traffic is expected on to the proposed expressway from National/ State Highways/MDRs. Section-wise (*leg-wise)* breakup of project stretch is shown in ***Figure-9.65***.

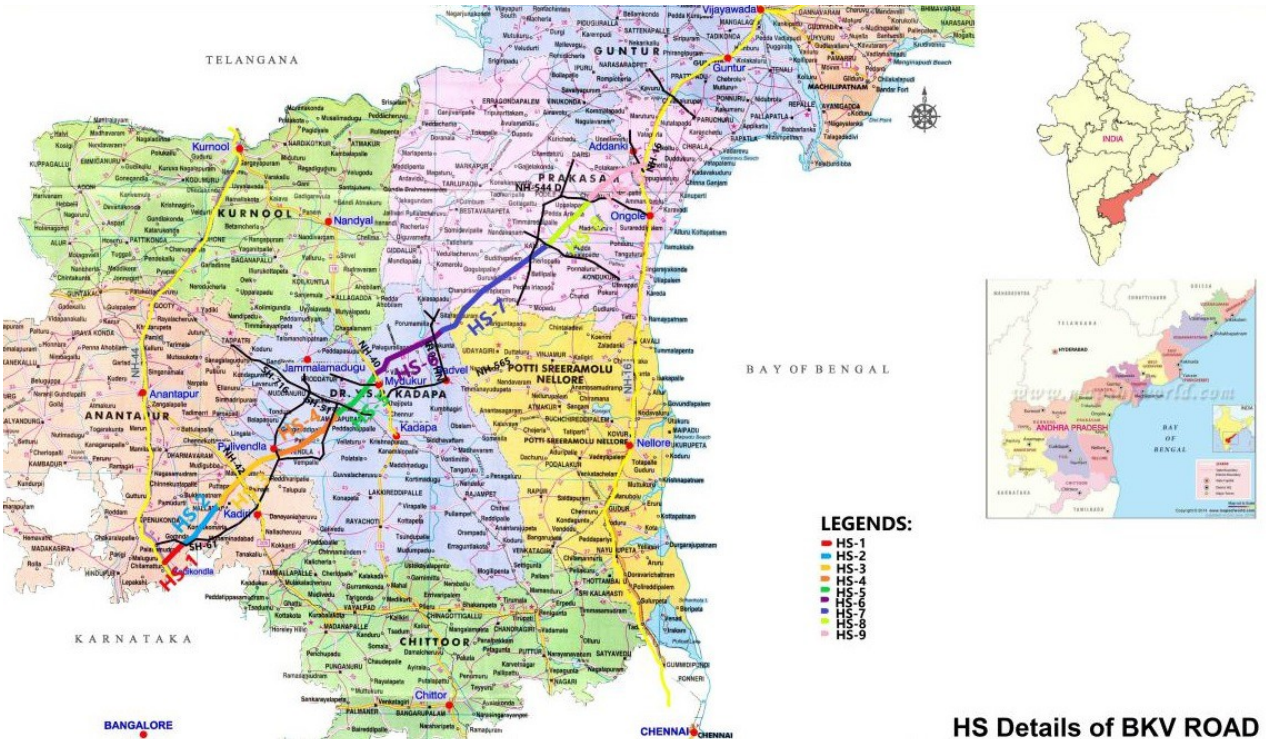


Figure-9.65: Section-wise breakup of Project stretch

Description of individual sections (*legs*) is given as under:

- **Leg 1:** Stretch from Kodikondla Check Post to Gorantla (Anantapur Dist.) – Length of 14.10km.
- **Leg 2:** Stretch from Gorantla to Kadri / Anantapur road (Anantapur Dist.) – Length of 42.50km.
- **Leg 3:** Stretch from Kadri / Anantapur road to Pulivendula (Anantapur & Kadapa Dist.) – Length of 24.90km
- **Leg 4:** Stretch from Pulivendula to Yerraguntla / Kadapa road (Kadapa Dist.) – Length of 44.30km
- **Leg 5:** Stretch from Yerraguntla / Kadapa road to Mydukuru / Produturu road (Kadapa Dist.) – Length of 23 km.
- **Leg 6:** Stretch from Mydukuru / Produturu road to Porumamilla (Kadapa Dist.) – Length of 38.6 km.
- **Leg 7:** Stretch from Porumamilla to Kanigir / Pamuru road (Kadapa, Nellore & Prakasam Dist.) – Length of 67.5km
- **Leg 8:** Stretch from Kanigir / Pamuru road to Podili / Cheemakurthi road (Prakasam Dist.) – Length of 40.35km
- **Leg 9:** Stretch from Podili / Cheemakurthi road to Addanki/Medarametla (Prakasam Dist.) – Length of 39.25km

Note: Details of sections/legs of Project corridor is tentative, it may vary (increase or decrease) unless otherwise specified.

Step 2: Influential zones were identified for individual sections (*legs)* from where traffic is expected to get diverted. Such section-wise zones have been marked up and grouped together. This aids in arriving at traffic figures expected to ply on individual sections of project stretch.

Step 3: It is assumed that the existing traffic prefers to travel at shorter (*reduced*) distances in shorter times. Hence traffic travelling on existing routes from influential zones is completely assigned to corresponding sections of expressway without any precipitates.

Step 4: Upon arriving the traffic on individual sections, total traffic on project stretch is calculated by cumulative summation of applicable section-wise traffic figures. Care has been taken to segregate sections and assign traffic depending upon their origin and destination characteristics.

In a nut shell, in order to estimate the travel demand on the project road the shortest path method is considered to analyze the traffic data. Traffic surveys are conducted at 11 locations along the project corridor. The traffic on a specific leg is arrived by considering the influence of O-D survey at only eight locations. For example, if the traffic is generated at Kodikondla checkpost (Location 1) and destined to Pamuru (Location 10), then the traffic is assigned on the Leg-1, Leg-2, Leg-3, Leg-4, Leg-5, Leg-6 and Leg-7. Same method is adopted for all legs by considering the shortest distance between the O-D pairs, so that cumulative traffic on each leg from all O-D locations is obtained. After arriving the cumulative traffic on each leg, the traffic is considered for section-wise (leg-wise) projections. Total diverted traffic on proposed expressway for the year 2021 is shown from ***Table-9.32.***

Traffic survey was conducted at 11 locations but on keen and detailed observation, traffic from only 09 locations were found more likely to access the expressway. The following table gives us information regarding the traffic survey locations from where the assignment is carried out.

Table-9.31: Survey locations used for Traffic assignment

S. No	Location	Stretch	Highway
1	Kodikondla Checkpost	Bengalore - Ananthapur	NH-44
2	Near Kadiri	Kadiri - Gorantal	SH- 61
3	Near Sambepalli	Kadapa - Rayachoti	NH-40
4	Near Basapuram Toll Plaza	Badvel – Mydukur	NH - 67
5	Near Kothuru	Naidupeta – Srikalahasti)	NH-71
6	Near Pandillapalli Toll Plaza	Porumamilla - Cumbum	NH-544D
7	Near Pamuru	Pamuru – Udayagiri	NH 565
8	Budavada (Near Marri Chetla Palem	Podili – Chimakurthy	
9	Tanguturu Toll Plaza	Nellore - Vijayawada	NH -16

Table-9.32: Potential Diverted Traffic, on Proposed Expressway in the year 2021

S No.	Leg No.	MODE WISE TRAFFIC								Total	Total PCU
		Car	Bus	Mini Bus	Tata Magic	LCV	2Axle	3 Axle	Multi Axle		
1	Leg - 1	2,699	406	40	42	522	475	489	1,148	**5,821**	**12,860**
2	Leg - 2	2,408	317	40	34	454	458	485	1,143	**5,339**	**12,107**
3	Leg - 3	2,270	283	31	33	445	484	502	1,164	**5,212**	**12,062**
4	Leg - 4	2,267	284	31	34	448	497	502	1,170	**5,233**	**12,134**
5	Leg - 5	2,392	293	29	48	459	584	569	1,216	**5,590**	**12,982**
6	Leg -6	2,487	286	34	46	460	598	574	1,190	**5,675**	**13,003**
7	Leg - 7	2,558	344	33	43	459	612	623	1,200	**5,872**	**13,476**
8	Leg - 8	2,632	454	32	38	460	622	660	1,213	**6,112**	**14,076**
9	Leg - 9	2,207	258	27	31	411	508	523	1,129	**5,094**	**11,843**

1.15.2 INDUCED TRAFFIC

In addition to the diverted traffic on the proposed Expressway, a significant additional trips / generated trips on proposed Expressway due to easy access to the existing / proposed roads and development of Industrial activities.

The following are the major road networks have been considered for estimating the induced traffic.

- New greenfield highway (Economic Corridor) : Surat - Ahmednagar - Soalpur - Akkalkote and Akkalkote - Kurnool. - 5% induced traffic considerd for horizon year (2025)

- New four / Six lane corridor : Connectivity B/W Telangana & AP through hinterland i.e., Kalwakurthy - Nagarkurnool - Nandyala section of 167 K - 5% Induced traffic for horizon year (2025)
- Industrial Traffic: Proposed corridor attracts the trips from Existing Industrial zone - 5% Induced traffic for horizon year (2025)

Based on the above, overall 15% of induced traffic has been considered for Horizon year 2025.

9.15.3 DEVELOPMENTAL TRAFFIC

The land along the proposed alignment of the Expressway has good scope for industrial and commercial development. With the onset of expressway, the development activity in the proximity will boost up. While the development has been initiated in the form of SEZs and industrial parks, to take the advantage of opportunities that comes with the expressway, huge growth is expected in future in the form of industrial, commercial and residential developments. The following data has been collected in view of the same.

(a) National Investment and Manufacturing Zones (NIMZ)

The Government of India (GoI) has announced a National Manufacturing Policy, 2011, with the objective of enhancing the share of manufacturing in GDP to 25% within a decade and creating 100 million jobs. As per the Policy, "NIMZs will be developed as integrated industrial townships with state-of-the art infrastructure and land use on the basis of zoning; clean and energy efficient technology; necessary social infrastructure; skill development facilities, etc."

Govt. of India has accorded in-principle approval for setting up two NIMZs:

a. Chittoor

b. Prakasam

These NIMZs would be developed as world class industrial regions with each spread over a minimum of 5,000 hectares. These regions will act as growth nodes for industrial development and employment generation in the State. The estimated investment flow into each of the two National Investment and Manufacturing Zones (NIMZ) coming up in Chittoor and Prakasam districts is expected to be around Rs.30,000 crore and the employment potential about three lakh.

The Government of India has (GoI) has accorded in-principle approval for setting up two NIMZ in the two districts in an extent of 5,000 to 6,000 hectares out of which NIMZ in Prakasham District, has planned with an extent of 14230.90 Acr, with an estimated project cost of 10859Cr. and which will contribute around 2.5lakh employment opportunities (Projected) according to Socio-Economic Survey 2020-21.

NIMZ will be developed as integrated industrial townships with the state-of-the-art infrastructure and land use on the basis of zoning, clean and energy efficient technology, necessary social infrastructure and skill development facilities. The land acquisition in Chittoor district is under process.

NIMZ will be created as combined industrial townships along with the modern facilities and also land use on the foundation of zoning, well-maintained and also electricity effective innovation, important social infrastructure as well as capability progression facilities.

For Industrial Framework System, top priority was provided to create clusters having little market concentration. The plan carried out on a public-private partnership project received.

Details	Chittoor NIMZ	Prakasam NIMZ
Location/ Materials	Falls within Valmikipuram (Vayalapad), Kalikiri and Gurramkonda mandals, Chittoor District (Close to Chennai – Bangalore Industrial Corridor – CBIC)	Falls within Pamuru and Pedacherla Palli Mandals, Prakasham District (Falls in Vizag Chennai industrial corridor – VCIC)
Extent Proposed	12818.51 acres (51.875 sq.km/ 5187.467 ha)	14231 acres (57.59 sq.km/ 5759 ha)
Estimated Project Cost (External and Internal Infrastructure)	Rs. 11693 Cr.	Rs. 10859 Cr.
Economic Benefits (Expected)	Investments: Rs. 40000 Cr. Employment: 1.92 Lakh (Direct & Indirect) Exports: Rs 20300 Cr.	Investments: Rs 437000 Cr. Employment: 205 Lakhs (Direct & Indirect) Exports: Rs 24000 Cr.

Source: *www.apiic.in*

(b) Information Technology Investment Regions (ITIR)/Electronic Manufacturing Clusters (EMC)

Electronic Manufacturing Cluster (EMC) Scheme supports creation of world-class infrastructure for attracting investments in the Electronics Systems Design and Manufacturing (ESDM) Sector. It was notified on 22nd October 2012 and the guidelines for operationlization of EMC Scheme were issued on 15th April 2013. EMCs scheme supports grant assistance for setting up of both Greenfield and Brownfield EMCs.

To promote investment in the Information Technology (IT) / Information Technology Enabled Services (ITES) / Electronic Hardware Manufacturing (EHM) units, the Government of India had notified policy on Information Technology Investment Regions (ITIRs) in May 2008. ITIRs will be self contained integrated township to accelerate growth of IT/ITeS/EHM industry. As per the policy, minimum area of 40 sq km should be delineated for ITIR. Out of the total delineated area, 40% should be earmarked for processing zone and remaining area for non-processing zone. Processing zone would comprise of Information Technology/ Information Technology Enabled Services and Electronic Hardware Manufacturing Units, along with associated logistics and other services and required infrastructure.

The State Government would play the lead role in setting up of the ITIR. ITIRs have been proposed in two districts of Andhra Pradesh:

a. Visakhapatnam
b. Chittoor

ITIR would be a combination of IT/ITES and Electronics Hardware Manufacturing Units; Public utilities, residential area, social infrastructure and administrative services. Such regions could include new integrated townships, SEZs, industrial parks etc. The Information Technology Investment Region (ITIR) project, planned by the Government of Andhra Pradesh, may generate employment to approximately, up to 15 lakh IT professionals and also the it can generate revenue for the economy, of up to INR 3.11 crore (US$460,000).

(c) Special Economic Zones (SEZ)

SEZs aim to provide simplified clearances and controls, world class infrastructure and a stable fiscal regime to attract foreign investments in the state. Currently there are 32 functional SEZs (Notified) and 10 SEZs (formal) in AP and additional 5 SEZs with in-principle approval.

APIIC Notified SEZs:

S. No.	Developer	Type of SEZ	Location	District	Total Extent (Acres)
1	APIIC Ltd.	IT / ITES	Hill-3, Madhurawada	Visakhapatnam	88.92
2	APIIC Ltd.	Multi Product	Atchutapuram	Visakhapatnam	3,213.03
3	APIIC Ltd.	IT / ITES	Hill-2,Madhurawada	Visakhapatnam	39.52
4	APIIC Ltd.	IT / ITES	Sarpavram(V),Kakinada (M)	East Godavari	25.71
5	APIIC Ltd.	IT / ITES	Kurukalva(V), Renigunta (M)	Chitoor	80.45
6	APIIC Ltd.	IT / ITES	Putlampalli (V)	Kadapa	52.76
7	APIIC Ltd.	Multi Product	Dwarakapuram, Pallepalem, Menkuru, Konetrajupalem & Palluchuru (V), Naidupet (M)	Nellore	2,550.05
8	APIIC Ltd.	IT / ITES	Gambheeram (V)	Visakhapatnam	51.25
9	APIIC Ltd.	Biotech	Pulivendula	Kadapa	77.02
10	APIIC Ltd.	Building Product	Annangi (V), Maddipadu (M)	Prakasham	262.96
	APIIC Notified Total				6,441.7

Source: www.apiic.in

APIIC Joint Ventures:

S. No.	Developer	Type of SEZ	Location	District	Total Extent (Acres)
1	L&T Hitech City	IT/ITES	Keesarapalli (V), Gannavaram (M)	Krishna	30
2	Bharatiya International Developer	Leather Product	Tada (M)	Nellore	250.38
3	Ramky Pharma city	Pharmaceuticals	Lemarthi (V)	Visakhapatnam	611.05
	APIIC Joint Ventures Notified Total				891.43

Source: www.apiic.in

Assisted by APIIC (Notified):

S. No.	Developer	Type of SEZ	Location	District	Total Extent (Acres)
1	APACHE SEZ Development India Pvt. Ltd.	Footware	Tada (M)	Nellore	257.08
2	Brandix India Apparel City Private Ltd.	Textile	Atchutapuram (M)	Visakhapatnam	1,000
3	Satyam computers Ltd	IT/ITES	Thotla kond (M)	Visakhapatnam	49.4
4	Neogen Properties Pvt. Ltd	Apparel Park	Thumkunta & Gollapuram (V), Hindupur	Anantapur	350
5	SRI CITY (Satyavedu Reserve Infracity Pvt. Ltd.)	Multi Product	Chitoor	Chitoor	3,799.16
6	MAS Fabric Park (India) Pvt. Ltd.	Textile and Apparel	Chintavaaram (V), Chilakur (M)	Nellore	583.09

S. No.	Developer	Type of SEZ	Location	District	Total Extent (Acres)
7	Anrac Aluminum Ltd.	Alumina	Makavarapalem	Visakhapatnam	1,866.48
Assisted by APIIC Notified Total					**7,905.21**

Source: www.apiic.in

Assisted by APIIC (Formal Approval):

S. No.	Developer	Type of SEZ	Location	District	Total Extent (Acres)
1	Real Griha Nirman Pvt. Ltd.	Biotech	Hindupur	Anantapur	70
2	Krishnapatnam Infratech Pvt. Ltd.	Multi Product	Chillakur, Kota(M)	Nellore	2,526.81
3	M/s Lepakshi Knowledge Hub Pvt Ltd	Biotechnology	Chillamaturu & Gorantla (M)	Anantapur	29.34
4	M/s Lepakshi Knowledge Hub Pvt Ltd	Aerospace & Precision Engineering	Chillamaturu (M)	Anantapur	285.06
5	M/s Lepakshi Knowledge Hub Pvt Ltd	Free Trade Warehousing Zone	Chillamaturu (M)	Anantapur	98.8
Assisted by APIIC Formal Approval Total					**3,010.01**

Source: www.apiic.in

Assisted by APIIC (Principle Approval):

S. No.	Developer	Type of SEZ	Location	District	Total Extent (Acres)
1	M/s Lepakshi Knowledge Hub Pvt Ltd	Multi Product	Ananthapur	Anantapur	2549
2	Planet SEZ Pvt.Ltd	Petroleum, oil & Gas Industry	Rajayyapeta (V)	Visakhapatnam	266.76

Source: www.apiic.in

Private Developers (Notified):

S. No.	Developer	Type of SEZ	Location	District	Total Extent (Acres)
1	Divi's Laboratories Limited	Pharmaceuticals	Chippada (V)	Visakhapatnam	327.62
2	White Field Paper Mills Ltd.	Writings & printing paper	Tallapudi (M)	West Godavari	271.23
3	Hetero Infrastructure	Pharmaceuticals	Nakkapalli (M)	Visakhapatnam	247.69
4	Kakinada Sea Portal Ltd	Multi Product	Ramanakkapeta & A V Nagaram (V)	East Godavari	2,558.08
5	Parry Infrastructure Company	Food Processing	Kakinada	East Godavari	250
6	Rassai Properties & Industries Pvt. Ltd.	Multi Service	Parigi (V), Hindupur (M)	Anantapur	905.03
7	Raaghmayuri Builders Pvt. Ltd.	IT / ITES	Kurnool	Kurnool	30

S. No.	Developer	Type of SEZ	Location	District	Total Extent (Acres)
8	Dr. Reddy's Laboratories Ltd.	Pharmaceuticals	Devunipalavalas (V). Ranasthalam (M)	Srikakulam	247.91
9	Indian Farmers Fertilizers Co-operation Ltd. (IFFCO)	Multi Product	Naidupet	Nellore	2,526.81
10	Indus Gene Expressions Ltd	Biotech	Kodur & Settipalli (V), Chilamathur (M)	Anantapur	26.01
11	Kakinada SEZ Pvt Ltd	Multi Product	Ponnada, Mulapeta, Ramanakkapeta (V), Kakinada Rural (M)	East Godavari	2,503.69
Private Developers Notified Total					**9,894.07**

Source: www.apiic.in

Private Developers (Formal Approval):

S. No.	Developer	Type of SEZ	Location	District	Total Extent (Acres)
1	Bavana Sai Associates	IT/ITES	Uppaluru, Manthana, Kesarapalli(V), Vijaywada	Krishna	61.75
2	Whitecity Projects International Ltd.	IT/ITES	Mangalagiri (M) & Sy No. 23-29, 55-71, Tadikonda(M)	Guntur	113.13
3	JSW Aluminium Limited	Alumina	S. Kota, Dist, Vizianagaram	Vizianagaram	592.80
Private Developers In-principal Approvals Total					**767.68**

Source: www.apiic.in

Private Developers (IN-Principal Approval):

S. No.	Developer	Type of SEZ	Location	District	Total Extent (Acres)
1	South Coast Infrastructure Development Co of A P Pvt. Ltd. (SCIDCAP)	Building Material	NH 5 between Prakasham and Nellore Districts	Prakasham	291.46
2	M/s Vivimed Labs Ltd	Pharmaceuticals	Boyapalem, Chittivalasa (V), Ranasthalam (M)	Srikakulam	325.5
3	M/s Drugs & Pharmaceuticals Manufacturers Association	Pharmaceuticals	Nakkapalli (M), Visakhapatnam	Visakhapatnam	296.4
Private Developers In-principal Approvals Total					**913.36**

Source: *www.apiic.in*

UDAs (Notified):

S. No	Developer	Type of SEZ	Location	District	Total Extent (Acres)
1	VGTM Urban Development Corporation	IT / ITES	Nowluru (V), Mangalagiri (M)	Guntur	40.61
UDAs Notified Total					40.61

Source: *www.apiic.in*

UDAs (Formal Approval):

S.No.	Developer	Type of SEZ	Location	District	Total Extent (Acres)
1	Deccan Infrastructure and Land Holdings Ltd. (DIL)	IT / ITES	Kommadi (V), Madhurawada (M)	Visakhapatnam	42.61
2	Deccan Infrastructure and Land Holdings Ltd. (DIL)	IT / ITES	Pardesipalem (V), Madhaurawada (M)	Visakhapatnam	39.00
UDAs Formal Approval Total					81.61

Source: *www.apiic.in*

(d) Industrial Parks

Andhra Pradesh Industrial Infrastructure Corporation (APIIC) has developed 475 industrial parks spread over an extent of about 1,21,655 acres. GoAP plans to develop new industrial parks and upgrade/maintain the existing ones. The Industrial Areas ranges from 15 acres to 2500 acres. The Industrial Areas are equipped with approved layouts, internal roads, water supply and power supply. The Corporation has presence in each and every Mandal Head Quarters of the District. The Corporation has also encouraged setting up Common Effluent Treatment Plants and also Treatment Storage Disposal Facility (TSDF) in Industrial Parks.

Under MSE-Cluster Development Programme of Govt. of India, the following new Industrial Parks have been taken up apart from up-gradation of existing Industrial Parks. The Ongoing Projects under MSE-CDP Scheme are given below:

S.No	Name of the Industrial Park	Greenfield /Brown field project	Project cost (in Lakhs)
1	Autonager, Gajuwaka, Visakhapatnam	Brownfield: Upgradation of existing Autonagar	490.64
2	IP Peddapuram, East Godavar	Greenfield: New Industrial Park	690.91

S.No	Name of the Industrial Park	Greenfield /Brown field project	Project cost (in Lakhs)
3	IP Grandrajupalli, Chittoor	Greenfield: New Industrial Park (Textile & Readymade Garments)	833.71
4	IE Singarayakonda, Prakasam	Brownfield: Upgradation of Existing Industrial Estate	1,055.84
5	Autonagar, Nellore	Brownfield: Upgradation of Existing Autonagar	2,202.57
6	IP Kopparthy, Kadapa	Greenfield: New Industrial Park	2,202.47

(e) PPP for Regional Integrated Development Enterprises (PRIDES)

PPP for Regional Integrated Development Enterprises (PRIDE) scheme promoted by the Department of Economic Affairs (DEA), Government of India aims to provide an infrastructure enabled backbone in a secure and connected area for attracting businesses, manufacturing, as well as for people to live and work. The goal is development of modern, cost competitive and world class business centres of excellence which can become hubs for a well spread economic growth across the country.

In pursuit of taking forward the GoI initiative, Government of Andhra Pradesh (GoAP) proposed to develop PRIDEs at SPS Nellore, Kurnool (within proposed Kurnool Mega Industrial Hub) and Prakasam (within proposed Donakonda Mega Industrial Hub) Districts. APIIC engaged IIDC Limited (An IL&FS Group Company) for preparation of Project Report, Site Master Plan and application documents. The documents for Nellore PRIDE project have already been submitted to DEA, GOI for approval and others are under progress. The Salient features of Nellore PRIDE project are as below.

Details	Nellore PRIDE
Location/ Materials	Falls within Ozili mandal, SPS Nellore District. (Falls in Vizag-Chennai Industrial Corridor (VCIC)
Extent Proposed	3728.22 acres (1508.76 ha)
Estimated Project Cost (External and Internal Infrastructure)	Rs 4762 Cr.
Economic Benefits (Expected)	Investments: Rs 17000 Cr. Employment: 93000 (Direct & Indirect), Exports: Rs 8000 Cr.

(f) Gundlapalli Industrial Growth Centre (GIGC) :

Gundlapalli Industrial Growth Centre (GIGC), which was set up 15 years ago in an extent of 1,470 acres near the NH-16 in the district of Prakasham. Nearly 400 out of 650 industrial plots are occupied by allottees. Currently, the Gundlapalli Industrial Growth Centre has units dealing in granite, chemicals, plastic and plastic recycling units, numbering 300. It has been providing livelihood to 10,000 workers. GIGC is very close to proposed expressway.

(g) Industrial Corridors

Government is undertaking development of Chennai Bengaluru Industrial Corridor (CBIC) with Vizag- Chennai Industrial Corridor (VCIC). As part of CBIC, Krishnapatnam node has been identified for development in Andhra Pradesh. The Shareholder's Agreement(SHA) and State Support Agreement(SSA) have been executed and a Joint Venture Company by the name "NICDIT Krishnapatnam Industrial City Development Limited" has been incorporated. Detailed master planning and preliminary engineering activities for the activation area of Krishnapatnam node have been finalized.

For VCIC, Asian Development Bank(ADB) has prepared the Concept Development Plan(CDP) of the project and four nodes i.e. (i) Visakhapatnam (ii) Machilipatnam (iii) Donakonda and (iv) Chittoor have been identified for development. Out of the four identified nodes, two nodes i.e., Visakhapatnam and Chittoor have been prioritized. Initial Master Planning has been completed by ADB for these prioritized nodes.

Further Hyderabad Bangalore Industrial Corridor is also identified to be developed along with CBIC and VCIC. Details as shown below:

1. Visakhapatnam – Chennai Industrial Corridor:

Node	Sub Node	Total Land (Acres)
Vizag (6848 Acres)	Nakkapalli	4,316
	Atchutapuram (Ramballi)	2,532
Chittoor (13319 Acres)	South Block	13,319
Kopparthy	Kopparthy	2,596

2. **Chennai – Bengaluru Industrial Corridor**

Node	Sub Node	Total Land (Acres)
Krishnapatnam (12944 Acres)	Nellore	11,340
	Chittoor	1,604

3. **Hyderabad – Bengaluru Industrial Corridor**

- Orvakal Node – 9350 Acres (NICDC)

*Source: Socio- Economic Survey 2021

(h) Cement Manufacturing industries

It has been observed that lot many Cement Manufacturing industries in the state of Andhra Pradesh, and few of them are directly/indirectly influence the traffic on the project corridor. The details of existing cement manufacturing are given below:

S. No	Name	Location
1	ACC Limited, Vizag Cement Work	Vizag
2	Bhavya Cements Private Limited	Dachepalli, Guntur
3	Dalmia Cement (Bharat) Ltd	Kadapa
4	Hemandari Cement Ltd	Jaggayyapet, Krishna Dt
5	The India Cements Ltd- Chilamkur Works	Chilamkur
6	The India Cements Ltd- Yerraguntla	Yerraguntla
7	Jaiprakash Associates Ltd - Jaypee Cement- Durga Cement Works	Dachepalli, Guntur
8	Jaiprakash Associates Ltd - Jaypee Cement- Visaka Cement Works	Vizag
9	JSW Cement Ltd	Nandyal
10	The K.C.P. Ltd	Muktyala
11	The K.C.P. Ltd	Macherla
12	My Home Industries Ltd	Vizag

S. No	Name	Location
13	Panyam Cement & Mineral Industries Ltd.	Kurnool
14	Parasakti Cement Ltd	Jettipalem, Guntur
15	Penna Cement Industries Ltd	Boyareddypalli
16	Penna Cement Industries Ltd	Tadipatri
17	Penna Cement Industries Ltd	Nellore
18	R.V.R Exports And Imports	Nellore
19	Rain Cements Ltd- UN- II- Line I	Kurnool
20	Sagar Cement Limited	Bayyavaram
21	Sagar Cement Ltd	Gudipadu
22	Sree Jayajothi Cements Pvt. Ltd.	Kurnool
23	Sri Chakra Cements Ltd	Guntur
24	Srikalahasthi pipes limited – Cement Plant	Tirupati
25	The Ramco Cements Ltd	Jayanthipuram, Krishna Dt
26	UltraTech Cement Ltd - Balaji Cement Works	Jaggiyapet, Krishna Dt
27	UltraTech - AP Cement Works	Anantapur
28	Zuari Cement Ltd	Yerraguntla

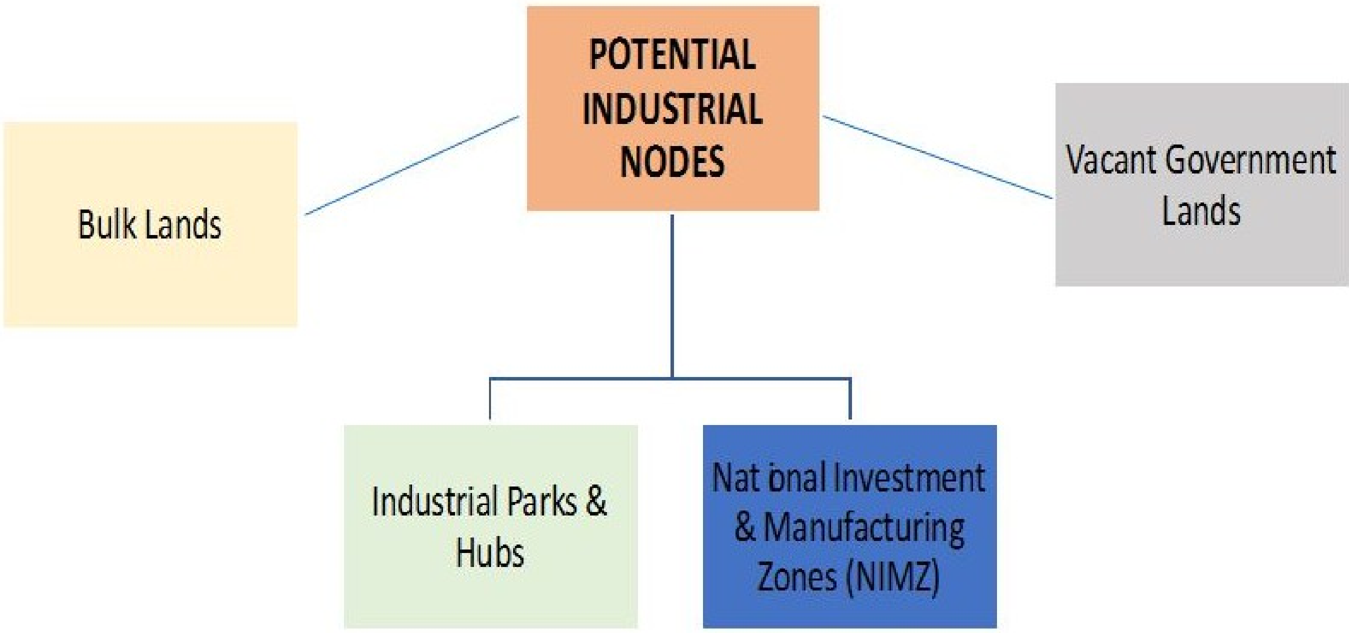
** Source - eaindustry.nic.in*

9.15.4 METHODOLOGY ADOPTED FOR DEVELOPMENTAL TRAFFIC

The Consultant has reviewed secondary data pertaining to existing investments as well as expected development likely to happen along the proposed expressway. The developmental activities are scattered across the region. The generated traffic, as a result, makes its movement between major capital cities, industrial zones and centers of economic development. Hence all the sections (legs) of expressway bear the impact. The proposed expressway will continue to glitter its attraction and thus invites steady industrial as well as commercial investments as a result. While it is strenuous to predict the exact level of investments in the future and corresponding traffic movements, the Consultant, taking into account the past experience of the same, assumes the following for the development of growth centers to arrive at calculation of developmental traffic:

- Data related to district-wise availability of vacant Govt. lands has been collected from the official website of Andhra Pradesh Industrial Infrastructure Corporation (www.apiic.in). Similarly, from the portal of Meebhoomi (www.meebhoomi.ap.gov.in) as well as from corresponding village maps collected, vacant lands have been identified which are in close proximity to the project road and which are considered suitable for industrial set up and development. Only such lands (both Govt. and Pvt.) having a vacant area of above 50 Hectares has been considered for setting up of industries.
- It is assumed that 70% of the gross available land will be utilized as industrial space while the rest 30% of land use will be utilized for other purposes.
- The consultant has reviewed case studies of previous projects viz. Mumbai Integrated Special Economic Zone (MiSEZ), SEED Access connectivity project of AP CRDA and latest ITE trip generation manuals to get an estimate of generated trips from the green field industrial development based on the proposed land use. Accordingly, the consultant has worked out that a hectare of industrial land use would generate 12 truck trips on to the proposed expressway.
- While few industrial developments, as discussed above, may start even before the expressway comes in operational in the year 2025, the major share of developmental traffic is expected to occur stage-wise post expressway construction. A 5-year interval period is considered till 2038 for steady growth of developmental traffic.
- 25% of generated trips are assumed to utilize the expressway by year 2028, 60% of generated trips by year 2033 while 100% of generated trips are assumed utilize the project road by year 2038.
- The zones of development will be scattered in nature. Care has been taken to properly assign such generated traffic on different sections (legs) of expressway.
- Although Construction activities will be generating traffic related to movement of materials but the probability of its diversion to expressway is considered as nil.

Flow charts and tables describing the step by step procedure adopted for selecting the land for industrial nodes, Minimum area requirements for establishments of SEZs. Number of truck trips per hectare for each development and the presumptions made in calculating development traffic are given below:

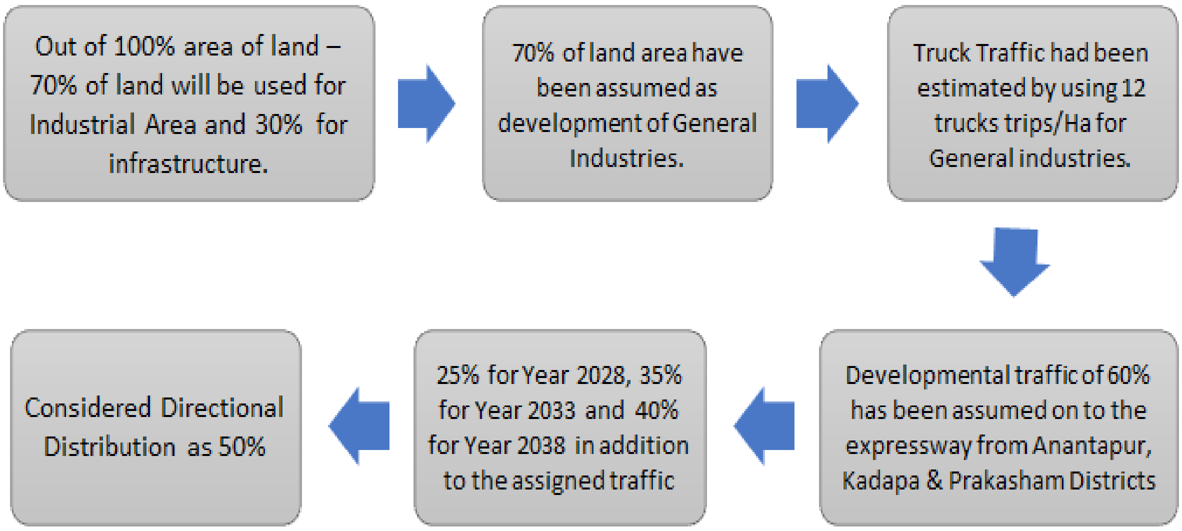


MINIMUM AREA REQUIREMENT FOR ESTABLISHMENT OF SEZs*				
S.no	**Type**	**Area**	**Area for Special States/UTs**	**Minimum Built up areas**
1	Multi-product	1,000 hectares	200 hectares	NA
2	Multi services	100 hectares	100 hectares	NA
3	**Sector specific**	**100 hectares**	**50 hectares**	**NA**
4	Handicrafts	10 hectares	10 hectares	NA
5	IT/ITES Electronic Hardware	10 hectares	10 hectares	1 Lakh sq. meters processing area.
6	Gems and Jewellery	10 hectares	10 hectares	50,000 sq. meters processing area

**Source: Ministry of Commerce and Industry*

Development	Truck Trips/Ha
NPA	4
IT/ITES	11.2
Apparel	15.1
Logistics	41
General Industries	**12**
DTA	41
IFSC	11.2
Gems/Jewellry	12
Pharma	12
BioTech	12
Auto and Auto Ancillary	12
Electronics	12
Other Business	12
Food /Agro	12
Light Engineering	12

**Source: Table 5.12 of Perspective Transportation plan for Mumbai Special Economic zone Ltd. Report and DMICDC Report*



Developmental traffic has been analysed based on the above adopted methodology for the districts which the alignment is traversing through it (i.e Ananthpuram, Kadapa, Nellore and Prakasham) and also the project influencing districts (i,e Chittoor, Kurnool and Guntur). The details of estimated developmental traffic each district wise has been given in the below tables.

Table-9.33: Estimated Developmental traffic, in the year 2028 (Leg wise)

S No.	Leg No.	District							Total	Total PCU
		Anantapur	Kadapa	Prakasam	Nellore	Chitoor	Kurnool	Guntur		
1	Leg - 1	1,144	-	-	-	-	836	-	**1,980**	**8,908**
2	Leg - 2	1,144	1,682	-	-	-	836	-	**3,661**	**16,475**
3	Leg - 3	1,144	3,363	-	-	-	836	-	**5,343**	**24,041**
4	Leg - 4	572	3,363	-	-	230	-	-	**4,165**	**18,740**
5	Leg - 5	286	3,363	-	-	459	-	-	**4,108**	**18,486**

S No.	Leg No.	District							Total	Total PCU
		Anantapur	Kadapa	Prakasam	Nellore	Chitoor	Kurnool	Guntur		
6	Leg -6	-	3,363	-	-	230	-	-	**3,593**	**16,166**
7	Leg - 7	-	1,682	3,577	597	-	-	-	**5,856**	**26,350**
8	Leg - 8	-	-	3,577	299	-	-	35	**3,911**	**17,597**
9	Leg - 9	-	-	3,577	-	-	-	35	**3,612**	**16,254**

Table-9.34: Estimated Developmental traffic, in the year 2033 (Leg wise)

S No.	Leg No.	District							Total	Total PCU
		Anantapur	Kadapa	Prakasam	Nellore	Chitoor	Kurnool	Guntur		
1	Leg - 1	1602	-	-	-	-	1169	-	**2771**	**12467**
2	Leg - 2	1602	2354	-	-	-	1169	-	**5124**	**23058**
3	Leg - 3	1602	4707	-	-	-	1169	-	**7478**	**33649**
4	Leg - 4	801	4707	-	-	321	-	-	**5829**	**26231**
5	Leg - 5	401	4707	-	-	642	-	-	**5750**	**25873**
6	Leg -6	-	4707	-	-	321	-	-	**5028**	**22626**
7	Leg - 7	-	2354	5008	835	-	-	-	**8197**	**36884**
8	Leg - 8	-	-	5008	417.5	-	-	49	**5475**	**24635**
9	Leg - 9	-	-	5008	-	-	-	49	**5057**	**22757**

Table-9.35: Estimated Developmental traffic, in the year 2038 (Leg wise)

S No.	Leg No.	District							Total	Total PCU
		Anantapur	Kadapa	Prakasam	Nellore	Chitoor	Kurnool	Guntur		
1	Leg - 1	1,827	-	-	-	-	1,336	-	**3,163**	**14,231**
2	Leg - 2	1,827	2,688	-	-	-	1,336	-	**5,851**	**26,327**
3	Leg - 3	1,827	5,376	-	-	-	1,336	-	**8,539**	**38,423**
4	Leg - 4	914	5,376	-	-	367	-	-	**6,657**	**29,954**
5	Leg - 5	457	5,376	-	-	734	-	-	**6,567**	**29,550**
6	Leg -6	-	5,376	-	-	367	-	-	**5,743**	**25,844**
7	Leg - 7	-	2,688	5,722	951	-	-	-	**9,361**	**42,125**
8	Leg - 8	-	-	5,722	475.5	-	-	57	**6,255**	**28,145**
9	Leg - 9	-	-	5,722	-	-	-	57	**5,779**	**26,006**

1.15.5 METHODOLOGY FOR FORECASTING

Investment priorities are governed by traffic demand, assessed benefits and cost of the project. Demand plays the important role, which governs which type of facility/ infrastructure to be created. This in turn determines likely benefits and costs to develop the same. An expressway project of this magnitude calls for significant investment. Prediction of traffic demand becomes an important task and has to be carried out as accurately as possible. Accurate estimation of traffic has direct bearing on the viability of the project. Recognizing this, efforts need to be made to carefully assess all the parameters that help in predicting the traffic demand in future, which necessitates realistic estimation of traffic growth rates. Traffic growth on a road facility is generally estimated on the basis of historical trends. In the present case, traffic growth rates are estimated using elasticity method as per IRC:108-2015. Demand changes are usually because of shifts in the pattern of economic activities in the surrounding regions. Hence, future traffic estimation necessitates a preview, however imprecise, of the probable pattern of future growth of the economy. In the absence of historical traffic census data on the project road, the future traffic has been forecasted using transport demand elasticity approach by regression of registered vehicles of Andhra Pradesh with respect to socio-economic parameters *viz.,* population, PCI and NSDP as explained below.

The exercise of traffic growth rate estimation has been carried out by us using the elasticity approach. The elasticity method relates traffic growth to changes in the related economic parameters. According to IRC:108-2015, elasticity based econometric model for highway projects could be derived in the following form:

Log e (P) = A_0 + A_1 Log_e (EI)

Where:

- P = Traffic volume (of any vehicle type)
- EI = Economic Indicator (GDP/NSDP/Population/PCI)
- A_0 = Regression constant;
- A_1 = Regression co-efficient (Elasticity Index)

The main steps followed are:

- Defining the Project Influence Area from OD analysis of travel pattern
- Estimating the past elasticity of traffic growth from time series of registered vehicles of influencing states
- Assessment of future elasticity values for major vehicle groups, namely, cars, buses and trucks
- Study of past performance and assessment of prospective growth rates of state economies of influence area
- The growth rates are found using the formulae Eqn (a) & (b).
- For Passenger vehicles,
- $G=\Sigma[(R_i*E_i*I_i)$……………….Eqn. (a)
- Where R_i = Growth in PCI and Population index of Andhra Pradesh
- E_i = Elasticity Value
- For commercial vehicles,
- $G=\Sigma\ [(R_j*E_j*I_j)$…………….…Eqn. (b)

Where, R_j = Growth in Economic index (NSDP) of Andhra Pradesh

E_j = Elasticity Value

I_j = Influence factor

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1.15.6 SECONDARY DATA COLLECTION

A study of the socio-economic profiles of the regions comprising the project influence area (PIA) provides an overview of the factors likely to influence the pattern of economic development, and hence the flows and volumes of traffic on the proposed highway. The details include population, per-capita Income, NSDP, GDP and targeted growth rates of the economy. The profiles help to generate basic inputs for the estimation of future growth in transport demand on the basis of past scenarios, prospective changes in transport demand elasticity and economic growth rates

(a) Growth of Registered Vehicles

In order to analyze the vehicle growth in the state, the vehicle registration data of Andhra Pradesh has been collected from the state hand book of statistics. The Compounded Average Growth Rate (%) of different vehicle types is shown in ***Table-9.36.***

Table-9.36: Growth of Registered Vehicles in Andhra Pradesh

S.No	Year	Car	Truck	Bus
1	2012	3,79,886	2,40,539	47,766
2	2013	4,32,090	2,65,677	51,925
3	2014	4,84,294	2,90,815	56,085
4	2015	5,36,498	3,15,953	60,244
5	2016	5,88,702	3,41,091	64,404
6	2017	6,40,906	3,66,229	68,563
7	2018	6,93,110	3,91,367	72,723
8	2019	7,45,314	4,16,505	76,882
Annual Average Growth Rate		**10.13%**	**8.17%**	**7.26%**

- ***Source: Statistical Hand Book of AP & further Rationalised the data***

(b) Economic Growth

The past performance of the economic indicators for Andhra Pradesh was also collected for the same period (2012-19), with the objective of establishing elasticity of travel demand to the different economic indicators. The economic indicators considered for the analysis include:

- Gross/ Net State Domestic Product
- Per Capita Income (PCI)
- Population

Table-9.37 gives the growth of Economic indicators for Andhra Pradesh.

Table-9.37: Growth in Economic Indices of Andhra Pradesh State (2011-12 Prices)

S.No	Year	GSDP (Rs Cr.)	PCI (Rs.)	Population (No.)	NSDP (Rs. Cr)
1	2012	3,44,057	65,708	4,99,02,314	3,47,765
2	2013	3,87,841	73,889	5,02,27,525	3,86,433
3	2014	4,31,626	82,069	5,05,52,736	4,25,100
4	2015	4,75,410	90,249	5,08,77,947	4,63,768
5	2016	5,19,195	98,430	5,12,03,157	5,02,435
6	2017	5,62,979	1,06,610	5,15,28,368	5,41,103
7	2018	6,06,764	1,14,790	5,18,53,579	5,79,770
8	2019	6,50,548	1,22,971	5,21,78,790	6,18,438
Annual Average Growth Rate		**9.93%**	**9.38%**	**0.64%**	**8.58%**

Source: Statistical Hand Book of AP & further Rationalised the data

9.15.7 TRANSPORT ELASTICITY DEMAND

Description of Regression Analysis

The regression analysis tool performs linear regression analysis by using the "least squares" method to fit a line through a set of observations. We can analyze how a single dependent variable is affected by the values of one or more independent variables. In the present case, registered vehicles by type are dependent variables whereas the economic parameters are independent variables.

R Square

R Square is another measure of the explanatory power of the model. In theory, R square compares the amount of the error explained by the model as compared to the amount of error explained by averages. The higher the R-Square, the better it is.

Regression analysis has been carried out by creating econometric models as suggested in *IRC: 108–2015*, using past vehicle registration data, and economic indicators such as population and PCI for passenger vehicles and NSDP for freight vehicles. All India registered trucks are also regressed with GDP to estimate national level elasticity value for trucks and its growth rate. The elasticity values obtained for each class of vehicle are given in *Table-9.38*.

- The following steps have been adopted to derive the Elasticity and Growth factors:
- Growth rate of registered vehicles of zone of influence (A.P) is found out
- Growth rates of NSDP/GSDP, GDP, Per Capita Income (at 2011-12 constant prices) and population are obtained
- For Cars, number of registered vehicles has been regressed with Per Capita Income of Andhra Pradesh State
- For Buses, number of registered vehicles has been regressed with Population of Andhra Pradesh State
- For trucks, number of registered trucks has been regressed with NSDP of the State for Intra-State movement and GDP for Inter-State movement
- Mean value of Average growth rate of registered vehicles and the growth rate obtained by Regression Analysis for all categories were found out both at State level and at National level (For trucks only)
- For Cars and Buses, the mean growth rate of registered vehicular growth rate and growth rate from regression analysis is adopted

Recommended Elasticity Values

Vehicle registration data represents all vehicles registered in the state, but does not indicate actual number of vehicles plying on the road owing to vehicles taken off the road due to lack of fitness certificate. Consequently, the elasticity values based on registration data are usually higher than those based on actual traffic.

Hence, there is a need to moderate values obtained from registration data. In order to arrive at realistic future elasticity's for the project road; various factors relating to vehicle technology changes besides character of traffic and travel pattern on the project road have been considered:

High elasticity of cars being witnessed now is because of large demand facilitated by financing schemes and loans. Factors like growth of household incomes (particularly in urban areas), reduction in the prices of entry-level cars, growth of the used car market, changes in life style, growing personal incomes, desire to own a vehicle facilitated by availability of loans/financing schemes on easy terms, etc. have all contributed to the rapid growth in ownership of cars. However, such trend would slow down and elasticity can be expected to decline. The elasticity obtained by using registered vehicles is actually an overestimate for the traffic moving on suburban and inter-city routes. In view of all this, combined with the travel pattern of vehicles moving on the road, elasticity value obtained by using registration data has been moderated for future years.

Over the years, there is a change in passenger movement with more and more persons shifting towards personalized modes. Moreover, buses are usually plying on fixed pre-decided routes and thus elasticity values for buses have been considered accordingly. With the changing freight vehicle mix in favor of LCV for short distance traffic and 3-axle/MAV for long-distance traffic, higher elasticity values for these have been considered as compared to 2-axle trucks. Considering the ongoing technical advancements in automobile industry, some of the standard two axle trucks would gradually be replaced by three axle truck and MAVs, leading to reduction in number of trucks. This shift has already started taking place in different parts of the country.

Considering the economic indicators of Andhra Pradesh, the projected elasticity values for various vehicle types are presented in, which have been used to estimate the growth rates of each vehicle type. The transport demand elasticity by vehicle type over a period of time tends to decline and approach unity or even less.

As the economy and its various sectors grow, every region tends to become self-sufficient. Moreover, much of the past growth has been associated with the country's transition from a largely rural, subsistence economy to cash based urban economy, dominated by regional and national linkages.

As the transition proceeds, its impact on transport pattern can be expected to become less dominant. Therefore, the demand for different type of vehicles falls, over time, despite greater economic development. The same is also clear from the relationships of the economy and transport demand elasticity over time nationally and internationally.

Table-9.38(a): Adopted Elasticity Values for Andhra Pradesh

Mode	Variable	Elasticity	R-Square
Car/Jeep	PCI	1.08	0.99
Bus	POP	10.93	0.99
Truck	NSDP	0.95	0.99

The estimated traffic growth rates are arrived at by multiplying elasticity values and projected growth in economic factors.

Table-9.38(b): Projected Traffic Growth Rates for Andhra Pradesh

Projected Growth Rates of Andhra Pradesh				
S.No	**Period**	**Car**	**Truck**	**Bus**
1	2021 - 2024	10.0%	8.00%	7.00%
2	2025 – 2029	10.0%	7.00%	6.5%
3	2030 – 2034	9.0%	6.5%	6.0%
4	2035 - 2039	8.0%	6.0%	5.5%
5	Beyond 2039	7.0%	5.0%	5.0%

1.15.8 RECOMMENDED GROWTH RATES

Against this background, any agenda for future growth of the state economies has to take into account past trends, future prospects and the emerging challenges. The growth prospects for the state have been developed taking into consideration the past performance of the state economies and the economic growth envisaged for the future. The pace with which the regional economies grow with the envisaged growth of the state is a major contributing factor in growth of traffic. Final growth rates were obtained for horizon years by considering the projected economic trend of the State. ***Table-9.39*** shows the growth rates, which are adopted in finding the future traffic demand estimates.

Table-9.39: Recommended/Adopted Traffic Growth Rates

Projected Growth Rates of Andhra Pradesh				
S.No	**Period**	**Car**	**Truck**	**Bus**
1	2021-2024	5.0%	5.0%	5.0%
2	2025 – 2029	5.0%	5.0%	5.0%
3	2030 – 2034	5.0%	5.0%	5.0%
4	2035 - 2039	5.0%	5.0%	5.0%
5	Beyond 2039	5.0%	5.0%	5.0%

1.15.9 PROJECTED TRAFFIC ON PROJECT CORRIDOR

The project stretch has been divided into 9 homogeneous traffic sections based on interchange points have been proposed along the project stretch through which the traffic shall make its entry and/ or exit. In view of the same, section-wise (*leg-wise*) traffic is considered for forecasting.

1.15.10 FORECASTED TRAFFIC

The proposed expressway is assumed to commence its operations from year 2025. Total traffic expected on the project stretch is arrived as the summation of diverted traffic, induced traffic and developmental traffic. The growth rates suggested in ***Table-9.39*** have been considered in calculating the forecasted traffic volume.

Based on the methodology discussed in para ***1.15.3*** above, traffic which can be generated from the newly set up industries due to the presence of expressway in near vicinity is calculated. This calculation is done for each district is calculated and the traffic is distributed on each leg. In this calculation, for every 5 years the traffic is increased with an assumptions of more industries being set up in the vicinity of expressway. This traffic comprises of only Multi axle vehicles. This is again due to the assumption that majorly only Multi axle vehicles will be used for transporting goods from the industries. For this traffic calculated, Then 3 scenarios were assumed

1) Optimistic scenario – Where 100% of the traffic uses the expressway.

2) Most likely scenario – Where 50% of the traffic uses the expressway.

3) Pessimistic scenario – Where no developmental traffic uses the expressway.

Then based on few studies and suggestions from the clients "Most Likely Scenario" is used and 50% of the calculated traffic is finalized as "Developmental Traffic". A growth rate of 3% is adopted for the developmental traffic. Developmental traffic is assigned/will use the expressway after 3years from the year it is opened to traffic.

Table-9.40 and ***1.41*** provides the developmental traffic and the years in which they are assigned to each leg of expressway

Table-9.40: Developmental Traffic (in Vehicles)

Year	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Leg 7	Leg 8	Leg 9
2028-29	1980	3661	5343	4165	4108	3593	5856	3911	3612
2033-34	2771	5124	7478	5829	5750	5028	8197	5475	5057
2038-39	3163	5851	8539	6657	6567	5743	9361	6255	5779

Optimistic Scenario

Table-9.41: Developmental Traffic (in PCU)

Year	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Leg 7	Leg 8	Leg 9
2028-29	8908	16475	24041	18740	18486	16166	26350	17597	16254
2033-34	12467	23058	33649	26231	25873	22626	36884	24635	22757
2038-39	14231	26327	38423	29954	29550	25844	42125	28145	26006

Optimistic Scenario

Table-9.42: Developmental Traffic (in Vehicles)

Year	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Leg 7	Leg 8	Leg 9
2028-29	990	1831	2671	2082	2054	1796	2928	1955	1806
2033-34	1385	2562	3739	2915	2875	2514	4098	2737	2529
2038-39	1581	2925	4269	3328	3283	2872	4681	3127	2890

Most Likely Scenario

Table-9.43: Developmental Traffic (in PCU)

Year	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Leg 7	Leg 8	Leg 9
2028-29	4454	8237	12021	9370	9243	8083	13175	8799	8127
2033-34	6234	11529	16824	13115	12936	11313	18442	12318	11378
2038-39	7116	13164	19212	14977	14775	12922	21062	14073	13003

Most Likely Scenario

Forecasted traffic (PCU) without considering the developmental traffic has been presented in the Table-9.44.

Growth Rate: 5%

Table-9.44: Projected Traffic on Expressway Excluding Developmental Traffic (PCU)

Year	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Leg 7	Leg 8	Leg 9
2021	12860	12107	12062	12134	12982	13003	13476	14075	11843
2022	13503	12712	12665	12740	13631	13653	14150	14778	12435
2023	14178	13347	13298	13377	14313	14336	14857	15517	13056
2024	14887	14015	13963	14046	15028	15053	15600	16293	13709
2025	17864	16818	16756	16855	18034	18063	18720	19552	16451
2026	18758	17659	17594	17698	18936	18966	19656	20529	17274
2027	19696	18542	18473	18583	19882	19915	20639	21556	18137
2028	20690	19479	19407	19522	20890	20918	21682	22645	19052
2029	21723	20448	20379	20497	21935	21965	22768	23779	20004
2030	22809	21473	21397	21523	23029	23061	23905	24966	21003
2031	23950	22544	22465	22600	24181	24215	25098	26216	22053
2032	25144	23674	23592	23726	25389	25428	26355	27527	23155
2033	26405	24855	24772	24915	26660	26697	27671	28900	24316
2034	27721	26101	26008	26160	27993	28031	29058	30348	25532
2035	29109	27405	27307	27468	29393	29432	30510	31862	26805
2036	30564	28774	28674	28840	30865	30905	32035	33454	28147
2037	32091	30213	30106	30281	32405	32449	33635	35131	29553
2038	33698	31725	31615	31796	34027	34073	35318	36886	31032
2039	35382	33309	33193	33385	35727	35778	37083	38730	32584
2040	37151	34973	34852	35054	37512	37563	38937	40668	34211
2041	39010	36721	36595	36807	39390	39442	40882	42700	35922

Year	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Leg 7	Leg 8	Leg 9
2042	40960	38560	38426	38650	41358	41412	42926	44835	37716
2043	43004	40489	40346	40581	43426	43485	45072	47076	39604
2044	45155	42512	42365	42611	45597	45660	47328	49431	41585
2045	47415	44635	44482	44740	47875	47943	49691	51898	43663
2046	49783	46869	46704	46979	50272	50338	52179	54495	45846
2047	52275	49211	49042	49326	52785	52854	54787	57221	48136
2048	54888	51670	51491	51793	55423	55497	57527	60080	50545
2049	57632	54255	54064	54380	58192	58273	60404	63084	53073
2050	60513	56967	56769	57099	61105	61184	63420	66240	55723
2051	63539	59815	59608	59957	64159	64243	66594	69550	58511

Forecasted traffic (PCU) with developemental traffic has been presented in the Table-9.45 (for Optimistic Scenario) & 1.46 (For Most likely Scenario).

Growth Rate: 5%

Table-9.45: Projected Traffic on Expressway Including Developmental Traffic (PCU)

Year	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Leg 7	Leg 8	Leg 9
2021	12860	12107	12062	12134	12982	13003	13476	14075	11843
2022	13503	12712	12665	12740	13631	13653	14150	14778	12435
2023	14178	13347	13298	13377	14313	14336	14857	15517	13056
2024	14887	14015	13963	14046	15028	15053	15600	16293	13709
2025	17864	16818	16756	16855	18034	18063	18720	19552	16451
2026	18758	17659	17594	17698	18936	18966	19656	20529	17274
2027	19696	18542	18473	18583	19882	19915	20639	21556	18137
2028	29598	35953	43448	38262	39376	37084	48031	40242	35306
2029	30631	36922	44420	39237	40421	38131	49118	41376	36258

Year	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Leg 7	Leg 8	Leg 9
2030	31717	37947	45438	40263	41515	39227	50255	42563	37257
2031	32858	39019	46506	41341	42667	40382	51447	43813	38307
2032	34051	40149	47633	42466	43875	41594	52704	45124	39409
2033	47780	64388	82462	69886	71019	65490	90905	71133	63326
2034	49096	65633	83698	71131	72352	66824	92292	72581	64543
2035	50484	66937	84997	72438	73752	68224	93744	74094	65815
2036	51939	68306	86364	73811	75223	69697	95269	75686	67157
2037	53466	69746	87796	75252	76764	71241	96869	77363	68563
2038	69304	97585	127728	106721	107936	98709	140676	107263	96048
2039	70988	99169	129306	108310	109637	100413	142441	109108	97600
2040	72757	100833	130965	109979	111421	102199	144295	111045	99227
2041	74616	102581	132708	111732	113299	104078	146240	113078	100938
2042	76566	104420	134540	113575	115267	106048	148285	115213	102732
2043	78611	106348	136459	115506	117336	108121	150431	117454	104620
2044	80761	108372	138479	117536	119506	110295	152686	119809	106601
2045	83021	110495	140595	119665	121784	112578	155050	122276	108679
2046	85389	112728	142817	121904	124182	114974	157538	124873	110862
2047	87882	115071	145155	124251	126694	117490	160146	127598	113152
2048	90495	117530	147605	126718	129332	120133	162886	130457	115561
2049	93238	120114	150177	129305	132101	122909	165762	133462	118089
2050	96120	122826	152882	132024	135014	125820	168779	136617	120739
2051	99145	125675	155722	134882	138068	128879	171952	139928	123527

Optimistic Scenario

Table-9.46:Projected Traffic on Expressway Including Developmental Traffic (PCU)

Year	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Leg 7	Leg 8	Leg 9
2021	12860	12107	12062	12134	12982	13003	13476	14075	11843
2022	13503	12712	12665	12740	13631	13653	14150	14778	12435
2023	14178	13347	13298	13377	14313	14336	14857	15517	13056
2024	14887	14015	13963	14046	15028	15053	15600	16293	13709
2025	17864	16818	16756	16855	18034	18063	18720	19552	16451
2026	18758	17659	17594	17698	18936	18966	19656	20529	17274
2027	19696	18542	18473	18583	19882	19915	20639	21556	18137
2028	25144	27716	31428	28892	30133	29001	34856	31443	27179
2029	26177	28685	32399	29867	31178	30048	35943	32578	28131
2030	27263	29710	33417	30893	32272	31144	37080	33764	29130
2031	28404	30782	34486	31971	33424	32299	38272	35014	30180
2032	29598	31911	35613	33096	34632	33511	39530	36325	31282
2033	37092	44621	53617	47400	48839	46094	59288	50016	43821
2034	38409	45867	54853	48646	50173	47427	60675	51465	45037
2035	39796	47171	56152	49953	51572	48828	62127	52978	46310
2036	41252	48540	57519	51325	53044	50301	63652	54570	47652
2037	42778	49979	58951	52767	54585	51845	65252	56247	49058
2038	51501	64655	79672	69258	70981	66391	87997	72074	63540
2039	53185	66239	81250	70847	72682	68095	89762	73919	65092
2040	54954	67903	82909	72516	74466	69881	91616	75857	66719
2041	56813	69651	84651	74270	76344	71760	93561	77889	68430
2042	58763	71490	86483	76113	78312	73730	95605	80024	70224
2043	60808	73418	88402	78043	80381	75803	97751	82265	72112
2044	62958	75442	90422	80074	82551	77978	100007	84620	74093

Year	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Leg 7	Leg 8	Leg 9
2045	65218	77565	92538	82203	84829	80260	102371	87087	76171
2046	67586	79798	94760	84442	87227	82656	104859	89684	78354
2047	70078	82141	97099	86789	89739	85172	107466	92409	80644
2048	72692	84600	99548	89256	92378	87815	110207	95268	83053
2049	75435	87184	102121	91843	95147	90591	113083	98273	85581
2050	78316	89897	104826	94561	98059	93502	116099	101428	88231
2051	81342	92745	107665	97420	101113	96561	119273	104739	91019

Most Likely Scenario

Forecasted traffic (PCU) with actual growth rate (based on the economic indicators) and without considering the developmental traffic has been presented in the Table-9.47.

Table-9.47: Projected Traffic on Expressway Excluding Developmental Traffic (PCU)

Year	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Leg 7	Leg 8	Leg 9
2021	12860	12107	12062	12134	12982	13003	13476	14075	11843
2022	13931	13114	13064	13141	14060	14085	14595	15240	12827
2023	15092	14206	14150	14234	15229	15258	15809	16503	13893
2024	16351	15390	15328	15418	16496	16529	17124	17871	15049
2025	19621	18468	18393	18501	19795	19835	20549	21446	18059
2026	21117	19870	19785	19900	21290	21338	22104	23064	19425
2027	22729	21382	21284	21407	22902	22958	23780	24808	20896
2028	23877	22463	22359	22492	24056	24115	24980	26059	21950
2029	25240	23739	23636	23775	25441	25502	26422	27568	23208
2030	26640	25050	24943	25092	26856	26923	27897	29109	24491
2031	28115	26437	26321	26481	28352	28421	29454	30734	25855
2032	29670	27899	27782	27948	29927	30004	31098	32456	27287

Year	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Leg 7	Leg 8	Leg 9
2033	31318	29443	29320	29498	31599	31676	32838	34275	28805
2034	33056	31077	30947	31137	33361	33445	34676	36194	30408
2035	34828	32740	32607	32805	35155	35246	36543	38148	32038
2036	36695	34492	34356	34566	37046	37143	38512	40206	33762
2037	38663	36343	36198	36420	39045	39146	40589	42376	35573
2038	40737	38290	38139	38376	41146	41256	42783	44664	37486
2039	42924	40342	40185	40436	43364	43481	45090	47079	39505
2040	45072	42364	42198	42461	45537	45660	47351	49435	41481
2041	47329	44484	44312	44588	47817	47947	49720	51912	43557
2042	49701	46712	46534	46820	50217	50350	52212	54512	45742
2043	52194	49054	48863	49167	52730	52872	54829	57241	48032
2044	54805	51511	51311	51629	55374	55523	57577	60107	50437
2045	57553	54088	53881	54215	58149	58306	60462	63120	52962
2046	60436	56797	56578	56928	61067	61229	63492	66279	55615
2047	63464	59643	59415	59780	64124	64296	66671	69603	58402
2048	66646	62634	62390	62776	67341	67518	70010	73087	61325
2049	69988	65769	65517	65922	70717	70903	73522	76751	64397
2050	73493	69067	68795	69224	74264	74456	77207	80595	67623
2051	77176	72523	72245	72691	77986	78192	81072	84631	71010

Forecasted traffic (PCU) with developmental traffic and actual growth rate (based on the economic indicators) has been presented in the Table-9.48 (for Optimistic Scenario) & 1.49 (For Most likely Scenario).

Table-9.48: Projected Traffic on Expressway Including Developmental Traffic (PCU)

Year	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Leg 7	Leg 8	Leg 9
2021	12860	12107	12062	12134	12982	13003	13476	14075	11843
2022	13931	13114	13064	13141	14060	14085	14595	15240	12827
2023	15092	14206	14150	14234	15229	15258	15809	16503	13893
2024	16351	15390	15328	15418	16496	16529	17124	17871	15049
2025	19621	18468	18393	18501	19795	19835	20549	21446	18059
2026	21117	19870	19785	19900	21290	21338	22104	23064	19425
2027	22729	21382	21284	21407	22902	22958	23780	24808	20896
2028	32784	38937	46400	41232	42542	40281	51330	43656	38204
2029	34148	40213	47678	42515	43927	41668	52772	45165	39462
2030	35548	41525	48985	43832	45342	43089	54247	46706	40745
2031	37023	42912	50362	45221	46838	44587	55804	48331	42109
2032	38578	44374	51824	46688	48413	46170	57447	50053	43541
2033	52693	68976	87010	74469	75957	70468	96072	76507	67815
2034	54431	70610	88637	76108	77720	72237	97910	78427	69418
2035	56203	72272	90297	77776	79514	74038	99777	80380	71048
2036	58070	74025	92046	79536	81405	75935	101746	82438	72772
2037	60038	75875	93888	81391	83404	77938	103823	84609	74584
2038	76344	104150	134253	113301	115055	105892	148142	115042	102502
2039	78530	106202	136299	115361	117273	108116	150449	117457	104521
2040	80678	108224	138312	117386	119446	110296	152709	119813	106497
2041	82935	110344	140426	119513	121726	112583	155078	122289	108573
2042	85307	112572	142647	121745	124126	114986	157571	124889	110758
2043	87800	114913	144976	124092	126640	117508	160187	127619	113048
2044	90411	117371	147424	126554	129283	120159	162935	130485	115453

Year	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Leg 7	Leg 8	Leg 9
2045	93159	119948	149994	129140	132058	122942	165821	133498	117978
2046	96042	122657	152691	131853	134976	125864	168851	136657	120631
2047	99070	125502	155528	134705	138033	128932	172029	139981	123418
2048	102253	128494	158503	137701	141251	132154	175368	143465	126341
2049	105594	131629	161630	140847	144626	135538	178880	147128	129413
2050	109099	134927	164909	144149	148173	139092	182566	150973	132639
2051	112782	138383	168358	147616	151895	142828	186431	155009	136026

Optimistic Scenario

Table-9.49:Projected Traffic on Expressway Including Developmental Traffic (PCU)

Year	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Leg 7	Leg 8	Leg 9
2021	12860	12107	12062	12134	12982	13003	13476	14075	11843
2022	13931	13114	13064	13141	14060	14085	14595	15240	12827
2023	15092	14206	14150	14234	15229	15258	15809	16503	13893
2024	16351	15390	15328	15418	16496	16529	17124	17871	15049
2025	19621	18468	18393	18501	19795	19835	20549	21446	18059
2026	21117	19870	19785	19900	21290	21338	22104	23064	19425
2027	22729	21382	21284	21407	22902	22958	23780	24808	20896
2028	28330	30700	34380	31862	33299	32198	38155	34858	30077
2029	29694	31976	35657	33145	34684	33585	39597	36366	31335
2030	31094	33288	36964	34462	36099	35006	41072	37907	32618
2031	32569	34675	38342	35851	37595	36504	42629	39533	33982
2032	34124	36136	39803	37318	39170	38087	44272	41255	35414
2033	42005	49209	58165	51983	53778	51072	64455	55391	48310
2034	43743	50844	59792	53622	55540	52841	66293	57310	49913

Year	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Leg 7	Leg 8	Leg 9
2035	45515	52506	61452	55290	57335	54642	68160	59264	51543
2036	47383	54259	63201	57051	59226	56539	70129	61322	53267
2037	49350	56109	65043	58905	61225	58542	72206	63492	55079
2038	58541	71220	86196	75838	78101	73574	95463	79853	69994
2039	60727	73272	88242	77898	80319	75799	97770	82268	72013
2040	62875	75294	90255	79924	82491	77978	100030	84624	73989
2041	65132	77414	92369	82051	84772	80265	102399	87100	76065
2042	67504	79642	94591	84282	87171	82668	104892	89701	78250
2043	69997	81984	96919	86629	89685	85190	107508	92430	80540
2044	72608	84441	99368	89091	92329	87841	110256	95296	82945
2045	75356	87018	101937	91677	95104	90624	113141	98309	85470
2046	78239	89727	104634	94391	98021	93546	116171	101468	88123
2047	81267	92573	107471	97243	101078	96614	119350	104792	90910
2048	84449	95564	110447	100239	104296	99836	122689	108276	93833
2049	87791	98699	113574	103384	107671	103220	126201	111939	96905
2050	91296	101997	116852	106686	111218	106774	129886	115784	100131
2051	94979	105453	120302	110154	114940	110510	133751	119820	103518

Most Likely Scenario

1.15.11 CAPACITY STANDARDS

The leg wise projected Traffic volume/Design service volume has been compared against the respective capacities of 4/6/8 lanes as per expressway manual and also with the 4/6lane manuals and the year during which the projected volume reaches its capacity and the year of requirement of lane upgradation has been given in ***Table-9.50*** and ***Table-9.51***

In addition to the above, leg (section) wise, year of lane upgradation has been analysed with/without considering the developmental traffic in the Optimistic & Most likely scenarios has also been presented for both 5% growth rate (in Table-9.50 & 1.51) to and also with

Actual/calculated growth rate (Based on the economic indicators in tables 1.52 & 1.53) are given below.

Table-9.50: Capacity Calculations for the Homogeneous Sections (With 5% Growth)

S.No	Section/ Leg	Year Warranting 6 lane Upgradation			Year Warranting 8 lane Upgradation		
		Optimistic	Most likely	Pessimistic	Optimistic	Most likely	Pessimistic
1	Leg 1	2038	2045	2052	2051	2056	-
2	Leg 2	2034	2039	2052	2039	2053	-
3	Leg 3	2033	2038	2052	2038	2048	-
4	Leg 4	2033	2038	2052	2038	2052	-
5	Leg 5	2033	2038	2052	2038	2050	-
6	Leg 6	2033	2038	2052	2038	2052	-
7	Leg 7	2033	2037	2052	2037	2044	-
8	Leg 8	2033	2038	2052	2038	2049	-
9	Leg 9	2035	2039	2052	2040	2054	-

Table-9.51: Capacity Calculations for the Homogeneous Sections (With 5% Growth)

S.No	Section/ Leg	Year Warranting 6 lane Upgradation			Year Warranting 8 lane Upgradation		
		Optimistic	Most likely	Pessimistic	Optimistic	Most likely	Pessimistic
1	Leg 1	2033	2036	2042	2038	2043	2050
2	Leg 2	2032	2033	2043	2033	2038	2052
3	Leg 3	2028	2033	2043	2033	2038	2052
4	Leg 4	2030	2033	2043	2033	2038	2052
5	Leg 5	2029	2033	2042	2033	2038	2050
6	Leg 6	2031	2033	2042	2033	2038	2050
7	Leg 7	2028	2033	2041	2033	2034	2049

S.No	Section/ Leg	Year Warranting 6 lane Upgradation			Year Warranting 8 lane Upgradation		
		Optimistic	Most likely	Pessimistic	Optimistic	Most likely	Pessimistic
8	Leg 8	2028	2033	2040	2033	2038	2048
9	Leg 9	-	2033	2044	2033	2038	2052

Table-9.52: Capacity Calculations for the Homogeneous Sections (With Actual/calculated Growth based on the Economic Indicators)

S.No	Section/ Leg	Year Warranting 6 lane Upgradation			Year Warranting 8 lane Upgradation		
		Optimistic	Most likely	Pessimistic	Optimistic	Most likely	Pessimistic
1	Leg 1	2038	2041	2048	2047	2052	2056
2	Leg 2	2033	2038	2049	2038	2049	-
3	Leg 3	2033	2037	2049	2038	2044	-
4	Leg 4	2033	2038	2049	2038	2048	-
5	Leg 5	2033	2038	2048	2038	2046	2056
6	Leg 6	2033	2038	2048	2038	2048	2056
7	Leg 7	2033	2034	2047	2035	2040	2055
8	Leg 8	2033	2038	2046	2038	2045	2055
9	Leg 9	2033	2038	2050	2038	2050	-

Table-9.53: Capacity Calculations for the Homogeneous Sections (With Actual Growth based on the Economic Indicators)

S.No	Section/ Leg	Year Warranting 6 lane Upgradation			Year Warranting 8 lane Upgradation		
		Optimistic	Most likely	Pessimistic	Optimistic	Most likely	Pessimistic
1	Leg 1	2033	2033	2038	2037	2039	2046
2	Leg 2	2029	2033	2039	2033	2038	2048
3	Leg 3	2028	2033	2039	2033	2035	2048
4	Leg 4	2028	2033	2039	2033	2038	2048
5	Leg 5	2028	2033	2038	2033	2037	2046
6	Leg 6	2028	2033	2038	2033	2038	2046
7	Leg 7	2028	2030	2037	2033	2033	2045
8	Leg 8	2028	2032	2036	2033	2036	2044
9	Leg 9	2030	2033	2040	2033	2038	2048

1.16 Traffic Studies on Madnapalle – Kadapa section of the project corridor (Economic Corridor)

The project stretch starts from YSR Outer ring road in Kadappa district at Km 198.000 onf NH 40 (14°26'38.46"N, 78°48'20.94"E), and follows NH 340 from Rayachoty to Angallu and ends near Madanapalle, where NH -340 meets on NH-42 at Km 242.600 (13°37'47.29"N, 78°29'7.28"E) in Chittoor district in the state of Andhra Pradesh.

The entire project corridor traverses in Kadappa & Chittoor districts of Rayalasema region in the state of Andhra Pradesh.

The stretch from Madanapalle to Kadapa will make use of the existing alignment with bypasses and realignments wherever necessary.

The traffic surveys for this section of the project corridor has been conducted at the following locations.

Table-9.54: Traffic surveys for Madnapallr – Kadapa section

S. No	Location	TVC			Origin & Destination		Axle load	
		From	To	Duration	Date	Duration	Date	Duration
1	Sambepalli on NH 40	06.09.21	12.09.21	7 days	07.09.21	1 day	07.09.21	1 day
2	Ramiganivari Palle on NH 340	06.09.21	12.09.21	7 days	-	-	-	-

As discussed above, the entire project corridor is partly utilising the NH-40 from Kadapa to Rayachoti and NH-340 from Rayachoti to Anagallu.

1.16.1 Average Daily Traffic (ADT)

The Average daily traffic (ADT) for the above survey locations are given in the table below.

Table-9.55: Average Daily Traffic (ADT)

Stretch	Kadapa - Rayachoti	Rayachoti - Madanapalle
Location	Sambepalli (NH - 40)	Ramiganivari Palle (NH - 340)
Two Wheeler	3,126	1,293
Three Wheeler (Passenger)	571	140
Car (White board)	2,161	758
Car (Yellow Board)	24	1
Tata Magic	10	3
RTC Bus	286	191
Private Bus	101	23
Mini Bus	12	3
School/ College Bus	8	3
2 Axle	209	31
3 Axle	266	45
Multi Axle	1,033	227
HEM	3	14
LCV	234	71
Mini LCV	401	187
Tractor	6	14
Tractor with Trailer	21	28

Stretch		Kadapa - Rayachoti	Rayachoti - Madanapalle
Location		Sambepalli (NH - 40)	Ramiganivari Palle (NH - 340)
Two Wheeler		3,126	1,293
Three Wheeler (Goods)		27	14
Bicycle		0	2
Cycle Rickshaw		0	1
Animal Drawn		3	0
Government Exempted		13	0
Vehicles	Motorised	8,511	3,049
	Non Motorised	3	3
	Total Traffic	8,514	3,052
	Tollable Traffic	4,748	1,557
PCU	Motorised	12,525	3,974
	Non Motorised	24	3
	Total Traffic	12,549	3,977
	Tollable Traffic	10,239	3,025

1.16.2 Annual Average Daily Traffic (AADT)

The Annual Average Daily Traffic (AADT) for the above survey location was obtained by multiplying the Average Daily Traffic (ADT) with the Seasonal Correction Factor. The AADT for the year 2021 are calculated and tabulated in the table below.

Table-9.56: Annual Average Daily Traffic (AADT)

Stretch	Kadapa - Rayachoti	Rayachoti - Madanapalle
Location	Sambepalli (NH - 40)	Ramiganivari Palle (NH - 340)
Two Wheeler	3032	1280
Three Wheeler (Passenger)	565	141
Car (White board)	2118	758
Car (Yellow Board)	24	1
Tata Magic	10	3
RTC Bus	283	193

Stretch		Kadapa - Rayachoti	Rayachoti - Madanapalle
Location		**Sambepalli (NH - 40)**	**Ramiganivari Palle (NH - 340)**
Private Bus		100	23
Mini Bus		12	3
School/ College Bus		8	3
2 Axle		207	31
3 Axle		263	45
Multi Axle		1023	229
HEM		3	14
LCV		232	72
Mini LCV		397	189
Tractor		6	14
Tractor with Trailer		21	28
Three Wheeler (Goods)		27	14
Bicycle		0	2
Cycle Rickshaw		0	1
Animal Drawn		3	0
Government Exempted		13	0
Vehicles	Motorised	8342	3043
	Non Motorised	3	3
	Total Traffic	8345	3046
	Tollable Traffic	4679	1565
PCU	Motorised	12341	3990
	Non Motorised	24	3
	Total Traffic	12365	3993
	Tollable Traffic	10111	3046

1.16.3 Peak Hour Traffic

The peak hour traffic at the above survey locations based on AADT is presented in the below table.

Table-9.57: Peak Hour Traffic

Name of the Survey Location	Peak Hour Volume	Total Volume	Peak Hour Composition(%)	Time
Sambepalli (NH - 40)	713	12,371	5.76	17:00 – 18:00
Ramiganivari Palle (NH - 340)	230	3,961	5.81	16:00 – 17:00

1.16.4 Projected traffic on the Economic Corridor

The project stretch has been divided into 2 homogeneous traffic sections based on the intensity of the traffic.

Table-9.58: Homogeneous Traffic sections

Homogeneous section	From	To
1	Kadapa	Rayachoti
2	Rayachoti	Angallu near Madanapalle

1.16.5 Forecasted Traffic

The traffic forecast has been analysed based on the actual/ calculated growth rates as well as 5% growth rates. Forecasted traffic (PCU) has been presented in the below table.

Table-9.59: Forecasted Traffic on the project corridor (PCU)

Year	HS 1 (Kadapa - Rayachoti)		HS 2 (Rayachoti - Madanapalle)	
	5% Growth rate	Actual/Calculated Growth	5% Growth rate	Actual/Calculated Growth
2021	12367	12367	3993	3993
2022	12985	13428	4193	4337
2023	13633	14581	4402	4710
2024	14314	15834	4622	5117
2025	16460	18686	5315	6044
2026	17282	20186	5581	6536
2027	18145	21812	5860	7070

Year	HS 1 (Kadapa - Rayachoti)		HS 2 (Rayachoti - Madanapalle)	
	5% Growth rate	Actual/Calculated Growth	5% Growth rate	Actual/Calculated Growth
2028	19051	23573	6153	7648
2029	20002	25481	6460	8276
2030	21001	27372	6783	8898
2031	22050	29407	7122	9568
2032	23152	31599	7478	10290
2033	24308	33958	7852	11069
2034	25522	36500	8244	11908
2035	26797	38978	8657	12725
2036	28136	41628	9089	13600
2037	29541	44463	9543	14536
2038	31017	47496	10021	15538
2039	32567	50740	10521	16611
2040	34194	53724	11047	17605
2041	35902	56887	11599	18660
2042	37696	60243	12179	19779
2043	39580	63802	12788	20968
2044	41557	67578	13427	22230
2045	43634	71583	14099	23570
2046	45814	75833	14803	24994
2047	48104	80342	15543	26505
2048	50507	85127	16320	28111
2049	53031	90205	17136	29816
2050	55682	95594	17993	31628

Year	HS 1 (Kadapa - Rayachoti)		HS 2 (Rayachoti - Madanapalle)	
	5% Growth rate	Actual/Calculated Growth	5% Growth rate	Actual/Calculated Growth
2051	58464	101315	18892	33552

1.16.6 Capacity Standards

The homogeneous section wise projected Traffic volume/Design service volume has been compared against the respective capacities of 4/6/8 lanes as per 4/6lane manuals and the year during which the projected volume reaches its capacity and the year of requirement of lane upgradation has been given in ***Table-9.60*** and ***Table-9.61***

Table-9.60: Capacity Calculations for the Homogeneous Sections (With 5% Growth)

S. No	Section	Year warranting 4 Lane Upgradation		Year warranting 6 Lane Upgradation	
		IRC 64 & SP 84 – LOS B	MoRTH Circular	IRC 64 & SP 84 – LOS B	MoRTH Circular
1	HS – 1 (Kadapa - Rayachoti)	2026	2021	2044	2034
2	HS-2 (Rayachoti - Anagallu)	2051	2038	-	-

Table-9.61: Capacity Calculations for the Homogeneous Sections (With Actual/calculated Growth based on the Economic Indicators)

S. No	Section	Year warranting 4 Lane Upgradation		Year warranting 6 Lane Upgradation	
		IRC 64 & SP 84 – LOS B	MoRTH Circular	IRC 64 & SP 84 – LOS B	MoRTH Circular
1	HS – 1 (Kadapa - Rayachoti)	2025	2021	2036	2029
2	HS-2 (Rayachoti - Anagallu)	2041	2032	2054	2047

CONCLUSIONS

➢ **Kodikondla to Addanki / Medarametla (Expressway)**

1. As per the capacity standards mentioned in the expressway manual (IRC SP 99), the project corridor requires 6 lane configuration in the year 2033, **2037** and 2052 for Optimistic, Most likely and Pessimistic scenarios respectively considering 5% growth rate.
2. Whereas with actual/ calculated growth rate (based on the economic indicators), the project corridor requires 6 lane configuration in the year 2033, **2034** and 2046 for Optimistic, Most likely and Pessimistic scenarios respectively.
3. Development of a 6 lane lane expressway between Kodikondla Check post and Addanki will boost economic development of Rayalaseema region of Andhra Pradesh.
4. The actual traffic may exceed the projected traffic in the event of development of industrial corridors along the proposed expressway.
5. Considering the time required for completion of construction especially the tunnel packages, it is recommended that the expressway may be developed with 6 lane capacity.

➢ **Madanapalle - Kadapa (Economic Corridor)**

1. As per the capacity standards mentioned in IRC 64, IRC SP 87/84 manuals, the project corridor requires 4 lane configuration in the year 2025 and 2026 for actual (calculated) growth rates and 5% growth rates respectively.
2. Whereas, as per the MoRTH circulars the project corridor immediately needs to be upgraded to 4 lane configuration.

9.0 Pavement Design Report

9.1 Introduction

National Highways Authority of India has awarded the greenfield corridor from Bangalore to Vijayawada with a motive to reduce the distance and to provide direct connectivity between Bangalore and Vijayawada. Traffic volumes and axle loads are assessed by conducting various traffic surveys.

Both flexible and rigid pavement options are proposed for the project corridor. Flexible pavement code IRC:37 revised in 2018 permits the use of sub-base and base with alternative materials like cement, reclaimed asphalt options which were not available in the earlier revisions. For the design of rigid pavement, IRC:58 the latest revision issued in 2015 is considered for the design.

9.2 Pavement Design Objective

The Objective is to determine the total thickness of the pavement structure as well as thickness of individual structural layer components. Design strength of pavement must be adequate to support the projected traffic loading throughout the design period.

9.3 Design Guidelines

Design Life:

- Clause 5.3 of "Manual of Specifications and Standards for Expressways (IRC:SP:99-2013)" states that "flexible pavements shall be designed in accordance with IRC:37 and rigid pavement shall be designed in accordance with the method prescribed in IRC:58"

- Clause 5.4.1 of IRC:SP:99-2013, states that "Flexible pavement shall be designed for a minimum design period of 15 years or operation period whichever is more."

The thickness of bituminous, sub-base and base of pavement section is designed for a minimum design period of 15 years.

- Clause 5.4.2 of IRC: SP:99-2013, states:
  (a) Rigid pavement shall be designed for a minimum design period of 30 years. The stage construction shall not be permitted.
  (b) The Pavement Quality Concrete (PQC) shall rest over Dry Lean Concrete (DLC) sub-base of 150mm thickness.
  (c) A separation membrane shall be used between the PQC and DLC as per clause 602.5 of MoRT&H Specifications.

(d) The DLC shall meet the minimum cement and compressive strength requirement as prescribed in IRC:SP:49. The DLC shall extend beyond the PQC by 0.5 m on either side.

(e) Below DLC layer, a properly designed drainage layer GSB of 150 mm thickness shall be provided throughout the road width. It shall be designed to obtain a drainage coefficient of not less than 30 m per day.

9.4 Design CBR

The CBR of borrow material varies between 6% and 14%. Considering the fact that the contractor executing the works may opt for alternative sources than studied herein, an average value of 10% is adopted in the pavement design.

9.5 Traffic Volume Count Surveys

Since the proposed Bangalore-Kadapa-Vijayawada road is a greenfield corridor, traffic is assigned by studying the traffic pattern on the existing road network. Data regarding the through vehicle movement between Bangalore and Viajayawada are found by conducting traffic surveys on NH-44 near Kodikonda Checkpost, SH-61 near Kadiri, NH-40 near Sambepalle village, NH-340 near Ramiganivaripalle, NH-67 near Basapuram Toll Plaza, SH-54 near Akkalreddypalle, NH-71 near Kothuru, NH-544D near Mokshagundam village, SH-53 near chimakurthy, NH-565 near Pamuru and on NH-16 near Tanguturu Toll Plaza. Traffic which is anticipated from the cross roads through the Interchanges is assigned by conducting traffic surveys on cross roads and later confirmed with the traffic data availed from R&B NH wing. Total traffic on each leg is found by combining the through traffic with the cross road traffic. Automatic traffic counter and classifier surveys, Axle load surveys, commodity movement survey, origin destination survey by road side interview method are conducted at the survey locations to assess the trip pattern and load characteristics of commercial vehicles. Accordingly the commercial traffic is estimated using the fraction of the vehicle movement between the influential zones applied to the Annual average daily traffic data. Only the commercial vehicles are to be converted into standard axles for the purpose of pavement design. Detailed analysis has been presented in Traffic Report.

Table-9.1: Commercial Vehicles (AADT) for different leg's of the proposed project corridor

S. No.	Leg No.	MODE WISE TRAFFIC								Total Traffic in Numbers	Total Traffic in PCUs
		Car	Bus	Mini Bus	Tata Magic	LCV	2Axle	3 Axle	Multi Axle		
1	Leg - 1	2699	406	40	42	522	475	489	1148	**5821**	**12860**
2	Leg - 2	2408	317	40	34	454	458	485	1143	**5339**	**12107**
3	Leg - 3	2270	283	31	33	445	484	502	1164	**5212**	**12062**
4	Leg - 4	2267	284	31	34	448	497	502	1170	**5233**	**12134**
5	Leg - 5	2392	293	29	48	459	584	569	1216	**5590**	**12982**
6	Leg - 6	2487	286	34	46	460	598	574	1190	**5675**	**13003**
7	Leg - 7	2558	344	33	43	459	612	623	1200	**5872**	**13476**
8	Leg - 8	2632	454	32	38	460	622	660	1213	**6112**	**14076**
9	Leg - 9	2207	258	27	31	411	508	523	1129	**5094**	**11843**

9.6 Traffic Growth Rates

Past trends in the growth rates along the proposed project corridor provide a valuable information to the likely future traffic. But in most cases, the past traffic data from statistical department is inconsistent and cannot be taken as a basis for future traffic growth rate. Alternatively the motor vehicle registration data at the state level during the recent past provides more consistent information regarding the trends in traffic growth and thus presents a better tool for estimating future growth rates of different categories of vehicles. A more rational method is to establish a relationship between the socio - economic variables such as population, Net State Domestic Product and Per-capita income on one hand and the past registration data of different categories of vehicles on the other to determine the Elasticity of Transport Demand with respect to different categories of vehicles. The detailed calculations of growth rates are given in traffic report. The computed traffic growth rates are given in the below Table-9.2.

Table-9.2: Actual growth rates in percentages

S. No	Period	Car	Truck	Bus
1	2021-2024	10%	8%	7%
2	2025 – 2029	10%	7%	6.5%
3	2030 – 2034	9%	6.5%	6%
4	2035 - 2039	8%	6%	5.5%
5	Beyond 2039	7%	5%	5%

9.7 Axle Load Surveys

The Vehicle Damage Factor (VDF) is an index characterizing the traffic loading for a highway and is defined as a multiplier for converting the number of commercial vehicles of different axle loads to Standard Axle Loads (SAL). Equivalency factor (EF) is normally worked out by using the Fourth Power Rule derived by AASHTO. However, TRRL has suggested a factor of 4.5 for developing countries. In the present study, the Fourth Power Rule given by CRRI has been adopted. With the help of equivalency factors and frequency distribution of axle loads, Equivalent Axle Loads (EAL) are computed. The standard axle loads and the legal axle loads considered while calculating the equivalency factors for various axles are furnished below.

Table-9.3: Standard and legal Axle loads

S. No	Type of Axle	Standard Axle Load (Tonnes)	Legal Axle Load (Tonnes)	Reference
1	Single Axle (1^{le} wheel)	6.60	6.60	IRC-3
2	Single Axle (2^{al} wheel)	8.16	10.20	IRC-37/IRC-3

S. No	Type of Axle	Standard Axle Load (Tonnes)	Legal Axle Load (Tonnes)	Reference
3	Tandem Axle	15.09	19.00	IRC-37/IRC-3

VDF depends on the composition of commercial traffic, the load carried and the actual sample collected. The following table gives the VDF's adopted in design.

Table-9.4: Vehicle Damage Factor (VDF) at different Survey Locations

Mode	Sambepalli	Basapuram	Kodikonda	Mokshagundam	Kothuru
LCV	0.94	0.85	1.10	0.82	1.05
2A	1.98	1.75	2.25	1.48	1.70
3A	2.98	3.05	3.78	2.78	3.18
MA	5.66	5.42	6.82	5.78	5.42

Anticipating heavy commercial traffic movement on the proposed highway due to the future developments, average VDFs are adopted and the values are given in the Table-9.5.

Table-9.5: Vehicle Damage Factor (VDF) adopted

Mode	Adopted VDF
LCV	0.95
2A	1.83
3A	3.15
MA	5.82

9.8 Million Standard Axles (MSA)

Design traffic in terms of Million Standard Axles (MSA) is determined at location, where both volume count and axle load surveys were conducted.

The traffic loading in terms of the cumulative number of standard axles for the design period is computed using the following relationship.

$N = 365 * [(1+r)^n – 1] * A * D * L * F / r$

Where,

N: The cumulative number of standard axles to be catered for in the design in terms of MSA.

A: Initial traffic in the year of completion of construction in terms of the number of commercial vehicles per day

L: Lane Distribution Factor

D: Directional Distribution Factor

n: Design Life in years

r: Annual Growth rate of commercial vehicles (5 %).

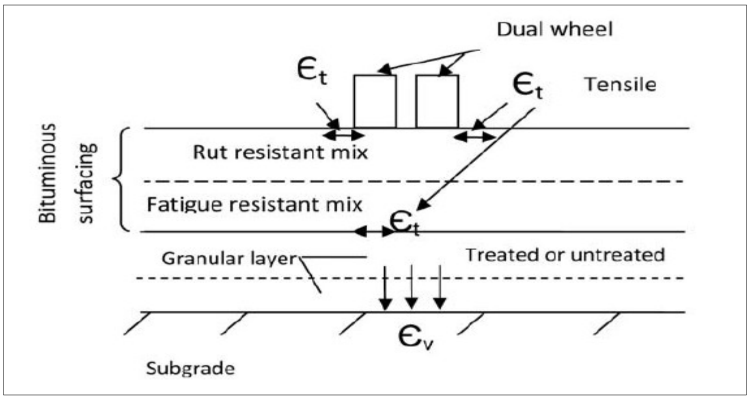
F: Vehicle Damage Factor

9.9 Preliminary Design of Flexible Pavement

9.9.1 General

The flexible pavement is modeled as an elastic multi layer structure. Stresses and strains at critical locations are computed using linear layered elastic model. The stress – strain analysis software IITPAVE has been used for the computation of stress and strain in flexible pavements as mentioned below

- Horizontal Tensile Strain at bottom of bituminous layer, which can cause fatigue failure of bituminous layer.
- Vertical Compressive Strain at the top of subgrade, which can cause rutting failure of pavement layers.
- Horizontal Tensile Strain at bottom of Cement treated base, which can cause fatigue failure of cement treated layer.



The flexible pavement has low flexural strength and hence layers reflect the deformation of the lower layers/sub-grade on to the surface layer after the withdrawal of wheel load. To control the deflections in the sub-grade so that no permanent deflections results the pavement thickness is so designed that the stresses on the subgrade soil are kept within its bearing power. Loading of bituminous pavement requires the stiffest layers to be placed at the surface with successive weaker layers down to subgrade. For the purpose of structural design, only the number of commercial vehicles of laden weight of 3 tonnes or more and their axle loading will be considered.

9.9.2 Fatigue Model

Due to repetition of loads, tensile strain develops cracks at the bottom of bituminous layers which is a problem for long term serviceability. The phenomenon is called fatigue of the bituminous layer and the number of load repetitions in terms of standard axles that causes fatigue denotes the life of the pavement. Two fatigue equations are considered, one in which the computed strains corresponds to 80% reliability level and the other corresponding to 90% reliability level.

The 80% reliability equation is used for the pavement where VG30 grade bitumen is used and 90% reliability equation is used for the pavement where VG40 grade bitumen is used. The two equations for the conventional bituminous mixes designed by Marshall method are given below.

$$N_f = 2.21 \times 10^{-4} \times (1/E_t)^{3.89} \times (1/M_R)^{0.854} \text{---------1 (80\% Reliability)}$$

$$N_f = 0.711 \times 10^{-4} \times (1/E_t)^{3.89} \times (1/M_R)^{0.854} \text{--------2 (90\% Reliability)}$$

N_f = Fatigue life in number of standard axles

E_t = Maximum tensile strain at the bottom of Bituminous layer.

M_R = Resilient Modulus of the Bituminous layer

The ***equation 2*** is modified by considering 90% reliability with air voids around 3% and the volume of bitumen about 13%.

9.9.3 Rutting Model

Rutting is the permanent deformation in pavement usually occurring longitudinally along the wheel path. The rutting may partly be caused by deformation in the subgrade and other non-bituminous layers which would reflect to the overlying layers to take a deformed shape. The 80% reliability equation is used for the pavement where VG30 grade bitumen is used and 90% reliability equation is used for the pavement where VG40 grade bitumen is used. The rutting model considers the vertical strain in subgrade and the two equations are given below by considering 80% & 90% reliability.

$$N = 4.1656 \times 10^{-8} \times (1/E_v)^{4.5337} \text{------3 (80\% Reliability)}$$

$$N = 1.41 \times 10^{-8} \times (1/E_v)^{4.5337} \text{---------4 (90\% Reliability)}$$

N = Number of cumulative standard axles to produce 20 mm rutting.

E_v = Maximum Vertical subgrade strain (micro strain)

9.9.4 Pavement Layers

In accordance with IRC:37-2018 for the following base and sub-base options are available.

- Granular base and sub-base.
- Cementitious bases and sub-bases with a crack relief layer of aggregate inter-layer below bituminous surfacing.
- Cementitious bases and sub-bases with SAMI in between bituminous surfacing and the contentious base layer for retarding the reflection cracks into the bituminous layer.
- Cemented base and granular sub base with crack relief inter-layer of aggregate above Cemented base.
- Bituminous surfacing over treated RAP and cemented sub base.

Stage construction is not permitted when we are using cemented base and sub-bases according to the guidelines of the code as it may lead to cracking of the stabilized layer leading to failure of the pavement. Hence, the consultants adopting Granular Base & Granular Sub-base for main carriageway pavement with stage construction.

9.9.4.1 Sub-base layer:

The sub-base layer serves three functions like to protect the sub-grade from over stressing, to provide a platform for the construction traffic and to serve as drainage and filter layer. Material passing through 0.425 mm (425 micron), LL & PI shall not more than 25 and 6 %. Material shall have a minimum 10% fines when tested in compliance with BS:812. The water absorption value (as per IS 2386) of the coarse aggregate shall be less than 2%, if not soundness test shall be carried out as per IS 383. 100% sample should pass through 75mm sieve and only 3-10% sample should pass through 0.075mm sieve for all the three grades. When coarse graded sub base is used as a drainage layer, Los Angeles abrasion value should be less than 40, so that there is no crushing during the rolling and the permeability is retained. The sub-base should be composed of two layers, the lower layer forms the separation/filter layer to prevent intrusion of subgrade soil into the pavement and upper layer forms the drainage layer to drain away any water that may enter through surface cracks.

Strength Parameter: Resilient Modulus (M_{Rgsb})

M_{Rgsb}= 0.2 X $h^{(0.45)}$ X $M_{R\ subgrade}$, where h is thickness of subbase layer in mm.

M_R value of subbase is dependent on M_R value of subgrade since weaker subgrade does not permit higher modulus of the upper layer because of deformation under loads.

$M_{R\ subgrade}$ = 10 X CBR if Subgrade CBR is <=5

$M_{R\ subgrade}$ = 17.6 X $(CBR)^{0.64}$ if Subgrade CBR is >5

9.9.4.2 Base layer:

Base layer consists of WMM, WBM, Crusher run macadam, reclaimed concrete etc. Relevant specifications of IRC/MORTH are to be adopted for the construction.

Strength Parameter: Resilient Modulus ($M_{R\ granular}$)

When both sub-base and base layers are made up of unbound granular layers, the composite resilient modulus of the granular subbase and base are as follows:

$M_{R\ granular}$= 0.2 X $h^{0.45}$ X $M_{R\ subgrade}$,

where h is combined thickness of subbase and base layers in mm.

9.9.4.3 Bituminous layers (Binder and Surface)

Binder layer consists of DBM and BM are to be adopted for construction. It acts like a load distribution and supporting layer.

Strength Parameter: Resilient Modulus ($M_{RBC/DBM}$)

The strength of bituminous mix based on extensive laboratory testing of Resilient Modulus Test. Based on the study data of India, IRC:37-2018 recommended resilient modulus for different mix types and temperatures are given below.

Table-9.6: Resilient Modulus of Bituminous Mixes, Mpa

Mix Type	Temperature °C				
	20	**25**	**30**	**35**	**40**
BC and DBM for VG10 bitumen	2300	2000	1450	1000	800
BC and DBM for VG30 bitumen	3500	3000	2500	2000	1250
BC and DBM for VG40 bitumen	6000	5000	4000	3000	2000
BC with Modified bitumen (IRC:SP:13)	5700	3800	2400	1650	1300
BM with VG10 bitumen	-	-	-	500	-
BM with VG30 bitumen	-	-	-	700	-
RAP treated with 4% bitumen	-	-	-	800	-

9.9.5 Flexible pavement design for Greenfield corridor

Design of flexible pavement is carried out in accordance with IRC:37-2018 for Granular base and sub-base. The standard designs given in plate-6, 14 and 22 of clause 12.1, 12.2 & 12.2 of IRC:37-2018 specify the minimum thickness and specifications of various component layers for different options for the given traffic in terms of cumulative standard axles and the 10% subgrade CBR. Cumulative standard axles calculated for the 20 year design life for leg wise is given in the Table-9.7.

Table-9.7: Leg wise Million standard axles for developmental traffic

Leg's	Cumulative MSA	Max. MSA	Design MSA
1	92.00	**128**	**130**
2	110.00		
3	120.00		
4	124.00		
5	123.00		
6	114.00		
7	**128.00**		
8	122.00		
9	109.00		

Anticipating heavy commercial traffic movement on the proposed highway due to the future developments flexible pavement is adopted for 130 MSA. Along with the flexible pavement composition with conventional layers option, layer composition with alternate materials have been considered and given in the following tables:

Table-9.8: Conventional Pavement Composition (Option-1)

Section	Eff. CBR (%)	MSA for 20 yrs design life	Bitumen Grade	Crust Composition (mm)				
				BC	DBM	WMM	GSB	Total
Bangalore-Kadapa-Vijayawada	10	130	VG40	50	140	250	200	**640**

Table-9.9: Composition details Bituminous pavement with Cemented base and sub base with Crack Relief Interlayer of aggregate (Option-2)

Section	Eff. CBR (%)	MSA for 20 yrs design life	Bitumen Grade	Crust Composition (mm)					
				BC	DBM	AIL	CTB	CTSB	Total
Bangalore-Kadapa-Vijayawada	10	130	VG40	50	80	100	100	200	**530**

Table-9.10: Composition details Bituminous pavement with Cemented base and Granular Sub base with AIL (Option-3)

Section	Eff. CBR (%)	MSA for 20 yrs design life	Bitumen Grade	Crust Composition (mm)					
				BC	DBM	WMM	AIL	CTB	Total
Bangalore-Kadapa-Vijayawada	10	130	VG40	50	70	200	100	160	**580**

Table-9.11: Composition details Bituminous pavement with Cemented base and Cemented Sub base with SAMI Layer (Option-4)

Section	Eff. CBR (%)	MSA for 20 yrs design life	Bitumen Grade	Crust Composition (mm)					
				BC	DBM	SAMI	CTB	CTSB	Total
Bangalore-Kadapa-Vijayawada	10	130	VG40	50	60	SAMI Layer	180	210	500

9.10 Final Flexible Pavement design Option for Main carriageway:

As per the equations mentioned in 2.3.2 and 2.3.3: Following are the results observed from the IIT-PAVE Software for crust composition mentioned in the below table.

Calculation of Allowable Strains at Critical Locations:

Allowable Horizontal Tensile Strian (E_t): At Bottom of the Bituminous layer

N_f = 2.021 X 10-4 X $(1/E_t)^{3.89}$ X $(1/M_R)^{0.854}$ ---------2 (90% Reliability)

Tensile Strian(E_t) **= 139.30** Micro Strain (Allowable Tensile Strain)

Allowable Horizontal Tensile Strian(E_t): At Bottom of Cement Treated Base layer

$$N = RF\left[\frac{\left(\frac{113000}{E^{0.804}}+191\right)}{\varepsilon_t}\right]^{12} \qquad (3.5)$$

Where,

RF = reliability factor for cementitious materials for failure against fatigue

= 1 for Expressways, National Highways, Sate Highways and Urban Roads and for other categories of roads if the design traffic is more than 10 msa

= 2 for all other cases

N = No of standard axle load repetitions which the CTB can sustain

7

Tensile Strian (E_t) **= 65.55** Micro Strain (Allowable Tensile Strain)

Allowable Vertical Compressible Strian(E_v): At top of the Subgrade layer

N = 1.41 X 10^{-8} X $(1/Ez)^{4.5337}$ ---------4 (90% Reliability)

Compressive Strian(E_v) **= 301.10** Micro Strain.

Calculation of Maximum Strains at Critical Locations by IIT-PAVE:

```
No. of layers                 4
E values (MPa)         3000.00 5000.00   600.00    76.83
Mu values                 0.350.250.250.35
thicknesses (mm)        110.00   180.00   210.00
single wheel load (N) 20012.00
tyre pressure (MPa)        0.80
Dual  Wheel
```

Z	R	SigmaZ	SigmaT	SigmaR	TaoRZ	DispZ	epZ	epT	epR
110.00	0.00	-0.4455E+00	-0.2198E+00	-0.2169E+00	-0.2961E-01	0.2315E+00	-0.9754E-04	0.4001E-05	0.5312E-05
110.00L	0.00	-0.4455E+00	-0.1201E+00	-0.1148E+00	-0.2962E-01	0.2315E+00	-0.7735E-04	0.3998E-05	0.5316E-05
110.00	155.00	-0.1079E+00	-0.1238E+00	-0.1864E+00	-0.1988E+00	0.2317E+00	0.2230E-06	-0.6919E-05	-0.3512E-04
110.00L	155.00	-0.1079E+00	-0.1197E+00	-0.2325E+00	-0.1988E+00	0.2317E+00	-0.3972E-05	-0.6919E-05	-0.3512E-04
290.00	0.00	-0.4322E-01	0.3100E+00	0.2478E+00	-0.1279E-01	0.2237E+00	-0.3653E-04	0.5177E-04	0.3623E-04
290.00L	0.00	-0.4322E-01	0.2453E-01	0.1706E-01	-0.1279E-01	0.2237E+00	-0.8936E-04	0.5178E-04	0.3621E-04
290.00	155.00	-0.4298E-01	0.3217E+00	0.2393E+00	-0.2887E-01	0.2277E+00	-0.3664E-04	0.5452E-04	0.3392E-04
290.00L	155.00	-0.4298E-01	0.2599E-01	0.1611E-01	-0.2887E-01	0.2277E+00	-0.8917E-04	0.5452E-04	0.3392E-04
500.00	0.00	-0.1294E-01	0.4883E-01	0.4246E-01	-0.1814E-02	0.2100E+00	-0.5960E-04	0.6908E-04	0.5582E-04
500.00L	0.00	-0.1302E-01	0.7581E-03	0.1369E-04	-0.1814E-02	0.2100E+00	-0.1729E-03	0.6910E-04	0.5602E-04
500.00	155.00	-0.1369E-01	0.5150E-01	0.4703E-01	-0.2541E-02	0.2134E+00	-0.6387E-04	0.7194E-04	0.6263E-04
500.00L	155.00	-0.1369E-01	0.8453E-03	0.3157E-03	-0.2543E-02	0.2134E+00	-0.1835E-03	0.7194E-04	0.6263E-04

Comparision of Strains With IIT-PAVE :

S. No	Allowable Strains			IIT-PAVE Results		
	Tensile Strain below BT layer (E_t)	Tensile Strain below CTB lyer (E_t)	Vertical Compressive (E_v)	Tensile Strain below BT layer (E_t)	Tensile Strain below CTB (E_t)	Vertical Compressive Strain (E_v)
1	139.3	65.55	301.10	6.919	54.52	183.50

Note: Bituminous mixes are carried out based on MS-2 and MoRT&H Clause 505.3.2 provisions, it was assumed 3% air voids and 13% binder content by volume of the mix for DBM, and the crust thickness were worked out using eq 3.4 as given in IRC:37-2018.

However, contractor/concessionaire shall carry out the actual mix design of DBM with proposed aggregates and binder to get the best properties. Properties such as air voids and optimum binder content thus arrived shall be used for determining the actual pavement Composition. Hence, the crust composition given above is for indicative purpose only.

9.11 Recommended Pavement Option

Considering the use of the alternate materials in the composition of flexible pavement, due to the lack in the significant practical experience while adopting the mix design and performance after laying, flexible pavement option with the cemented base, cemented sub base and SAMI is adopted for flexible pavement.

Table-9.12: Recommended Pavement Composition (BT, SAMI, CTB & CTSB)

Section	Eff. CBR (%)	MSA for 20 yrs design life	Bitumen Grade	Crust Composition (mm)				
				BC	DBM	CTB	CTSB	Total
Bangalore-Kadapa-Vijayawada	10	130	VG40	50	60	180	210	500

9.12 Preliminary Design of Rigid Pavement

Rigid pavement has been designed in accordance with IRC:58-2015. The area of toll plaza including the flared portion shall be provided with concrete pavement. Rigid pavement for entire project corridor including toll plaza is considered as second alternative in accordance with IRC:58-2015.

(a) Design Life and Traffic parameters:

30 years design period has been considered. The cumulative number of commercial vehicles over 30 years design life is estimated and considered as design traffic. The design Tyre pressure has been taken as 0.80 Mpa cemented base and 0.56 MPa for granular layers.

(b) Wheel Base Characteristics

Axles with spacing of less than 4.5m (transverse joint spacing) are considered for estimation of top-down cracking damage analysis. The percentage of axles with less than 4.5m wheel base is estimated from the axle load survey.

(c) Temperature Differential:

According to Table-1 of IRC:58-2015, the temperature differential is a function of geographical location of the project road and the temperature differential to be adopted for the project area (Andhra Pradesh) is given below:

Table-9.13: Temperature Differential

Concrete Thickness	150 mm	200 mm	250 mm	300 mm – 400 mm
Temperature Differential (^{0}C)	17.3	19.0	20.3	21.0

(d) Modulus of Subgrade reaction:

Dry Lean Concrete (DLC) sub base is generally recommended for a modern concrete pavement, particularly those with high intensity of traffic.

- CBR of the subgrade soil is considered 15 % and k-value becomes 55 Mpa/m.
- 150 mm DLC layer is provided as sub-base.
- Effective k-value, after providing DLC layer is 300 MPa/m

e) Concrete Strength

The 90 days flexural strength for the pavement quality concrete (PQC) has been taken as 4.95 Mpa for the purpose of design.

(f) Modulus of Elasticity, Poisson's Ratio & Coefficient of Thermal Expansion

The modulus of elasticity (E) and Poisson's Ratio (μ) of the cement concrete vary with concrete materials and strength. The elastic modulus increases with increase in strength, and Poisson's ratio decreases with increase in the modulus of elasticity. The coefficient of thermal expansion of concrete (α) is dependent to a great extent on the type of aggregates used in concrete.

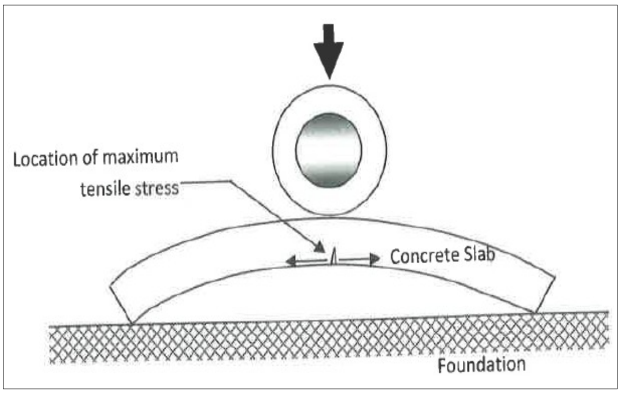
The values of the various parameters adopted are:

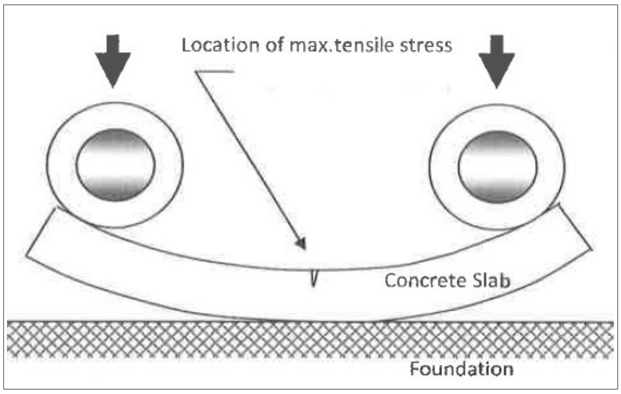
Modulus of Elasticity (E)	=	30,000 MPa
Poisson's Ratio (μ)	=	0.15
Coefficient of thermal expansion (α)	=	10×10^{-6}/ °C

g) Design of slab thickness

The flexural stress due to the combined action of traffic loads and temperature differential between the top and bottom fibers of the concrete slab is considered for design of pavement thickness. Positive temperature during day time will create bottom-up cracking and negative temperature during night will create top-down cracking in concrete slab. Hence analysis has been done for these two cases. For bottom-up cracking case, the combination of load and positive non-linear temperature differential has been considered where as for top-down cracking analysis, the combination of load and negative linear temperature differential has been taken.

For a trial slab thickness and other design parameters, the pavement will be checked for cumulative bottom-up and top-down fatigue damage. Cumulative fatigue damage (CFD) for bottom-up cracking is significant only during 10 AM to 4 PM because of higher stresses, hence the day traffic during the six hour (10 AM to 4 PM) is considered for bottom-up cracking analysis. Where as CFD for top-down cracking is significant only during 12 AM to 6 AM, hence the six hour night time traffic (12 AM to 6 AM) is considered for top-down cracking analysis.





(h) Design Thickness

Following Rigid Pavement design elements are proposed for the project road and details are provided in ***Appendix-2***.

Table-9.14: Rigid Pavement Composition

S.No	Item	Rigid Pavement Crust Composition Details
1	PQC of M40 grade (mm)	300
2	DLC of M10 grade (mm)	150
3	GSB (mm)	150
4	Dia. of Dowel bar (mm)	38
5	Length of Dowel bar (mm)	500
6	Spacing of Dowel bar (mm)	300
7	Dia. of Plain tie bar (mm)	12
8	Length of Plain tie bar (mm)	580
9	Spacing of Plain bar (mm)	370
10	Dia. of Deformed bar (mm)	12
11	Length of Deformed bar (mm)	640
12	Spacing of Deformed bar (mm)	595

9.13 Design of Shoulders

Paved Shoulder: The shoulder would be usable during all seasons of the year and hence as per Clause 5.10 of IRC:SP:99-2013 the crust composition and specification of paved shoulder shall be same as of the main carriageway.

Earthen Shoulder: Earthen shoulder shall be covered with 150 mm thick layer of granular material confirming to the requirements given in Clause 401 of MORTH specifications.

9.14 Recommended Pavement Composition for Greenfield corridor

Table-9.15: Flexible Pavement

Section	Eff. CBR (%)	MSA for 20 yrs design life	Bitumen Grade	Crust Composition (mm)					
				BC	DBM	SAMI	CTB	CTSB	Total
Bangalore-Kadapa-Vijayawada	10	130	VG40	50	60	SAMI Layer	180	210	500

9.15 Flexible Pavement Composition for Service Road

Service road pavement composition is designed for 10 MSA traffic loading as per IRC:SP-99-2013, Manual of Specifications & Standards for "Manual of Specifications and Standards for Expressways" published by IRC in 2013. The composition and thickness of component layers as worked out is given below in ***Table-9.16***.

Table-9.16: Pavement Composition for Service Roads (7.5 m wide)

S. No	Pavement composition	Design thickness (mm)	Total thickness (mm)
1	Bituminous Concrete (BC)	40	540
2	Dense Bituminous Macadam (DBM)	50	
3	Wet Mix Macadam (WMM)	250	
4	Granular Sub-Base (GSB)	200	

10.0 Preliminary Cost Estimates

10.1 Cost Estimates

Based on the improvement options considered, the quantities are estimated for:

- Construction of new carriageway
- Road side furniture including safety devices

The pavement quantities are worked out for the adopted flexible and rigid Pavement design made based on the traffic data and other design criteria. The analysis of rates has been carried out as per the Standard Data Book of MORT&H.

10.2 Unit rates

The Unit rates of all items of construction work have been analyzed as per the guidelines given in Standard Data Book of MoRT&H. The rates of materials are obtained from the Common schedule rates of Andhra Pradesh SoR (2021-22). Market rates are adopted for items for which the rates are not available in CSR. The location of material quarries like gravel, sand, crushed aggregate are obtained from the material investigations. The leads of different materials are obtained by drawing the lead chart. In respect of hourly hire and operating cost of various road construction machinery and equipment, rates given in MoRT&H Standard Data Book and CSR are considered. For machinery and equipment not covered by these two, the prevailing market rates are considered. The labour rates are taken from CSR. Unit rates so arrived have been compared with reference to the rates of similar items in the ongoing projects under NHAI and are found comparable.

10.3 Construction Quantities

The quantities of earthwork in cut and fill are calculated based on the highway design. Provision is made for hard rock excavation. The pavement quantities like Sub grade, GSB, WMM, DBM and BC are computed using the Pavement design and the typical cross section adopted. Adequate provision is made for road side furniture including safety devices and miscellaneous items. The summary of cost is as given below.

Table-10.1 Abstract of Cost

Total Project Cost	
Item Description	**Total cost in Rs.Cr**
BILL NO 1 : SITE CLEARANCE AND DISMANTLING	48.22
BILL NO 2 : EARTH WORKS	3680.77
BILL NO 3 : BASE COURSES	1167.88
BILL NO 4 : PAVING COURSES	1058.54
BILL NO 5a : REPAIR AND REHABILITATION OF STRUCTURES	-
BILL NO 5b : BRIDGES	2155.86
BILL NO 5c : CULVERTS	414.35
BILL NO 5d : UNDERPASSES	1945.75
BILL NO 5e : ROB	61.43
BILL NO 5f : DRAINAGE, PROTECTIVE WORKS AND OTHER SERVICES	942.83
BILL NO 5g : TOE WALLS	-
BILL NO 5h : INTERCHANGES INCLUDING APPROACH ROADS	1168.84
BILL NO 6 : TUNNEL	1587.00
BILL NO 7 : JUNCTIONS	8.35
BILL NO 7 : TOLL PLAZA/ TOLL BOOTH – EXCLUDING PAVEMENT	26.76
BILL NO 8 : USER AMENITIES	0.06
BILL NO 9 : TRAFFIC SIGNS, MARKINGS AND APPURTENANCES	228.80
BILL NO 10 : MISCELLANEOUS	89.64
Construction Cost including GST	**14,585**
Length of the proposed road (Kms)	**344.450**
Construction Cost in Crores per Km	**42.20**

11.0 Initial Social Impact Assessment Report

11.1 Introduction

Bharatmala Pariyojana is a new umbrella program for the highways sector that focuses on optimizing efficiency of freight and passenger movement across the country by bridging critical infrastructure gaps through effective interventions like development of Economic Corridors, Inter Corridors and Feeder Routes, National Corridor Efficiency Improvement, Border and International connectivity roads, Coastal and Port connectivity roads and Green-field expressways.

With iconic vision, the National Highways Authority of India (NHAI) envisages creating a world-class infrastructure facility to boost the interstate and intrastate economic development by inter-connecting all the project affected district head quarters, cities, major industrial hubs, places of tourism & religious importance and logistics hubs under Bharatmala Pariyojana.

Keeping the goals in mind, the NHAI has come up with the development of an expressway connectivity between Bangalore and Vijayawada by providing better infrastructure facilities and thus making this region a major potential hub for industrial development. In this regard, an expressway is planned under Bharatmala Pariyojana.

In pursuance of connecting Rayalaseema region to the southeast region of the Andhra Pradesh state the NHAI, has decided to carryout DPR for Bangalore-Kadapa-Vijayawada Expressway from Kodikonda on NH-44 in Anantapur district to Medarametla on NH-16 in Prakasham district as a strategic endeavor.

National Highways Authority of India (NHAI) has been assigned the DPR works for National Highways under BHARATMALA Project. In this regard, M/s Aarvee Associates Architects Engineers & Consultants Pvt. Ltd. Has been appointed to provide consultancy services for preparation of detailed project report of ***Greenfield Expressway*** connecting Bangalore, Kadapa and Vijayawada – approximate length 344.45 kms.

As part of this endeavour, NHAI has decided to propose greenfield alignment from Kodikonda on NH-44 to Medarametla on NH-16 with 344.45 kms. The intensity of traffic on Bangalore-Kadapa-Vijayawada road may increased in future as per the computed developmental traffic.

11.2 Project Road Description

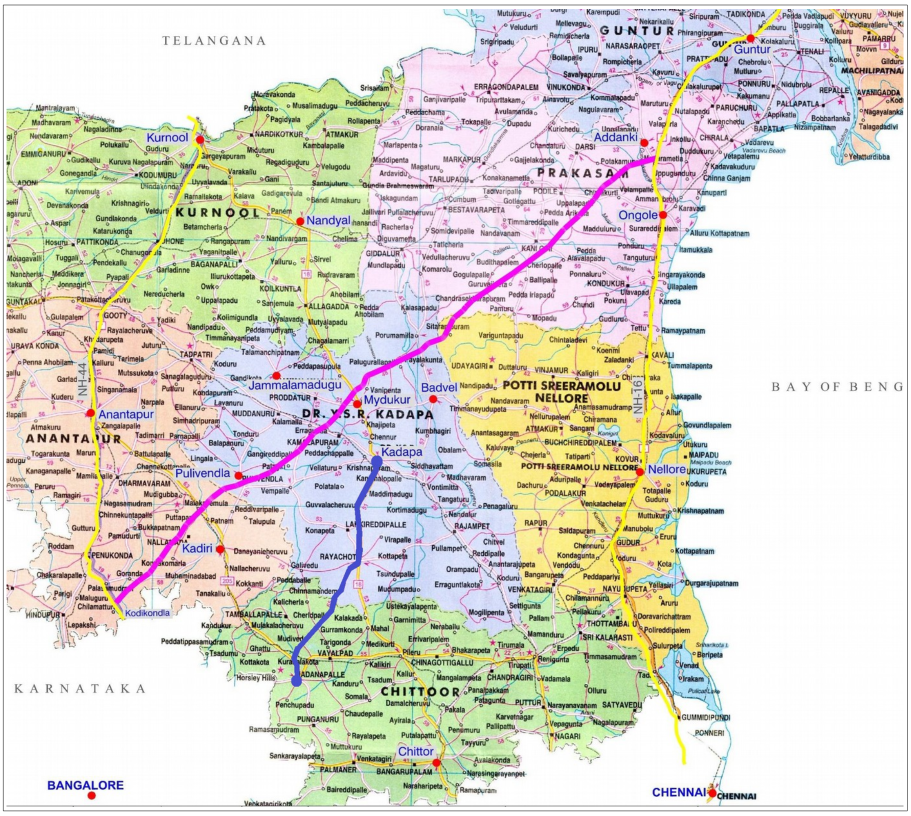
(i) Proposed Greenfield Alignment Option

Envisaging constraints with regard to improvement of existing lengthy road of Bengalore-Kadapa-Vijayawada section, a greenfield alignment comprises of 344.4500 kms in length from Kodikonda on NH-44 to Medarametla on NH-16 is proposed. The proposed road starts at Km 0.000 (design Chainage) near Kodikonda village and ends at Km 344.4500 near Medarametla.

S. No	Section	Design Chainage (Km)		Total Length (Km)	Proposed Lane Configuration
		From	To		
1	Kodikonda-Medarametla	0.000	344.450	344.450	4-Lane road with 6-lane structures.

(ii) Existing Conditions of Proposed Alignment

The project road part of expressway starts from Kodikonda village on NH-44 near AP/KN Border at Km 0+000 and ends in Medarametla village on NH-16 in Prakasham district in the state of Aandhra Pradesh. The corridor traverses through the Ananthapur, YSR Kadapa, SPS Nellore and Prakasham districts of Andhra Pradesh state. It traverses mostly



through plain terrain (80%) fallowed by Rolling terrain (20%), with agricultural fields and barren lands throughout the alignment and constraints like wild life, Reserve forest and major hills are anticipated. The Penna, Kundu, Champavathi, Gundlakamma and Sagileru are the major rivers crossing the alignment.

11.3 Need of Proposed Green Field Alignment

As per our field study, observation and through various consultations it is ascertained that greenfield alignment is inevitable for Bangalore-Kadapa-Vijayawada section. However, in the urban locations where widening of National Highway (NH-16) into expressway not possible and also to avoid/reduce the travel time and distrance, displacement and subsequent R & R implications, a new greenfield alignment is proposed.

The main objective of development of proposed road into four lane configuration is to improve the performance of national road transport network under Bharatmala Pariyojana. Apart from connectivity considerations, the corridor has been perceived to be important from the perspective of development in Anantapur, Kadapa, Nellore and Prakasham regions in particular. This alignment is completely lies in Andhra Pradesh state. About 305.500 km proposed road will be a vital link between project districts and it will carry both intra-state and inter-state traffic. For Socio-Economic analysis, identifying areas directly served by the project road, delineates the "broad" and "immediate" picture of influence areas.

11.4 Project Impacts

The proposed road improvement involves land acquisition from current owners/users. The construction of road project will have significant positive impacts, but they may simultaneously also bring negative impacts on nearby communities, if proper precaution is not taken during design and implementation stage of the project. Acquisition of land may cause social disruption and economic loss for project affected persons (PAPs) and their families. It is therefore important that disturbances and losses of PAPs due to project are minimized through proper planning with the help of Social Impact Assessment Studies. The Resettlement Action Plan needs a broad and comprehensive study and that will be incorporated in subsequent reports.

Social assessment study is generally carried out to identify critical locations and issues that need to be studied further in detail for impact assessment, mitigation measures and management plan. In socio economic point of view, the identified areas directly served by the project road delineate the broad and immediate picture of influence area.

The proposed expressway project is intended to augment the transport infrastructure in the new state of Andhra Pradesh and boost the industrial and tourism sectors by providing faster inter-region connectivity. The alignment of the corridor is planned to be as straight as possible with minimal curves and is located strategically to connect important towns of new state with National/ State Highways as well as existing and planned industrial/ tourism growth centres.

The BKV expressway from Kodikonda to Medarametla is a completely greenfield alignment. As per the decision taken by Authority, 90 mtrs of ROW is required for construction of four /six lane configuration of proposed expressway. It was proposed that this road will be designed for a speed of 100 kmph with straight alignments, avoiding habitations and locations of archaeological and religious importance. Tunnels and viaducts are proposed to be constructed to avoid hilly terrains and valley sections; the Expressway will carry all amenities viz. under passes, service roads, provision for green belt, rest houses, petrol pumps, service centers, interchanges, trumpets, toll plaza's, Truck laybays and bus laybays. All major intersections are to be improved by providing interchanges while minor junctions are improved by providing underpasses thereby minimizing the impact on expressway road user. Interchanges and Service roads are also considered to assist the road user in merging/ diverging with/ from project stretch. Salient features of the proposed project corridor are given in the fallowing table.

Table-11.1: Salient Features of Project Road

Sl. No.	Particulars	Unit	Total
1	Length of Proposed Road (Design Length)	Km.	344.450
2	Total no. of Villages (As per 3(a))	No.	253
3	Total volume of land (Tentative) to be acquired not including Interchange and Facilities	Ha.	3145.00
4	Total Volume of Land to be acquired for Interchanges and Facilities	Ha.	505.000
5	Total Volume of Land to be acquired for the Proposed greenfield alignment	Ha.	3650.00
6	Project Affected Districts	No.	4
7	Total Tentative Length of Forest/RF	Km.	27.20
8	Total volume of land (Tentative) to be acquired in Forest Area / RF locations	Ha.	244.800

11.5 Objective of the Study

The objective of the survey is to generate an inventory of social impacts on the likely to be affected people by the project. The project impacts were identified through a series of exercises including social screening during early project preparation stage and informal public consultations with villagers and road users. The screening on Kodikonda-Medarametla project corridor focuses on:

- Identification of social issues such as impact on livelihood due to land acquisition;
- Current usage of land in proposed ROW;
- Potential impact of the proposed project on productive resources, natural resources, common property resources and social infrastructures;
- Social, economic, cultural and demographic characteristics of the potential project affected, population;
- Identification and special need analysis of vulnerable groups, ethnic minorities and SC's/ST's among the population;
- Impact on Forest/RF Locations/Eco Sensitive zones.

11.6 Methodology

Approach and methodology mainly consist of quantitative and qualitative tools and techniques. The following are the activities undertaken for the social screening or initial social assessment survey.

11.6.1 Collection and review of project literature

This phase intends to familiarize with the concerned and important stakeholders to identify and collect the available literature and to scope the activities. The activity is involved in two pronged approach (a) discussions with Project Implementing authorities and other concerned, b) collection of available relevant project literature. The laws and regulations enacted by Government of India and state government of Andhra Pradesh pertaining to R & R issues. Consultations were held with concerned revenue/ government officials to establish the ownership of land. Literature review and informal discussions formed the basis for identification of key stakeholders.

11.6.2 Rapid Reconnaissance Survey to Familiarize Field Activities

In addition to review of literature and informal consultations, rapid preliminary field visits were conducted as part of ground truthing exercise. The reconnaissance survey helped to gather firsthand information on the likely to be affected area, revenue villages, land details e.g. private, government and forest etc.

11.6.3 Identification of Properties

For construction of new alignment, the social team conducted an identification exercises on different types of land within 90 meter of proposed ROW. Prior to initiation of physical identification of the properties, a detailed discussions were held with concerned officials to collect information on ownership of land. Since 3(A) activities are underway hence the type and classification of land and exact number of private land owners can not be ascertained at this stage. The exact number of likely to be affected households and thereby magnitude of impact can be determined after the completion of survey. All the affected properties belonging to legitimate owners shall be incorporated in the subsequent reports.

11.6.4 Public Consultation Meetings

Meaningful, informed, and effective public consultations are inevitable for successful of any infrastructural project. Approaches to the public involvement can yield productive, long-term and trusting relationships between citizen and government. Consultative procedures are critical but very important aspects in entire social impact assessment process. Public consultations in social impact assessment facilitates to make a rapport with the villagers and simultaneously provide clear communication about the purpose of the consultation and its relationship to the larger decision-making process.

In this regard, the social assessment ensures the involvement of local communities through participatory and structured consultations that would endorse and integrate important resettlement issues in the project cycle. In this regard, we shall disseminated the inforamation to the villagers about the characteristics of the proposed greenfield alignment in the laternal stage of the project.

11.7 Initial Social Impact Assessment (ISIA)

An Initial Social Impact Assessment (ISIA) is carried out to gauze the magnitude of impact and people's overall perception about the proposed project. It helps to understand if the project impacts are likely to be minor or limited, which can easily be predicted and evaluated, and for which mitigation measures can also be prescribed easily. Generally, information on ISIA is obtained during field visit to the areas that may probably be affected by the project road and through discussions with people whom it may affect positively or otherwise.

The ISIA is also done to confirm whether this indeed requires a full-scale Social Impact Assessment (SIA) or not. A detailed SIA therefore needs to be carried out to make project design responsive to social development concerns. Usually, a comprehensive SIA is required for large projects, which entails a more detailed study, time, and resources.

Reconnaissance and initial social assessment survey was undertaken to take a detailed note of affected properties. However, detailed survey needs to be undertaken for preparation of the Resettlement Plan as per the policy and guidelines of Central Government and State Government. In this regard, surveys relating to social assessment of the impact will be conducted within 90m of proposed Row. The focus of this study is to understand the factors underlying the agricultural activity with reference to requirement of land particularly in greenfield alignment affected villages. The input consists of a combination of secondary data and preliminary surveys and consultation with a cross-section of people.

In order to assess the potential impacts along the project corridor, critical sections from social impact point of view have been identified. Such locations have been identified with the potential issues and possible options for minimising the impact are to be suggested.

The primary information was collected through consultations with villagers to comprehend the socio-economic characteristics, physical features and cultural set-up of the project area before undertaking detailed field investigations. Relevant land inputs were also collected from local Revenue/Taluk offices.

While finalizing the road alignment efforts has to be made by adopting appropriate engineering designs, to minimize resettlement impacts. To minimize displacement and to reduce disruption of livelihoods, a greenfield alignment is proposed for the project corridor from Kodikonda on NH-44 in Anantapur district to Medarametla on NH-16 in Prakasham district of. The proposed greenfield alignment is completely lies in Andhra Pradesh state.

11.7.1 Impact on Structures

In our preliminary assessment it is found that about 42 structures comprising 33 fully affected, 9 partially affected structures and 6 wells are might be affected by the proposed greenfield alignment. As per the reconnaissance and walk through survey it is observed that agricultural land is affecting throughout the project corridor fallowed by Forest/RF and Barren lands. Out of the total likely to be impacted structures, sheds constitute a major chunk.

11.7.2 Extent of Land Acquisition

It is assessed that the proposed 90 m width would necessitate a large tract of land from government to private owners. In this regard, a huge parcel of 3650 hectares of land is to be acquired for development of greenfield alignment from Kodikonda to Medarametla for construction of 344.4500 kms.

The exact number of likely to be affected structures, wells and thereby magnitude of impact can be determined after the completion of survey. All the affected properties belonging to legitimate owners shall be incorporated in the subsequent reports. The scope of land acquisition for the project road includes a) a minimum 90 m RoW is required b) bypasses/greenfield alignment is proposed to avoid the impact on the properties and livelihood c) provisions on road side amenities. The project impacts are envisioned due to development of the Greenfield alignment & Realignments.

Table-11.2: Land Requirement (Tentative) for Proposed Alignment

Sl. No	Project Component	Length (Km)	Available RoW (m)	Required ROW (m)	Total Land Required (Ha)
1	Proposed Greenfield Alignment	344.45	0	90	3145
2	Interchange's & Facilities	-	-	-	505
Total					**3650**

11.7.3 Revenue Villages in Project Area

The proposed greenfield alignment for Bangalore-Kadapa-Vijayawada expressway, passes through 253 revenue villages. The list of villages is given in **Table-11.3.**

Table-11.3: List of revenue villages

S. No	Stretch of Land	State	District	Taluka/Mandal	Name of Village
1	From Km 0.000 to Km 75.000	Andhra Pradesh	Anantapur	Chilamathur	Settipalle
2					Chagaleru
3				Gorantla	Budili
4					Gorantla
5					Mareddipalle
6					Puleru
7					Bayanakuntapalle
8					Kammavaripalle
9					Vanavolu
10					Gownivaripalle
11					Jakkasamudram
12				Puttaparthi	Amagondapalem
13					Sataralapalle
14				Obuladevara Cheruvu	Kondakamarla
15					Daburuvaripalle
16				Nallamada	Nallamada
17					Vanakarakunta
18					Reddipalle
19					Gopepalle
20					Vellamaddi
21					Chowtakuntapalle
22				Kadiri	Patnam
23				Bukkapatnam	Kothakota
24					Agraharam
25				Talupula	Lakkasamudram
26					Odulapalle

S. No	Stretch of Land	State	District	Taluka/Mandal	Name of Village
27				Mudigubba	Malakavemula
28					Kondagattupalle
29					Sanevaripalle
30					Nagareddipalle
31					Thappetavaripalle
32					Devaragudipalle
33	From Km 197.000 to Km 215.000	Andhra Pradesh	S.P.S Nellore	Seetharamapuram	Chinthodu
34					Pandrangi
35					Seetharamapuram
36					Narayanampet
37					Singareddipalle
38					Ayyavaripalle
39					Devisettipalle
40					Nemalladinne
41					Jayapuram
42					Maramreddipalle
43					Gundupalle
44					Pabbuletipalle
45					Chinna Nagampalle
46					Pedda Nagampalle
47	From Km 215.000 to Km 344.4500	Andhra Pradesh	Prakasam	Chandrashekara puram	Kothapalle
48					Kondaboyinapalli
49					Ambavaram
50					Regula Chilaka
51					Vatla Bayulu
52					Chennapanayuni Palle
53					Medanulu Vengana Palli
54					Guntachennam Palli
55					Uppalapadu
56					Ranganayuni palle
57					Anikalla Palle
58					Nallamadugula
59					Chandrashekara puram
60					Darsi Thimmakka palli
61					Kovilampadu

S. No	Stretch of Land	State	District	Taluka/Mandal	Name of Village
62					Musunoor
63					Chintapudi
64					Komatigunta
65					Chintalapalem
66					Mundla padu
67					Peda Gogula palli
68				Pamuru	Kattakinda Palli
69				Kanigiri	Krishna Puram
70					Chilamakur
71					Vangapadu
72					Chennakesava puram
73					Chodavaram
74					Jammalamadaka
75					Guravaji Peta
76					Nagireddy palli
77					Umameheshwarapuram
78					Chirladinne
79					Takkellapadu
80					Chinna Alavalapadu
81					Nimma Maheshwarapuram
82					Kalagantla
83					Polavaram
84					Lingojipurum
85					Sankavaram
86					Chinairlapadu
87					Peramgudipalle
88					Kanigiri
89					Kodigudlapadu(west)
90					Hajispuram
91					Somanapalli
92					Punugodu
93					Kanchipuram
94					Chakirala
95					Rachagundlapadu
96					Gosulaveedu
97					Bommireddy palli
98				Veligandla	Kotala palli
99					Perugupalle
100					Marapaguntla
101					Nagireddy Palle

S. No	Stretch of Land	State	District	Taluka/Mandal	Name of Village
102					Mogallur
103					Hussainpuram
104					Bonthagunta palle
105					Manamadugu
106				Marripudi	Vankamarri palem
107					Garla peta
108					Kuchipudi
109					Marripudi
110					Ankepalli
111					Thippala Devipalle
112					Vallaya Palem
113					Gundla Samudram
114					Kellam Palle
115					Nirmammapuram
116					Pannuru
117					Gosukonda
118					Gosukonda Agraharam
119					Kakarla
120				Podili	Thallamalla
121					Lakshmipuram
122					Yeluru
123					Uppala padu
124				Darsi	Chinna Uyyalavada
125					Peddauyyalwada
126					Tripura sundari puram
127					Krishnapuram
128				Thallur	Boddikura padu
129					Madhavram
130					Sivarampuram
131					Surya Palem
132					Nagambhotla palem
133					Lakkavaram
134					Bellamkondavari Palem
135					Somavarappadu
136					Ramabhadra puram
137					Mannepalli
138					Thallur
139					Malkapuram
140				Chimakurthi	Nippatla padu
141					Budavada
142					Devarapalem

S. No	Stretch of Land	State	District	Taluka/Mandal	Name of Village
143				Addanki	Kunkupadu
144					Modepalle
145					Nannuru padu
146					Kotikala pudi
147					Manikeshwaram
148					Ramayapalem
149					Addanki(South – R)
150					Addanki(North – R)
151					Bommanampadu
152				Janakavarampangu luru	Kondamur
153					Kasayapuram
154					Reningavaram
155					Bytamanjulur
156					Muppavaram
157				Korisapadu	Pichikalagudi padu
158	From Km 75.000 to Km 197.000	Andhra Pradesh	YSR Kadapa	Pulivendula	Kanampalle
159					K.Veliamavanipalle
160					Bokkudupalle
161					Polepalle
162					Erraballe
163					Ulimella
164					Kachivaripalle
165					Bakarapuram
166				Thondur	Thimmapurampeta
167					Gotur
168				Vemula	Velpula
169					Peddajutur
170					Chinthalajutur
171					Gollalagudur
172					Pendluru
173					Nallacheruvupalle
174					Yadavakunta
175					Pernapadu
176				Vempalle	Alavalapadu
177					Muthukuru
178					Naguru
179					Ramireddypalle

S. No	Stretch of Land	State	District	Taluka/Mandal	Name of Village
180				Veerapunayunipalle	Moillacheruvu
181					North Palagiri
182					Animela
183					Kommaddi
184					Indukur
185					Gangireddypalle
186					Lingala
187					Ayyavaripalle
188					Keerthipalle
189					Urutur
190					Talapanur
191					Payasampalle
192				Yerraguntla	Peddanapadu
193					Koduru
194					Thippaluru
195					Valasapalle
196					T.Sunkesula
197				Kamalapuram	Thurakapalle
198					Yerragudipadu
199					Kokatam
200					Pachikalapadu
201					Apparaopalle
202					Pandillapalle
203					Sambatur
204					Mirapuram
205				Chapadu	Vedurur
206					Ananthapuram
207					Kutchupapa
208					Buddipadu
209					Peddaguruvalur
210					Alladupalle
211					Thummalapadu
212					Chapad
213					Kethavaram
214					Bhadripalle
215					Nerrawada
216					Somapuram
217					Morrayapalle
218					Chiyyapadu
219					Pitchapadu

S. No	Stretch of Land	State	District	Taluka/Mandal	Name of Village
220				Duvvuru	Chinthakunta
221				S.Mydukuru	S Mydukuru
222					Gaddamayapalle
223					Lingaladinne
224					Ganjikunta
225					Onipenta
226					Audireddipalle
227					Mittamanipalle
228					Thippireddipalle
229					Yakarlapalem
230					Settivaripalle
231					Mudireddypalle
232				Brahmagarimattam	Mallapalle
233					Palugurallapalle
234					Papirediipalle
235					Pulugurallapalle
236					Akkampet
237					Akkampetapadu
238					Mudumala
239				Sri Avadutha Kasinayana	Itigulapadu
240					Savisettipalle
241					Vankamarri
242				B.Kodur	Munnelli
243					Bodugundupalle
244				Porumamila	Pulliveedu
245					Perammagaripalle
246					Ranga Samudram
247					Boppapuram
248					Chennareddi peta
249					Chinnayapalle
250					Cherlopalle
251					S. Veerlapalle
252					Siddavaram
253					Chinayerasala

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11.7.4 Impact on Trees

The entire proposed road section from Kodikonda to Medarametla is flanked by high dense of trees except in Forest/RF locations. Greenfield alignment is proposed for the entire corridor due to this reason huge amount of agricultural fields and a few number of trees are going to be affected in barren lands and in forest areas the number trees affecting are more. The trees not only serve as natural sheds during summer but also enhance the beauty of the area. A huge number of Milletia Pinnata, eucalyptus, Saman trees and Shrub are present along the greenfield alignment. With regard to development of this expressway road, thousand of trees will be felled to make space for expansion.

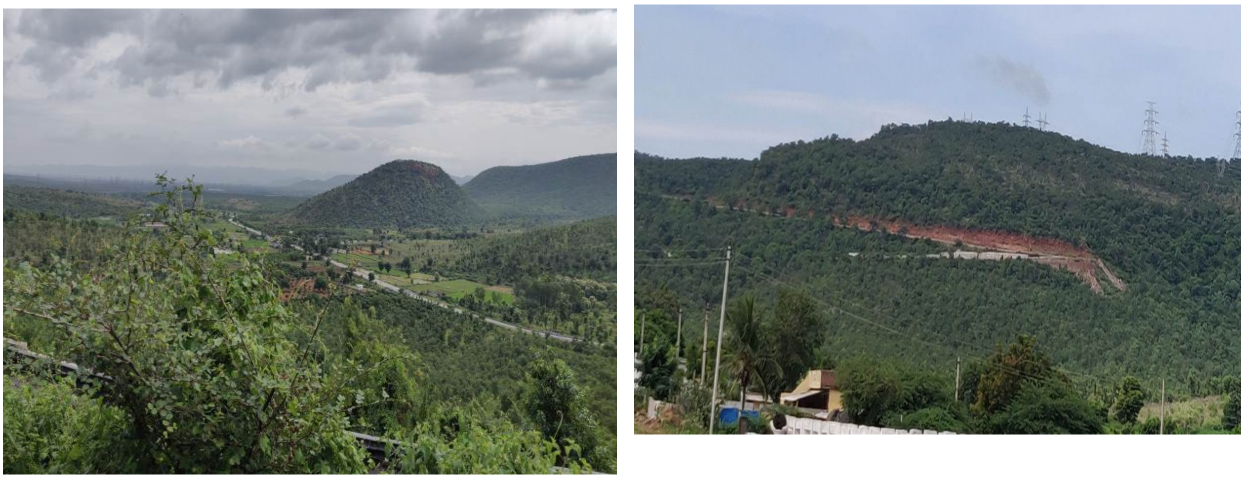

Figure-11.1: A few photographs of Trees along the project road

4.7.5 Indigenous People and Vulnerable Groups

Indigenous people are defined as those having a distinct social, cultural, economic, and political tradition and institutions compared with the mainstream or dominant society. According to Indian Constitution, indigenous people with similar cultural characteristics are recognized as Scheduled Tribes (ST). However, not a single household was found across project villages during informal consultation.

The number of likely to be affected ST population will be known after the completion of census and socio economic survey. Proper provisions and adequate measures need to be taken to protect these vulnerable community.

11.7.6 Gender Issues

The consideration of gender issues is crucial in the planning and implementation of resettlement and rehabilitation programs. Special needs and requirements of women must be considered and addressed in all program aspects site selection, site and housing design, provision of civic infrastructure, access to service, provision of land and housing title, payment of compensation, and income restoration etc.

According to LARR Act the widowed, divorced and women deserted by family is to be considered separate family. As per the primary assessment, women's participation and attendance in meeting is moderate in project area. However, majority of them do have decision making power at household level financial matters. Social and cultural factors may exclude women from participating actively in planning, implementing, and executing resettlement activities. Special efforts need to be made to ensure their inclusion. The resettlement policy provides women to be involved in the process of sustainable development.

11.8 Land Use Pattern

In project area, the land use is characterized by agricultural lands, barren and Reserve forest. The agricultural land accounts for 92 percent of the total land to be acquired for the proposed project road. With regard to land use pattern, a major track of land is used for cultivated purpose followed by barren land. In project area the land is classified as wet, dry, manavari, natham and poramboke etc. The high power transmission lines pass through most of the land viz. agricultural, barren and forest that pose threat to live and plant as well. During transect visit in proposed greenfield area, sparsely cultivated land with Mangoes, rice, sugar cane, Cotton, Tomato, Pulses, Mirchi, paddy and Jawar were noticed.

Figure-11.2: A Few Photographs of Land Use Pattern of the Project Area

11.9 Cropping Pattern

Rice, Corn, Sugar Crane, Cotton, Millets and Pulses is the principal crops grown in all districts. Apart from it, watermelon, mango cumbu are also cultivated in project villages as observed. The fertile land is unevenly distributed and found in scattered region. Rainfed, canal and well is the primary source of irrigation. The huge tract of project area is considered to be a dry region. The cropping pattern varies from taluk to taluk. Wet cultivation indicates to paddy cultivation in all project districts and the major share of the . Paddy is cultivated mainly in project villages.

Figure-11.3: A Few Photographs of Cropping Pattern of the Project Area

11.10 Land Value in Project Village

The land price particularly under private transaction, varies from place to place. The market price of agricultural land ranges from Rs. 3 lakh to 8 lakh per hectare in greenfield area of Bengalore-Kadapa-Vijayawada expressway section. The private land transaction in built-up locations recorded at Rs. 2 lakh – 9 lack per hectare. The land value in villages close to Anantapur, YSR Kadapa, SPS Nellore and Prakasham districts has gone up significantly in last 3 to 6 years because of proximity to urban improvement and also bifurcation of new state.

11.11 Legal Policies & Resettlement Frameworks

11.11.1 Principles and Policies needs to be adopted for the Project

The core involuntary resettlement and rehabilitation principles for this project are:

(i) Land acquisition, and other involuntary resettlement impacts will be avoided or minimized exploring all viable alternative project designs;

(ii)Where unavoidable, time-bound resettlement action plan (RAP) will be prepared and APs will be assisted in improving or at least regaining their pre-project standard of living;

(iii) Consultation with APs on compensation, disclosure of resettlement information to APs, and participation of in planning and implementing sub-projects will be ensured;

(iv) Payment of compensation to APs for acquired assets at replacement rates;

(v) Payment of compensation and resettlement assistance prior to the construction contractor taking physical acquisition of the land and prior to the commencement of any construction activities.

11.11.2 Minimization of Social Impacts

According to the broad principle mentioned above, an appropriate decision by engineering, environmental and social impact assessment teams has to be taken to avoid land acquisition from fertile lands.

11.11.3 Rehabilitation and Relocation of PAPs

Restoring livelihood for project affected people is an important task in resettlement plan. The required support shall be extended to the affected households during relocation (if required) and a time bound, fair & just entitlements shall also be given to the people to compensate and regain their pre-project level status.

11.11.4 National Highways Act- 1956

Land acquisition for National Highways is done in accordance with the procedure laid in "The National Highways Act, 1956". The act is applicable to the whole of India except the state of Jammu and Kashmir. The policy provides a broad guideline of procedure for land acquisition. The National Highways Act 1956 (NH Act) is commonly used for acquisition of land for public purpose of the road. It is used at the State level made to suit local requirements.

As a general practice Revenue Divisional Officer / Joint Collector in the district level is appointed as Competent Authority for Land Acquisition (CALA). Competent authority means any person or authority authorised by the Central Government, by notification in the Official Gazette, to perform the functions of the competent authority for such area as may be specified in the notification.

11.11.4.1 Intention & Declaration

When a National Highways require a land, an application is required to be made by it to the revenue authority;

3(a) - Intention to Acquire Land: The Central Government upon publication of the Gazette nominates "Competent Authority for Land Acquisition" and expresses its intention to acquire land in respective revenue villages;

After the government has been fully satisfied about the purpose, the least area needed, and other relevant facts as provided under land acquisition rules, it will issue a notification under Section 3A of the act that the particular land is required for public purpose;

3(A)- Power to Acquire Land: The central Government upon publication of this Gazette expresses its intention to acquire such land for construction, maintenance and management of National Highways. The same shall be intimated to the public through two local news papers, one of which will be in vernacular language.

The application should be accompanied with a copy of the plan showing survey nos., purpose of acquisition and the reason for the particular site to be chosen and the provision made for the cost of the acquisition;

The Competent Authority will hold an inquiry under Section 3-B of the Act;

3(B) - Power to entry for Survey: Upon getting the 3(A) notification published in the official Gazette, authorised persons are empowered to carryout survey, investigations and can cut trenches.

After notification the owner is prohibited from selling his property or disposing it off and prevented from carrying out any works of improvements for which no compensation will be paid if executed without prior permission from the collector.

11.11.4.2 Objection and Confirmation

Objections are invited from all persons interested in the land within 21 days from the date of notification under Section 3-A.

- The objections will be valid on one or more of the following grounds:
- That the purpose for which the land is proposed for acquisition is not a public purpose.
- That the land is not or less suitable than another piece of land for the said purpose.
- That the area under acquisition is excessive.
- That the acquisition will destroy or impair historical or artistic monuments or will desecrate religious buildings, graveyards and the like.

3(C)- Hearing of Objections: Any person interested in the land may within twenty-one days from the date of publication of the notification under sub-section (1) of section (3A), object to the use of the land for the purpose or purposes mentioned in that sub-section.

- The CALA after hearing the objections will submit his report to the Central government, who will finally declare the land for acquisition under Section 3-D of the Act.

3(D)- Declaration for Acquisition: After hearing the objections the competent authority shall submit a report accordingly to the Central Government for declaring the extents of land proposed for acquisition. The Central Government shall declare, by notification in the Official Gazette, that the land should be acquired for the purpose or purposes mentioned in sub-section (1) of section 3(A).

- Upon publication of the declaration in the official Gazette the land shall vest absolutely in the Central Government free from all encumbrances. A declaration made by the Central Government under sub-section (1) shall not be called in question in any court or by any other authority.
- After notification the collector proceeds with the claim. He is authorized to mark out the site, measure and plan of the same made vide Section 3-E.
- Power to take possession: For the lands vested in the Central Government under section 3(D) upon determining the compensation, the competent authority shall intimate by notice in writing direct the owner as well as any other person who may be in possession to surrender or deliver possession to the competent authority or any person duly authoritative within sixty days of the service of the notice.

11.11.4.3 Claim and Award

- The collector will issue notices under Section 3-G to all persons interested in the acquisition to file their claim reports;
- The collector is not to be a party to the proceedings, is to possess an expert knowledge on valuation, and offers a fair price to an owner and checks that the public funds are not wasted;
- The claim filed should contain the names of the claimants and co-shares, if any rents or profits for last three years and a valuation report of the land from an architect or an engineer;
- In determining the compensation the market value of the land is determined at the date of notification. The rise and fall in the value during the period of transaction and notification is taken into consideration;

Compensation is also payable when:

- Part of the property is proposed for acquisition in such a manner that the remainder depreciates in value.
- When the land notified for acquisition has standing crops or trees.
- If the person interested has to change his place of residence or business then the excess rent payable for the new premises is also considered for compensation.

Matters which are not taken into consideration for the purpose of land acquisition are:

- The degree of urgency which has led to the acquisition.
- Any disinclination of the person interested to part with the land.
- Any increase in the land value likely to accrue from the use to which it will be put when acquired.
- After necessary inquiries the collector declares his award showing true area of the land, total amount of compensation payable and apportionment of compensation if there are more than one owners or claimants.
- The collector has to make the award under section 11 within a period of two years from the date of notification.

11.11.5 The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation & Resettlement Act, 2013

The 1894 Land Acquisition Act was repealed and a new comprehensive legislation was brought in Parliament and it came to effect on 1st January 2014. This Central Act ensures, in consultation with institutions of Local Self-Government and Gram Panchayats established under the Constitution, a humane, participative, informed and transparent process of land acquisition for industrialization, development of essential infrastructural facilities and urbanization with the least disturbance to the owners of the land and other affected families and provide just and fair compensation to the affected families whose land has been acquired or proposed to be acquired or are affected by such acquisition and make adequate provisions for such affected persons for their rehabilitation and resettlement and ensuring that the cumulative outcome of compulsory acquisition should be that the affected persons become partners in development leading to an improvement in their post-acquisition social and economic status and for matters connected therewith or incidental thereto.

The provisions of this Act Under Section 2(1) relating to land acquisition, compensation, rehabilitation and resettlement, shall apply, when the appropriate government acquires land for its own use, hold and control, including for Public Sector Undertakings and for public purpose.

Under LARRA- 2013 for land acquisition for various types of project, provisions of consent has been inbuilt to secure the interest of the stakeholders. As far as this project is concerned [when the appropriate government acquires land for infrastructural projects under Section-2 (1) (B) (Vii)] consent is not required.

Table-11.4: Consent Requirements For Project As per Types and Sites

Protect Type + Area	Consent	
	Land Owners and Tenants	Gram Sabha/ Panchayat/ Autonomous district Council
Public + Non-Scheduled Area	Not required	Not required
Public + Scheduled Area	Not required	Required
PPP + Non-Scheduled Area	Required (70%)	Not required
PPP + Scheduled Area	Required (70%)	Required
Private + Non-Scheduled Area	Required (80%)	Not Required
Private + Scheduled Area	Required (80%)	Required

Source: LARR Act-2013, Ministry of Law and Justice

The LARRA, 2013 provides a framework for facilitating land acquisition in India. LARRA, 2013 enables the State Government to acquire private land for public purposes. With regard to land acquisition for the proposed alignment, NHAI has to adopt its own act (Schedule-IV, LARR Act). For provision of compensation and other applicable entitlements it is bound to abide by the guiding principles laid down under Schedule-I and II, LARR Act-2013. Table-1.7 presents the sections of LARRA Act-2013.

11.11.6 Scheduled Caste and Scheduled Tribes Orders (Amendment) Act, 2002

The Act provides for the inclusion in the lists of Scheduled Tribes (ST), of certain tribes or tribal communities or parts of or groups within tribes or tribal communities, equivalent names or synonyms of such tribes or communities, removal of area restrictions and bifurcation and clubbing of entries; imposition of area restriction in respect of certain castes in the lists of Scheduled Castes (SC) and the exclusion of certain castes and tribes from the lists of SCs and Sts.

11.12 Various Provisions Under LARR Act-2013

Table-11.5: The Land Acquisition, Rehabilitation and Resettlement Act, 2013

1. LAND ACQUISITION
In case of land acquisition the amount of compensation to be determined is that of the value of the land +100 percent Solatium+12 percent additional market value from the date of notification to taking over the possession or award whichever is higher. **Market value of land as mentioned under section 26 of LARRA Act-2013 needs to be multiplied by the radial factor (based on the distance of project from urban area as notified by the appropriate government- e.g multiplication of 2 in Rural area and Multiplication of 1 in Urban area) plus value of assets attached to land or building (mentioned in Section 29 of LARRA Act-2013) Plus Solatium (solatium includes 100% market value multiplied by 2 plus value of assets in Rural area and multiplied by 1 plus value of assets in urban area)**
2. PROVISION OF HOUSING UNITS IN CASE OF DISPLACEMENT
If a **house is lost in rural areas, a constructed house shall be provided as per the Indira Awas Yojana specifications.** If a **house is lost in urban areas, a constructed house shall be provided, which will be not less than 50 sq mts in plinth area.** The benefits listed above shall also be extended to any affected family which is without homestead land and which has been residing in the area continuously for a period of not less than three years preceding the date of notification of the affected area which has been involuntarily displaced from such area: Provided that any such family in urban areas which opts not to take the house offered, shall get a one-time financial assistance for house construction, which shall not be less than one lakh fifty thousand rupees:

Provided further that if any affected family in rural areas so prefers, the equivalent cost of the house may be offered in lieu of the constructed house:

Provided also that no family affected by acquisition shall be given more than one house under the provisions of this Act.

Explanation- The houses in urban areas may, if necessary, be provided in multi-storied building complexes

3. CHOICE OF ANNUITY OR EMPLOYMENT

The appropriate Government shall ensure that the affected families are provided with the following options:

(a) where jobs are created through the project, **mandatory employment at a rate not lower than the minimum wages** provided for in any other law for the time being in force, to at least one member per affected family in the project or arrange for a job in such other project as may be required; or

(b) one time **payment of five lakhs rupees** per affected family; or

(c) annuity policies that shall pay not **less than two thousand rupees per month per family for twenty years,** with appropriate indexation to the Consumer Price Index for Agriculture Labourers.

4. SUBSISTENCE GRANTS

The appropriate Government shall ensure that the affected families are provided with the following options:

Given monthly subsistence allowance equivalent to **three thousand rupees per month for a period of one year** from the date of award. In addition to this amount, the scheduled castes and the scheduled Tribes displaced from Scheduled Areas shall receive an **amount equivalent to fifty thousand rupees.**

5. TRANSPORTATION COST

The appropriate Government shall ensure that the affected families are provided with the following options:

Each affected family which is displaced shall get a one time financial assistance of **fifty thousand rupees** as transportation cost for shifting of the family, building materials, belongings and cattle.

6. CATTLE SHED/ PETTY SHOPS COST
Each affected family having cattle or having a petty shop shall get one-time financial assistance of such amount as the appropriate Government may, by notification, specify subject to a **minimum of twenty-five thousand rupees** for construction of cattle shed or petty shop as the case may be.
7. ONE TIME GRANTS TO ARTISAN, SMALL TRADERS AND OTHERS
Each affected family of an artisan, small trader or self-employed person or an affected family which owned non-agricultural land or commercial, industrial or institutional structure in the affected area, and which has been involuntarily displaced from the affected area due to land acquisition, shall get one-time financial assistance of such amount as the appropriate Government may, by notification, specify subject to a minimum of twenty-five thousand rupees.
8. ONE TIME RESETTLEMENT ALLOWANCE
Each affected family shall be given a one-time "Resettlement Allowance" of fifty thousand rupees only.
9. STAMP DUTY REGISTRATION
(1). The stamp duty and other fees payable for registration of the land or house allotted to the affected families shall be borne by the Requiring Body. (2). The land for house allotted to the affected families shall be free from all encumbrances. (3). The land or house allotted may be in the joint names of wife and husband of the affected family.
10. PROVISION OF INFRASTRUCTURAL AMENITIES
1. Roads within the resettled villages and an all weather road link to the nearest pucca road, passages and easement rights for all the resettled families be adequately arranged. 2. Proper drainage as well as sanitation plans executed before physical resettlement. 3. One or more assured sources of safe drinking water for each family as per the norms prescribed by the Government of India. 4. Provision of Drinking water for cattle. 5. Grazing land as per proportion acceptable in the State. 6. A reasonable number of Fair price Shops 7. Panchayat Ghars, as appropriate. 8. Village level Post Offices, as appropriate, which facilities for opening saving accounts. 9. Appropriate seed-cum-fertilizer storage facility if needed.

10. Efforts must be made to provide basic irrigation facilities to the agricultural land allocated to the resettled families if not from the irrigation project, then by developing a cooperative or under some Government scheme or special assistance.

11. All new villages established for resettlement of the displaced persons shall be provided with suitable transport facilities which must include public transport facilities through local bus services with the nearby growth centres/ urban localities.

12.Burial or cremation ground, depending on the caste communities at the site and their practices.

13. Facilities for sanitation, including individual toilet points.

14. Individual single electric connections(or connection through non-conventional sources of energy like solar energy), for each household and for public lighting.

15.Anganwadi's providing child and mother supplemental nutritional services.

16. School as per the provisions of the right of children to Free and Compulsory Education Act, 2009 (35 of 2009);

17. Sub-health centre within two kilo metres range.

18. Primary Health Centre as prescribed by the Government of India.

19. Playground for children.

20. One community centre for every hundred families.

21. Places of worship and chowpal/tree platform for every fifty families for community assembly, of numbers and dimensions consonant with the affected area.

22. Separate land must be earmarked for traditional tribal institutions.

23. The forest dweller families must be provided, where possible, with their traditional rights on non-timber forest produce and common property resources, if available close to the new place of settlement and, in case any such family can continue their access or entry to such forest or common property in the area close to the place of eviction, they must continue to enjoy their earlier rights to the aforesaid sources of livelihood.

24. Appropriate security arrangements must be provided for the settlement, if needed.

25. Veterinary service centre as per norms.

11.SPECIAL PROVISIONS FOR SCHEDULED CASTE AND SCHEDULED TRIBES

(1) In case of a project involving land acquisition on behalf of a Requiring Body which involves involuntary displacement of the Scheduled castes or the Scheduled Tribes families, a Development plan shall be prepared, in such form as may be prescribed, laying down the details of procedure for settling land rights due but not settled and restoring titles of tribals

on alienated land by undertaking a special drive together with land acquisition.

(2) The Development Plan shall also contain a programme for development of alternate fuel, fodder and non-timber forest produce resources on non-forest lands within a period of five years sufficient to meet the requirements of tribal communities as well as the Scheduled castes.

(3) The concerned Gram Sabha or the Panchayats at the appropriate level in the Scheduled Areas under the Fifth Schedule to the Constitution or , as the case may be, Councils in the Sixth Scheduled Areas shall be consulted in all cases of land acquisition in such areas, including acquisition in case of urgency, before issue of a notification under this Act, or any other Central Act or a State Act for the time being in force as per the Provisions of the Panchayats (Extension to the Scheduled Areas) Act, 1996 (40 of 1996) and other relevant laws.

(4) In case of land being acquired from members of the Scheduled Castes or the Scheduled Tribes, at least one-third of the compensation amount due shall be paid to the affected families at the outset as first instalment and the rest shall precede the taking over of the possession of the land.

(5) The Scheduled Tribes affected families shall be resettled preferably in the same Scheduled Area in a compact block, so that they can retain their ethnic, linguistic and cultural identity.

(6) The resettlement areas predominately inhabited by the Scheduled castes and the Scheduled Tribes shall get land, to such extent as may be decided by the appropriate Government, free of cost for community and social gatherings.

(7) In case of a project involving land acquisition on behalf of a Requiring body, the affected families belonging to the Scheduled Castes and the Scheduled Tribes resettled out of the district of acquisition will get twenty-five percent. Higher monetary benefits under Rehabilitation and Resettlement Scheme.

(8) Any alienation of tribal lands or lands belonging to members of the Scheduled Castes in disregard of the laws and regulations for the time being in force shall be treated as null and avoid; and in the case of acquisition of such lands, the rehabilitation and resettlement benefits shall be available to the original tribal land owners or land owners belonging to the Scheduled Castes.

(9) The affected Scheduled Tribes, other traditional forest dwellers and the Scheduled castes families having fishing rights in a river or pond or dam in the affected area shall be given fishing rights in the reservoir area of the irrigation or hydel projects.

(10) Where the affected Scheduled Castes and Scheduled Tribes are relocated outside of

the district then they shall be paid an additional twenty-five percent. Rehabilitation and Resettlement benefits to which they are entitled in monetary terms along with a one-time entitlement of fifty thousand rupees.

11.13 Entitlement Matrix

The broad entitlement matrix comprising the R & R compensation and assistance is presented in below table. The land owner (titleholder) will receive compensation for land and assets, as decided by the competent authority. The titleholders are also entitled to receive R & R assistance/ allowances and exempted from stamp duty. They should be given advance notice to harvest non-perennial crops, or compensation for lost standing crops. They will have the right to salvage material from existing structures.

The LARR-2013, represents a significant milestone in the development of a systematic approach to address resettlement issues in India and closes significantly the gap between Indian national policies and operational policy of the World Bank/ADB. All the affected persons irrespective of ownership status are eligible for respective allowances. The Act gives directives for the acquisition of land in the public interest and even provides assistance to landless, agricultural labours, tenants, sharecropper, dependents and those who reside preceding three years prior to land acquisition for their loss of livelihood/income under R & R provision.

Table-11.6: Entitlement Matrix

S. No	Category of Impact	Eligibility for Entitlement	TRFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
1	2	3	4	5	6
1.	Loss of Land	Land Owner	Compensation for land shall be considered at Market value of land. This will be determined by the district Collector as per Sections 26 to 29 of TRFC & TLARR (LARR) Act-2013).	(a) Compensation at market value of the land (b) Multiplier factor upto 2 for rural area (c) Value of the assets attached to land (d) Building/Trees/Wells/Crop etc. as valued by relevant govt. authority; (e) Solatium: 100% of total compensation (f) Additional 12% per anum on market value of land from the date of the publication of the notification of the SIA to till the date of the award or the date of taking possession of the land.	The method of calculation of market rate: The minimum land value, if any, specified in the Indian Stamp Act, 1899 for the registration of sale deeds in the area, where the land is situated; (or) the average of the sale price for similar type of land situated in the immediate areas adjoining the land being acquired, ascertained from fifty per cent of the sale deeds registered during the preceding three years, where higher price has been paid; (or) Consented amount of compensation as agreed upon under sub-section(2) of Section 2 in case of acquisition of lands for private companies or for public private partnership projects, whichever is higher

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S. No	Category of Impact	Eligibility for Entitlement	TRFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
			Amount equivalent to current stamp duty and registration charges on compensation amount for replacement of lost assets.		All the entitlements for loss of land will be provided for each survey number based on ownership records to the legitimate owner or their heirs as applicable.
			Land Value factor	Scale 1 to 2 based on the distance of project from urban area, as may be notified by appropriate government. Illustrative scale (0-10 km=1), (10-20=1.20), (20-30 km=1.40), (30-40 km=1.80), and (40-50 km=2).	The proposed alignment passes through rural areas in Anantapur, YSR Kadapa, SPS Nellore and Praksham districts of Andhra Pradesh state. Thus, as per First Schedule of LARRA 2013 the radial factor of 2 shall be applicable for calculating the market value of the land.
		Affected Family / Person	Land for land	Not applicable	Not applicable

S. No	Category of Impact	Eligibility for Entitlement	TRFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
2.	Loss of other Immovable Assets	Titleholder	Value of Assets attached to land or building	To be considered: Standing crops, Trees, Livelihood loss.	As per LARRA 2013 under First Schedule Sl. No.2 (ref. Section 29).
3.	Loss of Land, Structure and other immovable assets (1+2)	Titleholder	Solatium	100% on total compensation (including value of assets)	Under Section 30(1) of the LARRA Act 2013. The compensation is calculated for land and structures as applicable and the total compensation of all lost properties taken into account before considering the solatium. As per Section 30(1) of the Act Solatium of 100% on the compensation be considered.
4.	Loss of Land and other assets	Titleholder	Additional 12% on market value of land.	In addition to the market value of land, additional 12% per annum to be paid on such market value commencing on and from the date of publication of notification, till award or date of taking possession of land whichever is earlier.	Provision made Under section 30 (3) of the LARR Act 2013.

S. No	Category of Impact	Eligibility for Entitlement	TRFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
5a.	Loss of Structure	Titleholder	Provision of Housing unit or value of the lost structure	(a) If a house is lost in urban areas, a constructed house shall be provided, which will be not less than 50 sq. mts. in plinth area. (b) Provided also that no family affected by acquisition shall be given more than one house under the provisions of this Act. (c) Provided that any such family in urban areas which opts not to take the house offered, shall get a one-time financial assistance for house construction, which shall not be less than one lakh fifty thousand rupees. (Rs. 1,50,000.00). (d) Provided further that if any affected family in rural areas so prefers, the equivalent cost of the house may be offered in lieu of the constructed house; (e) Provided also that no family affected by acquisition shall be given more than one house under the provisions of this Act.	As per section 30 (3) of the LARR Act-2013.

S. No	Category of Impact	Eligibility for Entitlement	TRFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
				Explanation: The houses in urban areas may, if necessary, be provided in multi-story building complexes.	
5b.	Loss of Structure	Non-titleholder	Provision of Housing unit or value of the lost structure	The benefits listed above shall also be extended to any affected family which is without homestead land and which has been residing in the area continuously for a period of not less than three years preceding the date of notification of the affected area and which has been involuntarily displaced from such area: (a) Provided that any such family in urban areas which opts not to take the house offered, shall get a one-time financial assistance for house construction, which shall not be less than one lakh fifty thousand rupees. (Rs. 1,50,000.00). (b) Provided further that if any affected family in rural areas so prefers, the equivalent cost of the house may be offered in lieu of the constructed house;	Even Non-titleholder is eligible as mentioned in II Schedule of this LARR Act-2013 but it solely depend on the prerogative of the Executing Authority.

S. No	Category of Impact	Eligibility for Entitlement	TRFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
				(c) Provided also that no family affected by acquisition shall be given more than one house under the provisions of this Act. **Explanation:** The houses in urban areas may, if necessary, be provided in multi-story building complexes.	
5c.	Loss of Livelihood	Affected Family / Person	Annuity or Employment (a) Job OR (b) 5 lakh one-time payment OR (c) Rs. 2000.00 per month for 20 years (with increment) (the option of availing a, b, or c shall be that of the affected family)	Where jobs are created through the project affected families will get after providing suitable training and skill development in the required field, make provision for employment at a rate not lower than the minimum wages provided for in any other law for the time being in force, to at least one member per affected family in the project or arrange for a job in such other project as may be required; (or) (b) onetime payment of five lakhs rupees (Rs.5,00,000) per affected family; (or)	As per Second Schedule of LARRA Act.

S. No	**Category of Impact**	**Eligibility for Entitlement**	**TRFCTLARR Act- 2013 Provisions**		**Remarks**
			Entitlement	**Provisions**	
				(c) Annuity policies that shall pay not less than two thousand rupees per month per family for twenty years, with appropriate indexation to the Consumer Price Index for Agricultural Labourers. (Refer: http://labourbureau.nic.in).	
6.	Loss of Livelihood	Affected Family / Person	Subsistence grant for displaced families for a period of one year (even if the families displaced due to land acquisition)	Each affected family which is displaced from the land acquired shall be given a monthly subsistence allowance equivalent to three thousand rupees per month for a period of one year from the date of award. (Rs. 3000.00 per month for one year = 36,000.)	As per Second Schedule of LARRA Act.
				In addition to this amount, the Scheduled Castes and the Scheduled Tribes displaced from Scheduled Areas shall receive an amount equivalent to fifty thousand rupees. (Rs. 50000.00).	Provision made in Second Schedule of LARR Act- 2013

S. No	Category of Impact	Eligibility for Entitlement	TRFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
7.	Structure	Affected Family / Person	Transportation cost for displaced families.	One time financial assistance of Rs. 50000.00 for shifting family, building material, belongings and cattle.	Provision made in Second Schedule of LARR Act- 2013.
8.	Structure	Affected Family / Person	Commercial Establishments including Owners and Tenants	Each affected family having cattle or having a petty shop shall get one time financial assistance of such amount as the appropriate government may, by notification, specify subject to a minimum of Rs. 25000.00 for construction of cattle shed or petty shop as the case may be.	Provision made in Second Schedule of LARR Act- 2013.
9.	Livelihood	Affected Family / Person	One time grant to artisan, small traders and certain others	Each affected family of an artisan, small trader or self-employed person or an affected family which owned non-agricultural land or commercial, industrial or institutional structure in the affected area, and which has been involuntarily displaced from the affected area due to land acquisition, shall get one-time financial assistance of such amount as the appropriate Government may, by notification, specify subject to a minimum of Rs. 25000.00.	Provision made in Second Schedule of LARR Act- 2013.

S. No	Category of Impact	Eligibility for Entitlement	TRFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
10.	Land / Structure/ Livelihood	Affected Family / Person	One time resettlement allowance.	Each affected family shall be given a one-time "Resettlement Allowance" of Rs. 50000.00.	As per LARRA 2013 under Second Schedule of the Act.
11.	Land / Structure	Titleholder	Stamp duty and registration fee.	(a) The stamp duty and other fees payable for registration of the land or house allotted to the affected families shall be borne by the Requiring Body. (b) The land for house allotted to the affected families shall be free from all encumbrances. (c) The land or house allotted may be in the joint names of wife and husband of the affected family.	Provision made in Second Schedule of LARR Act-2013
12.	Land / Structure/ Livelihood	Affected Family / Person	Any other unforeseen impact	Any unforeseen impact would be addressed and mitigated as necessary by the Implementing Agency.	