STUDY OF ROAD NETWORK AND TRAFFIC CONDITIONS OF MEERUT :

a review of present scenario

A DISSERTATION

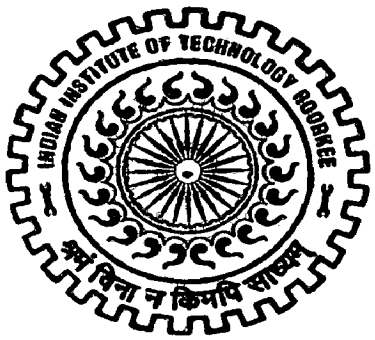
Submitted in partial fulfillment of the requirements for the award of the degree

of

MASTER OF URBAN AND RURAL PLANNING

By

PRABHAT KUMAR



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CANDIDATE'S DECLARATION

I hereby certify that the work, which is being presented in the dissertation, entitled **"STUDY OF ROAD NETWORK AND TRAFFIC CONDITIONS OF MEERUT : a review of present scenario"**, in partial fulfillment of the requirement for the award of the Degree of MASTER OF URBAN AND RURAL PLANNING submitted in the Department of Architecture and Planning, Indian Institute of Technology - Roorkee, is an authentic record of my own work carried out during the period from May 2006 to June 2007 under the supervision of Dr. Ashutosh Joshi, Assistant Professor and Dr. Nalini Singh, Associate Professor, Department of Architecture and Planning, Indian Institute of Technology - Roorkee.

The matter embodied in this dissertation has not been submitted by me for the award of any other Degree.

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ABSTRACT

Urban Transport is one of the most important components of urban infrastructure. A good network of roads and an efficient Mass Urban Transport System make a substantial contribution to the "working efficiency" of a large city. A poor urban transport system may slow down economic growth of the city and also lead to its decay.

Meerut is one of the metropolitan cities and a priority town of NCR region. If we see the present scenario, lots of construction activities are taking place. Due to this expansion and the modernization of the city, the pressure on the road is increasing. As a result, the Meerut city is getting congested day by day. This problem is more in the radial arterial roads. Basically this is due to Poor quality of roads network in terms of surface type, encroachment, significant proportion of slow-moving traffic and absence of pedestrian paths.

The study was done for the radial arterial roads of Meerut city. Analysis of field data has been used as an approach to solve the problem. Major variables are the traffic characteristics, users' preferences, landuse pattern, population growth, and increasing urbanization. Traffic forecast has been done for the year 2021. Based on the standard parameters, the radial arterial roads of the Meerut have been analyzed. The secondary analysis conducted of changes and trends over the last two decades.

The analysis reveals that rapid population growth plays an important role in the field of infrastructure planning. The study also says that the problem occur mainly due to the mixed kind of traffic and no special provision for them. There is an urgent need of

transportation plan as no transportation plan is acting at present. Non development of proposed ring road is another cause of entering the unwanted vehicles in to city.

The analysis suggests that proper utilization of road width can solve the problem to some extant but not completely. On street parking is another cause of congestion the city centre, as there are lot of commercial activities are taking place, so there is as urgent need of creating parking places with in the city limits. Study also suggests that improvement of junctions, flyover over the railway live and road crossings, subways and footpaths are having the first preference in the queue of priorities.

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INTRODUCTION

CHAPTER 1: INTRODUCTION

1.1. BACKGROUND

A road is an identifiable route, way or path between two or more places. Roads are typically smoothed, paved, or otherwise prepared to allow easy travel and historically many roads were simply recognizable routes without any formal construction or maintenance. In urban areas roads may pass through a city or village and be named as streets, serving a dual function as urban space easement and route. Economics and society depend heavily on efficient roads.

Roads are not just the routes along which people in vehicles move from one part of environment to another. Like building, the roads have users and like building it has to serve the needs of the different types of users. Roads have a heterogeneous mix of users whose needs are not only different but also often conflicting. This makes the task of road design very complex and demanding great sensitivity and imagination, this is more in urban roads.

Urban transport facilities in most of the Indian cities are inadequate and deteriorating over the years. The development of public transport system has not kept pace with the traffic demand both in terms of quality and quantity. As a result, the use of the undesirable modes such as personalized transport, mainly two-wheelers, and intermediate public transport, mainly three- wheelers, is growing at a rapid speed. Roads and footpaths today are heavily encroached by parked vehicles, hawkers, and roadside business forcing pedestrians to walk on the road. This results not only in restricting the traffic flow, but also putting the pedestrians' life at a great risk. Besides encroachment, it is found that road surface in most of the Indian cities is substandard. In addition, lane

marking and traffic signs are usually missing and the intersections often require geometric correction. Wholesale goods centers are usually located in center of the city, which attract substantial goods traffic on congested city roads.

The road sector suffers from a number of problems including the ones listed below:

1. Insufficient investment in the primary network given the rapidly growing demand for road transport,
2. Inadequate and sub optimal allocation of resources for road maintenance,
3. Limited private sector participation in development of the sector,
4. Institutional constraints of the key road agency, the Public Works Department (PWD) and
5. PWD's lack of customer focus as well as absence of road user and broader citizen involvement in sector management.

The road network is one of the most valuable assets in Meerut, facilitating the movement of many thousands of freight and helping millions of people to access workplaces and services every day. The network has very significant positive impact on society through stimulating growth, generating employment and helping to integrate the State, as well as some negative impacts by way of death and injury on the roads, environmental damage and social costs in terms of community severance or destruction of cultural property.

The PWD is responsible for the planning, design, construction and maintenance of SHs and MDRs, bridges and buildings, as well as the construction and maintenance of NHs on behalf of the Government of India (GoI). To manage and maintain the road

network effectively and to meet the transport demands of a modernising economy, the PWD needs to improve its efficiency and develop a structure and incentive system that motivates its staff. To date, the performance of PWD has been measured largely in terms of expenditure progress instead of benefits to road users. Road planning needs updating and in particular requires the systematic collection and analysis of data from the field.

1.2. Road Development in India

The economic development of the country and the consequent surge in the demand for transport services, and also the strategic needs of the country necessitated expansion as well as improvement of the road network. The country took up this uphill task in a planned manner.

Recognizing the need to develop arterial routes to link the Union capital with the state capitals, major seaports and other highways, the National Highways Act, 1956 was enacted. In 1957, the chief -engineers (road and bridges development) of the Central and the state governments met in Bombay. Having taken into account the size of area, population, regional levels of development and feature potential, the engineers presented a 20-year Road Development Plan (1961-81) in 1958 which is popularly known as the Bombay Plan.

The Plan anticipated an increase in road length from 6. 10 lakh km in 1960 to 10.50 lakh km in 1981. The Plan target was to achieve a density of 32.5 km of roads per 100 sq km of area, 44 km for developed agricultural areas, 19 km for semi-developed and 12 km for underdeveloped areas at an estimated cost of Rs 5,200 crore, including Rs 630 crore for village roads.

The Bombay Plan set a target of 8.88 lakh km of major district roads, order district roads and classified village roads. This target was exceeded in 1978 with the construction of 9.7 lakh km of roads. The target of 98,000 km of state highways could only be achieved a decade later. Of the target of 52,000 km only 34,619 km was achieved till 1 April, 1997.

Another Road Development Plan (1981-2001), known as the Lucknow Plan of the Indian Road Congress, has made a case for 66,000 km of National Highways by 2001 A.D.

The National Transport Policy Committee, set up in 1978 under the chairmanship of B. D. Pandey, submitted its report in May 1980. It recommended 37 roads with a 12,955 km length for inclusion in the National highway network. Out of these, only 11 roads, aggregating 3,595 km length, were completed over a span of one-and-a-half decades.

The Government of India instituted an Asian Development Bank-aided study in February 1990 on Development of Long-Term Plan for Expressways in India. The study was completed in 1991 and it has recommended development of 10,020 km of expressways by 2015 at an estimated cost of Rs 58,000 crore.

1.3. NEED OF THE STUDY

The road networks in India are not only used by different types of users but also for purposes other then the movement of traffic and accessibility. The failure of Indian roads arises mainly due to:

1. The existence of different types of users
2. use of roads other than the traffic and accessibility

In the design and planning process of urban roads, there is urgent need to shift the focus from motorized vehicles to all types of vehicles and other types of road users

Meerut is one of the metropolitan cities and a priority town of NCR region. If we see the present scenario, lots of construction activities are taking place. Due to this expansion and the modernization of the city, the pressure on the road is increasing. As a result, the Meerut city is getting congested day by day. So there is an urgent need of study the road network and the traffic conditions.

1.4. AIM AND OBJECTIVES

1.4.1. Aim

The aim of the study is to overview the road network of Meerut city and to give a use full solution for the betterment of its problem.

1.4.2. Objectives

1. To study the traffic flow pattern at begum bridge junction,
2. To study of demand of road users,
3. To analyze the problems at major roads i.e. Delhi road, Baghpat road, Baraut road, Sardhana road, Roorkee road, Mawana road, parishitgarh road, Garh road, and Hapur road (map no. 01)
4. To provide a better solution for the problem.

1.5. SCOPE

At present the road of the city are not able to fulfill the needs of all road users. Also rapid urbanization in the city needs some study for the proper movement on the roads. The

outcome of this work is expected to make the city congestion free as well as to fulfill the special demands of the rapidly urbanizing areas.

1.6. LIMITATIONS

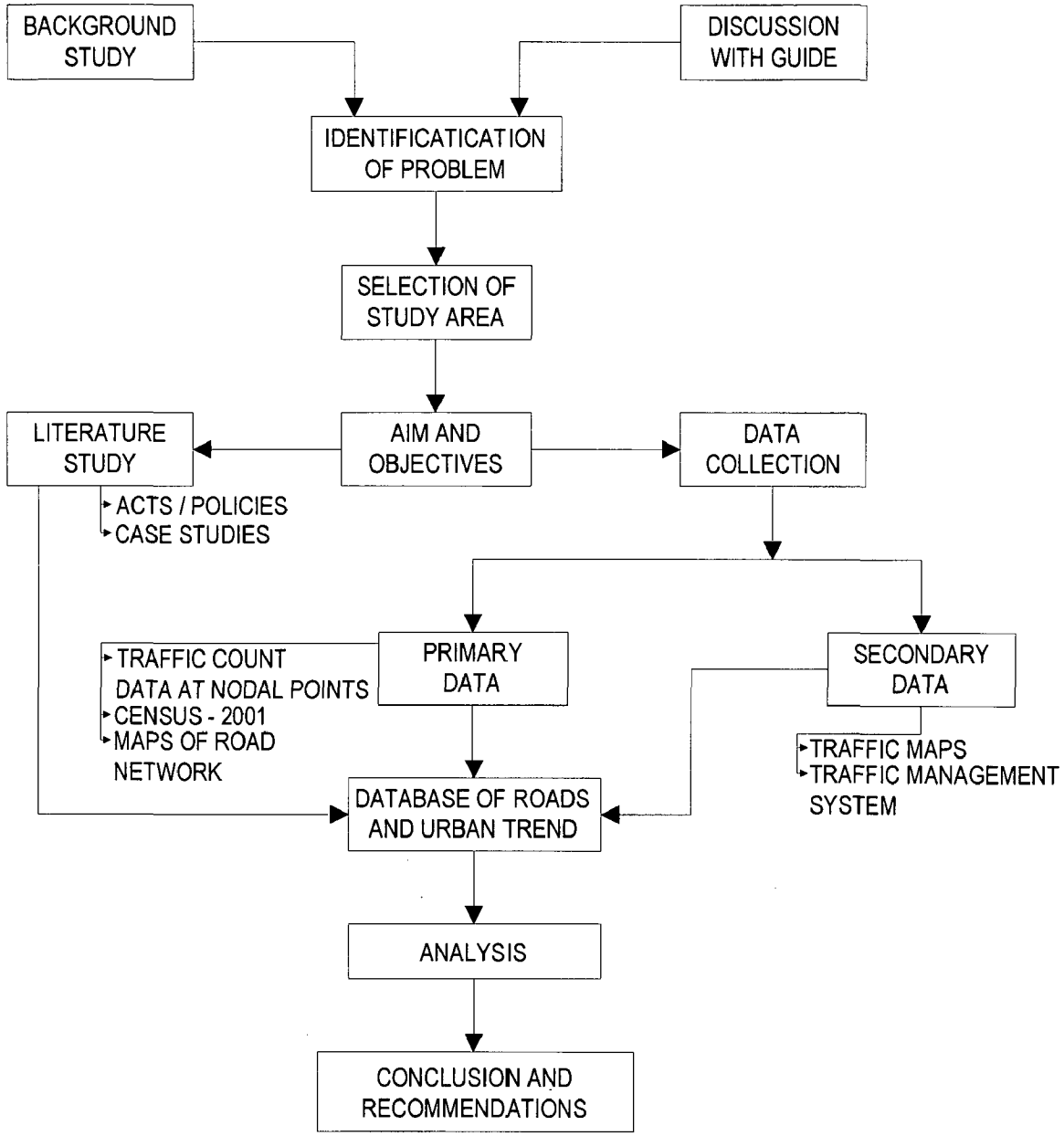
1. Only selected stretches of urban roads are studied in this work i.e.
   1.1. Delhi road,
   1.2. Baghpat road,
   1.3. Baraut road,
   1.4. Sardhana road,
   1.5. Roorkee road,
   1.6. Mawana road,
   1.7. parishitgarh road,
   1.8. Garh road, and
   1.9. Hapur road.
2. The solution may not be the perfect solution for other Indian cities
3. The bulk of the data is taken from Meerut Development Authority, T.C.P.O., Meerut division, and from the various reports and the data is presumed to be correct.

1.7. METHODOLOGY

The methodology adopted to fulfill the objectives as identified earlier covers the following stages:

1. **Literature Survey**
   a. Literature available on the internet,
   b. Literature available in the books.

2. **Case studies**– To understand the traffic flow characteristics and the bottlenecks of the road network two Case studies will be studied; one is metropolitan city Vijayawada which is a part of Andhra Pradesh state, and the second case study which is referred to understand the traffic phenomenon in the NCR region is Delhi NCR.
3. **Study of Site** – The site i.e., Meerut will thereafter be studied in terms of climate, existing landuse, road network, traffic characteristics etc.
4. **Identification of problem** – The problems will then be identified through field surveys and secondary data base.
5. **Study of problems** – all the problems will be studied and analyzed. The inputs to the database are derived from the literature studies, data from secondary survey, and field survey and reconnaissance survey.
6. **Proposals & Recommendations** – Finally after the detailed analysis, proposals & recommendations will be given.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LITERATURE STUDY
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TRAFFIC COUNT DATA AT NODAL POINTS
CENSUS - 2001
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TRAFFIC MANAGEMENT SYSTEM
DATABASE OF ROADS AND URBAN TREND
ANALYSIS
CONCLUSION AND RECOMMENDATIONS

LITERATURE AND CASE STUDIES

2.1. GENERAL OVERVIEW

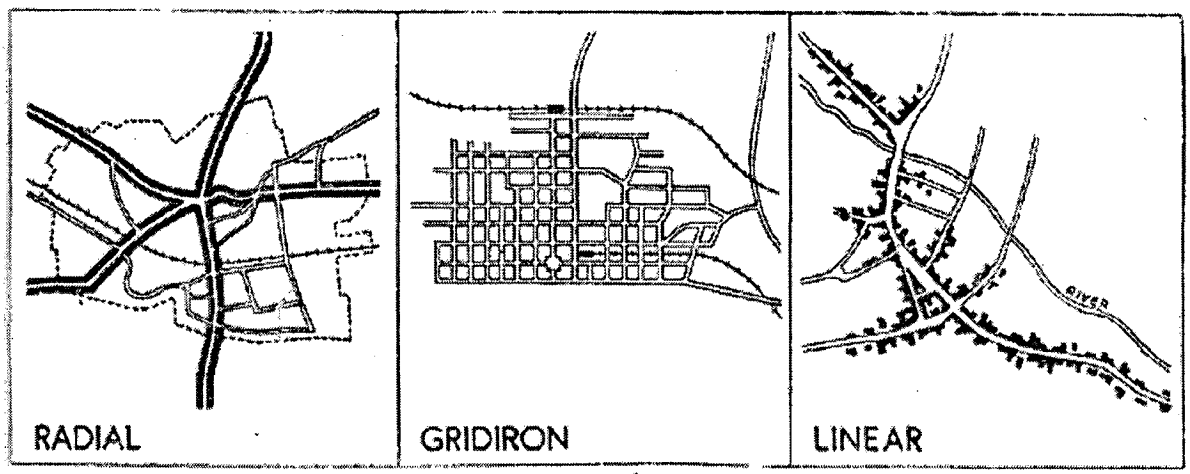
2.1.1. The Road Pattern : *Types*

Broadly speaking, there are three principal types of urban road pattern,

1. Radial,
2. Gridiron, and
3. Linear,

of which the first is the predominant type in this country, however unsymmetrical its outline may be. The tendency has been for centers of population to grow up at road intersections and, as these centres extend outwards, for new routes to develop from the hub.

Figure 2.1. types of road networks



2.1.2. Traffic function of roads

1. In the majority of towns radial and ring roads form the principal routes for through and local-through traffic.
2. Where there is a substantial volume of arterial traffic passing through a town provision should be made for a by-pass.
3. The main radials are the connecting links with the arterial road system and should be regarded primarily as through traffic routes.
4. Where circumstances make it desirable to provide for a large volume of high-speed traffic having its origin or destination in a large town or conurbation, or where, by reason of topography or prior development, a by-pass cannot be located outside built-up areas, consideration should be given to the construction of a sub-surface or elevated road rather than to attempt to mould a high-speed highway at ground level into the existing road pattern.

2.1.3. Factors to be considered in layout design

Roads in built-up area fall to be considered in relation to both

1. Their location and
2. Their design.

Within (1) main factors to be considered are:

1. The points of origin and destination of arterial traffic, with due regard to future developments, such as re-location of railway termini, or the provision of airport,
2. The present or proposed use-zoning of the area,

3. The principal movement of the traffic from one part the town to another, including daily movement of the population,
4. Alignment which will facilitate satisfactory treatment of road intersection.

Within (2) the main factors to be considered are:

1. The volume, type and variation of vehicular, cycle and pedestrian traffic,
2. The use to be made of road frontage.

2.1.4. **Estimating by-passable traffic**

Data from traffic surveys lead to the following assumptions:-

- In towns up to 10,000 population 80 percent of the entering traffic is by-passable.
- In towns of 10,000 to 50,000 population 65 percent of the entering traffic is by-passable.
- In towns of 50,000 to 100,000 population 45 percent of the entering traffic is by-passable.
- In towns of 100,000 to 250,000 population 20 percent of the entering traffic is by-passable.
- In towns of 250,000 to 500,000 population 15 percent of the entering traffic is by-passable.
- In towns of 500,000 to 1,000,000 population less than 10 percent of the entering traffic is by-passable.

Where there is justification for a by-pass, but the route selected materially increases the distance to be traveled, or imposes undesirable gradients, there is reluctance on the part of drivers to deviate from the shortest road, and the new route must be so planned on free flow principles as regards terminal points, alignment, gradient, freedom from frontage access, intersections at surface level and speed restrictions as to compensate for any additional length.

2.1.5. **Relation of the bypass to the urban road system**

The function of a by-pass is to provide an attractive alternative route for traffic which has no valid reason to pass through the busy streets of a built-up area, thereby alleviating conditions which on existing routes, contribute to danger, congestion and delay.

2.1.6. **Radial Road**

The point of convergence of radial roads constitutes in most towns the crux of the traffic problem. Main radials serve primarily the needs of through traffic and minor radials the needs of local-through traffic.

The problem however becomes increasingly difficult as the radial road approaches the town centre. Unless the width between buildings is sufficient to permit the construction of waiting lanes or service roads the elimination of standing vehicles is almost impossible

The improvement of the radial roads existing towns so that they may be brought into conformity with reasonable standards of free flow and safety must be by a continuous, though it may be slow, process of widening associated with the

reconstruction of adjacent buildings. This assumption emphasizes the importance of providing at outer ring road designed to attract traffic which have no real need to enter the inner part of the town.

Connections with other road

Provision must be made for convenience and safe connections between the radial and ring roads. Broadly speaking, three types of design are available:

1. The fly-over,
2. The roundabout either of the double-deck type or at surface level and
3. Intersections controlled by traffic signal.

2.1.7. Ring Road

Ring roads can be divided into three classes; outer, intermediate, and ineer.

2.1.7.1. Outer Ring Road

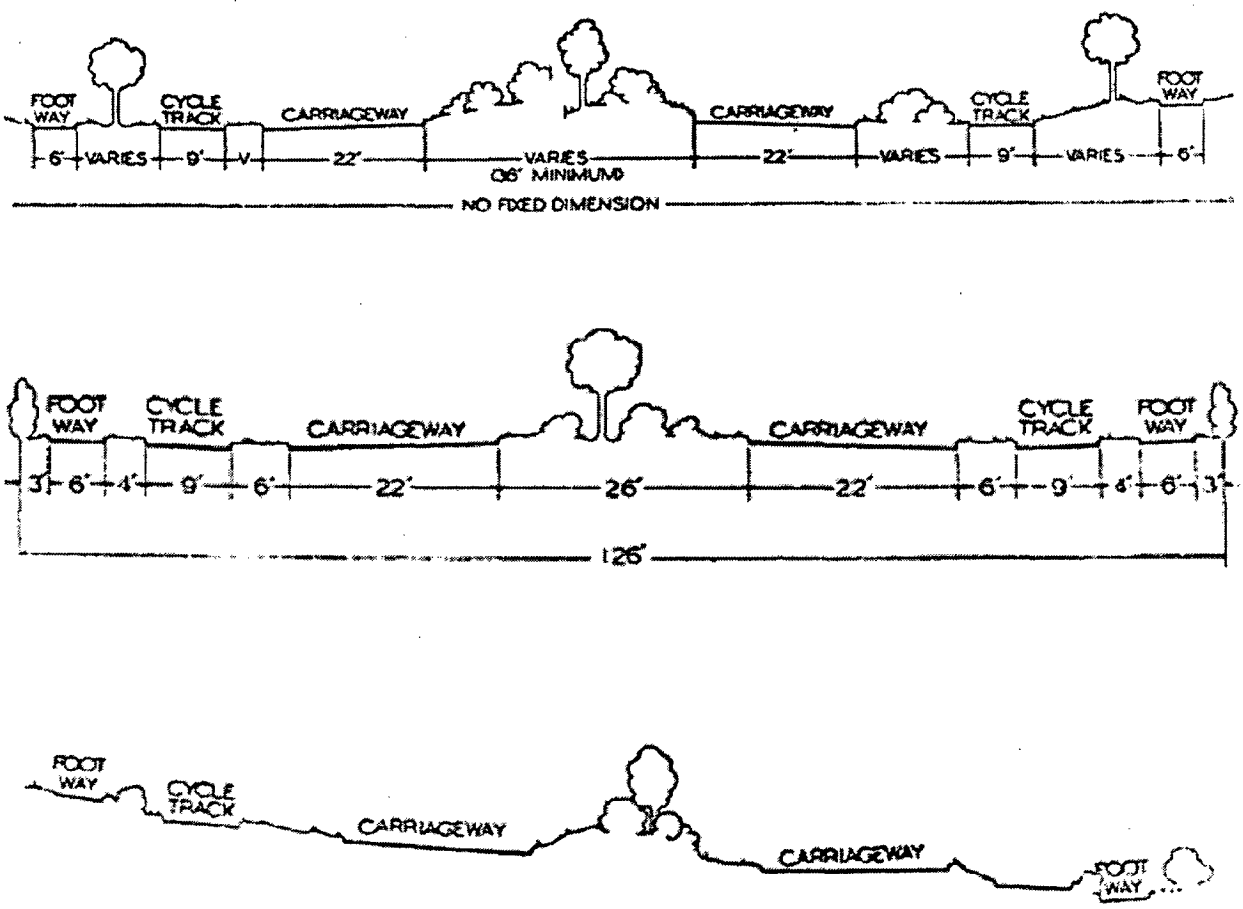
In most towns, however, the primary function of an outer ring road is to serve the traffic of the town itself by linking up the outer communities and acting as a distributor between the radials. On this assumption it should be located not outside the limits of the town but within the outer fringe of present and potential urban development.

Principles of location and design

The location and design of an outer ring road should be based on the following principles:

1. Its predominant function is to serve the needs of local through traffic.
2. For this purpose it should not be all-circumscribing but located within the outer fringe of present and potential development.
3. It should be so designed as to compensate for the detour involved in its use by facilities for higher speed, added convenience, safety and amenity.
4. Provision should be made upon it for all classes of traffic, i.e., vehicular, pedal cyclist and pedestrian.
5. Frontage development entailing direct means of access should not be permitted.

Figure 2.2 cross section standard for outer ring road



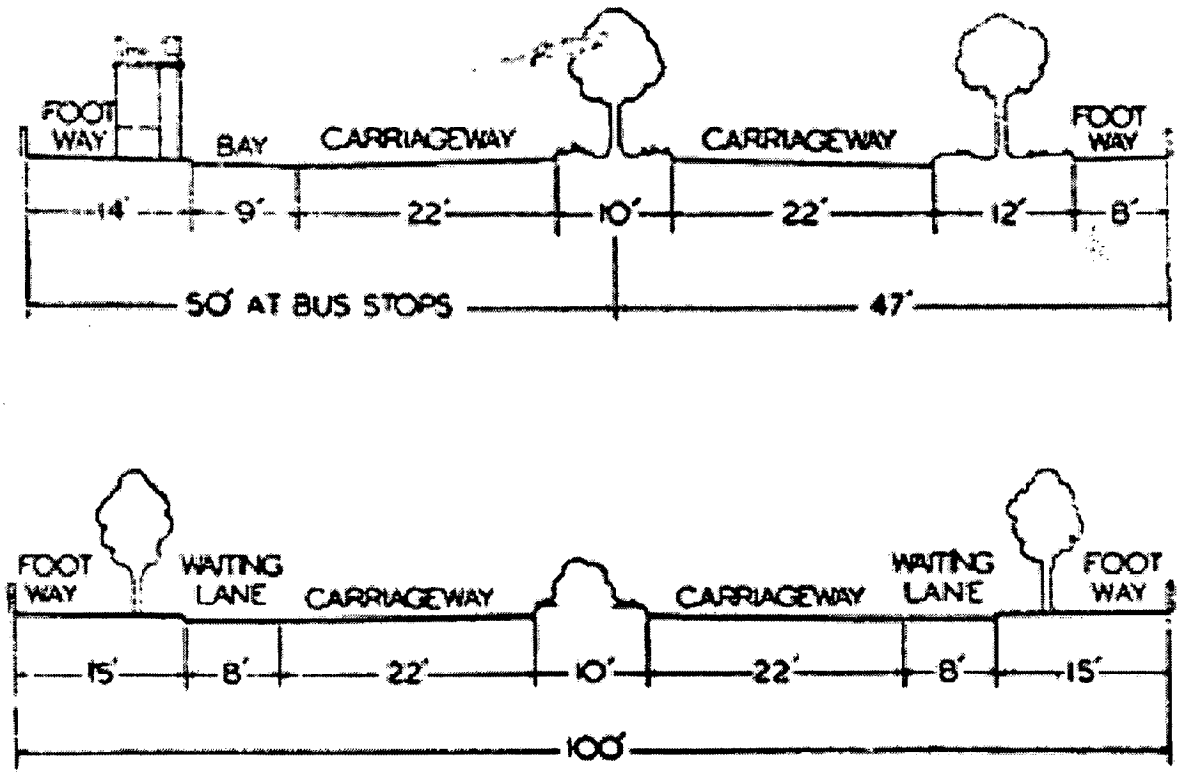
2.1.7.2. **Intermediate Ring Roads**

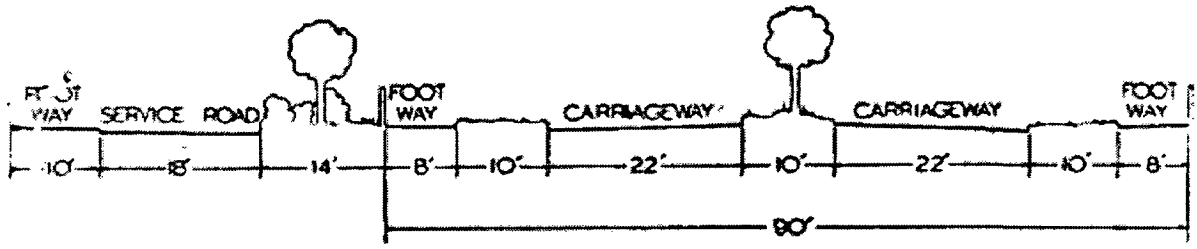
Intermediate ring roads serve primarily the needs of traffic whether from a distance or of local origin desiring to reach points between the outer and inner ring roads. They will normally be located in areas already partially developed.

Connections with other roads

Fly-over connections of the intermediate ring road with the main or minor, radials will rarely be practicable, and roundabouts should in general be adopted. Connections with subsidiary roads should be treated in accordance with the principles.

Figure 2.3 Cross section standards for intermediate ring road





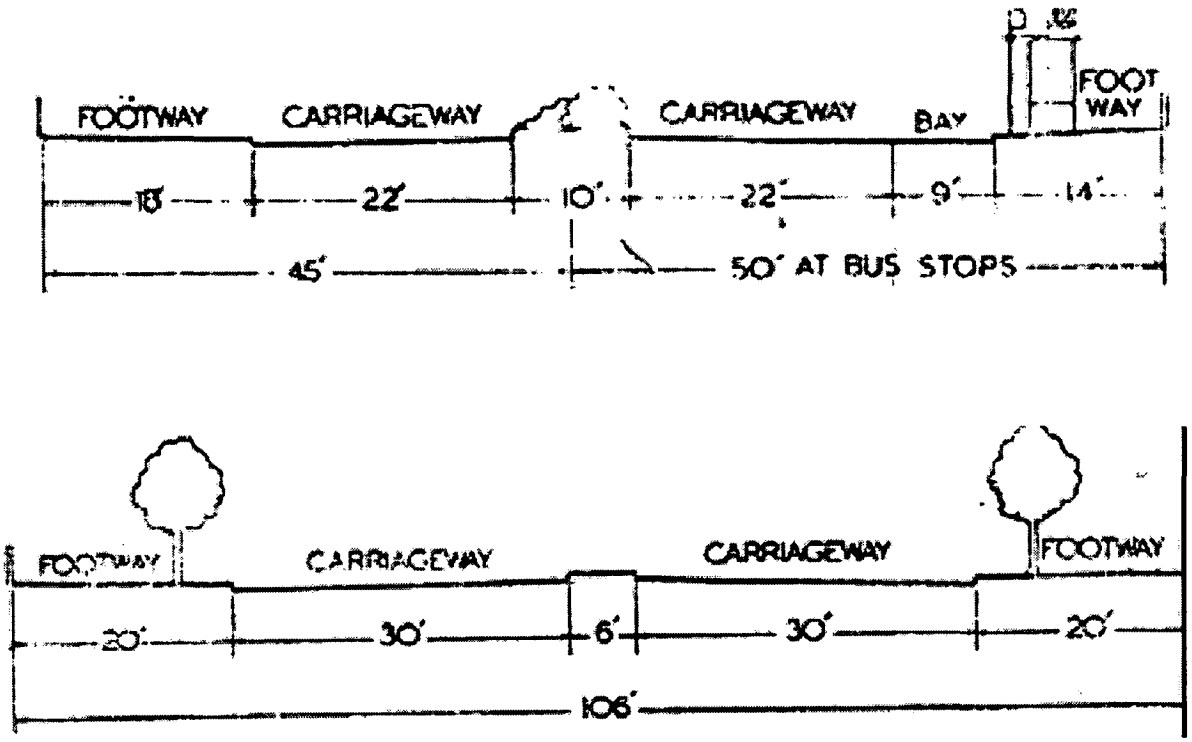
2.1.7.3. **Inner Ring Roads**

The inner ring road should not be regarded as a route for through traffic other than that having its points of origin or destination in the central area. Its traffic function is to serve the needs of local-through and local traffic, and its purpose to promote the convenient use and the amenity of the central area by deflecting from it all vehicles which have no need to traverse it. Its location and design is therefore closely bound up with the size, layout and use of the central area.

Traffic requirements of inner ring road

If all or most public service vehicles are to be excluded from the central area, the inner ring road will become a more or less continuous picking up and setting-down circuit for them. Provision for this purpose must be made in its design a layout; its overall width should be sufficient to allow for a waiting lane on each side of the divider carriageway and for footways. If, therefore, the volume of moving traffic estimated to use the inner ring road is such as to require two lanes in each direction in order to maintain free flow, the overall width will be of the order of 100ft. made up of two footways, each 15 ft. wide, carriageways each 30 ft or 31 ft. wide.

Figure 2.4 cross section standards for inner ring road



2.2. **Literature studies**

2.2.1. **National urban transport policy 2006**, ministry of urban development, GOI.

The objective of this policy is to ensure safe, affordable, quick, comfortable, reliable and sustainable access for the growing number of city residents to jobs, education, recreation and such other needs within our cities. This is sought to be achieved by:

1. Incorporating urban transportation as an important parameter at the urban planning stage rather than being a consequential requirement
2. Encouraging integrated land use and transport planning in all cities so that travel distances are minimized and access to livelihoods, education, and

other social needs, especially for the marginal segments of the urban population is improved

3. Improving access of business to markets and the various factors of production
4. Bringing about a more equitable allocation of road space with people, rather than vehicles, as its main focus
5. Encourage greater use of public transport and non motorized modes by offering Central financial assistance for this purpose
6. Enabling the establishment of quality focused multi-modal public transport systems that are well integrated, providing seamless travel across modes
7. Establishing effective regulatory and enforcement mechanisms that allow a level playing field for all operators of transport services and enhanced safety for the transport system users
8. Establishing institutional mechanisms for enhanced coordination in the planning and management of transport systems
9. Introducing Intelligent Transport Systems for traffic management
10. Addressing concerns of road safety and trauma response
11. Reducing pollution levels through changes in traveling practices, better enforcement, stricter norms, technological improvements, etc.
12. Promoting the use of cleaner technologies
13. Raising finances, through innovative mechanisms that tap land as a resource, for investments in urban transport infrastructure
14. Associating the private sector in activities where their strengths can be beneficially tapped

15. Taking up pilot projects that demonstrate the potential of possible best practices in sustainable urban transport

Findings of the study

1. Cities in India vary considerably in terms of their population, area, urban form, topography, economic activities, income levels, growth constraints, etc. Accordingly, the design of the transport system should be change according to cities' features.
2. Each city should also encourage identifying potential corridors for future development and then establish a transport system that would encourage growth around itself.
3. It is well known that public transport occupies less road space and causes less pollution per passenger-km than personal vehicles. As such, public transport is a more sustainable form of transport.
4. Encroachment of footpaths too affects pedestrian safety adversely and requires strict enforcement coupled with public participation. Pedestrian safety is also adversely affected by the lack of safe crossing facilities at busy intersections of even high traffic corridors.
5. Land is valuable in all urban areas. Parking places occupy large portions of such land. This fact should be recognized in determining the principles for allocation of parking space.
6. State governments would be required to amend building bye laws in all million plus cities so that adequate parking space is available for all residents / users of such buildings.

2.1.1. **CAPACITY OF ROADS IN URBAN AREAS**: Central Road Research Institute,1988

This study was done by the Central research road institute New Delhi in 1988 for developing the standards for roads in urban and rural areas. The factors affecting the road way capacity are road width factor, traffic factor and traffic control factor. The need of the study for urban capacity standards were because of the western standards are not applicable in India because of appreciable difference in the Indian condition the most important is high degree of heterogonous traffic composition. For the different types of the roads in urban and rural areas and practical approach will be useful for the economic and functional design of the road.

Table 2.1 Capacity of Two-Lane Roads With Different Carriageway Width

S No.	Total Capacity (PCU/hr)	Carriageway width (m)
1	3,590	8.8
2	3,220	8.0
3	3,002	7.4
4	2,707	7.0
5	2,656	6.9
6	2,549	6.7
7	2,507	6.6
8	2,290	6.4
9	2,095	6.0
10	1,905	5.5

Source : Chandra S, Kumar U. ; Effect of Lane Width on Capacity under Mixed Traffic Conditions in India

Salient findings of the study:

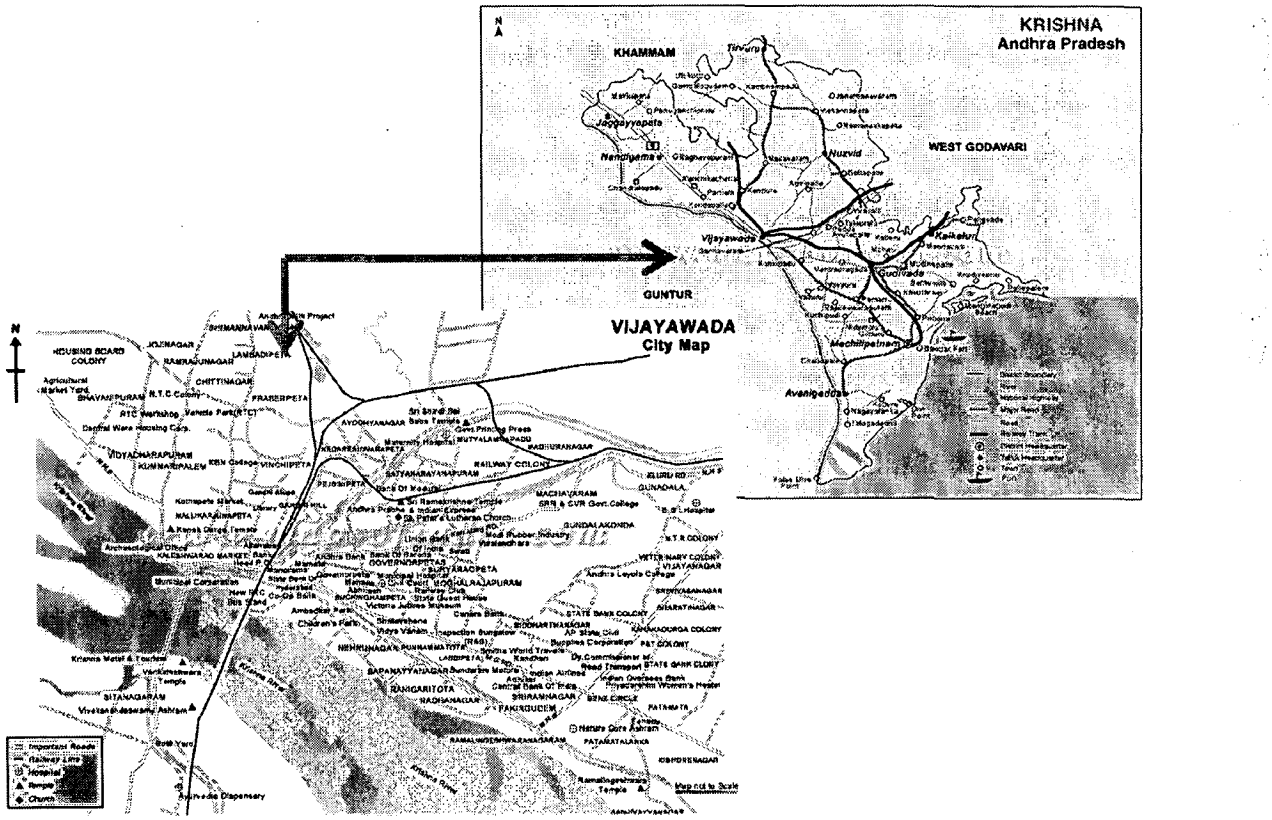
1. Factors affecting the road capacity are road way factor, traffic factor, adjoining land use and traffic controls and regulation.
2. Particular type of vehicle, which is having major share, should be taken as the standard vehicle.
3. The design of the roads includes both the future as well as the existing facilities restricting the animal vehicle at the peak hour.
4. Regulation of the pedestrians' movement along the road at predetermined locations only through railing barriers and zebra crossing.
5. Prohibiting on street parking and developing the off street parking.
6. Segregate the lip and down traffic by constructing central verge or median.
7. Segregate the vehicular and non-vehicular component of the street.

2.2. CASE STUDY – 1 : VIJAYAWADA CITY

2.2.1. Location And Area

Vijayawada, also called as "Bezawada", is 257-km from Hyderabad and is located on the banks of the Krishna River, and is bounded by the Indrakiladri hills on the West and the Budameru River on the North. The city forms a part of the Krishna district, spread over an area of 58 sq. km (urban area).

Figure 2.5 Location map of Vijayawada city



Source : website www.mapsofindia.com

2.2.2. Climate

The climate of Vijayawada is tropical in nature with hot summers and moderate winters. April to June are the summer months with temperatures ranging from a minimum of 27^0 C to 45^0 C. The temperatures during the winter months range from 28^0 to 17^0 C. The area is very humid; the average humidity ranges from 68% during summer season. The annual rainfall in the region is about 965 mm and is contributed by the Southwest monsoon.

2.2.3. Occupation

The Majority of the people in Vijayawada are engaged in trade and commerce, others in agriculture, a few are employed, and the others engaged in casual labour.

2.2.4. Traffic And Transportation

2.2.4.1. Current Situation

Vijayawada is well connected with most parts of the state and the country through roadways, railways and airways. It holds the distinction of being one of the major railway junctions in the state and is connected by the two National Highways - NH 5 connecting Chennai and Kolkata and NH 9. It can be said that no other city in Andhra Pradesh has such connectivity through the network of roads, rails and waterways.

The non-transport demand in the city is largely met by the following criteria:

- Bus transport contributing to 17% of the travel demand (the only public transport mode)

- Para transit (3 seated auto rickshaws and cycle rickshaws) contributing to nearly 45% of the total travel demand with a mode share of 22.3%
- Two wheelers and three wheelers with a mode share of 36.5%
- Non-motorized transport (NMT) using bicycles (85% of NMT), rickshaws, etc. to around 10% of the city traffic needs.

2.2.4.2. Traffic Flows and Travel Demand

Vijayawada city is stretching day by day due to its increased population and commercial activities. The new human settlements are coming up in the city at the outskirts and along the two high ways i.e. NH-5 and NH-9. Two high ways are passing through the city. The traffic volumes on these roads cause heavy congestion, accidents, reduced average speed, etc.

There are three canals and one rivulet passing through the city, which makes the users / traffic to take round about travel. Due to fast urbanization and development of the city in terms of various activities like industrial, commercial and residential, traffic volume has increased enormously. Haphazard development, narrow streets, congested junctions; unorganized parking has all created hindrance to the smooth flow of the traffic.

While traffic from the highways was allowed to pass through the city, the need to divert the traffic and provide a free flow to highway traffic resulted in the formation of a bye-pass to the city. A second road bridge across the river Krishna connecting Chinnakakani has further eased the pressure over the Prakasam barrage resulting from the inter and intra-regional traffic. The traffic and transport features that have been observed during the review of the master plan for Vijayawada are described below:

1. Ribbon development consisting of shopping and commercial centres along the highways has resulted in hampering the free flow of traffic.
2. Encroachment of hawkers and timber merchants along the arterial roads of the city has resulted in congestion of these areas and the consequent narrowing of the area available for movement of highway traffic.
3. Road intersections along the highways are improperly planned and executed.
4. Lack of adequate parking space in commercial areas has resulted in Kerb side parking causing bottlenecks in the existing narrow streets and roads.

The information provided is of the volume count surveys that have been conducted at 19 locations to realistically understand the traffic flow characteristics. Of them, 12 Intersection counts are simultaneously done. The maximum traffic flow over 24 hours duration has been observed. The traffic flow on major arterials is given in Table No.1.4.1

Table 2.2.1: Traffic Flows on Major Arterials

S. No.	Name of the Road	Traffic Flow	
		Vehicles	PCU
1	NH-5 (NTR Col. Jn-R.R)	20689	35871
2	NH-5 (Benz Circle-NTR Col. Jn)	25883	42346
3	NH-5 (Netaji Bridge Jn. - Benz Circle)	42190	63269
4	NH-9 (Gollapudi - Temple)	56292	67904
5	Temple - K.R. Market	39097	34950
6	Bander Road (Fire Stn. - IGMS)	72293	59030

7	Bander Road (IGMS - Benz Circle)	71742	57988
8	Bander Road (Benz Circle - Eenadu)	87515	87470
9	Eluru Road (Old Bus Stand - Chuttugunta)	49855	40570
10	Eluru Road (Chuttugunta - R.R)	44354	36148
11	Gollapudi - Tunnel Road	17464	16336
12	Chittinagar - Satyanarayanapuram	19206	15402
13	Temple - P.Barriage	43602	55757
14	Pejbinipeta Road (Sitara - Railaway Stn.)	44164	33630
15	KBN Col. Road (Kothapet - Chttinagar)	45101	39662
16	Pinnamaneni Road (P.Road - N.Convent)	35620	25547
17	Madhukalamantapam - Sidharatha	50760	37574
18	Puspha Hotel - M.K.Mandapam Road	39502	29204
19	Payakapuram Road (Sing Nagar - P.puram)	22793	21054
20	NTR Col. Jn. - Towards Autonagar	10964	11648
21	Exec. Club - Towards Autonagar	24372	20502
22	Sitara - Kummaripalam	12891	11211
23	Swathi - Bhavanipuram	9467	8243
24	Veterinary Jn. - Route no.5	13147	9148
25	Vijaya Talkies - Nakkala Road	23905	18786

Source: Vijayawada Master Plan Document

Table 2.2.2: Traffic Flows at Internal Cordon Points

S.NO.	Internal Cordon Points	Traffic Flow/Day	
		Vehicles	PCU
1	IC 1: Near Govt. Hospital (KR Market-Bus Stand)	54927	48534
2	IC 2: Near Pejbinipet (Rly. St. - Nuzvid)	44164	33630
3	IC 3: Near Chuttugunta Jn. (Old Bus St. - Gunadala)	44354	36148
4	IC 4: Near Sidhartha Acad. (Madhu Gardens - Gunadal)	50760	37574
5	IC 5: Near IGMC Stadium (Fire St. Benz Circle)	72293	59030

Source: Vijayawada Master Plan Document

The vehicular trips are converted into passenger trips by making use of average occupancy levels obtained from the respected O-D surveys. The average occupancy levels observed for different modes at all internal cordon points are presented in the Table 2.2.3

Table 2.2.3: Average Occupancy at Internal Cordon Points

S. No.	Mode	Occupancy
1	Two Wheeler	1.48
2	Auto / Tempo	3.29
3	Car / Jeep	3.19
4	Bus	32.63
5	Cycle	1.21
6	Cycle Cart / Rickshaw	1 .76

Source: Vijayawada Master Plan Document

2.2.4.3. Vijayawada Road Network

NH5 and NH9 are passing through the heart of the city resulting in the outflows and inflows of heavy vehicular traffic. The city does not have any ring road/ flyovers to facilitate the external traffic to flow without entering into the core city. The city even does not have specific diversion routes. Further, the expansion of the city along the NHs and SHs is resulting in frequent congestions and increased accidents on highways.

The average carriageway width of arterials, sub arterials and collector roads including all important roads in Vijayawada is 8.5m, 7.0m, and 7.5m respectively. The average percentage of road network is in between 12% to 14% the total city area, which is inadequate to address the travel demand. The main circulation pattern inside the city is established by arterials and sub-arterials. Circulation is only through existing streets and, the street network is neither junction ally developed as a system, nor adequate in width to carry the increasing traffic flow.

The Vijayawada city traffic consists not only of fast moving motor traffic but also of primitive modes of transport such as manually drawn carts and pushcarts. There is a considerable increase in the volume of motor vehicles, cycles and pedestrian traffic due to increased and high population density. Because of low speed vehicles that forms the considerable part of the mode split, the carrying capacity of road is affected resulting in frequent congestions.

The Vijayawada Authority is improving the road infrastructure in order to cope up with the increased travel demand and insufficient parking. Existing and new colonies are being connected to the arterial/ sub arterial roads by improving the road infrastructure in the colonies. The break-up of the road infrastructure is as follows:

Table2.2.4: Road infrastructure

Types of Road	Length(Km.)
Cement Roads	190
B.T. Roads	625
Metal Roads	175
Others	210
Total	**1200**

Source: Vijayawada Master Plan Document

2.2.4.4. Vehicular Growth and Composition

The total number of vehicles registered in Vijayawada Regional Transport Office as on 31- 03-2004 was 4, 53,815. Among these 50, 808 are Transport Vehicles (Public Carriers) and 3, 95,151 are Non Transport Vehicles (Private). Details of growth of vehicles are shown in *Table 1.4.5*

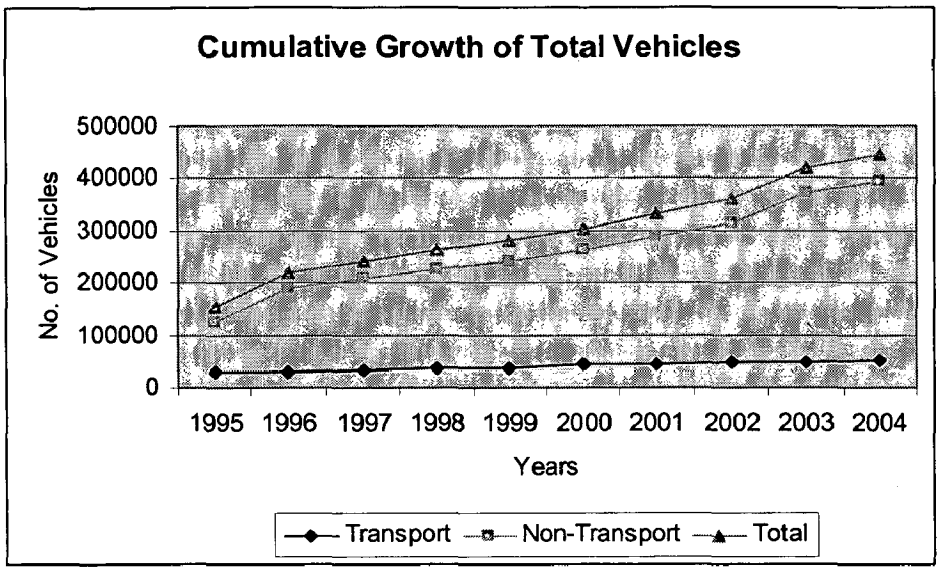
Table 2.2.5: Growth of Vehicles in Vijayawada Region

Year	Transport	Percentage Increase	Non-Transport	Percentage Increase	Total	Percentage Increase
1995	27499	-----	125765	-----	153264	-----
1996	30242	9.97	189794	50.91	220036	43.57
1997	34563	14.29	207591	9.38	242154	10.05
1998	36418	5.37	225299	8.53	261717	8.08
1999	37977	4.28	241588	7.23	279565	6.82

2000	42029	10.67	261656	8.31	303685	8.63
2001	43306	3.04	288509	10.26	331815	9.26
2002	48742	12.55	312384	8.28	361126	8.83
2003	49002	0.53	370990	18.76	419992	16.3
2004	50808	3.69	395151	6.51	445959	6.18

Source: Vijayawada Master Plan Document

Figure 2.6 cumulative growth of total vehicles



2.2.4.5. Public Transport System

The predominant Public Transport modes in Vijayawada are City Buses and Auto-Rickshaws. There are three other types of services like Sub-Urban, Moffussil and ordinary services along with City Buses and they are operating from 5 depots. There are 358 buses plying through 119 routes and, serves around 2 lakh passengers per day in and around the city. Auto rickshaws play on almost on all major routes. Presently, the shared-auto services are more in the city to all other surrounding areas of the city except near railway station and Bus Stand areas. The seating capacity of auto-rickshaw is 3+1; it is

observed that the average passenger occupancy in auto-rickshaw during peak and non-peak hours was 6 and 4 respectively. The seating capacity of city buses is 56, but was observed that the average passenger occupancy during peak and non-peak hours for city buses was 60 and 15 passengers respectively. The other mode of travel for the city observed as cycle rickshaw in almost all locations, but cycle rickshaw cater to short trips only.

2.2.4.5.1. Share *of Public Transport*

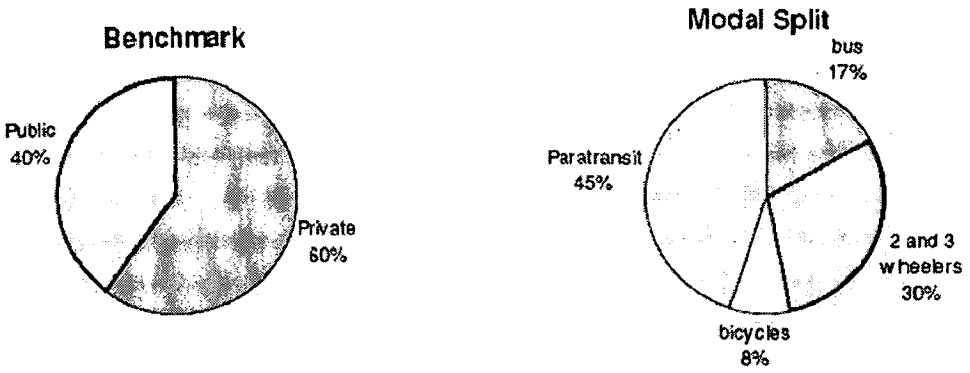
Standards / norms for public transport as per the policies given by ministries of urban development, GOI which stated that a city like Vijayawada having population , share of the public transport should be positioned from 50% to 60% of the total transport share.

Table 2.2.6: Share of Public Transport

S.No.	City population (in millions)	Desired share of public transport (%)
1.	0.5 to 1.0	25
2.	Above 1 .0 and up to 2.0	30-40
3.	2.0 to 3.0	50-60
4.	3.0 to 5.0	60-70
5.	5.0 plus	70-85

Source: Vijayawada Master Plan Document

Figure 2.7 Share of Public Transport in Vijayawada City:



2.2.4.6. Parking

2.2.4.6.1. Identification of Traffic Attraction Zones

The significant parking locations with high parking demand are Around Kaleswar Rao Market, BRP Road, Canal Road and Cross Roads of Besant Road from Eluru Road to MG Road. These areas are basically commercial centers or activity areas. Parking demand is directly dependent on activity. If the activity in any particular area of the city increases, the parking demand would increase proportionally.

The salient findings of the parking study are:

1. The maximum parking demand is around Kaleswar Rao market and, it is in the range of 5770 vehicles during the peak period from10:00 a.m. to 12:00 noon, inclusive of off-street parking lots.

2. Out of total parked vehicles in the study area, the share of two wheelers is in the range of 76% whereas for cars and auto rickshaws, it is 10% and 14% respectively.
3. The average share of short, medium and long term parking demands at all the on street parking locations are 74, 19 and 7 percent respectively.

2.2.4.7. Per Capita Trip Rate

Trips performed on an average day in Vijayawada Urban Area for all purposes are 10, 41,904 (including walk and excluding return home trips) and 6, 25,144 (excluding walk and excluding return home trips). The per capita trip rate (PCTR) for Vijayawada Urban Area works out to be 1.04 and per capita vehicular trip rate is estimated to be 0.62. This indicates that majority of the inter-zonal trips are performed by vehicular modes and most of the intra-zonal trips are done by walk.

2.2.5. Findings Of The Study

1. Factors which affect the road safety are road layout, road surface, and the design parameters like carriageway etc.
2. Percentage of the road network is also very vital to address the travel demand.
3. Absence of link roads and bye-pass roads causing traffic problems in the study area.
4. Highway passing through the city causes congestion, accidents, reduces average speed etc.
5. Main circulations occur in arterial and the sub arterial or collector roads.
6. The maximum parking demand is around the commercial area.

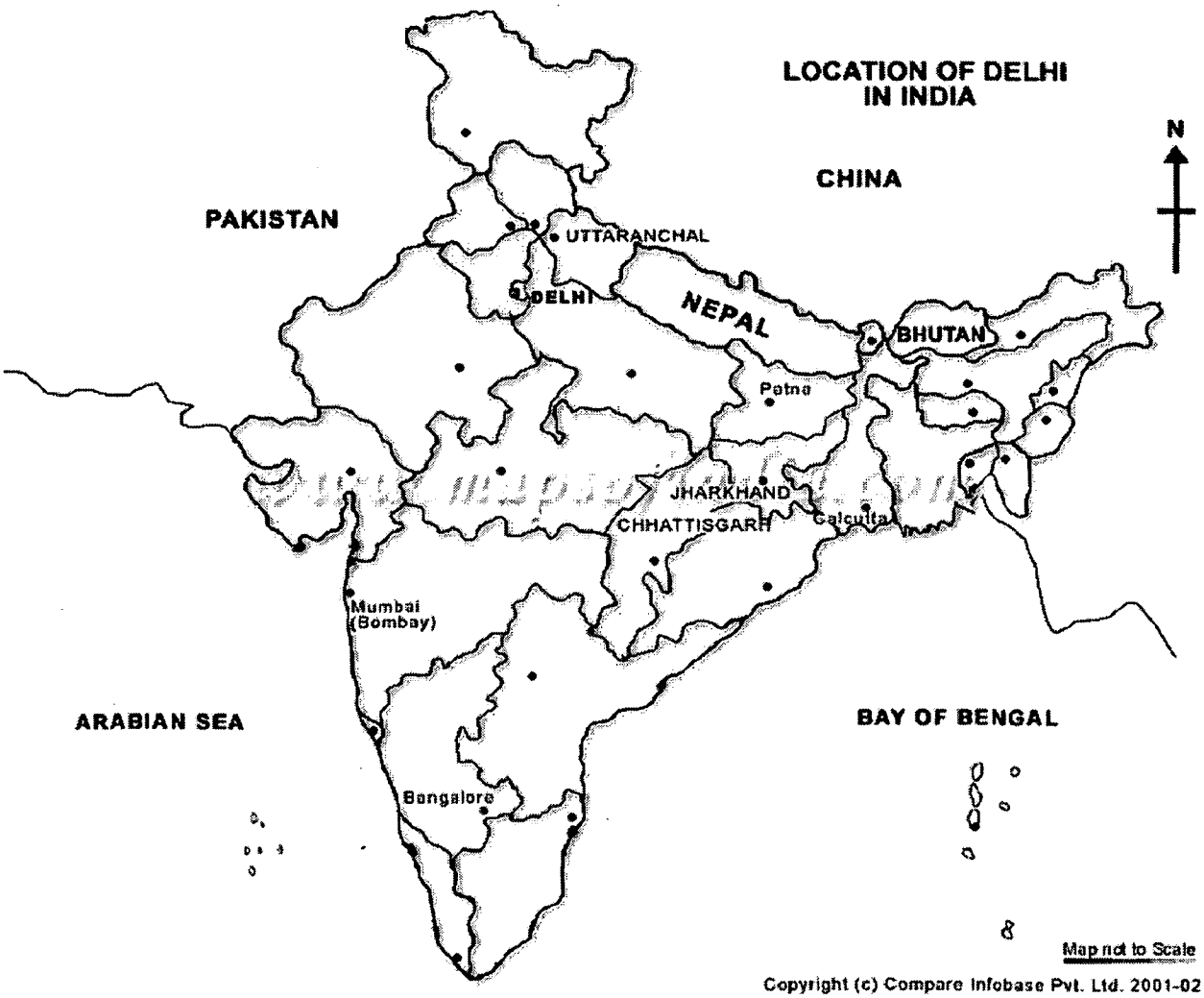
7. Haphazard development and unorganized parking has caused hindrance to the smooth traffic flow.
8. Encroachment is another obstruction which is approaching in way of smooth traffic flow.
9. Lack of proper design at crossings causes accidents and reduces the average speed.
10. Fly-over connections are the most appropriate and practicable.
11. Parking problems generally arises in commercial areas or the activity areas.
12. In a city like Meerut having population 11,70,985, less then 10% of entering traffic is by-passable

2.3. Case study – 2 : DELHI NCR

2.3.1. Location Of Delhi

Delhi is located in the northern part of the India and extends latitude 28.38°N and longitude 77.12°E. It is encircled by the North Indian state of Uttar Pradesh in the east and by Haryana in the other three sides. Delhi is an ideal gateway to travel to the North Indian states of Rajasthan, Jammu and Kashmir, Uttar Pradesh, Punjab, Uttaranchal and Haryana. Delhi is connected to all the major cities in the world by regular flights.

Figure 2.8 location map of Delhi



Source : website www.mapsofindia.com

2.3.2. Climate Of Delhi

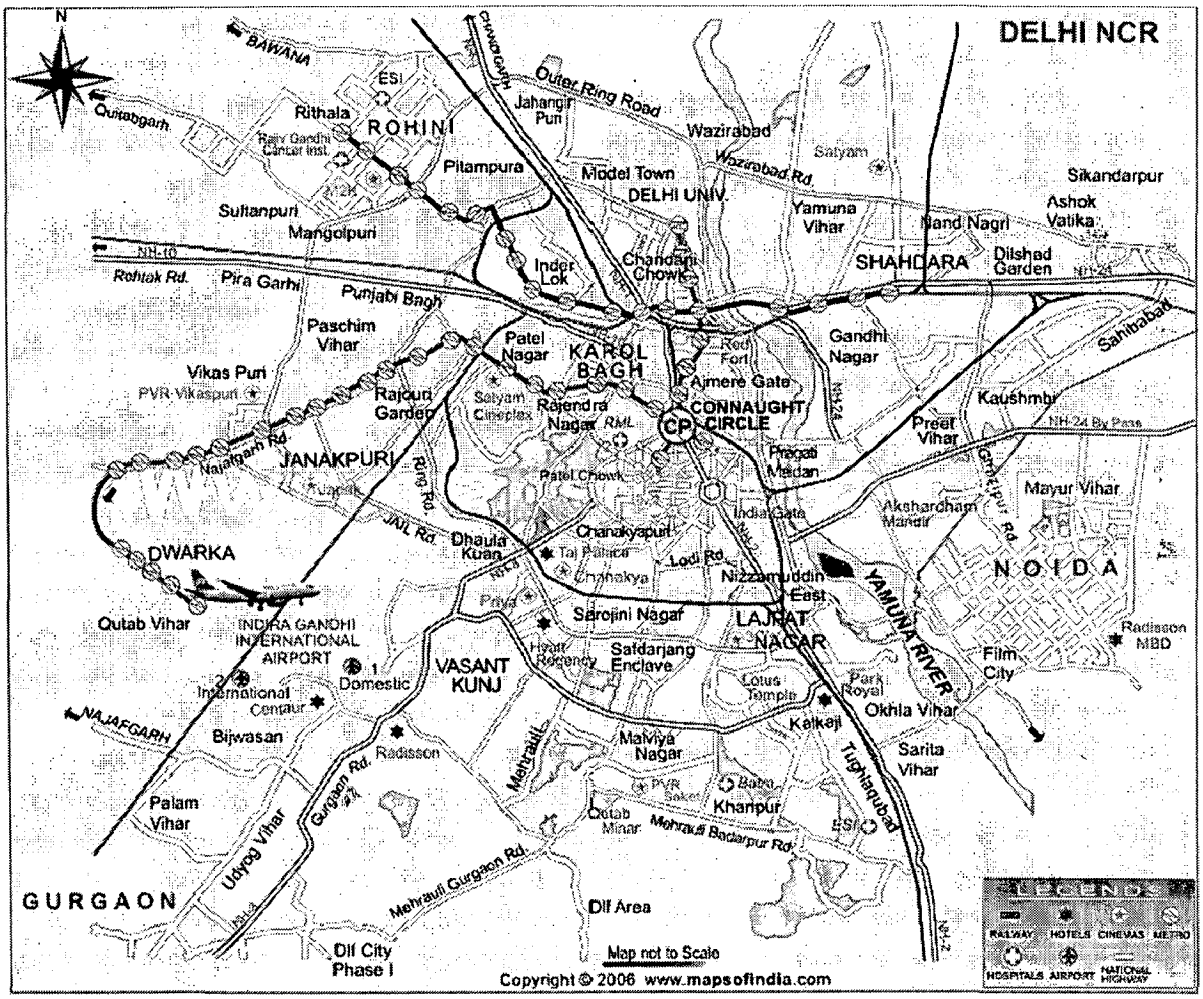
The climate of Delhi is hot and humid in the summers and cold in the winters. The average temperature ranges from 25°C to 46°C during summer and 2°C to 5°C during winter. The cold wave from the Himalayan region makes winters very chilly. In summers, the heat wave is immense and adequate precaution has to be taken before going out in the afternoons.

2.3.3. Transportation In Delhi

Delhi, from Shahjahanabad to the present National Capital Territory of Delhi, has grown to a population of about 140 lakh in 2001 and is expected to grow to about 230 lakh by the year 2021. By virtue of its location and strategic importance, the city plays a very important role as a transport node. The character of Delhi is mixed in nature and contains industries, business and education, together with political and administration citadels. Delhi Master Plan, 1962 envisaged a polycentric pattern of development with a hierarchical structure of commercial, industrial and public semi - public, residential and other activities. Travel demand generated by increased mobility far exceeds the supply of transport systems. As of today, the transport system is primarily road based and consists of buses, private cars and two wheelers besides hired modes of transport like auto-rickshaws, taxies and cycle rickshaws. The operations of transport are often ill-planned and competing, rather than being complementary. There is a need to evolve a clear direction, objectives and goals for the future transport system, aimed at giving preference to high capacity and low polluting modes of transport, so as to provide efficient movement of the people and goods.

A set of policies for the control of land uses and development of infrastructure in the region have been formulated in Regional Plan – 2001. Also a functional plan on transport prepared and approved by the NCR planning board in 1995 envisaged an organized transport network to improve accessibility and the movement of the goods and passengers within the region. It suggested construction of the road and rail linkages along the high-density routes in and around the capital.

Figure 2.9 Road Network Map of Delhi NCR



Source : website www.mapsofindia.com

2.3.3.1. Existing Network

The transport system of NCR as of today consists of well-knit road network and radial rail corridors catering to inter-city and intra-city commuters and long-distance traffic. The freight traffic is also substantial in the region and this is mostly carried by road. Delhi acts as collection and distribution centre for the northern region.

2.3.3.1.1. Road *Network*

Existing road network in the region shows convergence of five national highways i.e. NH-1, 2, 8,10 and 24 on Delhi and two National Highways namely NH 58 and NH 91 meet NH 24 at Ghaziabad. These national highways have four lane divided caniageway on most of the stretches of NCR. The Delhi - Rohtak (NH 10) from Delhi to Delhi-Haryana border is four to six lane divided carriageway, Ghaziabad-Meerut (NH58) is four lane divided carriageway up to Meerut excluding Meerut bypass, which is two lane, and GhaziabadBulandshahar (NH91) which is two lane highway. In addition to this, NH71, NH71A and NH7l B also pass through the region.

Ten state highways also serve in strengthening the regional road network. Most of the state highways are of single lane or intermediate lane.

2.3.3.1.2. *Rail Network*

The NCR rail network covers three zonal railways (northern, western and central) zones and five divisions. The rail network in the region consists of both broad and metre gauges. Five broad gauge railway lines converge at Delhi

2.3.3.1.3. *Airport*

At present two airports are located at Delhi-Indira Gandhi Airport is for international flights and Palam Airport for domestic flights.

2.3.3.2. Traffic Volume (2001)

2.3.3.2.1. Traffic Counts

On the boundary of NCT-Delhi, the highest traffic volume is at NH24 (Delhi-Ghaziabad) followed by NH8 (Delhi-Gurgaon). The lowest traffic volume is at SH57 (Delhi-Loni). The maximum traffic volume crossing-over on river Yamuna is at ITO bridge followed by Nizamuddin bridge while the lowest is at Okhla banage bridge.

2.3.3.2.2. Directional Flow

The directional split of passenger trips by purpose clearly demonstrates that people are commuting to Delhi for work in the morning and returning in evening. The commuter behaviour is extremely pronounced at the Nizamuddin Bridge where nearly 80% of the traffic in the morning is towards NCT-Delhi. In the evening peak hour, ITO Bridge shows the highest directional split in favour of movement from NCT-Delhi approximately 75%.

2.3.3.3. Policies And Strategies

Based on the observations and findings in the analysis as above, the following policy actions are to be provided to achieve the overall objectives of the Regional Plan-2021:

- To decongest NCT-Delhi roads, rail and rail terminals by diverting the bypassable traffic from Delhi.
- To provide linkages amongst Metro/Regional Urban Settlements in the outlying areas of NCR.
- To connect Metro/Regional Centres with the Capital by an efficient and effective transport network for facilitating faster movement of traffic among such centres and NCT-Delhi.
- To link the Sub-regional Centres with effective and efficient transport network for facilitating the faster movement of traffic among such centers and higher order settlements.
- To directly link other urban nodes having maximum attracting and generating characteristics.
- To create the Unified Metropolitan Transport Authority for NCR.

2.3.3.4. Transport Plan 2021

Transport plan 2021 is proposed to:

•Develop activities keeping in view rail and road linkages in Central NCR having better accessibility and at the same time relieving pressure on the existing transport routes converging at NCT-Delhi.

•Unrestricted movement of buses, taxis, and auto-rickshaws within NCR.

•Focus on certain inter-state issues for workable coordination and evolve an institutional mechanism on priority basis to encourage private participation.

•Execution without further delays of the Regional Plan-2001 proposals of Integrated Mass Rapid Transport System (MRTS), Regional Rapid Transport System (RRTS), Expressways and Bypasses.

2.3.3.4.1. Road *Network*

It is proposed to develop following hierarchical road network in order to encourage, guide and sustain the envisaged development in the region and to cater to higher traffic interaction among NCT-Delhi and Regional towns:

- Primary Road Network
- Secondary Road Network
- Tertiary Road Network

2.3.3.4.1.1. Primary *Road Network*

Primary roads are radial roads connecting Regional/Priority Towns with NCT - Delhi. Seven radial roads have already been declared as National Highways. Proposed Transport Network (Roads) 2021]. Out of the seven national highways NH1 (Delhi to Panipat), NH2 (Delhi to Palwal) and NH8 (Delhi to Behror) are already having four lane divided carriageway, whereas NH1 (Delhi to Rohtak) and NH24 (Delhi to Hapur) are partially four lane. Besides, NH71 (Rewari to Rohtak). NH71 A (Rohtak to Panipat), NH71B (Rewari-SohnaPalwal), NH58 (Ghaziabad-Meerut-Muzaffarnagar) and NH91 (Ghaziabad-KhUlja-Aligarh) needs upgradation. It is proposed to develop the existing ring road, outer ring road and the five radial roads (national highways) upto CNCR towns (i.e. NH1 Delhi to Kundli, NH2 Delhi to Ballabhgarh, NH8 Delhi to Gurgaon, NH10 Delhi to Bahadurgarh and NH24 Delhi to Ghaziabad) to expressways standards. It may be

necessary in some places that a complete elevated expressway is required if no land is available for upgradation. Inter-state junctions and approaches to Delhi should be improved to remove the bottlenecks

2.3.3.4.1.2. Secondary *Road Network*

Secondary road network consists of Major District Roads connecting smaller towns with the priority towns of the region and with the primary road network of the region. Priority has to be established through Sub-regional Plans and all the towns in the Sub-region have to be connected with regional towns and with the primary road network by 2021. These roads are proposed to be two intermediate/single lane depending upon the envisaged traffic and interaction with the adjoining areas. Roads connecting expressways with international airport should be upgraded. Action Plan for their up gradation is to be prioritized in the Sub-regional Plan.

2.3.3.4.1.3. Tertiary *Road Network*

All the villages, work places, small business employment centres, residential areas and agriculture/forest areas are to be provided access through tertiary road network. It will consist of a single/intermediate/double lane metalled roads connecting to Sub-regional towns and secondary road system of the region for efficient movement of traffic and to boost balanced development in the region.

2.3.3.5. Strategies for Resolving Transport Problems of Delhi

1. Recognizing the fact that the growth of metropolitan city seems to be irreversible;
2. Optimal use of existing road network and full development of right of way by removing all impediments;

3. To establish transport systems and networks in the NCR so that the distance between Delhi to any corner of the NCR can be covered within 2 hours;
4. To improve and achieve efficient movement, road network needs to be restructured to have expressways, arterial roads, district distributors and access roads. This requires that critical areas are identified and Urban Relief Roads are developed as alternative link roads;
5. As an innovative strategy, alternative network through elevated, underground, tube roads can be thought of, which will ease the movement of the traffic and reduce air pollution;
6. Rationally located, identified and designed passenger and goods terminals on the basis of directional need to be developed with adequate infrastructure. The infrastructure should cover transfer, storage and interface modes and the related facilities;
7. To encourage energy conservation and environmental protection, an integrated and multi-modal transport system has to be developed. The main mode being the Mass Rapid Transit System (both Road and Rail) and supportive modes i.e., public buses, Intermediate Passenger Transport (IPT), Non motorized Transport (NMT) and private vehicles, there is a need to make the provisions for all the modes;
8. To ensure that parked vehicles are not a hindrance to the movement of vehicles on distributors and arterial roads, proper parking and provision of additional parking spaces including multilevel facilities may be encouraged
9. Bus terminals / centroids in all directions, preferably for each division, near MRTS stations or strategic locations need to be developed;

10. Intermediate Passenger Transport and Non Motorized Transport should be encouraged taking into consideration their potential as environment friendly and low cost transport;
11. Parking is emerging as a major problem associated with urban development. There should be two pronged strategy
    - to augment parking capacity and supply; and
    - demand management and fiscal measures;
12. Since the city is witnessing unprecedented growth of vehicles, it is necessary to explore the options like time zoning concepts, auction of car registrations, mandatory certificate of parking space, incentives for use of public transport, etc;
13. Provide long lasting good quality roads;
14. Provide good traffic management and road furniture;

THEORIES OF TRANSPORTATION PLANNING

3.1. Nagpur Road Plan Or First 20 Year Road Plan

The Conference of Chief Engineer held at Nagpur in 1943 finalized the first twenty year road development plan for India called Nagpur Plan for the period 1943-63. The road network in the country was classified into five categories viz.

1. National Highways
2. State Highways
3. Major District Roads
4. Other District Roads and
5. Village Roads

Recommendations were made for the geometric standards of roads, bridge specifications and highway organizations. Two plan formulae were finalized at the Nagpur Conference for deciding two categories of road length for the country as a whole as well as for individual areas (like district). This was the first attempt for highway planning in India.

The two plan formulae assumed the *Star and Grid pattern* of road net work. Hence the two formulae are also called *Star and Grid Formulae.*

The total length of the first category or metalled roads for National and State Highways and Major District Roads in km is given by the formula:

$$NH + SH + MDR(km.) = [\ A/8 + B/32 + 1.6N + 8T] + D - R$$

Where

A = Agricultural area km2

B = Non – Agricultural area km2

N = Number of town and villages with population range 2001 – 5000

T = Number of town and villages with population over 5000

D = development allowance of 15 % of road length calculated to be provided for agricultural and industrial development during next 20 years.

R = existing length of railway track

The total length of second category roads for Other District Road and Village Roads in km is given by the formula:

$$ODR + VR\ (km.) + [0.32\ V + 0.8\ Q + 1.6\ P + 3.2\ S\ ] + D$$

Where

V = Number of villages with population 500 or less

Q = Number of villages with population range 501 – 1000

P = Number of villages with population range 1001 – 2000

S = Number of villages with population range 2001 – 5000

D = Development allowance of 15 % for next 20 years.

Salient Features of Nagpur Road Plan

1. The responsibility of construction and maintenance of national highways was assigned to the central government.
2. It was a 20-year plan intended for the period 1943-63 aiming to provide for about two lakh km of surfaced roads and remaining unsurfaced roads, so that when this target is reached, the total road length of 5, 32, 700 km with a density of about 16 km of road length per 100 sq. km area would be available in the country by the year 1963.
3. The formulae were based on star and gird pattern of road network. But the existing irregular pattern of roads and obligatory points not fitting in the geometric pattern were to be given due consideration.
4. The first category roads are meant to provide main grids bringing the farthest points in developed and agricultural area within 8 km of metalled road.
5. The second category roads are meant to provide internal road system linking small villages with first category roads.
6. An allowance for agricultural and industrial development during the next 20 years was estimated as 15 percent and this allowance was to be provided while calculating the road length for both the categories of roads.
7. The length of railway tracks in the area was also considered in deciding the length of first category road.

3.2. Bombay Road Plan or Second Twenty Year Road Plan (1961-81)

The Nagpur road plan was intended for the period 1943-63, but the target road length was nearly completed earlier in 1961, mainly because of the phased development that took place in the country during the first two 5-year plans. hence the next long term plan for the twenty year period commencing from 1961 was initiated by the IRC and was

finalized by the sub committee and this was approved by the chief Engineers. *The Second Twenty Year Road Development Plan* 1961-81 is also culled *Bombay Road Plan.*

Five different formulae were framed to calculate the lengths of National Highways, State Highways, Major District Roads, Other District Roads and Village Roads.

These five formulae are given below:

1. National Highway (km.)

   = [A / 64 + B / 80 + C / 96] + [32 K + 8 M] + D

2. National Highways + State Highways (km.)

   = [A / 20 + B / 24 + C / 32] + [48 K + 24 M + 11.2 N +1.6 P] + D

3. National Highways + State Highways + Major District Roads (km.)

   = [A / 8 + B / 16 + C / 24] + [48 K + 24 M + 11.2 N + 9.6 P + 6.4 Q + 2.4 R] + D

4. National Highways + State Highways + Major District Roads + Other District Roads (km.)

   = [3 A / 16 + 3B / 32 + C / 16] + [48 K + 24 M + 11.2 N + 9.6 P + 12.8 Q + 4 R + 0.8 S + 0.32 T] + D

5. National Highways + State Highways + Major District Roads + Other District Roads + Village Roads (km.)

$$= [\ A / 4 + B / 8 + C / 12\ ] + [\ 48\ K = 24\ M + 11.2\ N + 9.6\ P + 12.8\ Q + 5.9\ R + 1.6\ S + 0.64\ T + 0.2\ V\ ] + D$$

Where

A = Developed and Agricultural Land; km2

B = Semi Developed Area; km2

C = Undeveloped Area; km2

K = Number of Towns with Population over 1,00,000

M = Number of Towns with Population over 1,00,000 – 50,000

N = Number of Towns with Population over 50,000 – 20,000

P = Number of Towns with Population over 20,000 – 10,000

Q = Number of Towns with Population over 10,000 – 5,000

R = Number of Towns with Population over 5,000 – 2,000

S = Number of Towns with Population over 2,000 – 1,000

T = Number of Towns with Population over 1,000 - 500

V = Number of town with range below 500

D = Development allowance of 5 % of road length calculated for future development and other unforeseen factors.

Salient features of the Second 20-year Plan

1. This plan is considered to be drawn more scientifically in view of development needed in under-developed areas.
2. Maximum distance of any place in a developed or agricultural area would be 6.4 km from a metalled road and 2.4 kin from any category of roads.
3. The maximum distance from any place in a semi-developed area would be 12.8 km from a metalled road and 4.8 kin from any road; similarly the maximum distance in an undeveloped area would be 19.2 kin from a metalled road and 8.0 km from any road.
4. Expressways have also been considered in this plan
5. Length of railway track is considered independent of the road system and hence it is not subtracted to get the road length.
6. The development factor of only 5 % is provided for future development and unforeseen factors.

3.3. LUCKNOW ROAD PLAN OR THIRD 20 YEAR ROAD DEVELOPMENT PLAN 1981-2001

Policies and Objectives:

The Third Twenty Year Road Development Plan, 1981-2001 (also known as *Lucknow Road Plan)* was finalized and the plan document was published by the year 1984. The major policies and objectives of this road plan are listed below:

1. The future road development should be based on the revised classification of road system consisting of primary, secondary, and tertiary road systems.
2. The road net work should be developed so as to preserve the rural oriented economy and to develop small towns with all the essential facilities.
3. All the villages with population over 500 (based on 1981 census) should be connected by all weather roads.
4. The overall road density in the country should be increased to 82 km per 100 sq. km area by the year 2001.
5. The National Highway net work should be expanded to form square grids of 100 km sides so that no part of the country is more than 50 km away from a NH.
6. The lengths of SH and MDR required in a state or region should be decided based on both areas and number of towns with population above 5,000 in the state or region.
7. All the towns and villages with population over 1500 should be connected by Main District Roads and the villages with population 1000 to 1500 by Other District Roads.
8. There should be a road within a distance of 3.0 km in plains and 5.0 km in hilly terrain connecting all villages or groups of villages with population less than 500.
9. Roads should also be built in less industrialized areas to attract the growth of industries.
10. Long term master plans for road development should be prepared at various levels.

11. The existing roads should be improved by rectifying the defects in the road geometries; widening of the pavements, improving the riding quality of the pavement surface and strengthening of the pavement structure to save vehicle operation cost and thus to conserve energy.
12. There should be improvements in environmental quality and road safety.

3.4. Standards And Norms

3.4.1. Design Speed : The recommended design speeds for different categories of roads are:

Table 3.1 design speed standards

Type	**Design Speed (kmh)**
Arterial	80
Sub-Arterial	60
Collector Street	50
Local Street	30

Source: UDPFI Guidelines

3.4.2. Space Standards : The space standards (land width) recommended for different categories of roads are:

Table 3.2 standards for land width

Type	**Land Width (m)**
Arterial	50 - 60
Sub-Arterial	30 - 40

Collector Street	20 - 30
Local Street	10 - 20

Source: UDPFI Guidelines

3.4.3. Carriageway Widths : The recommended carriageway widths are shown below:

Table 3.3 standards for carriageway width

Description	**Width (m)**
Single lane without kerbs	3.5 m
2-lane without kerbs	7.0 m
2-lane with kerbs	7.5 m
3-lane with/without kerbs	10.5/11.0 m
4-lane with/without kerbs	14 m
6-lane with/without kerbs	21.0 m

Source: UDPFI Guidelines

3.4.4. Footpath (sidewalk)

The minimum width of footpaths should be 1.5 m. The width should be increased by 1 m in business/shopping areas to allow for' dead width. Footpaths adjoining shopping frontage should be at least 3.5 m and a minimum of 4.5 m is desirable adjoining longer shopping frontages. The capacity guidelines for design of footpaths are as below:

Table 3.4 standards for footpaths or sidewalk

Capacity (Person)		Required Width of footpath
All in One Direction	**In Both Direction**	
1220	800	1.5
2400	1600	2
3600	2400	2.5
4800	3200	3
6000	4000	4

Source: UDPFI Guidelines

3.4.5. Cycle Track

The minimum width of cycle tracks should be 2.0 m. Each additional lane, where required, should be 1.0 m. Separate cycle track should be provided when the peak cycle traffic is 400 or more on routes where motor vehicles traffic is 100 – 200 vehicles/hr. when the number of motor vehicles using routes is more then 200 per hour, separate cycle tracks are justified even if cycle traffic is only 100 cycles per hour. The capacity of cycle tracks recommended is as below:

Table 3.5 standards for cycle track

Width of cycle tracks	**M**	**Capacity (cycles/hr.)**	
		One way	**Two way**
Two lanes	3	250 - 600	50 - 250
Three lanes	4	>600	250 - 600
Four lanes	5		>600

Source: UDPFI Guidelines

3.4.6. Passenger Car Units (PCU)

1. Urban roads are characterized by mixed traffic conditions, resulting in complex interaction between various kinds of vehicles. Capacity of urban roads is normally expressed in terms of a common unit namely Passenger Car Unit (PCU). Each vehicle type is converted into equivalent PCU based on their relative interference values.
2. The relative PCU of a particular vehicle type is affected to ascertain extent by increase in its proportion in the total traffic. Following table shows the recommended PCU factors for various types of vehicles on urban roads.
3. Recommended PCU factors for various types of vehicles on urban roads:

Table 3.6 PCU factor for fast and slow moving vehicles

Vehicle Type	**PCU Factor**
Fast Moving Vehivles	
Car, Jeep, and Van	1.0
3 Wheeler	1.0
2 Wheeler	0.5
Mini Bus	1.5
Bus	3.0
Light Goods Vehicles	1.5
2 Axial Truck	3.0
3 Axial Truck	3.0
Multi Axial Truck	4.5
Agricultural Tractor	1.5

Agricultural Tractor With Trailer	4.5
Slow Moving Vehicles	
Cycle	0.5
Cycle Rickshaw	2.0
Animal Drawn Cart	6.0
Hand Drawn Cart	8.0

Source: IRC - 106: 1990

3.4.7. Design Service Volume

The design service volumes for different categories of urban roads are shown in the table given below:

Table 3.7 type of carriageway and design service volume per hour

Type of Carriageway	**Total Design Service Volume per hour**		
	Arterial	**Sub-Arterial**	**Collector**
2 Lane (one way)	2400	1900	1400
2 Lane (two way)	1500	1200	900
3 Lane (one way)	3600	2900	2200
4 Lane Undivided (two way)	3000	2400	1800

Source: UDPFI Guidelines

STUDY AREA AND EVOLUTION OF CITY

CHAPTER: 4 - STUDY AREA AND EVOLUTION OF THE CITY

4.1. GENERAL

4.1.1 Origin of Name

The district of Meerut (which forms part of the revenue division of the same name) is named after its headquarters city and is said to be associated with earliest traditions of the Hindus according to which Maya, the father-in-law of Ravana, founded this place which has, therefore, been call Maidant-ka-Khera. According to another version Maya, a distinguished architect, got from king Yudhishther the land on which the city of Meerut now stands and he called this place Mayrashtra, a name which in course of time became shortened to Meerut. Tradition are so has it that the district formed part of the dominions of Mahipal, king of Indraprashta and the word Meerut is associated with his name.

4.1.2 Location, Boundaries and Area

Meerut district is the part of upper Gagna - Yamuna doaab, which lies 28 degree 47' and 29 degree 18' in north direction and 77 degree 7' and 78 degree 7' in east direction. In shape it is roughly a rectangular. Its length from east to west varying between 92 km and 51 km from north to south direction. On the north it is bounded by district of Muzaffarnagar, on the south by that of Bulandshahar district and on the south Ghaziabad, and district Baghpat is in the west direction. Ganga River makes its boundary in east direction a separates it from the districts of Moradabad and Bijnore. Hindon River makes its Boundary in west Direction in separates it with the Baghpat district.

4.1.3 Climate

The climate of the city is typical of the plains in the Uttar Pradesh. Summer is hot and the temperature is slightly higher towards the southern than in the northern reaches of the city. Hot winds are Common in summer. Especially towards the western side sand particles are considerably disturbed on summer evenings and one can see suspended sand for several hours in the horizon. Lack of forests, level land contributes a lot to this condition which spread uninterruptedly over stretches of miles• winter is more severe towards the western belt. Mist is almost a Common occurrence in the entire district, especially in the arid lands.

Rainfall usually breaks about the end of June and lasts till about the end of September, persisting sometimes even into October. The heaviest rainfall occurs during July and August and there are only a few showers in winter.

4.2. Evolution of Meerut

Situated between Ganga and Yamuna, close to the imperial capital, Meerut District has been a centre of varied activities throughout the course of history. The fertility of the soil, its temperate climate and its proximity to Delhi bestowed orderly progress in the times of peace and wrought bloody upheavals in times of political commotions. Inhabited by sturdy Tyagis, Rajputs, Vaishyas, Jats, Gujjars, etc. - all of whom have contributed towards its progress by either agricultural skill, enterprise and sweat, the people of Meerut faced the onslaught of Qutub-ud-din and Timur with courage and tenacity.

Coming under the control of the 'Company's Government', the Meerut district assumed its present geographical features in 1836. Prior to 1836, it formed a part of

Moradabad and then Saharanpur. In 1818 it was separated from Saharanpur, in 1824, Bulandshaher was separated from Meerut and finally, in 1836, after the death of Begum Samru, Sardhana was added to its territory.

Meerut leapt into international prominence during the revolt of 1857, when on 24 April, 1857; eighty-five troopers out of ninety of the third cavalry refused to touch the cartridges and after court martial were sentenced to ten years imprisonment. This marked the beginning of a general movement of freedom from the British yoke, with the support of the civilian populace.

However, the events of 1857 established the British authority firmly and they began to create an elaborate system of transportation and communication; and a chain of English schools to turn out an army of intermediaries between the rulers and the ruled. Since Meerut was the most important town in the western part of the United Provinces, and a better centre of commerce, education and politics, it contained a higher proportion of men engaged in the liberal professions, in the judiciary and in business.

The socio-religious reform movements of the nineteenth century moulded the social orientation of the English educated middle class. Dayanand Saraswati, Col. Olcott, Annie Besant, Vivekanand and Sir Syed Ahmed Khan visited Meerut, profoundly influencing the thought process of the people.

The Arya Samaj Movement gained popularity in Meerut and started publications of magazines and newspapers, opened schools and laid emphasis on anti-untouchability campaigns, Swadeshi and Swaraj. A number of prominent middle class and middle caste people of Meerut were attracted towards the teachings of Arya Samaj.

The public life in Meerut began with the founding of a branch of Indian Association in 1877 by S.N.Banerjee. A number of social service and voluntary organizations like Vaish Mahasabha came up in the district of Meerut. In 1914, Meerut became the venue of three important conferences i.e., Meerut Political Conference, the U.P. Industrial Conference, and the U.P. Political Conference. Meerut had been an important centre of religious, cultural, intellectual and political activities and was also an important cotton producing district and a big centre of cotton trade and weaving. Archeological excavations carried out at Village Alamgirpur near Meerut have discovered remains from the Harrapan culture. This has put Meerut on the International map of ancient cultures. Painted Grey Wares have been found as also an ancient well that dates back to the Mauryan Period.

Meerut has since time immemorial been, on the national as well as international scene. Its progress and development has, therefore, been rapid and on the latest modern technological lines. Its proximity to Delhi was a boon to this small district. The enterprising populace armed with modern education and latest technology fast developed Meerut into one of the most important business centres of Western U.P. Meerut already had an important cantonment to boast of; but now it soon developed a huge pharmaceutical market, innumerable factories, schools, colleges and management institutes as well as medical colleges.

4.3. History

City history dates back to the period of Ramayan. The city was the site of the capital of ancient kings of Maharasthtra named Mai Danav, the daughter of who's married Ravan the king of Lanka. Story of Shravan Kumar is also related to the great empire of Mahabharat. Seat of Indian Mutiny in 1857.

1019 Jama Masjid built by Hasan Mahndi wazir of Gazni and was repaired by Hanuman. This still exits. Raja Hari Dutt Built Fort wall, at present does not exist but its gates still stand as parts of the fortification.

1192 Most hindu temples are converted in to mosques.

1194 Kutubuddin erected Dargarh near nauchandi ground

1396 Mangol invasion.

1628 erection of the red sand stone Dargah by Nurjahan in memory of Fakir named Shahpir

1714 Surajkund surrounded by the sattipillar

1775 Meerut was the scene of perpetual strife and was only rescued from enarchy by exertion of an European military adventure.

1803 all possession of sindia was ceded to the British.

1805 It was declared as a resinous depopulated town with no trade

1806 the cantonment was established.

1821 first church was erected.

1847 population spurt from 29,000 to 82,000

1853 Meerut declared as district headquarters.

1864 municipality was established

1867 extension of northern railway line was laid, a bounded warehouse was established

1884 town hall was constructed by duke of cannaught.

1892 seat of higher education was established

1895 water supply established

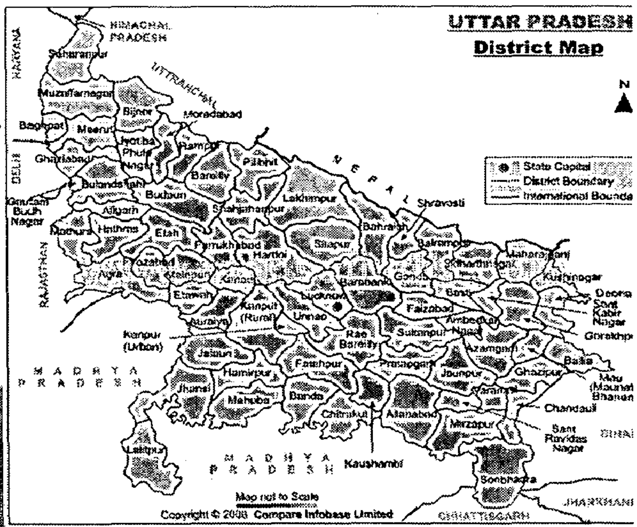
1901 last settlement established by the British including the cantonment, population 1,50,000

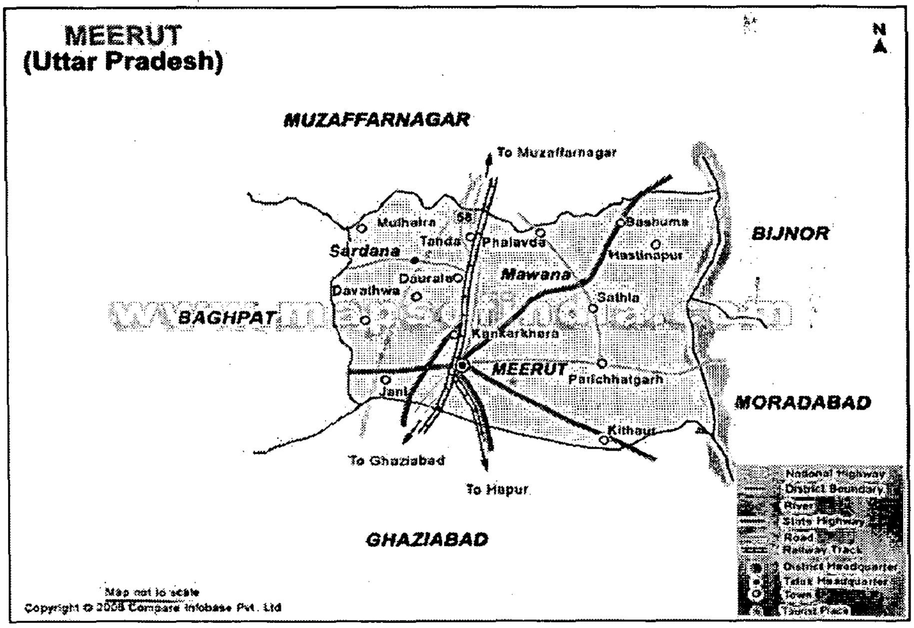
4.4. Regional Setting

Meerut is an important regional transportation hub. Road transport is the most dominant means of transport in the city. City is well connected by rail with other parts of state and country. (map no. 02)

Nearest airports are IGI intentional airport, Delhi and Domestic Airport, Delhi

Figure 4.1 location map of Meerut





Source : website www.mapsofindia.com

4.5. Demographic Profile

4.5.1 Population

As per the census 2001, Meerut city had the population of about 11,70,985 out of which 6,26,376 are male and 5,44,609 are females. The overall density of population of the city in 2001 was 1213 persons per sq. km. as compared to 683 persons per sq. km. of the state. Urbanization in Meerut is fairly high with the urban population constituting around 48.44 percent. Of total population as against 21 percent for the state.

4.5.2 Decadal Growth

Meerut is the second biggest populated city in the National capital region of India other than Delhi. According to the 2001 census Meerut city had the population of about 11,70,985 including Cantonment area, due to which Meerut fall in the category of Metropolis.

Table 4.1 decadal growth of Meerut city

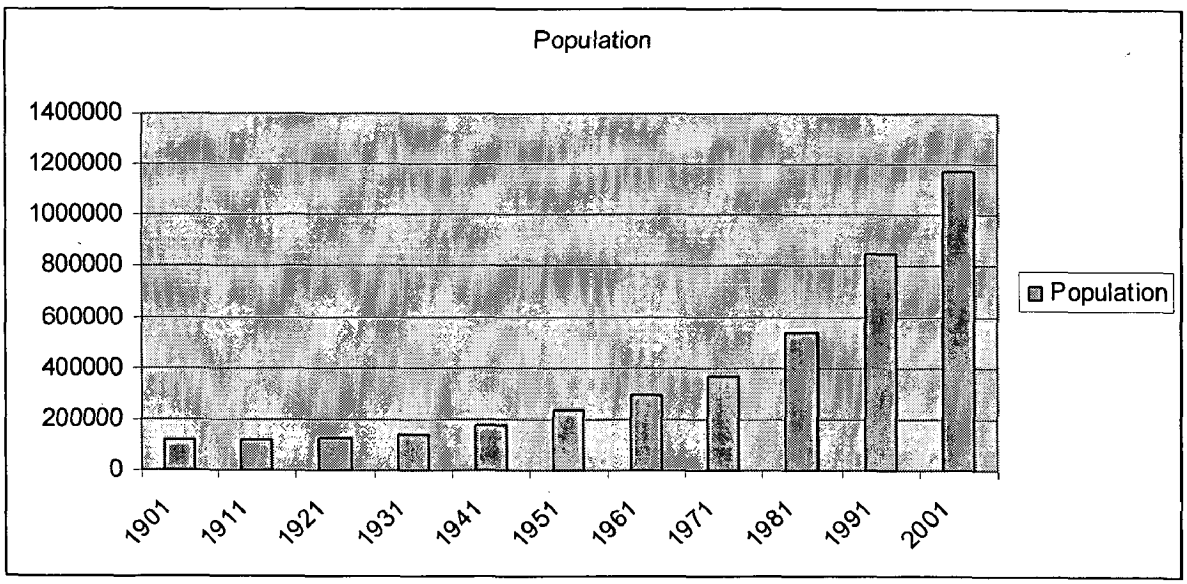
S. No.	Decades	Population	Decade Difference	% Difference
1.	1901	121180	0	0
2.	1911	119435	- 1745	- 1.44
3.	1921	125506	+ 6071	+ 5.08
4.	1931	141025	+ 15519	+ 12.37
5.	1941	179155	+ 38130	+ 27.04
6.	1951	239440	+ 60285	+ 33.65
7.	1961	294853	+ 55413	+ 23.14

8.	1971	371760	+ 76907	+ 26.08
9.	1981	536615	+ 164855	+ 44.34
10.	1991	849799	+ 313184	+ 58.36
11.	2001	1170985	+ 321186	+ 37.79

Table showing the population in different decades and its % increase. From this table we can see that from 1901 to 1951 population doubled from 121180 to 239440. So till half of the century the average population growth was 1.95%.

Till 1971 it was normal and in 1951 – 1961 and 1961 – 1971 population growth was 23.14% and 26.08% respectively. In these decades, growth at national level was 26.14% and 38.23% which is very high from the city growth. From 1971 – 1991 Meerut city grew vary rapidly with 44.34% and 58.36% decadal growth.

Figure 4.2 decadal growth of Meerut city



4.6. Economic Profile

The city is the improved and enlarged form of that area in which production activities take place and people contact to each other. Economic base of the city was developed due to its geographical condition and its cultivable land. From the study of history it is clear that those cities which can not develop strong economic base will turn towards the historic places. Traditionally the economic base of Meerut city is to make the gold jewelries, playing goods, scissors, publication works and engineering instruments. (map no. 03)

4.6.1 Economic growth

Earlier the nineteenth century, trade in Meerut was primarily held in agricultural goods and handloom clothes, leather, building materials etc. were other major areas of trade. Today the situation is changing and though agricultural based institutes are of prime importance, large number of small scale industries has been developed in and around the city. Meerut is well known for production of good quality sports goods, jewellery and scissors manufacturing.

With in the all state of National Capital Region (NCR), UP sub region is the most prosperous part of the NCR. There are several large scale industries located in Meerut i.e. sugar mills, spinning mills, auto-tyre factory, fiber board industry etc. apart from that there are number of small scale cottage industries like sports goods, scissors and razor manufacturing, handloom printing and dying etc. functioning, thus forming a important platform for economic development of the city. (map no 04)

The important role of industrial sector in Meerut was recognized by the State Government thereby blessing with incentives to give a boost to this sector. The sub

regional plan, 2001 prepared by Town and Country Planning Organization (TCPO), has also proposed some services in Meerut city which are as follows:

Table 4.2.: Economic Functions Assigned in Meerut

S. No.	Predominant functions / Industries	Services
1.	Textiles (including handloom and khadi)	Central Govt. / State Govt. sub ordinate office.
2.	Machinery (including automobile spare parts)	
3.	Basic metal	Public sector and undertakings.
4.	Leather goods	
5.	Rubbers and tyres	
6.	Engineering	Industrial and agricultural research institutes.
7.	Food and beverages	
8.	Electrical goods manufacturing	Professional educational services.
9.	Sports goods	
10.	Service industries	Banking and financial institute.

Source: master plan NCR, Delhi.

Meerut city has 15,510 small scale industries in this 61,254 labors used to work.

Meerut city has divided its economic categories in four zones:

1. Primary category
2. Secondary category
3. Tertiary category

4. Marginal labor

Meerut city is the major area for trade & commerce activity in western Utter Pradesh. At present, city has 19,037 nos. of commercial institutions.

Major development of the commercial area took place parallel to the road on both sides. (map no 05)

4.2. Role of Meerut in Envisaged National Capital Region

Meerut is one of the areas covered under the UP sub-region as part of National Capital Region (NCR) development. The policy of NCR for UP sub region encourages development of industrial activities with incentives, concession and provision of basic infrastructure. One of the projects envisaged by NCR planning board for Meerut was to develop an expressway. Since Meerut being one of the biggest city in NCR has been proposed as multipurpose priority urban centre because of its immense interaction between Delhi. Due to heavy traffic on the existing roads, the present road widths are proving to be inefficient.(map no 06)

4.3. Traffic And Transportation

Road type and traffic and transportation are the main base for development of any area. With the physical infrastructure, economic and social activities of the city are directly affected by the traffic and transportation activities. Development and construction of the road should be according to the traffic rules.

The construction of the road and its pattern should be same as our needs and what is good for future development.

City consist of following highways –

1. Delhi – Mana Pass NH – 58
2. Meerut – Badaun NH – 22
3. Garhmukhteshwar – Meerut – Karnaal National Highway
4. Meerut – Baghpat – Sonipat National highway
5. Meerut – Bijnaur - Pauri National Highway
6. Meerut – Baraut highway
7. Meerut - Parisithgarh Highway

Other than this city has main internal road network which connects all the areas of city and provide an important base for the traffic and transportation. But in the past two decades population grew very rapidly with lots of construction and also with heavy increase in city traffic which makes the city traffic worse. There are jams at every place arterial as well as sub – arterial roads of the city. The detailed traffic conditions are given in the successive chapter.

MEERUT:
THE PRESENT SCENARIO

CHAPTER 5: MEERUT: THE PRESENT SCENARIO

5.1 Introduction

Meerut has seen a boom in its construction business for the past decade and the city is now aflush with new high rise shopping complexes, apartment buildings and businesses. Meerut is the largest manufacturer of Musical Instruments in India and is also one of the largest suppliers of sports goods. Meerut is well known for its sweet shops. Nowadays Meerut is emerging in jewellery designing also.

Meerut is becoming a big education hub in Western U.P. Students from all over U.P and other states come to Meerut to study BCA, MCA, MBBS, BDS, MBA, B.Ed courses. Meerut is having a large number of government & private institutes providing education in these fields. Situated between Ganga and Jamuna, close to the imperial capital, Meerut Distt. has been a centre of varied activities throughout the course of history. The fertility of the soil, its temperate climate and its proximity to Delhi bestowed orderly progress in the times of peace and wrought bloody upheavals in times of political commotions. Inhabited by sturdy Tyagis, Rajputs, Vaishyas, Jats, Gujjars, etc. - all of whom have contributed towards its progress by either agricultural skill, enterprise and sweat, the people of Meerut faced the onslaught of Qutub-ud-din and Timur with courage and tenacity.

The events of 1857 established the British authority firmly and they began to create an elaborate system of transportation and communication; and a chain of English schools to turn out an army of intermediaries between the rulers and the ruled. Since Meerut was the most important town in the western part of the United Provinces, and a

better centre of commerce, education and politics, it contained a higher proportion of men engaged in the liberal professions, in the judiciary and in business.

The Arya Samaj Movement gained popularity in Meerut and started publications of magazines and newspapers, opened schools and laid emphasis on anti-untouchability campaigns, Swadeshi and Swaraj. A number of prominent middle class and middle caste people of Meerut were attracted towards the teachings of Arya Samaj.

The public life in Meerut began with the founding of a branch of Indian Association in 1877 by S.N.Banerjee. A number of social service and voluntary organizations like Vaish Mahasabha came up in the district of Meerut. In 1914, Meerut became the venue of three important conferences i.e., Meerut Political Conference, the U.P. Industrial Conference, and the U.P. Political Conference. Meerut had been an important centre of religious, cultural, intellectual and political activities and was also an important cotton producing district and a big centre of cotton trade and weaving. Archeological excavations carried out at Village Alamgirpur near Meerut have discovered remains from the Harrapan culture. This has put Meerut on the International map of ancient cultures. Painted Grey Wares have been found as also an ancient well that dates back to the Mauryan Period.

Meerut has since time immemorial been, on the national as well as international scene. Its progress and development has, therefore, been rapid and on the latest modern technological lines. Its proximity to Delhi was a boom to this small district. The enterprising populace armed with modern education and latest technology fast developed Meerut into one of the most important business centers of Western U.P. Meerut already had an important cantonment to boast of; but now it soon developed a huge

pharmaceutical market, innumerable factories, schools, colleges and management institutes as well as medical colleges.

5.2 Urban Planning In Meerut City

The Meerut Master Plan, 1991 and 2001, was prepared by the Town and Country Planning. A new Master Plan for the horizon year 2021 is being prepared by the Town and Country Planning Organization. (map no. 07)

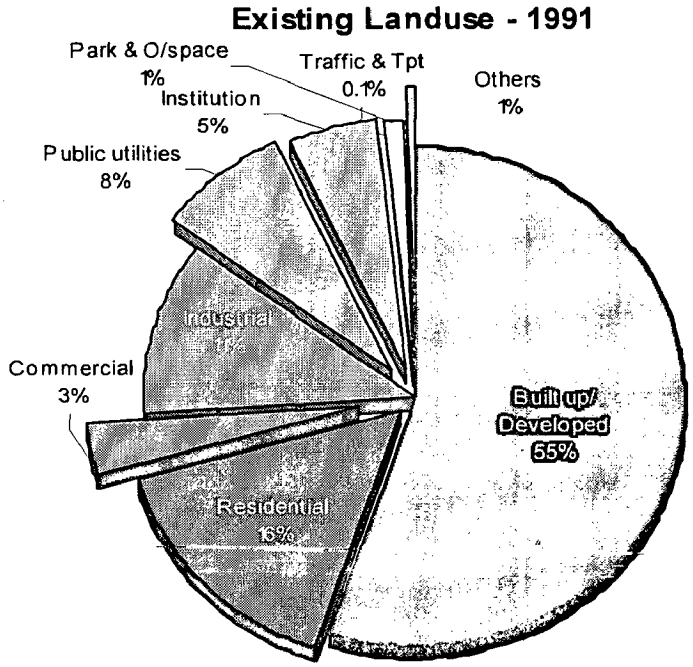
5.2.1. Spatial Pattern of growth

The spatial- growth of Meerut shows a finger shaped development pattern along the major radial roads passing through the city. Till 1971 the growth was confined in and around core city areas. From 1971-1911, the development of Meerut was at peak, during which the growth took place towards southern direction. With the commencement of Meerut bypass, the city witnessed development on the western side in linear fashion. The growth towards northern side is limited due to the presence of cantonment area, which is also one of the reasons for southbound spread. The growth pattern is shown in map no 08.

5.2.2. Meerut master plan 1991 landuse pattern

The Master plan for the period 1971-91 was planned for a well-planned city and accordingly had proposed land use for future development.

Figure 5.1 Existing landuse classification 1991



Source : Meerut Master Plan 2001

Figure 5.2 Comparison between Landuse allocation in master plan 1991 and existing landuse 1991

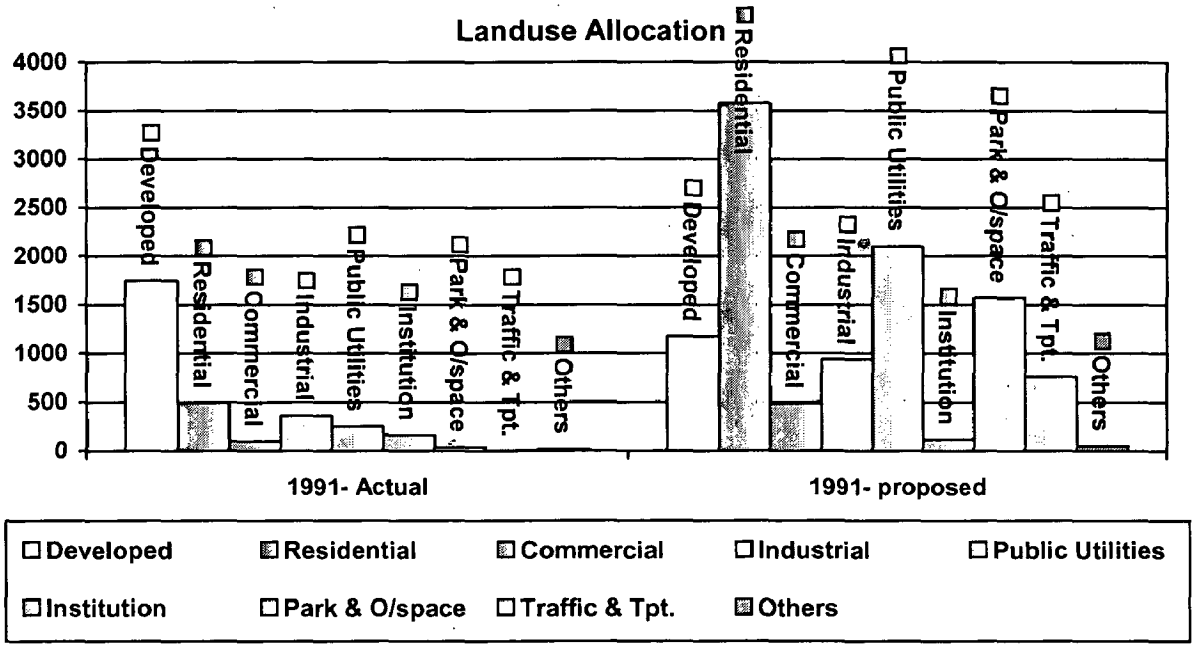


Figure presents the existing and proposed Landuse as per Meerut Master Plan, 1991. The plan has a clear-cut pattern of the basic road network, which, if have been implemented, could have resulted in solving many of the current traffic problems. It has also been identified that the area developed was only 29.39 per cent as against proposed 10783.4 ha. One of the reasons for poor implementation of the Master plan is involvement of various agencies in planning. There lack a clear-cut implementation mechanism and responsibility of each of these agencies. Land use conversion has also been a common practice, which has encroached planned green belt. Over the year the total land conversion has been taken place for an area of 545 hectare in the entire Meerut development area.

A series of various activity centers were also proposed at various locations across the development area, but except for few, others have not materialized. This gets reflected in less developed area under commercial use. Instead, mixed landuse activities have occurred along many of the city's streets, resulting in sever traffic congestion and problems of parking.

The 1991 plan had proposed an area of 763.05 hectare for traffic and transportation component against which only 2.56 hectare was developed, thereby developing only 0.34 per cent of the proposed area standard have been 15 - 20 per cent of the total area which is very less in Meerut. This could be due to practical reasons such as; difficulty in implementation, as this kind of development involves extensive acquisition of private properties where the land value is high and development is dense. As against this development the area under build up area has increased considerably, almost 148 per cent. This could be correlated to high growth rate in population, lack of proper land development mechanism and institutional framework.

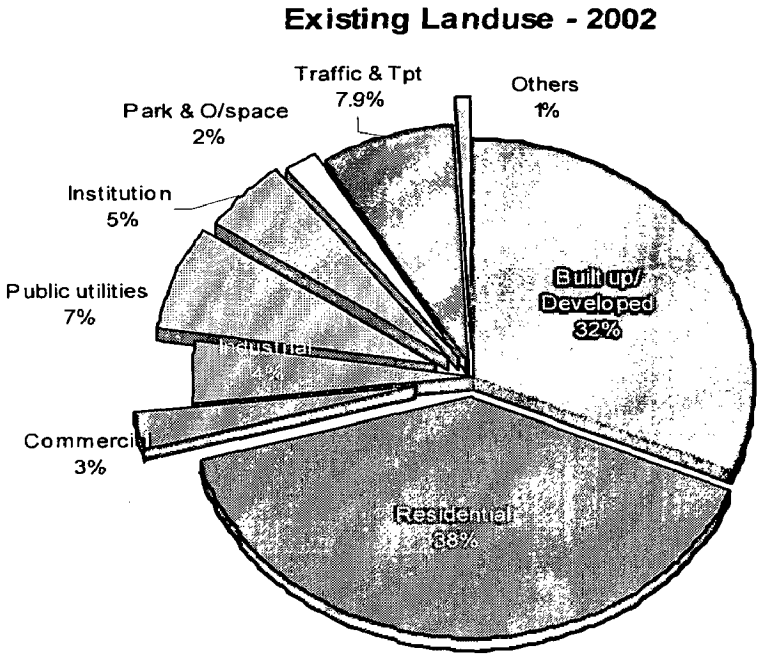
As a result of this variation, the MDA undertook an exercise in 1991 to update the Meerut Master Plan, 1991 to an extended planning horizon of 2001.

5.2.3. Meerut Master Plan, 2001- Landuse Pattern

The Master Plan 2001 was prepared for an estimated population of 13.5 lakhs as population for future development.

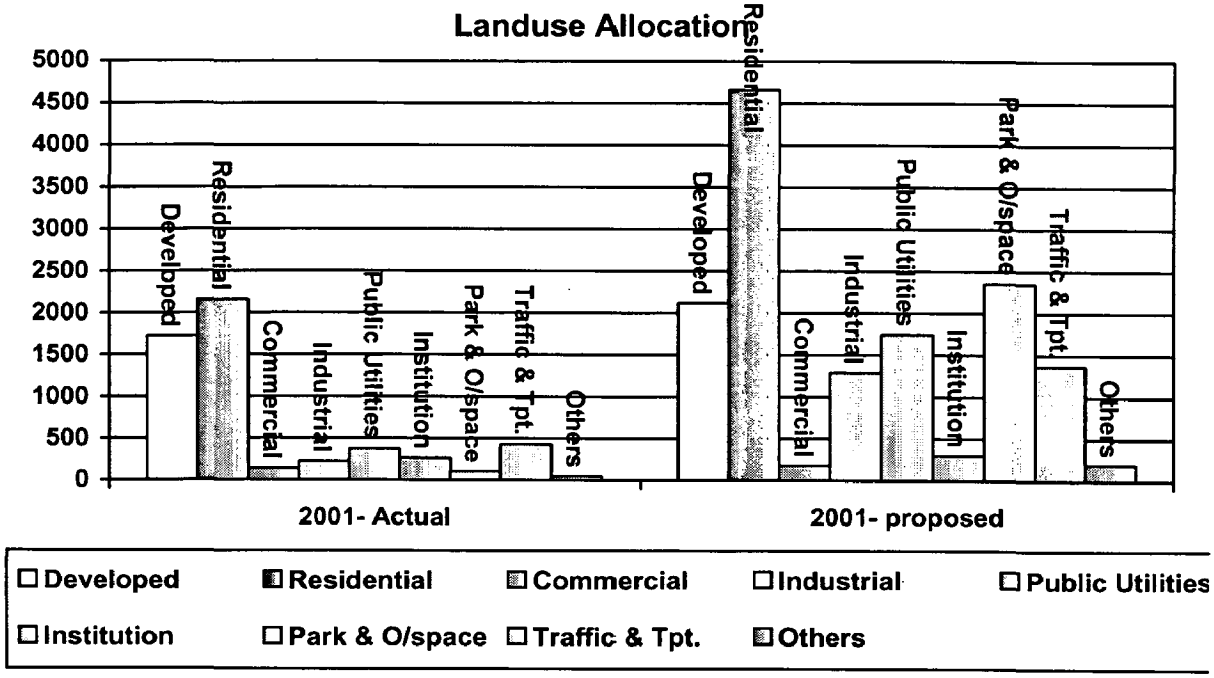
One of the major criteria for a successful Master Plan is to be able to contain land development within the planning limit and not to allow growth outside the proposed limit. This means the plan has to fit within the extent of area available and direction of growth.

Figure 5.3 Existing landuse classification 2002



Source : Meerut Master Plan 2021

Figure 5.4 Comparison between Landuse allocation in master plan 2001 and existing landuse 2001



Source : Author

The modified Master Plan for 2001 has also been formulated on the earlier concept of a clear-cut pattern of road network. The land requirement envisaged is on the higher side, 14223.4 hectare, while development has already occurred very limited on 5474.39 hectare. On the whole, the land use pattern has not been able to retain the same standards as envisaged, with most of the use being under developed. It has been identified that the areas developed are primarily between Garh road and Hapur road. The total land that was made available was around 14,223 hectare for an estimated 13.40 lakhs. It was estimated that, if at all the development would have taken place; it would have occupied almost 95 per cent which was around 10,244 hectare. But on the contrary, only 5,474.39 hectare of land has been developed, which constituted 38.49 per cent. It is clearly evident,

that wards of the city along the Delhi road and Roorkee road have been developing at a faster rate as compared to other areas. It envisages net residential density of 565 persons per Ha as compared to the 1991 levels of 432 persons per Ha.

Therefore the basic assumption on gross density and land acquisition was not proper. In was in excess of the needs. This puts additional cost on provision of infrastructure. In addition the growth direction or growth of the city could not be properly identified, which resulted in conversion of agriculture land in urban use.

5.2.4. Variation In Master Plan

The Master Plan, 2001, appears to have accepted the haphazard development that has occurred, and makes no significant attempt at effecting change, which is explained 'by the increase in residential area with respect to previous plan from 494 ha in 1991 to 2158 ha in 2001, thereby changing the Landuse break up drastically. The increased commercial use proposed could be attributed to the fact that significant mixed (residential & cOr.1mercial) land use has occurred in the city during the last few years. The implementation of road proposals in the original Master Plan, 1991, appears to have prompted the MDA to increase allocation of land for transportation. One of the striking features is that the share of share of park and open space has not shown a significant increase in the share as compared to 1991 plan.

The non-development of non-remunerative activities like open space and roads confined in the next phase of the Master Plan also. Development authority did not pay enough share on developing the same, as finances for the same is not available. Therefore, in term of provision of public spaces and roads the Master Plan for 2001 has seen very little implementation.

Regarding industrial development as most of the small scale industries are in mixed land use areas. Separate provision of land for industrial use for large industries did not make much sense. Similar location of many new proposals of are far away from the existing industrial areas, which do not help to integrate with the existing industrial fabric

5.2.5. Density Pattern

Most of the development in terms of population growth in the city has occurred along the Delhi road and in the southern portion and along the Roorkee road in the northern side. The ward-wise spatial distribution of population in the city based on different density ranges as shown in the map. The summary of distribution of wards by population density is presented in the Table 5.1 (map no 09)

Table 5.1 Ward wise density pattern.

Ward No.	Ward Name	Population	Area (Ha)	Density (ppHa)
1.	Shivlokpuri	12,496	74	169
2.	Mewla	25,137	190	132
3.	Maliyana	19,251	262	73
4.	Bhagwatpura	NA	NA	NA
5.	Medical College	33,517	580	58
6.	Palhaida	10,234	852	12
7.	Anup Nagar	NA	NA	NA
8.	Shobhapur	20,378	860	24
9.	Shubash Nagar	8,928	180	50
10.	Lisadi	13,984	338	41

11.	Shegadi	NA	NA	NA
12.	Fahruddin Nagar	42,840	110	389
13.	Karim Nagar	11,739	64	183
14.	Kidwai Nagar	13,206	9	1,467
15.	Shahpir Gate	13,911	16	869
16.	Zakir Colony	33,744	44.5	758
17.	Dakshini Islamabad	11,400	45.4	251
18.	Badoli	33,936	618	55
19.	Budhera, Jahidpur	NA	NA	NA
20.	Purvi Islamabad	10,460	35.7	293
21.	Purvi Feyazali	18,943	33.4	567
22.	Karim Nagar – I	NA	NA	NA
23.	Nangla Tasi	26,931	1024	26
24.	Sarai Bahalim	21,990	11.2	1,963
25.	Sundera Urf Putha	14,397	1,149	13
26.	Multan Nagar	26,761	236	113
27.	Purvi Ilahibaqsh	15,440	6.9	2,238
28.	Rithani	18,581	656	28
29.	Purvi Abdulwali	7,274	5.6	1,299
30.	Rashid Nagar	16,820	118	143
31.	Kashi	3,482	612	6
32.	Govindpuri	15,094	42	359
33.	Tarapuri	20,855	31	673
34.	Shastri Nagar Sec 7,2	NA	41	NA

35.	Shastri Nagar Sec 7,3	NA	20	NA
36.	Brahmapuri Paschim	11,560	15.5	746
37.	Thapar Nagar	9,614	44	219
38.	Kotla	10,675	30	356
39.	Shastri Nagar 'L' Block	NA	310	NA
40.	Kaseru Baksar	23,656	428	55
41.	Shivshakti Nagar	14,838	194	76
42.	Makbara Abu	7,335	24	306
43.	Hafiz Ahmed	8,644	21.9	395
44.	Kasampur	15,051	224	67
45.	Kailashpuri	16,800	112	150
46.	Prahlad Nagar	31,666	209	152
47.	Purvi Brahmapuri	29,870	21.8	1370
48.	Aurang Shahpur	17,178	312	55
49.	Ishwarpuri	NA	8	NA
50.	Phoolbagh Colony	19,413	62.02	313
51.	Khairnagar	10,702	22.1	484
52.	Bhopal Singh Road	11,427	66	173
53.	Surajkund Road	9,441	38	248
54.	Shivshankarpuri	8,596	34.5	249
55.	Prempuri Railway Colony	7,725	38	203
56.	Saddique Nagar	10,901	46	237
57.	Baghpat Nagar	14,234	19.5	730

58.	Darudran	6,262	11.8	531
59.	Police Line	9,082	50	182
60.	Devpuri	7,643	66	116
61.	Mohanpuri	12,081	38	318
62.	Mori Pada	13,202	12.5	1,056
63.	Nangla Battu	12,040	100	120
64.	Civil Line	9,407	154	61
65.	Kanon Goyan	5,971	14.9	401
66.	Abdullapur	18,837	460	41
67.	Roshanpur Dorli	25,506	604	42
68.	Ismail Nagar	8,879	12.3	722
69.	Swami Pada	9,775	20.8	470
70.	Modipuram	9,038	248	36

5.3 Traffic And Transportation

The aim of conducting detailed study is for the identification of planning parameters, which contribute to the fulfillment of the performance criteria which in turn a prerequisite for the fulfillment of the users of urban roads. The field survey has been analyzed with respect to the parameters given in the chapter no 2. The bulk of the data has been taken from Meerut Development Authority and Town and Country Planning, Meerut Division.

The major roads in Meerut Corporation jurisdiction are constructed and maintained by the Meerut Municipal Corporation, except for the roads belonging to the Public Works Department (highways and other district level roads). The internal road

constructed in the colonies is the responsibility of the MDA and respective private agencies. The Municipal Corporation checks the adequacy of these roads at the time of according sanction to the schemes.

5.3.1. Existing Situation

The total road length in Meerut is approximately 1275.66 km, of which 12.5 kms is national highway. The state highway contributes 243 km of the total road length. The development and maintenance of national highways and the state highways are the responsibilities of the Public Works department. The total road maintained by Municipal Corporation is about 854.98 kms, out of which kutcha and pucca each contributes almost 50 per cent each. The other road of about 65.18 kms is maintained by the Cantonment board, which contributes about 5.11 per cent of the total road length in Meerut. The current network covers 7.01 kmjsq. km accounting for a per capita road length of 1.08 m. (map no 10)

Table 5.2: Road Network in Meerut (2001)

Particulars	**Road length (kms)**	**% Road length**
National highway	12.5	0.98
State highway	243	19.05
District roads	100	7.85
Road length	**355.5**	
Municipal roads (pucca)	425.61	33.36
Municipal roads (kutcha)	429.37	33.66
Cantonment roads	65.18	5.11

Total road length	1275.66	100.0

Sustainability indicators	Details
Per capita road length	1.08 m
Road density	7.01 km/sq.m
% Area under roads	7.76 %

5.3.2. Total No Of Vehicles In Uttar Pradesh

Uttar Pradesh has a significant no of registered vehicles. The total no of registered vehicles are 3,20,27,771 as on 31 march 1996. Uttar Pradesh had accounted for 8.93 per cent of all vehicles at the national level. The State also occupied eighth position in number of motor vehicles density per sq.km. of geographical area next to Punjab and Kerala which have the highest vehicle density among the major States.

Table 5.3 Total no of vehicles in Uttar Pradesh

State	Two-Wheeler	Auto-Rickshaw	Jeeps	Cars	Taxis	Buses	Goods Vehicles	Miscellaneous
							(1)	(2)
Uttar Pradesh	2265294	31374	38613	164535	32931	29176	103653	459069

Source: Transport Research Wing, Ministry of Surface Transport

5.3.3. Number of Registered Vehicles(Decade wise)

The increase in population, coupled with steady rise in per capita income, had triggered off an unprecedented rise in vehicle population in the State. The number of registered vehicles in the state stood at 3,20,27,771 (1996)

Table 5.4 No. of Registered Vehicles in Uttar Pradesh (Decade wise)

Year	Number of Registered Vehicles in UP, '000			
	2 Wheeler	Car, Jeep, & Taxi	Bus	Truck
1990 - 1991	1,331.00	139.00	24.00	74.00
1991 - 1992	1,521.00	169.00	25.00	77.00
1992 - 1993	1,642.00	176.00	27.00	77.00
1993 - 1994	1,736.00	183.00	27.00	78.00
1994 - 1995	1,815.00	187.00	27.00	78.00
1995 - 1996	2,057.00	194.00	28.00	78.00
1996 - 1997	2,264.00	224.00	28.00	91.00
1997 - 1998	2,731.00	253.00	28.00	96.00
1998 - 1999	2,940.00	295.00	30.00	98.00
1999 - 2000	3,351.00	354.00	35.00	102.00
2000 - 2001	3,856.00	404.00	39.00	108.00

Source: Transport Research Wing, Ministry of Surface Transport

5.3.4. Traffic Count Survey at Inner Cordon Points

The data shows the daily traffic count at inner cordon points in different highways namely delhi road, Baghpat road, Baraut road, Sardhana Road, Roorkee road, Mawana road , Parisithgarh road, Garh road, Hapur road. The survey was done in the year 2002 by the Government body. Values written in the bracket are the percentage increase in the traffic as compared with the traffic count survey 1992. The table clearly shows that most of the traffic is at Delhi road. Table also shows that there is a regular decrease in the number of cycles and cycle rickshaws. Only two roads i.e. Sardhana road and Garh road are having the increase in the number of cycle and cycle rickshaws.

In terms of total numbers, every road is getting some increase in the traffic with the increase in the population.

Table 5.5 Traffic count survey at inner cordon points-2002

Name of Roads	**Stations**	**Bus / trucks**	**Car/ Jeep / Tampo / Tractor**	**Scooter/ M.Cycle**	**Animal Drawn Vehicles**	**Cycle/ Rickshaw**	**Total**
Delhi Road	Near Partapur	5639 (-4.9)	10053 (+98.72)	5033 (+175.48)	257 (+46.02)	853 (+15.90)	21,835 (+59.10)
Baghpat Road	Multan Nagar	4044 (+37.69)	2674 (+136.22)	2353 (+141.33)	305 (- 56.92)	1524 (-30.56)	10,900 (+37.16)

Baraut Road	Railway Crossing	1701 (+4.74)	2112 (+56.09)	2231 (+70.18)	303 (-48.02)	1219 (-66.77)	7,566 (-11.39)
Sardhana Road	Railway Crossing	2094 (+22.96)	2784 (+180.64)	6160 (+201.52)	224 (-32.53)	3505 (+45.43)	14,767 (+97.42)
Roorkee Road	Appu Ghar	4921 (+40.24)	6593 (+135.72)	3836 (+320.15)	338 (+35.74)	539 (-14.44)	16,227 (+100.38)
Mawana Road	Ganga Nagar	2926 (+45.49)	3362 (+225.45)	4125 (+351.31)	531 0	1656 (-13.79)	12,600 (+96.57)
Parisithgarh Road		1078 (+63.83)	1011 (+273.06)	1561 (+195.08)	558 (+92.41)	1759 (+129.64)	5,967 (+137.55)
Garh Road	Medical	2235 (+53.93)	3179 (+73.72)	3080 (+141.00)	1692 (+477.470	2228 (+14.96)	12,414 (+82.80)
Hapur Road	Shatri Nagar	2054 (-16.86)	3317 (+161.18)	2966 (+198.99)	291 (-64.460	1398 (-31.54)	10,026 (+45.19)

Source: Meerut Master Plan 2021

5.3.5. Daily Traffic at Outer Cordon Points

As already said in the above paragraph, the most of the traffic can be seen on the national highway 58 in both the direction. If we compare the composition on the highway listed below than also the national highway 58 has the highest no of cars moving on the road. buses and trucks are the same as on the other highway.

Table 5.6 Daily traffic at outer cordon points,2005

Vehicles	NH 58 Towards Roorkee	NH 58 Towards Delhi	SH Towards Garh	SH Towards Mawana	SH towards Hapur
Car	7774	5632	2178	3052	2120
Jeep & Van	1832	2757	1544	1156	1477
3 Wheelers	1114	3725	1734	518	1906
2 Wheelers	5511	6080	3475	6992	3956
Minibus	278	1831	454	199	531
Bus	1512	3040	1588	1211	1293
LGV	1311	728	998	1132	993
2 Axial Trucks	1822	2042	1738	605	1783
3 Axial Trucks	1159	870	990	207	1439
Multi Axial Truck	357	0	131	87	102
Agri. Trailors	273	523	13	467	663
Pedal Cycle	630	1682	2064	3700	1736
Cycle Rickshaw	210	2071	886	451	903

Hand Cart	33	102	9	128	14
Animal Cart	184	883	1172	798	1114
Total					
Total Fast Moving Vehicles	22943	27228	18974	15626	16263
Total Slow Moving Vehicles	1057	4738	4131	5077	3767
Total Vehicles	24000	31966	23105	20703	20030
Total Fast Moving PCUs	33003	42172	28627	19694	29946
Total Slow Moving PCUs	2398	12656	12237	9907	11670
Total PCUs	35401	54828	40864	29601	41616

Source: Preliminary Study for construction of By Pass, FTEPL.

5.3.6. Region Wise Contribution of Trips (In %)

In order to assess the percentage of through traffic passing from Meerut city and to understand the travel demand pattern in the region origin and destination survey were analyzed.

From the table it can be seen that the goods traffic is generally a mix of short and long distance traffic whereas most of the passenger traffic generates within Uttar Pradesh and Uttrakhand states.

Sivaya at NH 58

Neighboring states like Punjab and Northern / North West part of Uttar Pradesh state contributing most of the goods trips originating / Terminating from / to the NH 58 around Meerut. Of total goods traffic, about 35% generates at Meerut, 6% generates at Roorkee, 25% at Delhi. Of total passengers traffic, about 25% generates at Meerut, 25% at Delhi, 10% at Roorkee and rest are from other districts and states.

Partapur at NH 58

Ghaziabad, Meerut, Delhi, are the major contributors to both type of traffic in this area. Of total goods traffic about 30 % generates (including either originating or terminating traffic) at Meerut, 11% generates at Ghaziabad, 34% generates in Delhi. Of total passengers traffic about 34% generates at Meerut, 35% in Delhi and 18 % in Ghaziabad.

At SH to Mawana

Mawana, Bijnaur and Meerut are the major contributors of traffic on this road.

At SH to Garh Mukteshwar

Garh, Moradabad, Khatauli are the major contributors of traffic on this road for both direction.

At SH to Hapur

Hapur, Meerut, Agra, Mathura are major contributors of traffic on this road for both directions.

Table 5.7 Region wise contribution of trips (in %)

Vehicle Type	Region Wise Contribution of Trips (in %)					
	Meerut	Delhi	Neighboring Districts	Rest of the U.P.	North India	Rest
Goods Trips						
LGV	43	14	24	6	10	2
2 Axial Truck	33	14	26	11	9	7
3 Axial Truck	29	12	25	6	17	10
Multi Axial Truck	29	9	31	1	18	12
Passengers Trips						
Car	45	35	5	11	3	1
Auto	89	11	0	0	0	0
Mini Mus	84	16	0	0	0	0
Standard Bus	32	26	14	9	18	0

Source: Preliminary Study for construction of By Pass, FTEPL.

5.3.7. Traffic Composition at Outer Cordon Points

Analysis is carried out to find the composition of traffic in terms of fast and slow moving traffic and in terms of vehicles among the fast moving traffic. The salient points from the traffic composition analysis are summarized in the following figures.

Figure 5.5 - Traffic composition at Sivaya North of Meerut on NH 58

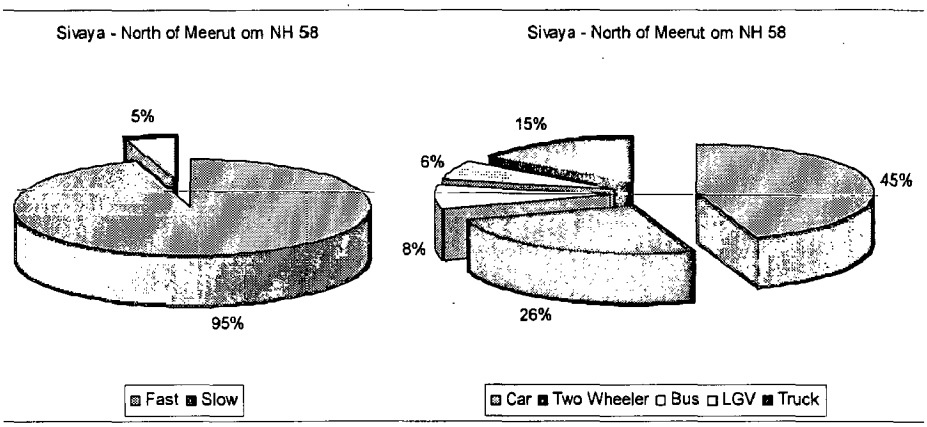


Figure 5.6 - Traffic composition at Partapur South Of Meerut on NH 58

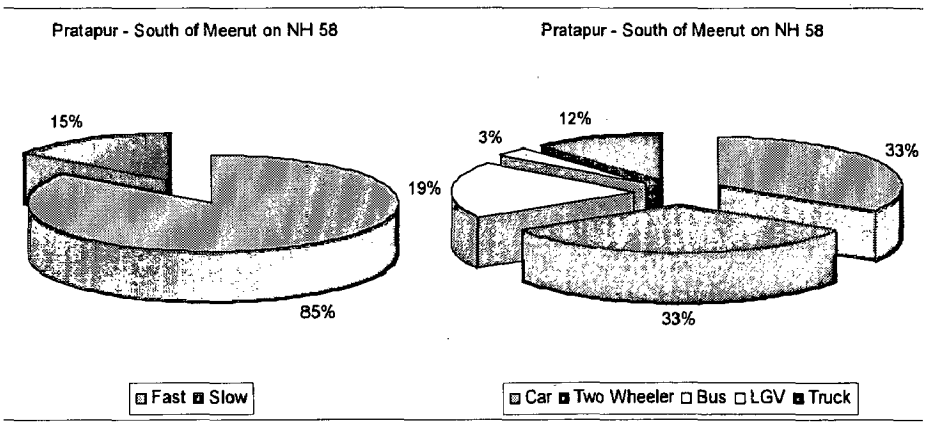


Figure 5.7 - Traffic composition at SH Leading to Garh Mukteshwar

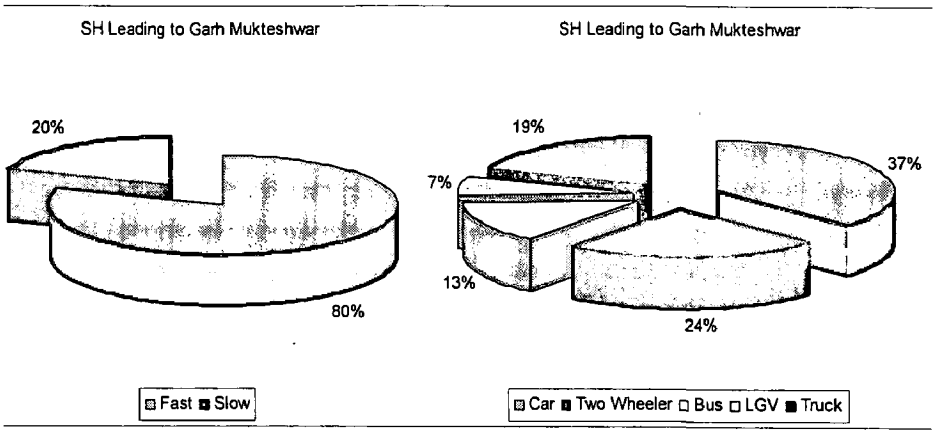


Figure 5.8 - Traffic composition at SH Leading to Mawana

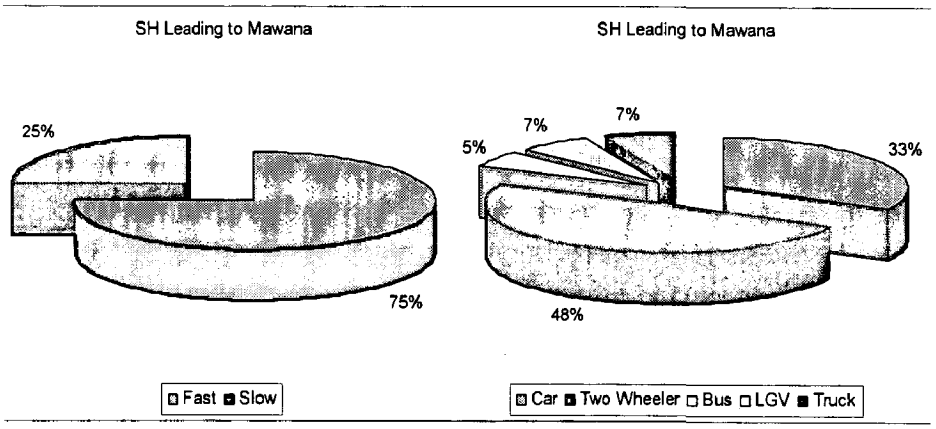
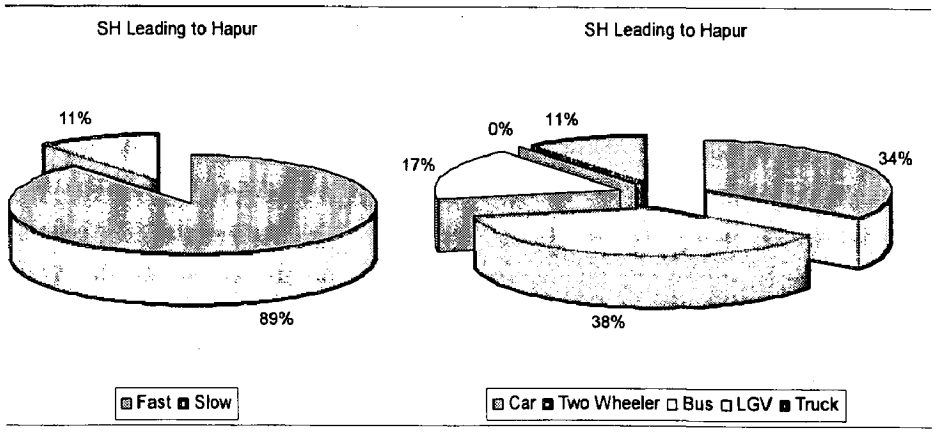


Figure 5.9 - Traffic composition at SH Leading to Hapur



5.3.8. TRAFFIC FORECAST : Table 5.8 Traffic forecast for Delhi road

Year	Bus/ trucks	Car/Jeep/ Tampo/ Tractor	Scooter/ M.Cycle	Cycle/ Rickshaw
2,002	5,639	10,053	5,033	853
2,003	5,921	10,807	5,436	917
2,004	6,217	11,617	5,870	986
2,005	6,528	12,489	6,340	1,060
2,006	6,854	13,425	6,847	1,139
2,007	7,197	14,432	7,395	1,225
2,008	7,557	15,515	7,987	1,316
2,009	7,935	16,678	8,626	1,415
2,010	8,331	17,929	9,316	1,521
2,011	8,748	19,274	10,061	1,635
2,012	9,185	20,720	10,866	1,758
2,013	9,645	22,274	11,735	1,890
2,014	10,127	23,944	12,674	2,032
2,015	10,633	25,740	13,688	2,184
2,016	11,165	27,670	14,783	2,348
2,017	11,723	29,746	15,966	2,524
2,018	12,309	31,977	17,243	2,713
2,019	12,925	34,375	18,622	2,917
2,020	13,571	36,953	20,112	3,135
2,021	14,249	39,724	21,721	3,371

Table 5.9 Traffic forecast for Baghpat Road

Year	Bus/ trucks	Car/Jeep/ Tampo/ Tractor	Scooter/ M.Cycle	Cycle/ Rickshaw
2,002	4044	2674	2353	1524
2,003	4,246	2,875	2,541	1,638
2,004	4,459	3,090	2,745	1,761
2,005	4,681	3,322	2,964	1,893
2,006	4,916	3,571	3,201	2,035
2,007	5,161	3,839	3,457	2,188
2,008	5,419	4,127	3,734	2,352
2,009	5,690	4,436	4,033	2,528
2,010	5,975	4,769	4,355	2,718
2,011	6,274	5,127	4,704	2,922
2,012	6,587	5,511	5,080	3,141
2,013	6,917	5,925	5,486	3,377
2,014	7,262	6,369	5,925	3,630
2,015	7,626	6,847	6,399	3,902
2,016	8,007	7,360	6,911	4,195
2,017	8,407	7,912	7,464	4,509
2,018	8,828	8,505	8,061	4,848
2,019	9,269	9,143	8,706	5,211
2,020	9,732	9,829	9,403	5,602
2,021	10,219	10,566	10,155	6,022

Table 5.9 Traffic forecast for Baraut Road

Year	Bus/ trucks	Car/Jeep/ Tampo/ Tractor	Scooter/ M.Cycle	Cycle/ Rickshaw
2,002	1701	2112	2231	1219
2,003	1,786	2,270	2,409	1,310
2,004	1,875	2,441	2,602	1,409
2,005	1,969	2,624	2,810	1,514
2,006	2,068	2,821	3,035	1,628
2,007	2,171	3,032	3,278	1,750
2,008	2,280	3,259	3,540	1,881
2,009	2,393	3,504	3,824	2,022
2,010	2,513	3,767	4,129	2,174
2,011	2,639	4,049	4,460	2,337
2,012	2,771	4,353	4,817	2,512
2,013	2,909	4,679	5,202	2,701
2,014	3,055	5,030	5,618	2,903
2,015	3,207	5,408	6,067	3,121
2,016	3,368	5,813	6,553	3,355
2,017	3,536	6,249	7,077	3,607
2,018	3,713	6,718	7,643	3,877
2,019	3,899	7,222	8,255	4,168
2,020	4,094	7,763	8,915	4,481
2,021	4,298	8,346	9,628	4,817

Table 5.10 Traffic forecast for Sardhana Road

Year	Bus/ trucks	Car/Jeep/ Tampo/ Tractor	Scooter/ M.Cycle	Cycle/ Rickshaw
2,002	2094	2784	6160	3505
2,003	2,199	2,993	6,653	3,768
2,004	2,309	3,217	7,185	4,050
2,005	2,424	3,459	7,760	4,354
2,006	2,545	3,718	8,381	4,681
2,007	2,673	3,997	9,051	5,032
2,008	2,806	4,297	9,775	5,409
2,009	2,946	4,619	10,557	5,815
2,010	3,094	4,965	11,402	6,251
2,011	3,248	5,338	12,314	6,720
2,012	3,411	5,738	13,299	7,224
2,013	3,581	6,168	14,363	7,766
2,014	3,761	6,631	15,512	8,348
2,015	3,949	7,128	16,753	8,974
2,016	4,146	7,663	18,093	9,647
2,017	4,353	8,238	19,541	10,371
2,018	4,571	8,855	21,104	11,149
2,019	4,799	9,519	22,792	11,985
2,020	5,039	10,233	24,615	12,884
2,021	5,291	11,001	26,585	13,850

Table 5.11 Traffic forecast for Roorkee Road

Year	Bus/ trucks	Car/Jeep/ Tampo/ Tractor	Scooter/ M.Cycle	Cycle/ Rickshaw
2,002	4921	6593	3836	539
2,003	5,167	7,087	4,143	579
2,004	5,425	7,619	4,474	623
2,005	5,697	8,190	4,832	670
2,006	5,982	8,805	5,219	720
2,007	6,281	9,465	5,636	774
2,008	6,595	10,175	6,087	832
2,009	6,924	10,938	6,574	894
2,010	7,271	11,758	7,100	961
2,011	7,634	12,640	7,668	1,033
2,012	8,016	13,588	8,282	1,111
2,013	8,417	14,608	8,944	1,194
2,014	8,837	15,703	9,660	1,284
2,015	9,279	16,881	10,432	1,380
2,016	9,743	18,147	11,267	1,484
2,017	10,230	19,508	12,168	1,595
2,018	10,742	20,971	13,142	1,714
2,019	11,279	22,544	14,193	1,843
2,020	11,843	24,235	15,329	1,981
2,021	12,435	26,052	16,555	2,130

Table 5.12 Traffic forecast for Mawana Road

Year	Bus/ trucks	Car/Jeep/ Tampo/ Tractor	Scooter/ M.Cycle	Cycle/ Rickshaw
2,002	2926	3362	4125	1656
2,003	3,072	3,614	4,455	1,780
2,004	3,226	3,885	4,811	1,914
2,005	3,387	4,177	5,196	2,057
2,006	3,557	4,490	5,612	2,212
2,007	3,734	4,827	6,061	2,377
2,008	3,921	5,189	6,546	2,556
2,009	4,117	5,578	7,070	2,747
2,010	4,323	5,996	7,635	2,953
2,011	4,539	6,446	8,246	3,175
2,012	4,766	6,929	8,906	3,413
2,013	5,004	7,449	9,618	3,669
2,014	5,255	8,008	10,387	3,944
2,015	5,517	8,608	11,218	4,240
2,016	5,793	9,254	12,116	4,558
2,017	6,083	9,948	13,085	4,900
2,018	6,387	10,694	14,132	5,267
2,019	6,706	11,496	15,263	5,662
2,020	7,042	12,358	16,484	6,087
2,021	7,394	13,285	17,802	6,544

Table 5.13 Traffic forecast for Parishitgarh Road

Year	Bus/ trucks	Car/Jeep/ Tampo/ Tractor	Scooter/ M.Cycle	Cycle/ Rickshaw
2,002	1078	1011	1561	1759
2,003	1,132	1,087	1,686	1,891
2,004	1,188	1,168	1,821	2,033
2,005	1,248	1,256	1,966	2,185
2,006	1,310	1,350	2,124	2,349
2,007	1,376	1,451	2,294	2,525
2,008	1,445	1,560	2,477	2,715
2,009	1,517	1,677	2,675	2,918
2,010	1,593	1,803	2,889	3,137
2,011	1,672	1,938	3,120	3,372
2,012	1,756	2,084	3,370	3,625
2,013	1,844	2,240	3,640	3,897
2,014	1,936	2,408	3,931	4,190
2,015	2,033	2,589	4,245	4,504
2,016	2,134	2,783	4,585	4,842
2,017	2,241	2,991	4,952	5,205
2,018	2,353	3,216	5,348	5,595
2,019	2,471	3,457	5,776	6,015
2,020	2,594	3,716	6,238	6,466
2,021	2,724	3,995	6,737	6,951

Table 5.14 Traffic forecast for Garh Road

Year	Bus/ trucks	Car/Jeep/ Tampo/ Tractor	Scooter/ M.Cycle	Cycle/ Rickshaw
2,002	2235	3179	3080	2228
2,003	2,347	3,417	3,326	2,395
2,004	2,464	3,674	3,593	2,575
2,005	2,587	3,949	3,880	2,768
2,006	2,717	4,245	4,190	2,975
2,007	2,852	4,564	4,526	3,199
2,008	2,995	4,906	4,888	3,438
2,009	3,145	5,274	5,279	3,696
2,010	3,302	5,670	5,701	3,974
2,011	3,467	6,095	6,157	4,272
2,012	3,641	6,552	6,649	4,592
2,013	3,823	7,043	7,181	4,936
2,014	4,014	7,572	7,756	5,307
2,015	4,214	8,140	8,376	5,705
2,016	4,425	8,750	9,047	6,132
2,017	4,646	9,406	9,770	6,592
2,018	4,879	10,112	10,552	7,087
2,019	5,123	10,870	11,396	7,618
2,020	5,379	11,685	12,308	8,190
2,021	5,648	12,562	13,292	8,804

Table 5.15 Traffic forecast for Hapur Road

Year	Bus/ trucks	Car/Jeep/ Tampo/ Tractor	Scooter/ M.Cycle	Cycle/ Rickshaw
2,002	2054	3317	2966	1398
2,003	2,157	3,566	3,203	1,503
2,004	2,265	3,833	3,460	1,616
2,005	2,378	4,121	3,736	1,737
2,006	2,497	4,430	4,035	1,867
2,007	2,621	4,762	4,358	2,007
2,008	2,753	5,119	4,707	2,158
2,009	2,890	5,503	5,083	2,319
2,010	3,035	5,916	5,490	2,493
2,011	3,186	6,359	5,929	2,680
2,012	3,346	6,836	6,403	2,881
2,013	3,513	7,349	6,916	3,097
2,014	3,689	7,900	7,469	3,330
2,015	3,873	8,493	8,066	3,579
2,016	4,067	9,130	8,712	3,848
2,017	4,270	9,815	9,409	4,137
2,018	4,484	10,551	10,161	4,447
2,019	4,708	11,342	10,974	4,780
2,020	4,943	12,193	11,852	5,139
2,021	5,190	13,107	12,800	5,524

5.3.9. ROAD USER ANALYSIS

Road users are being discussed in the pedestrians, vehicular users, and street hawkers

5.3.9.1. Problems faced by the pedestrians

1. No space for activity of the pedestrians,
2. No footpaths,
3. No facilities for special groups,
4. Absence of facilities like drinking water, benches, telephone booths,
5. Absence of pedestrian's safety devices.

5.3.9.2. Problems faced by the Vehicular User

1. In sufficient carriageway width resulting in congestion,
2. No cycle tracks,
3. Absence of safety devices,
4. No parking Facilities,
5. Absence of traffic signals,
6. No basic infrastructure.

5.3.9.3. Problems faced by the Vehicular User

1. Lack of space for their work,
2. No safety from moving vehicles,
3. Sharing the space with other users.

ILLUSTRATIONS

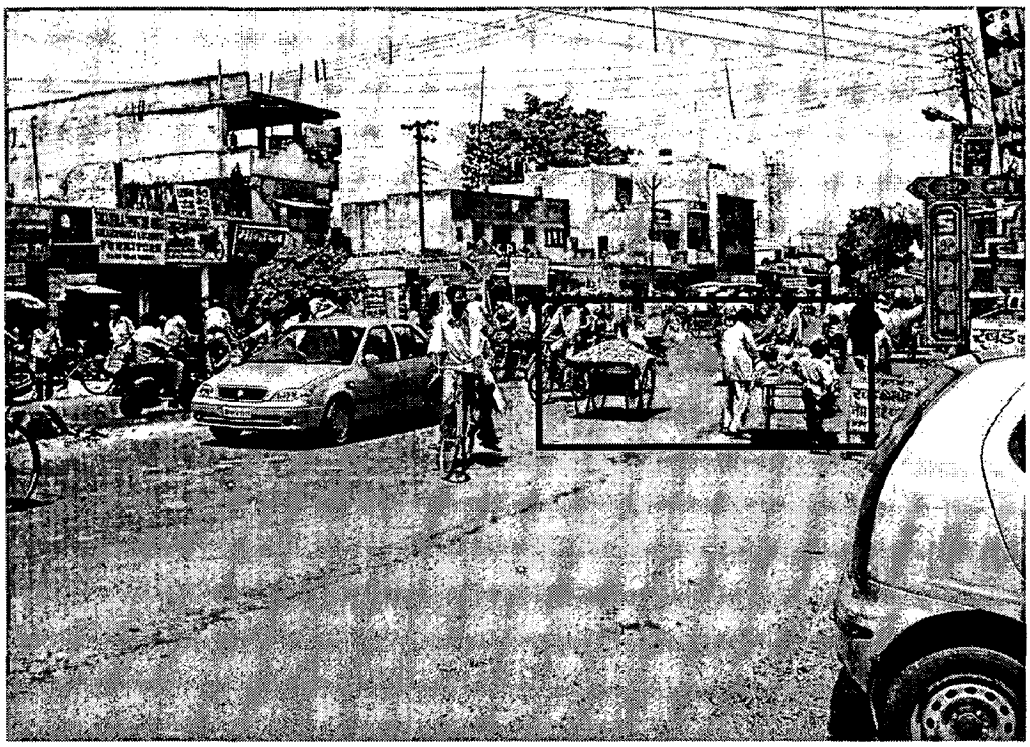


Illustration 5.4.1 Fruit seller moving on the road.

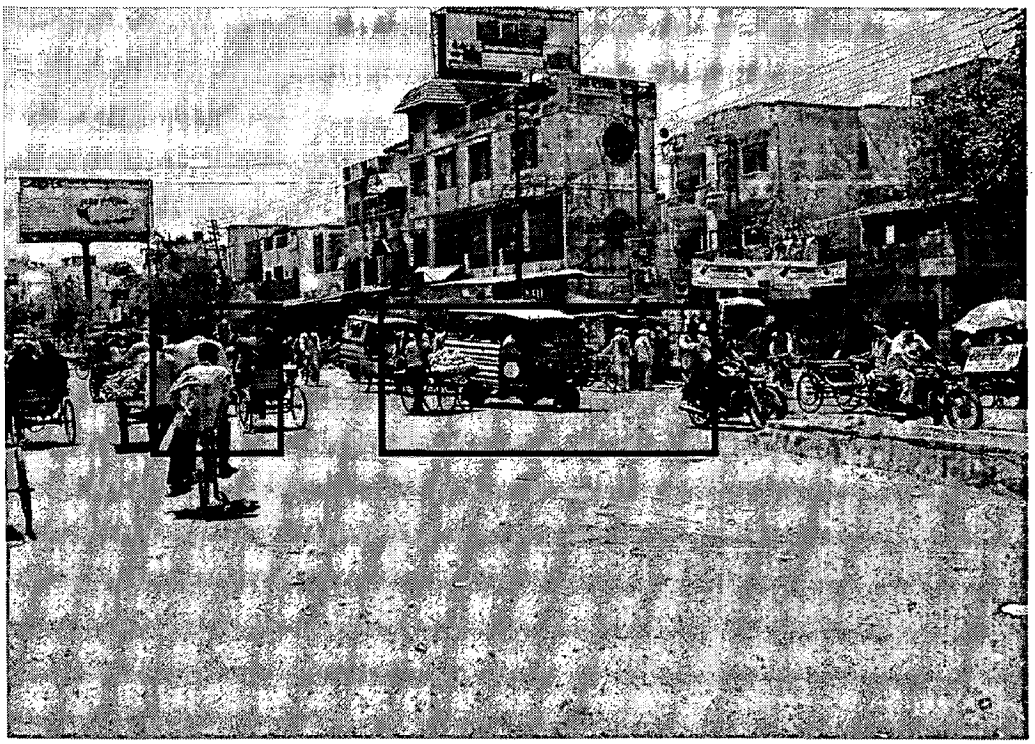


Illustration 5.4.2 Fruit seller crossing the road in the running traffic

Source : Author

Illustration 5.4.3 Signposts between the road but no light facilities.

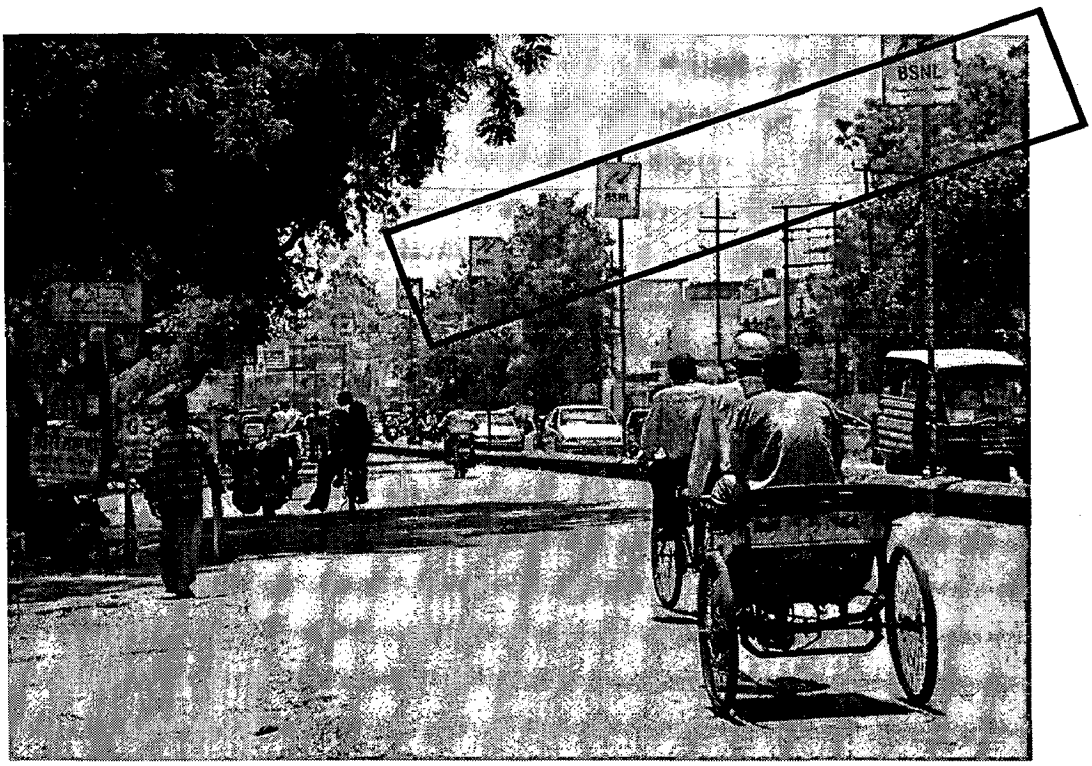


Illustration 5.4.4 Road with no lighting facility.

Source : Author

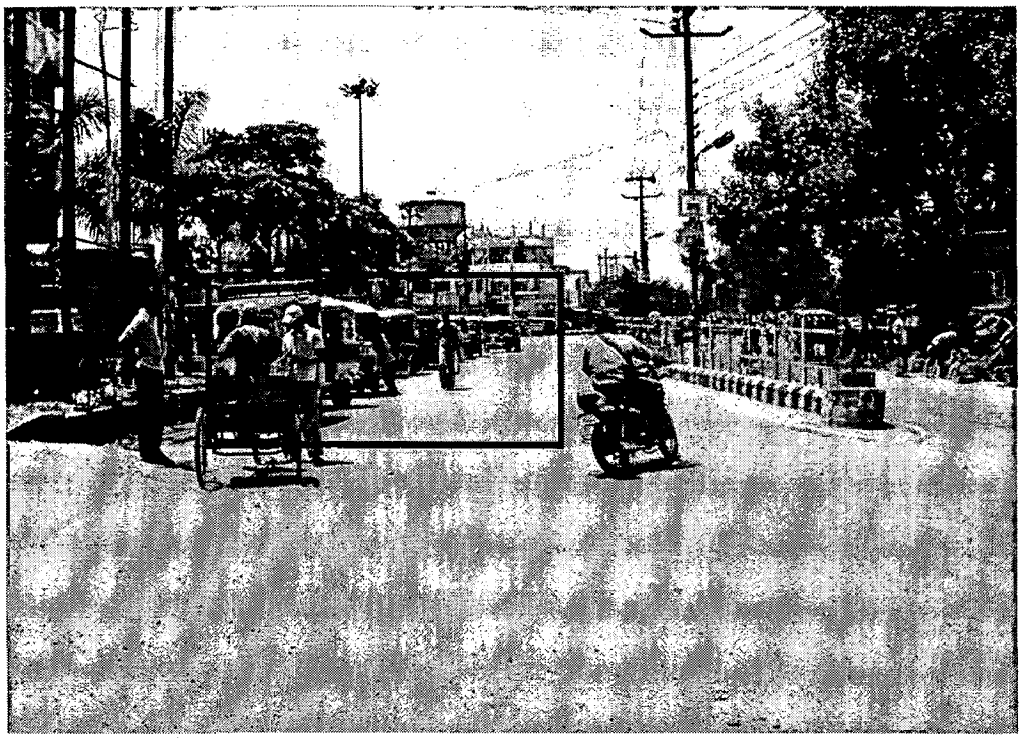


Illustration 5.4.5 Auto rickshaw standing on the road engaging the right of way

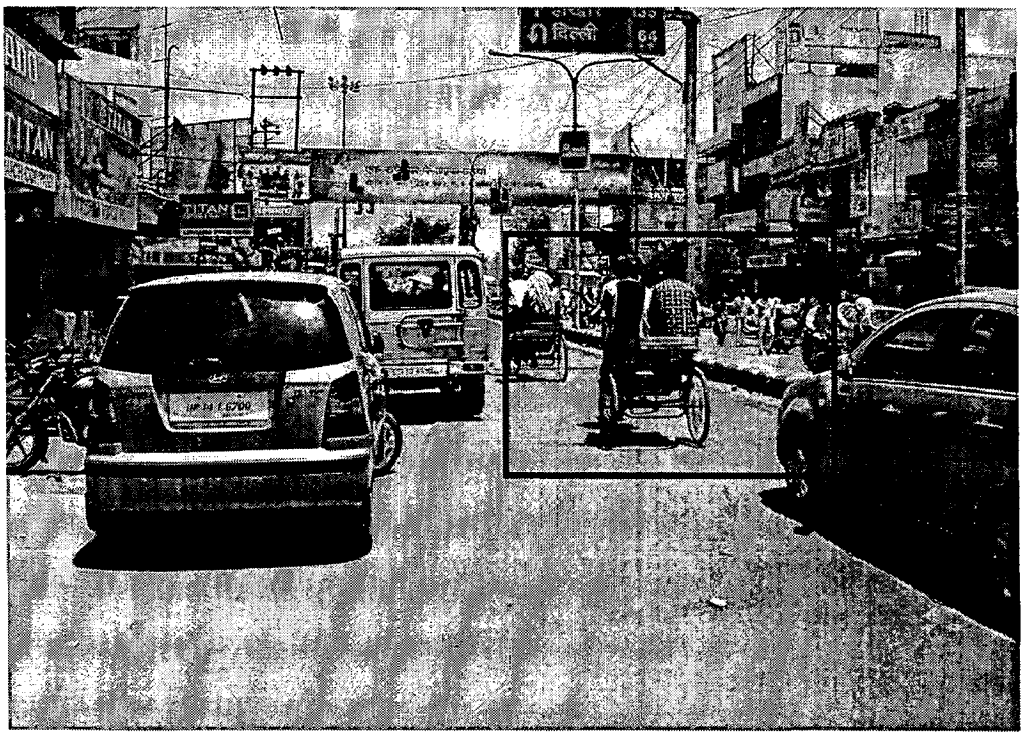


Illustration 5.4.6 Cycle rickshaws running in the middle of R.O.W

Source : Author

Illustration 5.4.7 Cycle rickshaws running in the middle of R.O.W causes problem for the smooth traffic flow

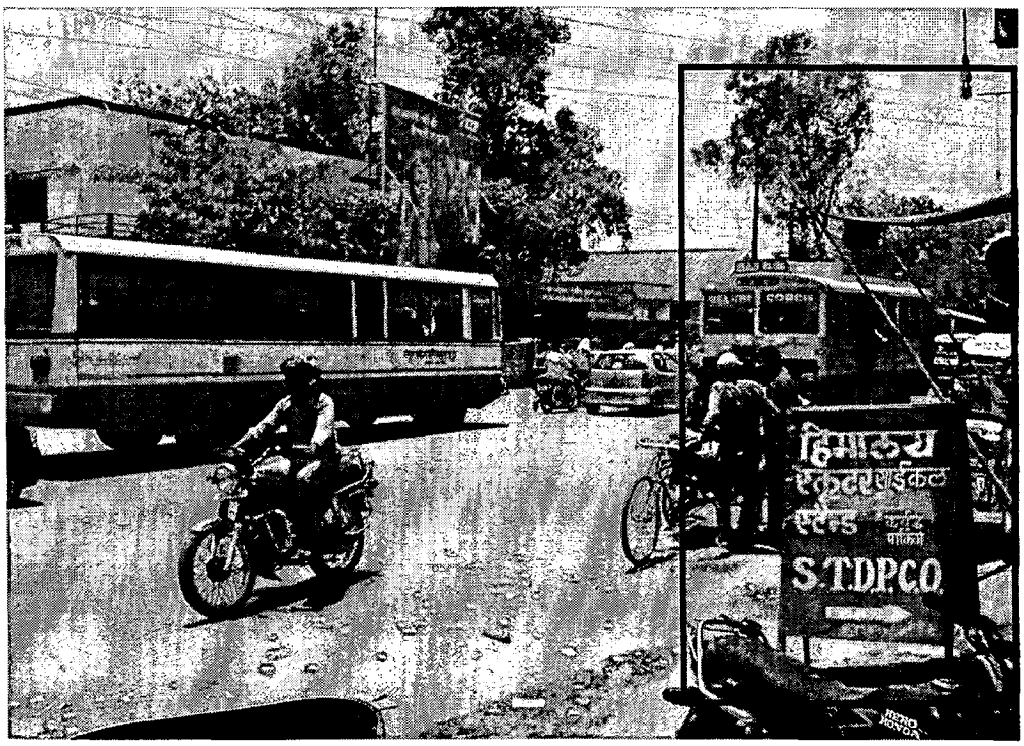


Illustration 5.4.8 Encroachment by the road side shop keepers

Source : Author

Illustration 5.4.9 Absence of Footpaths on all the roads

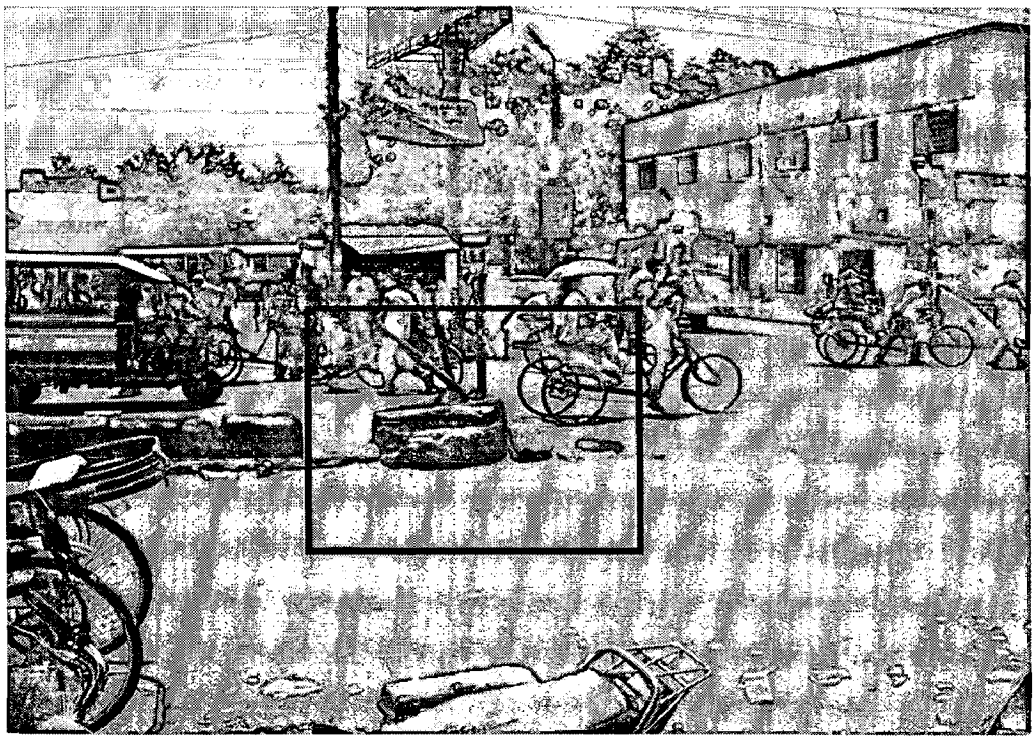


Illustration 5.4.10 Fractured road separator (lack of maintenance)

Source : Author

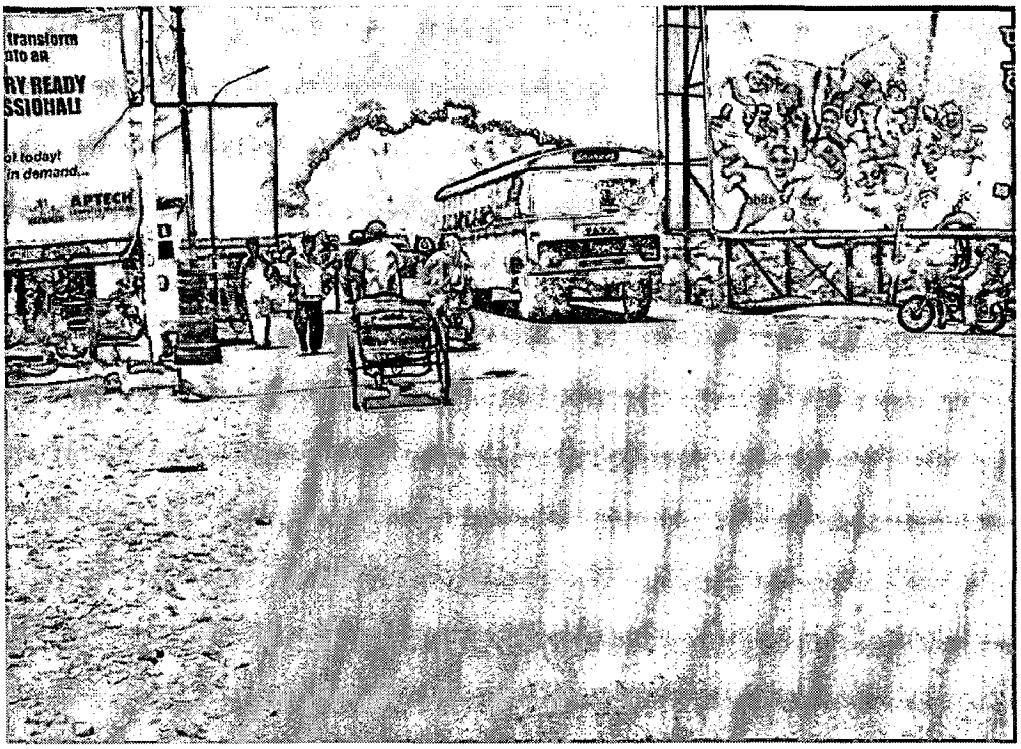


Illustration 5.4.11 Bridge over nalas having lesser width as compare to the right of way - I

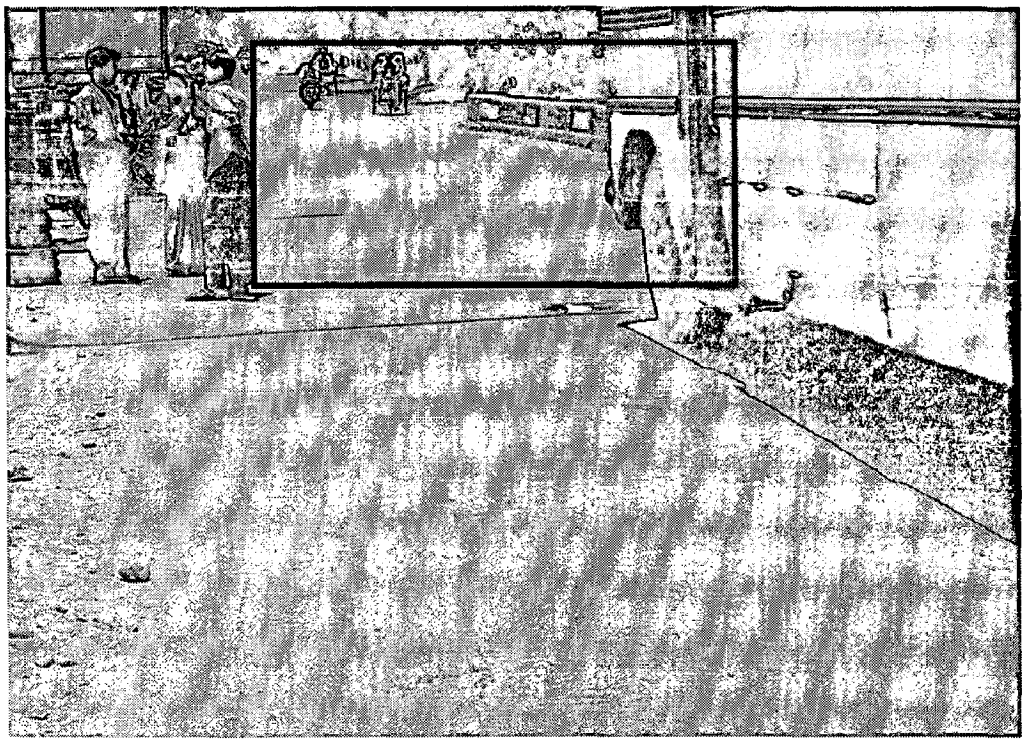


Illustration 5.4.12 Bridge over nalas having lesser width as compare to the right of way-II

Source : Author

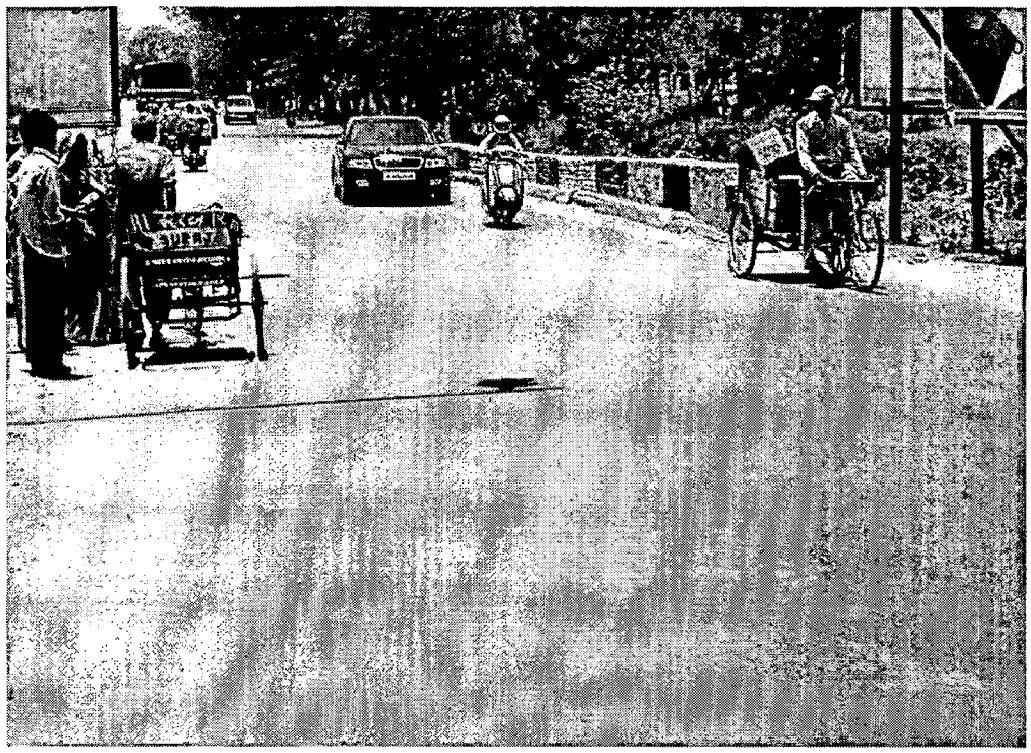


Illustration 5.4.13 Bridge over nalas having lesser width as compare to the right of way-III

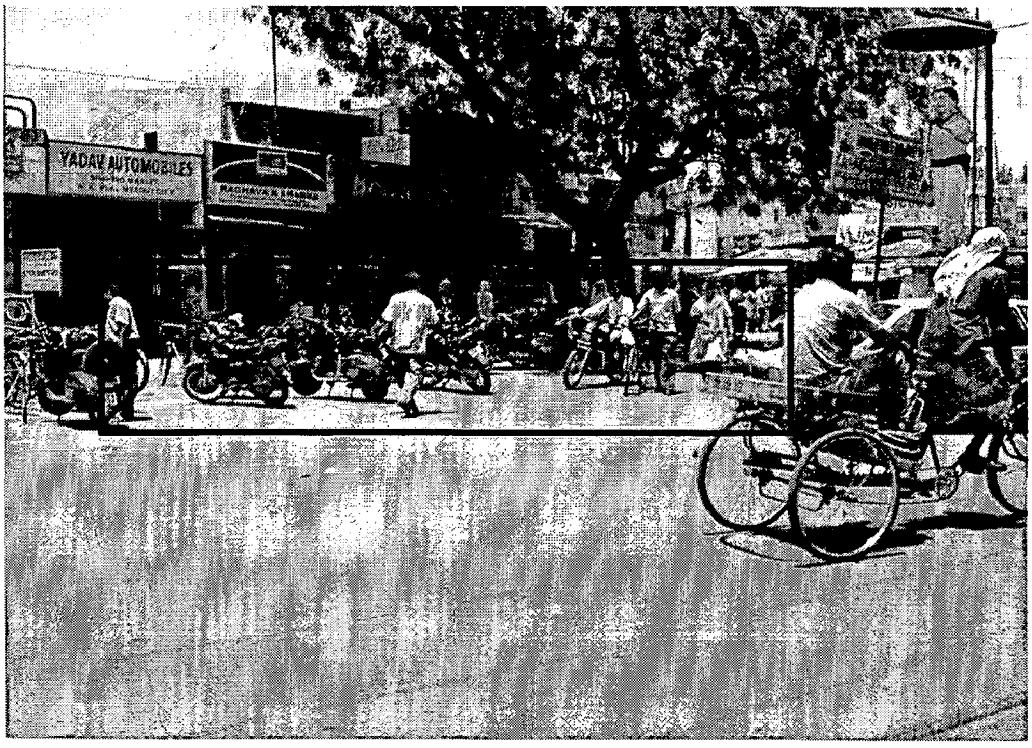


Illustration 5.4.14 Road side parking resulting in the lesser space for movement and reduces R.O.W.

Source : Author

Illustration 5.4.15 Road side parking

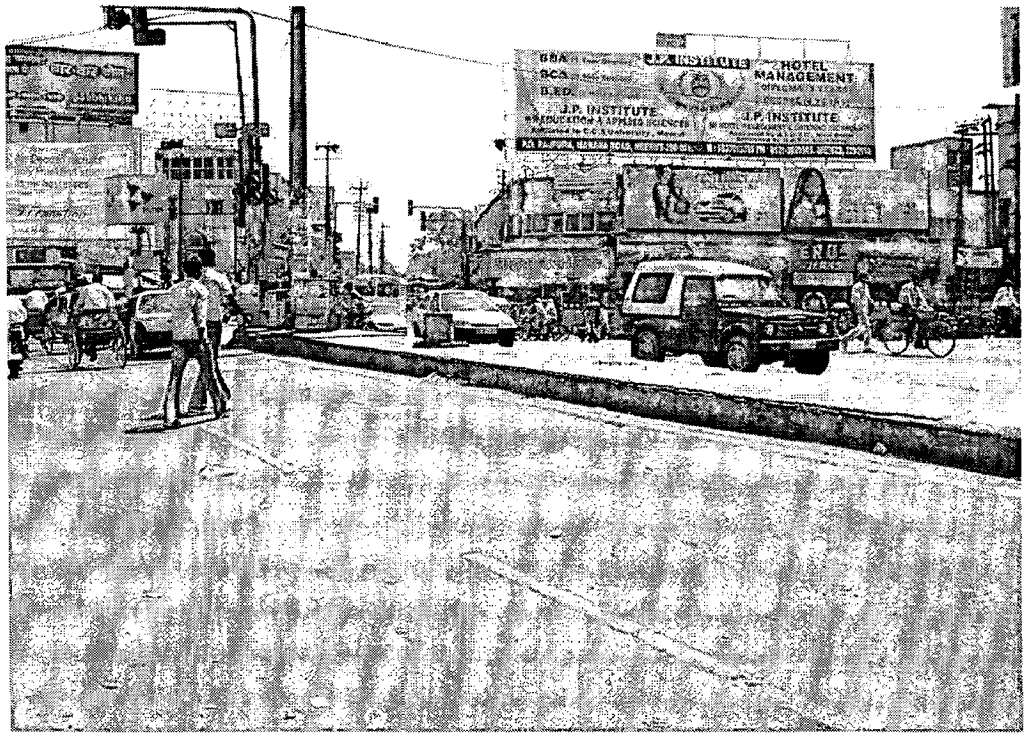


Illustration 5.4.16 Absence of advance direction / designation signs

Source : Author

Illustration 5.4.17 Peoples crossing the road in the running traffic

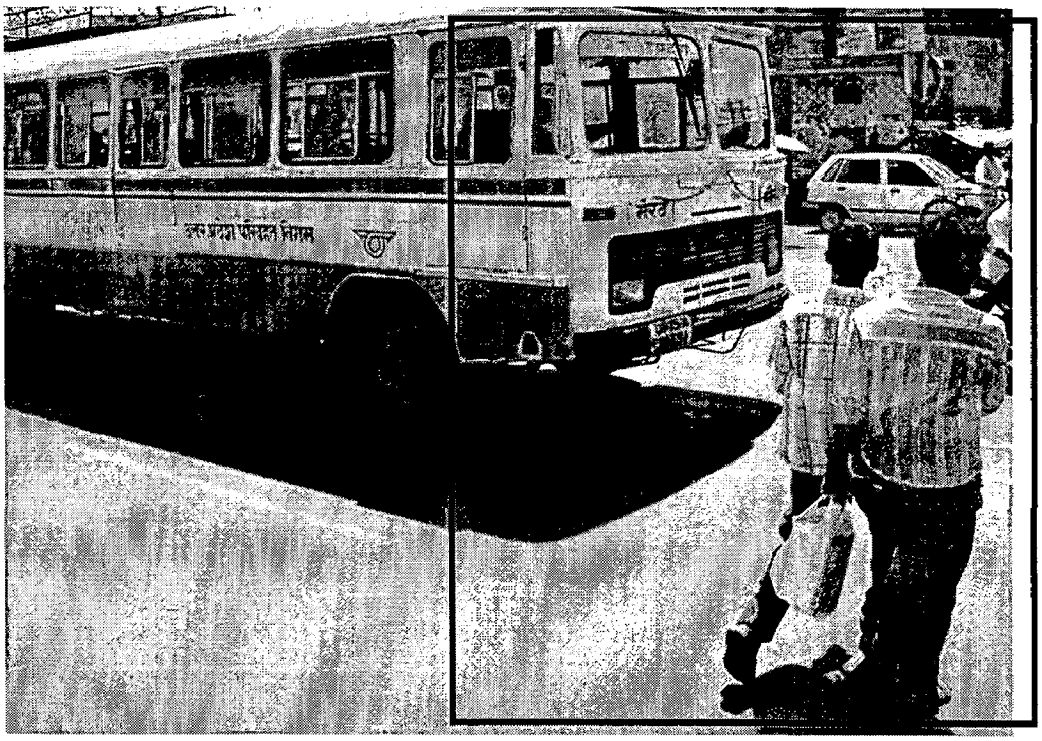


Illustration 5.4.18 Peoples crossing the road in the running traffic

Source : Author

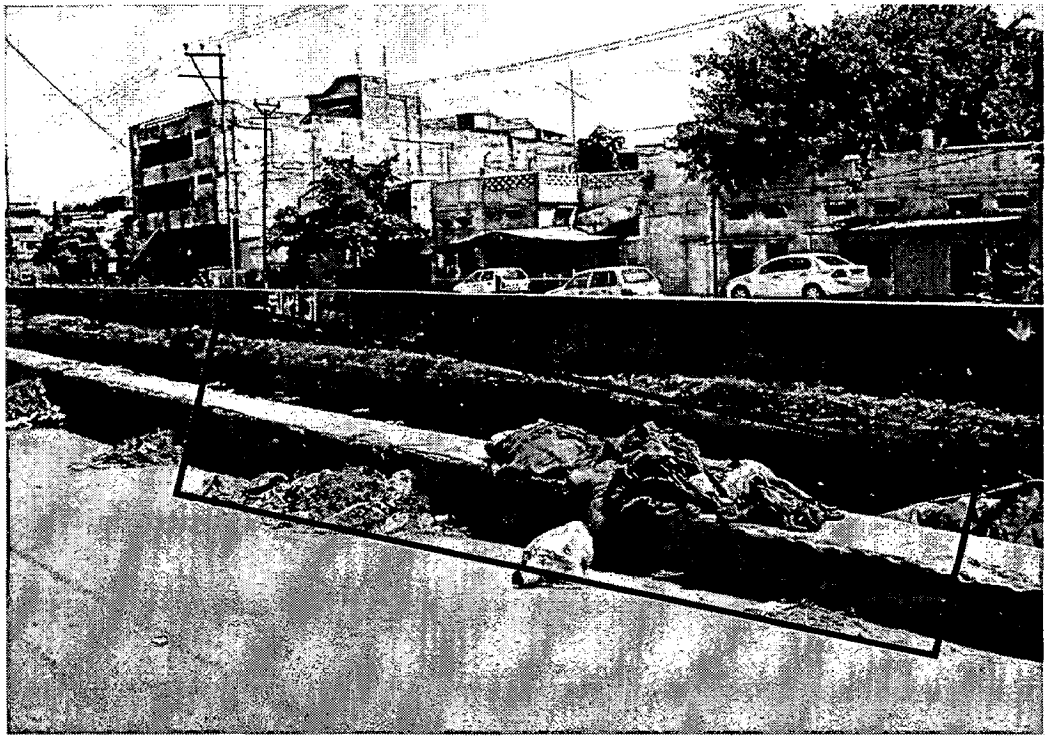


Illustration 5.4.19 Waste lying on the road side, a negative point for beatification

Illustration 5.4.20 Railway barrier at Sardhana road causing the problem for smooth traffic - I

Source : Author

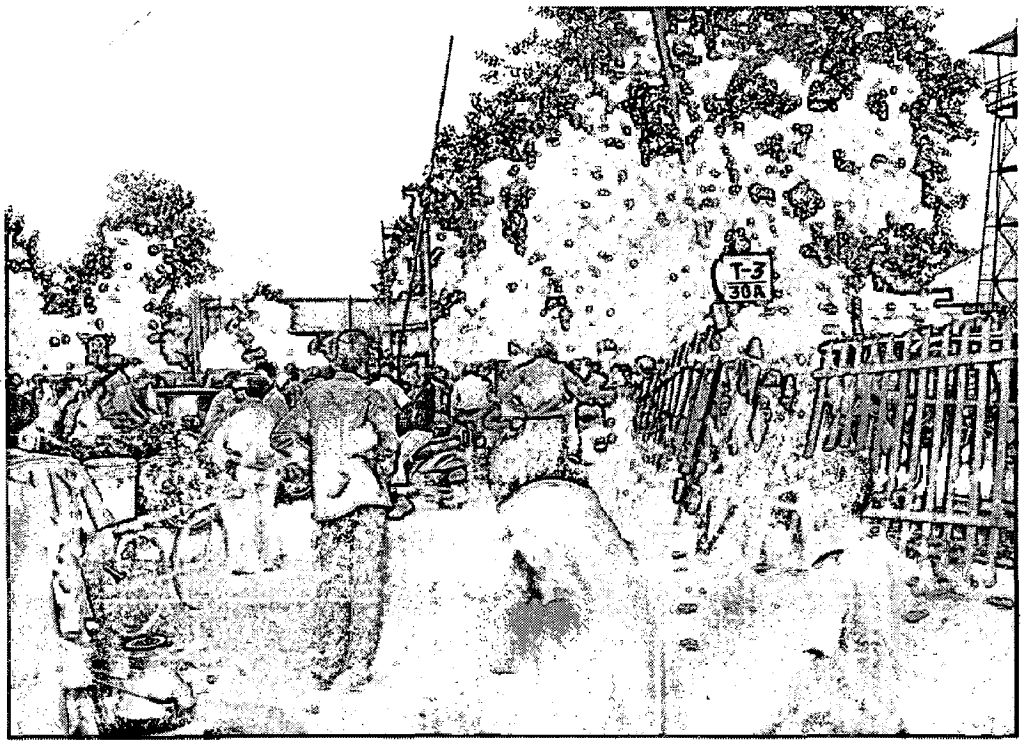


Illustration 5.4.21 Railway barrier at Sardhana road causing the problem for smooth traffic - II

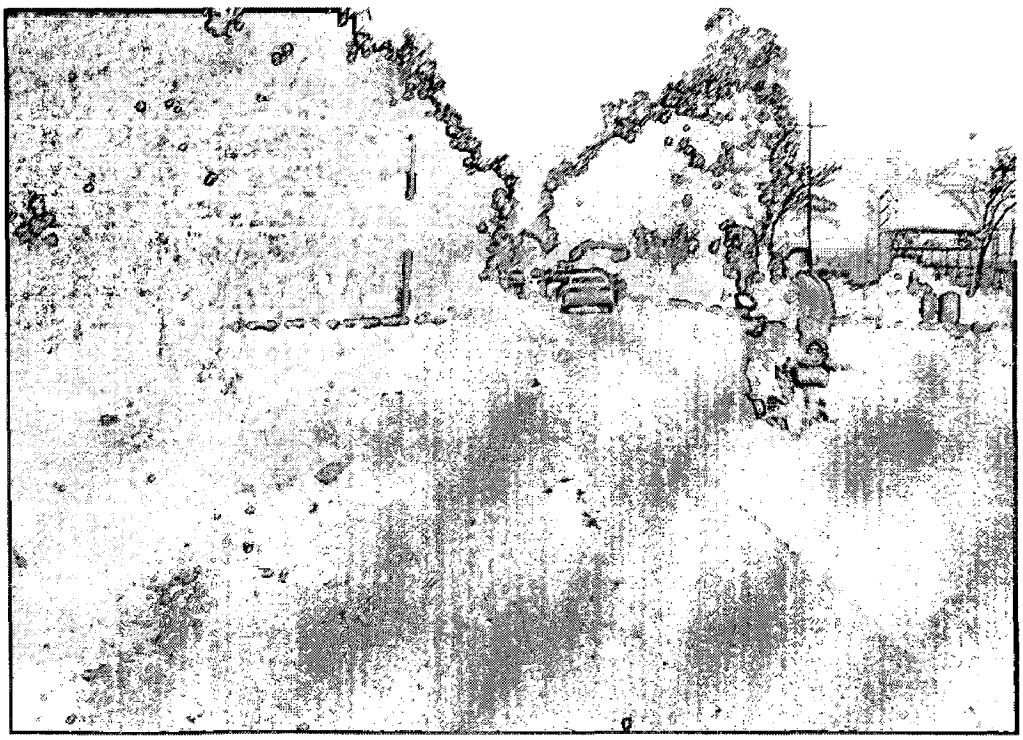


Illustration 5.4.22 Absence of lay-by on NH 58

Source : Author

CONCLUSION AND RECOMMENDATIONS

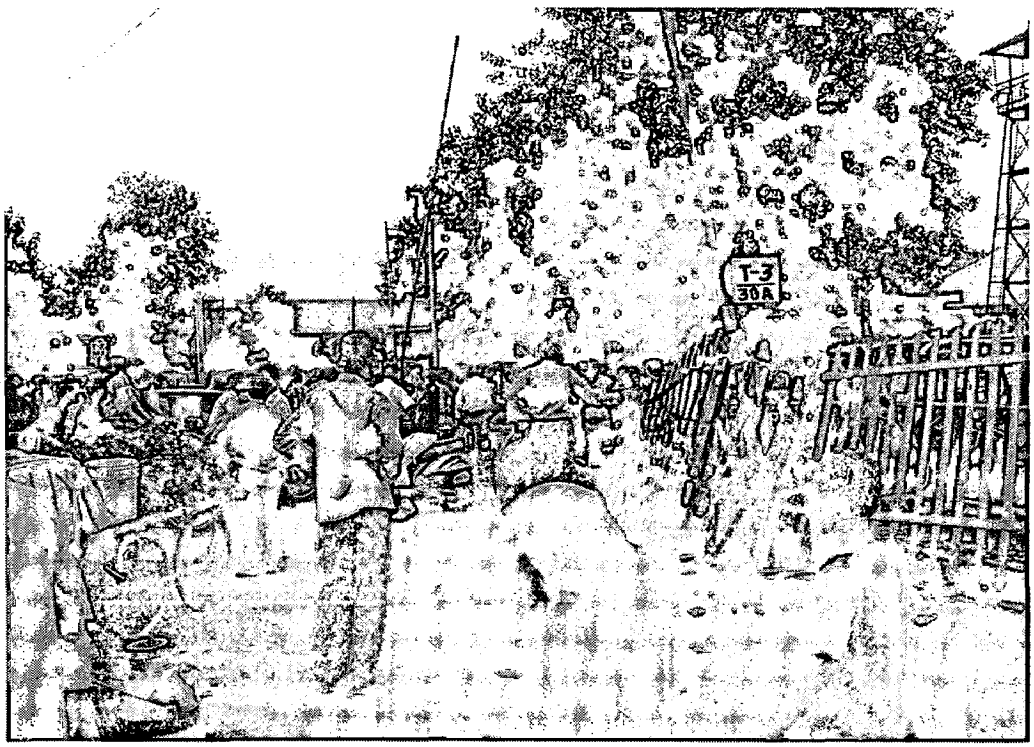


Illustration 5.4.21 Railway barrier at Sardhana road causing the problem for smooth traffic - II

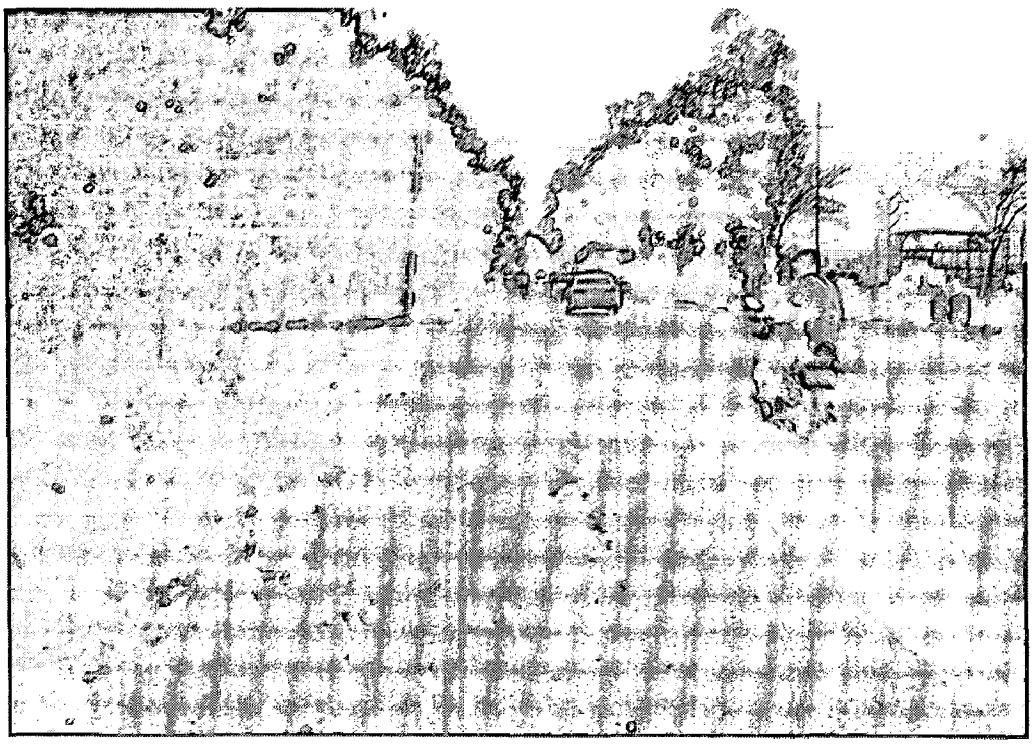


Illustration 5.4.22 Absence of lay-by on NH 58

Source : Author

Illustration 5.4.23 Bad conditions of roads (lack of maintenance) - I

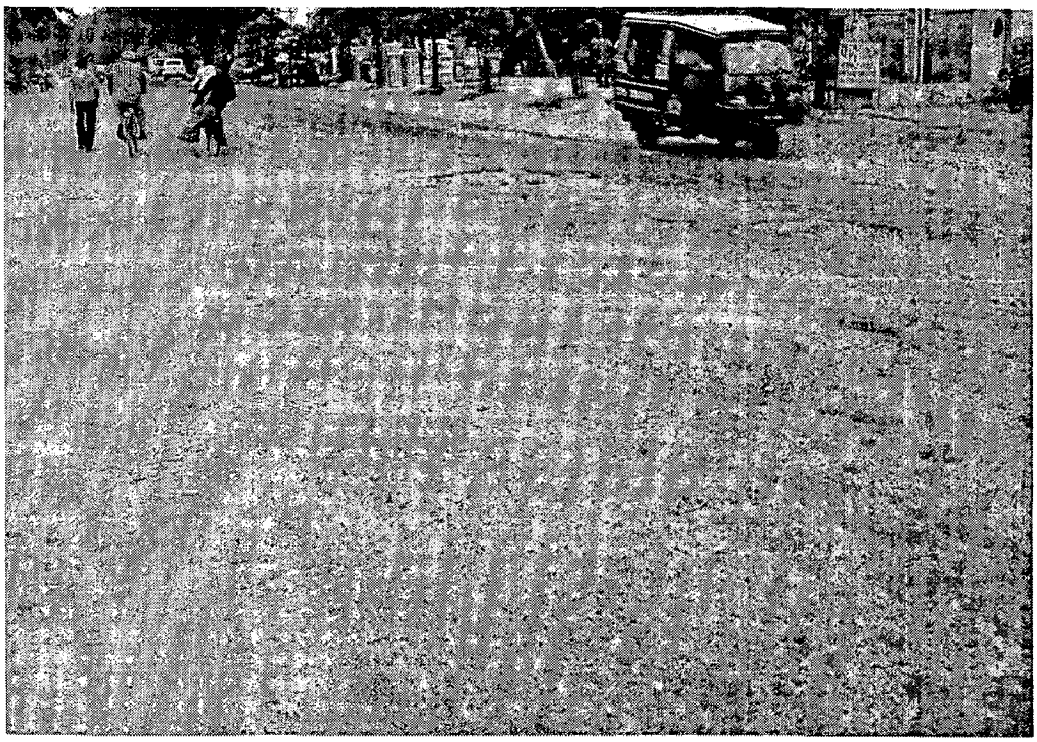


Illustration 5.4.24 Bad conditions of roads (lack of maintenance) -II

Source : Author

CONCLUSION AND RECOMMENDATIONS

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

As per the Meerut Master Plan 2001, the area under roads was about 432 hectare (7.76 %) as against the standard of 15-20 %. One of the problems of existing road network is non development of proposed ring roads connecting the radial roads. Some of the roads in the inner city, market areas and also arterial roads are narrow and congested, primarily due to large-scale encroachments on to the right-of-way, as result of which the carriage way is reduced considerably. This ultimately leads to major traffic problems along the roads thereby reducing speed.

6.1. Future Requirements & Strategies

With the mounting traffic pressure on existing road infrastructure, Meerut Corporation should propose to upgrade the existing road to cater to this demand. While preparing the strategies with consultation of people representatives, citizen groups and implementing agencies, it is assume that municipal corporation will manage and upgrade its 885 km road in priorities bases and MDA will take care of new propose road.

To discourage excessive growth in eastern part, investment in this region have not been proposed till the year 2011.Meerut Master Plan-2021 propose to develop, western part of city on a priority for balanced growth.

6.2. Road Planning:

Bearing the fact that area under road is low - 7.76 % as against standard of 15-20%, the corporation should initially plan to prepare inventory of existing road network. Prepare plan to upgrade existing earthen road to bituminous road. Currently 50 %of total road length of Municipality is kutcha.

Planning shall also ensure that road, parking and traffic infrastructure provision matches the city's existing and future needs for transport. MDA propose to under take implementation of proposed road to increase circulation area. MDA propose to develop all major and minor roads in newly developable area with public-private partnership.

6.2.1. **Western Ring Road**

Meerut Master Plan-2021 has proposed to connect Delhi Roorkee road through bye-pass. This will help in channelising growth in western part of city. The By-pass will connect Delhi road, Baghpat road, Satwai road, Barot Sardhana road and finally Roorkee road in the western part of the city.

6.2.2. **Eastern Inner and outer Ring Road**

On the Eastern part two parallel ring roads have been proposed. Both roads connect the Roorkee road with Delhi Road by connecting Bijnor road, Parishitgarh road and Garmukteshwar road. However inner Ring road would complete the ring by connecting the existing Meerut bye-pass. MDA exploring proposal for compact development therefore its priorities is to go for inner ring road.

6.3. Augmentation of the existing road network

With due consideration to the growing traffic intensity municipal corporation should propose to prepare comprehensive traffic management plan to utilize optimum capacity of roads.

The plan should also include phasing; resurfacing and widening of each road in such way that it would not result in excessive financial burden to the corporation.

6.4. Traffic Management and Characteristics

6.4.1. Road Network

Meerut urban area is served by nine radial arterial roads. Some of the critical road stretches are being discussed in a detail, which serves as major roads. (map no 01)

1. Roorkee road,
2. Mawana road,
3. Parkishatgarh road,
4. Garh Muketeshwar road,
5. Hapur road,
6. Delhi road,
7. Bagpat road,
8. Baraut road, and
9. Sardhana road

Delhi-Roorkee and Hapur-Roorkee road bisects the city from north-south direction and passes through the core commercial area. The other eight roads connect these roads at different location forming important nodes. A major bypass was proposed and developed partially, which now forms a part of the city, thus encompassing development around it. The major development has been taking place around these roads in a linear pattern.

6.4.2. Traffic Characteristics

Consultation with people representative, Citizen Groups suggests that within a city mixed nature of traffic and mis-utilization of road space is major problem. Corridor improvement Scheme prepared by MDA clearly suggest outskirt of the city experiences

very high percentage of fast vehicles (82% at Electra Factory.).As we enter the city, the composition reverses to 50 % as fast vehicles (At Ajanta Cinema) and 50 % slow vehicle (Study was conducted in year-1992). Study also says that this problem would be more severe in future.

6.4.2.1. **Two Wheelers**

This includes two wheelers and motor cycles. As indicated in the table, about 28 % of total volume plying on roads accounts from two wheelers. In last decade it has shown drastic increase of 70 % to 350 % on nine important roads. Though information is not available but discussion with officials suggests that in recent years there has been a rise in the ownership of motorized two wheelers leading to increased demand for parking and adding to the problem of congestion and air and noise pollution.

6.4.2.2. **Heavy Vehicle**

Heavy vehicles like bus and truck constitute 23% of total volume traveling on roads. Except Hapur and Delhi road, other roads have shown increased as high as 63 per cent Roorkee road, Baghpat road and Sardhana road where share of heavy vehicle is very high. There should be special measures to segregate slow and fast moving vehicles to improve efficiency of these roads.

6.4.2.3. **Intermediate Public Transport**

In the city there is no public transport. People are using cycle rickshaw as a prominent mode of transport. As we see in table Share of cycle rickshaw is 4 to 30 % on different road. On a whole 15 % of total volume on road plying by cycle rickshaw. While

the cycles do not add to the noise and, air pollution, their high maneuverability hampers the mobility of the fast moving traffic, resulting in accidents

6.4.3. **Traffic Intersection**

The intersection within MDA jurisdiction are developed by MDA and do not have any separate provision in the budget. There are around six major junction identified in Meerut, which are-

1. Railway Road
2. Begum Bridge
3. Bachcha Park
4. Eves Cinema Crossing
5. Hapur Bus stand Crossing
6. Plaza Crossing

Traffic signals at these intersections were installed around a decade back, but over the years, due to lack of attention by the authorities, these signals have vanished.

6.5. Parking

Demand for parking has increased in commercial areas, where lack of space for parking, growing vehicular population and encroachment results in narrow roads. Intense on – street parking activity is seen all along the major roads in the CBD. Stretches which urgently need of the parking area are-

1. Ghantaghar to Indirachowk,
2. Hapud chowk to Lishodi gate and
3. Railway road

Where intense commercial activities are observed. The need is felt to create off-street parking areas, especially in the CBD and regulate the on-street parking along the major commercial roads.

6.6. Proposals and Recommendations

After studying all various aspects and critical areas, some recommendations has been proposed. These proposals have been divided in the two categories:

1. at regional level
2. at city level

6.6.1. Regional level

6.6.1.1. Linkages:

1. Delhi- Ghaziabad Meerut expressway needs to be given priority
2. Upgradation of national highway no. 58 to 6 lane
3. Strengthening and upgrading of Garh-Meerut-Karnal state highway
4. Meeurt-Baghpat-Senipat state highway development
5. Link from expressway junction to Delhi-Roorkee byepass (NH 58)
6. Augmentation of Meerut-Hapur rail link single line to double line rail link
7. Electrification of Ghaziabaa Meerut Saharanpur railway line

6.6.1.2. Other activity:

1. Development of Hastinapur as a Regional Tourist and Cultural center
2. Development of Bhola-Jhal as Regional creational Center.

6.6.2. **City Level**

6.6.2.1. Traffic and transportation

New roads and Upgradation of existing roads is of high priority as the city roads are subjected to heavy traffic movement. Meerut Municipal Corporation can consider resurfacing their existing road in priorities bases, while MDA can take responsibility of implementation of new proposed roads in developing area through Public-private partnership mode. That will help in faster implementation of roads as well as reduce substantial financial burden on the Municipal corporation.

For smoothing traffic flow, some roads need to be widened and new roads need to be constructed. For this land should be acquired and land owners should he compensated monetarily or by offering alternate land elsewhere.

1. All major roads to be developed to their full Right of way.
2. Implementation of Ring road in Western Part of city followed by Eastern part.
3. Appropriate pedestrian facilities to be added to all major and minor roads.
4. Fly-overs should be constructed at busy junctions in the city.
5. Adoption and Implementation of Town Planning Scheme

6.6.2.2. Some specific proposals are:

1. Construction of by-pass or ring road from Satabdi nagar-Hapur road-Garh road-Mvana Road- Roorkee road as marked in Master plan proposal
2. The proposed bye-pass is 250 feet wide. All new residential colonies developing in the vicinity are being developed by keeping a distance of 100 feet only from the proposed bye-pass. This may cause problems later on when widening of the bye-

19. The informal activities should be restricted in the corridors.

20. Traffic law should be followed carefully and strictly.

21. Proper maintenance of roads should be done.

22. Foot paths should be designed.

There is an urgent need to evolve a clean direction, objectives, and goals for the future transport system, aimed at giving preference to high capacity and low polluting modes of transport. So as to provide efficient movement of the people and goods. There should be only one or two body for guiding the transportation system and also for maintaining the roads as there are three bodies are working at present.

MAPS

6.6.2. **City Level**

6.6.2.1. Traffic and transportation

New roads and Upgradation of existing roads is of high priority as the city roads are subjected to heavy traffic movement. Meerut Municipal Corporation can consider resurfacing their existing road in priorities bases, while MDA can take responsibility of implementation of new proposed roads in developing area through Public-private partnership mode. That will help in faster implementation of roads as well as reduce substantial financial burden on the Municipal corporation.

For smoothing traffic flow, some roads need to be widened and new roads need to be constructed. For this land should be acquired and land owners should he compensated monetarily or by offering alternate land elsewhere.

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pass need to be done. Instead, establishment of a green belt is proposed to secure the area required later on for widening.

3. Construction of Road along Rithani Miner-linking Delhi- Road- Baghpat road
4. Strengthening and Upgradation of all regional roads within the city area
5. Strengthening and Upgradation of all regional roads should take place according to the map no 11
6. Augmentation of Noornagar and Moudinpur Railway stations for passenger and cargo movement respectively
7. Construction of railway overhead bridges at
    a. Delhi road – Hapur railway line.
    b. Rithani minor road- Delhi railway line
    c. Sardhana road – Saharanpur railway line.
    d. Delhi-Roorkee bye-pass road Saharanpur railway line
    e. Proposed new bye-pass-Hapur rail line
8. Development of transport Nagar
    a. Baghpat Road
    b. GarhMukteshwar Road
9. Development of Bus Terminals
    a. Vedviyaspuri or opposite Sanjayvan Near P.A.C. on Hapur road
    b. Near J.P. Academy on Mawana road
    c. Near Pallavpuram on Roorkee road
    d. Near kali river on Garh road
10. phase wise development of roads, road junctions, fly-over connections are given in map no 12.
11. Development Of Main Road Crossings

a. Begum bridge

b. Ghantaghar

c. Old Hapur bus stand

d. Baghpat road bye-pass

e. Tejgarhi

f. Baraut road - bye pass

g. Sardhan road- bye pass road

12. Development of Parking Spaces

Parking spaces are required at the following places

a. Town hall

b. Gymkhana ground

c. Begum bridge- both sides on Abu nala

d. Specified parking lots on all major roads

13. Provision of multistoried parking can solve the problem of parking spaces.

14. The cycle track should be constructed parallel to the carriage way at a distance of 0.75 m from the carriage way. This 0.75 m can be used for the installation of street furniture.

15. The installation of traffic signs at proper place makes the movement easier and safe. For this traffic signs should be installed at proper places.

16. Road markings such as left turn, right turn, stop, and other markings should be done at the intersections.

17. Speed breakers in front of school buildings.

18. Local market from begam bridge junction should be shift to some other place so that the area can be available for the movement of traffic.

19. The informal activities should be restricted in the corridors.

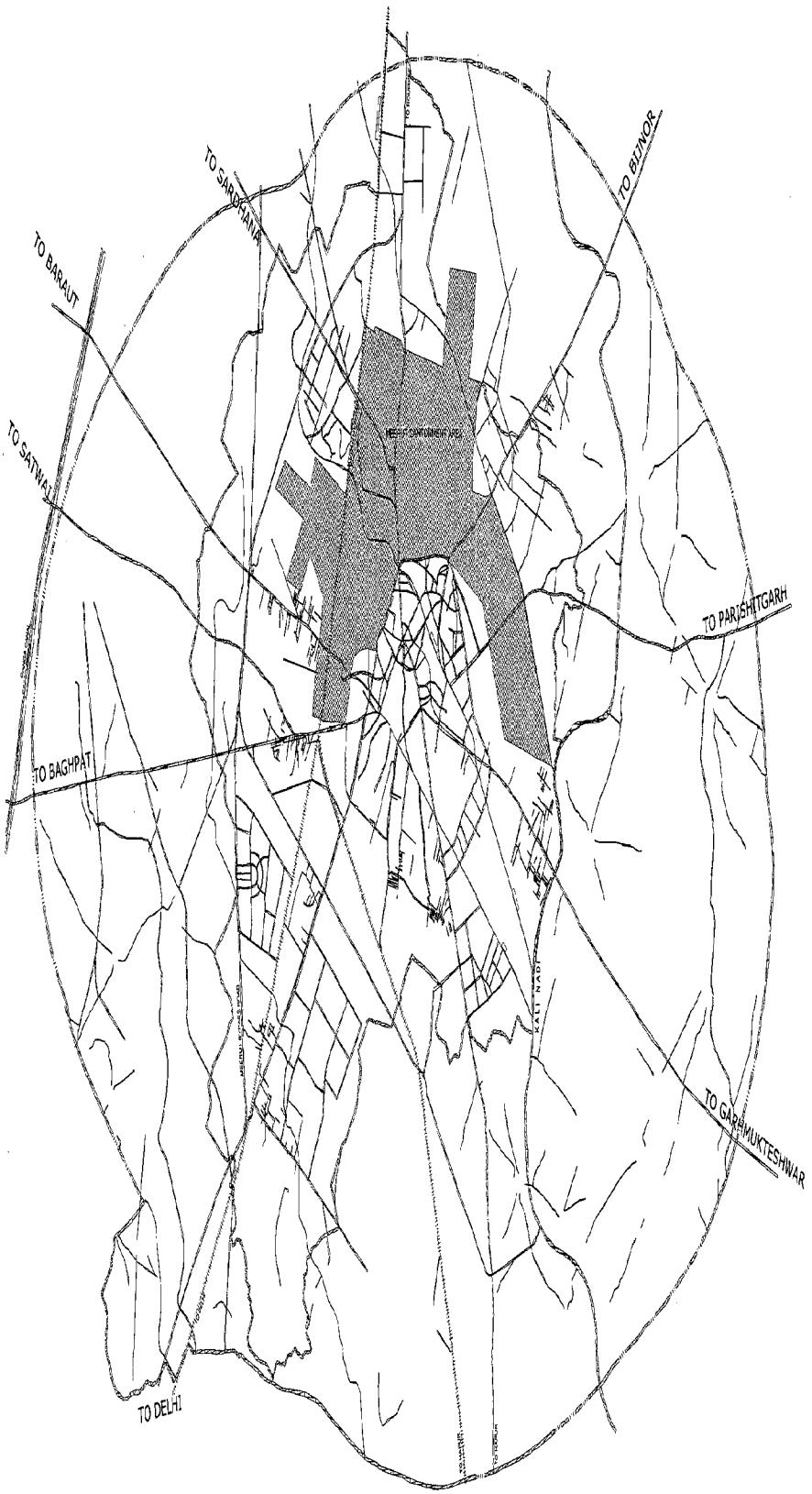
20. Traffic law should be followed carefully and strictly.

21. Proper maintenance of roads should be done.

22. Foot paths should be designed.

There is an urgent need to evolve a clean direction, objectives, and goals for the future transport system, aimed at giving preference to high capacity and low polluting modes of transport. So as to provide efficient movement of the people and goods. There should be only one or two body for guiding the transportation system and also for maintaining the roads as there are three bodies are working at present.

MAPS



LEGENDS :

- MUNICIPAL BOUNDARY
- MAIN NALA
- SUBSIDIARY NALA
- WATER BODY
- CANTONMENT AREA
- RAILWAY LINE
- PRIMARY ROAD
- SECONDARY ROAD
- TERTIARY ROAD

TITLE :
ROAD NETWORK OF MEERUT CITY

THESIS TOPIC :
STUDY OF ROAD NETWORK AND TRAFFIC CONDITONS OF MEERUT : a review of present scenario

DRAWING NO. 01

NORTH

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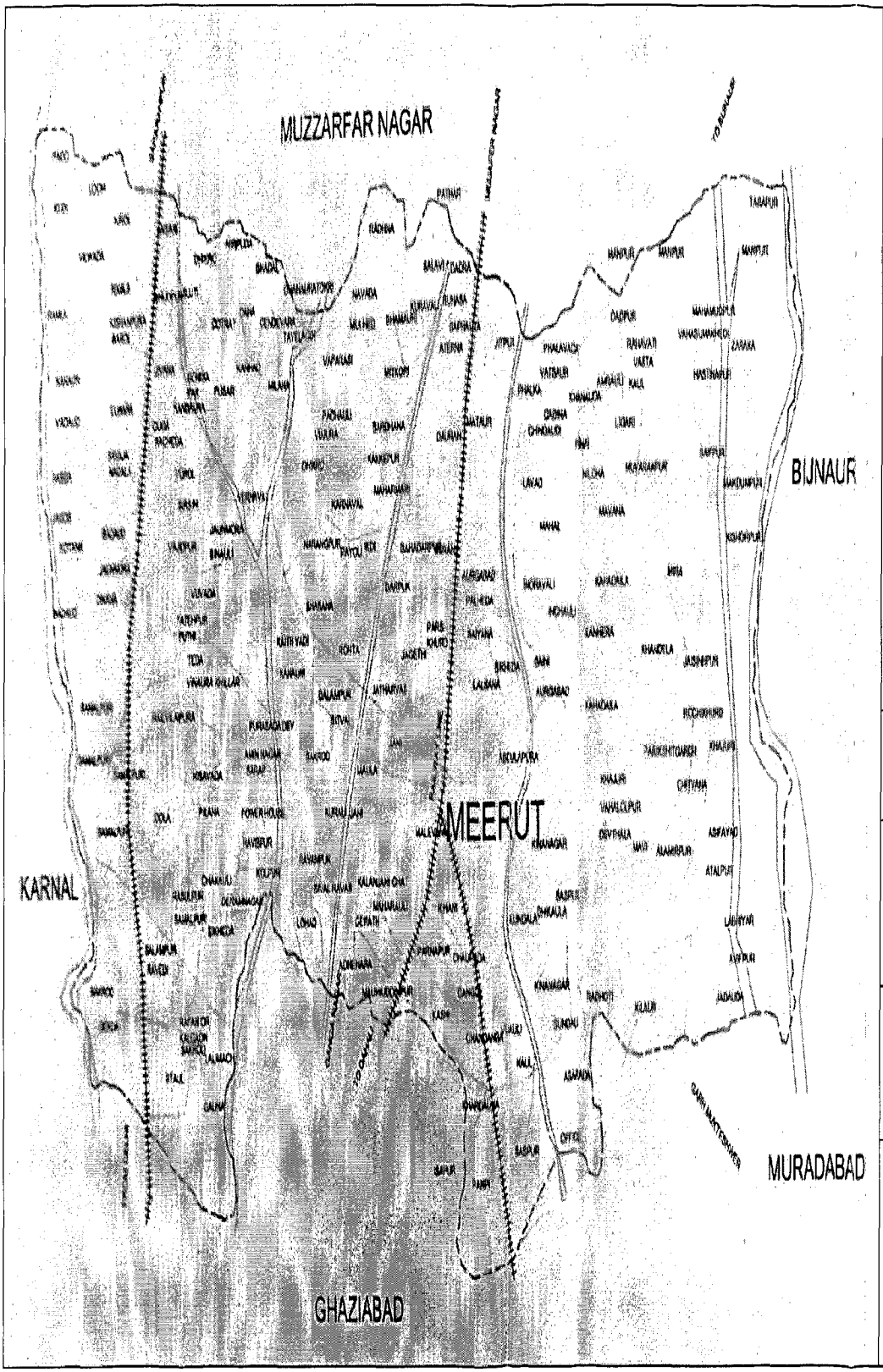

LEGENDS :

- PRIMARY ROAD
- DISTRICT BOUNDARY
- RAILWAY LINE
- RIVER / NALA

TITLE :
MEERUT REGIONAL CONNECTIVITY

THESIS TOPIC :
STUDY OF ROAD NETWORK AND TRAFFIC CONDITONS OF MEERUT : a review of present scenario

DRAWING NO. 02

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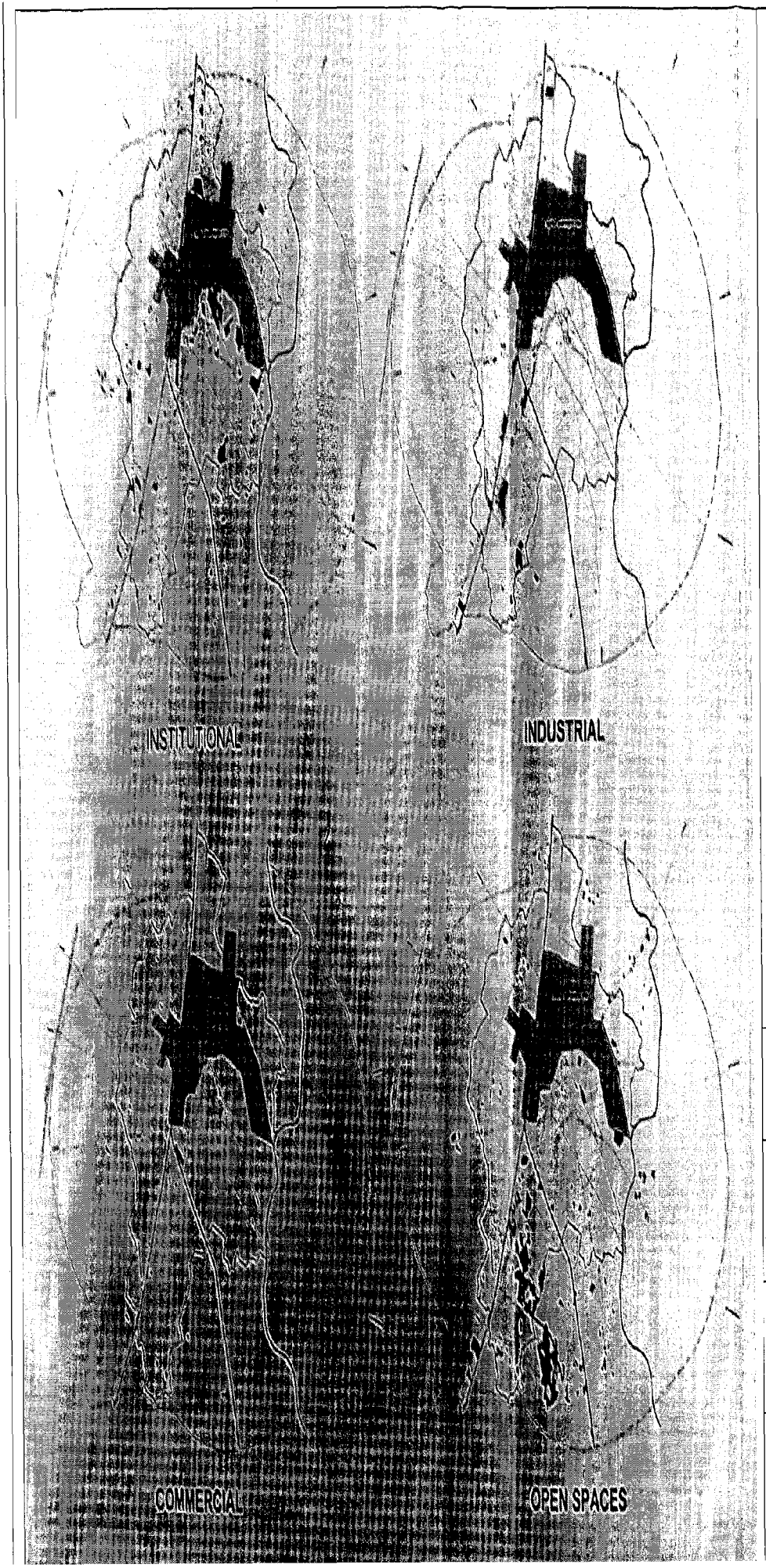

LEGENDS :

- INSTITUTIONAL
- INDUSTRIAL
- COMMERCIAL
- OPEN SPACES

TITLE :
EXISTING INSTITUTIONAL, INDUSTRIAL, COMMERCIAL, OPEN SPACE STRUCTURE

THESIS TOPIC :
STUDY OF ROAD NETWORK AND TRAFFIC CONDITONS OF MEERUT : a review of present scenario

DRAWING NO. 03

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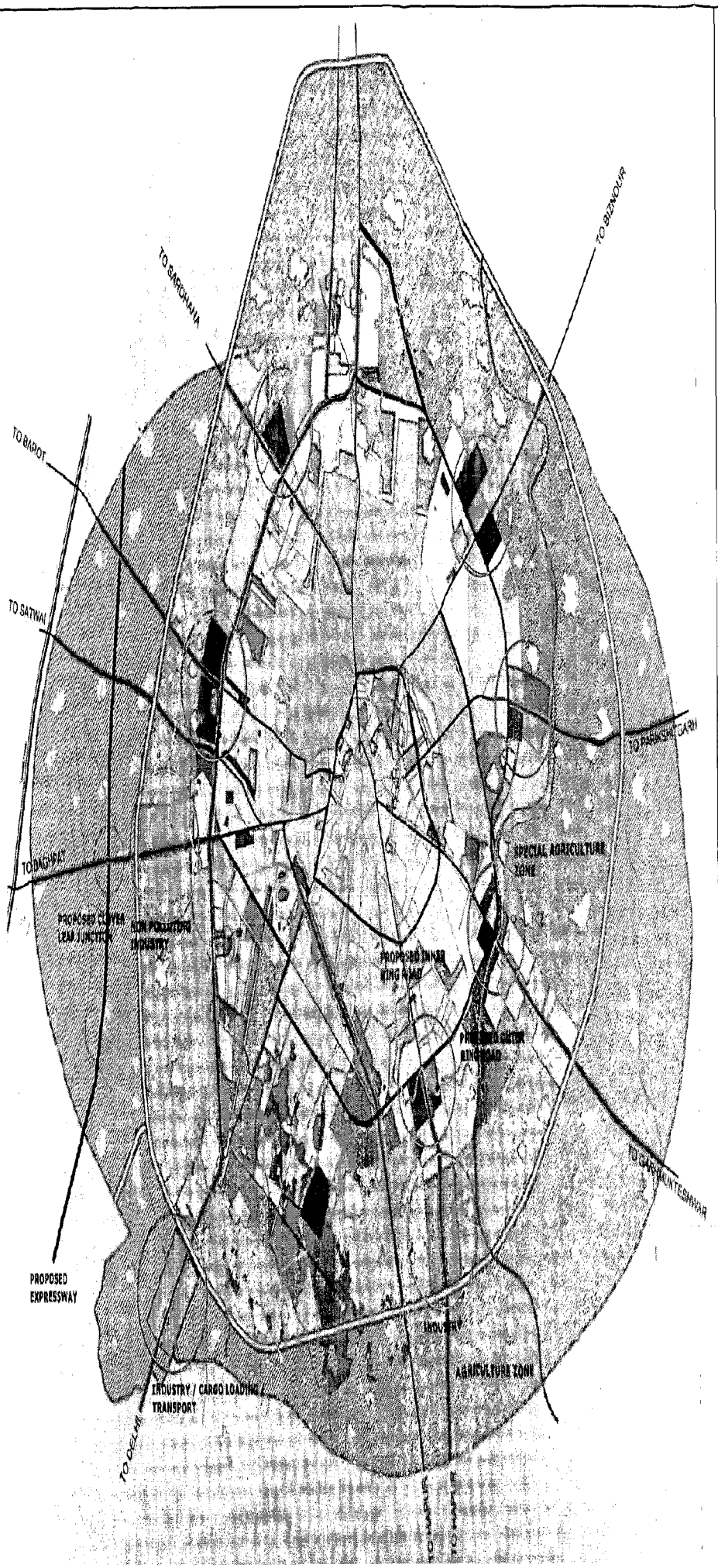

LEGENDS :

- RESIDENCIAL
- INSTITUTIONAL
- COMMERCIAL
- INDUSTRIAL
- GARDENS / OPEN SPACES
- WATER BODY
- VIKAS SHETRA BOUNDARY
- NAGAR NIGAM BOUNDARY
- PRIMARY ROAD
- RAILWAY LINE
- CANTONMENT AREA
- GROWTH CENTRES / NODES

TITLE :
GROWTH CENTRES / NODES AROUND THE CITY

THESIS TOPIC :
STUDY OF ROAD NETWORK AND TRAFFIC CONDITONS OF MEERUT : a review of present scenario

DRAWING NO. 04

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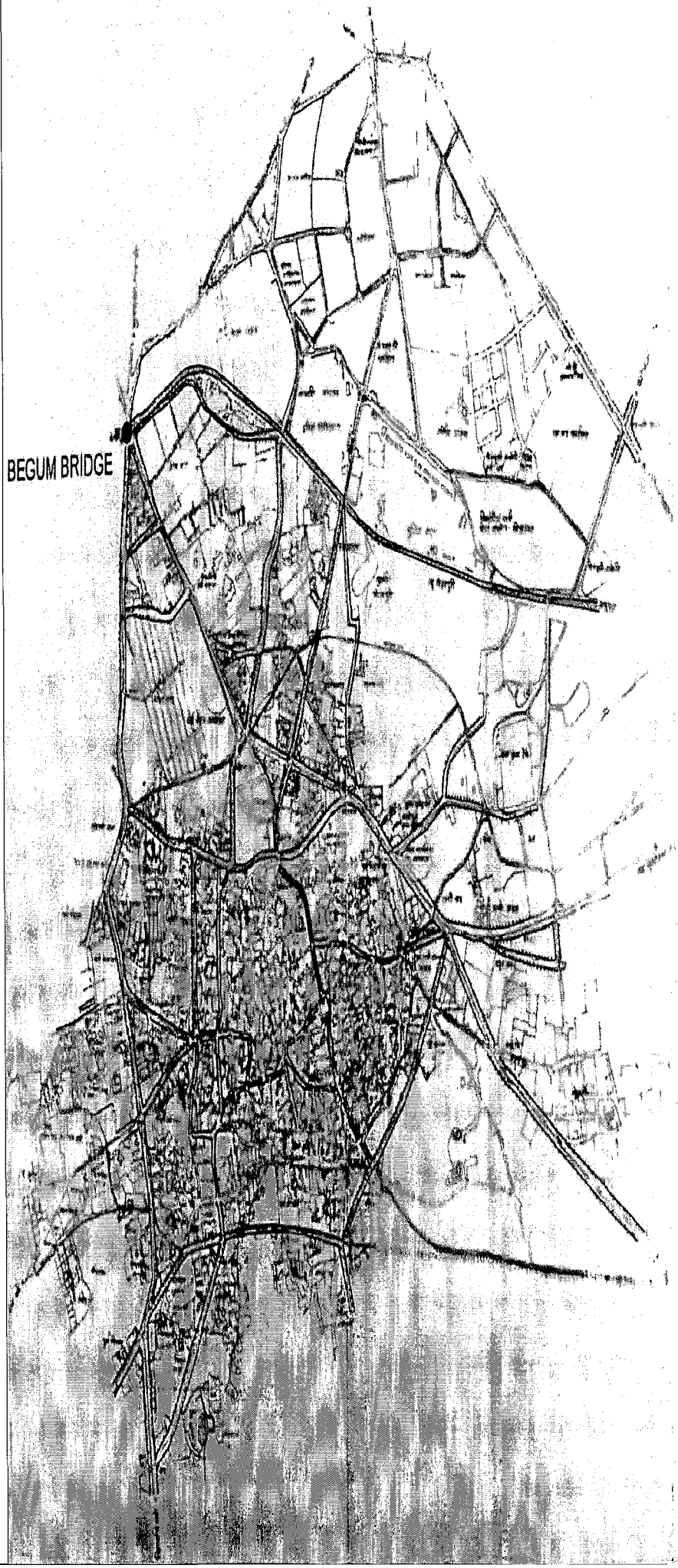

LEGENDS :

EXISTING COMMERCIAL DEVELOPMENT

TITLE :
EXISTING COMMERCIAL DEVELOPMENT ALONG THE MAIN ROADS AND MAIN CITY AREA

THESIS TOPIC :
STUDY OF ROAD NETWORK AND TRAFFIC CONDITONS OF MEERUT : a review of present scenario

DRAWING NO. 05

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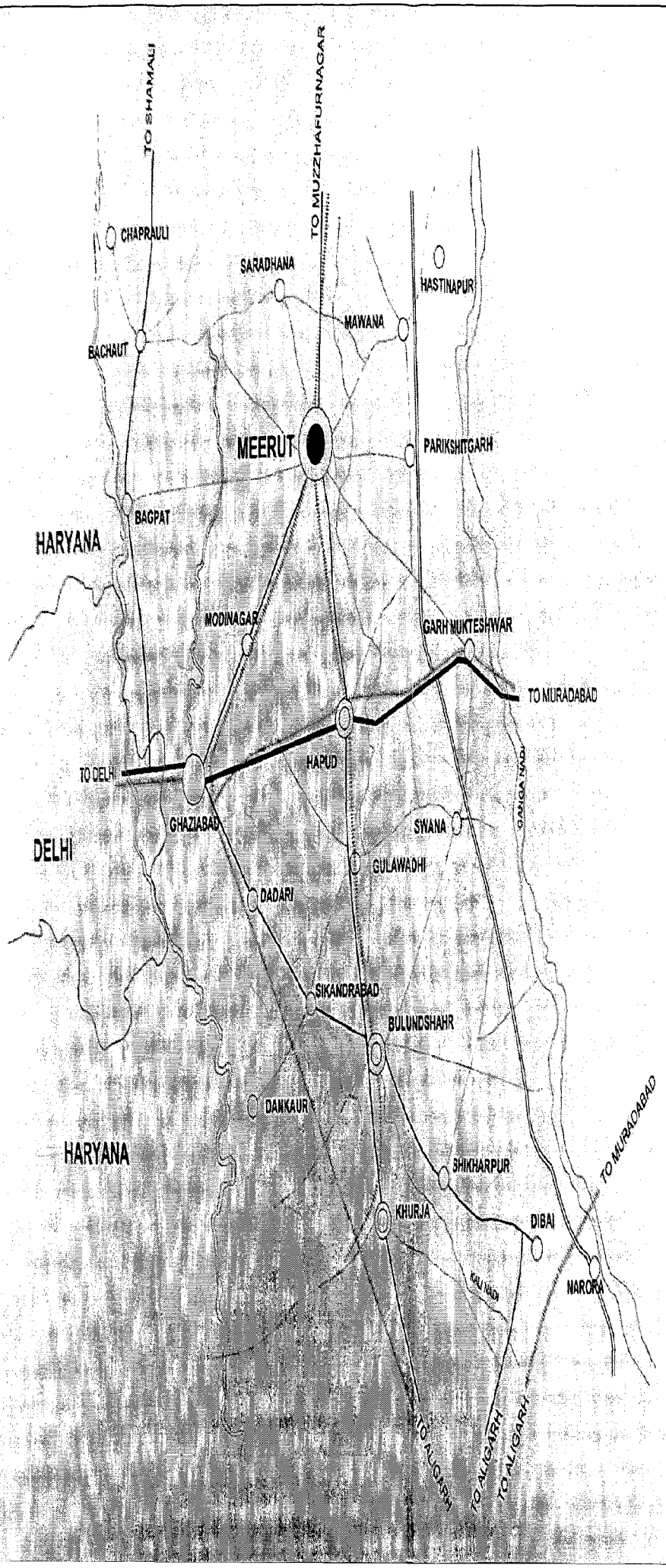

LEGENDS :

- OTHER CITY
- PRIMARY CITY
- MEERUT CITY

TITLE :
POSITION OF MEERUT IN NATIONAL CAPITAL REGION (NCR)

THESIS TOPIC :
STUDY OF ROAD NETWORK AND TRAFFIC CONDITONS OF MEERUT : a review of present scenario

DRAWING NO. 06

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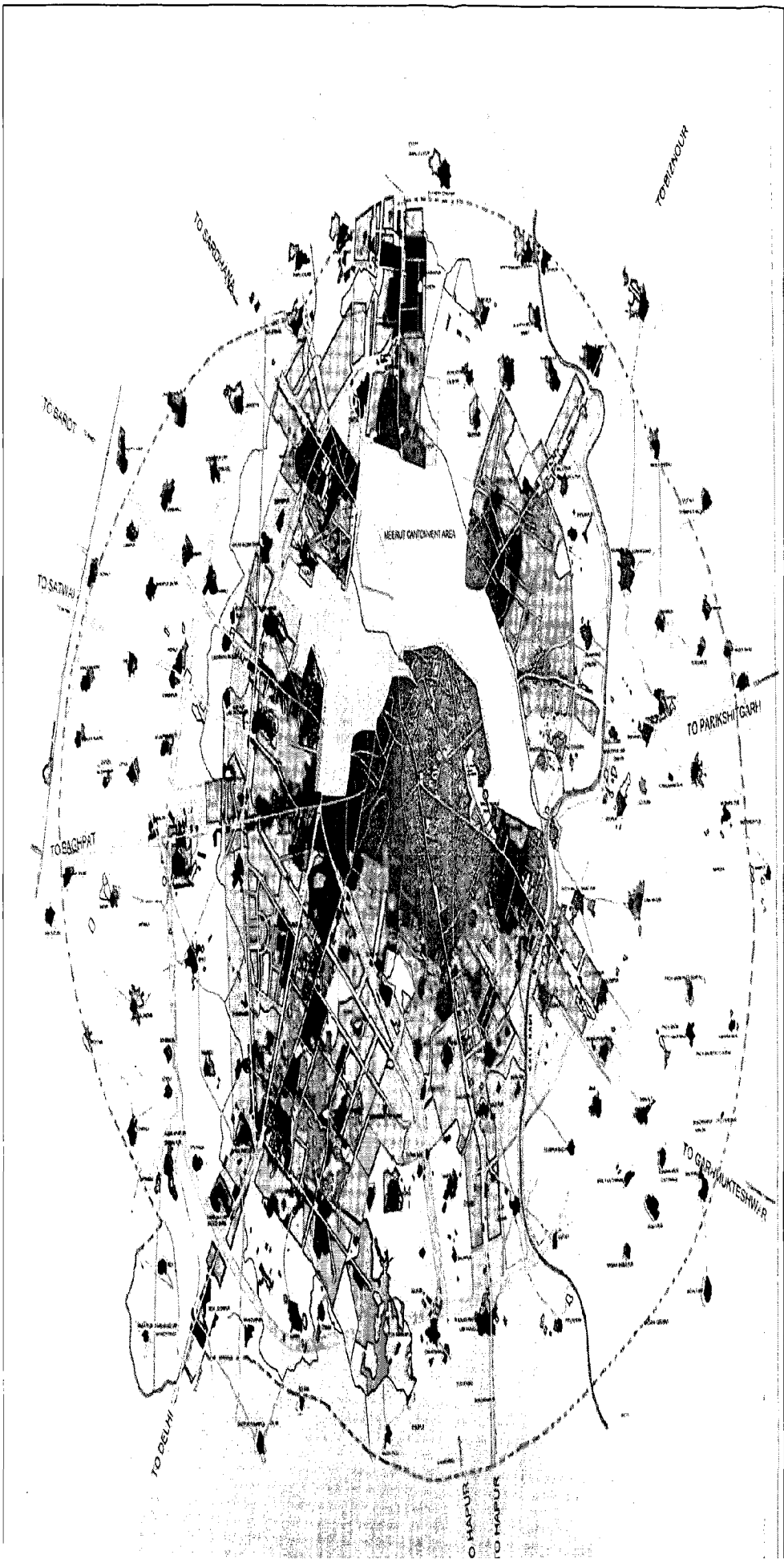

LEGENDS :

- EXISTING DEVELOPMENT AREA (2001)
- DEVELOPMENT AREA PROPOSED 2021
- OPEN SPACES

TITLE :

PROPOSED LANDUSE PLAN 2021 AND EXISTING LANDUSE OVERLAP

THESIS TOPIC :
STUDY OF ROAD NETWORK AND TRAFFIC CONDITONS OF MEERUT : a review of present scenario

DRAWING NO. 07

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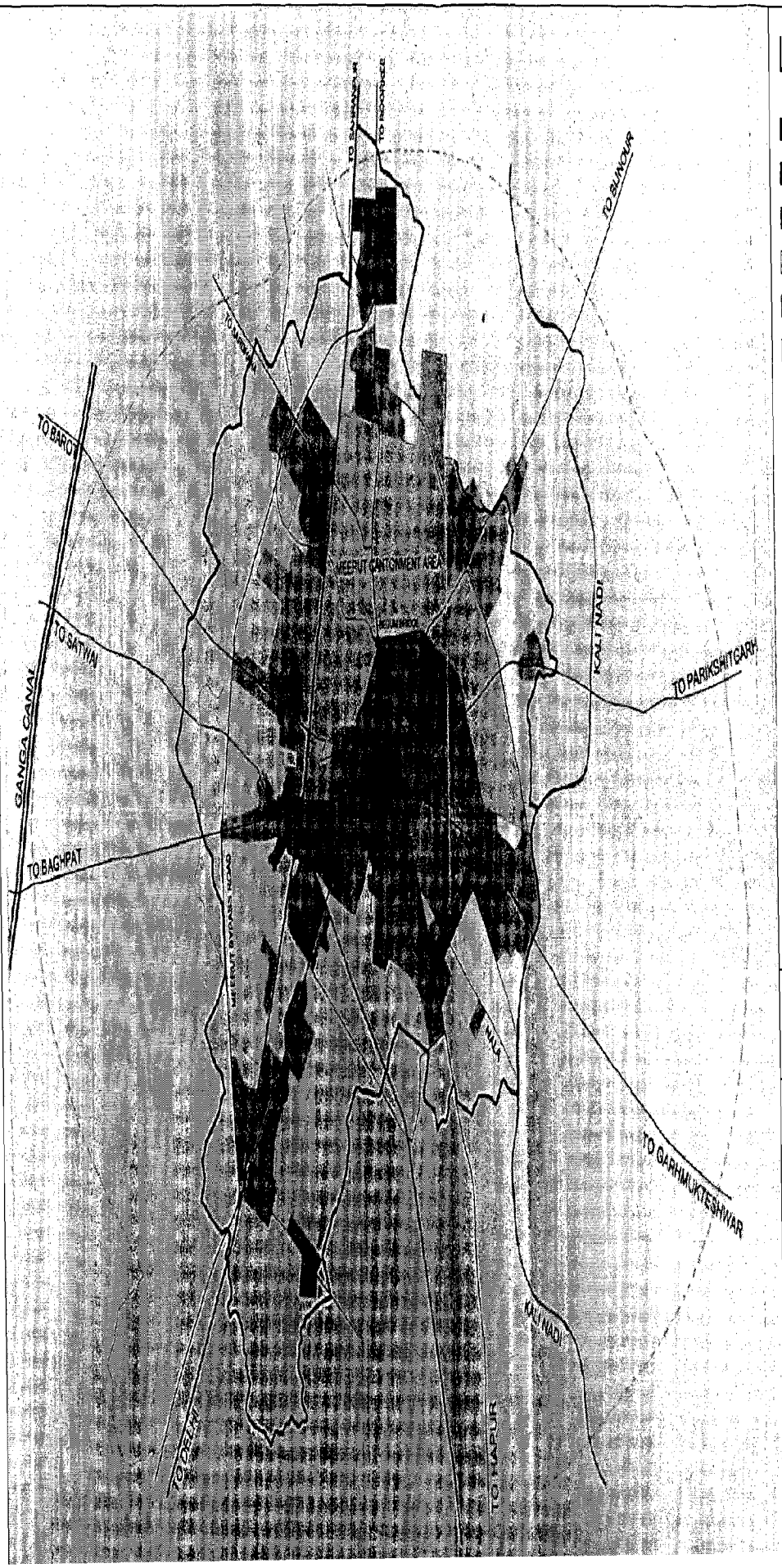

LEGENDS :

- TILL 1911
- 1911 TO 1946
- 1946 TO 1971
- 1971 TO 1991
- 1991 TO 2001
- CANTONMENT AREA
- RAILWAY LINE
- ROAD
- MUNICIPAL BOUNDARY
- NALA
- WATER BODY

TITLE :
URBAN GROWTH OF MEERUT CITY

THESIS TOPIC :
STUDY OF ROAD NETWORK AND TRAFFIC CONDITIONS OF MEERUT : a review of present scenario

DRAWING NO. 08

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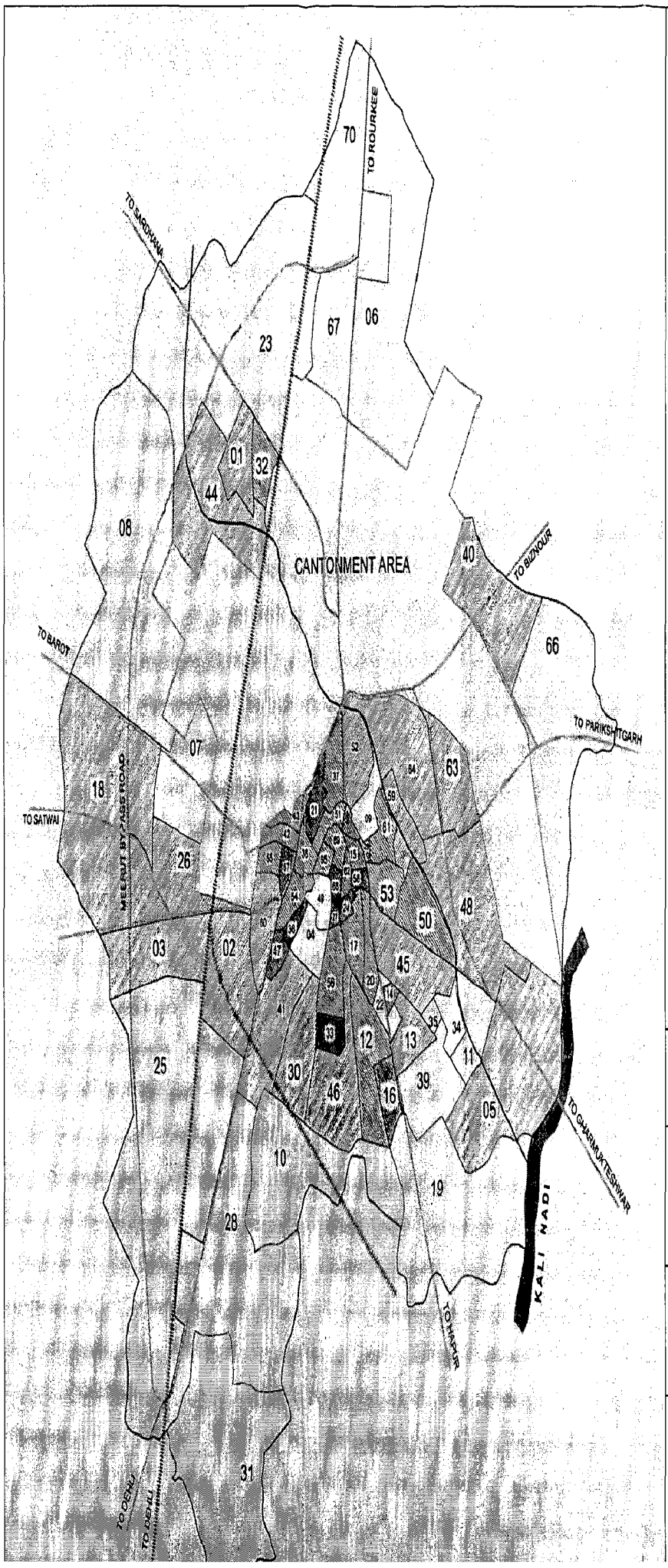

LEGENDS :

- MUNICIPAL BOUNDARY
- CANTONMENT AREA
- WARD BOUNDARY
- WARD NUMBER
- ROAD
- RAILWAY TRACK
- KALI NADI
- DENSITY < 50 PERSON / HA
- DENSITY 51 - 100
- DENSITY 101 -200
- DENSITY 201 - 500
- DENSITY 501 - 750
- DENSITY 751 - 1250
- DENSITY 1251 - ABOVE

TITLE :
WARDWISE POPULATION DENSITY

THESIS TOPIC :
STUDY OF ROAD NETWORK AND TRAFFIC CONDITONS OF MEERUT : a review of present scenario

DRAWING NO. 09

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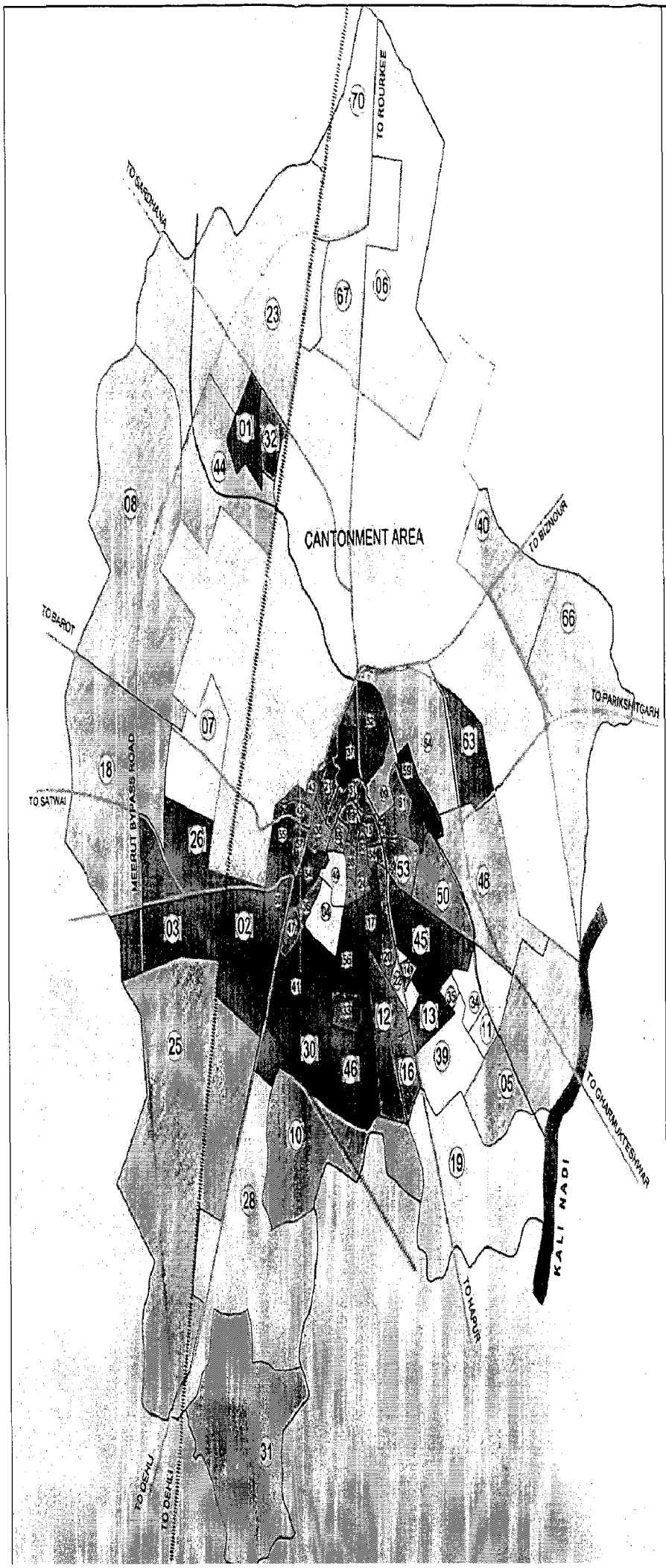

LEGENDS :

- CANTONMENT AREA
- WARD BOUNDARY
- 05 WARD NUMBER
- ROAD
- RAILWAY TRACK
- KALI NADI
- LOW STRESS AREA
- MEDIUM STRESS AREA
- HIGH STRESS AREA

TITLE :
STRESS AREA MAP
W.R.T. INFRASTRUCTURE AVAILABLE AND POPULATION DENSITY

THESIS TOPIC :
STUDY OF ROAD NETWORK AND TRAFFIC CONDITONS OF MEERUT : a review of present scenario

DRAWING NO. 10

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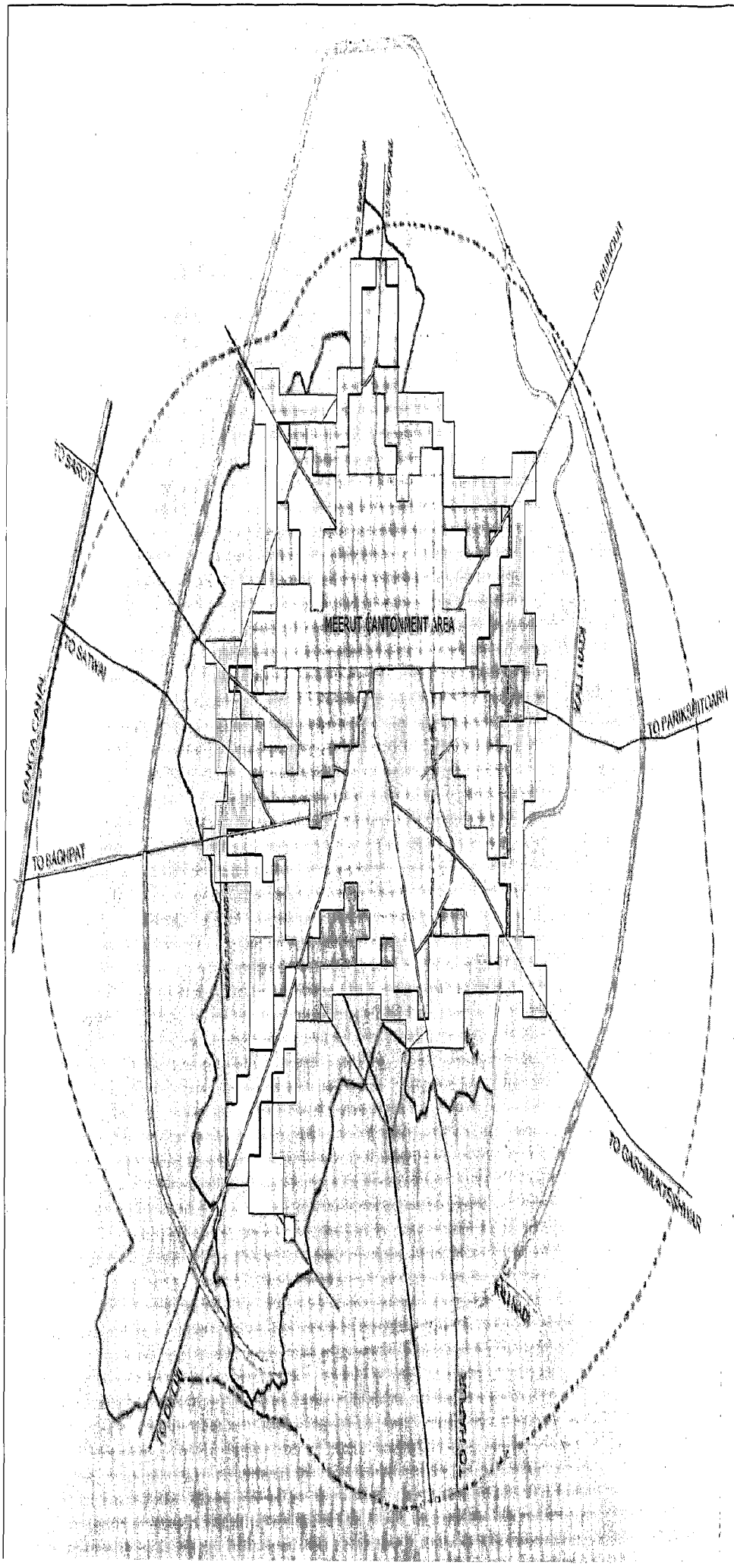

LEGENDS :

- ☐ EXISTING DEVELOPMENT
- ☐ EXISTING DEVELOPMENT 2001 (CANTONMENT AREA)
- ☐ PROPOSED DEVELOPMENT 2011
- ☐ PROPOSED DEVELOPMENT 2021

TITLE :
PROPOSAL FOR FUTURE DEVELOPMENT

THESIS TOPIC :
STUDY OF ROAD NETWORK AND TRAFFIC CONDITONS OF MEERUT : a review of present scenario

DRAWING NO. 11

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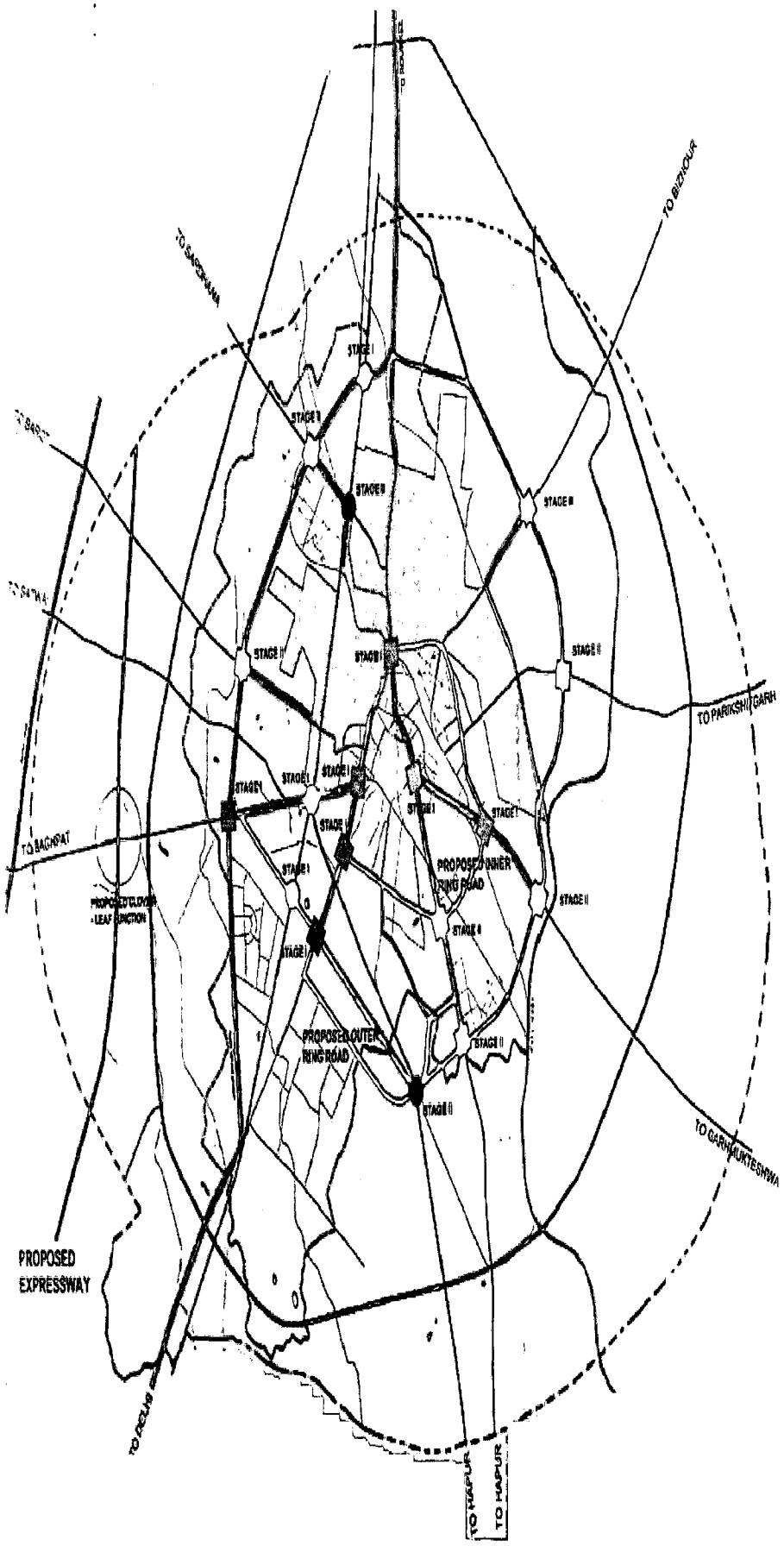

LEGENDS :

- DEVELOPMENT OF JUNCTION IN PHASE I
- DEVELOPMENT OF JUNCTION IN PHASE II
- DEVELOPMENT OF ROAD IN PHASE I
- DEVELOPMENT OF ROAD IN PHASE II
- FLYOVER CONNECTION IN PHASE I
- FLYOVER CONNECTION IN PHASE II
- ROADS
- RIVER

TITLE :
PROPOSAL FOR PHASE WISE DEVELOPMENT OF ROADS AND ROADS JUNCTIONS

THESIS TOPIC :
STUDY OF ROAD NETWORK AND TRAFFIC CONDITONS OF MEERUT : a review of present scenario

DRAWING NO. 12

NORTH

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