STUDY OF ENVIRONMENTAL POLLUTION AND STRATEGIES FOR IMPROVEMENT OF LUCKNOW CITY

A DISSERTATION

submitted in partial fulfilment of the requirements for the award of the degree of

MASTER OF URBAN AND RURAL PLANNING

By

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INTRODUCTION

CHAPTER I

INTRODUCTION

1.1 ENVIRONMENTAL PROBLEMS AND URBANIZATION:

The environmental degradation and ecological deterioration in urban areas is a world wide phenomenon, but it is more pronounced in developing countries because of mismanagement of science and technology, population explosion, widening gap between rich and poor and chronic poverty is taking place at macro level and city level due to population growth and migration & unplanned development.

In urban areas there is more population density, shortage of houses, congestion, more automobiles, shortage of parks, playground and open space. Problem of stray cattle on urban roads and areas, air, water, and noise pollution, traffic hazards, industries also creates slumps and squatter settlements. Besides this, there are more contaminants dusts, more cloudiness, more fog in winter, high temperature, less relative humidity, less radiation & less wind speed.

"The urban ecosystem is in a crisis which will increase in geometrical progression as urbanisation accelerates and as the availability of financial resources for urban development declines". This was the warning contained in the book 'planning the Indian city' by Mahesh N. Buch. The warning still holds good considering the pace and the manner of urban growth and the deterioration of its management.

Over crowding, pollution diseases and civic amenities stretched to breaking point, the classic urban nightmare is

already staring in the face millions of people living in Indian cities. Although at national level the urban growth rate has declined from 46% in 1971-81 to 36% in 1981-91, there has been a doubling in the number of metropolitan cities with a population of over one million from 12 in 1981 to 23 in 1991. Their population alone accounts for one third of the total urban population.

With the spatial spread of cities, environmental degradation sets in. In the first place a city grows to cover a large area however as the availability of land is limited an intense competition develops for the limited space and consequence is that urban agglomerations develop haphazardly and face greater civic problems. However the most common growth pattern is the sprawl that converts prime agricultural and pastoral land to urban uses.

Second, there is an impact on the surrounding region by the growing demand for energy, food and materials.Rapid urban growth leads to accelerated and exploitative withdrawl of the resources base. Large areas around cities are taken up or further development and forest are destroyed to meet the needs of the people, thus leaving the soil in an uncurable condition.

Third, the metabolism of the city increases resulting in a higher generation of metabolic by products such as waste waters, air pollution, noise etc. Much of the pollution of the river can be traced to the discharge of untreated system. The air is affected by gases from industrial units and vehicles, the weather undergoes a distinct change as the density of population increases.

Radiation hazard on rise in Lucknow

LUCKNOW, Jan. 5 (PTI)

People are exposed to an "invisible pollution" — radiation — and it is mainly the increasing growth of vehicular traffic which is responsible for this new kind of pollution, says a survey.

Lakes and rivers

A running problem

With increasing industrialisation, the problem of water pollution is no longer confined to a few places. Thus talk of water pollution is heard from all over: in the Chambal at Kota, the Gomti at Lucknow, the Damodar at Bokaro, the Godavari at Rajahmundry, the Narmada at Hoshangabad, the Tungabhadra at Harihar and the Chaliyar at Mavoor (Kerala). The list seems endless. The extent of pollution near the highly-industrialised and densely-populated Bombay is such that satellite photographs show the Arabian sea contaminated for a hundred kilometres northward.

Uttar Pradesh

Heading for ecodisaster?

The Yamuna and the Gomti, the two tributories of the Ganga, are in a very bad state. The Yamuna, with depleted flow, appears a mere trickle of brackish water at Agra. And the Gomti, flowing by the state capital Lucknow, is laden with sullage.

Though the implication of such a rapid growth of urban population have from time to time been high lighted in general and sought to be tackled, not enough attention has been focused on the environmental aspect of this demographic trend. The planning of the town should be such as to integrate the existing habitations within the town framework, causing a change only in the economic livelihood which retaining the social and cultural patterns and improving the physical and living environments. In other words it thrusts on minimising if not completely removing the adverse effects on the environment of rapid growth in urban population and the haphazard development of urban centres.

LUCKNOW : "The Eleventh Metropolis"

The urban panorama of mid nineteenth century upper India has as its center piece, the gracious feudal court city Lucknow, the capital of the Nawabs of Oudh. It was, at that point in history, the largest and most prosperous existing precolonial city in the sub continent. Only the three colonial port cities of Madras, Calcutta and Bombay exceeded it in size or affluence. However, today it is more of 'state of mind' with its reputation for culture and refinement involved in innumerable anecdotes, but very hard to substantiate from the existing reality.

GROWTH OF LUCKNOW CITY:

Lucknow, the capital city of the state of Uttar Pradesh is in the eleventh position in terms of its population size. The urban agglomeration of Lucknow has a population of plus 16 Lacs and a density range of 50 to 1000 persons per hectare. The growth

rate is almost three times the last decade i.e. from 23.79% in 1971-81 to 65.66% in 1981-91. The city has grown in terms of population, which is quite natural for any human settlement but the density figures, the second highest in the state and almost five times the national density figures indicates signs of congestion and over crowding. Its monumental heritage provide some relief but if conservation efforts are not speeded up Lucknow would lose its charm. Hence the planning of the town should be such as to conserve the environmental aspect.

Lucknow the elegant capital city of the state of Uttar Pradesh, lies on the banks of the river Gomti. Popularly believed to have been given to Lakshmana by his elder brother Rama, the city continues to be surrounded by innumerable myths and legends. Historically its origin can be traced more definitely to the medieval period and the local site seems to have been fairly occupied by the beginning of the fourteenth century. The Mughal Emperor Akabar is stated to have given Lucknow and its surrounding areas to one Abdul Rahim as a Jagir. The building programme of Lucknow was intiated by shaikhs. They built a fort called Qila Lakhna (after the name of Hindus architect who has designed it) at the site known as Machhi Bhawan and a town grewup around the fort named Lakhnau.

1.2 IDENTIFICATION OF THE PROBLEM :

Increasing urbanisation ,high density traffic,and industrialisation have resulted in a number of environmental problems.Primarily,it is the degradation of air and water quality that worries most a city dweller.A number of government

initiatives have been taken recently to monitor air and water quality and maintain the same within tolerable limits.

The population of the city has increased rapidly during the last few decades. At the beginning of the century i.e. 1901 it had a population of 2,56,239. By 1921 this had declined to 2,40,566 but then increased to 2,74,659 by 1931 and hence to nearly 7,00,0000 in 1961 and by 1981 this had increased to 10,07,604. The population of the city according to 1991 census is 16,69,204.

The ecology of Lucknow city is acute.One can find haphazard and chaotic growth of city misuse of land slums, Jhuggis & Jhonparies in all parts of city. Industries are estabished on political ground without consideration of pollution,it is likely to cause most of the residential areas are having obnoxious and noise creating industries. Heavy traffic passes through residential colonies, there is also problem for energy, electric and water supply, health and hygienic facilities etc. The main environmental problems faced by Lucknow city are:

(a) water pollution

(b) air pollution

(c) noise pollution

(a) Water pollution :

This problem becomes complex because of qualitative difference in pollution according to industries involved and due to the non-degradability of many of effluents.Water pollution caused by domestic sewage and industrial effluents.Within the city there are 31 open drains which shed their pollution

discharge in the river Gomti.

There are a number of medium and small scale units which do not come under the purview of the State Pollution Control Board, which could be Contributing the pollution of water.

(b) Air pollution:

The main source of air pollution are industrial plants, automobiles etc. The gaseous emissions from these sources mainly consist of aerosols (smoke, ash, dust) odours, gases (SO2, HC, NOX, CO). These air pollutant effect man, animals, vegetation and also having economic, sociological and psychological impact. The major cause of air pollution is vehicular emission this is attributive to the lack of an efficient public transport system which has led to an overwhelming reliance on the private modes, especially scooters and tempos. The no. of registered vehicles has tremendously increased from 55418 in 1981 to 215547 in 1991 (nearly 4 times).

(c) Noise pollution :

Noise is an important environment "pollutant" has been mostly ignored. Noise has increased to intolerable limits in many cities. There are a number of activities which lead to high noise levels in urban environments. The level of noise is increasing day by day, within the city Lucknow. It is created mainly by automobiles, industries, construction activities. Besides these public used loudspeaker, advertisement, house hold gadgits, Railway, air transportation also contribute to noise pollution in the city. Apart from high density traffic, industrial activity and

normal human activities,a number of our social activities also lead to much noise in our surroundings.

1.3 OBJECTIVES :

To study the existing problems of Lucknow city, concerning infrastructure, transportation, pollution etc. and propose strategies for environmental improvement.

1.4 SCOPE AND LIMITATIONS :

There are various aspects of environment study which have been dealt, mainly those which affects the living enviorment and nature of urban development. The main emphasis of the study will be on the impact of rapid city growth and its environment.

The secondary and primary data base formed the inputs of the analysis.The analysis and projections based on them helped to make strategies for improvement of present and future Lucknow City.

However the study was constrained, as it was not possible to cover each and every aspect in depth within the stipulated time .The non-availability of certain data restricted the scope of the study to the area of urban environment only and it was not possible to include regional considerations.

1.5 METHODOLOGY :

1. To study the existing environmental problems of the Lucknow city.
2. To study the existing infrastructure facilities (water supply, sewerage system) and related problems.

3. To study the existing transportation network and related environmental problems.
4. To identify the areas most severely affected.
5. Proposals and planning strategies for environmental improvement.

Chapter 2 :

LITERATURE SURVEY

CHAPTER II

LITERATURE SURVEY

2.1 GENERAL OVERVIEW :

Environment:

The environment is a combination of air, water, land, plants, animals, their interrelationships, natural and man modified surroundings and processes as well as socio-economic and cultural aspects of people inhabiting it.

Everything that surrounds us that to you as an individual is your world, that makes you and your world unique that begins to be the environment. It is a private environment, the acceptance of which by any individual would vary according to how that individual allows the environment to affect him.

Pollution is a very general term and is defined in many ways. In its broadest sense as conceived by the layman it is the befaulting of the environment by man's activities, particularly by the disposal of solids, gaseous, and liquid waste products. The word pollution has been adopted from the Latin word 'Pollution' meaning defines the oxford dictionary as derived its meaning from the verb pollute meaning physical contamination of terrestrial or aquatic environment. Different sections of the society have been giving different meanings to pollution depending on their own interest of investigation or use of the water. The common person thinks pollution as the introduction into water of anything dirty or foreign regardless of the amount as effects of material introduced and whenever the society finds

a useless for their use, they call it polluted.

USPH Services (1962) has defined pollution as the presence of any foreign substance (organic, inorganic, radiological or biologcial) in water which tends to degrade its quality so as to constitute hazard as impair the usefulness of water.

Warren (1971) defines pollution as any improvement of the suitability of water for any of its beneficial uses actual or potential, by man caused changes in the quality of water and if such an impairment is by nature then it is termed 'natural pollution'.

Baumann (1963) has stated that pollution may be due to solids, liquids or gases whose presence may be non-permissible, undesirable or objectionable.

Nemerow (1974) called a pollutant to mean too much of any given contaminant such that it renders the receiving water unusable in its existing state for its desired best uses.

According to Cairns & Lanza (1972) pollution is the appearance of some-environmental quality for which the exposed community has inadequate information and is thus incapable of an appropriate response.

Bhargava, D.S. defines pollution as 'entry of foreign matter in a water so as to make it unsuitable for a use'. Some biologists considered pollution as a change in the aquatic environment without due regard to the water use.

2.2 ENVIRONMENT AND DEVELOPMENT :

The earth's finite natural resources have been exploited for centuries. Only over the past two decades, however, has public attention been caught by serious phenomena of resource depletion and scarcity. Widespread concern about environmental degradation has also been expressed in conjunction with conspicuous pollution incidents in the 1960s. Zero growth of the economy and the population was then postulated in industrialised countries to avoid the disastrous transgression of the physical "outer limits" of the planes. Developing countries remained only peripherally interested considering environmental concerns to be marginal products of high level economic growth. Today environmental problems are generally seen to stem both from economic growth and from activities induced by an actual lack of development.

The degradation of environment started when the human settlements felt the vagaries of nature unbearable. The droughts, famines & other climatic disasters, though, they persist earlier too and tolled heavy lives, gave masses a new direction to think for self protection. This started the industrial revolution all over the globe and a large scale migration took place. Industrial slums were formed and so grew up the concept of towns and cities. Intensive industrialisation gave birth to the word pollution and there was than no end of the latter as the greed of the enterpreneurs multiplied. The filth and wastes got accumulated on roads. The quality of life became very much degraded.

The root cause of the environmental degradation was explosion of population as large scale industrialisation and

commercialisation took place which thereby spoiled all natural features of the cities. The sea, river, lakes became the large sites for dumping of wastes which created severe water pollution. The vehicular traffic created major air pollution. The flora and fauna gradually started disappearing. Heavy deforestation started which adversly effected the climatic conditions.

Environmental quality is, in a very real sense, all things to all men, for the quality of an environment is judged by the attitudes of individual men to it, and such judgements are likely to vary with age, culture, education, experience, income & sex - in short , with life style, and with personality. The American Public Health Association has suggested four levels of concern in assessing environmental health viz (a) ensuring survival (b) prevention of diseases & accidents (c) maintenance of an environment suited to man's efficient performance & (d) Preservation of comfort and the enjoyment of living and these might well form the basis for an assessment of environmental quality. Whether conceived in medical, economic or psychological terms, these criteria are all assessed on a human scale, though they are progressively more difficult to measure.

In man's history this is an area of exploding environmental and urban problems. To a large extent our environmental ills are caused by the demands, functions, and expansion of cities. Conversely healthy urban life requires understanding of and wise accommodation to the complex physical environment in and near cities.

In its broadest sense environmental planning is an

attempt to balance and harmonise the various enterprises, which man for his own benefit has superimpose on natural environments.

All human activities impact upon the environment of their setting. These imapct are most conspicuous, tangible, and measurable in respect of human settlements in general and urban centres which are nodes of intense, concentrated and diverse human actions in particular. The degree of impacts could be directly related to the intensity of development as an initial proposition.However, it would soon assume more complex dimensions consequent to the growth dynamics of the settlement particularly a growing urban centre, which would set into motion a chain of inter related impacts consequent to spatial structure and functional changes in the settlements during it process of growth.

Environment & settlements have a multi layered interface ranging from macro and meso levels to the micro level interactions of the immediate natural environment attributes primarily land, water, air, & vegetation with the settlement perse. This interface has implications on several aspects of planning for settlements notably in regard to location and siting, size & growth, physical form & development pattern, land use, socio economic structure functional disposition etc. Environment provides the basic life support system to settlements individually as well as collectively. For healthy growth of towns & cities, it is essential that this life support system is not impaired, either through over-taxing system ingredients like, land, water, air, & vegetation or by causing their degradation

through dumping and discharge of organic and inorganic wastes, rejects and effluents, consequent to high intensity urban function of production, consumption & distribution.

Large cities and agglomerations have played havoc with their environment, as the life support system and processes has only got depleted and degraded, but in most cases have suffered irreversible damages. Effects on these on the natural as well as the man made built environment, are too apparent to elaborate. Chronic water and power shortages, gross inadequate sewerage and solid wastes management systems, adversely affected micro climatic conditions owing to depletion and denundation of ecological cover, high degree of air and water pollutions, and various forms of land degradation are some of the common problems witnessed today. All of these have inter related causes and impacts on the quality of life.

In the contemporary situation of a developing economy towns and cities are considered on synonymous with growth. They are identified as vehicles of socio economic development. and hence conceived or dynamic entities, triggering growth not only within their own confines, but also in their hinter land regions. All developing countries are planning for higher growth, and consequently increased urbanisation and industrialisation. In this process more and more strain of natural environment of resources would be inevitable unless interventions are made to devise an urban pattern comprising town & cities, that is environmentally compatible sustainable and manageable.

There is obviously an urgent need to establish in any

given setting a healthy nexus between environment attributes and resources on one hand and urban development programmes on the other. This calls for a fine grain synthesis of environmental parameters with urban planning and development parameters. An urban pattern supported by such types of individual city structure which while drawing upon environmental resources, also enable their regeneration & recyling as an integral process of city growth & substance, would be conclusive to establishing such a harmonious relationship between environment and the settlements as well as achieve overall planned development.

2.3 CASE STUDIES :

Air Quality surveys in 4 major cities of India:

Introduction :

With the rapid growth of industries and urbanization, India has started to experience the effects of air pollution in some cities. The episodes of pollution from industrial emmisions are being reported with increasing frequency. The data collected and reported on air quality is fragmented and does not present a systematic picture in India.

The National Environmental Engineering Research Institute, Nagpur decided to embark on a programme of air quality survey and monitoring on selected cities of India. As a preliminary step a short term survey was undertaken in 4 major cities.

The short term survey were undertaken to assess the air

quality and determine the level of pollution currently obtaining in 4 major cities of India, with following specific objectives:

(A) To have a quick check of levels of various known pollutants in the cities.

(B) To obtain data as a first step towards formulating a general plan of air quality studies on long term basis for the country.

(C) To draw the attention of the concerned authorities towardsthe atmospheric pollution in these cities so as to generate interest in control measures.

Observations :

The short term survey has surved its purposes because it has high lighted the nature of the air pollution problem in the country and has given the scientists of the Institute a field experience which in tern has given insight into the problem. Some salient observations made in the study are given below.

(A) This study was scattered over various months of the year in the four cities, starting from April-1968 to March-1969.

(B) The following parameters of air pollution such as Sulpher dioxide, Nitrogen dioxide, Hydrogen sulphide, Oxidants and suspended particles were studied.

(C) The survey was carried out with a limited No. of stations selected judiciously in each city to given representative data. The sampling was done by rotation, at intervals of few days at each station, for a period

of approximately one to two months. The samples were colleted over 24 hours in 4 hours batches for gaseous pollutants and continuously for 24 hours for particulates. Therefore the values are averaged to give a broad picture of air pollution over the sampling period.

(D) BOMBAY CITY has a favourable climatological conditionwith mild breeze throughout the year with strong winds in monsoon. Stable condition rarely extends beyond a few hours at any time. The city shows fairly high level of air pollution in places like Chembur - Trombay where concentration was 3 to 6 times the average city level. It also had relatively high levels of H_2S compared to the Indian cities. Particulates were significantly high at all stations compared to the levels of other cities of the world as shown in the table 1. The total oxidants levels in Chambur - Trombay area are high probably due to presence of hydrocarbons from patro-chemical operations in the area. No study on automobile gasoline or diesel emission was done in the city in this short term survey, but it is desirable and will be included in subsequent studies.

(E) Delhi has hot dry climate with windy conditions in summer and mildly cold dry climate with low speed winds in winter. Radiation inversion does occur frequently in winter from late evening to early morning, unlike

Bombay, resulting in pollution acumulation. Locomotive discharges appear to contribute subtantially to SO2 pollution in Delhi. This is also aggravated by domestic emission from use of coal. Particulate concentrations in Delhi for average dust content recorded was 700 µg/cum. This is extremely high compared to various available data from other countries. During the actual occurrence of dust storm, value exceeded even 10,000 µg/cum. No work on vehicular emission was done in this city. It would be advisable to undertake this important study particularly in Delhi where heavy auto exhaust emission are visible throughout the year Table 2.

TABLE 1
BOMBAY : AIR SAMPLING STATIONS AND RESPECTIVE POLLUTION LEVELS

LOCATION	RANGE OF CONCENTRATION OF POLLUTANTS									
	SO2		NO2		H2S		O3		SUSPENDED DUST	
	AVE.	MAX.	AVE.	MAX.	AVE.	MAX.	AVE.	MAX.	AVE.	MAX.
	PPM		PPM		PPM		PPM		$\mu g/m^3$	
Worli	.014	.03	.011	.024	.023	.082	.005	.031	269	349
	REMARKS :- H2S is significantly high. Particulate load is also significant.									
Dadar	.01	.023	.008	.013	.012	.051	.003	.026	228	333
	REMARKS :- Moderate level of all pollutants.									
Hospital	.016	.067	.012	.032	.016	.022	NIL	TRACE	215	280
	REMARKS :- Levels of SO2, NO2 and H2S are relatively high.									
Chembur-Trombay road (In the vicinity of Refinery)	.137	.172	.015	.02	.035	.05	.017	.047	225	261
	REMARKS :- Higher values than above 3 stations can be accounted for by industrial emmisions from refineries and other petrochemical factories									
Chembur-Trombay road (In the vicinity of Fertiliser factory)	.031	.116	.033	.05	.004	.01				
	REMARKS :- Average concentration of SO2 is almost double that prevailing other residential areas in the city.									

TABLE 2

DELHI : AIR SAMPLING STATIONS AND POLLUTION LEVEL

LOCATION	RANGE OF CONCENTRATION OF POLLUTANTS									
	SO_2		NO_2		H_2S		O_3		SUSPENDED PARTICLES	
	AVE.	MAX.	AVE.	MAX.	AVE.	MAX.	AVE.	MAX.	AVE.	MAX.
	PPM		PPM		PPM		PPM		$\mu g/m^3$	
Motinagar	.012	.042	.013	.035	.005	.007	.013	.013	720	2831
Kisanganj	.03	.03	.012	.026	.004	.012	.006	.012	900	1426
Pahadganj	.024	.058	.012	.025	.002	.007	.008	.028	1100	2255
Irwin Hospital	.007	.019	.008	.016	.003	.011	.006	.025	500	10306
Town Hall	.008	.02	.011	.027	.002	.004	.011	.021	1225	2541

REMARKS :- 1. Of the selected areas for air quality survey, Kisanganj and Paharganj areas were comparatively more polluted. High levels of SO2 in these areas are attributed to over crowding. Other causes are the railway marshelling area in the vicinity and traffic activity.

2. High perticulate load in the atmosphere is attributed mainly to occurance of natural dust storm during this period. Part of significant particulate is also due to the heavy traffic activity and auto emmissions.

(F) CALCUTTA has significantly lower wind speed particularly in winter months, compared to other cities of this survey. It also has radiation inversions quite frequently. The automobile exhaust pollution level was studied in Calcutta city on four important traffic arteries. The parameter of Carbon monoxide was chosen as an index to auto exhaust pollution. Repeated instant samples of Carbon monoxide on these streets showed concentration as high as 35 ppm during peak traffic hours which were comparable with the other important cities of the world. With high traffic density Sulpher dioxide levels were uniformly high at all stations in Calcutta. Particulate average value was 530 µg/cum. Peak recorded was 1500 µg/cum. Sincce Calcutta is not subjected to dust storm, this could be attributed to traffic or unpaved roads and other emission sources. Nitrogen dioxide levels and oxidant levels in Calcutta was also higher compared to Bombay and Delhi.

(G) Kanpur is metrologically similar to New Delhi. The average concentration values for all pollutants are comparable to other cities. Particulates also show a trend similar to that of Delhi and Calcutta (Table 3).

TABLE 3

KANPUR : AIR SAMPLING STATIONS AND RESPECTIVE POLLUTION LEVEL:

LOCATION	RANGE OF CONCENTRATION OF POLLUTANTS									
	SO_2		NO_2		H_2S		O_3		SUSPENDED DUST	
	AVE.	MAX	AVE.	MAX	AVE.	MAX	AVE.	MAX	AVE.	MAX.
	PPM		PPM		PPM		PPM		$\mu g/m^3$	
CIVIL LINES	.03	.04	.015	.03			.025	.04		
ANWAR GANJ	.08	.11	.095	.13			.10	.135		
SWROOP NAGAR	.013	.025	.01	.02			.02	.028		
NAZEERABAD									488	550

Remarks : 1- Old industries including heavy chemicals with major emission of pollutants. This cause a severe pollution in the vicinity.

2- Swaroopnagar is away from the industrial zone and shows clear and cleaner atmosphere.

3- Particulates are significantly high.

Conclusions :

The work was done for about a couple of months in each city but it has given some useful ideas about the air quality in

general. The concentration level for all the parameters showed that these four important cities do have a problem of air pollution. The survey was carried out in different seasons in different cities, therefore it would not be correct to interpret this data as valid for all the year round.. However, in winter conditions for the northern cities of Delhi and Kanpur, the values may be 2 to 3 times higher than those recorded in this survey due to radiation inversion conditions for limited periods of 12 to 15 hours at a time (Table 3).

Through the stations were selected with care, it is possible that pockets of over higher concentration exist in the cities. Also automobile exhaust pollution study was limited to only one city to Calcutta. It shows a fairly high level of Carbon monoxide in the city. It is possible that similar condition may be existing in the other cities and therefore this aspect should be invariably studied in detail in future surveys.

This survey has revealed peculiar characteristics of air pollution in this country specially with reference to particulate matter. All the cities show 2 to 3 times higher values of average dust concentration when compared to the other cities of the world. This may have to be borne in mind while planning the future studies as well as air quality standard. The overall assessment of the result shows that there appears to be a very strong need to assess the exact status of air pollution in all the cities by a full scale investigation to obtain more detailed information on long term basis. Each city survey will have to be planned individually taking into consideration the

findings from this survey beside the standard survey techniques. The collection of such data will be useful to hasten the enactment of control legislation.

CHANDIGARH :

A survey of noise levels:

CHANDIGARH is a very well planned city. It is composed of 47 sectors, each about 1.5 Km long and 0.75 Km in width. All the 47 sectors are laid out in the form of squares on a chess board. There are vertical and horizontal roads which demarcate the 47 sectors. Most of these sectors are meant for residential purpose and are divided into four segments, A, B, C and D. Horizontal roads divide each of the sector into northern and southern portions. Each sector has one or two markets located along these dividing horizontal roads.

Chandigarh is a fast developing metropolis. The city has witnessed unprecedented growth in the number of vehicles of wide variety, plying on its roads. This has resulted in increase in noise all over the city . Exposure of common citizens to high levels of noise is not desirable. To gauge the present level of noise prevailing in different parts of the city a survey was carried out during the months of April, May and June 1989. The locations covered were the markets, the round abouts and residential areas in each sectors. A summary of the data colleted is presented in Table 4.

TABLE 4

SUMMARY OF NOISE LEVELS DATA

LOCATION	MAX NOISE Level dB(A)	MIN NOISE Level dB(A)	AVERAGE NOISE Level dB(A)
Each Quarter Sector	63 (34A)	42 (43A)	51
Markets in each Sector	74 (21)	46 (38)	64
Vertical roads	77 (22/21)	45 (39)	62
Intermediate Traffic Junctions	74 (18/17)	48 (7/26)	61
Round Abouts	77 (21/22/ 34/35)	45 (14/25/ 6/26)	63
Middle Points along Horizontal roads	77 (21)	43 (4)	61

Figures within parenthesis indicate sectors nos.

CONCLUSIONS :

(1) Noise has been observed to be a significant "pollutant" in urban environment of Chandigarh primarily due to high density of traffic and noisy vehicle engines.

(2) A common citizen in Chandigarh is exposed, on the average, to a noise level of 51 dB(A) in residential areas and about 64 dB(A) in through fares and markets.

(3) High noise levels associated with small scale industrial activity have been observed.

(4) Marketing of fruits, vegitables and daily necessities of life also contribute significantly to high noise levels.

(5) Very high noise levels have been encountered in the Inter State Bus Terminal.

(6) Dense hedges and trees should be increasingly used along roads for reduction of high noise levels observed in several parts of the city.

Chapter 3 :

EVOLUTION AND GROWTH OF LUCKNOW CITY

CHAPTER III

EVOLUTION AND GROWTH OF LUCKNOW CITY

3.1 HISTORY AND GROWTH:

Lucknow ,the elegant capital city of the state of Uttar Pradesh, lies on the banks of the river Gomti. Popularly believed to have been given to Lakshmana by his elder brother Ram, the city continues to be surrounded by innumerable myths and legends.

As a high growth potential calls for careful and systematic planning to optimise the growth and ensure balanced development and equitable distribution of the fruits, Lucknow has had a long history of planning efforts. It has experienced the incessant developments under the Mughals, the sensitive building programmes under Oudh dynasty, the aggressive and arrogant developments under the colonial government of the British, the sociological conservative surgery approach under the advise of Sir Patrick Geddes and the development oriented efforts is the post independence era. However,a comprehensive approach, based on the social and scientific principles of urban planning can be said to have been initiated during the third five year plan (1966-71), when under 100 percent financial assistance provided by the central government, the Master Plan for Lucknow was prepared in 1965.

Lucknow developed into a premier centre of art and culture under the Nawabs. But it was the British who laid the foundation plan for the present day Lucknow. The mutiny of 1857 dramatically changed the British view of Lucknow, which had been

one of tolerant non-interference. The initial strategic blunder of having built the pre annexation cantonment 3 to 4 miles away from the Residency on the other side of the river had cost the British dearly, and the new arrangements demonstrated that the lesson had not been lost. What imparted a sense of security to the European community was the fact that the cantonment and the police lines flanked the civil station and the three formed a large, well linked unit. Not only could troops quickly come to the defence of civilian families but those families could hastily withdraw into the cantonment or be evacuated from the city by rail. The need for political control dictated the new civic design of Lucknow. This high handed "Urban Planning " catered to Britain's industrial or imperial imperatives rather than to common-sensical, socio-ecological needs of civic inhabitants.

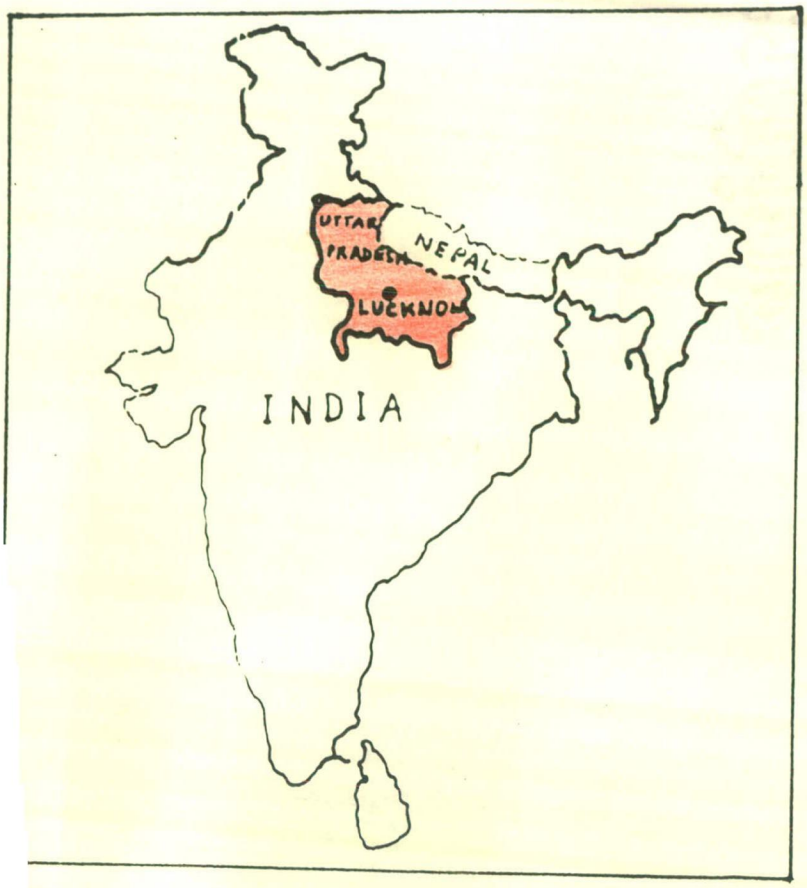
3.2 LOCATION AND LINKAGES:

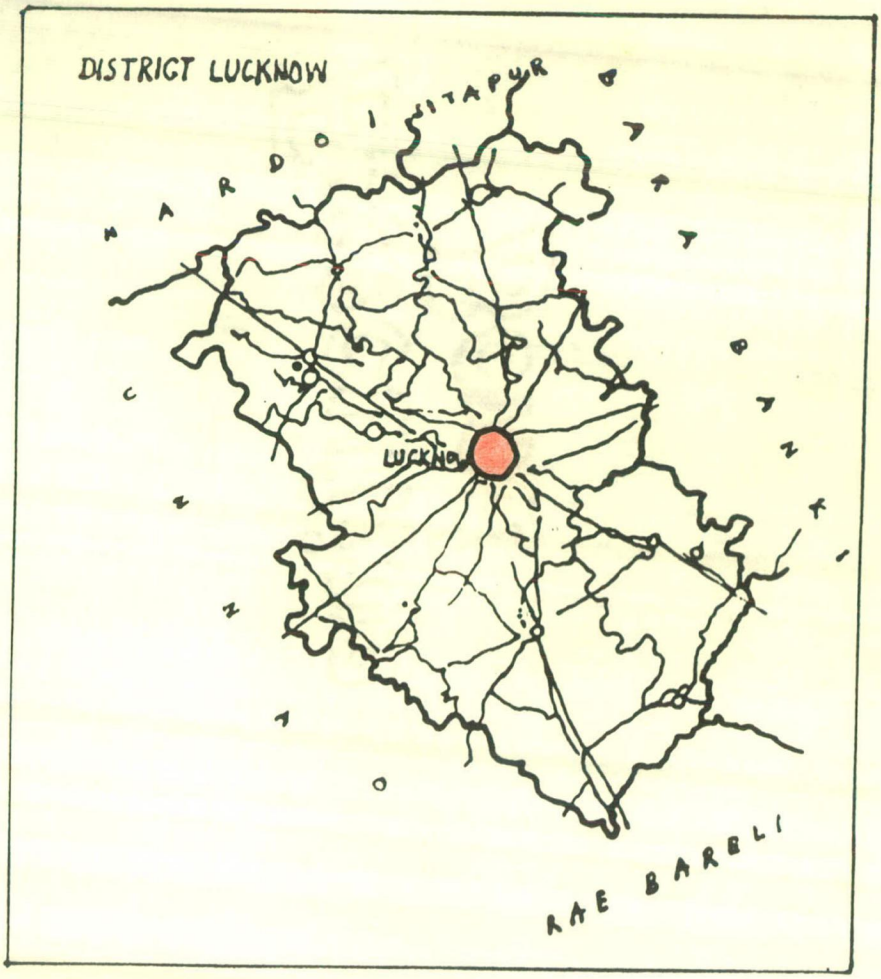
Lucknow is the second largest city in the state after Kanpur and is one of the five KAVAL towns of the state.

The urban agglomeration of Lucknow lies between parallels of $26^{o}42'$ and $26^{o}55'$ north latitude and $80^{o}50'$ and $81^{o}4'$ east longitude. The river gomti meanders through the heart of the town, dividing it into two halves - the southern half named as CIS -GOMTI comprises of older inhabitations while the northern side, named as TRANS - GOMTI is relatively new and still developing.

It is also the district head quarters of district Lucknow which is located almost in the middle of the state. The

LOCATION AND LINKAGES





MAP-1

district Lucknow comprises of three tahsils, namely, Lucknow, Malihabad and Mohanlalganj, of which Lucknow tahsil is largest in respect of population size. The Lucknow tahsil, in its turn, consists of three blocks, namely, Sarojini Nagar, Kakori, Chinhat and Lucknow city. It is bounded on the north by district Sitapur, on the north-east by district Barabanki, on the south-east by district Raebareili and on the south-west and north-west by districts Unnao and Hardoi, respectively.

The city is well linked with the neighbouring towns and districts and to the rest of big towns of India by rail, road and airways. Eight regional roads converge on to the city from all directions - of these 3 are national highways, namely, Lucknow-Kanpur (NH-25), Lucknow-Sitapur (NH-24), Lucknow-Faizabad (NH-28); 3 are state highways, namely, Lucknow-Hardoi (SH-25), Lucknow-Sultanpur (SH-34), Lucknow-Raebareili (SH-36). The other two roads link Lucknow to Kursi and Mohan.

An extensive network of railways criss-cross Lucknow city area-they are both an asset in providing high accessibility between Lucknow and the region and a liability in that they form bottlenecks for movement of intra-city road traffic. The Charbagh railway station of the city is one of the biggest railway stations of northern and north-eastern railways. In addition there are 3 other railway stations - Aishbagh, city station and Badshahnagar. These rail corridors within the city have a great potential for being developed and operating as future intra-urban rail system.

Lucknow is on the air route map of the domestic airlines-the Amausi Airport is a class B airport, handling jet air crafts, including Boeing 737 and serves as an alternative airport to Delhi in case of emergencies. It is directly linked with Delhi, Patna, Bombay and a number of urban centres within the state of Uttar Pradesh itself.

3.3 CLIMATE :

Lucknow falls in the subtropical region and its climate is classified as subtropical monsoon type. Lucknow's climate is characterised by three distinct seasons, namely, summer, rainy and winter. Winter usually commences in November and extends upto February, whereas, summer starts from April and extends upto the middle of June. March is a transitional period. The rainy season starts by the third week of June, normally and continues till September/October.

3.3.1 Temperature:

The temperatures increases rapidly after February till May which is generally the hottest month. The mean daily maximum temperature in May is 41.1^{o}C and the mean daily minimum is 25.7^{o}C. Hot dust-laden westerly winds blow often during the summer afternoons, popularly known as the 'LOO' and these add to the discomfort. However, the occasional thunderstorms cool the air a little, though only temporarily. January is generally the coldest month with mean daily maximum temperature at 22.2^{o}C and the mean daily minimum at 7.9^{o}C.

TABLE 5

NORMALS OF TEMPERATURE AND RELATIVE HUMIDITY (LUCKNOW)

MONTH	MEAN DAILY MAXIMUM TEMPERATURE	MEAN DAILY MINIMUM	HIGHEST MAXIMUM EVER RECORDED		LOWEST MINIMUM EVER RECORDED		RELATIVE HUMIDITY	
	^{0}C	^{0}C	^{0}C	DATE	^{0}C	DATE	0830(%)	0830(%)
JANUARY	22.2	7.9	28.9	1965 JAN 20	-1.0	1964 JAN 31	84	58
FEBRUARY	26.2	9.7	34.2	1963 FEB 16	0.0	1964 FEB 02	66	39
MARCH	32.4	15.0	40.4	1984 MAR 31	5.4	1979 MAR 10	52	29
APRIL	38.1	20.6	44.0	1980 APR 21	11.6	1983 APR 01	33	18
MAY	41.1	25.7	45.6	1973 MAY 09	17.5	1979 MAY 04	37	2
JUNE	38.9	27.5	47.7	1966 JUN 09	19.7	1979 JUN 12	59	41
JULY	33.4	26.5	44.2	1982 JUL 05	21.7	1950 JUL 01	83	74
AUGUST	32.3	25.9	38.0	1979 AUG 30,31	21.2	1982 AUG 31	86	80
SEPTEMBER	33.0	24.8	40.1	1958 SEP 18	17.2	1950 SEP 29	81	72
OCTOBER	32.2	19.4	37.5	1979 OCT 10	10.0	1984 OCT 31	71	60
NOVEMBER	28.5	11.1	38.0	1963 NOV 08	3.9	1952 NOV 29	65	52
DECEMBER	24.3	7.7	29.9	1976 DEC 04	0.6	1961 DEC 26	80	59
ANNUAL	31.9	18.5					66	50

The highest maximum temperature recorded at Lucknow (Amausi) was 47.7°C on the 9th June' 1966 and the lowest minimum temperature was - 1.0°C on 31st January' 1964.

3.3.2 Rainfall :

The average annual rainfall received at Lucknow is 1014.4mm . About 88% is received during the south-west monsoon months, June to September, July being the rainiest month. On an average there are 48.8 rainy days at Lucknow.

3.3.3 Relative Humidity:

During the monsoon season relative humidity is generally high, exceeding 75%. The driest part of the year is the summer season when relative humidities are less than 30%.

3.3.4 Winds:

Winds are generally light. During the period May to September winds blow mainly from east. In March and April the winds are mostly from north-west and in the remaining months the winds are variable and blow from west or north-west.

3.4 SLOPE :

The general slope of the land is from north and north-west to south and south-east with an imperceptible fall of 1 foot per mile with the exception in the vicinity of the river where the land surface has been cut by ravines. The altitude of land surface at Alambagh, Lucknow is 120m. above mean sea level which becomes 114 m. a.m.s.n. near Nagram in the south-eastern part.

3.5 GEOMORPHOLOGY:

Lucknow, at the tahsil lavel can be divided into two broad geologic units, namely,

* The younger alluvium
* The older alluvium

The river Gomti and Sai, the two principal drainage systems of the district/tahsil, form a flood plain which is occupied by the younger alluvium. The river Gomti forms a wider flood plain while the Sai river flows in a narrow, shallow valley and forms a restricted flood plain. There are two subdivisions of the flood plain-

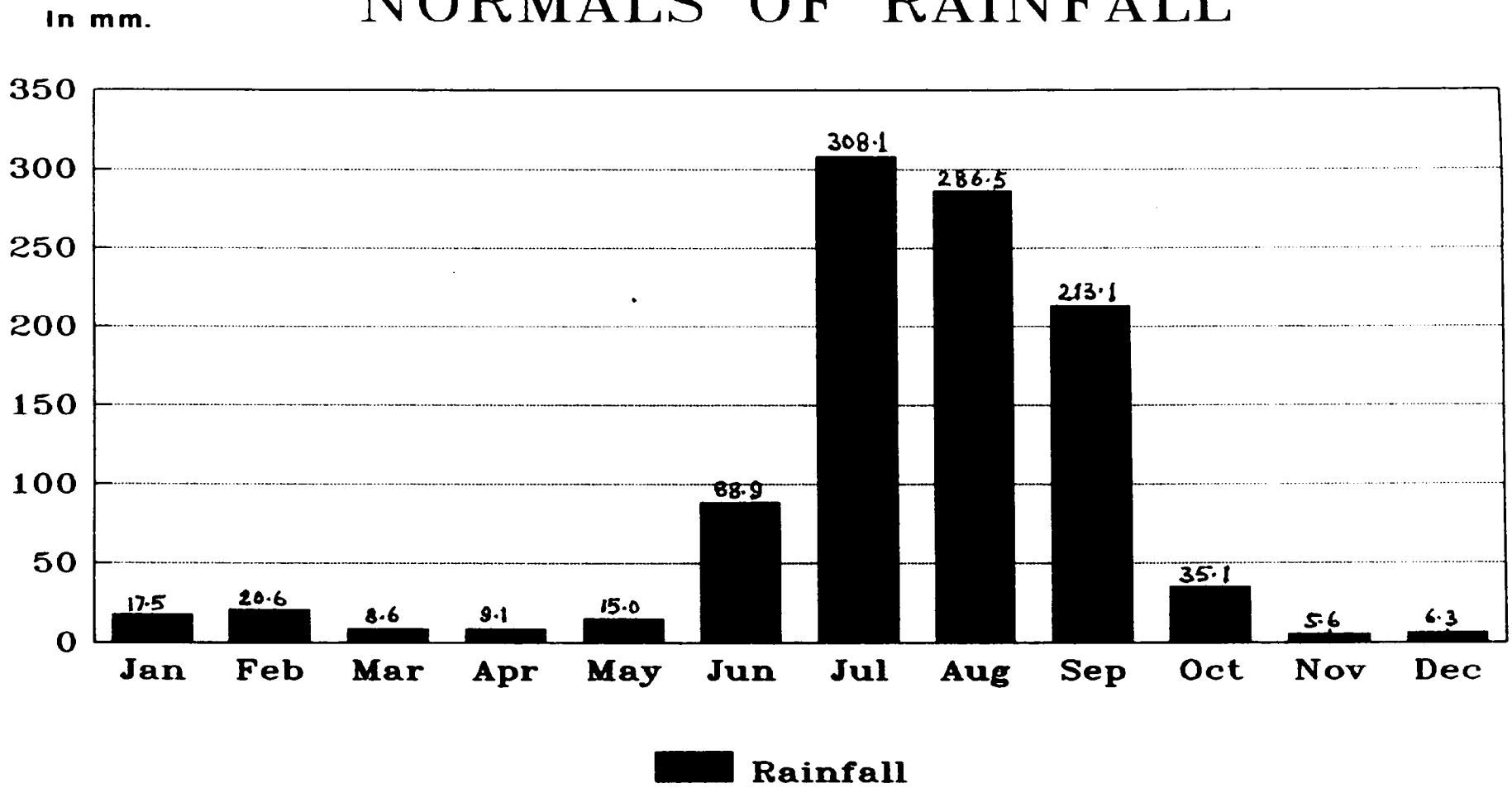
* The younger flood plain
* The older flood plain

The younger flood plain , lying adjacent to the river channels has been subjected to periodic flooding, forming terraces at places and consists of silt, sand, and little clay. The sediments geologically belong to younger alluvium and are deficient in calcareous matter.

The older flood plain of the Gomti river is fairly wide-spread. This zone is widely cultivated and produces good crops. The sediments are fine grained sand with silt and occasional clay beds. At the junction of the younger flood plain and the old flood plain, ravinous tracts and natural levees occur. Other fluvial landforms such as paleochannels, meander scars also occur in this zone.

The zone of younger alluvium merges with the older alluvium or upland area with imperceptible changes. This zone can also be referred to as inter-fluve plain or composite flood

NORMALS OF RAINFALL



Source:Meteorological Deptt.,New Delhi

FIG-1

plain, occuring between the major drainage ways. The sediments are clay and sand with admixed kankar. The soils are clayey to coarse loamy in nature. The slope is towards the drainage ways with minor channels cutting across. The area is under intensive cultivation and irrigated by canals and tube-wells. The occurrence of water bodies, with shapes resembling that of ox-bow lakes, cut-off meanders indicate that the area was subjected to drainage course changes in the past and the water bodies are remnants of wandering drainage ways.

Usar/Alkaline soils in varying aerial extent is a characteristic feature indicating a poor drainage system at present and poor permeability in the top sediments the most tangible reason seems to be the blockage of vertical drainage due to presence of kankar pans and clay beds, which retard the percolation of water to deeper levels.

3.6 FIORA AND FAUNA :

The environs of Lucknow city, at one time, had a considerable area under forests but continuous growth of population and the consequent need for more land for agriculture resulted in a large part of these forests being cut down. As of today, Kukrail, developed by the forest department is the only organised forest scheme, it includes a deer farm and a crocodile nursery. Besides these, spotted deer, black bucks, sambhars and a variety of birds can be found here.

3.7 HYDROLOGY :

3.7.1 Surface Drainage :

The Lucknow tashsil is cut across by a number of streams & nalas. The area falls in the drainge basin of two rivers, namely, the Gomti and the Sai, which is the tributary of the former. The northen, western, eastern and central part of the tahsil is drained by river Gomti and its other tributaries. . The major right bank tributaries are Loni, Behta, Jhilingi and Akhadi nala. The Sarda canal forms a surface drainage system and a water divide. The areas south of Sarda canal are drained by river Sai. Nagwa and Bankhi nala are the two left bank tributaries which drain the areas south of Sarda canal, falling in Kakori and Sarojini Nagar blocks of the tahsil.

3.7.2 Ground Water :

Sub-surface geology and hydrology has been deciphered from the study of strata logs of the stae irrigation tubewells and Jal Nigam tubewells, block wise and for the city Lucknow. The blocks and the city area are underlain by Quarternary sediments of the Gangetic alluvial plain.

3.7.2.1 Lucknow City :

The depth to water level data reveals that the depth to water ranges from 1.9 to 13.4 m below ground level in pre-monsoon period and from 1.31 to 14.81 m. b.g.l in the post-monsoon period. Deeper water levels being in the central part of the city, only along river Gomti water level is shallow.

Five major groups of aquifers, separated by clay beds, occur drilling down to a depth of 636.37 m. The majority of the city water supply tubewells have been drilled down to a depth of 150 m to 160 m and only screen the first group of aquifers. The tube-wells screening the first group of aquifer to a depth of 130-150m yield 1400-2000 lpm, whereas tube-wells screening deeper aquifers yield 2000-3200 lpm. The ground water quality in deeper aquifers, especially the IIIrd and IVth group is poor.

3.7.3 Chemical Quality of Ground Water :

3.7.3.1 Electrical Conductivity :

Electrical conductivity is the measure of mineralisation of water and indicates the degree of salinity of ground water. An isoconductivity map has been prepared after a careful study of the chemical analysis data for shallow aquifer and is seen that conductivity ranges from 346 to 2000 ms/cm at 25^0C. This indicates that ground water in shallow aquifer is generally fresh. Conductivity values greater than 2250 ms/cm have been recorded at few isolated places.

Electrical conductivity of ground water from first aquifer group and deeper aquifers screened by the state tube-wells and Lucknow city tubewells varies from 294 to 950 ms/cm at 25^0c. It is tentatively inferred that the quality of ground water in first group of aquifer is better than the shallow aquifer and deteriorates in deeper aquifer horizon.

3.7.3.2 Residual Sodium Carbonate (R.S.C) :

When carbonate concentration in irrigation water is relatively higher than alkaline earth metals, the remaining part

of HCO_3 which is left after precipitation of alkaline earth carbonate combined with sodium to form highly soluble sodium carbonate (black alkali) which is known as residual sodiun carbonate (R.S.C) and may be defined as :

$$R.S.C = (HCO_3 + CO_3) - (Ca+Mg)$$

where concentrations are expressed in meq/lt.

Water having R.S.C below 1.25 meq/lt is good for irrigation use where as water having R.S.C greater than 2.5 meq/lt is not suitable. Water having R.S.C range between 1.25 to 2.5 meq/lt is marginally suitable for irrigation.

3.7.4 Ground Water Potential And Level Of Development ;

The main source of ground recharge in the area is precipitation. The quantum of recharge relates directly to the intensity of rainfall, nature of soil, its textural characteristics, local vegetation and land utilisation pattern. The gross recharge to ground water, has been estimated by the Central Ground Water Board, following the:

* Water balance method and,
* Water table fluctuation approach

strictly adhering to the norms laid down by the Ground Water Estimation Committee(GEC). The total gross ground water recharge has been taken as sum of the input components e.g. gross annual ground water recharge, potential ground water recharge in flood prone areas.

It has been estimated that gross annual ground water resource available for irrigation is 85%. The remaining 15% is for domestic and industrial uses. The ground water balance

available for further development has been calculated by deducting the net annual ground water draft from the net annual utilisable ground water resource available for irrigation.

The level of development is represented as a percentage of the ratio of net annual draft to net annual utilisable groundwater resource available for irrigation. Based on the percentage level of development the block have been classified as follows.

Table 6

Level of development (%)	Status	Blocks
< 65	Safe	Kakori, Sarojini Nagar
65-85	Semi-critical	Chinhat
> 85	Critical	Lucknow city

SOURCE : CENTRAL GROUND WATER BOARD, LUCKNOW

3.8 DEMOGRAPHIC PROFILE:

Lucknow, the capital city of the biggest state in the country has a population size more than many of the nations. It is of interest to note that in 1850, Lucknow city had a population size more than the Delhi. Lucknow is the only district in the state where more than half of the population lives is towns. The Lucknow Urban Agglomeration comprises of :

* 40 wards of Lucknow Municipal Corporation.
* Cantonment
* Charbagh Alambagh Notified area.

Table 7 gives the population growth of the city from 1951 to 1991. The most notable trend apparent is the significant increase in the growth rate of population in the decade 1981-1991.

Table 7

POPULATION GROWTH IN LUCKNOW

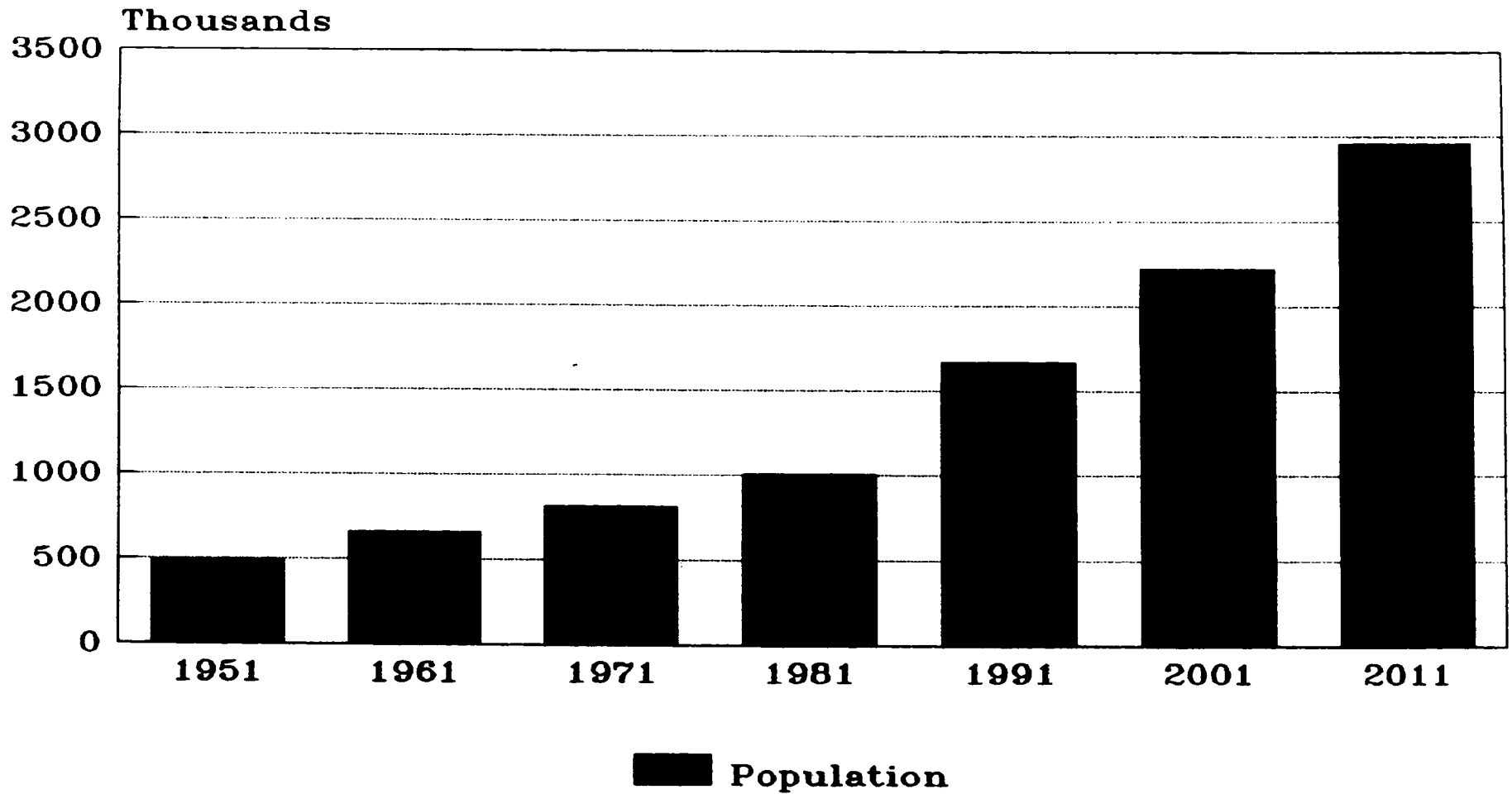
Sl No	YEAR	CENSUS POPULATION	DECADAL VARIATION	PERCENTAGE DECADAL VARIATION	INCREMENTAL INCREASE
1.	1951	496861	-	-	-
2.	1961	655673	+158812	31.96	-
3.	1971	813982	+158309	24.14	-503
4.	1981	1007604	+193622	23.79	+35313
5.	1991	1669204	+661600	65.66	+467978

Source : Directorate of Census, Lucknow

3.9 **DENSITY PATTERN :**

The gross density of Lucknow urban agglomeration is 71 persons per hecatre. Although, this density seems to be quite satisfactory as a whole, in truth the situtation is not so as the corporation area includes a lot of agricultural and vacant land in some wards which are sparsely populated. Table 8 shows the wardwise population densities in 1981 and 1991. On the other hand in the old city the situation is quite the opposite. In wards like Maulviganj, Basiratganj, Asharfabad the density is more than 1000 persons per hectare. Densities in wards, namely, Maqboolganj, Hussainganj, Masadganj, Kundri Rakabganj, Kashmiri Mohalla and Chowk are between 600-900 persons per hectare. These wards are characterized by absence of open space areas, wide roads and poor living environment. It is noteworthy that the developed (existing and core) wards have accommodated nearly 3 lacs i.e. 50% of the total decadal

POPULATION GROWTH IN LUCKNOW



Source:Directorate of Census,Lucknow

FIG- 2

TABLE 8

WARD WISE DENSITIES

WARD No.	NAME	AREA (in Ha)	POPULATION 1981	POPULATION 1991	DECADEL VARIATION (Popn)	DENSITY 1981 (ppHa)	DENSITY 1991 (ppHa)	DECADEL DENSITY VARIATION
1.	NARHI	418.03	22117	25472	3355	53	61	8
2.	HAZRATGANJ	452.57	24999	32430	7421	55	72	17
3.	MURLI NAGAR	94.60	10565	22818	12253	112	241	129
4.	GHASIARI MANDI	83.25	21609	23950	2341	260	288	28
5.	NAZAR BAGH	64.62	19017	17321	-1696	294	268	-26
6.	MAQBOOL GANJ	27.83	19210	21425	2215	690	770	80
7.	HUSSIAN GANJ	42.85	22218	27030	4812	519	631	112
8.	LAL KUAN	56.02	20093	20957	864	359	374	15
9.	GANESH GANJ	36.36	19766	19738	-28	544	543	-0.77
10.	BASIRAT GANJ	20.93	17261	22465	5204	825	1073	248
11.	AMINABAD	90.68	13197	27005	13808	146	298	152
12.	MAULVI GANJ	23.06	24961	24971	10	1082	1083	0.43
13.	WAZIR GANJ	133.36	17438	33901	16463	131	254	123
14.	MASAD GANJ	33.07	19141	20902	1761	568	620	52
15.	RAJA BAZAR	60.46	21051	25162	4111	348	416	68
16.	YAHIYA GANJ	55.30	15193	23245	8052	275	420	145
17.	KUNDRIRAKAB GANJ	55.30	16879	24459	7580	586	849	263
18.	AISHBAGH	253.80	31144	38352	7208	123	151	28
19.	RAJINDRA NAGAR	132.52	33650	31205	-2445	254	235	-19
20.	CH.BHANGUPTA NAGAR	63.90	14315	24625	10310	224	385	161

21.	ADARSH NAGAR	520.30	28925	39110	10185	56	75	19
22.	JAI PRAKASH NAGAR	359.40	31235	65228	33993	87	181	94
23.	SINGAR NAGAR	494.17	35905	44369	8464	73	90	17
24.	SAROJINI NAGAR	4134	29645	60786	31141	7	15	8
25.	KHARAIKA	2049	28479	42232	13753	14	21	7
26.	RAJAJI PURAM	1354.50	36497	98245	61748	27	73	46
27.	SADAT GANJ	946	21345	33365	12020	23	35	12
28.	KASHMIRI MOHALLA	55.67	14402	35975	21573	259	646	387
29.	ASHARABAD	31.84	13157	35956	22799	413	1129	716
30.	CHOWK	56.12	24373	35918	11545	434	640	206
31.	NEWAZ GANJ	1015	19864	36853	16989	20	36	16
32.	DAULAT GANJ	1512	12742	42418	29676	8	28	20
33.	TRIVENI NAGAR	1356	28754	40403	11649	21	30	9
34.	DALI GANJ	298.76	47218	41245	-5973	158	138	-20
35.	NIRALA NAGAR	378.40	22370	56511	34141	59	149	90
36.	BADSHAH NAGAR	473	30346	45102	14756	64	95	31
37.	GOMTI NAGAR	1832	16453	60056	43603	9	33	24
38.	INDIRA NAGAR	2469.50	17051	100041	82990	7	41	34
39.	MAHA NAGAR	254.21	33158	46859	13703	130	184	54
40.	ALI GANJ	1976.30	21213	125711	104498	11	64	53

population increase (1981-1991 - 645,816). The rest of the population has been accommodated in the peripheral wards and other wards (Aliganj, Indira Nagar, Gomti Nagar, schemes).

3.10 ECONOMIC BASE:

Lucknow is a historical town with clear impressions of Nawabs, the British regime and the post independence developments. Since long it has been a centre of art, culture and political activity. infact the growth of town is associated with the expansion of the government activities, mostly. Manufacturing activities, on a large scale, have so far not been able to concentrate here. The few large scale units that exists are Hindustan Aeronautics Ltd., Union Carbide (M/S Eveready Flash Light Co.), Mohan Meakins, Scooters India Ltd. and Co-operative Dairy (Parag). However, Lucknow, has a number and variety of small scale units and is the home of cottage industry. Business and commerce are also important activities in the city.

The workforce participation rate has been declining as is evident from Table 9 and the percentage of non-workers is increasing. The occupational structure has the tertiary sector employing the maximum number of the working population i.e. 71.6% in 1991, although the figures over the three decades show a declining trend. There has been a very nominal increase in the percentage of workers engaged in secondary activities (Table 10).

The percentage share of workers in the primary sector has almost doubled i.e. from 3.1% in 1981 to 7.3% in 1991- the reason attributive is the inclusion of the rural component to the

urban component by virtue of land acquisition for future development of Lucknow.

TABLE - 9

WORK FORCE PARTICIPATION RATE

YEAR	TOTAL POPULATION	TOTAL MAIN WORKERS	MARGINAL WORKERS	NON WORKERS
1971	8, 13, 982	2, 26, 617 (27.8%)	-	5,87,365 (72.2%)
1981	10, 07, 604	2, 79, 295 (27.7%)	1,652 (0.2%)	7,26,657 (72.1%)
1991	16,69,204	4, 42, 450 (26.5%)	2,453 (0.2%)	12,24,301 (73.3%)

SOURCE : DIRECTORATE OF CENSUS, LUCKNOW

TABLE 10

WORK FORCE PARTICIPATION RATIO

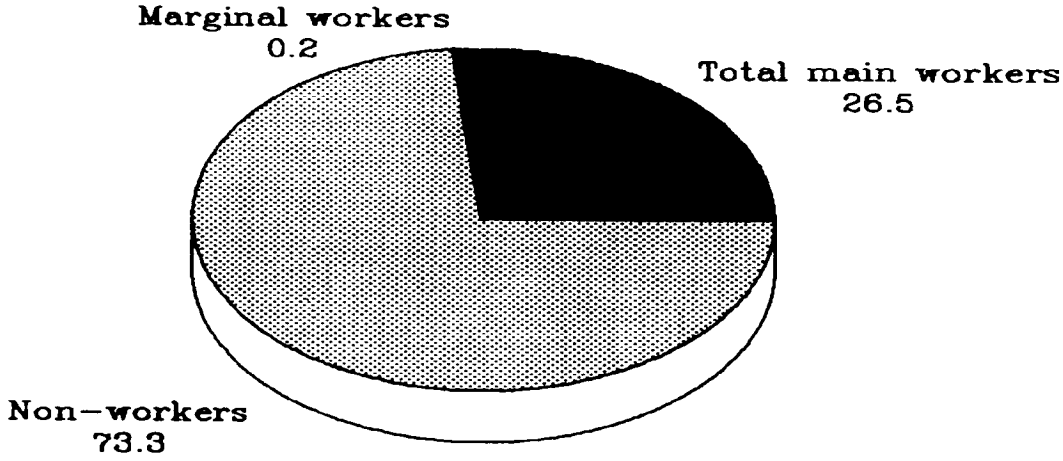
YEAR	TOTAL POPULATION	TOTAL MAIN WORKERS	PRIMARY SECTOR	SECONDARY SECTOR	TERTIARY SECTOR
1971	8,13,982	2,26,617 (27.8%)	8, 212 (3.6%)	50,511 (22.3%)	167,894 (74.1%)
1981	10,07,604	2,79,295 (27.7%)	8,706 (3.1%)	54,474 (19.5%)	216,115 (77.4%)
1991	16,69,204	4,42,450 (26.5%)	32,208 (7.3%)	93,632 (21.1%)	316,610 (71.6%)

SOURCE : DIRECTORATE OF CENSUS, LUCKNOW.

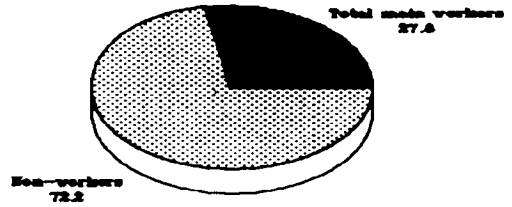
3.11 LAND USE PATTERN:

The Lucknow Master Plan-2001, has conceived Lucknow as a single great entity with one main centre, a transportation system providing radial movement to and from the main centre, a conical density pattern high near the centre and falling off with outward distance, a more a less defineable outer edge to its physically built-up spread and encircled by a substantial green belt.

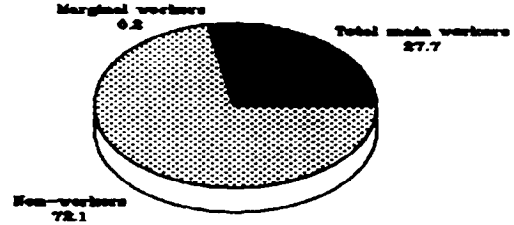
WORK FORCE PARTICIPATION RATE



1991



1971

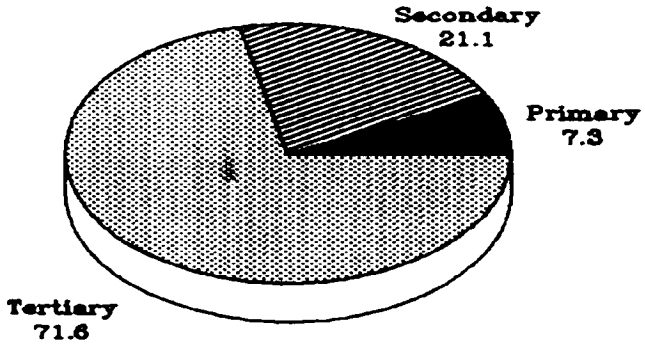


1981

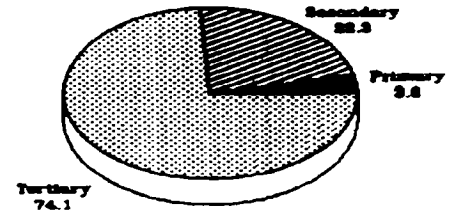
Source:Directorate of Census,Lucknow

FIG - 3

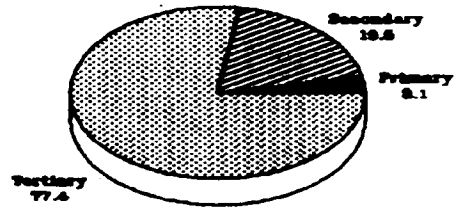
WORKFORCE PARTICIPATION RATIO



1991



1971

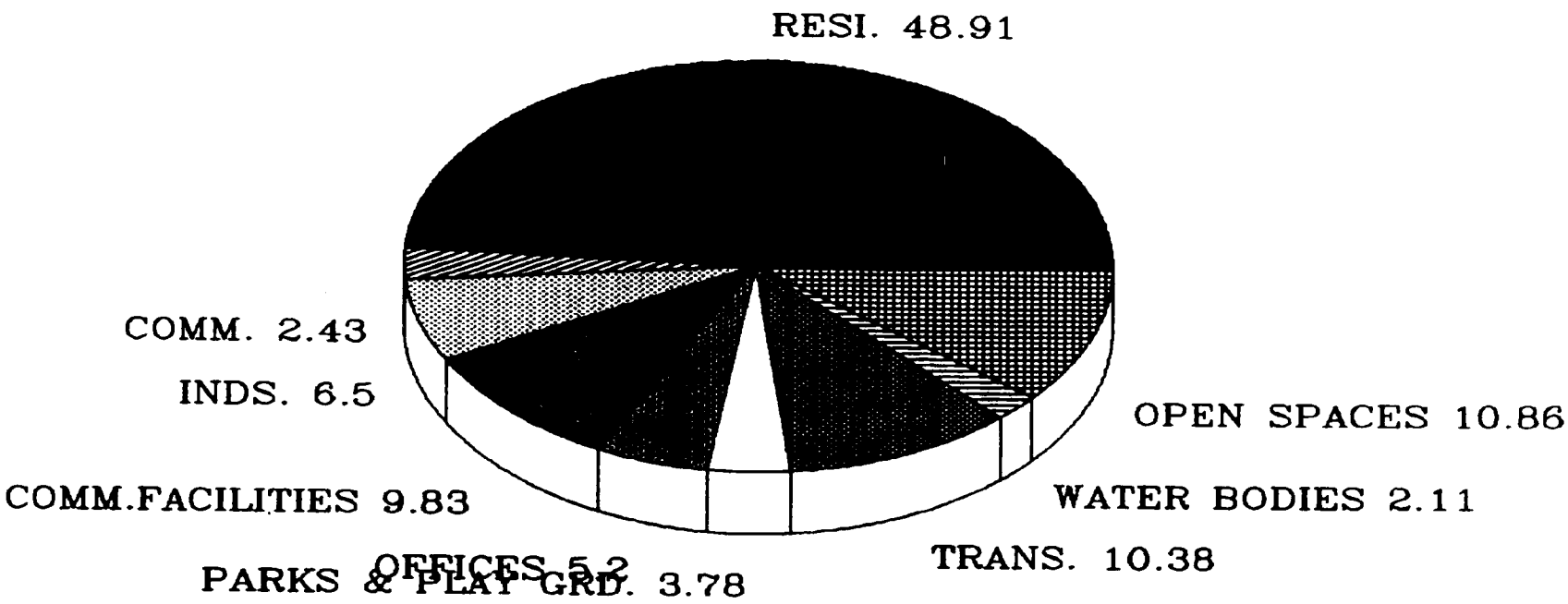


1981

Source:Directorate of Census,Lucknow

FIG-4

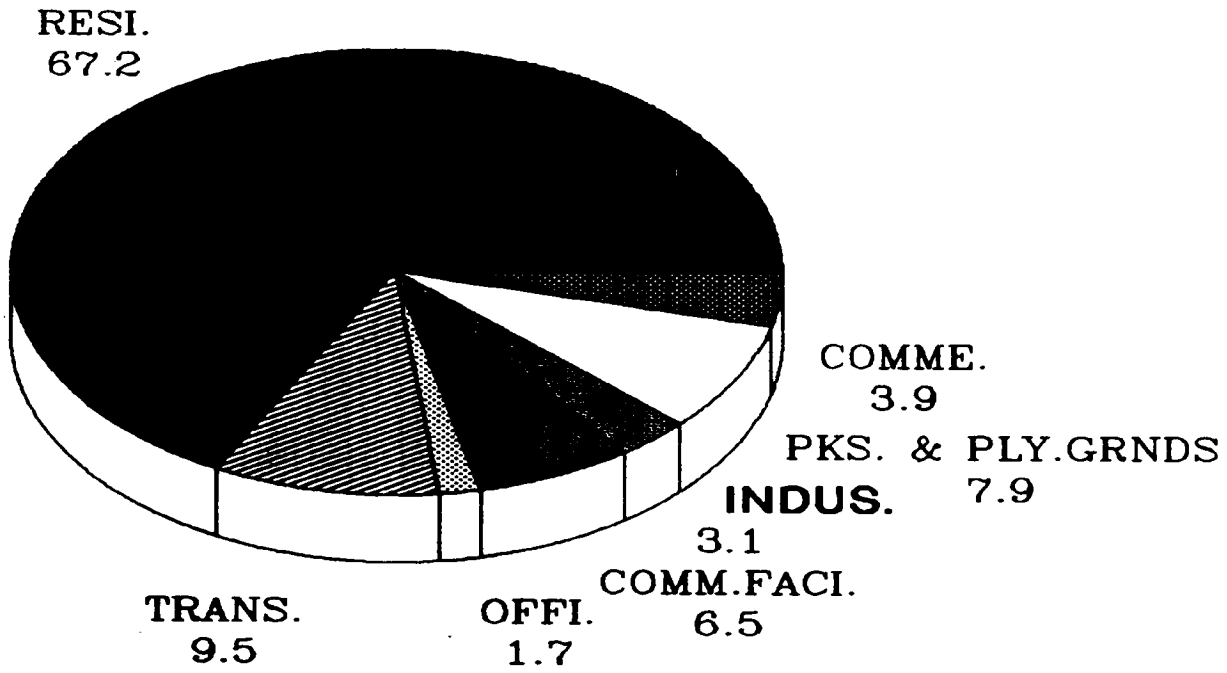
EXISTING LANDUSE



SOURCE: T.C.P.D.,LUCKNOW

FIG-5

PROPOSED LAND USE–2001



Source:T.C.P.D.,Lucknow

FIG-6

The built-up area of Lucknow as per the 1987 land use was 9170.9 hectares. The proposed built-up area by 2001, for which land has already been acquired, is 23,682 hectares. The additional area acquired lies in north-east i.e. Indira Nagar and Gomti Nagar schemes; in the north i.e. Aliganj and Sitapur road schemes and in the South along Kanpur and RaeBareili road. The details of the existing land use have been shown in Table 11.

TABLE 11
EXISTING AND PROPSED LANDUSE

SL. NO.	LAND USE CATEGORY	EXISTING-1987 AREA(In Ha)	AS %	PROPOSED-2001 AREA(In Ha)	AS%
1.	RESIDENTIAL	4485.98	48.91	15923.8	67.2
2.	COMMERCIAL	223.77	2.43	963.2	3.9
3.	INDUSTRIAL	596.22	6.50	731.0	3.1
4.	COMMUNITY FACILITIES	902.02	9.83	1537.0	6.5
5.	OFFICES	474.69	5.20	378.5	1.7
6.	PARKS AND PLAYGROUNDS	346.48	3.78	1868.5	7.9
7.	TRANSPORT	952.00	10.38	2260.0	9.5
8.	WATER BODIES	193.66	2.11	-	-
9.	OPEN SPACES	996.14	10.86	-	-
		9170.96	100.00	23682	100.00

SOURCE : TOWN AND COUNTRY PLANNING DEPARTMENT, LUCKNOW

3.11.1 Residential:

The residential are of Lucknow is 48.91% of the total built-up area-additions in residential areas have been due to the development of residential schemes taken up by L.D.A and U.P.H.B.. The trend of growth is mainly on the left bank of Gomti River, on either side of the Kukrail Nala and between Kanpur road and RaeBareili road.

3.11.2 Commercial:

The main central business districts of Chowk, Aminabad and Hazratganj along with the various wholesale centres, namely. Yahiyaganj, Fatehganj, Sadatganj etc., mainly constitute the commercial area of the city. However, shopping centres in the form of centralized business area are now emerging in the various planned extensions of the city, namely, Kapoorthala and Nishatganj market. The total area under commercial use is 2.43%.

3.11.3 Industrial:

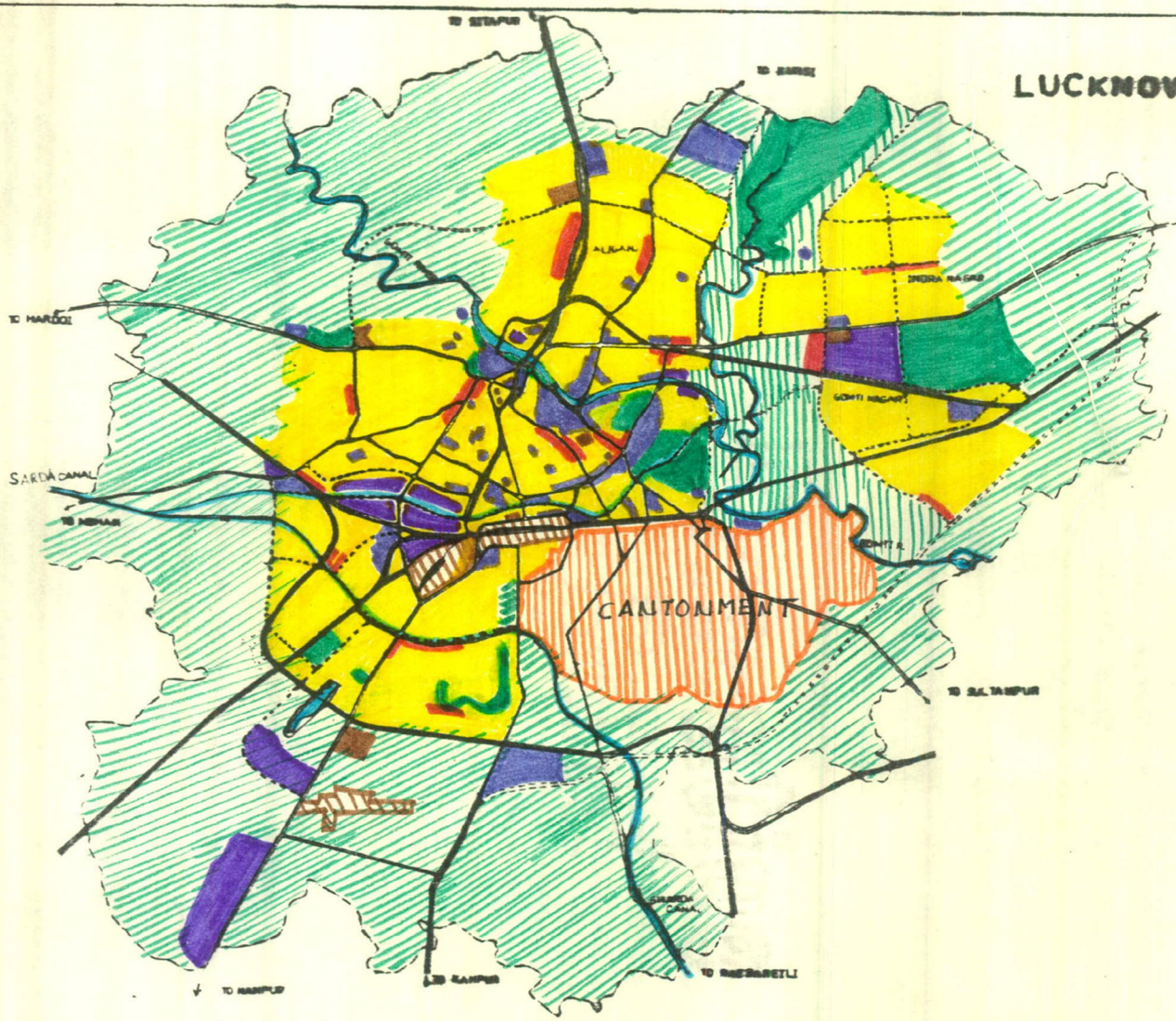
The area under Industrial use is 6.5% of the total area of the city. Three extensive industrial estates have been developed -two on Lucknow -Kanpur road ,namely Sarojini Nagar and Amausi and one near Chinhat along Lucknow-Faizabad road. A light industrial area is in Aishbagh.

3.11.4 Parks and Play grounds:

The area under this use is 3.78% of the total area of the city. Prominent old parks of the city include Begum Hazrat Mahal park, Jhandewalan park. L.D.A. has developed a number of parks along the river Gomti, namely, Surajkund park, Neembu park and Hathi park. The Residency, Botanical and Zoological gardens have spacious well kept lawns.

3.11.5 Transport:

The area under transport use is 10.38% of the total area of the city. Lucknow city has 3 transport modes e.g. road, rail and air, meeting the transport demand. The road transport



LUCKNOW METROPOLIS

LEGEND

- RESIDENTIAL
- COMM. FACILITIES
- COMMERCIAL
- INDUSTRIAL
- RECREATIONAL
- WATER BODIES
- AGRICULTURAL
- TRANSPORT

MAP-2

EXISTING LAND USE

STUDY OF ENVIRONMENTAL POLLUTION AND STRATEGIES FOR IMPROVEMENT OF

LUCKNOW CITY

N

SCALE

METRE KM

SUBMITTED BY RAJENDRA KUMAR SINGH M.U.R.P. II YEAR
DEPTT OF ARCH AND PLNG
U.O.R. ROORKEE

Hazratganj

Nishat Ganj

Commercial Areas of Lucknow City

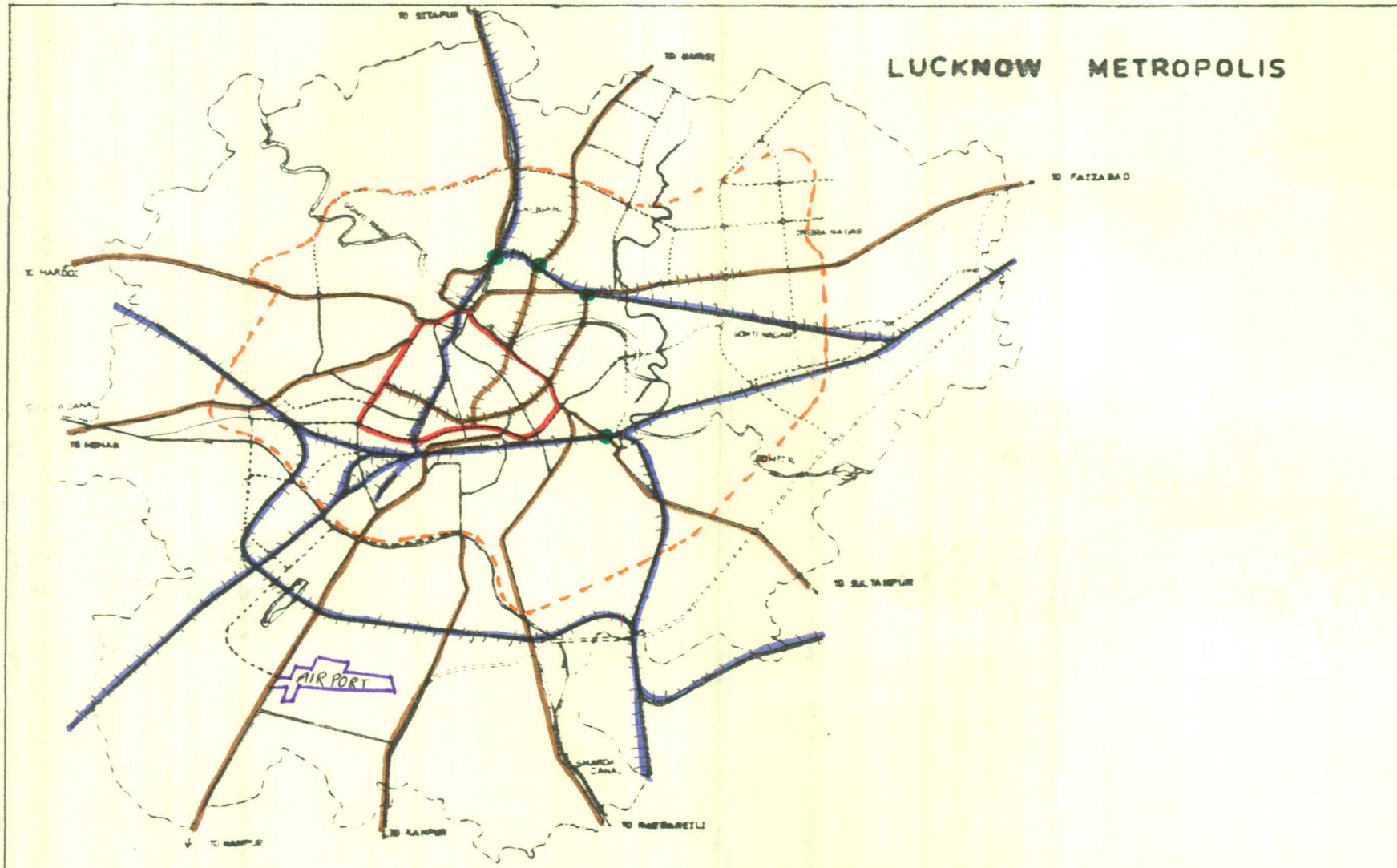
PLATE -1

Suraj Kund Park

Hathi Park

Parks Along the River Gomti

PLATE-2



STUDY OF ENVIRONMENTAL POLLUTION AND STRATEGIES FOR IMPROVEMENT OF LUCKNOW CITY

SUBMITTED BY RAJE YORA KUMAR SINGH
DEPT OF ARCH AND PLNG
J.S.R. ROORKEE

Near Charbagh Railway Station

I.T. Chauraha

Traffic Congestions on Roads of Lucknow

PLATE-3

mainly comprises of arterial, subarterial and collector roads (excluding local access roads). The present road network has basically nine regional roads in the form of radials converging into the heart of the city, from different parts of the state i.e. Lucknow to kanpur, Faizabad, Sitapur, Hardoi, RaeBareili, Sultanpur, Kursi and Mohan. The major railway lines are Lucknow-kanpur, Lucknow-Gorakhpur, Lucknow-Delhi and Lucknow-RaeBareili. Also the city is on the air route map of the domestic air lines.

3.12 PHYSICAL INFRASTRUCTURE:

The quality of life in any settlement depends upon the availability and quality of infrastructure it provides. With the population growing fast the per capita availability of sewerage lines and safe drinking water is shrinking year by year. An inadequate sewerage system has meant not only the spread of filth and disease but also pollution of the Gomti river into which the open drains flow. Also the intracity transport systems of the city is inadequate, resulting in congestion, delays and accidents. The existing transportation, water supply, sewerage, drainage and the solid waste management system of the city is as follows:

3.12.1 Transportation:

The road network is primarily of radial pattern. There is also a discontinues ring road linking most of the radials. Since the ring road is not yet constructed fully, traffic coming from Kanpur road and going towards Hardoi road and Sitapur road

has to pass through the city. In the process the internal ring consisting of Station road, Vidhan Sabha Marg, M.G.Marg, and Tulsi Das Road is also very loaded. Few railway crossings such as Nishtganj and Raidas Mandir are also very busy and are causes of great concern. Iron bridge and Daliganj bridge are major bottlenecks.

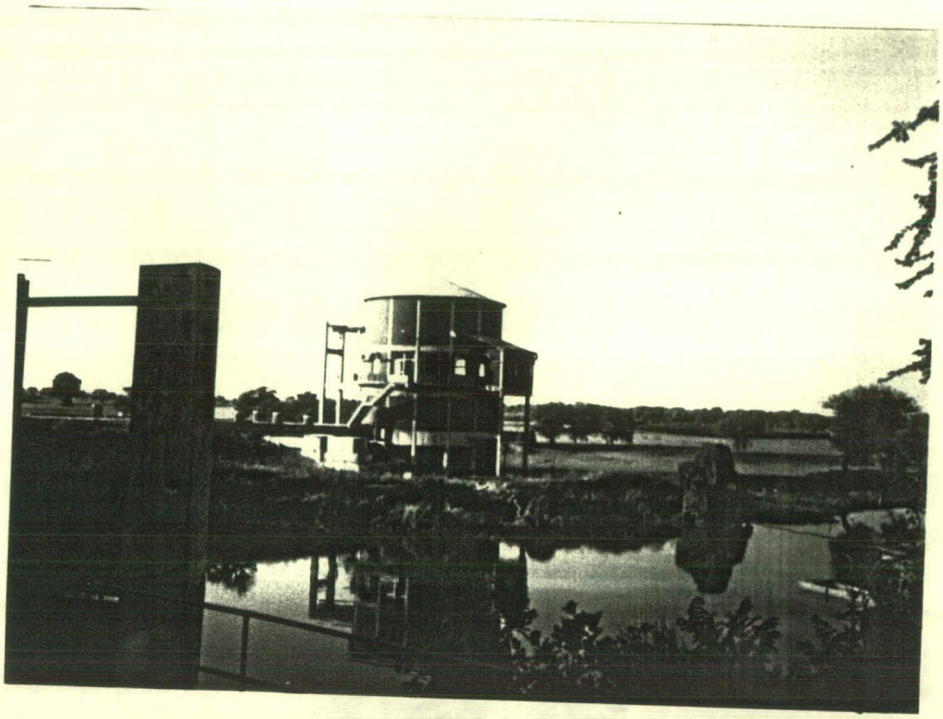
3.12.2 Water Supply:

The city has an established piped water arrangement with about 190 lpcd rate of effective water supply at present . The main source of raw water is river Gomti - approx. 250 to 300 mld of water is lifted from the river at Gaughat intake works. After conventional treatment at Aishbagh water works the water is supplied for domestic and other requirements of the city. A part of raw water demand is met by the tubewells (approx. 50 mld is drawn). There are, however, some peripheral areas which do not have a piped water supply.

3.12.3 Sewerage:

The water works was established in 1892, no sewerage system existed prior to 1920. Although about 60% of the town is sewered,but due to lack of disposal arrangements almost all of the sewage generated in the town finds way to the river Gomti flowing through the town without being treated.

The sewerage system was first introduced in the town in the 20's of this century and system has since been expended from time to time, in piece meals. The system as it stands today, basically, comprises of two sewers on both sides of the river



Gaughat Water Intake Work
(a)

Gomti Barrage
(b)

PLATE - 4

with scattered pockets of branch sewers along with 5 pumping stations and about 2 kms. of rising main which was meant to pump the sewage farm (600 acres of land) at Bhikampur. However, with the influx of population and growing housing needs this farmland has been encroached under the Gomti Nagar housing scheme and sewage farming is practically abandoned. The capacity of existing trunk sewers and existing pumping mains etc. has been determined and it is found that the existing system is inadequate even for the present total sullage flow.

3.12.4 Drainage:

There are several drains (or Nalas) carrying waste water from various residential and commercial areas of the town, which meet the river Gomti at several points. Many industries located in the city, also discharge their waste water into the river through drains. Gomti river along it, stretch to 10 kms receives the maximum pollutional load at Lucknow city, through 31 outfalls bringing in sewage and industrial waste rendering the water unfit for recreational purposes. The major drains discharging their water into the river gomti are given in the table 12.

TABLE 12

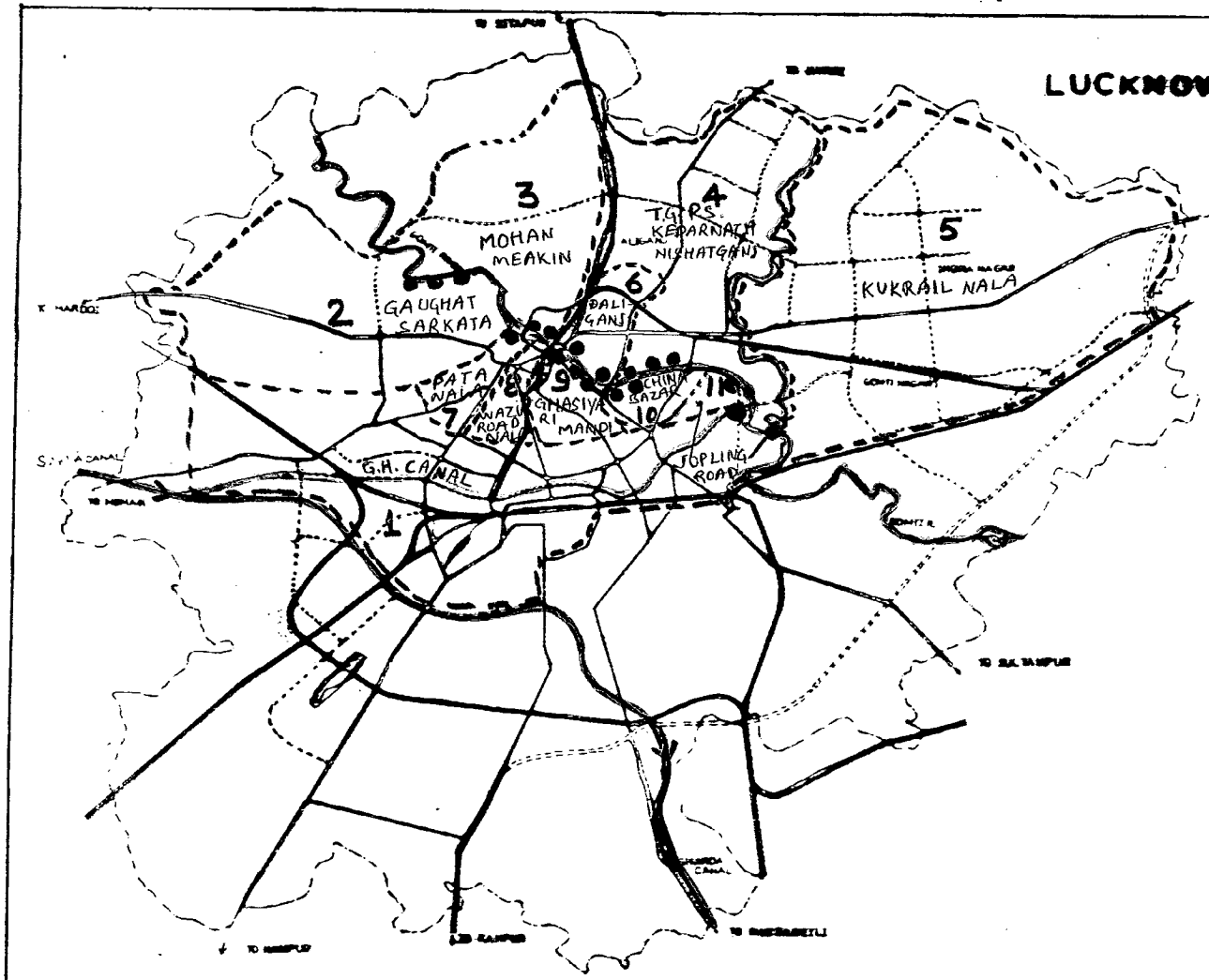
S.No.	Name of drains	Average flow mld
A.	**CIS Gomtiside**	
1.	Gaughat Nala	0.5
2.	Sarkata	15.0
3.	Pata Nala	10.0
4.	Wazir Ganj	N.A.
5.	Ghasiari Mandi Nala	7.0
6.	China Bazar Nala	3.0
7.	Laplace Nala	22.0
8.	Ghaziuddin Hyder Canal Nala	N.A.
9.	Jopling Road Nala	N.A.
B.	**Trans Gomti Side**	
1.	Daliganj No.1	20.0
2	Kedar nath Road Nala	1.0
3	Nishatganj Bridge Nala	N.A.
4.	Kukrail Nala	2.5
5.	Daliganj Bridge D/S Nala	N.A.
6.	Paper Mill Nala	N.A
7.	Mohan Meakin Brewery Nala	N.A.

SOURCE : U.P.JAL NIGAM, LUCKNOW

3.12.5 Solid Waste Management:

Solid waste management is the task of the Lucknow Municipal Corporation. On the whole 90% of the metropolitan area has the service, however, in some areas the collection frequency is once or twice in a week and in some older areas once a fortnight. The per capita generation rate estimated is 0.406 kg/capita per day.

Normally, all dumping sites are owned by the Nagar Mahapalika or L.D.A. within an approx. 16 Km. range from the respective collection points. The solid waste is also dumped on private low lying areas on individual request and payment.



LEGEND

- SEVERAGE ZONE BOUNDARIES
- DRAIN OUT FALL
- RIVER, NALA, NADI
- CANAL

MAP-4

Sewerage Zones.

STUDY OF ENVIRONMENTAL POLLUTION AND STRATEGIES FOR IMPROVEMENT OF LUCKNOW CITY

SCALE

SUBMITTED BY RAJENDRA KUMAR SINGH
U.R.P. II YEAR
DEPTT OF ARCH. AND PLNG
U.O.R. ROORKEE

Patanala

Daliganj Nala

Major Drains which meet the River Gomti

PLATE-5

About 10% of the solid waste generated is either never disposed off or disposed locally. This collected portion finds its way into the open drains which ultimately discharge into the Gomti.

Chapter 4 :

ENVIRONMENTAL POLLUTION AND ANALYSIS

CHAPTER IV

ENVIRONMENTAL POLLUTION AND ANALYSIS

Every human activity results in the generation of pollution in some form or the other.

4.1 AIR POLLUTION :

Gaseous substances are released into the atmosphere with unlimited assimilating capacity, however, air being of vital importance, cannot be exploited to the extremes when it becomes unsafe for use, its capacity to assimilate waste gases is not unlimited. The air that man breathes is polluted by the industrial and automobile emissions, bringing into the atmosphere suspended particulate matter (SPM), Oxides of sulphur (SO_2) and oxides of nitrogen (NOx), carbon monoxide(CO), photo chemical oxidants and hydrocarbons (HC). These pollutants, individually and collectively, have teratogenic and carcinogenic effects, and also cause respiratory ailments.

The Central Pollution Control Board (C.P.C.B) has fixed standards,

* Emission norms for industries based on the carrying capacity of the atmosphere.
* Stringent exhaust emission standards for automobiles; which are values that are not to be equalled or exceeded of various pollutants, so that the quality of air we breathe, is maintained which is the Ambient Air Quality Standard (A.A.Q.S). The A.A.Q.S is the level of air

TABLE 13

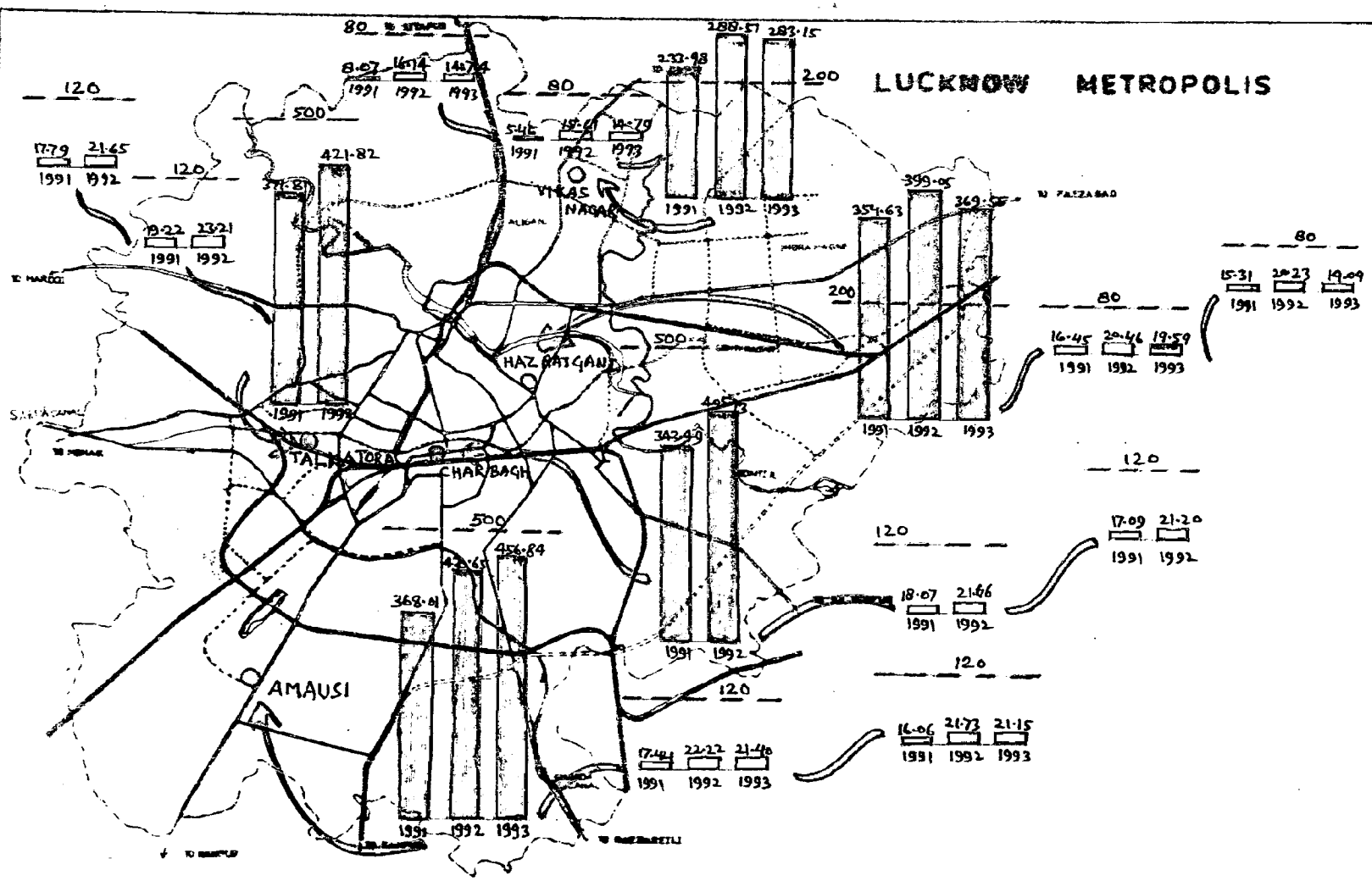
AMBIENT AIR QUALITY STATUS

LUCKNOW

(Annual Average - $\mu g/m^3$)

SAMPLING	1991			1992			1993			STANDARD		
STATION	SPM	SO2	NOX	SPM	SO2	NOX	SPM	SO2	NOX	SPM	SO2	NOX
VIKAS NAGAR	233.98	5.46	8.07	288.51	15.61	16.14	283.15	14.79	14.74	200	80	80
KAPOOR HOTEL	354.63	16.45	15.31	399.05	20.46	20.23	369.55	19.59	19.09	200	80	80
MOHAN HOTEL (charbagh)	343.49	18.08	17.09	405.13	21.66	21.20	-	-	-	500	120	120
TALKATORA	371.81	19.22	17.79	421.82	23.21	21.65	-	-	-	500	120	120
AMAUSI	368.01	17.44	16.06	430.65	22.22	21.73	456.84	21.40	21.25	500	120	120

SOURCE : STATE POLLUTION CONTROL BOARD, LUCKNOW



LEGEND

- MONITORING STATION
- SPM $\mu g/m^3$
- SO_2 $\mu g/m^3$
- NO_x $\mu g/m^3$
- STANDARD $\mu g/m^3$

MAP-5

AMBIENT AIR QUALITY STATUS

STUDY OF ENVIRONMENTAL POLLUTION AND STRATEGIES FOR IMPROVEMENT OF

LUCKNOW CITY

SCALE

SUBMITTED BY RAJENDRA KUMAR SINGH U.R.P. STUDY

DEPT. OF ARCH AND PLNG U.O.R. ROORKEE

quality necessary with an adequate margin of safety, to protect the public health, vegetation and property. Table 13 shows the Ambient Air Quality Status at different places in the city of Lucknow.

4.1.1 Vehicular Pollution :

Traffic is a derived commodity, it is generated/attracted because of some kind of activity or other. Traffic volume, its nature, composition and all other related characteristics are intimately connected with the growth pattern of the city.

TABLE 14

YEAR	POPULATION	NO. OF REGISTERED VEHICLES
1981	1007604	55418
1991	1669204	215547

The population growth trend has been phenomenal during the last decade (65.66 %) 1981-91, as compared to the previous decades (ref. Table 14) and so has been the growth in vehicles. In addition, a very large number of vehicles come to the city every day from the adjoining areas/towns.

The table 15 shows that the growth in the number of two wheelers is quite marked in 1980-81, out of the total number of registered vehicles about 67% were two wheelers, whereas in

1990-91 two-wheelers are 80% of the total registered vehicles. In the absence of an efficient public transport system, the intermediate public transport modes meet the travel requirements of the people, these modes consists of cycle rickshaws, tongas and tempos.

TABLE 15

MODE WISE REGISTERED VEHICLE GROWTH IN LUCKNOW

YEAR	TWO WHEELERS	PASSENGER VEHICLES	GOODS VEHICLES	CARS/ JEEPS	TAXIS	BUS	TOTAL
1980-81	37,537	256	7,686	8,773	94	327	55,418
1981-82	44,473	825	8,676	9,636	84	499	66,045
1882-83	59,842	1121	9,475	10,196	55	630	74,281
1983-84	58,068	1264	10.017	11,076	95	756	83,253
1984-85	66,289	1459	10,364	11,802	261	915	93,000
1985-96	76,917	1743	10,659	12,906	310	1007	105,664
1986-87	93,632	1959	9,073	14,223	410	1084	123,920
1987-88	112,306	2284	9,842	16,519	448	1178	145,729
1988-89	118,025	2567	11,488	17,035	549	1193	150,979
1989-90	154,556	3410	17,494	21,226	1027	894	193,607
1990-91	173,186	3881	13,004	22,917	1231	1328	215,547

SOURCE : NATPAC, NEW DELHI

Hazrat Ganj Chauraha

Near Nishat Ganj

Air Pollution in Lucknow City

PLATE-6

TABLE 16

MODE WISE PER CAPITA TRIP RATE

SL NO.	MODE OF TRANSPORT	PER CAPITA TRIP RATE
1	WALK	0.35
2	SCOOTER/MOTOR CYCLE	0.17
3	BUS	0.004
4	TEMPOS	0.06
5	CYCLE	0.20
6	TRAIN	0.002
7	CAR	0.06
8	SLOW VEHICLES (CYCLE RICKSHAW, TONGAS)	0.13
9	OTHERS	0.03

SOURCE : NATPAC, NEW DELHI

Amongst the different modes (Table 16) used for intracity trips, scooters and motorcycles and cycles are found to have the highest contribution i.e 0.17 (17%) and 0.20 (20%) respectively. Tempo is another popular mode of transport and contributes about (0.06)i.e. 6% of passenger trips. However walk trips contributes 35% (0.35) towards total trips.

The high intensity and heterogenity of traffic against in - adequate capacity of the transport system has its manifestations-congestion, increase in waiting time (delays), accidents and pollution. The C.P.C.B has assessed the vehicular

TABLE 17

POLLUTION GENERATED BY VEHICLES IN LUCKNOW (1987-88)

Sl. No.	Category of Vehicles	Registered No. of Vehicles	Total running (Kms)	Emission (Tonnes)				
				Particulates	SO2	NOX	HC	CO
I.	PETROL DRIVEN							
i	2-WHEELERS	112306	2004662	0.40	0.04	0.14	20.04	34.07
ii.	AUTO RICKSHAW	80	2040	0.0004	0.00004	0.00014	0.02	0.050
iii.	TAXIS	448	11424	0.003	0.0009	0.0036	0.068	0.456
iv.	CARS	11036	225134	0.074	0.018	0.72	1.35	9.05
	Total/petrol			0.4774	0.05894	0.86374	21.478	43.62
2.	DIESEL DRIVEN							
v.	TEMPOS	2204	551000	0.24	0.214	0.545	0.154	0.606
vi	JEEPS	5483	274150	0.12	0.106	0.271	0.076	0.301
vii	LCV (3 Wheeters)	104	5200	0.0023	0.002	3.005	0.0014	0.005
viii	LCV (4 Wheeters)	393	17685	0.0079	0.006	0.017	0.004	0.019
ix	Trucks	4127	165080	0.123	0.247	3.466	0.346	2.096
x	Buses	1066	53300	0.039	0.079	1.119	0.111	0.676
xi	Mini-Buses	112	11200	0.008	0.106	0.235	0.203	0.142
xii	Tractors	774	23220	0.017	0.034	0.487	0.048	0.294
xiii	Others	1792	44800	0.020	0.017	0.044	0.012	0.049
	TOTAL/Diesel			0.5772	0.811	6.189	0.7754	4.228
Grand Total/Petrol + Diesel				1.0546	0.96994	7.05274	22.2354	47.854

Source: Central Pollution Control Board, New Delhi

pollution load in Lucknow for the year 1987-88 (Table 17) by applying the World Health Organization (W.H.O) emission factors. (Table No. 18)

TABLE 18
EMMISION FACTORS FOR VEHICLES

TYPE OF VEHICLES	PARTICULATES kg/unit	SO_2 kg/unit	NOx kg/unit	HC kg/unit	CO kg/unit
LIGHT DUTY GASOLINE POWERED	0.33	0.08	3.20	6.00	40.00
LIGHT DUTY DIESEL POWERED	0.45	0.39	0.99	0.28	1.10
HEAVY DUTY DIESEL POWERED	0.75	1.50	21.00	2.10	12.70
MOTOR CYCLE /SCOOTERS	0.20	0.02	0.07	10.00	17.00

Unit 1000 km

SOURCE : WORLD HEALTH ORGANISATION

* The total vehicular pollution load generated in the city in 1987-88 was about 79 tonnes/day.
* Petrol driven vehicles contribute about 84.11% of the total vehicular pollution load and rest is contributed by diesel driven vehicles.

* Petrol driven vehicles are major contributors of HC (96.51%) and CO (91.16%) and contribute 45.26% Particulates.

* Diesel driven vehicles contribute a major share of NOX 84.11% and 54.73% of Particulates, Tempos contributing a major share (41%).

* By visual observation pollution created by vehicles is visible specially in the evenings. Some majors roads and their surroundings such as Vidhan Sabha Marg, Alam Bagh, Station Road etc, become smokey and sooty in the evening time and morning peak hours due to exhaust emissions of vehicles specially two-wheelers and Tempos.

4.1.2 Industrial pollution :

Industries are another major source of air pollution. However, Lucknow being an administrative centre and unable to attract manufacturing activities, on a large scale, is free from the menace caused as a consequence of industrial emissions. Of the few large scale establishments in the city Mohan Meakins and M/S. Eveready Flashlight Co. are being monitored by the State Pollution Control Board (S.P.C.B). The emissions from these units are within the normal permissible range indicating that these units are being operated and maintained satisfactorily.

4.2 NOISE POLLUTION :

If all the symbols of civilization from jet planes vehicles and railway engines to factories, generators,

construction, machinery, Television and radio sets and public address systems have one thing in common, it is noise. Its measurement is made in terms of relative units of energy or power on a logrithmic decibel (dB) scale. Normal conversation touches 60 dB. The annoyance level (subjective) is determined by measuring the sound pressure level on the A- weighted network on the sound level meter and the measurements are indicated as dB(A)

Exposure to noise levels exceeding 75 dB(A) for more than eight hours daily can impair hearing. Other effects include hypertensions, disturbance in sleep, speech interference and stress reactions. On the basis of extensive research into human response and preferences, the World Health Organization (W.H.O) has recommended ambient noise level limits for the various areas as follows (Table 19).

TABLE 19

THE AMBIENT NOISE LEVEL LIMITS

AREA	DAY TIME Leq dB(A)	NIGHT TIME Leq dB(A)
INDUSTRIAL AREA	75	65
COMMERCIAL AREA	65	55
RESIDENTIAL AREA	55	45
SILENCE ZONE	50	45

SOURCE : WORLD HEALTH ORGANISATION

Butler Palace Colony

Mahanagar Colony

Noise Pollution in Residental Areas

PLATE - 7

Medical College

High Court

Noise Pollution in Sensitive Areas

PLATE -8

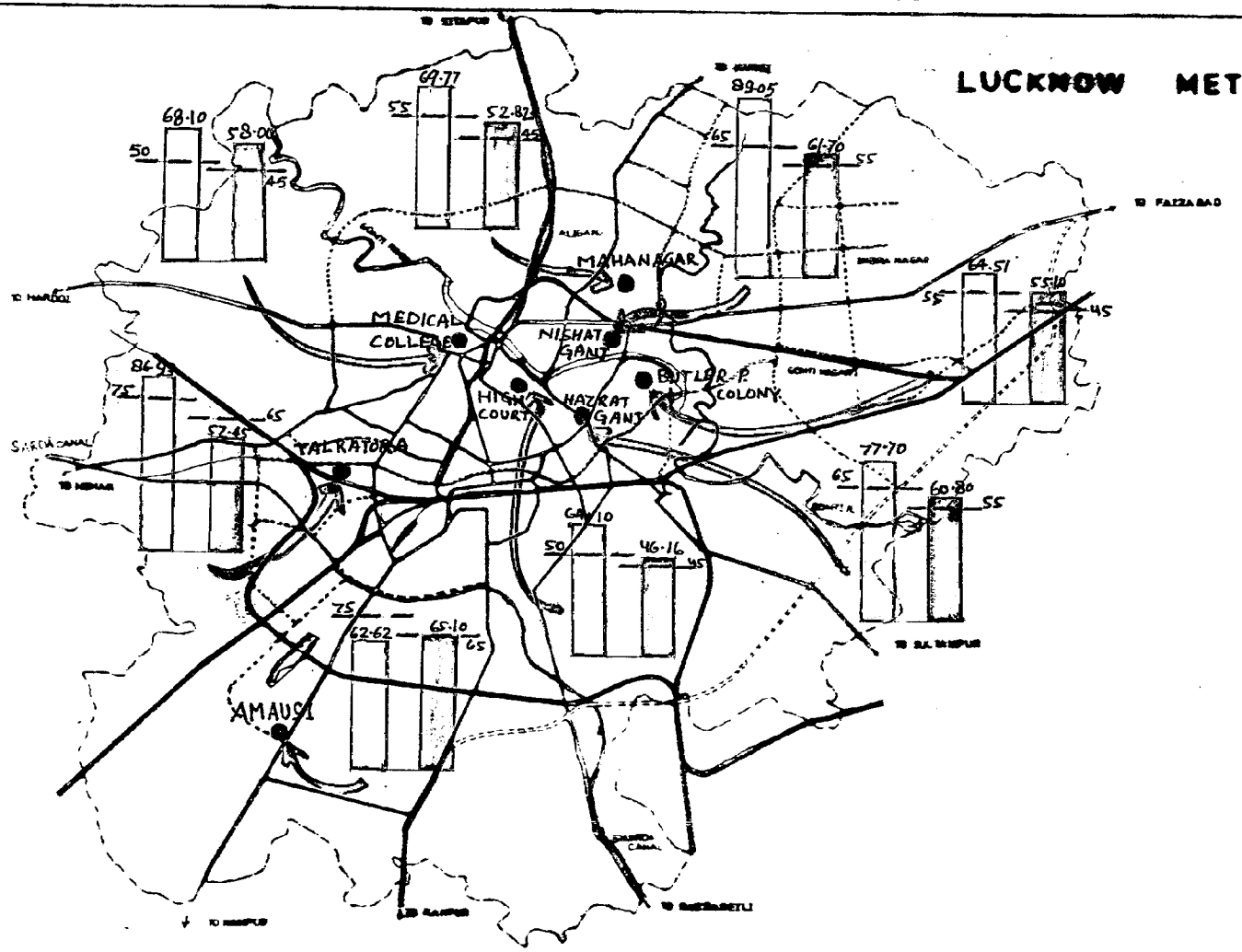
The Ambient noise levels recorded at various places in Lucknow are above the levels prescribed. A sensitive area like the Medical College,too has noise levels almost 70 dB (Table 20) where as the prescribed is 50 dB.

TABLE 20

AMBIENT NOISE LEVELS

LAND USE CAYTEGORY	AREA	TIME	NOISE LEVEL dB(A)
RESIDENTIAL	BUTLER PALACE COLONY	DAY TIME	64.51
		NIGHT TIME	55.10
	MAHANAGAR	DAY TIME	69.77
		NIGHT TIME	52.82
INDUSTRIAL	TALKATORA	DAY TIME	86.93
		NIGHT TIME	57.45
	AMAUSI	DAY TIME	62.62
		NIGHT TIME	65.10
COMMERCIAL	NISHATGANJ	DAY TIME	89.05
		NIGHT TIME	61.70
	HAZRATGANJ	DAY TIME	77.70
		NIGHT TIME	60.80
SENSITIVE AREA	HIGH COURT	DAY TIME	64.10
		NIGHT TIME	49.16
	MEDICAL COLLEGE	DAY TIME	68.10
		NIGHT TIME	58.00

SOURCE : STATE POLLUTION CONTROL BOARD, LUCKNOW



LEGEND

- DAY TIME
- NIGHT TIME
- MONITORING STATION

MAP-6

AMBIENT NOISE LEVELS

STUDY OF ENVIRONMENTAL POLLUTION AND STRATEGIES FOR IMPROVEMENT OF

LUCKNOW CITY

N

SCALE

METRE 1KM

SUBMITTED BY RAJENDRA KUMAR SINGH M.URP 3YEAR
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4.3 WATER POLLUTION :

Reasons for contamination of water are not far to seek. Few settlements near lakes or rivers have systems to treat their wastes. The ability of the water body to clean it-self has been affected because of the sheer quantity of wastes generated by the ever increasing population. Of the 3119 towns and cities in the country, only 209 have partial and just 8 have full sewage treatment facility. This problem of water pollution is aggravated by the diversity of industrial wastes. This problem becomes complex because of the qualitative differences in pollution according to the industries involved, and due to the non-degra dability of many of the effluents. Though industrial wastes, discharged into water bodies, are just a fourth of the community wastes, the treatment of the polluted water becomes more complex and expensive.

The river Gomti originates from a natural reservoir near village Chanderpur, in district Philibhit, in the state of Uttar Pradesh. It flows a distance of 715 kms through 15 districts of the state before merging with the Ganges near Audiar in district Gazipur. The total catchment area is 25,735 sq-km., inhabited by 14.84 million people, out of which 15% reside in urban settlements with high population densities. The river Gomti ranks fifth in the state as far as flow is concerned but from pollution point of view it is the first in the state.

The river Gomti, after traversing a distance of 240 kms from its source enters the city of Lucknow. Just at the entrance to the city about 250 mld to 300 mld raw water is lifted from the river, at Gaughat intake works, for domestic and other requirements of the city. The river while meandering its 10.5 km(approx) course through the heart of the city is joined by 31 city drains which shed their polluted discharges in the river. The problem is aggravated with the presence of barrage (D/S) which had been constructed to facilitate the pumping at Gaughat intake works.

The discharge in the Gomti varies from about 500 mld in the driest seasons to about 55,000 mld in high monsoons, with an average flow of about 1500 mld. The flow in summer becomes so thin, that at Lucknow the river is able to dilute the incoming waste only by 8 to 9 times resulting in the abnormal increase of B.O.D and C,O.D and other toxic agents. The count of the deadly fecal coliform bacteria shoots beyond the pemissible levels. The pollution levels in Gomti is being monitored at various places along its course all through the year.

Based on the Designated Best Use Classification of rivers (Table 21) and the corresponding water quality criterias, the pollution profile of the Gomti is as follows-(Table 22).

TABLE 21

THE DESIGNATED BEST USE CLASSIFICATION OF RIVERS AND THE WATER QUALITY CRITERIA

CLASS	PARAMETER	CRITERIA	BENEFICIAL USES
A	D.O.	> 6 mg/L	DRINKING WITHOUT
	$B.O.D_5$	< 2 mg/L	CONVENTIONAL TREATMENT
	COLIFORM (MPN)	< 50/100 mL	
	pH	6.5-8.5	
B	D.O.	> 5 mg/L	BATHING
	$B.O.D_5$	< 3 mg/L	
	COLIFORM (MPN)	< 500/100 mL	
	pH	6.5-8.5	
C	D.O.	> 4 mg/L	DRINKING AFTER
	$B.O.D_5$	< 3 mg/L	CONVENTIONAL TREATMENT
	COLIFORM (MPN)	< 500/100 mL	
	pH	6.0-9.0	
D	D.O.	> 4 mg/L	PROPAGATION OF WILD
	pH	6.5-8.5	LIFE AND FISHERIES
	COLIFORM (MPN)	< 5000/100 mL	
	FREE AMMONIA	< 1.2 mg/l	
E	pH	6.0-8.5	IRRIGATION,COOLING
	SODIUM RATIO	< 26	AND CONTROLLED WASTE
	BORON	< 2.0 mg/L	DISPOSAL
	E.C. 25^0 C	< 2250 micromhos per cm.	

TABLE 22

POLLUTION PROFILE OF RIVER GOMTI

STRETCH	LENGTH	GRADE	
		EXISTING	DESIRED
1. Upto Mohammadi	65 Kms	B	C
2. Mohammadi to Bhatpur	125 Kms	C	C
3. Bhatpur to Lucknow (Gaughat)	50 Kms	D & C	C
4. Lucknow (Gaughat) to Barrage	10.5 Kms	D & E	B
5. Lucknow to Sultanpur	259 Kms	E	C
6. Sultanpur	8 Kms	E	B
7. Sultanpur to Jaunpur	120 Kms	E	C
8. Jaunpur	8 Kms	E	B
9. Jaunpur to Confluence with Ganges	75 Kms	E	C

SOURCE : U.P. JAL NIGAM LUCKNOW.

Table 23 shows the pollution profile of the river Gomti within the city of Lucknow.

Wazir Ganj Nala

Ghasiyari Mandi Nala

Drains which Polluted River Gomti

PLATE-9

TABLE 23
POLLUTION PROFILE OF RIVER GOMTI WITHIN THE CITY OF LUCKNOW

SAMPLING STATION	DESIRED GRADE	CRITERIA	VALUES RECORDED	GRADE EXISTING
GAUGHAT (LUCKNOW)	B	COLIFORM(MPN)	5333	C & D
		D.O. (mg/L)	11.0	
		B.O.D. (mg/L)	1.6	
		C.O.D.	12.0	
MOHAN MEAKINS NALA (U/S)	B	COLIFORM(MPN)	14,000	D
		D.O. (mg/L)	7.4	
		B.O.D. (mg/L)	3.0	
		C.O.D.	16.0	
MOHAN MEAKINS NALA (D/S)	B	COLIFORM (MPM)	21, 333	BEYOND D
		D.O. (mg/L)	6.5	
		B.O.D (mg/L)	3.7	
		C.O.D	22.0	
BARRAGE (U/S)	B	COLIFORM (MPN)	293,333	E
		D.O. (mg/L)	1.8	
		B.O.D (mg/L)	10.9	
		C.O.D.	37.3	

SOURCE : U.P. JAL NIGAM, LUCKNOW

4.4 ANALYSIS :

The analysis of vehicular, industrial & water pollution is done as follows.

4.4.1 Vehicular Pollution :

The total vehicular pollution load in the city, at present has been calculated by applying the emmission factors for vehicles. The table 24 shows the po l lution generated by various

TABLE 24

TOTAL VEHICULAR POLLUTION LOAD
(TONNES/DAY)

Sl. No.	Category of Vehicles	Registered No. of Vehicles	Total running (Kms)	Emission (Tonnes)					
				Particulates	SO2	NOX	HC	CO	Total
I.	PETROL DRIVEN								
i	2-WHEELERS	173186	3091369	0.61	0.06	0.21	30.91	52.55	84.34
ii.	AUTO RICKSHAW	106	2703	0.0005	0.00005	0.00018	0.027	0.057	0.0847
iii.	TAXIS	1231	31391	0.010	0.0025	0.100	0.188	1.255	1.5555
iv.	CARS	16436	335294	0.110	0.026	1.072	2.011	13.411	16.63
	Total	190959	3460757	0.7305	0.0885	1.3821	33.136	67.273	102.610
2.	DIESEL DRIVEN								
v.	TEMPOS	3376	337600	0.151	0.131	0.334	0.094	0.371	1.081
vi	JEEPS	6481	324050	0.145	0.126	0.320	0.090	0.356	1.037
vii	TRUCKS	4379	175160	0.131	0.262	3.678	0.367	2.224	6.662
viii	TRACTORS	786	23580	0.017	0.035	0.495	0.049	0.299	0.895
ix	BUSES	1328	66400	0.049	0.099	1.394	0.139	0.843	2.524
x	OTHERS	2034	50850	0.022	0.019	0.050	0.014	0.055	0.160
	TOTAL	18384	977640	0.515	0.672	6.271	0.753	4.148	12.359

categories/type of vehicles.

* The total vehicular pollution load generated in the city is about 115 tonnes/day.
* Petrol driven vehicles contributes about 89% of the total pollution load and the rest is contributed by diesel driven vehicles.
* Petrol driven vehicles are major contributors of HC(97%) and CO(94%) and contribute 58% Particulates.
* Diesel driven vehicles contribute a major share of NOX (82%) and 41% of Particulates, Tempos contributing a major share (29%).

4.4.2 Industrial Pollution :

The Koch and Thayer model (1971,72) has been used to determine the concentration of pollutants at varying distances from the source of emmision(the industrial unit). The stack monitorings (Table 25) of two units, being monitored regularly by the State Pollution Control Board (S.P.C.B) were analysed, using this model.

TABLE 25
STACK MONITORING

NAME OF THE INDUSTRY	STACK HEIGHT(Mt.)	FLOW Nm^3/Sec	SPM mg/m^3	SO_2 mg/m^3	NOX mg/m^3
MOHAN MEAKINS LTD.	30	4.10	143.3	36.42	53.2
M/s EVEREADY FLASHLIGHT CO.	30	0.332	354	12.0	34.0

SOURCE : STATE POLLUTION CONTROL BOARD, LUCKNOW

The Koch & Thayer model assumes emission as a point source and gives the concentration of pollutants in the downwind direction only and the basic algorithm is

$$\eta_A = \sum \frac{a(x)}{\pi \bar{u}\ \sigma y(x)\ \sigma_z(x)} \exp\{-h^2/ 2\ \sigma^2 y(x)\}$$

Where :

n_A- is the calculated concentration at 'A' at a distance x meter in down wind direction from the source of emission ($\mu g/m^3$)

a(x)- is the emission rate (μg/sec)

h - is the height of emission point from ground level in metres.

$\bar{u}$ - is the velocity of wind in mt/sec.

Each steady state period is characterized meterologically by a horizontally uniform mean wind speed profile, a mixing layer depth and a stability. The last two characteristics determine the parameters of diffusion functions which have the form -

$$\sigma_y (x) = Ax^a$$
$$\sigma_z (x) = Bx^b$$

The parameters A, a, B and b are determined from the stability conditions given in the table 26.

TABLE 26

STABILITY	CROSS WIND CONSTANT		CONSTANT FOR VERTICAL DIFFUSION (<600 MT) PARAMETER (> 600mt)			
	A	a	B	b	B	b
A	1.42	0.745	0.0926	1.18	0.072	1.22
B	1.26	0.730	0.0891	1.11	0.169	1.01
C	1.13	0.710	0.0835	1.08	1.07	0.682
D	0.992	0.650	0.0777	0.955	1.01	0.554

There are four categories of stabilities 'A', 'B', 'C'and 'D'which represent the built environment, density, open spaces and height of the building of the city.

Stability A :- Represents very low built profile, low density, large open spaces and structures of less height.

Stability B :- This also represents low profile built enviornment but the built up area, the density etc. are more than stability A.

Stability C :- Represents densely builtup areas with less open spaces and medium size structures.

Stability D : - Represents very large cities which are densely built up with very less open spaces and high rise structures.

The stability Index chosen for Lucknow is 'C' - heavy built up areas with less open spaces, dense, medium rise structures.

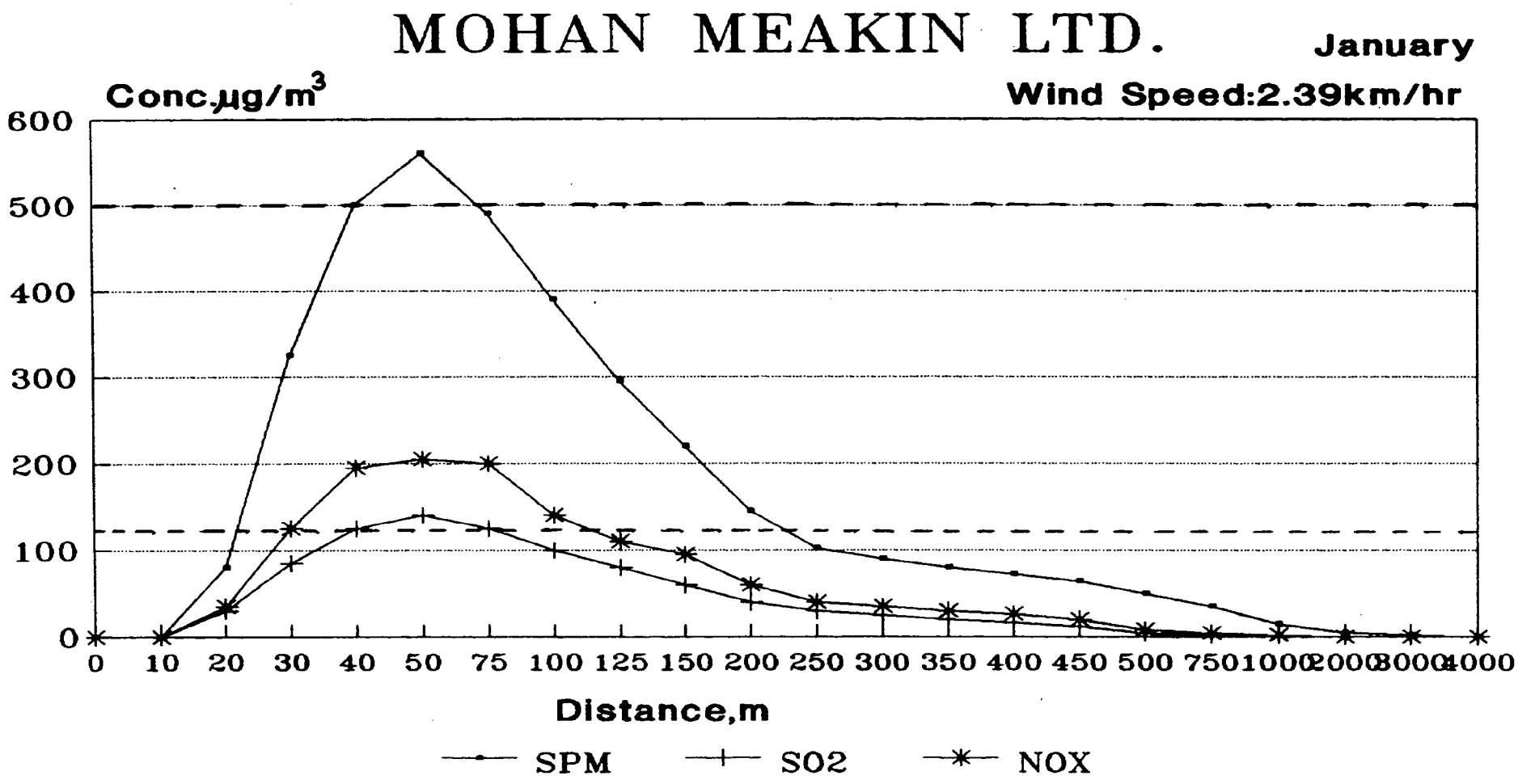
The figures 7 to 14 show the concentrations of pollutants at varying distances for the two units.

4.4.3 Water Pullution :

The impact of drain discharges on the river water quality has been analysed by drawing up the B.O.D. profile of the river Gomti. The Streeter-Phelps model, giving the relationship of reduction of B.O.D. due to aerobic decomposition of organic matter with travel time, has been applied (Table 27).

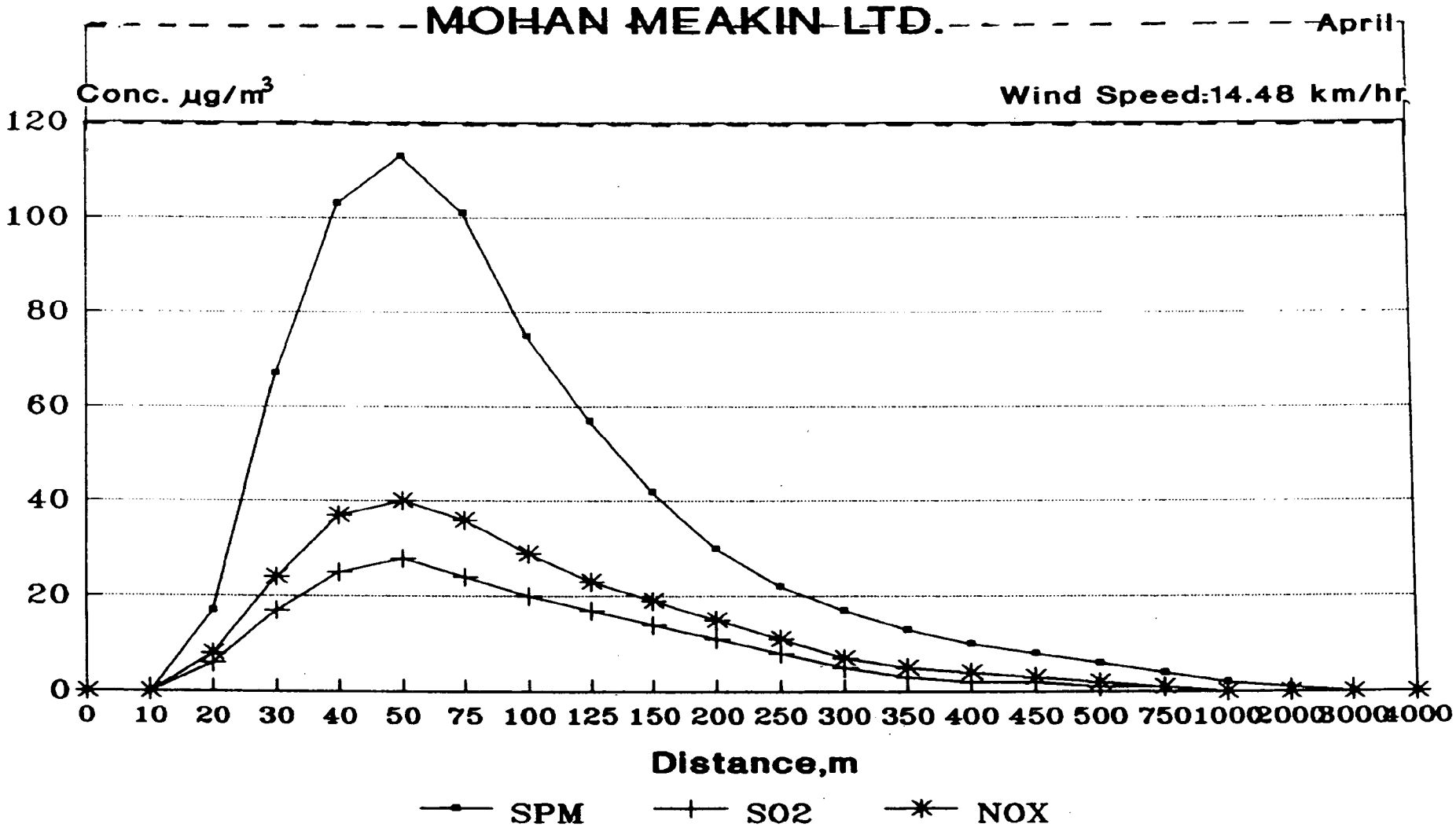
TABLE 27
TRAVEL TIME OF RIVER GOMTI IN LUCKNOW

SL. NO	DRAIN OUTFALL POINT(FROM)	DRAIN OUTFALL POINT (TO)	RIVERRINE DISTANCE(kms)	TRAVEL TIME(Days)
1.	GAUGHAT	SARKATA	0.62	0.157
2.	SARKATA	PATNALA	2.6	0.605
3.	PATNALA	MOHAN MEAKIN	0.62	0.157
4.	MOHAN MEAKIN	DALIGANJ	0.43	0.099
5.	DALI GANJ	WAJIR GANJ	0.33	0.078
6.	WAZIR GANJ	GHASIARI MANDI	0.61	0.142
7.	GHASIARI MANDI	KUKRAIL	3.93	0.911
8.	KUKRAIL	G.H. CANAL	0.52	0.121
9.	G.H.CANAL	ONWARDS	-	-



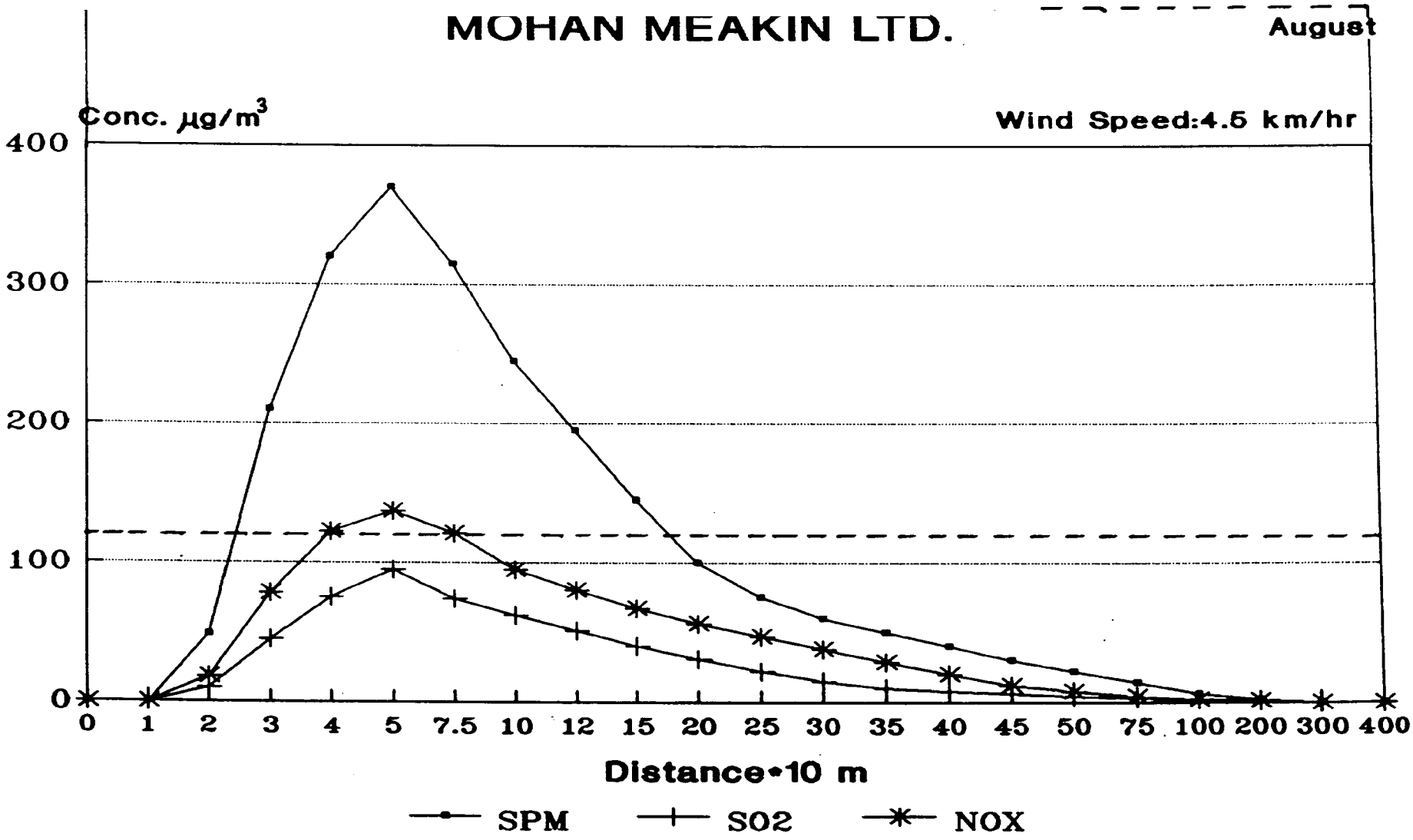
Source:S.P.C.B.Lucknow

Fig-7



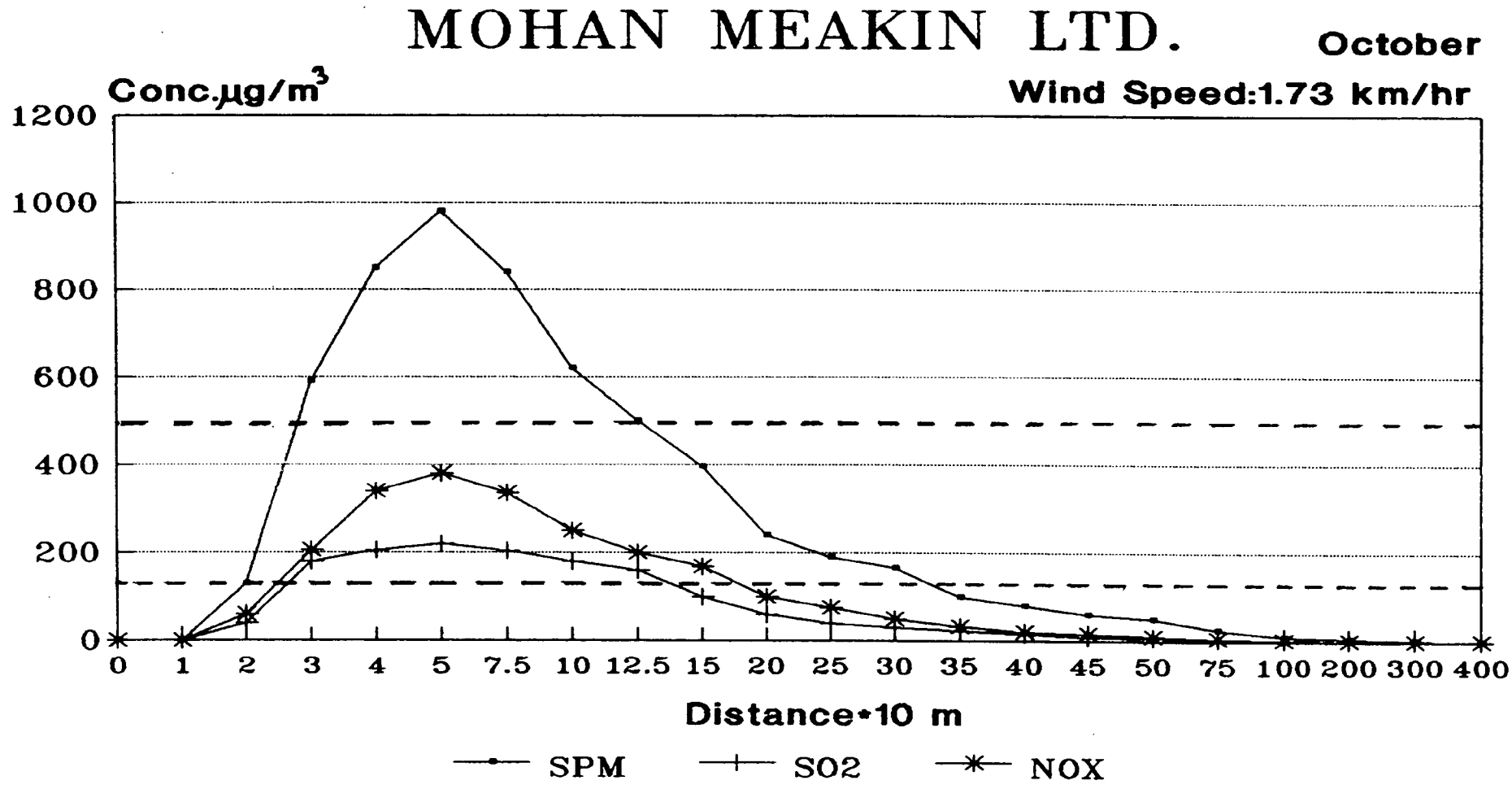
Source:S.P.C.B.,Lucknow

FIG - 8



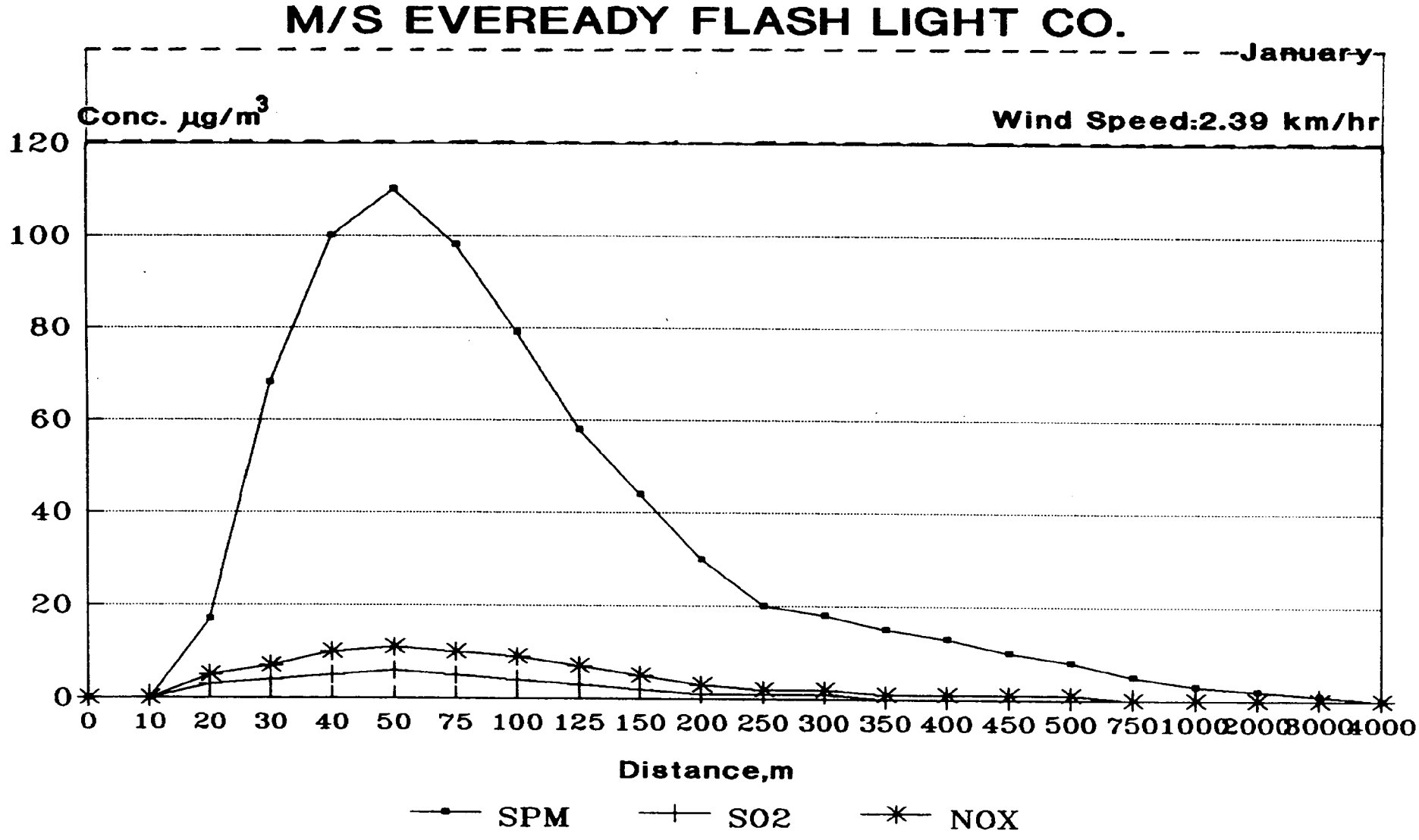
Source:S.P.C.B.,Lucknow

F19-9



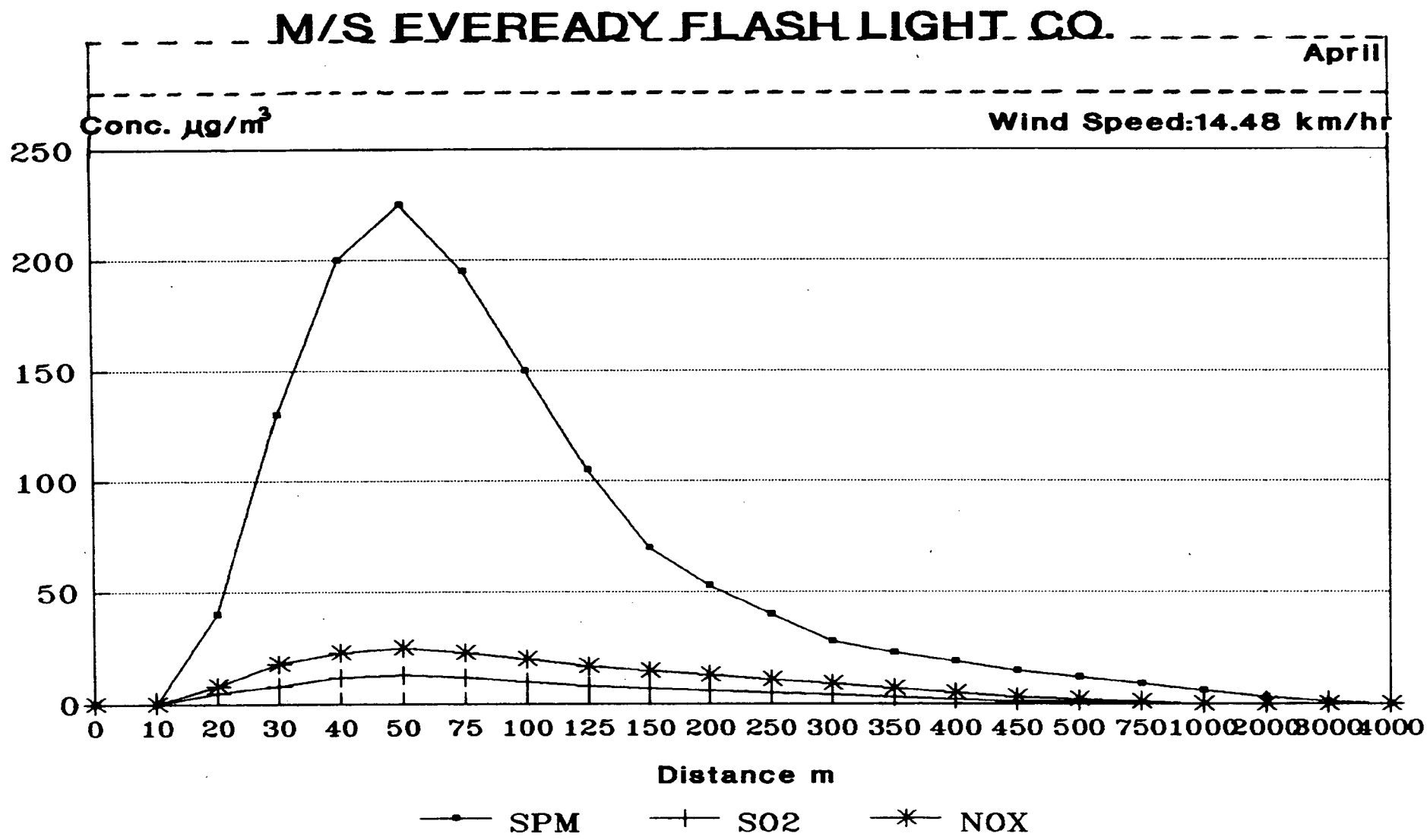
Source:S.P.C.B.Lucknow

FIG-10



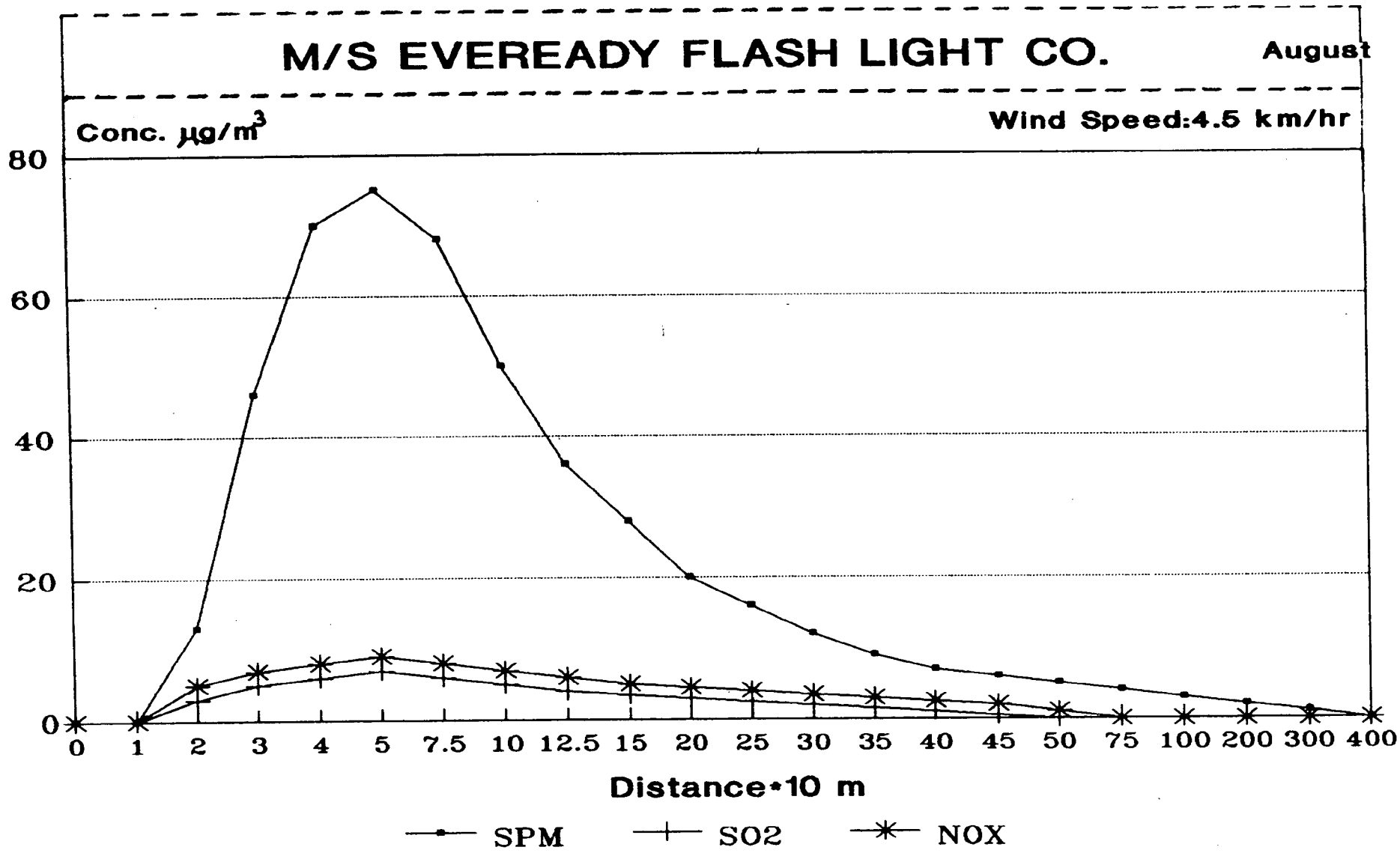
Source:S.P.C.B.Lucknow

FIG - 11



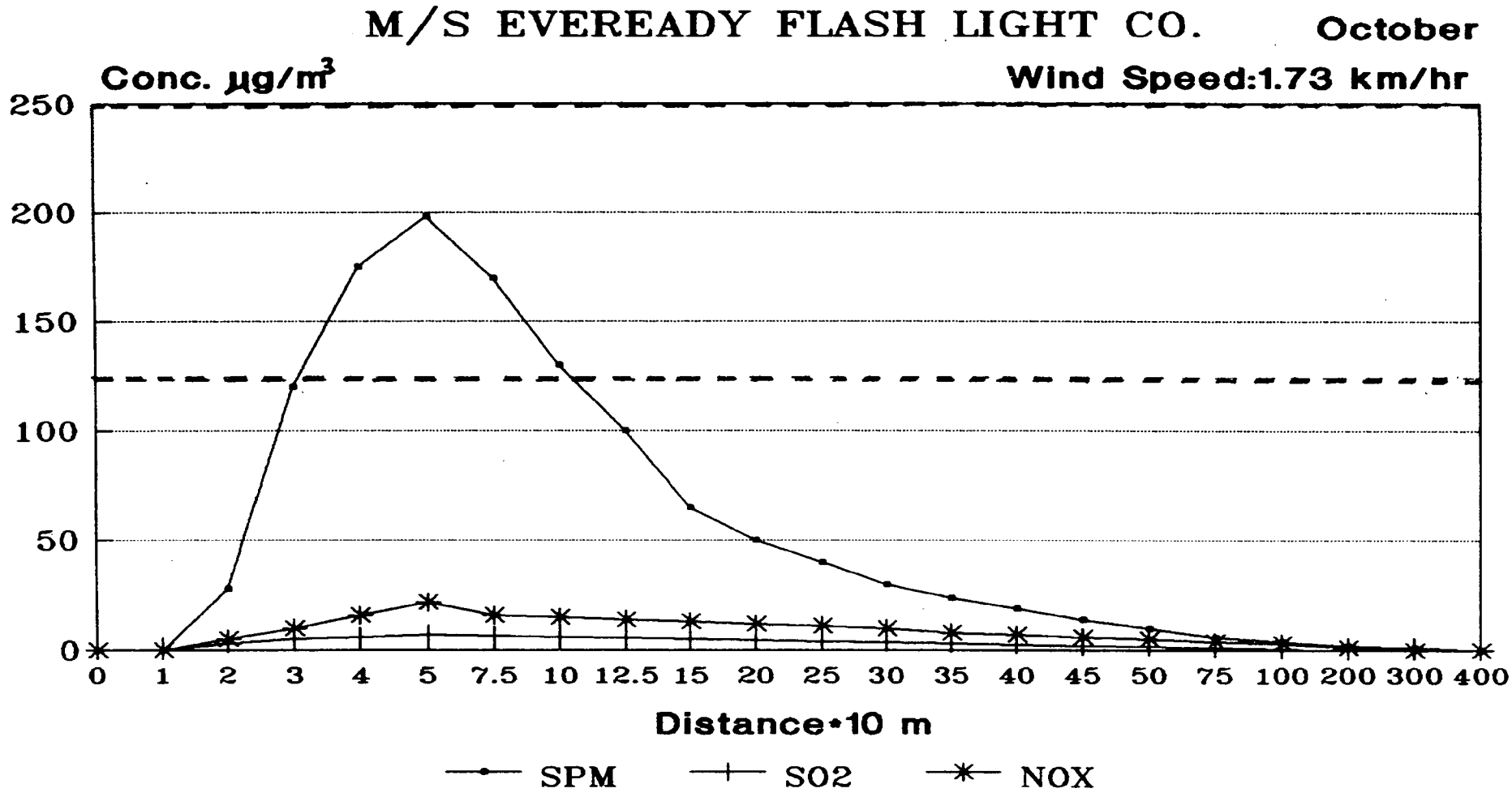
Source:S.P.C.B.Lucknow

FIG - 12



Source:S.P.C.B. Lucknow

FIG-13



Source:S.P.C.B.Lucknow

FIG - 14

According to streeter-Phelps model.

$$L_t = L_0 \times e^{-kt}$$

where :

L_t = Ultimate B.O.D. at time 't'

L_0 = Ultimate B.O.D. at zero distance

k = Deoxygenation rate constant

t = Travel time(days)

This relation, however, can be applied to the B.O.D. values other than the ultimate B.O.D.. The monitoring data regarding the B.O.D. of 5 days at 20^0C whereas, the ultimate B.O.D.is the final B.O.D.in the given sample at infinite time. The B.O.D. values are measured for 5 days at 20^0C can be converted into the ultimate B.O.D.using the following relation,

$$L_0 = Y_5 \; / \; 1-e^{-kt}$$

where :

L_0 = Ultimate B.O.D. content

Y_5 = Measured value of B.O.D. for 5 days at 20^0 C

k = Constant = 0.2 per day

t = Incubation period

Since the rate of deoxygenation is dependent upon the temperature, the deoxygenation rate at the actual temperature of

stream has been worked out using the following relation :

$$k \text{ (at } T^{\circ} C) = (1.056)^{T-20} \times k \text{ (at } 20^{\circ} C)$$

Taking the average temperature of river Gomti to be $28^{0}C$,

$$k \text{ (at } 28^{\circ}C) = (1.056)^{28-20} \times 0.2$$

$$= 0.309272$$

Hence, while drawing the B.O.D. profiles of river Gomti, the following steps have been followed :

1. Determine the B.O.D. content in the river at the Barrage (G.H. Canal)
2. Determine the B.O.D. concentration in each of the outfalling drains.
3. Determine the non-settleable B.O.D. (70% of total) in each of the drains.
4. Estimate the B.O.D. content in the river u/s of the drain.
5. Find out the resulting B.O.D. afterthe drain discharge mixes with the river water using the Mass Balance Equation,

$$\text{Resulting B.O.D.} = \frac{\{BOD(river) \times Flow(river)\} + \{BOD(drain) \times Flow(drain)\}}{\text{Total flow after mixing}}$$

6. Convert the resulting B.O.D. into ultimate B.O.D.

7. Apply the Streeter-Phelps model to estimate the ultimate B.O.D. content at a point just in the u/s of next drain outfall.

8. Repeat the steps 5, 6 and 7 for all other drains also.

9. Draw the curve of B.O.D. profile taking travel time (days) along X-axis and Log of Y_5 and resulting B.O.D. values along Y-axis.

10. The ultimate B.O.D. at various sections in the stream have been worked out.

The B.O.D. profile of river Gomti under existing situation of pollution load dischages by the drains and critical flow conditions has been shown in fig. No. 15 . The desired water quality has been represented by a separate line corresponding to 3 mg/lt of B.O.D. concentration.

In order to improve the situation, either the B.O.D. load falling into the river has to be reduced or the flow should be increased, two options have been considered,

* Trapping of certain drains (D_2, D_3, D_5, D_7 and D_8)
* Trapping of the above drains and at the same time increasing the river flow.

The B.O.D. profiles of the river Gomti under the options have been shown in fig. No. 16 and 17 .

BOD PROFILE OF GOMTI RIVER

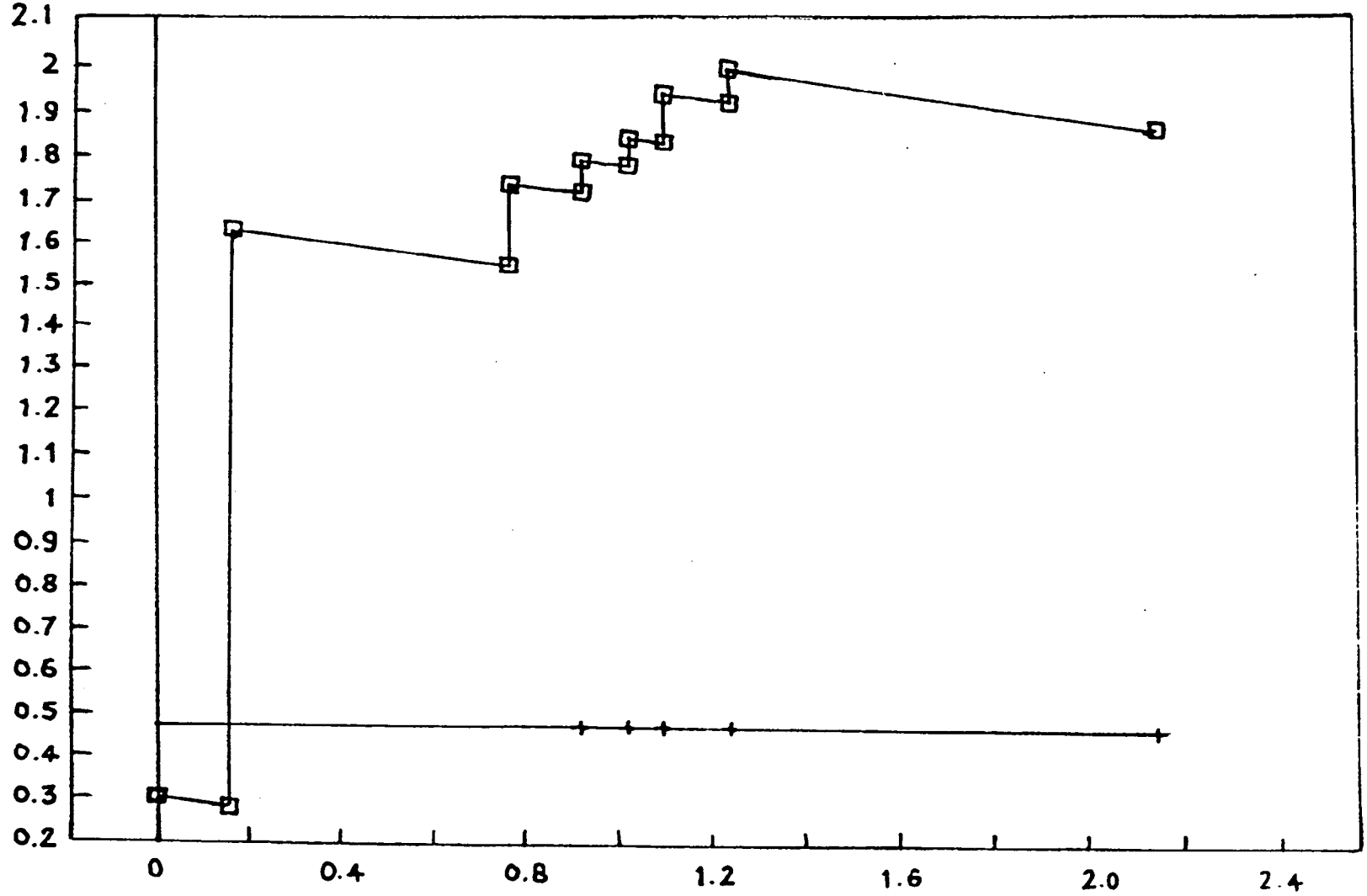


FIG - 15

BOD PROFILE OF GOMTI RIVER

AFTER TRAPPING D2,D3,D5,D7 AND D8

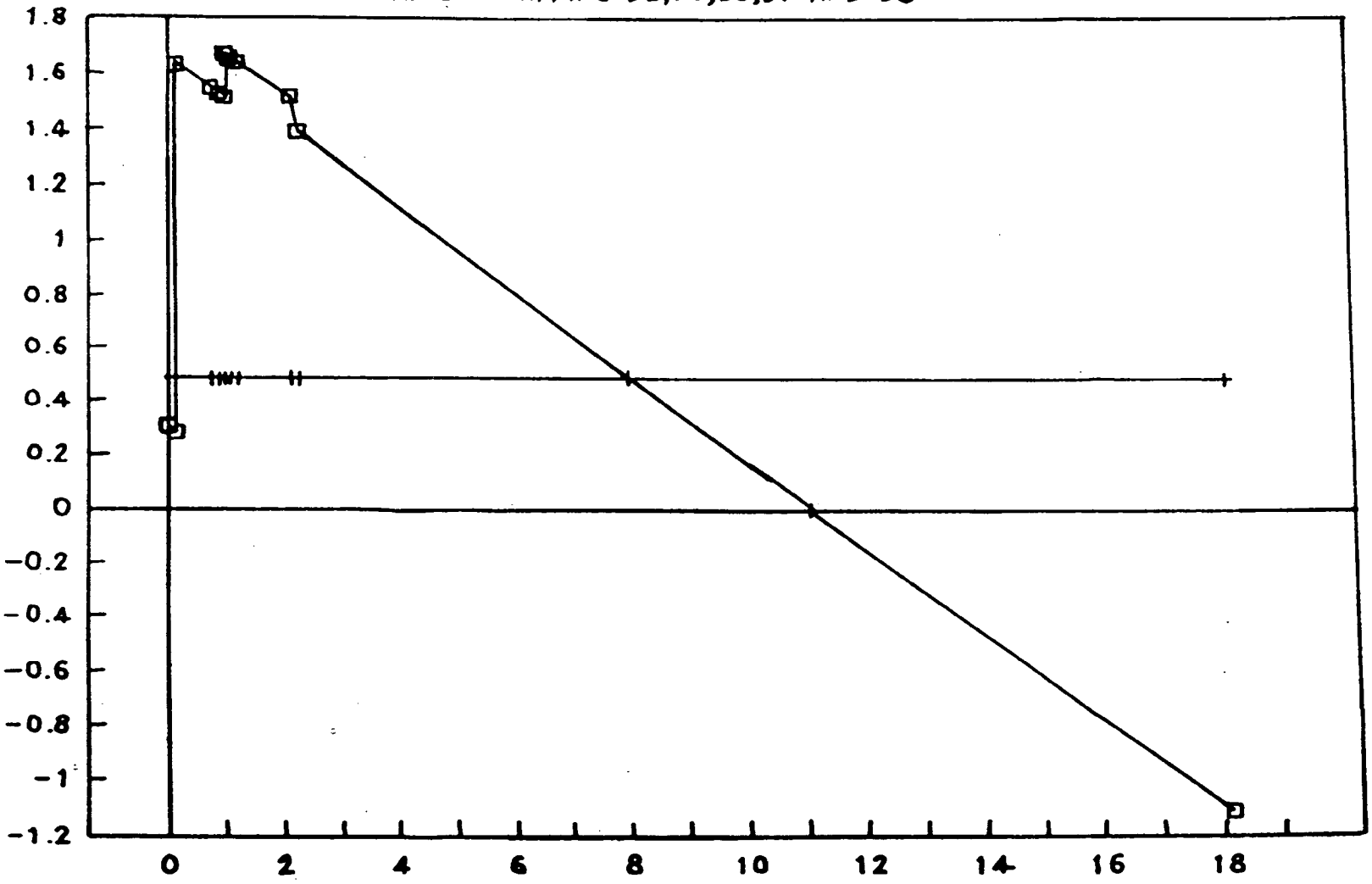


FIG-16

BOD PROFILE OF GOMTI RIVER

TRAPPING D2,D3,D5,D7,D8+ R.FLOW 20 M3/S

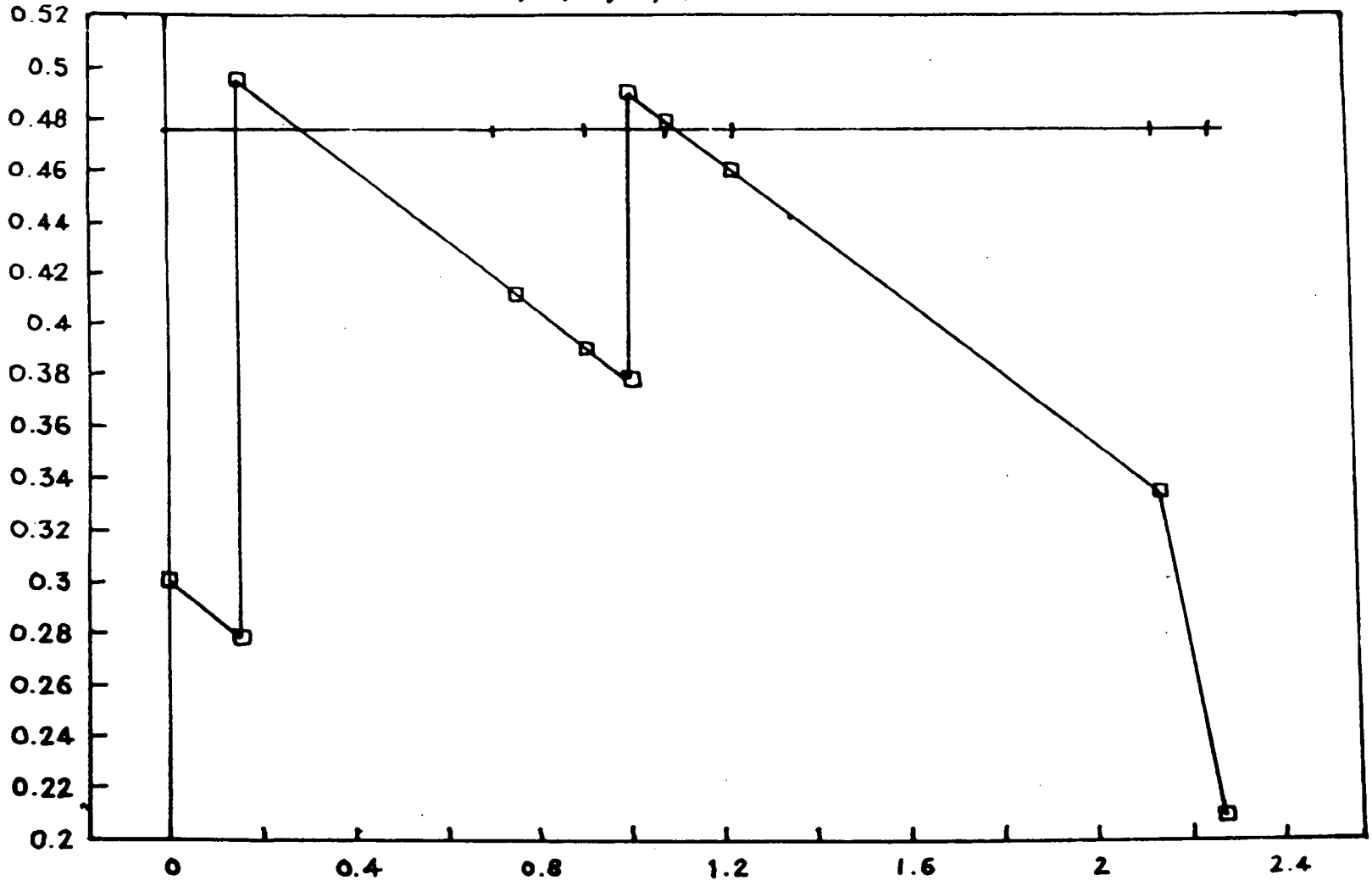


FIG. 17

Chapter 5 :

FUTURE PROJECTIONS

CHAPTER V

FUTURE PROJECTIONS

5.1 POPULATION PROJECTION :

The population of Lucknow for 2011 has been projected as 29 lacs taking the geometric progression method.

TABLE 28

POPULATION PROJECTIONS

SL. NO.	YEAR	CENSUS POPULATION	DECADEL VARIATION	% AGE DECADEL VARIATION	INCREMENTAL INCREASE
1	1951	496861	-	-	-
2	1961	655673	+158812	31.96	-
3	1971	813982	+158309	24.14	-503
4	1981	1007604	+193622	23.79	+35313
5	1991	1669204	+661600	65.66	+467978
6	TOTAL ⟶		1172343	145.55	502788
7	AVG. PER DECADE ⟶		293086	36.39	167596
8	AVG. PER YEAR ⟶		29309	3.639	16760
9	GEOMETRI -CAL MEAN ⟶			33.13	

Table 28 and 29 show the population projection calculations, using the various methods.

TABLE 29

Methods	Year		
	1991(existing)	2001	2011
Arithmetic	16,69,204	19,62,294 (19 lacs)	22,55,384 (22 lacs)
Geometric	-do-	22,22,211 (22 lacs)	29,58,429 (29lacs)
Incremental	-do-	21,29,886 (21 lacs)	27,58,164 (27 lacs)

5.2 LAND AREA CALCULATION :

The existing population of Lucknow city = 16,69,204 and the existing area = 23,738 hectares

The gross density achieved = 16,69,204/23,738

= 71 persons per hectare

However, it is natural for any city/town to grow and Lucknow is no exception to the rule. The population that Lucknow will accommodate by 2011 has been estimated to be 29 lacs(appox). Assuming a gross density of 90 persons per hectare, keeping the densities in core wards the same, the additional area required will be 84 84 hectares (32,222 Ha-23738 Ha= 8484 Ha).

The peripheral wards (Nos.24,25,26,27,31,32,33,37,38,40) have large areas vacant with very low densities. Hence, with the proposed density (90 pp Ha) these wards can be redensified, (with relative ease) and approx.10 lacs of the additional (13 lacs) population can be accommodated in these wards. For the remaining

3 lacs population an additional area of 3333 hectares will be required. This additional area can be acquired along the ;

* Lucknow - Rae Bareili Road
* Lucknow - Hardoi Road
* Lucknow - Kanpur Road
* Lucknow -Sultanpur Road

The additional area of 3333 hectares, to be acquired along the four corridors mentioned, has been selected based on the suitability matrices for agriculture and urban development. Agriculture and urban development are the two most competing land uses, therefore, only such land which is less/marginally suitable for agriculture has been selected for urban development.

Chapter 6 :

CONCLUSIONS AND PROPOSED STRATEGIES

CHAPTER VI

CONCLUSIONS AND PROPOSED STRATEGIES

6.1 CONCLUSIONS :

1. Lucknow has had a tremendous growth rate(65·66%) during the last census decade(1981-91) as compared to the previous decades which show a variable trend. Although there has a marginal increase in the secondary sector i.e. 19.50% in 1971-81 to 21.16% in 1981-91,the growth of the city can primarily be associated with the increase in the administrative functions and other services which includes Trade & Commerce also. The tertiary sector employs the maximum work force, a trend continuing since the past decades. The industrial estates(3 Nos) still have to be developed to the optimum capacity.

2. The density pattern in the wards of the city has a wide range from less than 50 persons per hectare to more than 1000 persons per ha. The older city and the wards which have higher densities whereas the peripheral wards have low densities and provide scope for redensification.

3. Public open spaces are confi ned to a narrow belt along the right banks of River Gomti or attached to places of historical importance, institutions besides the Zoological and Botanical gardens. Open spaces in the rest of the city which includes residential area, are limited and unkempt. Absence of a green belt is Clearly Visible.

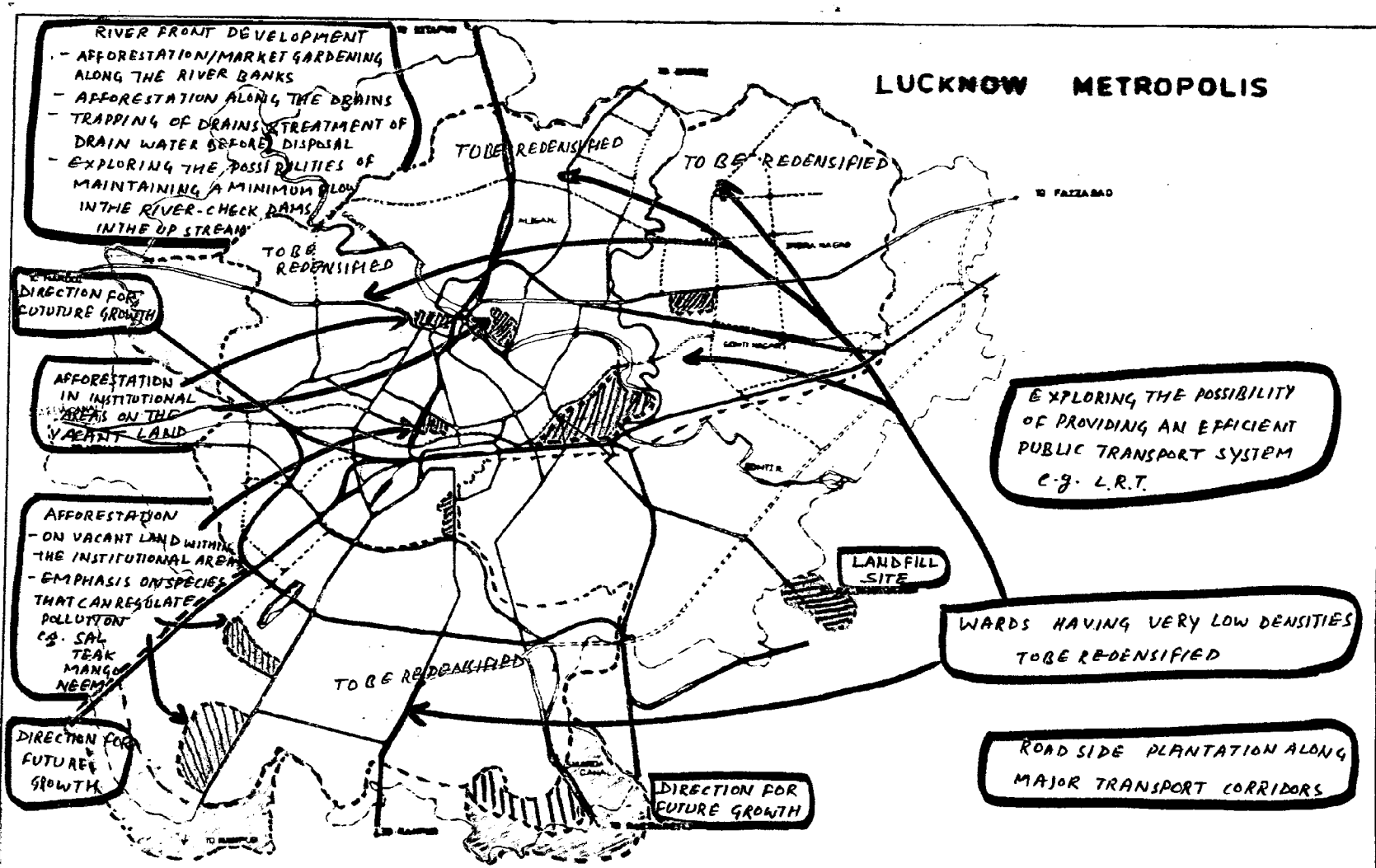
4. The offices being confi ned to the central part of the city (CBD) leads to congestion and a large influx of vehicles resulting in congestion, pollution, delays etc.

5. An analysis of the noise level data reveals that the noise levels are above the prescribed standards even in sensitive areas like the Medical College, High Court, Cantonment. The major sources of noise pollution are vehicles and loudspeakers etc.

6. The analysis reveals that the major cause of air pollution is vehicular emission this is attributive to the lack of an efficient public transport system which has led to an overwhelming reliance on private modes, especially scooters and tempos. The number of registered vehicles has tremendously increased from 55418 in 1981 to 215547 in 1991 (nearly 4 times).

7. The analysis reveals that industries do not contributes much to the pollution load of the city. The concentrations of pollutants are below the prescribed limits indicative of the fact that pollution is being monitored and controlled. However, there are a number of medium and small scale units which do not come under the purview of the State Pollution Control Board, which could be contributing to the pollution of air /water.

8. The pollution of Gomti is a source of major concern . Although about 60% of the town is sewered, due to lack of disposal arrangements almost all of the sewage generated in the town finds its way to the Gomti flowing through the



MAP—7

CONCEPT

STUDY OF ENVIRONMENTAL POLLUTION AND STRATEGIES FOR IMPROVEMENT OF LUCKNOW CITY

SCALE

SUBMITTED BY RAJENDRA KUMAR SINGH
M.U.R.P. II YEAR
DEPT OF ARCH AND PLNG
U.O.R. ROORKEE

town. The capacity of the city's existing system is inadequate even for the present total sewage flow.

9. The solid waste management system is very inefficient. The collection efficiency is irregular and erratic leading to land pollution and the pollution the river.

6.2 PROPOSED STRATEGIES :

The environmental pollution of the city is proposed to be mitigated or minimised by taking the following measures.

1. The densities in the core areas of the city are to be maintained at their present level as the rehabilitation of the people would require a huge capital investment and a large area of land to be acquired.
2. The peripheral wards which have very low densities and posses ample scope for accommodating more people shall be further densified.
3. Open spaces (parks & tot lots) to be provided in the other areas of the city.
4. There is an urgent need for an efficient public transport system, possibility of providing an intra-urban rail system should be explored.
5. Vehicles are the major sources of air pollution, especially two-wheelers and tempos,emissions from vehicles should be monitored regularly, and road worthiness of vehicles should be enforced as a law.
6. Road side plantation along major traffic corridors should be taken up with special emphasis on such species of trees

which help minimize the ill-effects of air pollution.

7. Industrial emissionsshould continue to be monitored closely by the competent authority.

8. An inventory of the small scale units operating in various parts of the city should be made,as they are also sources of water and air pollution.

9. The pollution of Gomti is a major source cause of concern. The drains discharging the city sewage directly into the river should be trapped and the sewage diverted and treated before disposal.

10. At present there is no sewage treatment plant(STP) for the city and the raw sewage is discharge directly into the river to E-grade whereas the desired is B. An STP with a capacity of 228 MLD is necessary to meet the present demand and a capacity augmentation to 413 MLD would be required by 2011.

11. The possibility of maintaining a minimum flow in the river Gomti should be explored,by providing check dams in the upstream sections.

APPENDICES

APPENDIX "A"

LUCKNOW URBAN AGGLOMERATION-OCCUPATIONAL STRUCTURE

Sl. No.	Category	Workers		
		1961	1981	2001
1.	Cultivators, Agr. Labour, Mining and Quarrying, Livestock, Plantation ect.	17515 (7.85)	8706 (3.1)	8505 (2.1)
2.	Household Industry	50467 (22.63)	14699 (5.3)	24300 (5.9)
3.	Other Mfg.	--	30000 (10.7)	35850 (8.7)
4.	Construction	7838 (3.52)	9775 (3.5)	22275 (5.4)
5.	Trade and Commerce	35919 (16.11)	50273 (18.0)	74520 (18.1)
6.	Transport, Storage & Communication	24630 (11.04)	36300 (13.0)	54270 (13.1)
7.	Others Services	86616 (38.85)	129542 (46.4)	192780 (46.7)
	Total	222985 (100)	279295 (100)	412500 (100)
	Participation rate	31.14	27.7	27.5

Note: Figures in brackets denotes %age.

SOURCES OF REFUSE & WASTE GENERATION AND LOAD ON MAHAPALIKA (IN TONS)
(1980-81)

Sl. No.	Source	Ave. waste generated	Waste removed by agencies other than Corporation	To be removed by Corporation	
				Total	Per capita(gm/d)
1.	Household Refuse	500	100	400	436
2.	Road sweeping	10	--	10	11
3.	Silt from drains	100	--	100	109
4.	Malva	100	50	50	54
5.	Institutional Waste	20	--	20	22
6.	Commercial Waste	50	--	50	54
7.	Dung	100	90	10	11
	Total	880	240	640	697

Source: National Institute of Urban Affairs , New Delhi

APPENDIX "B"

MAJOR FINDINGS FROM THE STUDIES DONE BY S.P.A. NEW DELHI, ABOUT THE TRAFFIC AND TRANSPORTATION NETWORK FOR LUCKNOW IN 1986-87.

Source : Draft Report, Master Plan 2001.

1 Nine regional roads converge to the city :

- From Kanpur, Two roads
- From Faizabad, One road
- From Sitapur, One road
- From Hardoi, One road
- From Rae Bareili, One road
- From Sultanpur, One road
- From Kursi, One road
- From Mohan, One road

2. Major railway lines :

- Lucknow - Kanpur
- Lucknow - Gorakhpur
- Lucknow - Delhi
- Lucknow - Rae Bareili - Allahabad

3. The city is on the air route map of the domestic air lines.

4. Intra city transport systems inadequate.

5. Growth in No. of vehicles is very high :

No. of motorised vehicles, 1979-80 = 49755

1984-85 = 90324

No of cycle rickshaws registered, 1984-85 = 23506

No. of motorised fast vehicles (Scooter, Motor cycles)

registered,

1979-80 = 34860

1984-85 = 66624

6. Average 1.2 accidents per day in the city :

Hazrat ganj area	= 37.6 %	(Of total accidents)
Kaiser bagh area	= 26.1 %	
Alambagh area	= 20.2 %	
Chowk area	= 15.95 %	

7. Nature of traffic :

-Heterogeneous traffic, at least 14 modes of traffic.

-predominance of slow moving vehicles, 70 % of total traffic of which

cycle = 64.5 % in outer area

= 54.2 % in core area (42316)

-Private modes, both slow and fast predominate over public modes.

-Share of public slow mode is greater than the public fast mode.

8. Traffic volumes :

- High spatial variation of daily traffic volume along the major corridors
- Core area of the city has more than 1089% over the volume at outer areas and 377% over the volume at the middle area.
- Road registering high volume:

Faizabad road =39550 vehicles / day

University road =76324 vehicles / day

Ashok Marg =64968 vehicles / day

9. Peak hour traffic :

-Concentration of peak hour traffic is too high as compared to

other cities

* Other Indian cities = 9-11 %

* Lucknow = 12-15 %

-Concentration on some major roads :

* Rae Bareili road = 27.6. % inbound
  = 24.1 % outbound
* Ashok Marg = 15.6 % inbound
  = 16.1 % outbound
* K.K.College road = 15.4 % inbound
  = 11.7 % outbound
* Daliganj-Gomti river bridge = 12.8 % inbound
  = 10.4 % outbound

10. Through traffic :

-16% of the total traffic (1126 vehicles) entering the metropolitan area is through traffic.

-Through traffic on major roads:

* Sitapur road = 28.6 % inbound
  = 26.3 % outbound
* Faizabad road = 21.1 % inbound
  = 21.0 % outbound
* Kanpur road = 18.6 % inbound
  = 16.4 % outbound

-Intensity of through fast traffic movement between Kanpur road and Faizabad road is maximum.

-Out of total 1126 fast through traffic, 362 are accounted for these two roads.

-Intensity of movement also considerable amongst Faizabad

road ,Sitapur road ,Kanpur road.

11. Over-bridge and Flyovers:

-Bridges existing over Gomti river are over-loaded / inadequate.

-Many railway level crossings o important arterial roads.

12. Wholesale market :

-On an average day,total flow of goods on different roads is 28342 tons; of this :

Kanpur road = 7069 tons / day

Sitapur road = 6820 tons / day

Faizabad road = 5625 tons / day

-The wholesale market of various commodities flowing to the city are located in the inner parts of the city;this creates congestion in the inner roads of the city.

13. Rail terminal :

- The goods traffic by rail to and from Lucknow is massive (15,58,300 tons / month).
- Railway stations located in the closely built-up area of the city causes acute congestion.

14. Bus Terminal :

- Inter-city bus system has a high load factor (67%) about 6.5 lacs passengers per month.
- Existing bus depots at Charbagh,Kaiserbagh and Amausi are inadequate.
- Intracity bus system is extremely inadequate :
  * 92 buses only for 6,75,000 passengers/month
  * load factor 48%
- One depot at Terhi Kothi looks after the maintenance and operation of the system.

APPENDIX "C"

PROPOSALS FOR TRAFFIC AND TRANSPORTATION IN LUCKNOW MASTER PLAN-2001

Source: Draft Report, Master Plan-2001

Based on the studies shown in the previous APPENDIX following major proposls have been made for traffic and transportation in Lucknow Master Plan-2001 :

1. Road network :
   - Proposed road network for agglomeration is, RADIAL-CUM-RING SYSTEM.
   - Existing nine radial roads are classified as ARTERIAL ROADS (r.o.w. 60 to 100 mts. from development area boundary upto their inter-section with the proposed ring road ; and r.o.w. 45 mts. wherever feasible, for their stretch between ring road and peripheral road round the core area).
   - Proposed ring road , r.o.w. 60 mts.
   - Arterial roads, Ring road and Peripheral road will have six lane divided carriageways with cycle/slow moving tracks and service road.
   - Within central core area , a ring system around Vidhan Sabha is proposed to integrate Vidhan Sabha and DarulShafa Complexes; the traffic in front of Vidhan Sabha is proposed to be closed.
2. Ring Road :
   - Ring road will join all the nine arterial roads.
3. Elevated Express Highway on G.H.Canal :
   -This would link residential areas , viz. Rajaji Puram, Aishbagh, Gomti Nagar, Indira Nagar with major work centres such as

Charbagh, Hazratganj, Secretariate and related offices.

-This express highway would be on G.H.Canal which passes through city (from Sharda Canal to Gomti river).

-This would decongest Station road , Vidhan Sabha Marg , Aishbagh road , Gurudwara road and Mill road.

4. Improvement on existing roads:

-Augmentation in road widths based on existing availability and significance of the road in overall transport system.

-Encroachments to be removed from Subhash Nagar Marg, Tulsidas Marg , Gautam Buddha Marg.

5. Bridges across river/canal:

-Presently five bridges including, a barrage across Gomti river, of these two are four lane and others three are only two lane.

-Most of the river/canal crossing are congested.

-Following bridges are proposed:

* Bridges across Gomti river:
  a. In the North-West of Husainabad (Ring road).
  b. At Dilkhusha (New road from Gomti Nagar complex).
  c. On ring road between Sultanpur and Barabanki railway line.

* Improvement/widening of existing bridges :
  a. Hardinge bridge .
  b. Daliganj bridge.
  c. Hanuman Setu.
  d. Barrage near Gomti Nagar.

* Brid ges across Sharda Canal:
  a. New constructions
    (i) Near Telibagh (Ring road).
    (ii) Near Central Jail (30m roads meeting Ring road).
    (iii) 24m road (near Central Jail).

(iv) 45m road (near Singer Nagar).

b. Improvement of existing brid.ges:

(i) Bijnore road.

(ii) Kanpur road.

(iii) Rae Bareili road.

-Bridges across Kukrail river:

* Improvement of existing bridges:

a. Faizabad road.

b. On Ring road.

c. 45m road (near proposed sub-city centre).

6. Railway over/under bridges:

- Of the 18 major crossings, 7 are presently grade separated.
- Existing Rail bridges to be up graded.
- All new arterial/sub-arterial road should be constructed with grade separation, wherever they cross a railway line.

7. Truck Terminals:

- Up-coming Transport nagar on Kanpur road, truck terminals at Hardoi road and Kursi road, and U.P.S.R.T.C. Depot at Faizabad road in developing city centre in Gomti nagar, would cater the need of Truck terminals.

8. Bus Terminals:

- Bus terminals are proposed in Kanpur road, Rae Bareili road, Kursi road, Hardoi road and one in proposed city centre in Gomti nagar.
- Various bus terminals proposed :

* Charbagh (intra-urban).

* Kanpur road (Alambagh) (Inter-city).

* Kaiserbagh (intra-city and Depot) (inter-city depot

to be shifted).

* Kursi road (combined terminal & depot).

* Faizabad road (as a part of city centre of Gomti nagar).

* Rae Bareili road (combined terminal & depot).

* Hardoi road (combined terminal & depot).

9. Rail terminals :

- Existing rail terminal shall continue.
- Proposed to open Charbagh railway station on the South side also, to decongest Station road / Alambagh road.
- Daliganj railway station is proposed to be developed as terminal for N-E railways.

10. Light Rail Transit (LRT) System:

- Two corridors of LRT are proposed:

a. North Central (Aliganj line)

b. East-West (Gomti Nagar line)

a. Aliganj line, main stations:

* Aliganj, inter-city bus terminal

* Aliganj sub-city centre

* Kapoorthala complex

* Raidas Mandir

* University

* Stadium

* Kaiserbagh

* Aminabad

* Gautam Buddha Marg

* Charbagh

b. Gomti Nagar line , main stations:

* Gomti Nagar city centre

* H.A.L.

* Nishatganj

* National Botanical Garden

* Jawahar Bhawan

* Vidhan Sabha

* Husainganj

* Charbagh

* Aishbagh (Rajendra Nagar)

* Moti Jheel (Talkatora road)

-LTR should be running either in middle of the road or along one side,as per feasibility. For a small stretch it may be underground also.

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