CARRYING CAPACITY BASED REGIONAL PLANNING

For

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Final Report

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PREFACE

This research report on **Carrying Capacity Based Regional Planning** is essentially an attempt to develop a methodology and tools towards sustainable development of Indian urban areas that may be operationalised at local level.

An operational concept of Carrying Capacity based planning has been introduced here (CHAPTER 1) which focusses on the supply-demand gaps in various urban environmental resources and infrastructure in sustaining urban population and activities and the decision making process to manage such supply-demand gaps. A methodology towards assessment of carrying capacities of urban areas in term of various environmental resources and infrastructure has been discussed in CHAPTER 2 which centres around the development of a set of Carrying Capacity Indicators and their measures. Several instruments for a wider application of Carrying Capacity Based Planning at local level are dealt in CHAPTER 3; while CHAPTER 4 aims towards action planning at local level with focus on institutional arrangements and CHAPTER 5 provides a brief description of capacity-building for Carrying Capacity Based Regional Planning.

This report is an outcome of sustained efforts of NIUA's research faculty; in particular, those of Dr. Souro D. Joardar for the development of CHAPTER 1 and CHAPTER 2; Ms. Usha Raghupathi for the development of CHAPTER 3 and Dr. Madhusree Mazumdar for the development of CHAPTER 4. Hopefully, further discussions among participants of all institutions involved in the Research Study on **Carrying Capacity Based Regional Planning** (viz. HSMI, IHS and NIUA) will provide helpful guidelines towards shaping the final outcome of the study.

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DIRECTOR

CARRYING CAPACITY BASED REGIONAL PLANNING

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CARRYING CAPACITY BASED REGIONAL PLANNING

Executive Summary

1. Objective and scope of the study

Carrying capacity based approach to planning is both a concept and a tool towards sustainable development of human settlements. The improvement and long term sustenance of the quality of life of human settlements is a critical issue facing urban and regional planners and policymakers all over the world today, in the wake of severe environmental degradation of air, water and land. It is surmised that depletion of environmental resources, inadequate infrastructure, social amenities and inappropriate institutions to tackle such problems have led to deterioration of environment within human settlements. Looking at the all pervasive lack of awareness of urban environmental issues and concerns in the development policies and action programmes towards sustainable development of human settlement, a sharp focus on urban environment management has been brought into planning through Agenda 21 of the UNCED. Despite being one of the most populated countries with severe urban environmental problems, amongst the signatories of Agenda 21, India is yet to operationalise the agenda at its country level.

The very concept of carrying capacity based planning is new in India, not to speak of the availability of tools and techniques to operationalise the concept at the urban and regional planning levels. This study, therefore, aims to define the concept of carrying capacity based urban and regional planning and then develop a methodology to operationalise such a planning approach.

The methodology developed in this study includes tools and techniques of assessment of various supportive and assimilative capacities of (urban) environmental resources and of decision-making based on the concept of the carrying capacities, demonstrating their applications in the Indian context. Furthermore, the study indicates the institutional restructuring to introduce the concept into planning practices and capacity building at the local level, including training modules.

2. What is carrying capacity based planning? : Definition and Concepts

"Carrying Capacity" refers intrinsically to the finite capacity or the limitations of the natural environment both as a reservoir of resources to support human consumption and as a sink to assimilate the residuals or wastes. Thus carrying capacity based planning needs to deal with the management of the "throughput", i.e., the size and nature of human activities leading to resource consumption and waste generation, as well as the supportive resource base and the absorption capacity of the environment. Hence, planning approach may require optimization of human demands in relation to manageable supply of environmental resources.

3. Carrying Capacity Based Approach in the Context of Urban Planning and Development

Deriving from the above concept, carrying capacity based urban planning aims towards management of the demands for various regional and local environmental resources required to sustain the desired economic activities and the quality of life across urban areas, and the supply of such environmental resources within their regenerative capacities. This should translate into policies, strategies and action plans at the local level towards augmentation and sustenance of urban environmental resources in terms of their supportive and assimilative capacities on one hand and the size, nature and distribution of urban-economic activities and their concomitant demands on these environmental capacities, on the other.

4. The Elements of Carrying Capacity Based Planning

The elements of carrying capacity based planning process have been summarized in Figure-1 of the report. Urban developmental policies and actions are directed to produce socio-economic goods and services for the betterment of the quality of life of the people in a city or a region. Such actions in turn put demands on various supportive and assimilative capacities of the setting. The supply of such carrying capacity depends on various economic, infrastructural and institutional resources of the setting, as well as waste assimilative capacities of the air, water, land/soil and biological components of its environment. Carrying capacity based planning is directed towards the management of these supply-demand gaps or the "Carrying Capacity Differential" (Bishop et al, 1974).

Hence, the process, in essence, implies:

- Estimation of various supportive and assimilative capacity dimensions and impacts thereon of alternative developmental actions across an urban or regional setting through a set of carrying capacity indicators or indices.

- Development of strategies toward carrying capacity demand and supply side, management techniques to deal with such impacts, including tradeoffs among alternative developmental activities and concomitant resource allocations, technology, and institutional arrangements towards control of environmental and resource management.

5. Dimensions of Carrying Capacity: Urban Environmental Components and Resources

An urban environment should have capacities to assimilate, i.e. to manage and recycle various wastes - air, water, land and noise pollution - generated by its population and economic activities. It also must have capacities in terms of various natural and socio-economic resources and infrastructure, viz. land, water, energy, transport, social amenities, economic base and institutions to support its population and economic activities. Thus the two broad dimensions of environmental carrying capacities of urban areas may be categorized into:

- Waste Assimilative Capacities;

- Carrying Capacities in respect of various Environmental Resources and Infrastructure (which form the supportive capacity).

Five different modules of carrying capacity indicators have been developed in this study to estimate capacities in respect of the various identified urban environmental resources along with their respective parameters and procedures for measurement. They are grouped into:

Module A: Waste Assimilative Capacity indicators for air, water, land/soil, biological and acoustic environmental components of the urban area.

Module B: Supportive Capacity indicators for land, housing and various social amenity resources of the urban area.

Module C: Supportive capacity indicators for transportation infrastructure facilitating regional and internal accessibilities and communication infrastructure for the urban area.

Module D: Supportive capacity indicators of urban utilities, viz. water supply, sanitation and energy supply for the urban area.

Module E: Socio-economic capacity indicators of man-power resources, economic base and local institutional resources of the urban area.

Besides the formulation of the above mentioned modules attempts have been made to develop:

- **multiple indicator measures** for the different environmental resources;

- indicators to assess resource capacities in **both quantitative and qualitative terms**;

- **quantitative measures** of supportive resource capacity indicators **as related to population size.** That is, their capacities are measured in terms of the size of population these resource are capable of supporting; for instance, urban land resource, housing stock, occupancy rate of housing, household amenities, outdoor living space, extent of slumming, amount of health, educational, recreational and public security facilities, commercial resources, viz. postal and telephone services, installed capacities of water supply, sanitation and power generation, manpower supply and literacy rate, income and employment generation in urban economy and income, expenditure and man power capacity of urban local bodies that can be related to their population support capacities;

- waste assimilative capacity indicators dealing with **natural assimilation** of pollution through ventilation, dilution/ absorption or sink potentials of urban

airsheds, water regimes, soil environment and biological resource as well as **waste management capacities of man made infrastructure** through emission controls, waste water treatment, solid waste management, noise control and attenuation methods, etc.

- **stress indicators** that would measure **population and activity pressure** or stress on urban infrastructure resources and indirectly measure their capacities.

  Existing levels of air pollution emissions, waste water discharge, solid waste disposal and noise levels across urban areas may also indicate stresses on the assimilative capacities of air, water, land, biological and acoustic environments.

- **surrogate indicators** when the necessary information on estimation parameters for the Carrying Capacity indicators are difficult to obtain. The stress indicators also provide surrogate measures in terms of deficiencies in capacities.

6. Estimation of Carrying Capacity Indicators

Several Carrying Capacity indicators are measurable against existing **standards** or **norms**.

Standards are necessary for assimilative capacity measures for ambient air and water quality parameters and acceptable noise levels for urban landuses. In the Indian context, air, water and noise quality standards have been developed through several environmental legislations and implemented through the central/ state pollution control boards, or local level administrative measures.

The Planning Commission and several National Level Commissions in India have attempted to develop norms or acceptable standards from time to time, in respect of urban infrastructure and services as well, especially those related to public health, such as water supply, sanitation, health facilities, etc. against whom capacity indicators can be measured.

Capacity norms for transportation infrastructure and services are also be available through state public works departments and highway and railway authorities in India in terms of lane capacities, right of ways of highways and urban roads and number of trains for different classes of railway lines.

Similarly, various other individual public authorities or departments responsible for planning and development of individual social infrastructure, such as central and state health departments, education departments, postal and telephone authorities etc., may have there own norms for capacities of such infrastructures in term of space requirement, numbers or frequencies, personnel requirements, etc., in relation to the population size these infrastructure should serve.

All such above mentioned information would then form part and parcel of the Management Information System, to be used for research and impact assessment studies.

Carrying Capacity estimate of urban areas should be viewed more in **relative rather than in absolute terms.** While there is the need for development of local norms for social resources applicable across homogenous societies or population, relative measures of carrying capacities of urban entities may be an useful approach for decision making in urban environmental planning and management. Each of the carrying capacity indicators developed may be used to compare among urban areas at sub-regional, regional, sub-national or national level. "**Relative Carrying Capacities**" of urban areas analysed at the level of defined planning regions (such as the NCR of Delhi) will be useful to develop spatial strategies for allocation of population, activities and resources across the region towards sustainable development, as well as plans for environmental management of individual urban areas in relation to their respective carrying capacities.

Local areas with critical deficiencies in assimilative or supportive carrying capacities are considered to be "hotspots". Identification and estimation of hotspots will help in resolving problems.

7. Spatial context of carrying capacity indicators

The indicators developed in the study are intended to measure carrying capacities in respect of resources that support the population and activities of a particular urban area. While some such resources may be available within the statutory spatial jurisdiction of the urban area, various others, especially natural resources like air, water or land and even social resources like regional transportation links, energy sources, etc., transcend typical urban spatial boundaries. Thus the information base and parameters for assessment of carrying capacities lie both within and outside the urban limit. Furthermore, various environmental information are often available at aggregate levels, i.e., at the level of blocks, tehsils, districts or even sub-regions. For instance, motor vehicle registration data

are available at District/sub district levels; natural land classification data, water resource data, etc., may be available at block/tahsil level - which poses difficulties in spatial resolution for analysis (The various sources of information base for individual indicator measures have been identified in TABLE 1 of the report).

8. Urban Information System for Carrying Capacity Assessment

The specific parameters and information base necessary for estimation of individual carrying capacity indicators have been outlined in the modules, which may help in developing a global urban information system for carrying capacity assessment for use at local municipal and regional levels, with periodical data update.

9. Methodology and Tools for Wider Application of Carrying Capacity Based Planning

To achieve the objectives of Local Agenda 21, mechanisms have to be evolved to involve communities in planning and managing their environment. Such as:

- urban environmental assessment;
- environmental consultations;
- environmental mapping;

With the help of environmental assessment reports and urban environmental maps, it is possible to involve all the stakeholders, in whatever capacity, to plan, prepare and implement action plans at the local level.

10. Action Planning for Local Agenda 21

The purpose of the Earth Summit, recommending Local Agenda 21, was to emphasise the need to protect the environment at the local level; the thrust areas being shelter, human settlement management, sustainable landuse planning and management, integrated environmental management planning and management of disaster prone areas, construction industries, energy and transportation systems, and human resources and capacity development.

Almost simultaneously, along with the conception of the Local Agenda 21, the government of India ammended the Constitution to introduce democratic decentralisation and local area planning.

With the support of such policies and legislations action at the city level can be structured hierarchically and horizontally, to facilitate integrated management, and at the same time take cognizance of local area characteristics while planning. The emphasis is on democratic decentralisation.

At the district level, rural-urban integration can be done by modifying the district planning process, with the District Magistrate looking after sectoral development, and the Zilla Parishad working on local level spatial planning. The link between rural-urban and the line agencies of the state should be at the district level.

The study suggests linking of planning policies and management among the centre, state and the municipality, and formulation of action plans at the local level (city, ward, neighbourhoods). A set of measures to be taken for strengthening the environment management institutions is also indicated.

11. Capacity - building for carrying capacity based planning

While conventional planning emphasises on landuse-allocations, carrying capacity based regional planning focuses of multi-sectoral and multi-territorial assessment and integration. Introduction of the latter would require capacity building of the local government and strengthening of other institutional capacities in the form of legal, administrative and technical support. In India, the legal basis of environmental protection is adequate. But there is a need to prepare comprehensive plans addressing multi-sectoral issues. This major shift in planning requires a change in the "mind-set" of the planners and decision makers. This will have to be done through training programmes. The training modules could be on:

Training Modules:

1. Concept of Carrying Capacity
2. Indicators of Carrying Capacity
3. Tools for assessment of assimilative and supportive capacities
4. Presentation tools-like environmental mapping, GIS based analysis.
5. Strategy formulation on the basis of Carrying Capacity estimates.
6. Consultations with stake holders non-officials, business and Industry and Community Groups for action plan formulation.

Note: Each of the training module will need to be structured with adequate case studies to illustrate the methodology.

CHAPTER 1

CONCEPTS AND ELEMENTS OF CARRYING CAPACITY BASED PLANNING

1. Introduction: Objective and scope of the study

Carrying capacity based approach to planning is both a concept and a tool towards sustainable development of human settlements. The improvement and long term sustenance of the quality of life in our human settlements, is a critical issue facing urban and regional planners and policymakers today in the wake of the severe environmental degradation of air, water and land. Depletion of environmental resources, inadequate infrastructure and social amenities as well as, inadequate and inappropriate institutions to tackle such problems have led to further deterioration of environmental qualities of human settlements. The pervading lack of awareness of urban environmental issues and concerns amongst not only the general populace but also the urban managers in India may frustrate our efforts towards sustainable developments of our cities. The need for urgent development of policies and action programmes towards sustainable development of human settlement have been brought into sharp focus through the Agenda 21 of the UNCED. Despite being one of the most populated countries with severe urban environmental problems amongst the signatories of Agenda 21, India is yet to operationalise the agenda at its country level.

The very concept of carrying capacity based planning is new in India, not to speak of the availability of tools and techniques to operationalise the concept at the level of urban and regional planning. Therefore, research of the nature of the present study which aim to define the concept of carrying capacity based urban and regional planning and to develop a methodology to operationalise such a planning approach cannot be more useful and timely.

The methodology developed in this study incorporates tool and techniques of assessment of various supportive and assimilative capacities of urban environmental resources and of decision-making based on these carrying capacities, demonstrating the applications of the same in the Indian urban context, such as in the case of National Capital Region of Delhi. Furthermore, the study leads to ways and means of implementation of the concepts and methods of carrying capacity based planning through institutional restructuring and capacity building at the local level.

This chapter introduces to the definition and concepts of carrying capacity based planning leading to an outline of the elements of such a planning process. The methodology for operationalising the process including tools and techniques of assessments of carrying capacities of urban region, alongwith illustrations or case studies of their applications has been presented in the following chapter (CHAPTER 2). Instruments for wider application of the carrying capacity based planning approach, action planning for the local level including institutional re-arrangements and capacity building are the themes of the subsequent chapters.

2. What is carrying capacity based planning? : Definition and Concepts

The notion of "Carrying Capacity" refers intrinsically to the finite capacity or the limitation of the natural environment both as a reservoir of resources to support human consumption and as a sink to assimilate the residuals or wastes. Thus carrying capacity based planning needs to deal with the management of the "throughput", i.e., the size and nature of human activities leading to resource consumption and waste generation, as well as the supportive resource base and the assimilative capacities of the environment. In other words, the planning approach may require optimization of human demands in relation to manageable supply of environmental resources.

The idea of natural carrying capacity or environmental limits to growth is not new in scientific disciplines, especially cybernetics, demography and bio-science. As early as in the 18th century, Verhulst attempted to derive a logistic population growth curve that approached its asymptote after initial increase, indicating limiting biological and economic factors in the environment (Bishop et al,1974:14). Food resource had been the critical factor in the well known Malthusian concept of natural carrying capacity which may lead to sudden and dramatic crash in expontial population growths. Lotka (1925) and Volterra (1926) developed logistic population growth curves that would have upper bounds due to density dependent negative feedbacks resulting from resource depletion, disease, predation etc. Population density dependent carrying capacity has been the premise also in the practice of forest and animal resource management, where the maximization of "sustained yield" of lumber harvest or cattle population is linked to the capacities of regeneration of resources to support such yields.

Qualitative factor of life have also been linked to the notion of carrying capacity more recently. For instance, Ackerman (1959) attempted to measure it not in terms of the quantity or size alone, but also the "standard of living", incorporating various technological, institutional and economic aspects of the population. Colhoun (1973)

linked social pathology or "behavioral sink" in animal population with carrying capacity in term of space reaching its limit.

However, the concern for environmental carrying capacity is relatively recent among planners and economist. Computer modelling of global growth scenarios in the seventies stretched the concept of carrying capacity to a notion of "limits to growth" (viz. Meadows et al, 1972) that was akin to environmental determinism forecasting doom. This nevertheless raised storms of controversy as to the so-called "limits", especially in term of population growth, for later forecasts indicated sharp differences among world countries in sustaining population growth (viz. FAO/HASA,1987). Furthermore, the notion of limits of population growth and resources in challenged in the light of technological progress as well as market forces that tend to balance demands and supply of resources (viz. Kahn, 1982; Kirchner et al, 1985; Simon, 1981).

More recent contentions favour sustenance of optimal economic growth (rather than limiting growth) through management of environmental resources and constraints, in order to enhance quality of life, including pollution abatement (viz. Balwin, 1994; Beckerman, 1992; Scott, 1994; World Bank, 1992). At the same time, the 'business as usual' scenario of unabated exponential population growth, consumption of non-renewable resources and pollution is rejected. Thus carrying capacity based planning endeavors to maintain on a sustained basis a balance between the growing demands for human economic activities and concomitant consumptions of natural resources on one hand and the supply of various environmental resources to meet such demands, on the other.

3. Carrying Capacity Based Approach in the Context of Urban Planning and Development

Deriving from the above concept, carrying capacity based urban planning aims towards management of the demands for various regional and local environmental resources required to sustain the desired economic activities and quality of life across urban areas and the supply of such environmental resources within their regenerative capacities. This should translate into policies, strategies and action plans at the local level towards augmentation and sustenance of urban environmental resources in term of their supportive and assimilative capacities on one hand and the size, nature and distribution of urban-economic activities and their concomitant demands on these environmental capacities, on the other (see also **Figure 1**).

While urban centres, especially large cities are increasingly assuming the role of engines of the country's economic growth, their demands for both natural and 'human' or social resources, such as land, housing, water, energy and other required infrastructure and institutions as well as their pollution generation are often stressing their environmental settings beyond their capacities to supply economic resources and assimilate urban wastes, resulting in degradation of quality of life in the cities.

Is the traditional urban and regional planning approach capable of facing the above task?

Conventional urban planning as represented, for instance, through preparation of master plans or so-called comprehensive plans are deterministic in their concerns for size and efficient distribution of urban activities and infrastructure rarely questioning the probability of achieving the goals within the resources and environmental constraints of any given setting. "Dianopolis" and "Ecumenopolis", for instance, are extreme models of urban plan and regional urbanization based on assumptions of unlimited growth possibilities. Although economic and social improvements in the human environment are focussed in the traditional urban planning approach, the ecological system that provides necessary natural resource support and waste assimilation to achieve such economic and social goals are not equally examined. Carrying capacity based urban planning approach, on the other hand, requires the development of a procedure and analytical mechanism that will reconcile the varied social expectations in the human environment and the quality and stability of the natural environment. It relies on the emerging thesis that growth and environmental conservation across urban settings are complementary rather than conflicting goals.

However, the similarity between traditional planning and carrying capacity based approach lies in the normative and rhetorical aspects of any democratic planning process which should be participatory and interactive in nature. Reconciliation of varied socio-economic goals and ecological imperatives in any given urban settings as required in the carrying capacity based planning necessitates resolution of conflicts and tradeoffs among development alternatives to converge on socially and economically viable and environmentally sound decisions. Bishop (1974) thus emphasizes that carrying capacity based planning should be a dynamic " planner-decisionmaker-public" interactive process rather than a model to generate " a plan". To this extent, any pluralistic planning should reconcile among plethora of values, be they economic, social or ecological in nature through a process of interaction where rhetoric is integral to the art of suasion.

4. The Elements of Carrying Capacity Based Planning Process

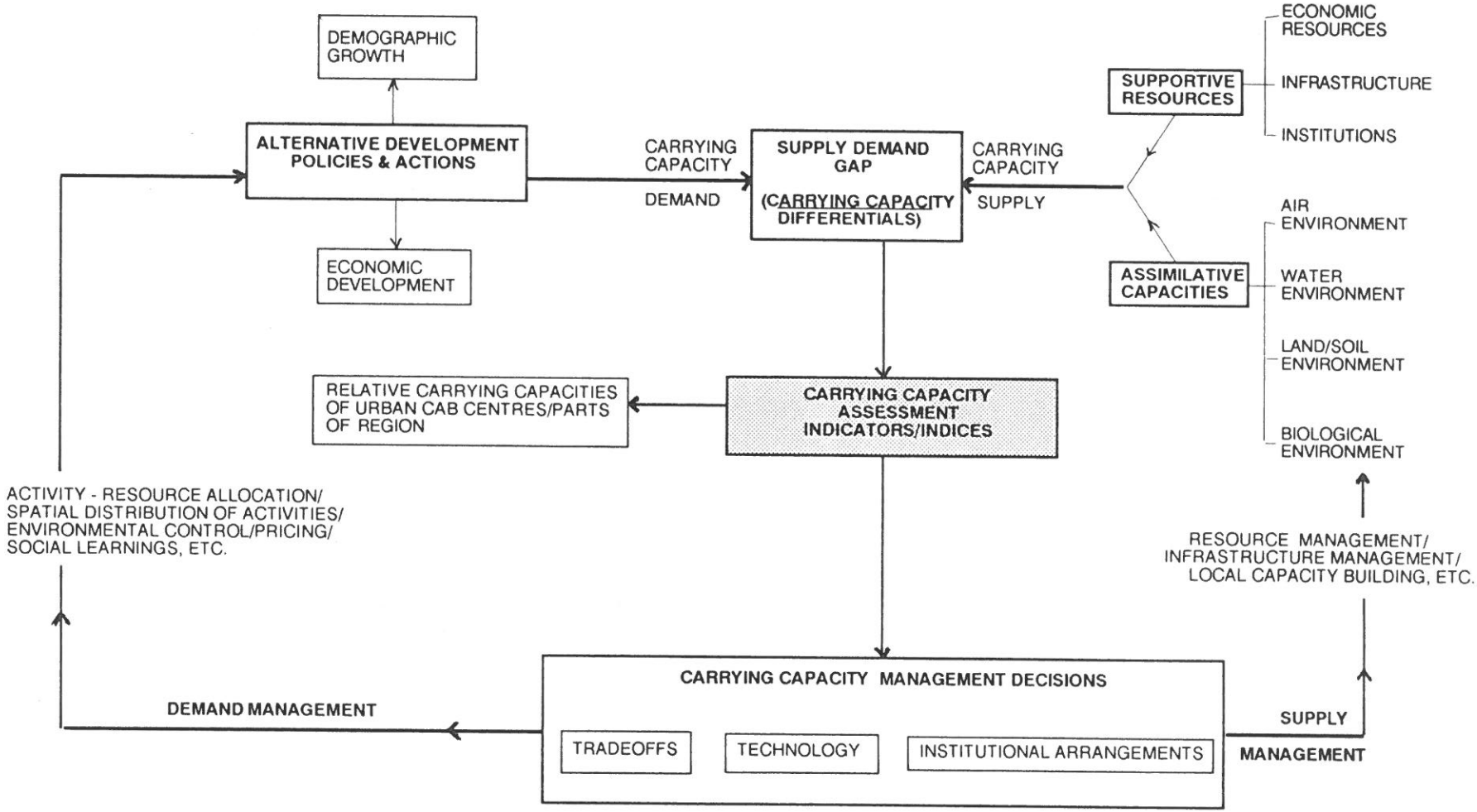
The elements of carrying capacity based planning process have been summarized in Figure-1. Urban developmental policies and actions are directed to output socio-economic goods and services for betterment of quality of life of the population in a city or a region. Such actions in turn will put demands on various supportive and assimilative capacities of the setting. The supply of such carrying capacity depends on various economic, infrastructural and institutional resources of the setting as well as waste assimilative capacities of the air, water, land/soil and biological components of its environment. Carrying capacity based planning is directed towards the management of these supply-demand gaps or the "Carrying Capacity Differential" (Bishop et al, 1974).
Thus the process, in essence, implies:

- *Estimation of various supportive and assimilative capacity dimensions and impacts thereon of alternative developmental actions across an urban or regional setting through a set of carrying capacity indicators or indices.*

- *Development of strategies toward carrying capacity demand and supply side, management to deal with such impacts, including tradeoffs among alternative developmental activities and concomitant resource allocations, technology, and institutional arrangements towards environmental control and resource management.*

The methodological implication for operationalising the above process have been elaborated in the following chapters. The concept of "**relative carrying capacity** " of urban centres or parts of a region may be useful in developing strategies towards spatial allocation of activities and resources, especially across large urban regions with competing centres (such as the Natural Capital Region of Delhi). Different urban centres may be compared in terms of their carrying capacity based development potentials.

FIGURE 1: ELEMENTS OF CARRYING CAPACITY BASED PLANNING PROCESS



CHAPTER 2

ASSESSMENT OF ENVIRONMENTAL CARRYING CAPACITIES OF URBAN AREAS

2.1 DIMENSIONS OF CARRYING CAPACITY: URBAN ENVIRONMENTAL COMPONENTS AND RESOURCES

2.1.1 An urban environment needs to have capacities to assimilate, i.e. to manage and recycle, various wastes - air, water, land and noise pollution - generated by its population and economic activities. It also requires capacities in terms of various natural and socio-economic resources and infrastructure, viz. land, water, energy, transport, social amenities, economic base and institutions to support its population and economic activities. Thus the two broad dimensions of environmental carrying capacities of urban areas may be categorized in terms of its:

- *Waste Assimilative Capacities;*

- *Carrying Capacities in respect of various Environmental Resources and Infrastructure.*

2.1.2 Several recent studies on urban indicators and environmental management help to identify the specific **Environmental Components and Resources** in respect of which carrying capacities of an urban area need to be assessed. The following research have been considered in the identification of the set of urban environmental resources as well as the **indicators** (see section 2.2) for assessment of their carrying capacities:

- *Urban Policy Goals and Indicators* developed by the UNCHS[1]

- *Resource Classification* developed in the Carrying Capacity Based Developmental Planning by the NEERI[2].

- *The Environmental Concerns* and the *Urban Environmental Indicators* proposed by the OECD[3].

- The *Urban Environmental Issues* (Problem Areas) and *Urban Environmental Indicators* developed by Leitman for UMP of World Bank[4].

Through a comparative analysis of case studies across seven developing countries of Asia, Europe and Latin America, Leitman has been able to group the major urban environmental problems into 13 areas (see APPENDIX - A) which can be linked specifically to the waste assimilative capacities of air, water, land, biological and cross-media components of these urban environment. Interestingly, noise pollution or the acoustic environment of cities has not been identified as a major environmental problem area.

Resource classification are helpful for inventorying the existing resource base of an urban region and analyzing impacts thereon of development scenarios. NEERI's classification of regional resources (See APPENDIX - B) help to identify the various environmental components in respect of which carrying capacity assessments are important for sustainable development of the city. Again, this resource classification identifies the air, water, land and biological resources, economic resources for urban industrial activities, organizational/institutional resources for both economic development and urban amenities and infrastructure industrial technological base and urban infrastructure and social amenities resources.

The OECD developed a set of environmental concerns in 1978 alongwith their indicators (see APPENDIX - C) which focusses on the urban environmental components of housing urban services, specifically, commercial, health, educational, recreational, transportation and protective services; employment, which have been considered as the key concern in respect of urban economy; air, water and acoustic environments; urban solid and hazardous waste management; and land quality and urban landscape which refers specifically to conservation, open spaces and landscape amenity. Although social and cultural concerns have also been listed, the list does not articulate any specification for this component.

The UNCHS has developed two sets of indicators: "urban indicators" and "Housing Indicators", where the enlisting of policy goals help to identify different urban environmental components for planning and development purposes (see APPENDIX - D). The urban indicators, organised into five different modules, focus on the environmental components of urban economy, specifically, poverty, employment and productivity; life quality of population in term of life expectancy, infant mortality, literacy, health,

education and social integration; urban utilities and services, viz. water, sewage, electricity, telephone; transportation infrastructure; and local government institutional resources. The housing indicators deal specifically of various policy goals for housing development.

The urban environmental indicators developed by Leitman for the World Bank UMP Project on Rapid urban Environmental Assessment (see APPENDIX -E) are organised under four modules covering demographic characteristics of population, growth rate, density, life expectancy, infant mortality and economic status; natural environment including its biological component; land characteristic in term of drainage and topography and climate; urban landuse; air quality and energy use in term of pollution emission, energy consumption and pollution control mechanism; water resources and supply and waste generation and management.

While varying in their scope and specific objectives, the above studies on classification of environmental issues and concerns, policy goals, resources and indicators help to identifying a comprehensive set of universally applicable urban environmental resources, for assessment of their carrying capacities, **Figure - 2** shows the proposed set of environmental components/resources constituting the carrying capacities of urban areas. The assimilative and supportive carrying capacity components are defined in the Figure.

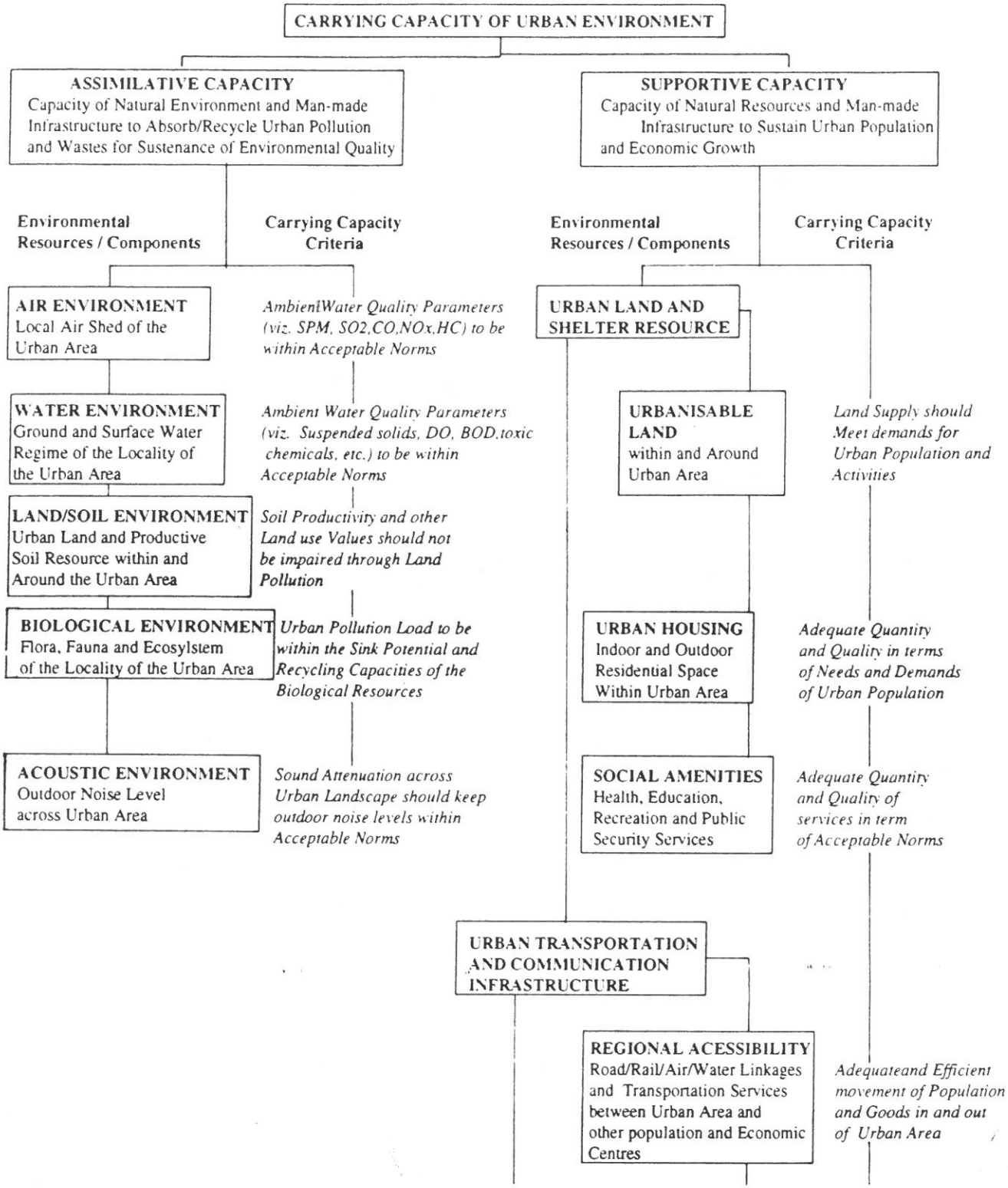
Furthermore, a set of **carrying capacity criteria** has been identified to define the carrying capacities of these environmental resources. In other words, what does carrying capacity in respect of each of these urban environmental resources would mean? The criteria serve as environmental policy goals for sustaining these environmental resources to support urban population and economic activities. The criteria are related to norms or standards of supply and demand or requirements of these environmental resources in an urban area. The development of **indicators** and **parameters for assessment** of carrying capacities of the environmental resources follow from these criteria or policy goals.

2.2 CARRYING CAPACITY INDICATORS FOR URBAN ENVIRONMENTAL RESOURCES

2.2.1 Indicators are measures of the status or the changes thereof for any environmental dimension. In this study, *indicators* have been developed to assess the *carrying capacities* of various environmental resources in terms of sustaining the quality of life and the needs and demands of population and economic activities for these resources across an urban area. As mentioned under section 2.1.2 several recent studies have attempted

FIGURE 2

ENVIRONMENTAL COMPONENTS/RESOURCES CONSTITUTING CARRYING CAPACITY OF URBAN AREAS



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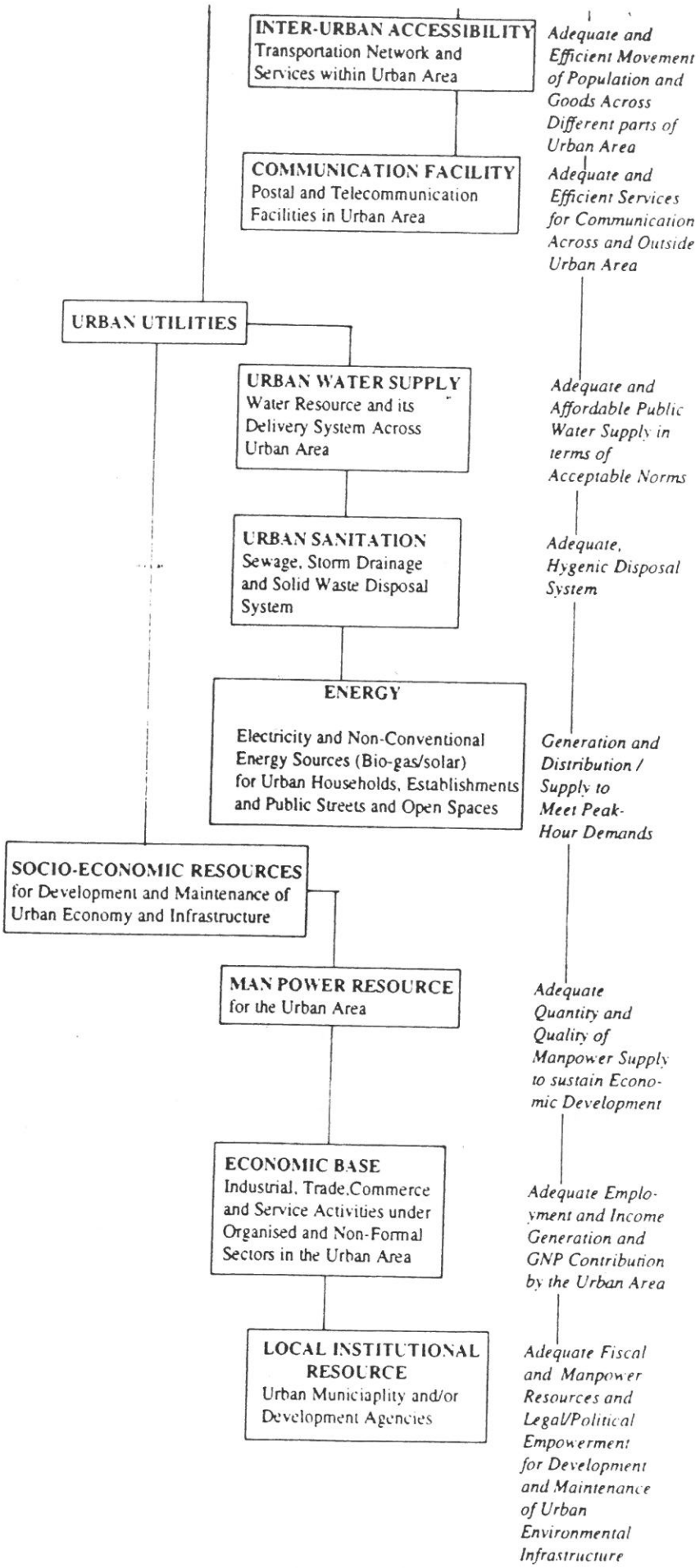

INTER-URBAN ACCESSIBILITY
Transportation Network and Services within Urban Area
Adequate and Efficient Movement of Population and Goods Across Different parts of Urban Area
COMMUNICATION FACILITY
Postal and Telecommunication Facilities in Urban Area
Adequate and Efficient Services for Communication Across and Outside Urban Area
URBAN UTILITIES
URBAN WATER SUPPLY
Water Resource and its Delivery System Across Urban Area
Adequate and Affordable Public Water Supply in terms of Acceptable Norms
URBAN SANITATION
Sewage, Storm Drainage and Solid Waste Disposal System
Adequate, Hygenic Disposal System
ENERGY
Electricity and Non-Conventional Energy Sources (Bio-gas/solar) for Urban Households, Establishments and Public Streets and Open Spaces
Generation and Distribution / Supply to Meet Peak-Hour Demands
SOCIO-ECONOMIC RESOURCES
for Development and Maintenance of Urban Economy and Infrastructure
MAN POWER RESOURCE
for the Urban Area
Adequate Quantity and Quality of Manpower Supply to sustain Economic Development
ECONOMIC BASE
Industrial, Trade,Commerce and Service Activities under Organised and Non-Formal Sectors in the Urban Area
Adequate Employment and Income Generation and GNP Contribution by the Urban Area
LOCAL INSTITUTIONAL RESOURCE
Urban Municiaplity and/or Development Agencies
Adequate Fiscal and Manpower Resources and Legal/Political Empowerment for Development and Maintenance of Urban Environmental Infrastructure

to develop indicators for measurement of various urban environmental dimension (See APPENDICES C through E). The objectives behind development of such indicator measures vary and the arrays reflect different sets of environmental issues, concerns or components, albeit with overlaps or commonalities. In essence, the indicators developed under the above studies help to measure various existing demographic characteristics and socio-economic qualities of urban life and the existing status of various natural as well as men-made urban amenities and resources. While none of these arrays of indicators may be directly applicable to measure carrying capacities of the set of urban environmental resources identified in this study (see Figure -2) several indicators across the arrays are helpful as parameters of carrying capacity measures in respect of several specific resources.

2.2.2 The carrying capacity indicators developed in this study to estimate capacities in respect of the various identified urban environmental resources are shown in TABLE 1 along with their respective parameters and procedure for measurement. Grouped under five (5) different modules, the carrying capacity indicators constitute:

Module A: Waste Assimilative Capacity indicators for air, water, land/soil, biological and acoustic environmental components of the urban area.

Module B: Supportive Capacity indicators for land, housing and various social amenity resources of the urban area.

Module C: Supportive capacity indicators for transportation infrastructure facilitating regional and internal accessibilities and communication infrastructure for the urban area.

Module D: Supportive capacity indicators of urban utilities, viz. water supply, sanitation and energy supply for the urban area.

Module E: Socio-economic capacity indicators of man-power resources, economic base and local institutional resources of the urban area.

- Attempt has been made to develop **multiple indicator measures** for the different environmental resources. Often - arbitrary selection of a single value to represent a complex environmental concern has been criticized in the past (Leitman, 1993, p2) as limitations in number of variables may fail to present a complete picture of the environmental issue.

- Indicators have been developed to assess resource capacities in **both quantitative and qualitative terms**

- The **quantitative measures** of several supportive resource capacity indicators **are related to population size.** In other words, their capacities are measured in term of the size of population these resource are capable of supporting; for instances, urban land resource, housing stock, occupancy rate in housing, household amenities, outdoor living space, extent of slumming, amount of health, educational, recreational and public security facilities, commercials resources, viz. postal and telephone services, installed capacities of water supply, sanitation and power generation, manpower supply and literacy rate, income and employment generation in urban economy and income, expenditure and man power capacity of urban local bodies can be related to their population support capacities.

- The waste assimilative capacity indicators deal with **natural assimilation** of pollution through ventilation, dilution/ absorption or sink potentials of urban airsheds, water regimes, soil environment and biological resource as well as **waste management capacities of man made infrastructure**, through emission controls, waste water treatment, solid waste management, noise control and attenuation methods, etc.
- **Stress Indicators:** Various indicators may help to indicate the **population and activity pressure** or stress on urban infrastructure resources and indirectly measure their capacities.

  Existing levels of air pollution emissions, waste water discharge, solid waste disposal and noise levels across urban areas may indicate stresses on the assimilative capacities of air, water, land, biological and acoustic environments.

In respect of supportive resources:

* "Slumming" in the cities indicates stress on shelter quantity and quality indirectly measuring the demand-supply gap for a section of the population or insufficient carrying capacity in respect of shelter resources.

* Both "accident rate" and "vehicle density" in urban areas indicate stress on urban transportation network and services or deficiency in the carrying capacity.

TABLE 1

INDICATORS AND ESTIMATIONS OF URBAN ENVIRONMENTAL CARRYING CAPACITIES

Module A: Waste Assimilative Capacities of Urban Environment

CARRYING CAPACITY INDICATORS FOR ENVIRONMENTAL COMPONENTS/RESOURCES	CARRYING CAPACITY ESTIMATION PARAMETERS
AIR ENVIRONMENT	
INDICATOR 1 *Natural Assimilation:* *Ventilation of Pollutants in M^2/S in the Local Air Shed During Lowest Windflow Seasons and Times of the Day.*	• Assimilation potential of air shed is estimated as the Ventilation Coefficient (VC) for the area which indicates both horizontal and vertical mixing. VC is estimated from meteorological data on MIXING HEIGHT and MEAN WIND SPEED for different seasons and hours . Ground Level Concentrations (GLC) of pollutants across an urban region may be predicted on the basis of VC, windirections and actual emissions from different sources.
INDICATOR 2 *Emission control: Air Pollutant Emissions in Kg/Hr from point, line and area sources in the urban area.*	• Emissions from: Point sources will depend on the numbers, types, production capacities, raw materials and process and stack emission control of air polluting industries; Line sources will depend on the number and composition of motor vehicles and their fuel use/combustion process and emission control and Area sources will depend on the population size, household, and domestic combustion across the urban area.
INDICATOR 3 *Cross Media Transfer from air to land/ water, especially of dust particles and acid rain.* *(Monthly Rainfall in MM).*	•Air to land/water transfer will depend on local precipitation level and its seasonal variation in relation to air pollution load in the local air shed. Rainfall may be a surrogate indicator generally across indian urban areas which will indicate air to land/water transfer capacity.

WATER ENVIRONMENT	
INDICATOR 4 *Natural Assimilation :* *Maximum Pollutant Load of the Critical Water Quality Parameters (viz. BOD, DO, TOXIE Chemicals, etc.) That Can be Discharged into the Local Water Shed without Impairing Water Quality for Designated Urban Uses.*	•Dilution of critical air quality parameters at the most polluted stretches of important water ways in the urban region during lowest flow period may be predicted/simulated on the basis of their hydrological conditions. •Waste water discharge across the urban area and its impact on the water quality of Critical Stretches of urban water-ways will determine the most critical stretches of Urban Waterways. •Hydro-geomorphological condition of the urban region in terms of delineation of watershed, drainage channels, ground water aquifer and soil drainage regime will determine the surface and ground water qualities in relation to waste water discharge.
INDICATOR 5 *Emission Control:* *Installed Capacities in MLD of Waste Water Treatment Facilities as proportion of Waste Water Generation in the Urban Area in term of* *(a) Municipal Sewage Treatment Plants* *(b) Industrial Waste Water Treatment/Recycling Plants.*	• Waste water discharge in waterbodies from Area sources will depend on population size, households and sewerage system and Point sources will depend on number, production capacities, raw materials and process and effluent control of industrial units.
LAND/SOIL ENVIRONMENT	
INDICATOR 6 *Natural Assimilation:* *Bio-Degradation Rate of Solid Wastes In Local Soil*	• Degradation in soil depends on their bio-chemical and physical properties, especially the presence of micro-organism as well as the class of solid wastes, i.e., bio-degradable/non biodegradable and movable/immovable wastes.
INDICATOR 7 *Solid Waste Management:* *Installed capacities of* *7.1 Municipal Solid Waste Collection in Gms Per Unit Population.* *7.2 Municipal Solid Waste Collection as percentage of generation in MTD* *7.3 Garbage Disposal Site in Ha/10000 persons* *7.4 Municipal/Industrial Solid Waste Treatment/Recycling Plant in MTD per 10,000 population.*	• Solid waste generation form Area sources depends on Population size and Expenditure pattern; Point sources depends on number, production capacities, raw materials and process and solid waste management of industrial/commercial establishments generating solid wastes. • Municipal Solid Waste Collection will depend on Manpower, transport facilities and the size, frequency and location of waste collector bins across the urban area • The location of the garbage disposal site in relation to inhabited areas of the city will determine the qualitative dimansion of its Carrying Capacity • Recycling may augment capacity in respect of energy and socio-economic (employment, income, etc.) resources.

BIOLOGICAL ENVIRONMENT	
INDICATOR 8 *Diversity and Stability of the Ecosystem in the Urban Region.* *(Types and Densities of Flora and Fauna)*	• A relatively mature, diverse and stable ecosystem will withstand better environmental impacts than a fragile system. Ecological parameters, especially available biomass, productivity, energy flow and food-web relationship and state of ecological succession in the region will indicate the relative stability of the ecosystem. In turn these will depend on the species diversity of flora, fauna, micro-organisms, etc.
INDICATOR 9 *Air Pollution Sink Potential of Land Vegetation in the Urban Region.* *(Types and Densities of Vegetation)*	• Sink potential index of individual plant species will depend on the size and frequency of stomata which varing with species density of vegetation and species types in the region will determine the overall assimilative capacity of the land vegetation.
INDICATOR 10 *Bio-degradation and Nutrient Uptake Rates in the Aquatic Ecosystem in the Urban Region (marshlands, lakes, ponds, rivers and marine ecosystems)*	• Natural waste water recycling in water through bio-degradation and nutrient uptake depends on micro-organism, aquatic vegetation, fishes, etc. Waste water load will affect water quality especially DO level which in turn will affect water ecosystem. Physical conditions, i.e., hydrological conditions, temperature and sunlight will influence water quality as well as bio-degradation process.
ACOUSTIC ENVIRONMENT	
INDICATOR 11 *Sound Attenuation in DBA Through Open Air Media Across the Urban Area.* *(% Open Space and Vegetation Density)*	• The % Noise Saturation Index of towns in Leq used by NEERI (1994) only shows existing status in term of proportion of ambient noise standards (CBCB) in the observed Ldn in DBA and not assimilative capacities of alternators. • Parameters affecting open air distances between noisy and silent zones, viz density, landuse zoning, building setbacks, etc. as well as sound buffers in open space, especially density and type of vegetation and other landscape buffers, viz. berms, walls, screens, etc., at critical noise sources, viz. roads, and highways, factory sites, etc. will determine the media absorption.
INDICATOR 12 *Sound Attenuation in DBA at Critical Point and Line Sources of Noise Across the urban area.* *(Presence/Absence of Control Installation and Legislations)*	• Noise levels from Line Sources will depend on the volume and composition of traffic along major roads and Point sources on location and types of industrial establishments and community noise sources, viz. loud speaker. • Noise control at source will depend on (a) Legislation viz. silence and noise zoning, road speed limits, time zoning of industrial operations, etc. and (b) Control Installation viz. enclosures, mufflers, screens, etc.

MODULE B : SUPPORTIVE CAPACITIES OF URBAN LAND AND SHELTER RESOURCES

CARRYING CAPACITY INDICATORS	CARRYING CAPACITY ESTIMATION PARAMETERS
URBAN LAND RESOURCE	
INDICATOR 13 *Population Holding Capacity of Developed Land Within Urban Area in Terms of Acceptable Gross Density/Land-Man Ratio. (Land-Man Ratio/Gross Density)*	• Developed urban land commonly refers to the urban statutory limit including municipal limits and other notified areas connected with offsite networks of utilities and services, but should exclude prime agricultural and rural lands and natural lands that need to be conserved and/or used for special purposes, viz. forests, marshlands, hills, rivers and lakes, etc. • For gross densities or land-man ratio there are no absolute norms; but planning norms should be developed based on local consideration as well as comparison with other cities. Opportunities for capacity augmentation through densification/infilling will depend on landuses, vacant land availability, land development costs and regulations specifically, sub-division, F.A.R. and building regulations as well as urban renewal.
INDICATOR 14 *Suitable Land For Physical Expansion of the Urban Area in Hectares/sq.kms.* *(Vacant land,"Waste Land",etc. in the Block/Tehsil of the Urban Area)*	• Land suitability for urban expansion need to take into account: * Physical constraints and natural berries, viz. topography, soil, natural drain water bodies. * Growth trend and desirable directions of growth of the urban area. * Conservation of surrounding productive lands, viz., good agricultural soil, aquifer recharge zones, etc. • Land classification data may be available at the level of Tehsil and District where the urban area is located. When detailed information on land types in the immediate surroundings are unavailable classified data at Tehsil level developed through satellite imageries and/or land records may indicate the types and amounts of land potentially available for future urban expansions.

HOUSING	
INDICATOR 15 *Census Housing Index:* *Ratio of Existing Housing stock Per Thousand Households.*	•Housing index measures deficiencies/surplus in the existing housing stock. Comparison with other Urban Areas and the National Average Index (eg. 980 in Census of India, 1991) will indicate the relative carrying capacity of the Urban Area
INDICATOR 16 *Rate of Housing Supply: No. of Housing Units Constructed and transferred to Users Per Year.*	• The rate may be measured through annual records of public agencies, co-operative societies, company housing records, municipal housing plan section and mutation records, Registrar's deed records, etc. Capacity will be determined by the rate of housing supply in excess of household growth rate.
INDICATOR 17 *Occupancy Rate: Average Floor Area Per Person (or Person Per Room) in Housing Units.*	• Measured by: Covered Area in Housing Stock $\frac{\text{}}{\text{(No. of Households-Houseless Households)x AV.H/Hold size.}}$ Capacity is determined by occupancy rate in excess of acceptable norm.
INDICATOR 18 *Permanent structures: Percentage of Housing Units with Structural Stability of > 20 years Under Normal Maintenance (% Census "Pucca" Houses)*	• Census data on frequency distributions of "Pucca","Kutcha" and "Semi-Pucca" units and Wall and Roof Materials will provide surrogate measures of structural stability "Pucca" may be considered as permanent structure.
INDICATOR 19 *Household Amenities: Percentage of Housing Units With* *19.1 Municipal Water Supply* *19.2 Electricity and* *19.3 Sanitary Latrine having Municipal Sewerage/Community Septic Tank Connections.*	• No. of Census households with water tap/electricity/toilet. • No. of domestic cunstomer(Meters) of electricity boards/corporations and Metered Water tax payers are alternative data source
INDICATOR 20 *Outdoor Living Space: Percentage of Households in Residential Areas of Having Net Densities Less than Acceptable Maximum Standard.* *(AV. Net Residential Density in the Urban Area)*	• Net Densities may be computed at housing cluster or neighborhood level including areas under local access roads, paths, children's park and common utility areas, but excluding collector and arterial roads and higher order community facility areas. Difference between existing and acceptable net density will indicate surplus/deficiency in capacity. In the absence of detailed information, average residential net density of urban area may be a surrogate measure.
INDICATOR 21 (Stress Indicator) *Extent of Slums: Percentage of Urban Population Living in Recognized slums.*	• Local authorities make official declaration of slum areas from time to time; but agency differences may exist in slum definition and data on slum units. Census notified slums may be one measure.

SOCIAL AMENITIES	
INDICATOR 22 *No. of Medical Beds Per 1000 Persons (in Hospitals, Clinics, Dispensaries, etc.)*	• District census publishes information on health, educational and recreational/cultural facilities for individual urban areas which may be supplemented by departmental records, municipal statistics and other sources. Census information are available on Numbers of Social facilities of different types which may be used as surrogate for Room or Space Capacities. • Levels of educational, health and recreational facilities vary with city size. Indicators of higher order facilities, such as, colleges and technical institutions should be considered for large urban areas.
INDICATOR 23 *No. of Doctors Per 1000 Persons*	• Public Outdoor recreational space complements private outdoor space and open spaces within housing areas. Municipal records of areas of parks and gardens is one source.
INDICATOR 24 *School Capacity: Class Room Capacity (in No. of Students) Per 1000 Persons in* *24.1 Primary Schools* *24.2 Secondary Schools* *24.3 High Schools* *(No. of Schools Per 1000 or Lakh Population)*	• Although there is no universal space standard for most of these facilities, locally acceptable norms and comparative analysis may be applied to determine relative carrying capacities of urban areas. • Various Norms and Standards for educational and health amenities have been developed by Indian agencies (See APPENDIX) which may be used to assess surplus/deficient capacities of Urban Area.
INDICATOR 25 *Outdoor Recreational Space: Area Under Parks and Playgrounds (in M2 or Hectare) per 1000 persons*	
INDICATOR 26 *Indoor Recreational Space: No. of seats memberships in Cinema/Theater/Auditorium/Clubs per 1000 persons*	
INDICATOR 27 *Public Security: Size of Police Force Per 10,000 persons.* *(No. of Recorded Thefts/Robbery and Other Crimes Per 10,000 Persons)*	• Crime rate may vary with city size, economic activities and population characteristics. Existing crime rate may be a surrogate indicator of capacity of security services.

MODULE C: SUPPORTIVE CAPACITIES OF URBAN TRANSPORTATION AND COMMUNICATION INFRASTRUCTURE

CARRYING CAPACITY INDICATORS	CARRYING CAPACITY ESTIMATION PARAMETERS
REGIONAL ACCESSIBILITY	
INDICATOR 28 *No. of Highways and Railway Lines Linking the Urban Area*	• Highway and railway links will indicate the relative nodality and accessibility of the urban area with respect to other centres or any given region.
INDICATOR 29 *Highway Link Capacity: Cumulative Right of Ways (R.O.Ws) or No. of Lanes of All Highway Links to the Urban Area. (Peak Hour Traffic Volumes)*	• Designated highway capacities are often reduced through encroachments upon ROWs near or inside urban areas. • Peak hour traffic counts in passenger car units (PCUs) on highways at cordon points along peripheries of the city and the city centre may surrogate actual capacities in term of traffic flow and also indicate difference with designed capacity. Traffic Volume capacities can be measured against standard ROWs of different road classes and normal speed limits.
INDICATOR 30 *Railway Line Capacity: No. of Chartered UP and DOWN Trains in the Railway Sections Linking the Urban Area*	• No. of trains actually operating will indicate surplus/deficiency in chartered capacity.
INDICATOR 31 *Regional Bus Service:* *31.1 Daily Regional Bus Trips To and Fro the Urban Area.* *31.2 No. of Major Urban Centres as Destination Points of Bus Service From The Urban Area.*	• No. of destination points (major urban areas) will indicate the regional nodality of the urban area.

INTRA-URBAN ACCESSIBILITY ***INDICATOR 32*** *Extent of road network: Total road area as percentage of total land area of urban area in sqkms/Ha.*	• Total road surface in relation of the citisize is a general indicator of its capacity to support movement. Although there is no universal standard, comparison with other cities will indicate relative carrying capacity. • Published information on road lengths may be useful surrogate indicator of capacity when information on road widths or area are not available.
INDICATOR 33 *Surfaced road length in kms in the urban area:* *33.1 Per sqkms/Ha of Urban Land Area* *33.2 Per 1000 Urban Population*	• Traffic flow capacity of the urban area and connectivity among its different parts depend on the extent of road network, their levels of hierarchy and R.O.W. or lane capacities. Peak hour traffic count surrogates actual capacity and indicates difference with designed capacity. • Public Works Departments and Local/Municipal bodies on information sources.
INDICATOR 34 *Planned Road Capacity in terms of cumulative R.O.W. in Meters/No. of Lanes in Urban Roads of Different Hierarchies, viz.* *34.1 Arterial Roads* *34.2 Sub-Arterial Roads* *34.3 Collector Roads* *34.4 Local Access Roads* *(Peak Hour Traffic Volumes)*	
INDICATOR 35 *Public Bus Service Capacity: Total No. of Bus Routes x Frequencies of Service*	• Difference between operating and designed frequencies and total and operating bus fleets will indicate idle capacity of bus and MRTS. • Only very large Indian cities have local bus services; but regional buses also serve local bus passenger movements. Information sources are the public and private bus companies.
INDICATOR 36 *MRTS Capacity: No. of Seats/Passenger Capacity x Frequency of Service*	• The indicator is applicable in special cases of large cities when the facility exists.
INDICATOR 37(Stress Indicator) *Average Peak Hour Journey Speed in KMPH Between City Centre and Periphery Along Different Directions:* *37.1 By Car* *37.2 By Bus.* *(Peak Hour Traffic Volumes along Major Arterials)*	• Journey speed will indicate relative congestion and stress on road capacity. Average journey speed may be measured through sample survey of vehicles and total time and route followed for different major routes/directions.
INDICATOR 38 (Stress Indicator) *No. of Traffic Accidents Per Year* *38.1 Per 1000 vehicles* *38.2 Per Unit Road Leng*	• Traffic accident counts indicate effects on capacities of road congestion, design of road system (conflicts, road engineering and geometry) and traffic control service.
INDICATOR 39 (Stress Indicator) *Vehicle Density: No. of Registered Vehicles Per Unit of Road Area (Sq.kms)/Road Lengths (kms.)*	• Vehicle density will surrogate planned volume capacity of roads in PCU under normal speed limits based on road widths or No. of lanes. However, existing registered vehicle data are generally aggregated at district/sub district rather than urban area level. Further, urban roads carry vehicles registered in other locations/districts.

COMMUNICATION FACILITY ***INDICATOR 40*** *Density of Communication Services: No. of Urban Population Served Per Unit of* *40.1 Post and Telegraph Office* *40.2 Telephone Line*	• Source: Post and Telegraph Department at City/district headquarters.

MODULE D : SUPPORTIVE CAPACITIES OF URBAN UTILITIES

CARRYING CAPACITY INDICATORS	CARRYING CAPACITY ESTIMATION PARAMETERS
WATER SUPPLY	
INDICATOR 41 *Distance in kms. of Urban Area from Water Source: Main Water Line Length From City Centre to Main Pumping Station/Water Works.*	• Capacity will reduce with distance due to pipeline and pumping costs for transporting water
INDICATOR 42 *Utilizable water in MCM/Y for the Urban Area in* *42.1 Rivers/Lakes/Reservoirs* *42.2 Ground water Aquifers*	• Quantity and quality of ground and surface water available for the urban area will depend on various hydro-geomorphological characteristics of the watershed where the ground and surface water bodies are located, specifically, precipitation rate, topography and natural drainage, soil and rate of recharge of ground water, distribution and depth of ground water aquifers, hydrology and flow in rivers, streams, etc., discharge from dams/reservoirs or waterworks into rivers, streams, lakes and wastewater discharge across the watershed. • Tehsil/Block level data on groundwater are usually available which may be used for the urban area.
INDICATOR 43 *Water Quality Parameters in Relation to Prescribed Norms for Designated Water Use for the Urban Area in* *43.1 Rivers/Lakes/Reservoirs* *43.2 Ground water Aquifers*	• CPCB prescribes norms/standards for different water quality parameters, i.e., DO, BOD, coliforms, dissolved solids, etc., for different classes of water use. Existing water quality of surface and ground water sources for the urban area can be measured against these standards.
INDICATOR 44 *Installed Capacity of Public Water Works, including Treatment Plant Capacity (if any), in LPCD*	• Difference between installed plant capacity and actual supply in LPCD will indicate capacity utilization and maintenance problems, viz. leakage. Actual supply to households and local public water taps will depend on capacities of local water reservoirs, pumping rate and water pressure in the mains. Difference between actual supply in LPCD and prescribed norms will indicate surplus/deficient capacity of public water supply.
INDICATOR 45 *Coverage of Public Water Supply Network as percentage of :* *45.1 Urban Population* *45.2 Urban Land Area*	• Coverage of public supply network may be estimated on the basis of No. of water connections to lots/housing units (see INDICATOR 19) and No. of public taps/tubewells per unit population according to acceptable norms/standard. No. of water meters will be applicable where the system exists. Distribution layout of installed water mains and branches and local reservoirs and pumping stations across the city will provide the land coverage of public water supply.

SANITATION ***INDICATOR 46*** *Percentage of Urban Population served by Sanitary Latrines connected to :* *46.1 Municipal Sewerage system* *46.2 Public Septic Tanks* *46.3 Private Septic Tanks* *(See also INDICATOR 19)* ***SEE INDICATOR 5*** *(Sewage/waste water treatment plant capacity)* ***SEE INDICATOR 7*** *(Solid Waste Management Capacity)*	• No. of sewerage system connection will indicate higher sewage disposal capacity than other systems in term of technology.
ENERGY ***INDICATOR 47*** *Installed capacities of Power Plants in KWH Per 1000 Urban Population Supplying Electricity to the Urban Area.* ***INDICATOR 48*** *Power Supply as percentage of peak Hour Power Requirement or Demand in MU.* ***SEE ALSO INDICATOR 19*** *(Percentage Housing Units/Population with Electricity)*	• Capacity will depend on generation in local plants of urban electricity supply corporation and /or state electricity boards as well as their power purchase from outside grids for supply to the urban area. Difference between installed capacities and plant generator will indicate idle capacities of plants. • Power requirement should be based on acceptable consumption norm per capita. Actual consumption may not indicate requirement in case of power failure. • Actual Supply level at different location of urban power grid may indicate distribution system capacity discounting loss, leakage, pilferage, etc.
NON-CONVENTIONAL ENERGY DEVELOPMENT ***INDICATOR 49*** *Installed Capacity of Non-Conventional Energy Sources in Urban Area in* *49.1 Bio-Gas Plants in BTU/KWH Per 10,000 Persons.* *49.2 Solar Panels in M2 Per 10,000 Persons.*	• These energy sources have little application to date in indian cities and therefore the indicator may have limited application at present, but future situation may change. • Bio-gas plants or energy generation from domestic wastes, hospital wastes may be installed at community level within residential neighborhoods and at special waste generation sites, viz. hospitals, hostels, hotels, etc. Capacity may be measured in term of MT of wastes handled, cubic meter of gas generation or BTU/KWH of heat/electricity supply. • Solar panels may be installed at building roof tops for water/space heating and electricity generation using photo-voltaic cells. Depending upon location and climate of the urban area, capacity estimate may be made on the basis of sq.meter of solar panel installed.

MODULE E: SUPPORTIVE CAPACITIES OF SOCIO - ECONOMIC RESOURCES

CARRYING CAPACITY INDICATORS	CARRYING CAPACITY ESTIMATION PARAMETERS
MANPOWER RESOURCE	
INDICATOR 50 *Labour Force: Total and as Percentage of Urban Population for:* *50.1 Male* *50.2 Female*	• Existing and potential future labour force will be constituted by the legal working age group population which may be estimated from the frequency distribution and natural growth and migration trends of population by age-sex groups . Difference between labour force and employment generation in the urban economy will indicate surplus/deficient capacity of urban man power vis-a-vis economic base.
INDICATOR 51 *Participation Rate :Workers Population Ratio (%)* *51.1 Main Workers* *51.2 Marginal Workers*	• Published data on participation rate indicates the trend in labour force utilization.
INDICATOR 52 *Adult Literacy Rate: Adult Literates as Percentage of Population for* *52.1 Male* *52.2 Female*	• Literacy rate indicates availability of skilled vis-a-vis unskilled manpower.
ECONOMIC BASE	
INDICATOR 53 *Annual Value Added Per Capita Urban Population in Industrial Economy for* *53.1 Large and medium sector units* *53.2 Small scale industries units* *53.3 Unorganised sector units* *53.4 Commercial Establishments*	• Classification of establishments should be made on the basis of NIC or similar National classification system. • Location/Region specific input-output analysis may be necessary estimate location and sector specific outputs, value added, employment, etc.
INDICATOR 54 *Ratio of Employed (in Different Urban Sectors) and Total Urban Population.*	• Published census data on urban workers in different sector should be complemented with information from other secondary sources. Estimation of employment generation is required through studies as different urban economic sectors.

LOCAL INSTITUTIONAL RESOURCE	
INDICATOR 55 *Annual Revenue Income of Local Bodies Per Capita Urban Population*	• Income from taxes, fees, octroi, lease, rent and sale and interests should indicate the financial capacity of the municipality. Income from grants and loans are not true indicators of capacity.
INDICATOR 56 *Annual Expenditure, Excluding Debt Service and Salary Expenditure of Local Bodies Per Capita Urban Population*	• Expenditure on capital heads and costs of urban services, viz. water supply, road maintenance, garbage disposal, street lighting, operation of educational and health services, etc. will indicate the spending capacity of local bodies.
INDICATOR 57 *No. of Employee in Local Bodies Per 1000 Urban Population*	• Municipal yearbooks and statistical often provide sources of information on municipal income, expenditure, employment, etc.
INDICATOR 58 *Political and Legal Autonomy of Urban Local Bodies Under State Legislation for :* *1. Setting Revenue Rates* *2. Development Control*	• Urban municipalities are governed by state municipal acts which vary from state to state. The relative flexibility under state acts in respect of municipal authorities, power to set revenue rates and for development control functions will provide the relative legal and fiscal autonomy of local bodies. For instance, the range between maximum and minimum municipal tax limits vary across states, large cities/metropolises (like Bombay or Calcutta) may be governed under separate acts,etc.

- **Surrogate Indicators:** Surrogate measures are useful especially when the necessary information on estimation parameters for the Carrying Capacity indicator are difficult to obtain. These have been shown in parenthesis in the TABLE 1. The stress indicators also provide surrogate measures in terms of deficiencies in capacities.

2.2.3 Estimation of Carrying Capacity Indicators

2.2.3.1 Several Carrying Capacity indicators are measurable against existing **Standards** or **Norms**: (see APPENDICES F&G)

- Standards are applicable for assimilative capacity measures in respect of ambient air and water quality parameters and acceptable noise levels for urban landuses. In the indian context, air, water and noise quality standards are developed through several environmental legislations and implemented through the central as well as local or state pollution control boards (see APPENDIX F).

- The Planning Commission and several National Level Commission in India have attempted from time to time to develop norms or acceptable standards in respect of several urban infrastructure and services, especially those related to public health, viz. water supply, sanitation, health facilities, etc. against whom capacity indicators may be measured (APPENDIX G).

- Capacity norms for transportation infrastructure and services may be available through state public works departments and highway and railway authorities in India in term of lane capacities, right of ways of highways and urban roads and chartered number of trains for different classes of railway lines .

- Similarly, various other individual public authorities or departments responsible for planning and development of individual social infrastructure, such as central and state health departments, education departments, postal and telephone authorities etc., may have there own norms for capacities of such infrastructures in term of space requirement, numbers or frequencies, personnel requirements, etc., in relation to the population size these infrastructure should serve (VIZ APPENDIX G).

2.2.3.2 **Relative Measures:** Carrying Capacity estimate of urban areas should be viewed more in **relative rather than absolute terms.** For, locally applicable standards or norms are unavailable for various estimation parameters whereby absolute measures of capacities can be worked out. Furthermore, socio-economic and physical factors determining parameters for capacity estimation of different urban social resources like housing space,level of social amenities, urban land resource, etc., may vary across urban areas, regions and nations and, therefore, universal standards are not applicable. For instance, it is difficult, if not futile, to develop absolute measures or universal standards in respect of urban gross deminities, net deminities of residential areas, occupancy rates in housing, outdoor recreation space or even maximum levels of domestic water and energy supply, for the requirements for such social resources vary widely with income, life style and culture and even city size.

While there is the need for development of local norms for social resources applicable across homogenous societies or population, relative measures of carrying capacities of urban entities may be an useful approach for decision making in urban environmental planning and management. Each of the carrying capacity indicators developed may be used to compare among urban areas at sub-regional, regional, sub-national or national level. National level indicators are available for some resources, such as National Average Urban Housing Index, average adult literacy rate in cities, against whom the capacity of a particular urban areas may be measured. More useful comparisons may be made through indicators for classified cities, such as cities of similar population size or function. **"Relative Carrying Capacities"** of urban areas analyzed at the level of defined planning regions (such as the NCR of Delhi) will be useful to develop spatial strategies for allocation of population, activities and resources across the region towards sustainable development as well as plans for environmental management of individual urban areas in relation to their respective carrying capacities.

2.2.3.3 **Estimation of "Hot-Spots"**: Hotspots may be identified as locations or resources with critical deficiency in assimilative or supportive carrying capacities. For instance, a particular city in a region may be a hotspot in term of air assimilative capacity in a region; a particular stretch of river may be hotspot in term of water assimilation capacity; a city or tahsil or district may be hotspot in term of supportive water resources. The carrying capacity of a particular location is determined, more often than not, by its capacity in term of the most limiting

resource to support human quality of life; for instance, water or energy may be the most critical resources for many regions, such as the NCR. Estimation of hotspots within a city or across a region is therefore necessary, in order to identify priority among environmental concerns or to prepare plans for carrying capacity management on priority basis. Estimation, again, may be made in absolute (where absolute measures/standards are available) or relative terms.

2.2.3.4 **Setting Priority and Building Overall Index of Carrying Capacity:**

Deriving an aggregative measure of environmental carrying capacity for an urban area poses the vexing question of setting priorities among environmental concerns and assigning " weights" to these as well as to the various indicators or their measures. Single environmental index have been developed in impact assessment studies through multi-dimensional scaling, such as the Batle-Columbus Environmental Quality Index. Also **Quality of Life** measure has been advocated as a measure of human carrying capacity (eg. Bishop, 1974: 32). The NEERI (1994) has attempted to develop a holistic measure of Quality of Life build upon economic, social and biological needs of population as advocated by Maslow (1954) (see APPENDIX - H for the factors and methods of measurement of Quality of Life).

However, such holistic index approaches are invariably open to judgmental calls either through so-called "experts" judgement or the perceived needs of people for different factors of life. Thus, a valid approach may be to leave the array of environmental resources and their capacity indicators open to local participatory decision-making for tradeoffs among these resources or concerns or setting priorities among them, especially since urban environmental problems and the perception of these may vary widely across urban areas and regions.

2.2.3.5 **Spatial context of carrying capacity indicators**

The indicators developed here are intended to measure carrying capacities in respect of resources that support the population and activities of a particular urban area. While some such resources may be available within the statutory spatial jurisdiction of the urban area, various others, especially natural resources like air, water or land and even social resources like regional transportation links, energy sources, etc., transcend typical urban spatial boundaries. Thus the information base and parameters for assessment of carrying capacities lie both within and outside the urban limit. Furthermore, various environmental information are often

available at aggregate levels, i.e., at the level of blocks, tehsils, districts or even sub-regions. For instance, motor vehicle registration data are available at District/sub district levels; natural land classification data, water resource data, etc., may be available at block/tahsil level - which poses difficulties in spatial resolution for analysis (The various sources of information base for individual indicator measures have been identified in TABLE 1).

When the carrying capacity of an urban areas is dependent largely on environmental resources in "distant" locations, the urban area is said to have "**Appropriated Carrying Capacity**" (viz., Rees, 1972; whitney, 1990). Water supply, energy supply or even manpower supply are common example of environmental resources which an urban area may appropriate. Appropriated carrying capacities may be analysed through input-output of goods, services, migration, etc. between the urban area under study and the "distant" places or regions.

2.2.3.6 Urban Information System for Carrying Capacity Assessment

The specific parameters and information base necessary for estimation of individual carrying capacity indicators are outlined in TABLE 1 which may be helpful in developing a global urban information system for carrying capacity assessment for use at local municipal and regional levels, with periodical data update.

2.3 CASE STUDIES OF USE OF CARRYING CAPACITY INDICATORS

2.3.1 Waste Assimilative Capacities of the National Capital Region (NCR) of Delhi:

Several indicators developed in this study can be applied to assess the assimilative capacities of air, water, acoustic, land and biological resources of the entire region as well as NCR cities, especially Delhi, using the data generated through a joint collaborative study on Carrying Capacity Based Development Planning for the NCR.

BOX ITEM 1: Assimilative Capacity of Air Environment of Delhi and NCR

* ***Natural Assimilation (INDICATOR 1):*** *Ventilation co-efficients(VC) for different seasons and hours of the day have been measured for Delhi (for instance, see Fig 3 for January 1990 data). VC peaks during the highest insolation periods of the day, especially during 12-16 Hrs. and tends to be lowest during early morning, i.e. 4-8 Hrs. across months of this year. It tends to peak in summer (June) afternoon hours (12-16 Hrs) and ebb in winter (December-February) early morning hours (4-8 Hrs). This indicates the variations in the natural assimilative capacity of the local air shed (or conversely, its ambient air pollution concentration potential) across seasons and hours of the day. Actual measures of ambient air quality in respect of parameters. SPM, NOx,SO2 for Delhi measured across 10 sampling sites of the CPCB during 1989-91 indicates variation in concentration of the parameters across the seasons (see Figure 4).*

* ***Air Pollution Emission from Point, Line and Area Sources (INDICATOR 2):***

Total gross emissions from the three sources of parameters: SO2, NOx, SPM, CO and HC in different 24kmsx24kms grids of NCR have been estimated from secondary source data (for instance, see Fig 5). Point source data have been estimated on the basis of the number and types of industries across different areas/cities of NCR. Area source data have been estimated on the basis of urban and rural population (1991) in major grids and line source data have been made on the basis of growth and comparison of vehicles in Delhi and other parts of NCR.

* ***Relative Carrying Capacity and Hotspots in respect of Air Environment***

Air Quality Exposure Index (AQE1) (Oak Ridge Index) has been estimated by NEERI on the basis of the above two indicators (natural ventilation and emission) to model potential combined Ground Level Concentration (GLC) effects of SPM, SO2 and NOx across the Grids (see Figure 6). Delhi area has been ranked as "dangerous" category.

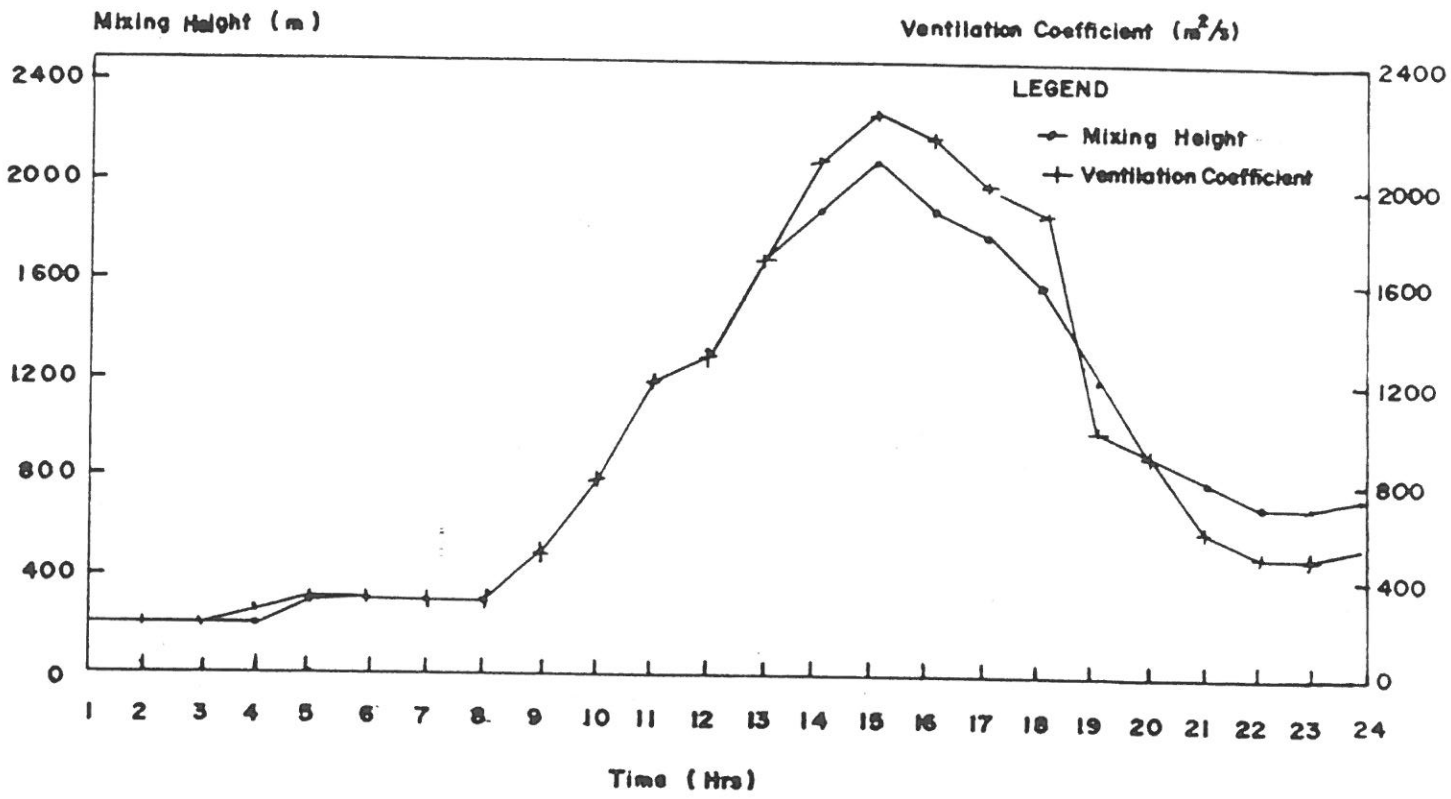


Fig. 3 : Diurnal Variations of Mixing Height and Ventilation Coefficient for January, 1990 (Delhi)

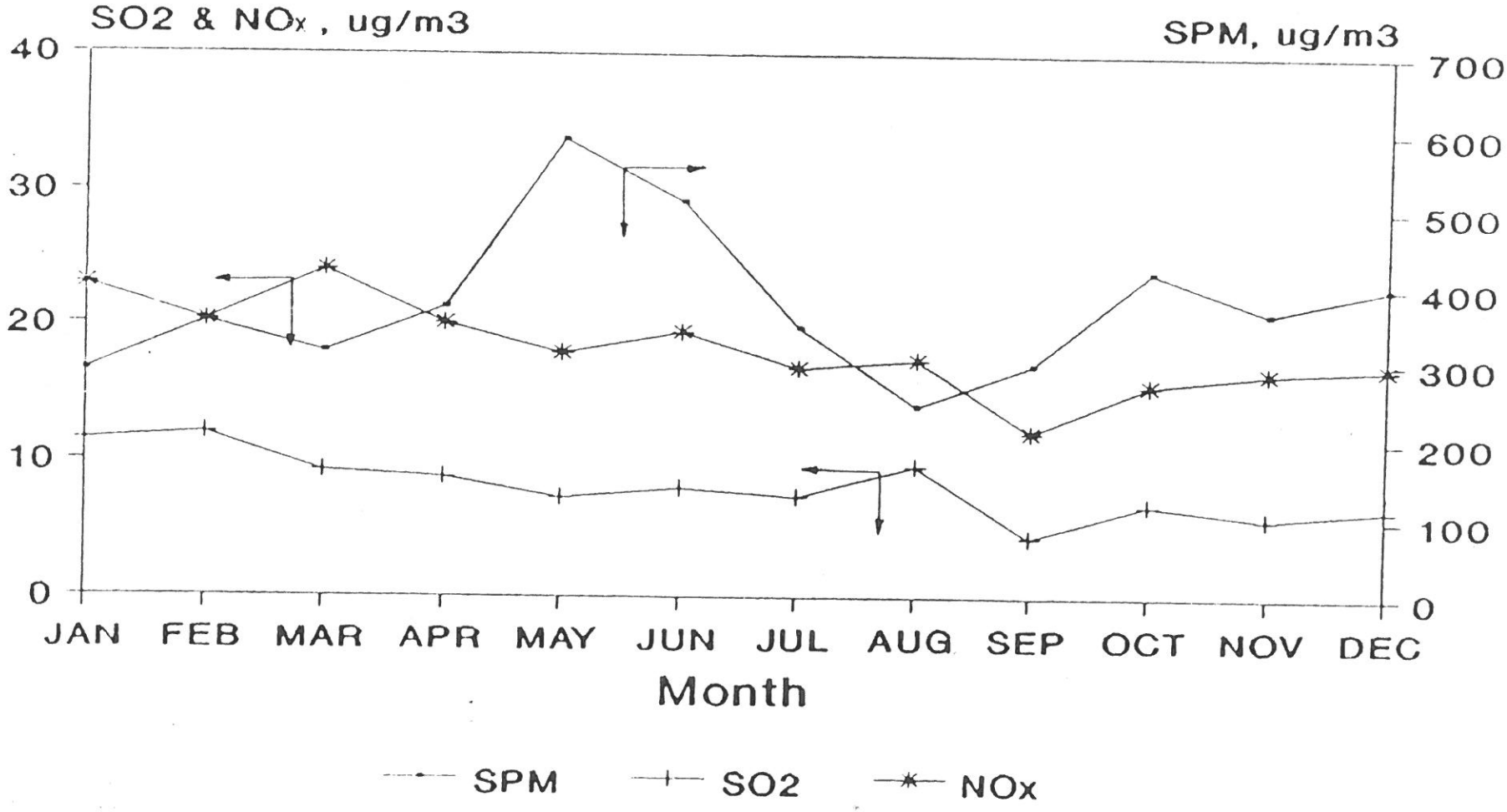


Fig: 4 Average Ambient Air Quality : Delhi (1989-91)

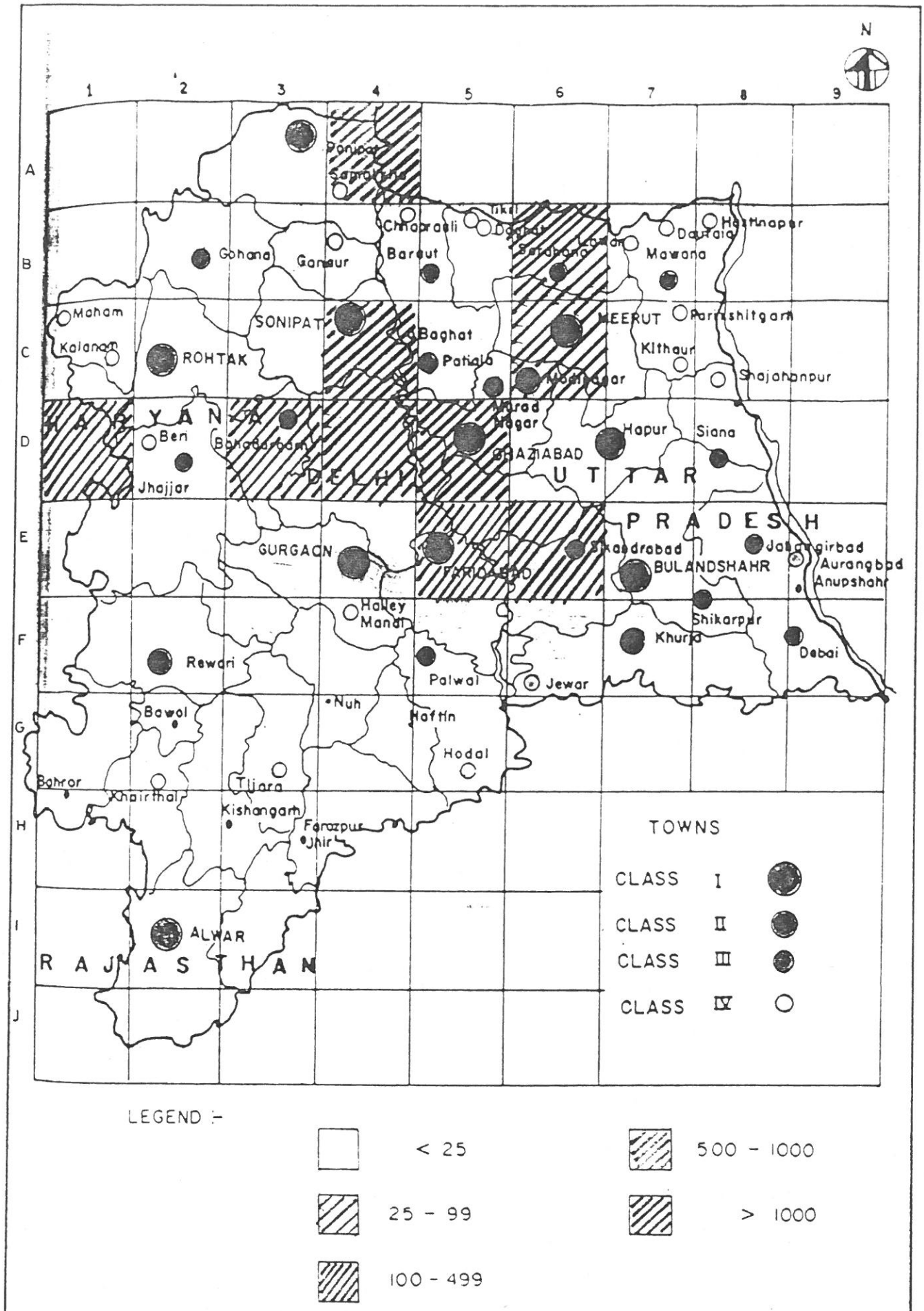


Fig. 5 : Emission Level in Different Grids of NCR (SO_2: kg/hr)

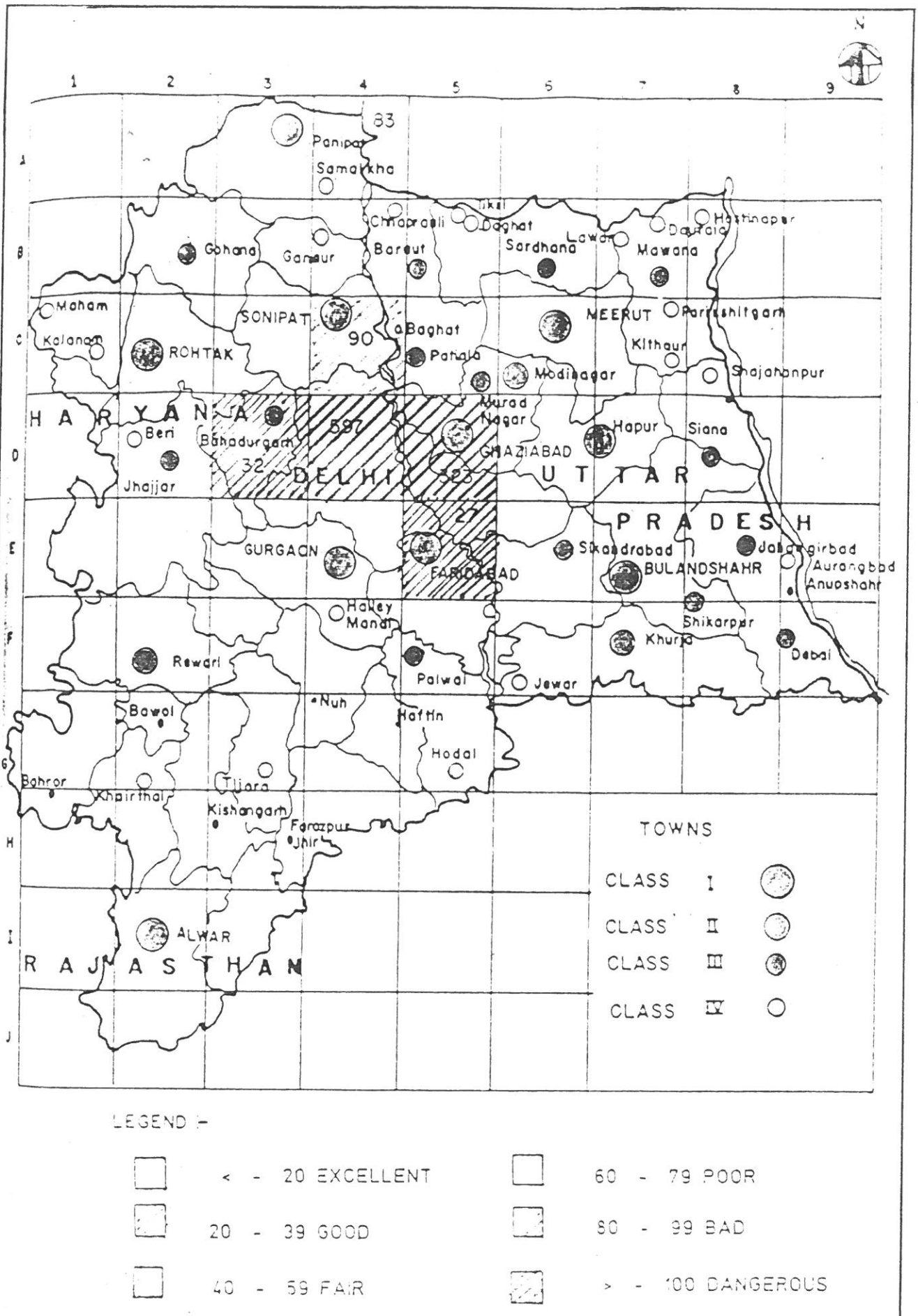


Fig. 6 Relative Ranking of Grids With Respect to Pollution Index -

BOX ITEM 2 : Assimilative Capacity of Water Environment of Delhi and NCR

* ***Natural Assimilation - Maximum Dischargeable Pollution Load in Local Water Environment (Yamuna River) (INDICATOR 4):***

- *While there are four river sub-basins in the NCR watershed, Yamuna River has been identified as the critical example for waste assimilative capacity assessment in view of the regions water use, natural drainage, waste water discharge and ambient water quality data which indicate that the river water quality is unsuitable for its best use classification made by the CPCB (class-C: drinking water source with conventional treatment followed by disinfection).*

- *The most critical stretch of the River has been identified as a 25 kms. stretch between Wazirabad on North and Okhla on South, on the basis of water usage and ambient water quality at different stretches.*

- *BOD has been chosen as the critical parameter since upstream BOD is more than derived level. Assimilative Capacity needs to be assessed for BOD load during the critical flow period, i.e. summer.*

- *Simulated estimates of maximum upstream BOD load has been generated through QUAL-IIc celiberated model to achieve the desired limiting downstream value (through natural assimilation) of 3mg/l. A BOD load of 23.0 mg/l or 43,804.8 kg/day has been found to achieve this condition (NEERI, 1994). Thus, the present discharge of 1,12,512.0 kg/day along the stretch is three times the above assimilative capacity.*

* ***Emission Control - Capacity of Waste Water Treatment as Proportion of Generation (INDICATOR 5):***

- *In the NCR, sewage and industrial wastes are not treated in any of the industrially developed town except the capital city of Delhi.*

- *Waste water treatment in NCT Delhi is 1065 MLD which is 47.02% of the generation of 2265 MLD (NEERI, 1994).*

BOX ITEM 3: Assimilative Capacity of Land/Soil Environmental NCR

* ***Municipal Solid Waste Collection in grams per unit population (INDICATOR 7.1)***

- *The Relative Carrying Capacities of 12 class I cities of NCR in term of this indicator are apparent from TABLE . The U.P. cities of Ghaziabad and NOIDA have much higher carrying capacities than other cities; Alwar has the least capacity in term of solid waste collection (ORG, 1994).*

* ***Solid Waste Collection as % of Generation (INDICATOR 7.2):***

- *Separate sets of data have been collected for (1) Solid Waste Collection (MTD) (ORG, 1994) and (2) Municipal solid wastes (T/day) (Municipal Authorities, 1992-93) for various cities of NCR including Delhi; but the data are not compatible in terms of time.*

- *Observational surveys (NEERI, 1994) however raise several critical issues w.r.t. to Solid Waste Collection Capacities of NCR Cities:*

  Generally inadequate collection in the region.

  Improper size and location of collection bins.

  Inadequate transportation capacity for collection.

Apart from municipal waste, a large quantity of slaughter house wastes, and industrial wastes are generated. About 20-25 Tones of hazardous hospital wastes are generated in Delhi, but presently horpital wastes are mixed with municipal solid waste. Industrial wastes are being recycled to the extent possible.

* ***Solid Waste Disposal Site Capacity (INDICATOR 7.3):***

- *Information on disposal site capacity have not been collected; but observation indicate that uncontrolled dumping at the nearest available low lying sites within inhabited areas is being practiced across NCR cities (NEERI, 1994), leading to health hazards, land degradation and contamination of surface and*

BOX ITEM 4: Assimilative Capacity of Biological Environment of Delhi

* ***Air Pollution Sink Potential of Vegetation (INDICATOR 9):***

- *Sink Potential Index values for different dominant plant species at different sampling sites in Delhi have been estimated, which show that plants like Jamun or Neem have much higher sink potential than other dominant species, especially Peepal, Ashok or Amaltas. The overall air pollution assimilation by the vegetative environment will depend on the density of plant species of specific sink potential index values.*

* ***Diversity of the Ecosystem (INDICATOR 8):***

- *Several "Hotspots" have been identified in the biological (vegetative) environment of Delhi on account of lack of vegetation:*

  Southern Ridge Forest is being denuded with illegal felling and urban encroachments;

  Old Delhi Suffers from air pollution and lack of space for streetside plantation; etc.

2.3.2. Supportive Carrying Capacities of NCR Cities

Several indicator measures of carrying capacities of various supportive resources have been applied across several cities of the NCR the results of which are presented in TABLE 2. Such comparative analysis is helpful towards objective assessment of growth or development potentials of urban centres across a region in order to develop strategies for future urbanisation based on carrying capacities of urban environmental resources. Besides Delhi, several Class I cities (1991) within Delhi Metropolitan Area (DMA) and among the "priority towns" outside DMA as identified as future growth centres by the Regional Plan-2001 of the National Capital Region Planning Board (NCRPB) have used for this application.

Obviously all the assessment indicators developed in the study could not be used and only those for which information for most the cities are readily available have been selected. Further, data gaps exist even across the selected indicators. Nevertheless, the NCR case study in illustrative of the use of both assimilative & supportive carrying capacity measures in urban and regard planning. The conclusions from the relative carrying capacity assessment of the urban areas have been summarised under BOX ITEM 5 which may be helpful in developing scenarios for urban development across NCR.

TABLE 2

GROWTH , SUPPORTIVE AND ASSIMILATIVE CARRYING CAPACITIES OF CLASS-1 CITIES OF NCR : A COMPARATIVE EVALUATION

INDICES	NCTD		U.P. SUB-REGION					HARYANA SUB-REGION					RAJ.S.REG.
	DELHI	NOIDA	G'BAD	B'SHAHR	HAPUR	M'NAGAR	MEERUT	F'BAD	G'GAON	SONIPAT	PANIPAT	ROHTAK	ALWAR
I. ENVIRONMENTAL POLLUTION STRESS													
1. Local Air Pollution (Pollution Index & Emissions)	Dang. (NCTD)	Dang.	Dang.	Exce.	Exce.	Exce.	Exce.	Good	Exce.	Bad	Exce.	Exce.	Exce.
	L	L	L	H	H	M	M	M	H	L	H	H	H
2. Water Environment & Ground Water Balance	Quality Quantity Excess W.Drawl		Salinity in low W.T	Quality	Quality Quantity		Quality	Salinity	Excess W.drawl	Excess W.drawl	Excess W.drawl Salinity	Quality	Excess W.drawl
	- 60.33		309.11	471.05			792	243.86	75.47	314.38	- 19.2	543.52	170.2
	L		M	H	H		H	M	M	M	L	H	M
3. Noise Pollution (Avg. Percent Noise Saturation Level)													
Day Time (dB)	114.21	105.25	112.75	108	110.33	_	113.75	102.75	107.75	_	93.75	112.25	104.25
	L	M	L	M	L		L	M	M		H	L	H
Night Time (dB)	127.15	106.5	120.5	114	120.33	_	115.25	113	112.25	_	104.25	123	105
	L	M	L	M	L		L	M	M		H	L	H

Contd..../-

INDICES	NCTD		U.P. SUB-REGION					HARYANA SUB-REGION					RAJ.S.REG.
	DELHI	NOIDA	G'BAD	B'SHAHR	HAPUR	M'NAGAR	MEERUT	F'BAD	G'GAON	SONIPAT	PANIPAT	ROHTAK	ALWAR
II. REGIONAL ACCESSIBILITY													
4. Nodality (Highway Links in Urb.Area)	HIGH H	HIGH H	HIGH H	LOW L	MOD M	MOD M	MOD M	HIGH H	MOD M	MOD M	LOW L	LOW L	LOW L
5. Access Time (Minutes by Car)													
a. To Delhi	0	20 H	24 H	72 M	49 M	47 M	75 M	34 H	31 H	83 M	110 L	83 M	154 L
b. Other NCR Cities(cumltv)	–	889 H	801 H	1223 M	977 H	985 H	1201 M	1001 M	972 H	1352 M	1583 M	1382 M	2189 L
6. Regional Bus Service (No. of Daily Trips)	4001* H	–	725 M	199 L	292 L	192 L	984 M	–	834 M	1070 M	746 M	451 L	397 L
III. INTERNAL ACCESSIBILITY													
7. District Road Density													
a. Kms./Sq.Km.	12.86 H	–	0.75 M	0.44 M	–	–	–	0.53 M	0.56 M	0.47 M	–	0.36 L	0.22 L
b. Kms./1000 Persons	2.03 H	–	0.7 L	0.67 L	–	–	–	0.78 L	1.35 M	1.35 M	–	0.88 L	0.8 L
8. Road Area as % of Total Urban Area	–	13.6 H	7.61 M	15.5 H	8.8 M	–	–	–	–	–	10.18 H	–	6.4 M
9. City Road Density													
a. Kms./Sq.Kms	12.86 M	18.18 M	3.78 L	16.99 M	26.52 H		5.14 L	5.05 L	8.74 M	2.95 L	9.02 M	5.28 L	3.27 L
10. Road Patteren (Planned/Organic)	PLN. H	PLN. H	ORG. L	ORG. L	ORG. L	PLN. H	ORG. L	PLN. H	PLN. H	ORG. L	ORG. L	ORG. L	PLN. H

Contd..../-

INDICES	NCTD		U.P. SUB-REGION					HARYANA SUB-REGION					RAJ.S.REG.
	DELHI	NOIDA	G'BAD	B'SHAHR	HAPUR	M'NAGAR	MEERUT	F'BAD	G'GAON	SONIPAT	PANIPAT	ROHTAK	ALWAR
IV. URBAN LAND RESOURCE													
11. Potential Urbanizable Land in Tehsil (Ha) ("waste" & "rocky" lands)	11621.98 M (Tehsil)	–	1603.14 L	549.77 L	648.22 L	–	171.22 L	4517.57 M	21979.32 H	6001.84 M	8081.48 M	14877.05 M	48355.04 H
12. District wise Urban Land-Man Ratio(settlement+transportation land Hectares/1000 persons)	8.07 M	–	15.15 H	8.51 M	–	–	8.42 M	9.47 M	10.37 M	12.1 H	6.21 L	8.4 M	5.32 L
13. City Land-Man Ratio (Hectares/1000 persons)	15.78 M	61.72 H	14.58 M	9.69 L	9.71 L	16.99 M	20.89 M	58.07 H	17.76 M	19.67 M	10.89 L	13.13 M	27.66 M
14. Additional Holding Capacities (1991-2001) (As per Regional Plan Density Norm)	–	983861 M	421241 M	26924 L	9938 L	138596 M	1369951 M	3841922 H	165741 M	210078 M	69038 L	96084 L	429284 M
V. HOUSING STOCK & QUALITY													
15. Census Housing Index	958 M	965 M	919 L	882 L	940 M	972 M	943 M	965 M	998 H	996 H	998 H	975 L	989 M
16. Permanent Structures % Pucca Houses	86.49 M	82.17 M	86.05 M	43.39 L	76.99 M	–	79.22 M	81.87 M	94.41 H	64.89 L	63.59 L	72.62 M	92.77 H
17. Slums - % Population	21.38 M	–	–	67.08 L	31.83 M	34.93 M	17.85 H	24.28 M	25.89 M	37.53 M	16.42 H	23.61 M	–
18. Household Amenities (% of Households With Electricity and Toilet)	59.86 L	58.91 L	69.39 M	82.21 H	65.33 L	76.29 H	73.69 M	57.01 L	76.87 H	67.73 M	77.13 M	72 M	73.78 M

Contd..../-

INDICES	NCTD		U.P. SUB-REGION							HARYANA SUB-REGION				RAJ.S.REG.
	DELHI	NOIDA	G'BAD	B'SHAHR	HAPUR	M'NAGAR	MEERUT	F'BAD	G'GAON	SONIPAT	PANIPAT	ROHTAK	ALWAR	
VI. URBAN UTILITIES														
19. Water Supply Coverage	100%	100%	100%	65%	75%		75%	90%	90%	–	75%	80%	70%	
Population	H	H	H	L	M		M	H	H		M	M	M	
20. Per Capita W.Supply (lpcd)	245	488	152	182	7		102	147	135	–	128	105	86	
	M	H	M	M	L		M	M	M		M	M		
21. Sewerage Coverage	100	100	85		15		47	70	40	–	25	40	–	
Population	H	H	M		L		M	M	M		L	M		
22. Solid Waste	425	477	573	39	171		265	243	147	–	131	116	0.37	
Collection/Pop.(gms.)	H	H	H	L	M		M	M	M		M	M	L	
23. Power Supply	100		95	91	83	95	54	82	95	74	80	91	–	
as % of Demand (MU)	H		H	M	M	M	L	M	H	M	M	M		

Contd..../-

INDICES	NCTD		U.P. SUB-REGION						HARYANA SUB-REGION					RAJ.S.REG.
	DELHI	NOIDA	G'BAD	B'SHAHR	HAPUR	M'NAGAR	MEERUT	F'BAD	G'GAON	SONIPAT	PANIPAT	ROHTAK	ALWAR	
VII. ECONOMIC BASE AND DEVELOPMENT & PROSPECT														
24. Workers Population Ratio Sub-Regionwise data	Delhi NCT - 31.82 M			Haryana - 28.37 L			U.P. - 42.28 H				Rajasthan - 27.78 L			
25. Per Capita Value Added														
L & M	Delhi NCT - 0.49 L			Haryana - 4.86 M			U.P. - 1.84 L				Rajasthan - 7.09 H			
SSI	Delhi NCT - 2.03 M			Haryana - 5.92 H			U.P. - 1.23 L				Rajasthan - 2.36 M			
26. Estimated Employment in Industries as % of Population														
L & M	Delhi NCT - 0.21 L			Haryana - 4.92 H			U.P. - 1.58 M				Rajasthan - 2.63 M			
SSI	Delhi NCT - 3.15 M			Haryana - 6.68 H			U.P. - 2.87 L				Rajasthan - 3.9 M			
27. No.of Industrial Units														
L & M	53 M	40 M	222 H	32 M			29 M	51 M	15 L	12 L	8 L	9 L	84 M	
SSI	13715 H	2271 M	3304 M	1780 M	309 L		4575 M	5481 M	4062 M	–	3911 M	2136 M	2992 M	
28. % Annual Growth in														
L & M	3.6 L	–	12.68 M	15.9 M			11.83 M	1.55 L	54.12 H	5.95 L	2.78 L	–	35.42 H	
SSI	7.33 L	–	19.62 M	31.45 H	11.53 M		20.09 M	20.22 M	23.13 M	–	16.15 M	17.06 M	4.8 L	
29. Proposed Mega Projects	–	STP	–	–	–	–	–	–	TV,STP,E EHTP,FC	–	–	–	HT	
VIII. MUNICIPAL INCOME														
30. Municip. Income per Capita	4788.66 H	–	81.49 L	94.05 L	75.65 L			204.82 M	128.4 L	133.65 L	142.22 L	118.16 L	121.98 L	

Contd..../-

INDICES	NCTD		U.P. SUB-REGION						HARYANA SUB-REGION					RAJ.S.REG.
	DELHI	NOIDA	G'BAD	B'SHAHR	HAPUR	M'NAGAR	MEERUT	F'BAD	G'GAON	SONIPAT	PANIPAT	ROHTAK	ALWAR	
IX. POPULATION GROWTH POTENTIAL														
31. Base Population (1991)	8471625 H	146514 L	511759 M	127201 L	146262 L	123279 L	849799 M	617717 M	135884 L	143922 L	191212 L	216096 L	210146 L	
32. Gross Density (1991)	12361.20 H	1620.19 L	6856.36 M	10316.36 H	10300.14 H	5664.44 M	4785.44 M	1732.82 L	5631.33 M	5081.99 M	9184.05 H	7614.38 M	3615.10 L	
33. Population Growth Rate (1991)	46.95 M	–	78.21 H	22.98 L	42.23 M	–	58.36 M	–	34.7 M	31.59 M	38.63 M	29.58 L	44.14 M	

* Only DTC Buses
STP = Science and Technology Park
TV = Textile Vally
EC = Electronic City
EHTP = Electronic & Hardware Technology Park
HT = Highway Tourism

NOTE : RANKS are shown in terms of "LOW" (L),"MODERATE" (M) and "HIGH" (H) of Carrying Capacities /Growth Potentials

Box Item 5: Relative Carrying Capacities of Delhi vis-a-vis other Major Cities of NCR.

A critical regional planning issue that may emerge from the comparative analysis of NCR cities is that the so-called "priority" cities that have been assigned population in excess of their projected populations in the Regional Plan-2001 tend to have less carrying capacities in respect of most of the supportive resources than Delhi and the DMA cities.

- *The land-man ratios of Delhi and the DMA cities of NOIDA, Faridabad and Gurgaon and Sonepat are more than most outlying cities and NCT Delhi has larger amount of potential urbanisable land than the tahsils of most other cities. The DMA cities and Sonepat together have much larger population holding capacity (in term of Density Norm) then the outlying cities. Alwar, with its large amount of "rocky" and "waste" lands in the Tahsil is however an exception among the priority cities.*

- *Delhi ranks sixth among the cities in tern of housing index and is superior to most cities also in term of quality of housing i.e., proportion of "pucca" houses as well as extent of slums. The outlying cities of Bulandshahr, Hapur and Meerut tend to have far worse housing situation than Delhi and DMA cities.*

- *The DMA cities and especially NOIDA have clearly better water supply infrastructure than the priority cities both in terms of area and population coverage and in term of levels of supply. The utilizable ground water supply is however is much better in the U.P. sub-region (viz. Meerut and Bulandshahr tahsils/blocks) than Haryana and Rajasthan sub-region. NCT Delhi's groundwater supply is more than most other cities although salinity condition prevails. However, the Yamuna River stretch along Delhi and DMA tends to be a hot spot in term of pollution load.*

- *The DMA cities of NOIDA and Ghaziabad appear to have much better sanitation than the priority cities of Hapur, Bulandshahr and Panipat and Alwar.*

- *Delhi and the DMA cities of Ghaziabad and Gurgaon has considerably less supply-demand gap in power than Meerut, Panipat, Sonepat and Hapur.*

- *Delhi is the hub of regional transportation network in the region and is much better linked in term of regional bus service than other cities. The internal road length density is also far superior. The DMA cities in general and Ghaziabad in particular has greater regional road linkages than the outlying cities. Alwar tends to have the worst regional accessibility. Although Bulandshahr and Hapur have high densities of internal road network, the actual volume capacities of road networks of these old cities are likely to be very low due to their narrow roads, organie pattern and poor geometry.*

- *In term of economic base, the sub-regional level data on per capita industrial value added and estimated employment are not very useful in comparing cities, particularly because of the large rural population base across sub regions, especially Rajasthan. District level information on numbers of large, medium and small-scale units and citiwise total investments in the unorganised sector provide surrogate indicators of the existing industrial economy of the cities. The DMA cities of Gurgaon, Faridabad, Ghaziabad and NOIDA has better economic base as well as future industrialization programme (especially Gurgaon and NOIDA) than priority towns.*

- *The Assimilative Capacity Studies (section 2.3.1) indicate that air pollution stress, in terms of emission and estimated ground level concentration, Delhi is a "hotspot". The stress is generally higher across DMA towns than the priority towns. Higher industrial activities as well as vehicular volumes across the DMA are obvious reasons for the higher stress.*

Although this case study of Relative Carrying Capacity of Urban environments has not been comprehensive on account of non-availability of information on various carrying capacity indicators, it nevertheless is able to raise policy implications in future spatial distribution of population, activities, resource and investments. The two critical implications might be:

* ***In case decentralisation and equitable distribution of population and industrial activities across the regionals major growth centres are envisaged in future (as in the case of the Regional Plan-2001) large-scale investments on development of urban environmental infrastructure may be necessary over a wide spatial area especially the outlying "priority" cities.***

* ***Economic imperatives as well as infrastructure base may dictate faster growth in and around Delhi, i.e. across the the DMA cities than the "priority" cities at least in the immediate future.***

Future Urban Development Scenario for NCR

Policies and Objectives

The analysis of Relative Carrying Capacities and demographic and economic growth indicators for Delhi and other major urban centres (class I cities) of NCR leads us to critical policy implications in respect of the future spatial distribution of urban population, economic activities environmental infrastructure and investment across the NCR.

- In case decentralisation and equitable distribution of population and industrial activities across the region's major growth centres are envisaged in future (as recommended in the Regional Plan 2001) large scale investments in the development of urban environmental infrastructure may be necessary over a wide spatial area, especially the so-called "priority" cities.

- Economic imperatives and available infrastructure base may dictate a faster growth in and around Delhi, i.e., across the DMA cities rather than "priority" cities, at least in the short or middle run future.

- In view of the relatively low carrying capacities as well as economic development across many outlying cities, a phased development policy may be followed, whereby economic resources may be generated capitalising on the relatively developed infrastructure, land resources and industrial programmes of cities close to Delhi in the short and middle run future, which may be utilised for more intensive investments on infrastructure and industrial development across the outlying cities later to fulfill the long term objective of equitable distribution of quality of life and goods and services across the region.

Several policy objectives may be derived from the assimilative and supportive capacities of the region and parts thereof:

- Demand and supply managements are imperative in respect of the critical resources of the region, specially water. While Delhi and Rajasthan Sub-region and Alwar area require immediate urban water resource management plans, demand management may be emphasized especially in Delhi.

- Delhi and the DMA area may be considered as "Hotspots" in term of air assimilative capacities. While industrial pollution control is imperative across DMA cities of Ghaziabad, Faridabad and NOIDA, Delhi requires effective transportation management towards environmental control.

- Different political and economic opportunities given in terms of initiatives, policies and programmes of urban industrial developments of different states should be optimally utilised in the immediate and middle run future for the allocation of population and activities across the region. Especially, the governmental policy initiatives towards

industrial development in NOIDA and Gurgaon and should be exploited to the fullest extent.

- Institutional capacity building is imperative in the supply and demand management of urban environmental infrastructure, especially with regard to municipal financial strengthening. While more information base is required in respect of capacities of local bodies, urban local financial resource strengthening appears to be a critical issue especially for the UP sub-region.

Urban Population Distribution and Growth Strategies

- If the present growth trend of Delhi is continued, its urban population will be over 25 million by 2021 A.D. Even if 50% of NCT Delhi's agricultural land is urbanised, the gross urban density may rise to 280 ppa. At the same time, the class I DMA and outlying cities will be able to accommodate their own growth (considering current growth trend) in 2021 only at an average gross density of 160 ppha which is the average density of Asian cities.

- In light of the above growth trends and the relative carrying capacities of various urban centres several alternative scenarios should be considered:

  A. Urban-industrial infrastructure development across medium (viz. class II) as well as small towns;
  B. Development of Counter Magnets outside the NCR;
  C. Densification and physical expansion of selected major cities (class I).

- Densification is a realistic short term alternative for several cities including Delhi which are having relatively low land-man ratio's and high population holding capacities, at least to remove the density anomalies across cities of NCR. Densification efforts may be vigorously pursued especially across Faridabad and NOIDA. In Ghaziabad, scope for densification may exist in the Shahibabad area; in Gurgaon, in the new HUDA lands; in Delhi, in the North-West, Trans Yamuna and South Delhi areas and in Meerut, in the peripheral new housing and industrial areas.

- Significant physical expansion of the urban limit may be proposed in the case of the large cities which are suffering from low land-man ratio and moderate to high growth rates and population densities wherever potential urbanisable lands are available in their immediate vicinities. Among the class I cities, Hapur and Panipat are the two most appropriate cases where planned urban expansions may be followed in the short to middle run future. On the other hand, Meerut, NOIDA and Faridabad are cases where physical expansion should be discouraged since they have large population holding capacities within their urban limits.

- Information base on the carrying capacities of lower order centres, specifically the class II and III towns of NCR need to be developed in order to assess the relative growth

potentials of these centres. However on the basis of population, regional linkages and sub-regional data on land and economic resources, several priority centres of future growth may be identified; namely: Khurja, Sikandarabad, Gulacthi, Gurumukteswar, Muradnagar, Baghpat, Sardhana, Loni and Barout of the U.P. Sub-region; Samalkha, Gohana, Bahadurgarh, Jhajjar, Dharuhera and Sohana of the Haryana Sub-Region and Khairthal and even smaller centres like Bhiwadi, Tijara and Behror in Rajasthan.

- **Sub-centre Development:** A limited number of class I cities apparently have prospects for development as strong regional sub centres to counterbalance the growth of Delhi and DMA in the short and middle run future.

  * Meerut should be encouraged to develop as a strong sub-centre on a priority basis capitalising on its regional linkage both within (especially Delhi, Ghaziabad, Hapur, Bulandshahr, etc.) and outside the NCR, existing base of small scale industries and trade and commerce and other supportive capacities, especially in term of land, housing and water resources. Furthermore, its relatively high air assimilative capacity may allow for expansion of manufacturing activities. Meerut's growth may reduce future out-migration from U.P. sub region to Delhi and DMA. However, Meerut's power supply situation requires immediate attention towards improvement. Meerut has an "additional population holding capacity" of approx 1.5 million in the short term future. Further population may be accommodated, primarily through densification of its urban lands beyond the old city core as well as long term urban renewal of its old city core.

  * Alwar has a strong industrial base and the high air and noise assimilative capacities of this centre should be an impetus towards strengthening industrial activities. Furthermore, relatively high supportive capacities in terms of land, housing and internal road network render Alwar a favorable candidate for sub-centre development at least in the middle run future. By virtue of its geographical location, a strong sub centre at Alwar has potential to act as a countermagnet within the NCR. However, the most critical issue in respect of growth and capacity development of Alwar is further development of its highway and railway linkages, especially with Delhi, Gurgaon, Rewari and Rohtak. Although the additional population holding capacity of Alwar remains low in the immediate future (approx 0.5 million), with further industrialisation, expansion of its urban limit and augmentation of water resources, the city may accommodate a much higher population in the long term future.

  * Most other large outlying cities of NCR have much less economic and demographic growth prospects as well as relatively lower carrying capacities than the above two cases. In the long run, however, a balanced regional growth may be attempted through focussing investments in other outlying parts, specifically, the south west, west or north-western parts of the NCR.
    Bulandshahr-Khurja highway and railway corridor may have long term prospects

for development as a sub-centre on the basis of its regional accessibility, high assimilative capacities and high to moderate water and energy resources. Furthermore, the economic growth prospects of Bulandshahr (especially in agro-based industries and agro-services) are moderately high. However, massive investments may be envisaged in development of urban land resources, housing, road network and other infrastructure in order to render Bulandshahr as a strong sub centre in the long term future. Large scale land agquisition for future urban expansion, with due regard to conservation of its agriculturally productive lands may be an immediate strategy towards this end.

Among the large outlying cities of Haryana sub-region, Rohtak and Panipat may be competing centres as future candidates for growth centre development. Rohtak, however, has a slight edge over the latter in term of carrying capacities, especially water resources, urban land resource, social amenities like educational institutions and urban utilities.

Regional Landuse Policies

- Strategies towards agricultural land conservation vis-a-vis urban growth need to be worked out carefully, especially for Delhi, Bulandshahr-Khurja, Hapur and Alwar.

- Captive forestry for forest based industries should be encouraged in Bulandshahr-Khurja, Gurgaon, South Delhi and Faridabad areas.

- Natural resource based recreation development should be encouraged along ridge area of Rajasthan sub-region and Gurgaon and South Delhi areas, riparian land of Yamuna and natural lakes of Rajasthan and Haryana sub-regions.

- Green belts, social forestry and public outdoor spaces should characterise recharge zones, natural drainage areas, steep slopes and water bodies. In Delhi, especially, this refers to the Yamuna River banks, lands along major drains and the ridge areas. Furthermore, all national highways as well as important state highway links, such as SH-27, SH-45, SH-10, SH-13, SH-28, etc. should have as much as possible green belt planting.

Regional Transportation

- Orbital highway linkage development to reduce future nodality of Delhi and increase inter-dependencies among large outlying growth centres, especially Meerut, Hapur, Bulandshahr, Khurja, Rewari, Rohtak and Sonipat. Specifically, the following linkages should be developed on priority basis:

* Widening of SH-10 and G.T. Road augmenting Meerut-Hapur-Bulandshahr-Khurja access.
* Widening of SH-15 between Rohtak-Rewari
* Widening of SH-13 between Gurgaon-Sohna-Alwar
* Development of State highway between Meerut-Baghpat-Sonipat

- Highway accessibility among several DMA cities may be taken up in the immediate future; specifically:

  * Ghaziabad-NOIDA-Faridabad Expressway
  * Flyover NH-2 near Baderpur crossing to augment NOIDA-Faridabad-Gurgaon access
  * Development of old Mehrauli Road to augment Faridabad-Gurgaon Access.

- Bypasses on NH2 near Ghaziabad and SH 45 near Modinagar will improve accessibility of Meerut with respect to Delhi and Ghaziabad.

- In the long run, strong highway and railway links should be developed between Faridabad and Bulandshahr with bridges over Yamuna.

- Capacity development of the following railway links on priority base:

  * Gurgaon-Rewari-Alwar (doubting line capacity)
  * Link between Gurgaon and the Delhi-Avoiding-Line Loop (D.A.L.) to augment railway access among DMA cities of Gurgaon, Faridabad and Ghaziabad.
  * Meerut-Hapur link
  * Hapur-Bulandshahr-Khurja link.

WATER RESOURCE MANAGEMENT

- There should be proper harvesting of monsoon discharge in the Yamuna R. as well as harvesting of rain water, especially in Delhi, Faridabad-Gurgaon and Alwar through development of reservoir sites, tanks, small lakes and roof top harvesting.

- Old stream like Barapula and the Ridge-Stream should be revived.

- Afforestation across the Ridge and along Yamuna and Sahini Rivers and nullahs and lakes. Ground water recharge potential of Alwar Tahsil and district should be augmented through afforestation.

- Early implementation of the schemes on tubewells, pumping, water treatment plants and other water management projects in the various major cities, viz NOIDA, Ghaziabad, Meerut, Faridabad, Gurgaon and Alwar.

- Maintenance of municipal water pipes and mains may lead to conservation of municipal water supply to the tune of 30%.

- Demand management through rationalisation of water rates, prohibition of extensive private gardening practices, mandatory water recycling in large commercial and industrial enterprises and accounting for private bore wells, especially in Delhi and cities of Rajasthan and Haryana sub-regions.

- Development of ECO-Parks for modified wetland method of municipal sewage treatment and recycling of water for irrigation, especially near around Delhi and large cities of U.P. and Haryana Sub-Regions, viz, Bulandshahr, Khurja, Meerut and Rohtak.

- Construction and expansion of dams in the Tehri Garhwal region for water supply to NCR should not be implemented until schemes are developed for conservation of the ecological system in the region, rehabilitation of people who may be uprooted and management of waste water resulting from increased irrigation.

Other Urban Utilities and Services

- Augmentation of social amenities in all DMA cities on priority basis.

- Augmentation of municipal solid waste collection system, especially for Meerut, Gurgaon, Delhi and Faridabad.

- Augmentation of sewerage and sewage treatment, especially in Meerut and Gurgaon.

- Augmentation of power supply especially in Faridabad, Ghaziabad, NOIDA and Meerut.

URBAN FORM

- Urban Sprawl is to be restrained in all large cities (half-a-million and above) with compact residential development and high net densities.

- Vigorous housing and land supply policy is necessary, especially for Delhi and the deficient cities such as Hapur and Bulandshahr. Strategies for private and cooperative sector investment in housing including slum improvement and L.I.G. and EWS housing is essential in light of inadequate housing supply through the public sector. Slum rehabilitation to release the supply of prime lands for various urban uses should be taken up on a priority basis. Effective rent control, urban land ceiling and land acquisition regulations should augment land and housing supply and discourage vacancy rate in housing.

- Urban renewal may be necessary across several large, old cities viz Bulandshahr, Hapur, Meerut and Panipat to improve internal road network and augment infrastructure and density development.

- Early implementation of Mass Rapid Transit System in Delhi is necessary. Intra-city bus system should be developed in all major cities, especially, Faridabad, Gurgaon, Noida and Meerut on a priority basis and should be a regular feature for all cities with future population of 10 lakhs and above.

- Water sensitive urban design process should be encouraged in Delhi and major cities of Rajasthan and Haryana sub-region, especially Alwar and Panipat. This should include waste water treatment and recycling of domestic water for agriculture and urban horticulture, conservation of surface water bodies and use of catchments of rainwater in tanks, ponds, depressions and even rooftops in dwelling units.

- Energy conserving urban forms should be encouraged through effective building layouts and orientation, compact forms, restricted vehicular access and extensive pedestrian paths and bikeways, use of proper building material and development of community based solid waste recycling, bio-gas and solar and wind energy development.

CHAPTER 3

METHODOLOGY AND TOOLS FOR WIDER APPLICATION OF CARRYING CAPACITY BASED PLANNING

3.1 Concern for environment is a global phenomenon which has intensified after the UNCED Earth Summit at Rio de Janeiro held in 1992. Sustainable development is now the crux of all issues related to planning and managing the future.

Agenda 21, the major policy document of the Rio Earth Summit, outlines specific actions for human settlement development to achieve cleaner global environment. Its Chapter 28, known as Local Agenda 21, lists initiatives that should be taken by local authorities in order to integrate environmental goals into local plans with community participation. To achieve the objectives of Local Agenda 21, mechanisms have to be evolved to involve communities in planning and managing their environment.

3.2 Urban Environmental Assessment

Very little information is readily available on environmental conditions, the interaction between urban development and ecosystems, or the managerial setting for responding to environmental problems. As a result, much of what has been done until now has not been very useful to those who are in a position to take action.

In order to provide information to urban managers, planners and others, rapid urban environmental assessment is necessary. A three step process has been developed (by Josef Leitmann) for this: a) completion of a data questionnaire on urban environmental indicators; b) preparation of an urban environmental profile; and c) discussion of the results through a series of consultations.

With the help of such environmental assessments, environmental management strategy and plan can be prepared.

3.3 Environmental Consultations

It is recognized that urban environments cannot be improved without constituencies that demand environmental quality and are willing to pay for it. This requires appropriate tools and instruments which could be used for communicating information on environmental status and problems to all **stakeholders** in the city. The stakeholders with respect to urban environment will include environmental protection agencies, planning agencies, local government, politicians, sectoral agencies, NGOs, private and informal enterprises, concerned residents and community based organizations, and news media.

The effectiveness of environmental decision making requires sustained participation of all the stakeholders. This process of consultations can be organized collectively with the entire group as well as individually with different groups. To facilitate such consultations tools such as environmental maps can be used which will give a profile of environmental problems in a given area and will help in preparation of an action plan for the area.

3.4 Environmental Mapping

Knowledge is the first step towards action. Therefore, it is important to provide appropriate and adequate information to all concerned for timely action. However, information provided should be such that it is easily comprehensible and sufficiently detailed in order to make it useful. For instance, while aggregate data at the city level can indicate the status of urban environment, dis-aggregated data is required for a complete understanding of intra-city differences in environment. Mapping is a useful tool to indicate the environmental differences within cities. Local environmental planning is possible only with such dis-aggregate information base. Mapping clearly brings into focus not only the difference in environmental quality in different parts of the city but also makes city-wide environmental monitoring possible. Table 3 lists the environmental resources/ components, parameters for mapping and inferences for evolving local agenda.

Table 3

Urban Environmental Mapping And Inferences for Local Agenda

Environmental resources/Components	Parameters for Mapping	Inferences for evolving local agenda
Population	* Population density in different wards of the city * Population changes in different wards over past decades * Number of households and sex-ratio in each ward	Indicates areas requiring de-densification and densification. Highlights needs for improving/ strengthening social infrastructure.
Housing	* Number of dwelling units in each ward * Dwelling conditions (kutcha/pucca) - ward-wise * Number of persons per room - ward-wise * Location and number of slums * Level of services in slums (per capita availability) * Average house rents and land prices in different areas/ wards of the city * Housing supply by government/ public/ private sector in the city	Highlights availability of housing, crowding and living conditions. Indicates slums requiring services or improvement in services.

Water Supply	* Sources of water supply (surface/ground), including community based sources (hand pumps, wells) * Location and capacity of water treatment plants * Average per capita supply (at city level and in different wards) * Areas in the city facing acute shortage of water and with poor quality of drinking water * Total supply and consumption of water for different uses in all the zones/wards of the city * Water supply network showing trunk lines, distribution lines etc. * Zone-wise/ward-wise number of connections (for each type of use)	Indicates spatial availability and quality of potable water in the city. Highlights areas having higher levels of water consumption and requiring conservation measures. This can give an indication of population that a city can support for sustainable development.
Sewerage and Drainage	* Location and capacity of sewage treatment plants * Zone-wise/ward-wise number of individual connections, number of public latrines in each slum/community group * Sewerage network in the city * Topographical map of the city depicting prominent water logged areas and all the open drains	Suggests areas in the city requiring sanitation facilities like public latrines, septic tanks etc. and drainage facilities. Discharge of untreated sewage create unhygienic conditions affecting the health of urban citizens.
Solid Waste	* Total and per capita generation and collection of solid waste - ward-wise/ zone-wise * Collection and disposal of hazardous industrial waste, hospital waste, abattoir waste etc. * Location of landfill sites - filled, existing and proposed * Areas not covered by the service	Highlights areas with poor waste collection facilities. Indicates where hazardous industrial waste and hospital wastes are disposed and the measures that can be taken to deal with such wastes.

Transport	* Peak hour traffic volume on major roads * Accidents on major roads * Accident prone areas and bottlenecks on different corridors * Routes of public transport	Identifies roads requiring widening and/or better traffic management and suggests the need for remedial measures in different parts of the city.
Green Spaces	* Location and area of forests, public parks and other green spaces in the city * Temporal variations in the green cover of the city	Indicates action required for saving trees and preserving open spaces in different areas of the city.
Air Quality	* Ambient air quality in the city (at different monitoring stations) * Prevailing wind direction & areas affected by industrial air pollution.	Delineation of areas exceeding 'prescribed' air quality standards. Measures to reduce air pollution menace on polluted corridors and use of appropriate technology to reduce industrial air pollution.
Aconstic Environment	* Ambient noise levels in commercial, industrial and residential areas and near hospitals * Peak hour noise levels at major road intersections.	Helps to identify the causes of noise pollution in different areas and to evolve measures for reducing them.
Water Quality	* BOD and DO values for all drains, stream or river passing through the city * Quantity and quality of water discharged from industrial and commercial areas.	Indicates measures required to tackle water pollution.

Note: The parameters mentioned here are indicative only. Depending on the type of city and its urban environmental problems, there may be a need to emphasize one or more parameters in detail or add new parameters.

Maps give the spatial distribution of infrastructure and services and indicate areas with urban environmental problems. These maps are accompanied by text which analyze the problems and also give additional data regarding the parameters indicated above.

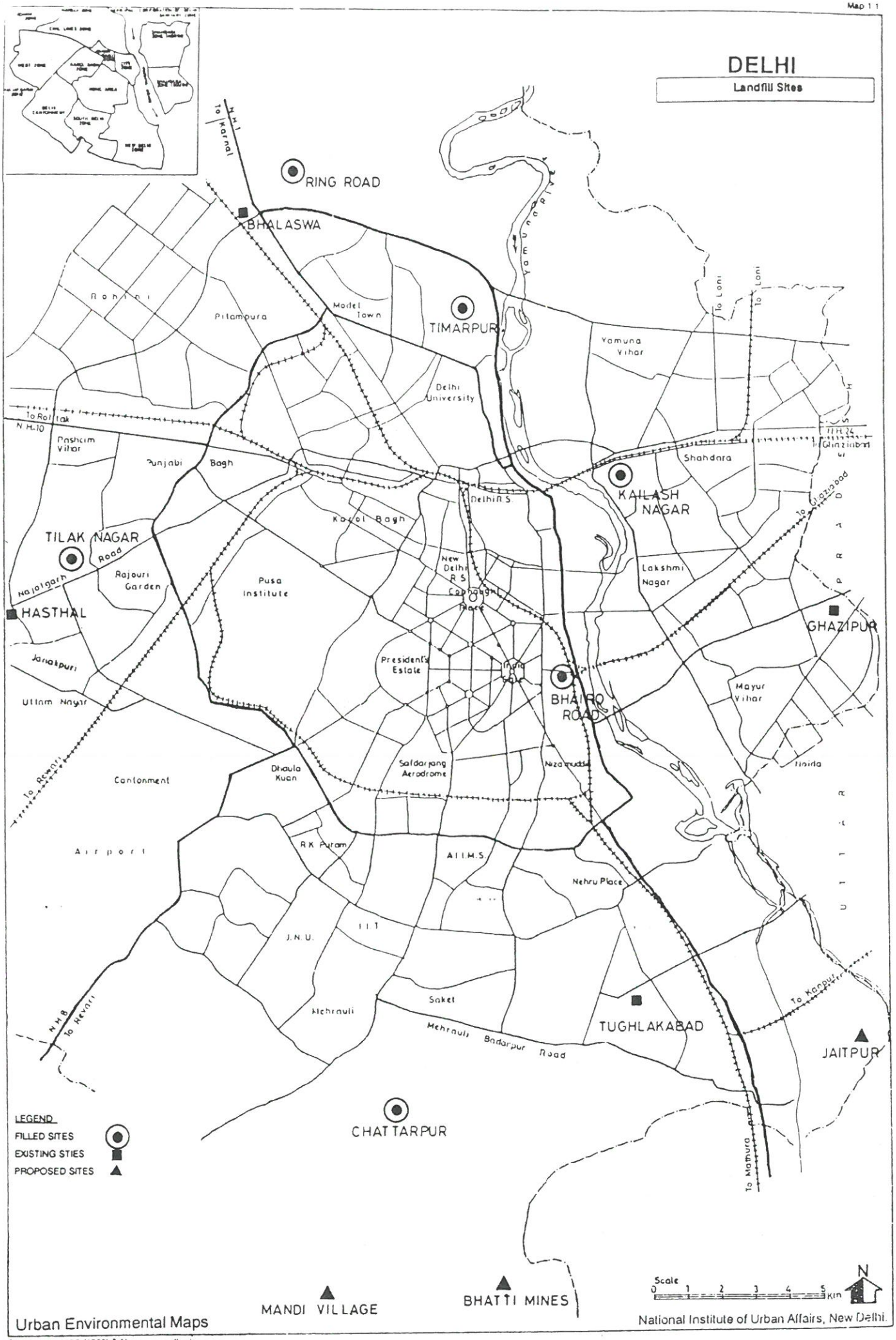
3.5 Use of Maps for Consultations

Urban environmental maps are useful for analyzing the problems of the city at the aggregate as well as dis-aggregate level. A few maps are appended here as examples. Agencies involved in dealing with city level problems can use the maps to understand the macro situation and devise strategies to deal with the problems. At the community level, residents can identify the major problems facing them and finds ways to overcome them. They can be helped in this process by the NGOs.

For instance, map 1.1 indicating the location of landfill sites in Delhi clearly shows that the existing sites are already filled or have very little life left. The future sites are all located to the south of the city and are very far from present dense habitation. This would mean that transportation of solid waste for final disposal in the future will be very costly. The city authorities must, therefore, consider all the options for dealing with city wastes at site or within the city itself. This would also involve seeking cooperation of the city residents.

Similarly, map 1.2 indicating ambient noise levels shows that even in residential areas the ambient noise levels are above the prescribed standards. The authorities as well as the public at large can come together to plan strategies to improve the situation.

With the help of urban environmental assessment reports and urban environmental maps it is possible to involve all stakeholders, in whatever capacity, to plan, prepare and implement action plans at the local level.



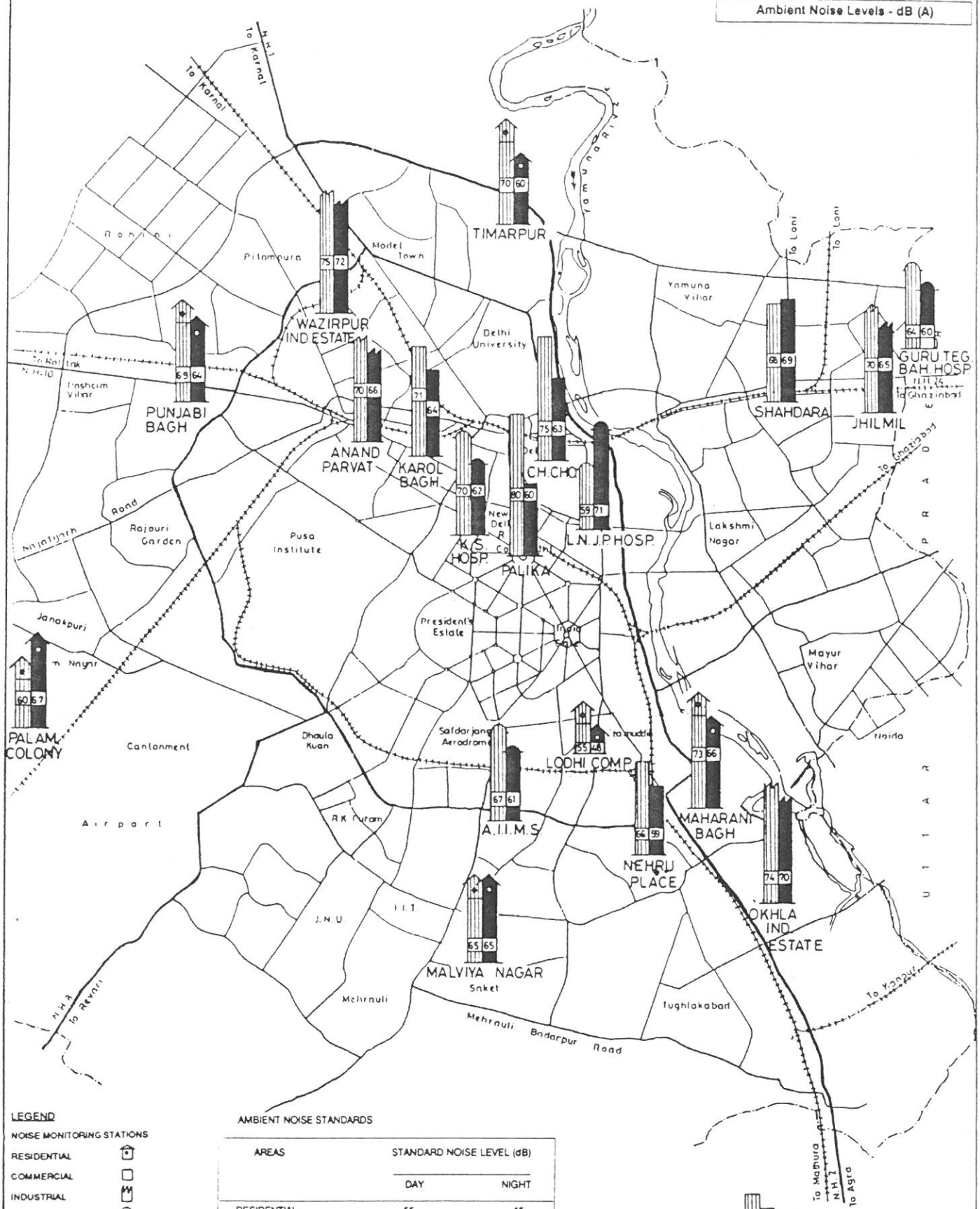
Urban Environmental Maps

National Institute of Urban Affairs, New Delhi.

Source: MPD (1993) & Newspaper clippings.

DELHI

Ambient Noise Levels - dB (A)



LEGEND

NOISE MONITORING STATIONS

RESIDENTIAL

COMMERCIAL

INDUSTRIAL

SILENCE

AMBIENT NOISE STANDARDS

AREAS	STANDARD NOISE LEVEL (dB)	
	DAY	NIGHT
RESIDENTIAL	55	45
COMMERCIAL	65	55
INDUSTRIAL	75	70
SILENCE	50	40

Source: Central Pollution Control Board (1989)

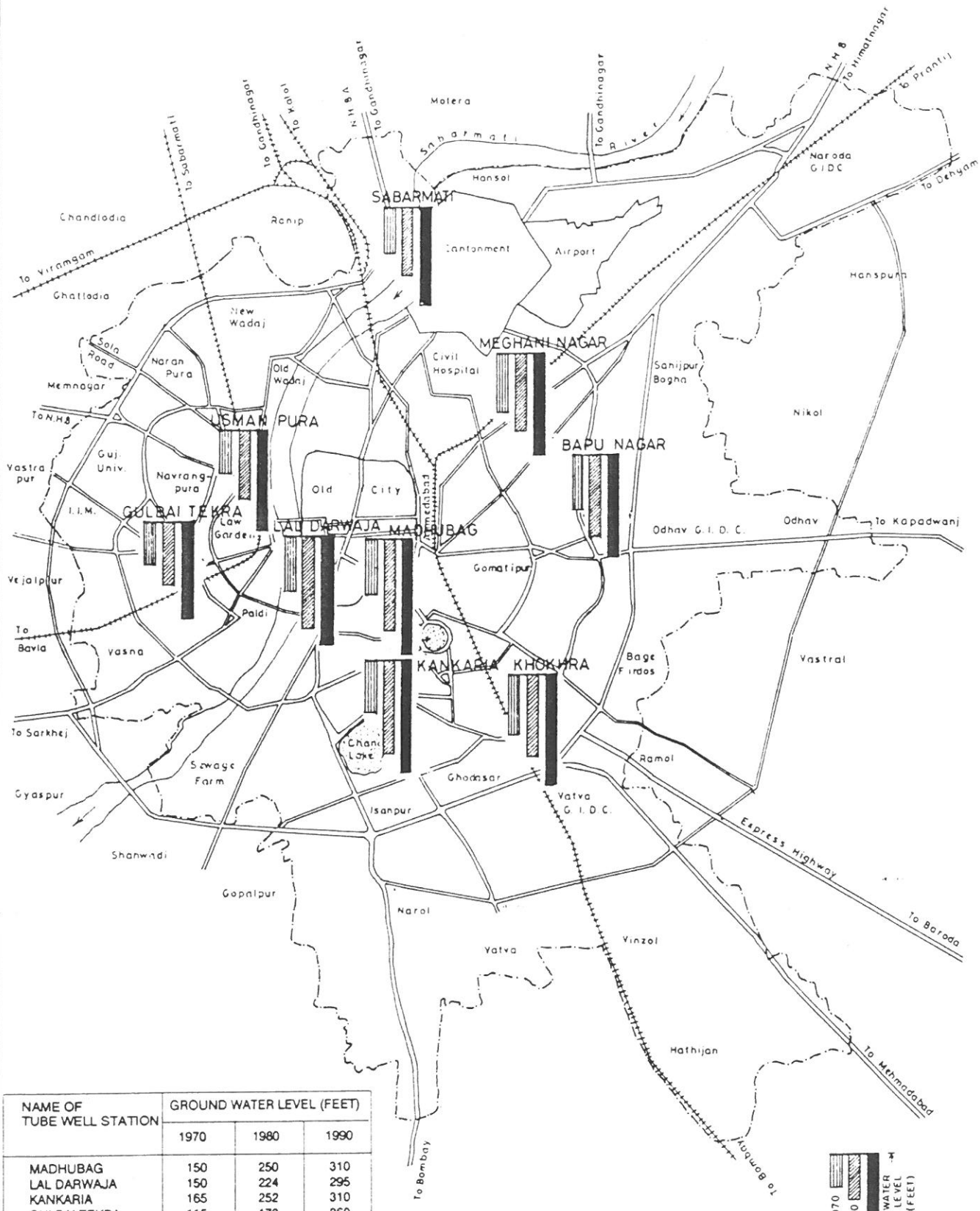
Urban Environmental Maps

National Institute of Urban Affairs, New Delhi.

Source: CPCB (1991).

AHMEDABAD

Ground Water Level



NAME OF TUBE WELL STATION	GROUND WATER LEVEL (FEET)		
	1970	1980	1990
MADHUBAG	150	250	310
LAL DARWAJA	150	224	295
KANKARIA	165	252	310
GULBAI TEKRA	115	170	260
USMAN PURA	120	192	275
SABARMATI	120	185	260
MEGHANI NAGAR	160	210	275
BAPU NAGAR	150	225	280
KHOKHRA	160	224	300

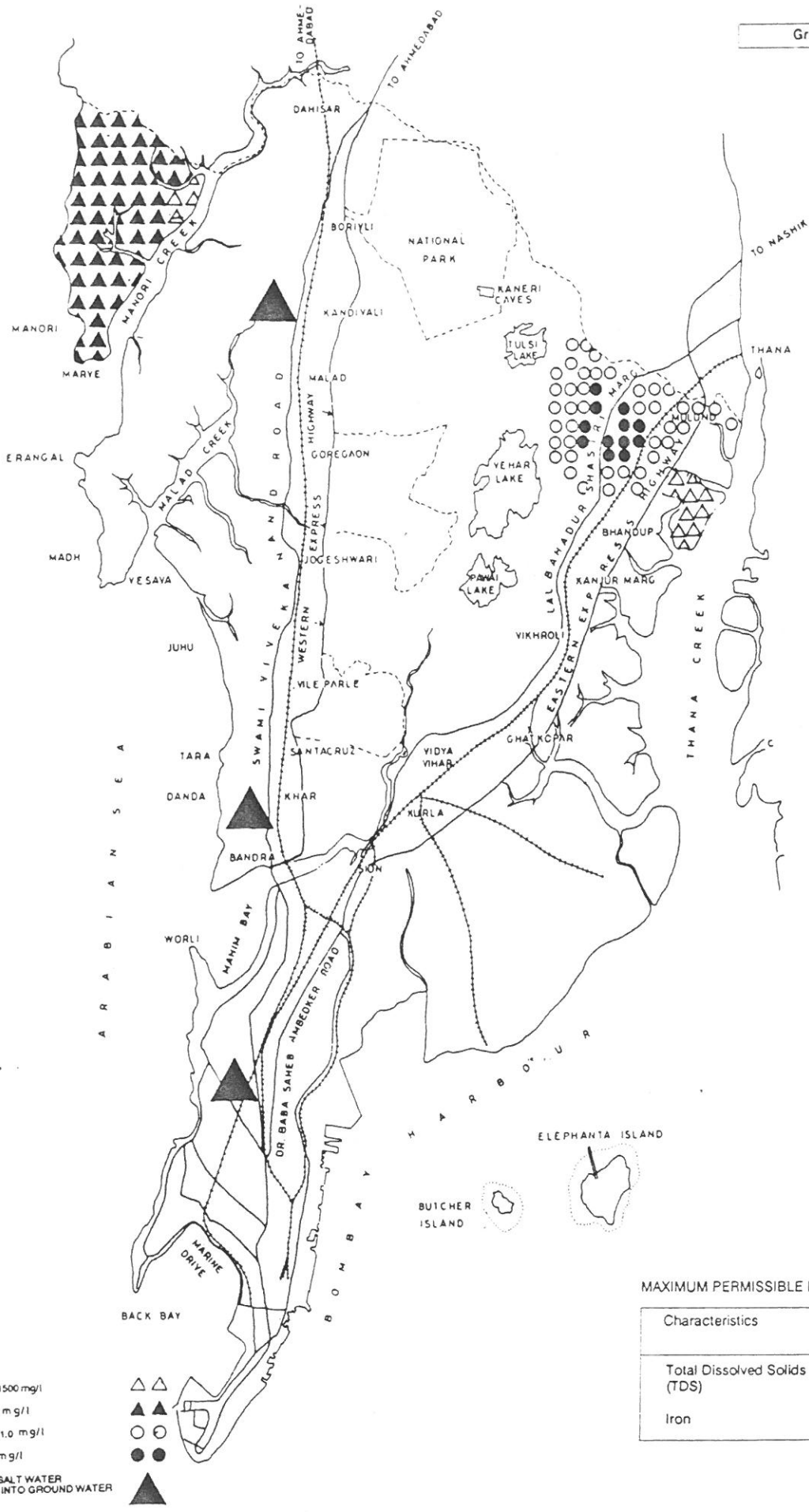
Urban Environmental Maps

National Institute of Urban Affairs, New Delhi.

Source: Bhandari, N. et. al. (nd.).

BOMBAY

Ground Water Quality



LEGEND

TDS 1000-1500 mg/l

TDS 1500 mg/l

IRON 0.30-1.0 mg/l

IRON 1.0 mg/l

AREAS OF SALT WATER INTRUSION INTO GROUND WATER

MAXIMUM PERMISSIBLE LIMITS FOR POTABLE WATER

Characteristics	Max. Permissible Limit (mg/l)
Total Dissolved Solids (TDS)	500
Iron	0.30

Scale 1·0 0·5 0 1 2 3 4 5 Km.

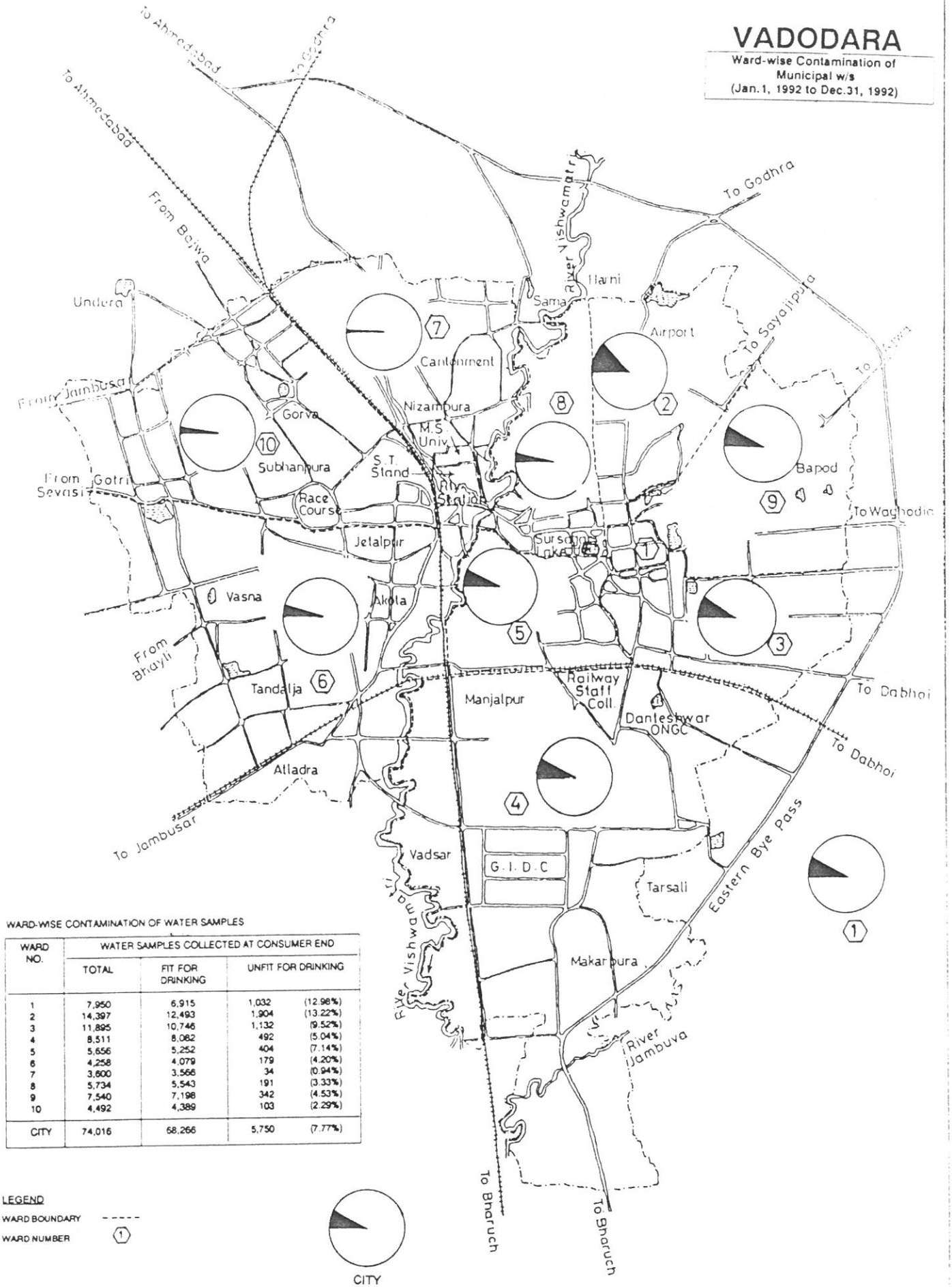
N

Urban Environmental Maps

National Institute of Urban Affairs, New Delhi.

VADODARA

Ward-wise Contamination of Municipal w/s
(Jan.1, 1992 to Dec.31, 1992)



WARD-WISE CONTAMINATION OF WATER SAMPLES

WARD NO.	WATER SAMPLES COLLECTED AT CONSUMER END			
	TOTAL	FIT FOR DRINKING	UNFIT FOR DRINKING	
1	7,950	6,915	1,032	(12.98%)
2	14,397	12,493	1,904	(13.22%)
3	11,895	10,746	1,132	(9.52%)
4	8,511	8,082	492	(5.04%)
5	5,656	5,252	404	(7.14%)
6	4,258	4,079	179	(4.20%)
7	3,600	3,566	34	(0.94%)
8	5,734	5,543	191	(3.33%)
9	7,540	7,198	342	(4.53%)
10	4,492	4,389	103	(2.29%)
CITY	74,016	68,266	5,750	(7.77%)

LEGEND

WARD BOUNDARY -----

WARD NUMBER (1)

CITY

7.77% (CONTAMINATED SAMPLES)

N

Scale 1.0 0.5 0 1 2 Km.

Urban Environmental Maps

Note: The Water Samples are tested for Sewage Contamination only

National Institute of Urban Affairs, New Delhi.

Source: Based on data provided by BMC (1993).

CHAPTER 4

ACTION PLANNING FOR LOCAL AGENDA 21

4.1 The Need

As mentioned in Chapter 1, the concept of carrying capacity refers to the limitations of the environmental and man-made resources as supported by the economic and technological developments. The issue is of demand and supply of goods and services to a given population to foster steady growth of the economy and the built space, without polluting the environment. In the context of the city, the two most important components that influence the carrying capacity are the assimilative (or the cleansing) and the supportive (i.e. the infrastructural) capacities. The former is a regenerative ability inherent in the elements of nature, such as air, water, vegetation and other natural resources to provide raw materials and to act as a sink, while the latter is a physical support (constructed by man) to make a city function. Both have self-perpetuating characters that promote city growth and economic development, and are dependent on each other. The outcome of the interaction between these two components of development determine the urban environment and the quality of life a city can give to its citizens.

At the time when the concept of regional and urban development was introduced into our national planning process, protection and improvement of environment was not given priority. This was because depletion of the assimilative capacities of nature (contributed by fresh air, water, vegetation, etc.) and the degradation of the man-made infrastructure (that form the supportive capacities), had not taken its toll on human health. As population continued to increase and cities kept expanding, the administrative machinery in cities was unable to cope with the rising demand. The resources allocated were insufficient to provide even the minimum basic services to all urban residents. As a result, many of the obligatory functions of the local government had to be devolved to parastatal agencies.

The deteriorating urban environmental conditions have prompted the planners today to consider the improvement of the quality of life of urban residents through upgradation of infrastructure and protection of the natural environment that is harmful for any living organism. To express this concern and make it a global issue, an international conference was held in Stockholm in 1972 by the United Nations, to bring home to all planners that

environment ought to be protected for sustainable economic and urban development. Since then, management processes to conserve and protect environment have continued to be devised to improve the carrying capacity of cities and regions.

In India the concern for sustainable development began with the preservation of natural resources. Many legislations were enacted, and the task of protecting the elements of nature (water, air, forests) were entrusted to the respective government departments administering these sectors of development. Subsequently, the focus expanded to industrial location and prevention of pollution. The legislation of the Environment Protection Act (EPA) in 1986 has been a major effort to integrate environment protection with economic development in India. The EPA has given directives in great detail (on air, water, hazardous wastes, forests, wild life and so on) as to how to protect the essential elements of nature that affect the quality of life of citizens. Standards have also been set by different boards/agencies after due considerations, and penalties framed for non-compliance of the regulations. It is hoped that careful management and technological innovations, if applied at the local area level, will improve the deteriorating quality of life.

Problems of environmental degradation are not just confined to India alone. It is a global issue. Hence, when even after the Stockholm Conference of 1972 the efforts that followed to restrain the uneconomical use of resources were considered to be inadequate, the U.N. once again held another conference in Rio (the Earth Summit) in 1992 to come to a consensus to integrate economic development and environmental upgradation. This time a change has been suggested in the management procedures from mere protection of natural resources and environment, to conservation of resources, and a more diligent use of man-made infrastructure. The Earth Summit also suggests to enforce better ways of conserving resources (by improving the technology), including the use of infrastructure and generation of more finances to improve planning and maintenance. Given the fact that all resources are limited, and will be inadequate if not used judiciously, this thrust in planning is being seriously considered. Local Agenda 21 is an outcome of such thinking that suggest the introduction of environment protection at the local "grassroots" level, which can be integrated with sectoral planning, in conjunction with the city's economic development.

4.2 Local Agenda 21

The purpose of the Earth Summit was to raise the issue of protecting the environment even while promoting economic development. All over the world, economic growth has led to such rapid urbanisation, that intracity environment has depleted because of congestion and indiscriminate use of infrastructure and resources. Agenda 21, emerging out the UNCED conference, therefore, makes an attempt to outline the actions that need to be taken for human settlements to attain a cleaner environment. It specifies four broad heads under which such issues can be tackled:

- sustainable development through social and economic improvements;
- conservation and management of resources for development;
- strengthening of the role of major groups/actors in the process of development; and
- improving the means and methods of implementation of developmental mechanisms.

In chapter 28 (which gives directions on Local Agenda 21), the document suggests that initiatives should be taken by the local authorities to support the policy of protection of environment. Action should begin with the municipalities entering into a dialogue with its citizens, local organisations and the private enterprises, so as to adopt a "local Agenda 21" through consultation and consensus-building. Such a process would increase people's awareness of sustainable development issues. Local authority programmes, policies, laws and regulations to achieve Agenda 21 objectives should be assessed and modified, based on local programmes to be adopted. Also strategies should be formulated to integrate local, regional, national and international funding. All these can be attained through:

- technical cooperation among countries;
- partnerships among public, private and community sectors;
- popular participation in the decision making process at the local/neighbourhood level; and
- special attention to women, children, the old and the disabled.

These approaches should form the core principles of settlement strategies. The main socio-economic objectives for improving the settlements should be: to understand demographic dynamics and the question of sustainability; to combat poverty; to change the consumption patterns; to protect and promote human health; to promote/develop

sustainable human settlements, and to integrate environment and development in policy decisions.

The programme areas defined for special attention are:

- shelter;
- human settlement management;
- sustainable land-use planning and management;
- integrated provision of environmental management (for water, sanitation, drainage and solid-waste);
- planning and management of human settlements in disaster prone areas;
- sustainable construction industries;
- sustainable energy and transportation systems in human settlements; and
- human resource development.

The Earth Summit thought that with an emphasis on local level planning, problems could be resolved at the grassroots level. In many countries local authorities construct, operate and maintain economic, social and environmental infrastructure. Being closest to the people, municipalities as a level of governance would be the most effective institution in motivating, educating and mobilising the people to promote sustainable development. India is yet to operationalise such a process of area development.

However, the Earth Summit did not specify intra-city levels where action can be generated. The task in this report is, therefore, to identify the different levels within a city where action can be taken to decentralise management for better implementation and to suggest the actions to be taken at each level and the kind of institutional strengthening that is required for the purpose.

4.3 Constitution (Seventy Fourth) Amendment Act, 1992

Almost simultaneously along with the conception of Local Agenda 21, the Government of India amended its constitution to introduce democratic decentralisation and empower the municipalities to carry out the tasks hitherto being usurped by the state. The Twelfth Schedule of the act lists out an array of duties to be devolved to the local government, some of which are already performed by them, while others such as environment, ecology and town planning are additional responsibilities. It is envisaged that such devolution of

functions to the local government would encourage action at the grassroots level - a proposition which is being suggested by Local Agenda 21 as well.

The context of the Seventy-fourth Amendment was a systematic erosion of the municipal functions and powers, a weakening of the executive system, inadequate resources, and an all pervasive state control that deterred local governments from performing their tasks effectively. In fact, with the gradual deterioration of the assimilative and the supportive capacities of cities, local governments have entered into a poverty - mismanagement syndrome from where retrieval seems to be an arduous task. This concern has led to modifications in the structure of the local management units, to bring planning and decision - making to the people.

To integrate rural and urban planning, District Planning Committees (DPCs) are to be constituted to prepare draft Development Plans for the districts. Plans prepared by DPCs are to be forwarded to the State governments to be consolidated into State Plans. It is also suggested that Metropolitan Planning Committees for large urban areas should be formed to carry out similar functions.

In total, the Amendment suggests both vertical and horizontal changes, touching upon important areas of management such as finance and resource generation, development at the local level (by introducing hierarchical management) and above all, by trying to introduce a system of popular democracy that will have political support.

Local Agenda 21 of the Earth Summit and the Seventy-fourth Amendment of the Indian Constitution are both once again emphasizing its importance in the planning process for local area development. Through the Seventy-fourth Amendment of the Constitution, the government of India is trying to facilitate "grassroots" level planning in urban areas and to give to the sustainable development concept a political sanction at all levels of administration and development.

4.4 Action at the City Level:

The average quality of life which a city offers, depends upon the type of infrastructure that is being provided by the local/ state governments, and the nature of the assimilative capacity a city has, to endure the population pressure. This "carrying capacity" of a city also depends upon the efficiency of the management institutions, including the use of effective technology to monitor development and maintenance. With intra-city variations in infrastructure, the carrying capacity or the quality of life also differs within a city.

Provision of urban environmental resources, whether natural or man-made, requires careful planning and administration. Very often difficulties arise when existing organisations create multiple jurisdictions which overlap each other, instead of integrating and coordinating their tasks. While such administrative duplications need corrections, there are often gaps in planning that needs to be bridged to bring in efficiency. Fragmented institutional arrangements often appear to be the root cause of ineffective application. However, considering the magnitude of the task, provision and management of urban environmental infrastructure is really a challenging task.

As cities grow, there is need to reinforce infrastructure with time. The built structure of a city is influenced by the physical, human and financial resources available; while the assimilative capacity is determined by the existing natural resources such as air, water, land, forests, etc. A symbiotic relationship exists among all these natural and man-made resources and the generation of employment, financial resources and economic development. A good assessment of the carrying capacity is the right mix of the assimilative and the supportive capacities, which put together gives a holistic picture of what is necessary for a city or a region. A plan for action at the city level has to be framed within the context of managing the environmental and economic consequences of development policies. Such a framework has to take congnizance of the existing institutional framework. The present legislative framework and the institutions responsible to carry out these tasks are shown in the enclosed charts.

Policies & Legislations for Urban Environment Management

Sl.No.	Urban Component	Policies & Objectives	Legislations & Amendments	Institutions
1.	Water	1. Prevention & control of pollution, restoration of wholesomeness of water (from contamination) so that it is not injurious to public health or any organism, & conservation.	- Water (Prevention & Control of pollution)Act, 1974	- CPCB/SPCB
			- Water (Prevention & Control of Pollution) Amendment Act 1988	
			- Factories Acts, 1948	- Inspector of Factories, Deptt. of industries.
			- Environment Protection Act, 1986	- Pollution Control Boards: Central/ State
			- The Coastal Regulation Zone Notification, 1991 (Section) 3(1) 3(2)(v) of EPA)	- Central/ State/ UT Govt. (MOEF)
		2. Collect Cess to augment the finances of PCBs, based on quantity of consumption.	- Water Cess Act, 1977	- Water Supply & Sewerage Board, Municipality or any local authority
		3. Supply of potable water	- Municipality Act	- Municipality or any authorised local body - Water Supply & Sewerage Board

Sl.No.	Urban Component	Policies & Objectives	Legislations & Amendments	Institutions
2.	Air	1. Prevention, Control & Abatement of air pollution	- Air (Prevention & Control of Pollution) Act, 1981	CPCB/SPCB.MOEF
			- Air Act amended in 1987 to include 'noise' pollution	
			- Environmental (P) Act, 1986	- Pollution Control Boards
			- Smoke Nuisance Act (Bengal, 1905, Bombay: 1912, Gujarat : 1963)	- Officers appointed under the Act
		2. Prevention & control of pollution from motor vehicles	- Motor Vehicles Act, 1939	- State & regional transport Authority
			- Motor Vehicle Rules amended in 1989	- Traffic Police (Home Min.)
		3. Control pollution from industries	- Factories Act, 1948	- Inspector of Factories
			- Industrial (Rules & Regulations) Act, 1956	- DG (TD) or not below the rank of Development Officer

Sl.No.	Urban Component	Policies & objectives	Legislations & Amendments	Implementing Agencies
3	Land	1. Bulk acquisition of land from individuals to organise its use for public purpose	- Land Acquisition Act 1894, amendment: 1989	- State Govt.
			- Metropolitan Development Acts	- Development Authorities
		2. Development of land through town planning scheme (Maharashtra Gujarat, Kerala, etc.)	- Town & Country Planning Acts	- Development Authorities, Municipality
			- Municipal Acts	- Local Town Planning Departments
		3. Town Planning, organising landuse through Master/ Development Plans	- Town & Country Planning Acts	- TCPO/ Planning Departments
		4. Controlling land market through redistribution by limiting ownership holding size in cities, to prevent concentration of urban property & land speculation.	- Urban Land Ceiling & Regulations Act, 1976	- State Govt.
		5. Improvement of built environment, specially in deteriorating areas & urban fringe	- Improvement Act (Bombay 1898, Calcutta: 1911, UP: 1919)	- Improvement Trusts

Sl.No.	Urban Components	Policies Objectives	Legislations & Amendments	Implementing Agents
4	Industry	1. Government policy to safeguard humanity & organisms	- Atomic Energy Act 1962	- Atomic Energy Regulatory
		2. Check on location for pollution, resource use & built environment	- Factories Act, 1948	- Chief/Regional Inspector of Factories
			- Industrial (Dev. & Regulation) Act, 1951	- Director General (TD) or his nominees not below rank of Development Officer
			- Mines and Mineral (Regulations & Development)Act, 1957	- Controller General of Indian Bureau of Mines
			- Indian Ports Act, 1908	- Conservator of Ports
			- Insecticide Act 1968	- Conservator of Ports
			- The India Boilers Act, 1923	- Licensing Officer
			- Environment (Protection) Act, 1986	- Inspector of Boilers
			- The smoke Nuisance Acts	- Pollution Control Boards
				- Officers appointed for Smoke Nuisance.
		3. Protect victims of pollution by compensating through insurance	- Public Liability Insurance Act, 1991	- Collector

Sl.No.	Urban Components	Policies & Objectives	Legislation & Amendments	Implementing Agencies
5.	Solid Waste & Street Cleaning	Local Management/collection and disposal of waste	- Municipal Act	- Municipality (i.e. local govt.)
6.	Slum upgradation	1. Clearance & upgradation of slum housing & infrastructure for improvement of life of the urban poor.	- Slum (Clearance & Improvement) Act, 1956	- Slum Clearance & improvement Board - State Govt.- Urban Poverty Alleviation Cell SUDA
		2. Development Schemes, EIUS, UBSP, NRY, LCS (convergence of all Urban Poverty Alleviation Programme) etc.	- Development Act	- Ministry of Urban Development and Municipality
7.	Urban Aesthetics	Control aesthetic quality of built urban environment in large cities, with aid from MOUA & E	- Urban Arts Commission Act (Delhi: 1973)	- Concerned agencies to whom advice is given.
8.	Traffic and Transportation	1. Register Vehicles	- Motor Vehicles Act, 1939 amended in 1988	- State & Regional Transport Authorities
		2. Organise traffic & transport	- Motor Vehicles Rules, 1989 EPA, 1986	- Traffic Police (Home Ministry) CPCB/SPCB
		3. Control Pollution	- The Indian Port Act, 1908	- Conservator of Ports.

Sl.No.	Urban Components	Policies & Objectives	Legislation & Amendments	Implementing Agencies
9.	Housing	Provide housing to all sections of the society	- Housing Policy 1990	- Housing Boards
				- Housing Co-operative
				- Development Authorities
				- Special Scheme under Urban Development
				- HUDCO
				- Municipalities
				- NBO
10.	Electricity	To provide electricity to all citizens	- Indian electricity Act, 1910	- Electric Supply Undertakings Boards
			- Electricity Supply Act, 1948	- Private Sector agencies (BEST, CESE) etc.
				- Municipalities
11.	Town Planning	1. Prepare general town planning scheme, Master/ Development	- Town & Country Planning Act	- TCPO
		2. Planning, Regulation the Development in towns & cities	- Metropolitan Development Act	- Development Authority
			- Municipal Act	- Municipalities & Municipal Corporation etc.

Note for the above chart:

It has not been possible to give a detailed account of technological innovations that help development, as methods used for implementation change with time, place and nature of problem.

Also, a glance at the powers and functions of the various management organisations set up so far for monitoring urban environment will reveal the complexity of the task of urban environment management.

Functions of Institutions Engaged in Management of Urban Environment

Sl.No.	Institutions	Powers & Functions
1.	Pollution Control Board	1. Advice Government 2. Provide technical assistance 3. Train Personnel 4. Collect, process & publish data 5. Lay down standards 6. Organise, plan & help to execute programmes 7. English laboratories 8. Give directions for discharging effluent 9. Inspect & Analyse water quality 10. Form appellate authority to solve problems 11. Follow MOEF guidelines 12. Do Impact Assessments, Risk Assessment Reports, Disaster Management Plans 13. Set up Air & Water Monitoring Stations
2.	Deptt. of Industries, Central/ State Govt.	1. Registration of Industries 2. Regulating industrial development (including location) 3. Ensure measures of safety & follow standards 4. Protect Environment
3.	Transport Authorities	1. Ensure pollution free air (including noise) 2. Ensure emission standards for automobiles 3. Organise traffic & transportation 4. Register Vehicles.

Sl.No.	Institutions	Powers & Functions
4.	Municipality/ Municipal Corporation	Obligatory Functions 1. Public health 2. Public safety & convenience 3. Medical relief 4. Public works like sanitation, conservancy, wholesome water supply, prevention of food adulteration, lighting & cleaning of streets, checking of offensive & dangerous trades, maintenance of fire brigade, municipal police (if feasible), provision of medical facilities (hospitals, maternity & child welfare centres), registration of births & deaths. 5. Town Planning 6. Housing 7. Slums/clearance 8. Road construction 9. Removal of road obstructions Discretionary Functions 1. Construction & maintenance of public streets, parks, garden, libraries, rest houses. 2. Furthering educational programmes & other primary education 3. Destruction of stray dogs/animals 4. Maintaining dairy farms 5. Holding fairs & exhibitions
5.	T.C.P.O.	1. Preparation of State Physical Plan 2. Formulation of Development Programme 3. Preparation of Regional Plan & Master Plan & its implementation 4. Co-ordination, public participation & publicity
6.	Development Authorities	1. Formulation of Building bylaws (in accordance with NBC & ISI standards). 2. Formulate special development programmes. 3. Land acquisition, redevelopment & disposal for use & reuse of land.
7.	National Building Organisation	Code building standards
8.	Atomic Energy Regulatory Board	Location of industries as per MOEF guidelines and the Acts.

Sl.No.	Institutions	Powers & Functions
9.	Housing Boards	Acquire & develop land for disposal & social housing.
10.	Electricity Board	1. Generate Electricity 2. Purchase electricity if necessary 3. Supply/Distribute electricity 4. Maintain infrastructure 5. Collect tariff
11.	Slum Clearance & Improvement Board	1. Upgradation of Infrastructure & Services for environmental Improvement 2. Health Education Programme 3. Creation of community structure
12.	Urban Arts Commission	Advice local bodies, NGOs & any agency related to the city's built environment.

Apart from the regular legislative and institutional arrangements made, many transitory or special purpose institutions have also been set up to cater to short term and/or special requirements, like the Central Ganga Authority (1985), the National Waste Land Development Board (1985) and so on. Mention should be made here of the innumerable Non-Governmental Organisations (NGOs) that are coming up to fill in administrative/management gaps, and to act as pressure groups. In fact, the Ministry of Environment and Forest has already established a cell (1992) to help non-governmental agencies to implement at the grassroots level.

Even though many provision have been made to improve environment, proper co-ordination at the local level does not take place. Each agency caters only to its sectoral requirements. It does not knit into each other to take care of the overall development. As a result, management gaps have developed, with certain functional areas totally neglected. Also, most of the agencies have a dominating central sanction, so that local level problems are ignored. This institutional arrangement needs to be altered to introduce environment protection at the grassroots level.

The mandate of the Rio Conference to "think globally but act locally" is being taken very seriously in many countries to fill in the gap between planning and implementation. Local Agenda 21 initiatives have been introduced in many cities with a variety of community - based approaches to analyse environmental issues. For example, the International Council for Local Environmental Initiatives operates by prioritizing issues

that need attention. Faced with overwhelming problems and expectations, as well as diminishing resources with increasing population, selection of issues become strategic for environmental improvement while promoting economic development. A variety of tools and methods are available to identify, critically analyse, and prioritise the problems and issues which will focus on action planning. Increasingly, planners have begun to understand the benefits of participatory and community-based approaches. Experience has shown that problem-ranking is strongly influenced by people's perception, as well as by hard scientific data. Participatory processes in planning are, therefore, becoming very popular.

4.5 Proposed Action Planning at the Local Level

The magnitude of the task demands systematic management procedures and institutions to be introduced at all levels of administration for an Integrated Urban Environment Management and Area Development Strategy. The principles followed should be:

- to create awareness in the local government and among people about environmental problems and responsibilities;
- to upgrade the capability of the local government;
- to train technical and administrative staff for environment management; and
- to encourage partnerships between local authorities, the community, and the private sector.

The steps/ stages for local management should be to:

- prioritize issues that need attention (identify cause and effect);
- relate issues to national development (social, economic) policies;
- seek political consent;
- locate areas of Action Plans (for specific issues);
- approach community groups for planning, administration, monitoring,

implementation (i.e. institutionalise community participation) which would lead to empowering people;

- define Action Plan details linking policy, resource management (budgeting cost recovery) administrative levels, organisational management, community participation framework, strategy for action;

- train people (local/administrative) for new technological and management practices and with regard to the link between the brown and the green agenda, between supportive and assimilative function;

- develop monitoring cells to guide/control/estimate Action Plan;

- develop Information System for efficiency in monitoring;

- link monitoring at different levels of administration;

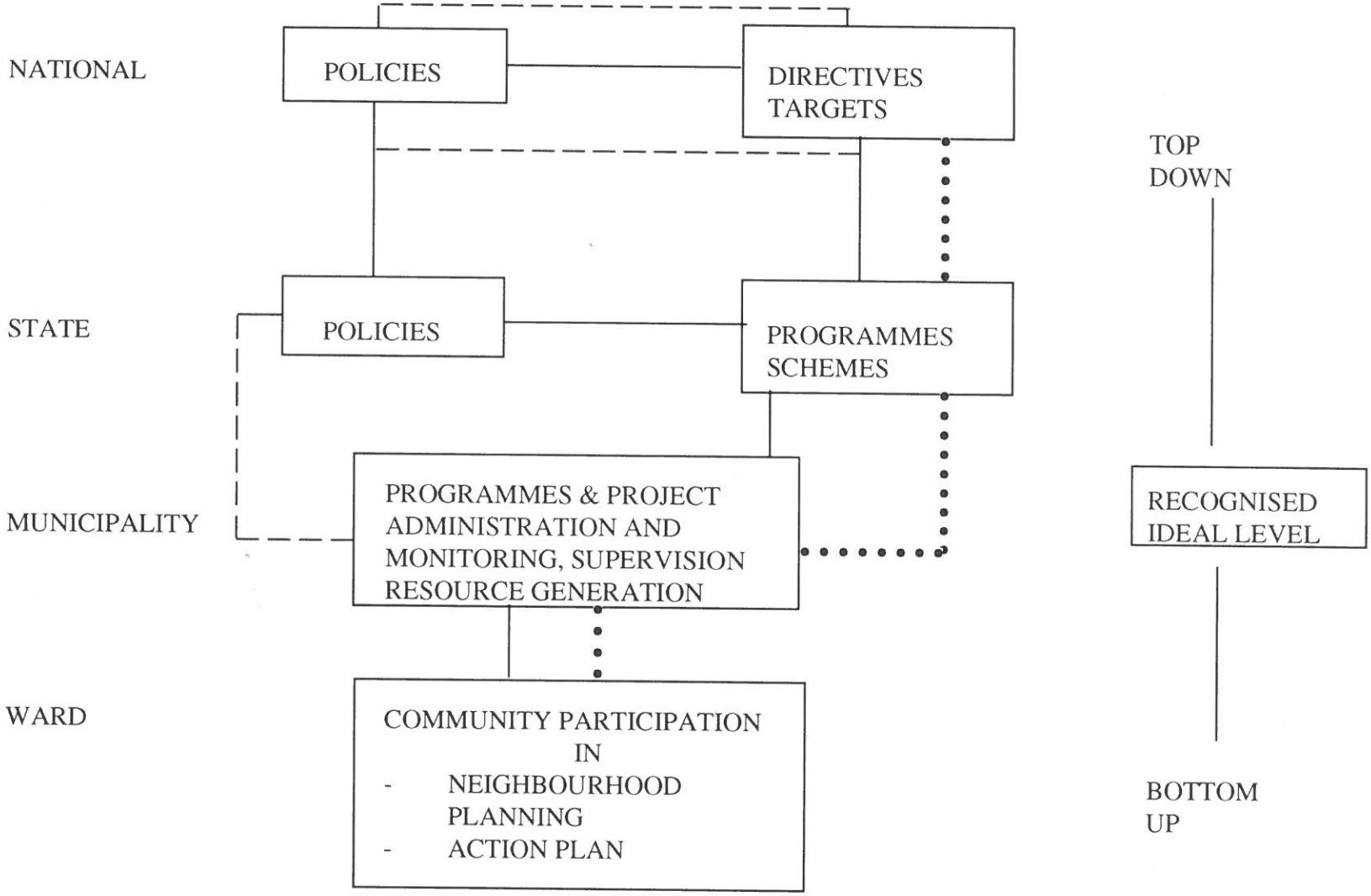
- evaluate performance, results, gaps to be bridged and Plans to be improved;

- suggest solutions to fill in gaps in Action Plan;

- feed back revisions/modifications at all levels of administration for re-orienting management procedures.

The ideal level for action would be the municipal authority level, which is the elected body at the local level. The municipality should be connected to the line agencies of the State to obtain funds and to relate local development to the State's economic development (flow chart). However, intra-city action plans will have to be worked out at the Ward Committee level, which will have to be done through community participation. This aspect of local level planning has already been given a political sanction through the Seventy-fourth Amendment Act. Care should be taken not to multiply the implementing and planning agencies/ organisations, but to strengthen the existing institutions in operation as far as possible, as drastic changes will only delay matters. However, local level organisations will have to be set up if it is absolutely necessary.

INTEGRATION OF URBAN ENVIORNMENT MANAGEMENT



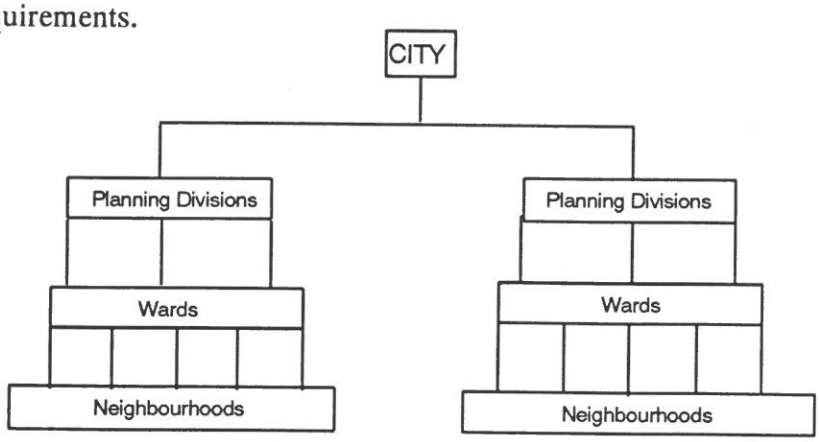
* Research & Technological Innovatives not only can affect the policies and programmes at National and State level but also at Municipal level as the latter is empowered to prepare Development Plan.

* Private Sector has to come in via change the policies at Central and State level only.

Source: NIUA (1995); Institutional Strengthening for Urban Environmental Management: A Strategy Paper, Draft Report, New Delhi.

The administrative structure for efficient local area management should be a hierarchical system that would distribute work evenly, to reach all areas of the city. The nature of the tasks to be performed within a city demands attention at different administrative levels - the neighbourhood, wards, zones, planning divisions, and the city as a whole. This is because needs vary with area and the order of the function. At the neighbourhood level, local area problems need to be solved quickly. This can be done by the Resident's Association. However, in larger areas/ planning divisions/ wards, networking of the neighbourhoods in required. Infact, the scale of operation increases with the order of hierarchy and the area to be served. While at the local level on-the-spot solutions are sought, at the upper levels administrative integration is required. Activities which cannot be done at the local level needs to be handled at higher levels. Thus the number of levels in the hierarchy would depend upon the size of the area and the magnitude of population to be managed/administered. At the local level, action plans will have to be formulated for integrated area development. Whereas, priority sectors should be identified at the Ward Committee level that would have the political support, as envisaged by the Seventy-Fourth Amendment Act.

A pyramidal structure of administration and management (which is not very uncommon) is the ideal institutional framework to be developed for local level implementation within a city. Lessons could be learnt from the Urban Basic Services for the Poor (UBSP) programme. Capacity - building for the different levels of management should be done as per requirements.



Implementation will have to be linked to the hierarchical level. Resource generation should be done keeping in mind the activities to be carried out. However, disbursement of funds to lower levels should be routed through the municipality, so that there is no overlapping of jurisdictions and repetition of work. Each organisation's responsibilities should be well defined and clear-cut directions should be given. Links between the different levels of the management system should be well established and fool-proof.

Action at Intra-City Levels

Intra-city Levels	Actions to be taken	Agencies for Action Planning	Strengthening of Institutions
City	Economic dev., coordination of Infrastructure Management	State Departments, Municipalities	Policy formulation Resource generation, Manpower Planning, Strategy formulation, Legislative reforms Political will.
Planning Divisions	Sectoral dev., Landuse dev., Special-purpose Infrastructure	State deptts., Dev. Authorities	Technical dev., Capacity - building
Wards	Local Action Plans, Area Infrastructure dev.	Ward Committees	Popular Participation, Area dev., self sufficiency in Management and Implementation
Residential Neighbourhoods	Area Specific Infrastructural and Social Dev., Employment generation	Resident's Associations	Local participation to cater to daily requirements, Initiation of Low Cost Methods of Maintenance.

Maximum attention should be given to the strengthening of the local government and institutionalising community participation. Legislations and policies will have to be introduced for action.

Involving the community serves two purposes - (1) that people themselves make an effort towards prevention/control of environmental degradation and (2) that people's participation is the best way to learn about problems that need correction. It also generates within people a sense of responsibility towards the environment. For, however much the government might want to improve the environment, controls can be incorporated only through the community's awareness. Consciousness of the community

will also make the government vigilant over environmental issues, which until now have often been neglected. There is a need to educate people on environmental issues and problems at all levels of the society. Bringing awareness (to people) can be done by introducing:

- special courses on environment in the universities, educational institutions and grassroots agencies (like the Schools of Planning, University Departments, Neighbourhood Associations, etc) to bring home to citizens the importance of a good and healthy life;

- development of Environment Management Information System to help to create greater awareness among the people through multimedia, and to encourage research to evolve better management procedures and technological improvements. A wider dissemination of data and management/technological methods will help to solve existing problems and to plan well;

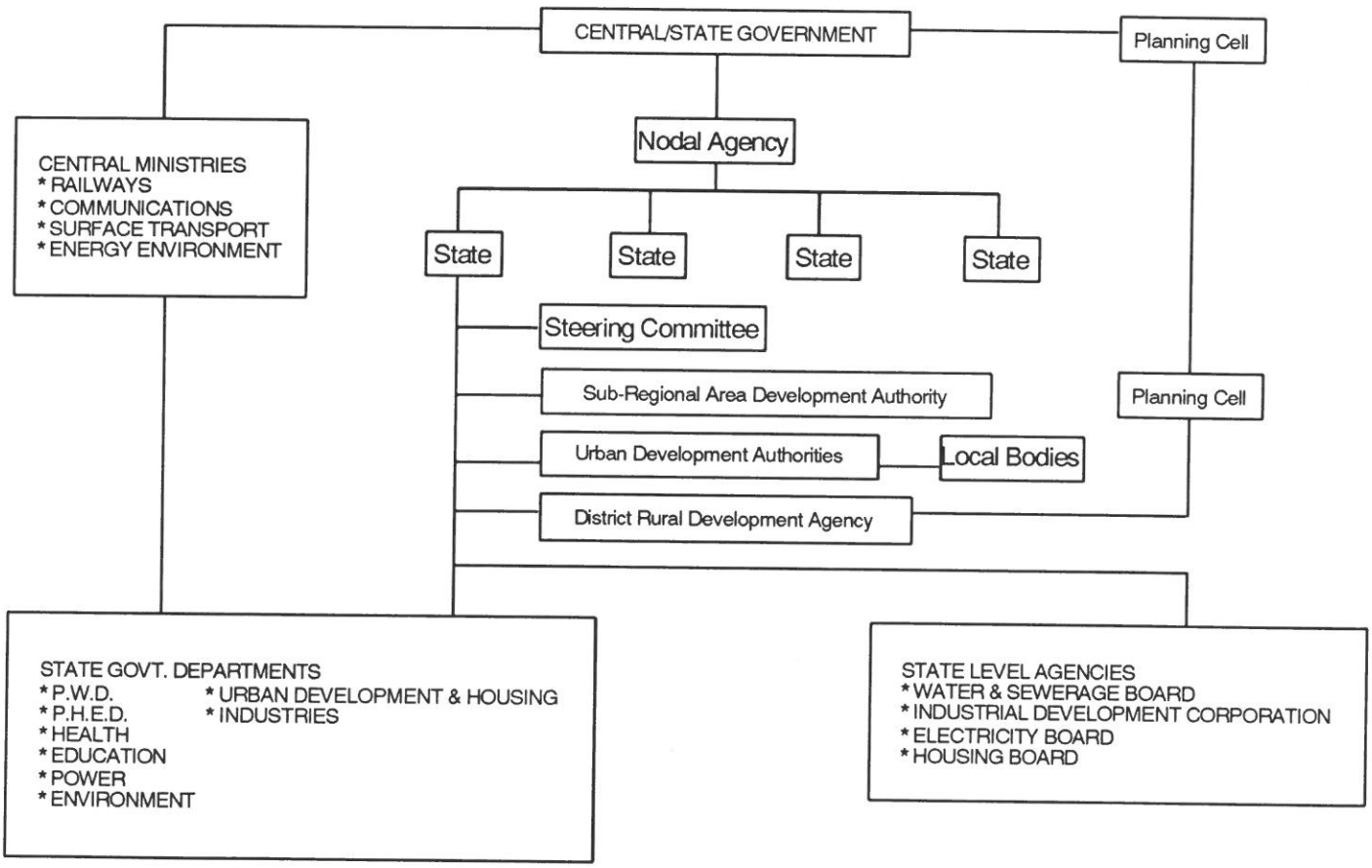
- training of officials for improved management and monitoring of environmental standards (at all levels of administration/ operation).

4.6 Action at the District Level

An aspect of development which has been hitherto ignored in the study of carrying capacity of regions, is rural-urban linkages and the steps to be taken in developing an integrated urban and rural administrative and management structure. An example of this can be cited from the National Capital Regions' (NCR) Plan, where even though the focus was on integrating urban and rural development of the Region, efforts had not been made to suggest institutional development for the rural areas. Perhaps this can be augmented through the District Planning process.

Two types of planning are required for regional development-settlement (point locations) and spatial (area development). At the settlement level there will have to be clear directions to integrate the overall economic development of the region with the local area scenario. Whereas, at the spatial level, the objectives will have to be sustained local area development. Further integration will have to be done between the settlements and their surrounding areas. An organisational structure will have to be worked out to support regional development, in which the different levels will have to have discreet jurisdictions. However, settlement planning will have to be linked to its rural hinterland.

ORGANISATIONAL STRUCTURE FOR IMPLEMENTATION
STATE LEVEL



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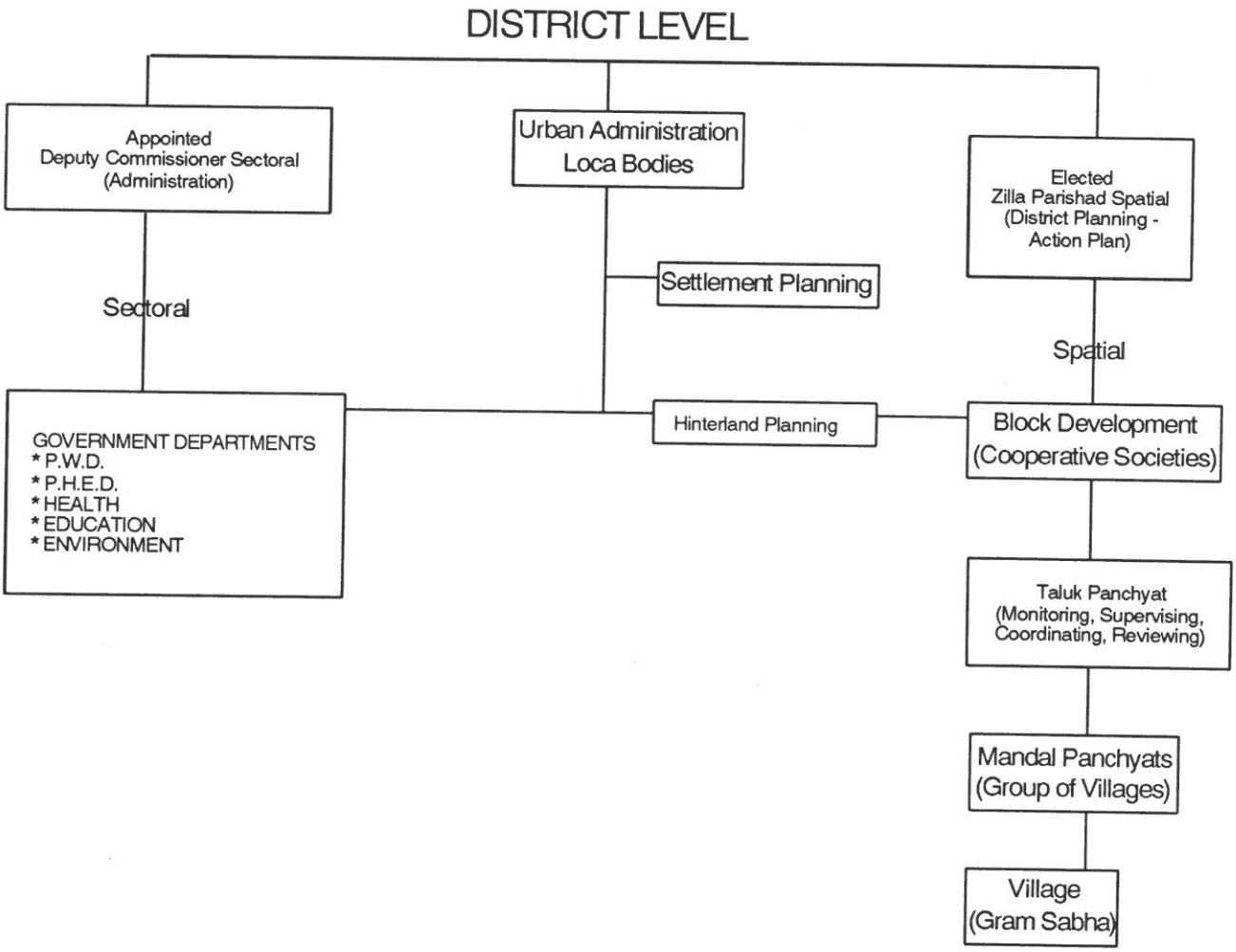
DISTRICT LEVEL
Appointed
Deputy Commissioner Sectoral
(Administration)
Urban Administration
Loca Bodies
Elected
Zilla Parishad Spatial
(District Planning -
Action Plan)
Settlement Planning
Sectoral
Spatial
GOVERNMENT DEPARTMENTS
* P.W.D.
* P.H.E.D.
* HEALTH
* EDUCATION
* ENVIRONMENT
Hinterland Planning
Block Development
(Cooperative Societies)
Taluk Panchyat
(Monitoring, Supervising,
Coordinating, Reviewing)
Mandal Panchyats
(Group of Villages)
Village
(Gram Sabha)

As mentioned above, the Seventy-fourth Amendment has suggested the setting up of District Planning Committees (DPCs) for the preparation of draft Development Plans (for the district) to be forwarded to the State governments, which in turn would consolidate them into State Plans. It is also advised that Metropolitan areas should have Metropolitan Planning Committees.

Even though District Plans can be consolidated into State Plans, action will have to be taken at the district level itself. Suggestions would be to act at the local (village or mandal- which is a cluster of villages) level. But the ideal administrative unit would be the district administration, where settlement planning (both urban and rural) could be coordinated within districts, as also with the line agencies. Metropolitan areas, however, would require special attention, as functions of such cities are very different from other urban areas. Care should be taken to systematically merge metropolitan management with the neighbouring regions. Often different states may have to coordinate their planning for management of such large cities, as has been the case with the National Capital Region in India.

4.7 Strengthening of Institutions:

Carrying capacity is a concept of self-reliance. The idea is to sustain development within the (re)generative capabilities of natural and man made resources in a given area. The aim should, therefore, be two-fold:

- to develop an administrative and management structure that would be able to implement what has been planned, so as to reach to all sections of the society, and to all parts of the city both vertically and horizontally; and that

- all implementing agencies should be competent enough to carry out their tasks smoothly, without depending on too many external factors or organisations. The aim should be to develop a self-reliant method by which requirements of cities can be met with from within, keeping in mind the objectives of democracy, which is by the people, for the people- a thrust which of late, has been realised to be the most effective form of local area management and implementation. However, integration of the different levels of management within the city will have to follow subsequently.

To bring to fruition what is being planned or propagated, the following steps/measures need to be taken:

- to set up self-reliant institutions for efficient implementation;

- to develop an organisational structure that would reach to all parts of the city and to all sections of the society;

- integrate institutions/organisations so as to link activities of different types and levels. The tasks should be well defined for each agency to avoid duplication and confusion;

- nodal agencies, if constituted, should be given the powers to persuade the different components of the planning regions to perform;

- priorities of the regional plans should be integrated with the interests of the constituent states. Well-defined partnerships should be formed, instead of thrusting a plan from above. This would help to avoid conflicting political issues;

- all concerned sectors or government departments will have to focus on the planning region irrespective of their individual tasks. For example, the Ministry of Surface Transport will have to take care of the development of highways connected to the planning region, on a priority basis;

- appropriate legislations will have to be enacted to integrate to all implementing agencies for a particular task. So far state and central enactments are supplementary, and not complementary to each other;

- community participation will have to be institutionalised by incorporating clear directives for the community in each planning process, and at all levels, wherever community participation is required;

- to make each institution or organisation self-reliant, manpower planning and development of personnel is a must. This might include technical training to improve expertise;

- a sharing of tasks and resources is also required through public, private and community partnerships. While certain services can only be provided by public agencies, the cost should be recovered from the users for using them;

- resource mobilisation for projects will have to be done through the introduction of financial instruments in the market. Lessons for this can be drawn from countries that have already introduced such methods of operation;

- introduce different partnership methods for implementation (BOO, BOT etc.) depending upon requirements;

- introduce Management Information System as a ready reckoner for action and research;

- decentralise action for easy implementation, and local area advantages;

- capacity-building for each institution.

CHAPTER V

TRAINING MODULES FOR CARRYING CAPACITY BASED PLANNING

5.1 Introduction

The approach of carrying capacity based planning is quite different from the conventional planning practice followed in India. The Carrying Capacity based Planning emphasises assessment and enhancement of both the assimilative and the supportive capacities of the urban ecosystem. While in the conventional urban planning approach, the land use alleviations are emphasised.

Urban environmental issues need to become a major focus of all planning approaches because cities are becoming increasingly important in the global economy and efforts to improve the environmental conditions in cities will increase its global competitiveness and attract economic investments. This requires strengthening the capacity of local government to prepare and implement plans for environmentally sustainable urban areas.

The emphasis on environmental aspects in the planning process would require a change in the mind-set of the planners and decision makers. The entire process of plan formulation and implementation requires to be altered to make the concept of "sustainable city" a reality.

5.2 Vertical and Horizontal Fragmentation

Urban environmental problems like air pollution, water pollution, lack of green spaces etc; are not just "local" problems affecting a single city. They have cross-border impacts. Yet, in management plans, these are treated a social problems. This is largely because of vertical and horizontal fragmentation. Vertical fragmentation arises when various tiers of governments intervene in the urban areas, by virtue of their statutory powers. In most instances, these agencies do not coordinate their policies at local level or cooperate at he margin. In some cases the policies are also in conflict. Horizontal fragmentation occurs when many units of local government operate in distinct sectors without coordination. In India, a large number of parastatal agencies, like Urban Development Authorities, Water Supply and Sewerage Boards, work in municipal areas, often in conflict or competition with one another.

5.3 Multi-sectoral and Multi-territorial nature of problems

Urban Environmental problems are multisectoral in nature, but are usually dealt on sectoral basis. It is common knowledge that urban environmental problems are interconnected. For example, poor traffic management not only leads to traffic congestion, but also air pollution. Inadequate landuse planning also has traffic implications. Thus, instead of a sectoral approach, it is necessary to adopt a multisectoral strategy to combat urban environmental problems.

The environmental problems are also multi-territorial. Water supply projects for a city can have implication on the upstream of the river as a result of dam construction. Waste water discharges, similarly, cause severe problems on downstream activities.

The carrying capacity based planning approach provides a framework for multi-territorial and multi-sectoral approach to urban environment. However, the present capacity of agencies involved in planning and implementation needs to be strengthened to carry out these tasks.

5.4 Strengthening Institutional Capacity

Strengthening the institutional capacity for preparation and implementation of carrying capacity based planning requires legal administrative and technical support.

The legal basis for carrying capacity based plan preparation exists in the present status of planning agencies. The mandate for preparation of urban development plan or regional plan implies that a comprehensive assessment of the various sectoral issues is made prior to formulation of plans. However, at present, the planning approach is largely confined to land based issues. The carrying capacity based planning requires a major shift in the approach and this can be attempted through a series of training programmes.

5.5 Training Modules

As a part of this exercise, three training modules have been developed. The first training module is designed as a one and a half day training workshop to sensitise the policy makers about the concepts of carrying capacity based planning. The second module is designed for senior technocrats who are involved in planning at city-level. The third training module is a detailed one month programme focusing on carrying capacity based plan preparation. These modules are described below.

Carrying Capacity Based Regional Planning

TRAINING MODULE - 1

Training Programme for Senior Officials/Policy Makers (For One and a half day)

Objectives

The new economic policy in India, with liberalised industrial growth, will bring in rapid urbanization, with cities as harbingers of economic development. Anticipating the importance role of the cities and the environmental and population pressures on them and their surroundings regions that would accommodate such growth, planners should try to enhance the carrying capacity of urban settlements, so as to act as a catalyst for economic growth and at the same time maintain a good quality of life. While it is hoped that industrialisation will promote development, it is also expected to congest cities with migrants for the new jobs that will be created. Unless supplemented, the intensity of use will erode urban infrastructure. There will also be a need to protection the deteriorating environment from pollution and wastes. These will have to be done on the basis of the "carrying capacity" of the cities and the regions to harbour the increasing population and all such physical growth that is associated with it.

The two most important components by which the carrying capacity can be judged are: the assimilative and the supportive capacities. The former is a cleansing quality inherent in nature, such as air, water, vegetation, and the latter is the infrastructural support given to a city or a region in order to function. These two components are a combination of innumerable elements that have a symbiotic relationship amongst themselves which collectively determine the status of the settlement and the quality of life of the citizens therein. It is, therefore, essential to measure these elements and understand their roles in the urban environment, to help policy decisions.

The proposed training programme is to highlight to the policy makers the diverse elements that contribute to the carrying capacity, and to explain the best methods to measures this capacity to plan for sustainable development.

The programme will also discuss the present management practices to regulate and operate these elements, identify the weaknesses of the existing systems, and suggest ways and means of strengthening the administrative legislative, financial and executive institutions.

Training Programme Outline :

DAY ONE **Economic Growth and Regional Planning**

Session - I **(Three Hours)**

Lectures : 1. Urbanisation, settlement growth and the Demand for Infrastructure.

2. Regional and Landuse Planning : The Role of Strategic and Regional Environmental Assessment.

Carrying Capacity for Sustainable Development

Session II **(Three Hours)**

Lectures : 1. Carrying Capacity as a concept and a tool for Sustainable Development.

2. Methodology to measure Carrying Capacity

DAY TWO **Environmental Management**

Session III **(Three Hours)**

Lecture : 1. Integrated Environmental Management. The need for Policy and Strategy

Panel Discussion 2. Strengthening of Resource Base and local Institutions;

Carrying Capacity Based Regional Planning

TRAINING MODULE - II

Training Programme for Technical Staff

(for three and a half day)

Objectives:

Planning is usually based on certain philosophies and behavioural and/or performance patterns. It would, therefore, be useful for technocrats to understand the concepts and the processes on which urban development rests.

This training workshop will not only try to understand the principles of sustainable development, but also try to assess the extent to which existing practices help to achieve it. It will then focus on institutional arrangements at local level for sustainable urban development.

Finally, new directions for the future will have to be given for better strategies. This will follow from the group discussions/exercises during the programme.

Target Group :

The target group for this training programme would be the Environmentalists/Engineers working in and other technical officers working at State Level and Local Level.

Training Methodology :

The training programme will be based on Lectures/Case Study presentations and Group exercises. The group exercises will be focussed on using existing information base for carrying capacity estimations and strategic planning.

Training Programme Outline :

Session I **Regional Planning and the Role of Environment Assessment**

Lectures : 1. Regional Planning for Sustainable Development

2. Strategic and Regional Environmental Assessment : Principle, Practices, Case Studies.

Session II **Concept and Application of Carrying Capacity**

Lectures : 1. Carrying Capacity : As a concept and a tool.

2. Exercise: Assessment of Assimilative Capacity:

- Air - Water - Land - Biodiversity	Group Work for a given region for which information will have to be provided.

Session III **Concept and Application of Carrying Capacity (contd.)**

Lectures : 1. Case Study of Carrying Capacity Application

2. Exercise : Assessment of Supportive Capacity:

- Water Supply & Sanitation - Solid Waste - Transportation - Housing - Electricity	Group work for whch data should be supplied for a region.

Session IV **Resource Generation and Institutional Strengthening**

Lectures : 1. Resource Generation for Infrastructure Development : Conventional Methods, Market - oriented methods, Public-Private Partnerships, Land, Law-Cost solution

2. Institutional Strengthening for Environmental Management

Session V **New Directions for Environmental Planning**

Presenta-tion : 1. Presentation of Group Work

2. Towards Better Strategies and Methods : concluding remarks.

Carrying Capacity Based Regional Planning

TRAINING MODULE - III

Training Programme for Planners

(One Month)

Objectives:

When planners plan for integrated urban development, the need for urban environmental management to monitor the carrying capacity of cities and regions becomes essential. Each element of nature that influences human life needs to be measured and its impact estimated. Similarly, the relationship between infrastructure and socio-economic development need to established. The rate of influence, the intensity of the impact, the quality of life etc, are some of the parameters that determine sustainable development. Hence, the right combination of the elements of both the assimilative and the supportive capacities is very crucial for planning. Care should, therefore, be taken to understand each element and the parameter that measures its contribution to sustainable development.

This Training programme will not only try to focus on the principles and the practices that determine development, it will study each element of the carrying capacity of cities that influence the quality of life. The objectives of the programme will also be to devise methodologies to attain sustainable development. Importance will, therefore, be also given on management issues.

Target Group :

This training Module is designed specifically for middle and senior level planner working at national, state and local level. This group of professionals require to incorporate the dimension of environmental planning in their current practices and reformulate their planning approach. Given the training methodology, a group of 15-20 participants is recommended.

Training Methodology :

The module is designed as a lecture-cum-case study presentations in the first half of the programme. The second half of the programme is designed as field work based exercise. For this, a city such as Delhi, Bombay and Madras, where previous studies of environmental assessment have been done, will be chosen. The participants would be expected to spend a week in collection of relevant information and discussions with concerned officers in the city. The final week would be devoted to preparation of strategic plan outline based on group discussions on carrying capacity estimations and urban environmental management strategies.

TRAINING PROGRAMME OUTLINE

WEEK ONE

Topic I : **Industrialization and Urbanization**

Lectures :

1. New Industrial Policy, Liberalisation and the Role of Cities.
2. Impact of Economic Growth and Industrial Development on Urban Settlements.

Group Work Exercise on how to select indicators for measuring Urbanisation and Industrialisation.

Topic II : **Carrying Capacity of cities and Regions**

1. Carrying Capacity : Concept and Elements.
2. Carrying Capacity of Cities us Increase in the Demand for Infrastructure.

Group Work: Exercise on selecting variables/parameters for estimating Carrying Capacity of a Region.

Topic III : **Regional Planning and the Role of Environment Assessment**

Lectures : 1. Regional Planning for Sustainable Development.

2. Strategic and Regional Environmental Assessments : Principles and Practices.

Topic IV : **Case Studies**

1. Regional Planning Case Study

2. Carrying Capacity Case Study

Topic V : **Methods for Application**

Lectures : 1. Population Regional Planning Methods

2. Carrying Capacity Methods : Rural and Urban

3. Systems Approach

4. Integrated Management

Topic VI : **Economic Growth and Infrastructure Development**

Lectures : 1. Demand-supply Gap : The need for New Infrastructure.

: 2. Infrastructure Development and Sustainability.

Topic VII : Infrastructure Development and Resource Generation

Lectures :

1. Present practices and mis-use of resources
2. Environmental costing and fiscal tools for internalising externalities
3. Public - Private Partnerships
4. Cost - Recovery and pricing
5. Using land as a resource for development
6. Appropriate Infrastructure Technology planning and design.

WEEK TWO

Topic VIII : Urban Environmental Management

Lectures :

1. Elements of Urban Environment and their Existing Regulatory Functions
2. The Need for Integrated Urban Environmental Management

Topic IX : Policies, Legislations and Provisions for Environmental Management

Lectures :

1. Policies, Legislation for Environmental Management : at the Centre, State and Local levels.
2. Role of local governments in the context of 74th Amendment.

Topic X : **Institutional arrangements for Infrastructure Provisions and Environmental Management**

Lectures :

1. Organisations providing Basic Infrastructure
2. Environmental Management and Administration.

Group Exercise : Institutional Arrangements for :

- Water Supply & Sanitation
- Solid Waste Management
- Electricity
- Transportation

Topic XI : **Physical Planning and Area Development**

Lectures :

1. Master Plans/Landuse Planning
2. Area Development : Integrated Landuse and Infrastructure Planning

Topic XII : Recapitulation and Comparisons of Alternative approaches.

Lectures :

1. Physical vs Developmental Planning
2. Landuse vs Strategic Planning
3. Carrying Capacity Planning and the Need for Institutional Strengthening
4. Good Practice : comparison of methods and evaluations.

Topic XIII: 1. Discussion to Finalise Methodology for Field Work

2. Formulation of of work programme and tasks assignment among groups.

WEEK THREE

Field work in Selected Case Study City

WEEK FOUR

Preparation of Strategic Plan for Selected Area

A Infrastructure Management

1. Requirements of Infrastructure Management.

2. Review of Existing Infrastructure Management

- Water Supply
- Sanitation
- Solid Waste
- Transportation

3. Identification of gaps in Infrastructure Management and Suggestions for Solutions

- Changes in Legislation
- Improvement of Organisations
- Technological Innovations
- Re-formulation of Standards
- Resource generation
- Strengthening of Institutions
- Community Participations/Local Level Participation

4. New Strategies : Alternative Scenarios

B. Urban Environmental Management

1. Requirements for Environmental Management

2. Review of Environmental Management
   - Air Pollution
   - Water Pollution / Toxic waste
   - Industrial Pollution
   - Water body Management
   - Land Management
   - Biodiversity Management

3. Identification of Gaps in Management and Suggestions for Solutions :

   - Changes in Legislation
   - Improvement of Organisations
   - Technological Innovations
   - Resource Management
   - Re-formulation of Standards
   - Strengthening of Institutions
   - Community Participation/ Local Level Participation

4. New Strategies : Alternative Scenarios

C. Integrated Infrastructure and Environmental Management :

   - Formulation of Policies
   - Formulation of Strategies/Action Plans

D. Area Development Plan Formulation for Regional Planning

- Land Development
- Water Supply
- Transportation
- Housing
- Sanitation
- Solid Waste
- Employment
- Rural - Urban Linkages

E. Action Plan to Monitor Sustainable Development

APPENDIX–A

Summary of urban environmental issues and options

Problem Area	Effects	Causes	Management Option
AIR-RELATED PROBLEMS			
AMBIENT AIR POLLUTION • community • city wide • regional • transnational	• health problems • economic costs from health care costs and productivity losses • amenity losses (aesthetic, cultural, and recreational)	- industrialization - increase in motorized fleet & congestion - use of highly polluting fuels (leaded gas and high sulfur coal) - energy pricing policies - topography and climate	+ fuel pricing + regulations, standa emissions charges + demand manageme + transport planning + appropriate techno (clean fuels, scrubb etc.)
INDOOR AIR POLLUTION • household • workplace	• health problems (chronic obstructed lung disease, acute respiratory infections, low birth weights, cancer) • economic costs from health care & productivity losses	- use of low-quality fuels for cooking and heating (biomass and high sulfur coal) - poorly ventilated dwellings & workplaces - passive smoking - cottage industry activities	+ substitute fuel and equipment pricing + fuel switching + building codes + public education + tax hazardous prod and processes
WATER-RELATED PROBLEMS			
SURFACE WATER POLLUTION • community • city wide • regional	• health problems • economic costs (additional treatment, new sources of supply, health costs) • amenity losses	- pricing policies - unclear property rights - poor regulations and/or enforcement - municipal & industrial waste disposal practices - urban runoff - irrigation practices	+ marginal cost pricin + regulations, standar licensing, charges + improve monitoring enforcement + demand managemer and wastewater re-u + appropriate technolo + land use controls + waste management
GROUNDWATER POLLUTION AND DEPLETION • community • city wide • regional	• reduced water quality from saline intrusion, biochemical seepage • health impacts • economic costs (damage from land subsidence, health costs, increasing marginal costs of supply)	- pricing policies - unclear property rights - poor regulations and/or enforcement - unsustainable extraction - sanitation, municipal & industrial waste disposal practices - poor demand management	+ marginal cost pricing (sustainable extracti aquifer recharge cost + regulations, standard licensing, charges + waste management + appropriate technolo + demand management + controls on land use and sources of contamination
COASTAL/LAKE POLLUTION • community • city wide • regional • transnational	• health effects due to contaminated seafood and direct contact • loss of recreational resources & tourism revenues • damage to fisheries • amenity losses • eutrophication	- unclear property rights - poor regulations and/or enforcement - municipal and industrial waste disposal practices - disposal of shipboard wastes	+ regulations, standard licensing, charges + appropriate technolo + coastal zone manage-ment and preservatior + shipping facilities + waste management + land use controls

Source: The World Bank; 1993, Urban Management Programme.

Problem Area	Effects	Causes	Management Options
LAND-RELATED PROBLEMS			
DEGRADATION OF LAND • city wide • periurban • regional	• declining agricultural productivity • reduced renewable resource base (deforestation, lost soil fertility) • erosion and siltation • amenity losses • loss of natural habitat & species	- changes in relative value of land uses - uncontrolled urban growth - unclear property rights - woodfuel and land pricing - mining and quarrying activities - land disposal of municipal and industrial wastes	+ internalize ecological value in land prices + designate special areas for management + local participation + clarify property rights + economic resource pricing + land use controls
LOSS OF CULTURAL AND HISTORICAL PROPERTY • community • city wide	• loss of heritage • loss of tourism revenues • damage to culturally valued buildings, monuments, natural sites	- land prices do not reflect social valuation - lack of regulation and/or enforcement - air pollution - SWM practices - land subsidence and poor drainage	+ internalize costs of loss in redevelopment planning + tax incentives for preservation + zone and building codes + pollution control + public education
DEGRADATION OF ECOSYSTEMS • regional	• health hazards • resettlement costs • loss of habitat and species • air, water, land pollution	- failure to anticipate effects in planning and development - pricing policies - lack of rural political power	+ internalize costs of rural degradation + resource pricing + clarify property rights
CROSS-MEDIA PROBLEMS			
MUNICIPAL SOLID WASTES • household • community • city wide • regional	• health impacts • costs related to blocked drainage and flooding • water pollution from leachates • air pollution from burning • amenity losses	- poor management (improper collection and disposal, little resource recovery) - pricing (no cost recovery) - disposal impacts external to community - input pricing	+ private sector delivery of collection and disposal + waste minimization (recycling, recovery, source reduction) + regulations, standards, licensing, charges + expanded coverage + inst. strengthening
HAZARDOUS WASTES • household • community • city wide • regional	• surface, ground, coastal water contamination • related health, economic, and resource impacts • accumulation of toxics in the food chain • reduced property values	- inadequate regulations and/or enforcement - no incentives for treatment - input pricing for waste-producing industries - low visibility, nonlinear, long-term effects - dispersed small-scale & cottage industries	+ regulations, standards, licensing, and charges + improve monitoring and enforcement + treatment and disposal incentives + economic input pricing + waste minimization + marginal cost pricing + special incentives for small-scale generators + privatization of treatment and disposal operations

APPENDIX -B

Resource Classification

Category	Components
Ecological and economic resources	Air, water, land, sunlight, space, green plants, non-green plants, animals, biodiversity, and CO_2 sinks; inputs for production processes, viz. raw materials, mineral resources, capital, human resources and organisational resources
Transformational resources	Processes for extraction, beneficiation and conversion of ecological and economic resources into productive goods and services with minimal residuals
Infrastructure and distributive resources	Transportation, water supply wastewater, communication and energy systems
Socio-cultural resources	Educational & cultural facilities; health services; security services, infrastructure resources; scenic and recreational areas

Source: NEERI, 1994; Development Planning of National Capital Region, Delhi

APPENDIX - C

Table 2

SUMMARY OF INDICATORS(1) (2)

Column 1	Column 2	Column 3
Concern	Proposed Indicators	Suggested Indicators for further development
1. HOUSING:		
1.1 Indoor space	Percentage of dwellings with less than specified numbers x of persons per room. For example x = 0.5, 1.0, 1.5	
1.2 Outdoor space	Percentage of population living in an area with net density of more than X persons per km^2	Average area (in m^2) of usable outdoor space per dwelling Average number of public children's playgrounds per 100 children in the relevant age group
1.3 Amenities and sanitation	Percentage of dwellings with private bath or shower	
1.4 Security of tenure	Percentage of owner-occupied households (including owners of long leases)	Percentage of households enjoying effective security from eviction for "X" periods of time
1.5 Cost of and access to housing	Percentage of households spending less than x per cent of their income on a specified type of housing. For example, x = 20%, 30%	
2. SERVICES AND EMPLOYMENT		
2.1 Accessibility and quality of commercial services	Percentage of population with access to a food store within x metres. For example x = 400, 800, 1200, 2400 metres	Indicator taking into account other aspects of quality
2.2 Accessibility and quality of health services	Percentage of population with access to a medical doctor within x metres. For example x = 800, 1600, 2400 metres	Average time delay between awareness of a functional disturbance of a non-emergency nature and appropriate treatment
2.3 Accessibility and quality of educational services	Percentage of pupils with access to primary school within x minutes or metres. For example x = 15 minutes (on foot or by bus); 800 m	Indicator taking into account other aspects of quality
2.4 Accessibility and quality of recreational services	Percentage of population with access to public open space within x metres. For instance x = 800, 1600, 2400 metres	Indicator taking into account other aspects of quality
2.5 Accessibility and quality of transport services	Ratio of number of persons killed or injured in a road accident to the total population over one year Percentage of population with access to an urban public transport stop within x metres (e.g. x = 400, 800 metres)	A further indicator of public transport quality (frequency, reliability, comfort)
2.6 Accessibility and quality of protective services	Percentage of dwelling units totally destroyed by fire over one year	Average response time between request for and delivery of emergency service
2.7 Accessibility to and safety of employment	Percentage of all employed persons living more than x minutes from their place of work (using usual mode of transport and at usual time). For instance x = 10, 20, 30, 40 minutes	Number of working days over one year lost due to industrial accidents as a percentage of total working days
3. AMBIENT ENVIRONMENT AND NUISANCES		
3.1 Air quality(2)	Percentage of population with residence in areas with outdoor concentrations: (i) of sulphur dioxyde in excess of 60μ g/m3 (annual average) and/or 2% of the observations being above 200μ g/m3 (24 hourly value); (ii) and/or of particulate matter in excess of 40μ g/m3 (annual average) and/or 2% of the observations being above 120μ g/m3 (24-hourly value)	Percentage of total population exposed to concentrations of sulphur dioxyde and particulate matter in excess of specified levels over specified periods of time. Percentage of total population exposed to concentrations of carbon monoxide in excess of specified levels over specified periods of time
3.2 Water quality	% of the population concerned multiplied by the number of days when water supplied is below the following standards: (i) when water contains E.Coli in a 100 ml sample, (ii) when water has an objectionable taste or colour. % of area (shore length) of recreational waters within urbanised area (or within zone of diameter twice that of urbanised area) per 1,000 inhabitants where water quality allows: (i) swimming, (ii) other water sports; fishing, boating, (iii) visual amenity	
3.3 Exposure to noise(2)	Percentage of residential population in areas with levels of outdoor noise expressed in terms of Leq in excess of (i) 75, (ii) 65, (iii) 55, (iv) 45 dBA over the period 6h-22h Percentage of population with residence in areas with levels of outdoor noise expressed in terms of Leq in excess of (i) 55, (ii) 45, (iii) 35 dBA over the period 22h-6h	Percentage of total population exposed to levels of noise expressed in terms of Leq in excess of (i) 75, (ii) 65, (iii) 55, (iv) 45 dBA over the period 6h-22h. Percentage of total population exposed to levels of noise expressed in terms of Leq in excess of (i) 55, (ii) 45, (iii) 35 dBA over the period 22 h-6h.
3.4 Solid waste disposal		[An indicator to reflect impact on ambient environment of solid waste disposal and quality of service from inhabitants' point of view]
3.5 Exposure to natural hazards	Annual average percentage of dwellings made permanently uninhabitable due to natural disasters such as landslides, subsidence, floods, high winds, or earthquakes during past 50 years	% of dwelling units located in identified zone of specified natural hazard exposure
3.6 Weather conditions	Number of (i) heating degree days; and (ii) cooling degree days per year Average monthly amount of precipitation (i) for six summer months; (ii) for six winter months, over a five-year period. Average hours of sunshine (i) over six summer months; (ii) over six winter months, over a five year period	Indicator reflecting temperature, wind, and humidity, e.g. by means of "comfort index" values
3.7 Land quality and urban landscape	% of urban area vacant or abandoned	Percentage of total urban area occupied by (i) conservation areas and protected buildings; (ii) landscaped amenity, open space; and (iii) precincts
4. SOCIAL AND CULTURAL(1)		

APPENDIX - D

URBAN INDICATORS

MODULE 1. POVERTY, EMPLOYMENT AND PRODUCTIVITY

POLICY GOALS	KEY INDICATORS
Alleviate urban poverty	Indicator 1: Households below poverty line. Percentage of households situated below the poverty line. Indicator 2: Poor household's expenditure on food. Average share (percentage) of expenditure on food by households below
	Indicator 3: Income disparity Ratio of income of highest 20% of households to income of lowest 20%.
Increase employment opportunities	Indicator 4: Employment growth. Average annual growth rate of the number of employed men and women aged 15 and above, during the last 5 years. Indicators 5: Informal/undeclared employment. Percentage of the employed population whose activity is part of the informal sector.
Increase urban productivity	Indicator 6: City product per head. City product divided by population.

MODULE 2. SOCIAL DEVELOPMENT

POLICY GOALS	KEY INDICATORS
Promote sustainable demographic growth and social development	Indicator 7: Life expectancy at birth. Average number of years new-born baby would live if patterns of mortality prevailing for all people at the time of birth were to stay the same throughout his/her life. Indicator 8: Infant mortality. Proportion of children who die before reaching their fifth birthday. Indicator 9: Infectious diseases mortality. Percentage of deaths due in infectious diseases. Indicator 10: Fertility rate. Average number of children expected for each women of childbearing age. Indicator 11: Adult literacy rate. Proportion (%) of adults who can read and write a simple paragraph about their everyday life.
Facilitate health and education for all	Indicator 12: School enrollment rates. Percentage of children of eligible age, by sex, who are enrolled in primary and secondary schools. Indicator 13: Mean years of schooling. Number of years spent in full-time education or equivalent by adults for makes and females. Indicator 14: Education costs. Mean cost per annum in US dollars to the parents or student for a child in primary or secondary school. Indicator 15: School classrooms. Number of school children per classroom per school in (a) primary schools, (b) secondary schools. Indicator 16: Hospital beds. Number of persons per hospital bed.
Promote social integration	Indicator 17: Crime rates. Number of reported crimes annually per 1000 population for: (a) murders; (b) thefts. Indicator 18: Single parent households. Percentage of households consisting of a family nucleus with a father or mother with one or more never married children.

Source: U.N.C.H.S.

MODULE 3. INFRASTRUCTURE.

POLICY GOALS	KEY INDICATORS
Improve access to and affordability of services	Indicator 19: Household connection levels. Percentage of households connected to: (a) water, (b) sewerage, (c) electricity, and (d) telephone.
Insure quality and sustainability of water delivery systems	Indicator 20: Access to potable water. Percentage of households with access to potable water. Indicator 21: Consumption of water. Average consumption of water in litres per day per person, for all uses. Indicator 22: Median price of water, dry season. Median price paid per hundred litres of water in US dollars, at the time of year when water is most expensive.
Improve provision of sanitation services	Indicator 23: Sewerage disposal. Proportion of households with following types of latrine facilities: (a) Sewerage pipe, (b) Under-ground - individual, (c) Under-ground - communal, (d) Pan collection, (e) Open ground or trench, (f) Other.
Improve provision of electricity service	Indicator 24: Electricity price. Price of electricity in US dollars per Kwh. Indicator 25: Power cuts Average number of interruptions to power supply per month.

MODULE 4: TRANSPORTATION

POLICY GOALS	KEY INDICATORS
Improve performance and sustainability of urban transportation systems	Indicators 26: Modal split Proportion of work trips undertaken by : a)Private car, b) Train or tram; c) Bus or minibus; d) Non motorized; e) Other Indicator 27: Travel time Average time in minutes for a work trip Indicator 28: Fuel fatalities Proportion of deaths per thousand in the last year from transport related causes Indicator 29: Fuel Price Price in US cents per litre, including tax, of: a) Petrol (gasoline); b) Diesel; c) LPG or CNG. Indicator 30: Transport fuel consumption Annual number of Litres per person of transport fuel (excluding aviation fuel) consumed.
Improve road network and reduce congestion	Indicator 31: Roads in poor repair Percentage of roads which are deemed to be in poor repair. Indicator 32: Expenditure on road infrastructure Per capita expenditure in US dollars on roads (three year average)
Promote sustainable use of private vehicles	Indicator 33: Automobile ownership Units of motorization in private oil driven car
Improve and facilitate public and mass transport services	Indicator 34: Public transport seats Number of public transport seats per 1000 population

POLICY GOALS	KEY INDICATORS
Improve urban water supply	Indicator 35: Percentage of waste water treated Percentage of all wastewater undergoing some form of treatment. Indicator 36: Percent of BOD removed Average fraction of Biochemical Oxygen Demand removal in major wastewater receiving bodies. Indicator 37: Cost of wastewater treatment Average cost in US dollars per cubic metre of water treated.
Improve provisions of solid waste collection and disposal service	Indicator 38: Solid waste generated Solid waste generated per person, in cubic metres per annum. Indicator 39: Disposal methods for solid waste Proportion of solid waste disposal: a) to sanitary landfill b) incinerated; c) to open dump; d) recycled; e) others Indicator 40: Regular solid waste collection Proportion of households enjoying regular solid waste collection service.
Ensure sustainability of resource use	Indicator 41: Energy usage per person Total energy used per annum per person in metric tonnes of coal equivalent
Reduce effects of natural and man-made disasters	Indicator 42: Housing on fragile land Number of dwellings in the city which are located on land which is subject to natural disaster

MODULE 8: LOCAL GOVERNMENT

POLICY GOALS	KEY INDICATORS
Improve inter-governmental institutional arrangements	Indicator 43: Government level of providing services Urban services delivered to the population by type of service and type of supplier (Check boxes indicator)
Improve financial viability of local government	Indicator 44: Major sources of income Indicator 44.1: Local government per capita income Total local government sources of funds in US dollars annually, both capital and recurrent for the metropolitan area, divided by population (three year average) Indicator 44.2: Percentage of local government income by source: a) taxes; b) user charges; c) other own source of income; d) transfer from higher levels of government; e) borrowings; f) other income Indicator 45: Per capita capital expenditure Capital expenditure in US dollars per person, by all local governments in the metropolitan area, average of the last three years Indicator 46: Ratio of debt service charge to total expenditure Total principal and interest repaid, including bond maturations, as a percentage of total expenditure by local governments
Promote democratic participation in local government decision making	Indicator 47: Elected and nominated councillors Total number of elected and nominated local government representatives per 100,000 metropolitan population, by sex
Increase local independence in decision making	Indicator 48: Control by higher levels of government Independence of action of local government (check boxes indicator)
Enhance effective use of public resources	Indicator 49: Local government employees Total local government employees per 1000 population Indicator 50: Personnel expenditure ratio Proportion of personnel expenditure (mention wage costs Indicator 51: Contracted recurrent expenditure ratio Proportion of recurrent expenditure spent on contracted activity.

HOUSING INDICATORS

Housing: Affordability and Adequacy

POLICY GOALS	KEY INDICATORS
Access to affordable housing	Indicator H1: House price to income ratio Ratio of the median free-market price of a dwelling unit and the median annual household income. Indicator H2: House rent to income tax ratio Ratio of the median annual rent of a dwelling unit and the median annual households income of renters.
Adequate housing for all	Indicator H3: Floor area per person Median usable living space per person (m) Indicator H4: Permanent structures Percentage of housing units located in structures expected to maintain their stability for 20 years or longer under local conditions with normal maintenance. Indicator H5: Housing in compliance Percentage of total housing stock in compliance with current regulations. Indicator H6: Infrastructure expenditure Ratio of the total expenditures (operations, maintenance and capital) by all levels of government on infrastructure services (roads, sewerage, drainage, water supply, electricity and garbage collection) during the current year and urban population

HOUSING PROVISION

POLICY GOALS	KEY INDICATORS
Improve access to housing finance	Indicator H7: The housing credit portfolio Ratio of total mortgage loans to all outstanding loans in both commercial and government financial institutions.
Encourage efficient production systems to housing	Indicator H8: Housing production Total number of housing units (in both the formal and informal sectors) produced in the previous year per 1000 population Indicator H9: Housing investment Total investment in housing (in both the formal and informal sectors), as a percentage of gross domestic product.
Ensure adequate supplies of affordable land for residential development	Indicator H10: The land development multiplier Average ratio between the median land price of a developed plot at the urban fringe in a typical subdivision and the median price of raw, undeveloped land in an area currently being developed.

Source: O.C.E.D., 1978, Urban Environmental Indicators

APPENDIX - E

URBAN ENVIRONMENTAL INDICATORS: SELECT DATA

Accra

I. BACKGROUND STATISTICS				
Indicator	**Unit**	**Year**	**Metro Area**	**City**
Population	'000	1970	735	625
		1990	1,566	1,330
		2000	2,674	2,273
			Jurisdiction	**Value**
Share of GDP	%			NA
Annual Growth	%	70-84	Metropolis	4.3
Total employment (industrial)	% of jobs	1987	Metropolis	19
Density	n/km²	1984	Metropolis	526
< Poverty line	%	1990	Metropolis	48
Substandard housing	%	1989	City	18
Overcrowding	n/room	1989	Metropolis	2.9
Life expectancy	years	85-90	National	54
Infant mortality	/1000 births	1988	City	57.7
Top three causes of morbidity	% all ill-ness	1987	Cause 1) malaria 2)respiratory 3) diarrhea	 45 10 7

II. NATURAL ENVIRONMENT AND LAND USE- ACCRA				
Indicator	**Unit**	**Jurisdiction**	**Value**	**Year**
Key ecosystems:	type			
Terrestrial		Metropolis	dry coastal	1991
Aquatic		Metropolis	rivers,inter tidal	1991
Temperature:	monthly			
Minimum	oC	City	24.7	1990
Maximum	oC	City	28.1	1990
Rainfall:	monthly			
Minimum	mm	City	14.7	1990
Maximum	mm	City	208.7	1990
Average slope		Metropolis	flat/var.	1991
Drainage (natural)		Metropolis	poor	1991
Natural risks:	severity			
Flooding		Metropolis	moderate	1991
Seismic		Metropolis	moderate	1991
Total area	km²	Metropolis	1079	1991
Built-up area	km²	Metropolis	935	1980
Residential	%		70	
Industrial	%		20	
Commercial	%		2	
Open/Green	%		8	
Public/Other	%		-	

III. AIR POLLUTION AND ENERGY USE - ACCRA				
Indicator	Unit	Jurisdiction	Value	Year
Emissions:	'000 t/year			
CO_2			NA	
CO			NA	
Hydrocarbons			NA	
NO_x			NA	
SO_2			NA	
SPM			NA	
Motorized fleet	vehicles/capita	City	.04	1989
Annual increase in motorized vehicles	%	City	13	'85-89
Gross energy use:	'000 tons of oil equivalent	National	1353	1987
Electricity			357	
Petroleum products			677	
Other			319	
Households electrified	%		NA	
Industrial pollution control policies?	incipient/ advanced	Metropolis	incipient	1991
Vehicular pollution control policies?	incipient/ advanced	Metropolis	incipient	1991
Monitoring network	# of stations	Metropolis	0	1991
# of measurements exceeding standards	annual %		NA	

IV. WATER RESOURCES AND URBAN WASTE - ACCRA				
Indicator	Unit	Jurisdiction	Value	Year
Total water use:	m^3/day	Metropolis	263,251	1990
Municipal	l/cap/day	Metropolis	134	1990
Industrial/commercial	l/cap/day	Metropolis	34	1990
Households with piped water supply	%	City	46	1989
Households with easy access to standpipe	%	City	47	1989
Unaccounted for H_20	%	Metropolis	40	1990
Households sewered	%	City	1	1991
Main alternative sanitation system	type (%)	City	pit latrine (27)	1989
Principal point of sewage disposal	location	City	streams/ rivers	1991
Sewage flow	m^3/day	Metropolis	46,000	
Sewage treated	%		20	
Solid waste generated:	tons/day	Metropolis	1000	1990
Municipal (MSW)	kg/cap/day	Metropolis	0.6	1990
Industrial	kg/cap/day		NA	
MSW collection rate	%	City	75	1990
Principal solid waste disposal method	type	Metropolis	open dump	1991
Hazardous waste management program	incipient/ advanced	Metropolis	incipient	1991

Source: World Bank; 1993, Urban Management Programme

APPENDIX -F

AIR, WATER AND ACOUSTIC ENVIRONMENTAL QUALITY STANDARDS

ENVIRONMENTAL RESOURCE	AMBIENT ENVIRONMENTAL QUALITY PARAMETERS	STANDARDS MINIMUM AMBIENT LEVEL STANDARD (MG/M3)					REMARKS
AIR	AIR POLLUTANTS	Annual Avg. 24 hrs.					
	1) Sulphur Dioxide (SO2)	Ind		Resd,Rural & other areas		Sensitive	
		80		60		15	1) Annual Avg. means minimum of 104 measurements in a year taken twice a week 24 hourly at uniform interval.
		120		80		30	
	2) Oxides of Nitrogen (NO2)	Annual Avg. 24 hrs.					
		80		60		15	
		120		80		30	2) 24 hourly/shortly values should be met 98% of the time in a year. However 2% of the time, it may exceed but not on two consecutive days.
	3) Suspunded Particular Matter (SPH)	Annual Avg. 24 hrs.					
		360		140		70	
		500		200		100	
	4) Lead (PB)	Annual Avg. 24 hrs.					
		1		0.75		0.5	
		1.5		1		0.75	
	5) Carbon Monoxide (CD)	Annual Avg. 8 hrs. 1 hrs.					
		5		2		1	
		10		4		2	
2) WATER	Inland surface water	Designated use Classifications					
			A	B	C	D	E	
	1) Dissolved oxygen (mg/L) (DO)	(min)	6	5	4	4	-	A - Drinking water source without conventional treatment but after disinfection.
	2) BOD (Mg/L)	(min)	2	3	3	-	-	B - Out door bathing
	3) Total Coliforms (MDN/100 ML)	(max)	50	500	5000	-	-	C'- Drinking water source with conventional treatment followed by disinfection.
	4) Total Dissolved solids (Mg/L)	(max)	500	-	5000	-	-	D - Propogation of wildlife fisheries.
	5) Chloride Cl (mg/L)	max	250	-	600	-	600	E - Irrigation, industrial cooling, controlled waste disposal.
	6) Colour(Hazen strips)	max	10	300	300	-	-	

	7) Sodium obsorption ratio	max	-	-	-	-	26	
	8) Sulphate Sot (mg/L)	max	400	-	400	-	1,000	
	9) Nitrates No3 (mg/L)	max	20	-	50	-	-	
	PH		6.5 - 8.5	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5	6.0 - 8.0	
	Flourides (mg/L)	max	1.5	1.5	1	-	-	
	Lead (Pb) (mg/L)	max	0.1	-	0.1	-	-	
	Copper Cu (mg/L)	max	1.5	-	1.5	-	-	
	Zinc Zn (mg/L)	max	15	-	15	-	-	
3) ACOUSTIC	Noise Levels in dbA							
			Ind Area	Resd Area	Comme rcial Area	Silen ce Zone		1) D.T. = Day Time 6 A.M. to 9 P.M. (15 hrs)
								2) N.T. = Night Time 9 P.M. to 6 A.M. (9 hrs)
								3) Silence Zone means Areas up to 100 mts. around certain premises like hospitals, educational institutions and courts.
		D.T.	75dB	55dB	75dB	50 dB		
		N.T.	70dB	45dB	55dB	40 dB		

Source: C.P.C.B.

APPENDIX -G

Minimum Physical Standards of Services

Service	Sector	Minimum levels of services to be obtained in next 5 years		Remarks
		Population/Area target	Service level target	
I. Water supply	Urban	• 100% pop. to be covered.	• Piped water supply with sewerage: 150* lpcd • Piped water supply without sewerage:70* lpcd • 40 lpcd with spot sources/ stand posts (* Including wastage of water - roughly 20%)	• Public stand posts in the low income settlements. • One source for 20 families with in a walking distance of 100 metres
	Rural	• 100% pop. to be covered including 'No Source' hard core problem villages in some states	• 40 lpcd of safe drinking water • Additional 30 lpcd in DDP/ DPAP areas for cattle needs.	• One hand pump/ spot source for 250 persons in a walking distance of 1.6 km or elevation difference of 100 mt. in hilly areas, to be relaxed as per field conditions applicable to arid, semi-arid and hilly areas
II Sanitation/ Sewerage	Urban	• 100% city area to be covered by sewerage system with treatment facilities in large urban centres • Low cost sanitation methods for other urban areas	• Large city: full coverage by sewerage with treatment. • Medium town: Public sewers with partial coverage by septic tanks. • Small town: Low cost sanitation methods	• In low income areas of large cities community latrines may be provided.
	Rural	• All households to be provided access to safe sanitation • Elimination of manual scavenging by using low cost sanitary methods.	• Low cost sanitary methods of disposal:- Sanitary latrines of different models may be used such as round concrete plate with lining (single pit), square brick/concrete plate with/ without lining (single pit with provision of double pit), etc.	
III Solid Waste Collection Disposal	Urban	• All the solid waste generated should be collected and disposed.	• 100% collection of generated waste, with its proper disposal. • Hazardous wastes such as hospital wastes must be incinerated in all cases. Whereas mechanised composting and incinerated is recommended for large urban centres, sanitary land fill method of disposal may be used in small and medium towns.	Keeping in view the refuse generation level and its composition, each local body should determine the requirements of collection bins/ collection centres, kind of transport vehicles to be used, staff deployment for various activities, type of treatment to be given to the collected wastes, etc.
	Rural	All the solid waste generated should be collected and disposed.	• Composting or bio-gas generation from organic waste.	
IV Primary Education	Urban and Rural Both	Fulfillment of national goal of universalisation of elementary education for children upto 14 years of age.	• Provision of primary school in all areas of country as per the following guidelines: - At least three reasonably large all weather rooms with teaching material - At least one teacher per class room/ section - One primary school for every 3000-4000 population. Area: 3 acres; seats/ school: 300-400	In order to improve enroiments at the upper primary stage specially for girls, the walking distance of school should normally be 2 kms. in case of primary schools this standard is 1 km.
V Primary Health Care	Urban & Rural Both	Fulfillment of national goal of health for all by 2000. AD	• One PHC for 20,000 - 30,000 pop. • One sub centre for 3000-5000 pop. • One community health centre for one lakh pop.	Primary health care has been accepted at the main instrument for achieving the goal of 'Health for All'.

Agency	Physical Standard	Cost of provision (Rs per capita at 1994-95 prices)	Cost of O & M (Rs per capita/annum,at 1994-95 prices)
a. Manual on water supply and treatment, CPHEEO, Ministry of Urban Development, Govt. of India, 1991	Urban: Small : 70-100 lpcd* Medium : 100-150 lpcd Large : 150-200 lpcd Public stand Posts: 40 lpcd (PSP) Rural: Not suggested	Urban: Not suggested Rural: Not suggested	Urban: Not suggested Rural: Not suggested
b. National Master Plan (NMP), India, International Water Supply and Sanitation Decade, 1981-90, Ministry of Urban Development, 1983	Urban: House connections : 70-250 lpcd with average of 140 lpcd Public stand Posts: 25-70 lpcd with average of 40 lpcd Rural: Piped supply : 25-70 lpcd with average of 40 lpcd Spot Source Supply: 40 lpcd	Urban: Not suggested Rural: Not suggested	Urban: Not suggested Rural: Not suggested
c. 8th Five Year Plan, Government of India, 1992-97	Urban: With sewerage: 125 lpcd Without sewerage: 70 lpcd Public stand Posts: 40 lpcd Rural: 40 lpcd	Urban: Not suggested Rural: Not suggested	Urban: Not suggested Rural: Not suggested
d. Report on Norms and Space Standards for Planning Public Sector Project ToSws, TCPO, Ministry of Works & Housing, Government of India, 1974	Urban: 180 lpcd Rural: Not suggested	Urban: Not suggested Rural: Not suggeasted	Urban: Not suggested Rural: Not suggested
e. Committee on Plan Projects for Industrial Townships (COPP), 1973	Urban: 180-225 lpcd Rural: Not suggested	Urban: Not suggested Rural: Not suggested	Urban: Not suggested Rural: Not suggested
f. Zakaria Committee (ZC) on Augmentation of Financial Resources of Urban Local Bodies, 1963	Urban: Small : 45 lpcd Medium : 67.5 - 112.5 lpcd Large : 157.5-202.0 lpcd Super metropolitan : 270 lpcd Rural: Not suggested	Urban: Small: 227.34 Medium : 277.86-378.90 Large: 492.57-593.61 Super metropolitan: 820.95 Rural: Not suggested	Urban:Small: 93.71 Medium: 95.48-109.12 Large: 123.77 -128.83 Super metropolitan: 136.40 Rural: Not suggested
g. Operations Research Group (ORG), Delivery and Financing of Urban Services, 1989	Urban: Small: 80 lpcd Medium: 80-150 lpcd Large: 180 lpcd Rural: Not suggested	Urban: Small: 603.15 Medium: 319.03 - 680-28 Large: 804.26-1108.29 Rural: Not suggested	Urban: Not suggested Rural: Not suggested
h. NIUA; Maintaining Gujarats Municipal Services - A Long Range Perspective, 1987	Urban: Small:95.125 lpcd Medium: with Industrial . base - 150 lpcd Problem areas: 90 lpcd; Average: 80-150 lpcd Large: With Industrial base - 170-210 lpcd Problem Areas: 120-125 lpcd Average: 115-210 lpcd Rural: Not suggested	Urban: Problem Areas: 1254-1463 Average: 627-731.50 Rural: Not suggested	Urban: Small: 22.99 Medium: 25.08 Large: 45.98 - 60.61 Rural: Not suggested
i. NIUA; Costs of Urban Infrastructure, 1995 (based on DWSSDU, HUDCO & CIDCO estimates)	Urban: Not suggested Rural: Not suggested	Urban: Small: 485.76 &Medium: 390-403.97 Large: 569.98 Metropolitan: 203.48 Rural: Not suggested	Urban: Small: 141.24 Medium: 108.42-119.55 Large: 172.64 Metro:76.41 Rural: Not suggested
j. Government of Gujarat (GOG); Gujarat 2005 (papers on Perspective Plan), 1989.	Urban: Small: 100 lpcd Medium & Large: 140 lpcd Scarcity Season: 13 lpcd Rural: 40 lpcd	Urban:House Connections: 825 Problem areas: 1072.50 Augmentation/Extension: 412.50 Rural: Simple well: 288.75 Handpump: 99.00 House Connections: 412.50-495.00 Regional water supply: 495.00-990.00	Urban: Not suggested Rural: @3% of capital cost
k. Planning Commission (PC), Task Force on Housing and Urban Development (Financing Urban Development), 1983	Urban: Not suggested Rural: Not suggested	Urban: Surface system: Low - 650.15 High - 1214.50 Ground water: Low: 694.00 High- 1042.00 Rural: Not suggested	Urban: Not suggested Rural: Not suggested

* Litres per capita per day

Norms and Standards of Sewerage/ Sanitation System

Agency	Physical Standard	Cost of Provision (Rs/ Capita at 1994-95 prices)	Cost of O & M (Rs./capita/annum at 1994-95 prices)
a. The Manual on Sewerage and Sewage Treatment, CPHEEO, 1950	Urban: Not suggested in terms of population/ area coverage, type of system, etc. However, it said that sewers should be designed for a minimum of 150 lpcd water supply level.	Urban: Not suggested	Urban: Not suggested
	Rural: Not suggested	Rural: Not suggested	Rural: Not suggested
b. National Master Plan, India, 1983	Urban: 100 % population coverage by sewerage system with treatment facilities in class I cities, and low cost sanitation for other urban centres	Urban: Not suggested	6Urban: Not suggested
	Rural: Low cost sanitation	Rural: Not suggested	Rural: Not suggested
c. Zakaria Committee, 1963	Urban: Small: Low cost sanitation methods Medium: Public sewers with partial coverage by septic tanks, and partial treatment to sewage. Large: Full coverage by sewerage with proper treatment facilities. Super Metro: Same as above	Urban: Small: 353.64 Medium: 429.42-568.35 Large: 694.65 - 820.95 Super Metro: 947.25	Urban: Small: 103.37 Medium: 109.88-117.46 Large: 136.40 - 150.30 Super Metro: 154.09
	Rural: Not suggested	Rural: Not suggested	Rural: Not suggested
d. ORG, 1989	Urban: 100 % population coverage by sanitation services by using different technological options.	Urban: Small: 934.99 Medium: 383.41-857.64 Large: 604.27 Metro: 587.45	Urban: Not suggested
	Rural: Not suggested	Rural: Not suggested	Rural: Not suggested
e. Planning Commissions, Task Force on Housing and Urban Development, 1983	Urban: Not suggested	Urban: Water borne system with treatment : Low 1214.50 High - 1735.00 Septic tank: Low - 494.00 High - 780.75 Pit latrines: Low - 416.40 High - 520.50	Urban: Not suggested
	Rural: Not suggested	Rural: Not suggested	Rural: Not suggested
f. Govt. of Gujarat, 1989	Urban: 100 % coverage by sewerage with treatment facilities in class I cities, and cities already having sewerage systems. Low cost sanitation methods for other urban centres	Urban: Average: 825.00 Problem areas: 990.00 - 1155.00 For extension of service: 495.00 - 577.50 Low cost sanitation as per design standard of UNDP/ World Bank : 4455.00	Urban: Not suggested
	Rural: Low cost sanitation	Rural: Rs. 2475.00	Rural: Not suggested
g. NIUA (1987)	Urban: 100% coverage by sewerage excluding slums in class I urban centres and cities already have sewerage system. Low cost sanitation methods for other urban centres.	Urban: Sewerage: 836.00 - 940.50 Low cost sanitation: 627.00 - 731.50	Urban: Medium : 12.54-20.90 Large: 17.62 - 39.71
	Rural: Not suggested	Rural: Not suggested	Rural: Not suggested
h. NIUA (1995)	Urban: Not suggested	Urban: Small: 149.98 Medium: 207.82-442.35 Large: 117.36 Metro: 124.99	Urban: Small: 25.95 Medium : 35.37 - 75.85 Large: 20.12 Metro: 21.43
	Rural: Not suggested	Rural: Not suggested	Rural: Not suggested

	Report on Rural Sanitatio n (1993-94)	Urban: Not suggested	Urban: Not suggested	Urban: Not suggested
		Rural: Low cost sanitary methods as per the models given below: a. Rural concrete plate (without lining) b. Square concrete plate (without lining) c. Single pit (brick lined) d. Single pit (with provision of double pit in future) e. As above f. As above (with concrete lined and brick flooring) g. Double pit - brick lined (without super structure) h. Double pit - concrete ring - lined (without super structure) i. Single pit (with provision for double pit in future) j. Single pit - concrete lined with honey comb (with provision for double pit in future) k. Double pit - brick lined (with super structure) l. Double pit - concrete lined (with super structure) **Average: Rs. 2500/latrine**	Rural: a. 321 b. 357 c. 714 d. 881 e. 1309 f. 1607 g. 1785 h. 2321 i. 2678 j. 2975 k. 3094 l. 3630	Rural: Not Suggested

Summary Table III
Norms and Standards of Solid Waste Collection and Disposal

Agency		Physical Standard	Cost of Provision (Rs/capita, at 1994-95 prices)	Cost of O & M (Rs/capita/ annum at 1994-95 prices)
a.	NIUA (1986 & 1992)	Urban: - Suggested waste generation level in the range of 250 - 450 grams/ capita per day, depending upon the size of cities, their functions etc. - Recommended, 100% collection of generated waste in a city. - Staff norms: i.e2 - 78 scavengers per 10,000 population as per UP health manual ii.2.8 sanitary workers per 1000 population as per report of the committee on 'urban wastes', 1973	Urban:Not suggested	Urban:Not suggested. However report mentioned that on an average, 80 % of the total revenue expenditure spent on account of salaries and wages of sanitation staff.
		Rural:Not suggested	Rural:Not suggested	Rural:Not suggested
b.	TCPO, 1974	Urban:Suggested basic guidelines for provision of dustbins, collection centres, disposal of solid waste, etc.	Urban:Not suggested	Urban:Not suggested
		Rural:Not suggested	Rural:Not suggested	Rural:Not suggested
c.	ORG, 1989	Urban: Suggested average waste generation level - 380 grams/ capita per day	Urban: - for waste collection: Rs.33 - 100, depending upon the quantity of waste collected - For transportation, Rs. 90.	Urban:Not suggested
		Rural:Not suggested	Rural:Not suggested	Rural:Not suggested
d.	Planning commission, 1983	Urban:Not suggested	Urban:Rs. 87-139, depending upon the standards and size of cities	Urban:Not suggested
		Rural:Not suggested	Rural:Not suggested	Rural:Not suggested

	Agency	Physical Standard	Cost of provision (Rs. at 1994-95 prices)	Cost of O & M (Rs/annum at 1994-95 prices)
a.	National Policy on Education, 1986 (Operation Black Board Scheme)	• Universal access and enrolment; • Universal retention of children upto 14 years of age; and • A substantial improvement in the quality of education to enable all children to achieve essential levels of learning. The following are the norms of primary schools as per Operation Black Board Scheme : - At least three large all-weather rooms per school should be provided with teaching material; • At least three teachers should be provided in every school. The target is one teacher per class/section; - At least 50 per cent of teachers recruited should be women. For upper primary schools, the norms are as follows: - at least one room for each class/section - a head master-cum office room - separate toilet facilities for girls/boys - essential teaching learning equipments including library; and - at least one teacher per class/section • walking distance at primary level: 1 km. • Distance of upper primary level : 2 kms.	Primary School (Class I - V): Construction Costs: @ Rs. 50,000 per class room Teaching Learning Equipments: @ Rs. 10,000 per school Upper Primary School (VI-VIII) Construction costs: @ Rs. 50,000 per class room Teaching Learning Equipments: - @ Rs. 50,000 per school	Average salary per teacher: Rs. 50,000
b.	NIEPA, 1982	Not available	Construction costs (Avr.) Govt. share of contribution on an average: Rs. 11,610 for each class room Teacher's quarters (Avr.) Rs. 15,000 per quarter Teachers training (Avr.) - Pre-service : Rs. 1161 per teacher - In-service: Rs. 774 per teacher Equipments (Avr.) Rs. 58/per student	Average salary per teacher: Primary level: Rs. 22222 Upper primary level: Rs. 27564 Non Teaching costs 10% of teaching costs in non-tribal areas, and 25% in the case of tribal areas. Incentives: On an average Rs. 77 per student
c.	COPP	One primary school for 3500 population. Area: 3 acres Seats: 400-500 per school	Not suggested	Not suggested
d.	Bureau of Public Enterprises	One primary school for 3000-4000 population Area: 3 acres Seats: 300-400 per school	Not suggested	Not suggested
e.	TCPO	• One nursery school for 1250-1500 population Area: 0.25 acres Seats: 75-90 per school • One primary school for 4000 population. Area: 2-2.5 acres Seats: 450-500 per school	Not suggested	Not suggested

APPENDIX - H

QOL Factor List

* Income and Employment
* Food
* Clothing
* Housing
* Water Supply
* Sanitation
* Health
* Environmental Pollution
* Fuel availability
* Education
* Social Security
* Human Rights
* Transportation
* Communication
* Recreation

Source: NEERI, 1994

Estimation of Quality of Life

I. Objective Quality of Life

$$QOL_o = \sum_{i=1}^{n} QI_i \times W_i$$

Where, QOL_o - Objective Quality of Life Index

n - No. of QOL Factors

i - 1,--------, n

QI_i - Satisfaction level (assigned by the expert group) for the i^{th} objective indicator

W_i - Normalized weight for i^{th} factor

II. Subjective Quality of Life

$$QOL_s = 1/P \sum_{i}^{m} \sum_{j}^{p} QI_{ij} \times W_i$$

Where, QOL_s - Subjective Quality of Life Index

P - No. of Respondents, j=1, ---,p

m - No. of Factors, i=1, ---,m

QI_{ij} - Subjective Quality Index (VFC) for i^{th} factor assigned by j^{th} respondent

$\sum QI_{ij}$ - Subjective Quality Index for i^{th} factor assigned by all respondents in an area

W_i - Weight of the i^{th} factor

III. Quality of Life

$$QOL = \frac{QOL_o + QOL_s}{2}$$

	Agency	Physical Standard	Cost of provision (Rs./centre at 1994-95 prices)	Cost of O & M (Rs./annum at 1994-95 prices)
a.	Minimum Needs Programme & Report of the Working Group on District Planning (1984)	• One Public Health Centre (PHC) for 30,000 population in plains and 20,000 pop. in tribal and hill areas • One sub-centre (SC) for 5,000 pop. in plains and 3,000 in tribal and hilly areas. Distance: 4-5 kms • One Community Health Centre (CHC) for one lakh pop.	Not suggested	Not suggested
b.	COPP	• One Health Centre for 20,000 population Area: 1-1.5 acre	Not suggested	Not suggested
c.	TCPO	• One health centre for 36,000 population Area:1-1.5 acre • One Health Clinic for 12,000 population Area: 1-0.5 acre	Not suggested	Not suggested
d	Planning Commission	Not suggested	Construction cost: - Sub Centre: Rs. 2,09,000 - Public Health Centre (PHC) : Rs. 10,45,000 - Rs. 12,54,000 - Community Health Centre (CHC) Rs. 31,35,000-41,80,000 Other costs - SC: Not available - PHC: Rs. 3,13,500 - CHC: Rs. 10,45,000	- SC: Not available - PHC: 1,04,500 - CHC: 4,18,000 (excluding sponsored schemes & programmes)

Source: S.F.C. Symposium

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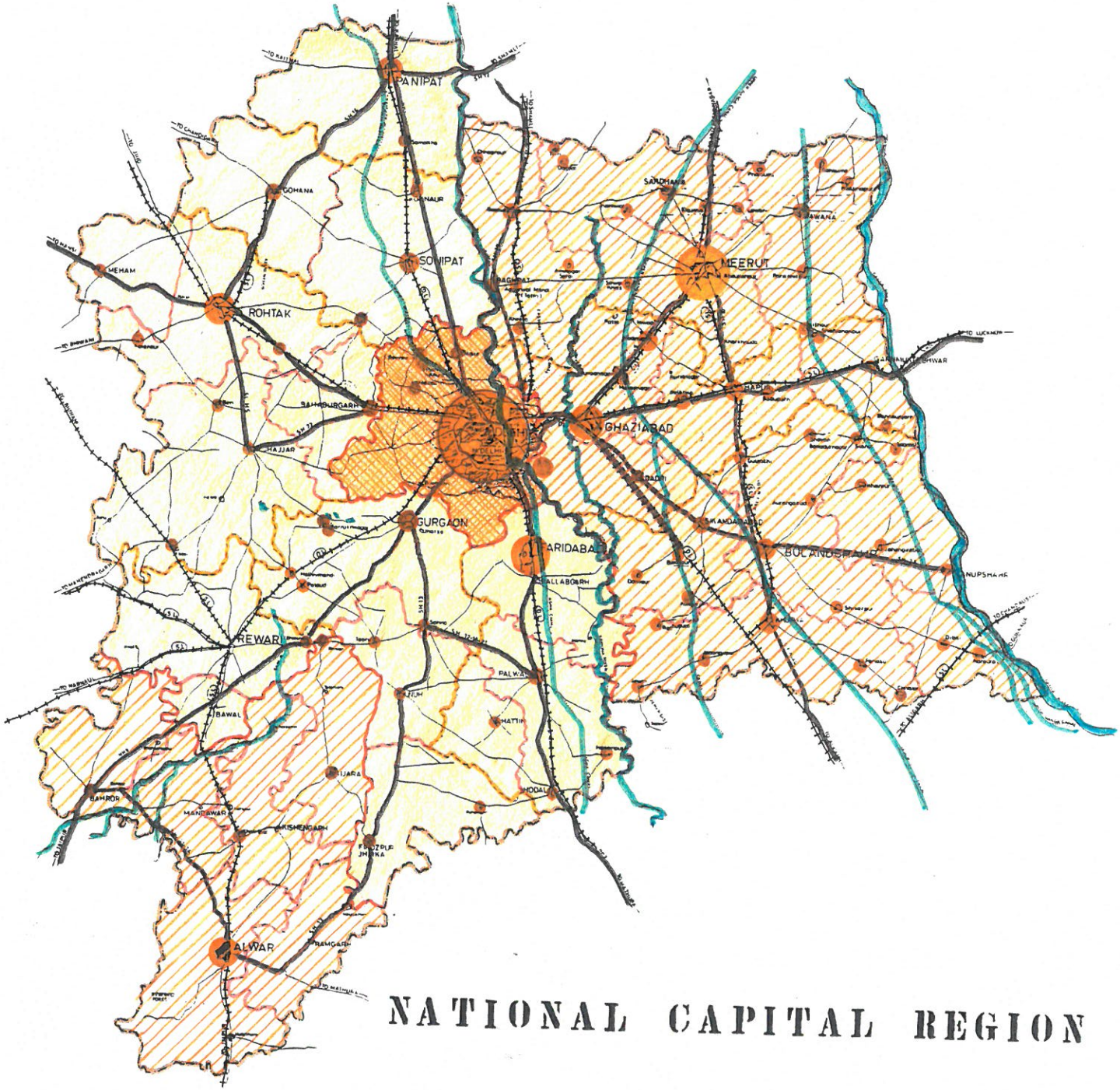

NATIONAL CAPITAL REGION

URBAN SETTLEMENTS & - POPULATION DENSITY

BOUNDARIES
- N.C.R.
- STATE
- DISTRICT
- TEHSIL

TRANSPORT NETWORK
- NATIONAL HIGHWAYS
- OTHER ROADS (SH — STATE HIGHWAY)
- RAILWAYS B.G. (DL DOUBLE LINE)
- RAILWAYS M.G. (SL SINGLE LINE)

TOWNS
- ALWAR DISTRICT HEADQUARTER
- HAPUR TEHSIL HEADQUARTER
- OTHER TOWNS
- RURAL SETTLEMENTS

PHYSICAL FEATURES
- RIVERS
- CANALS
- WATER SHEETS
- URBAN AREA

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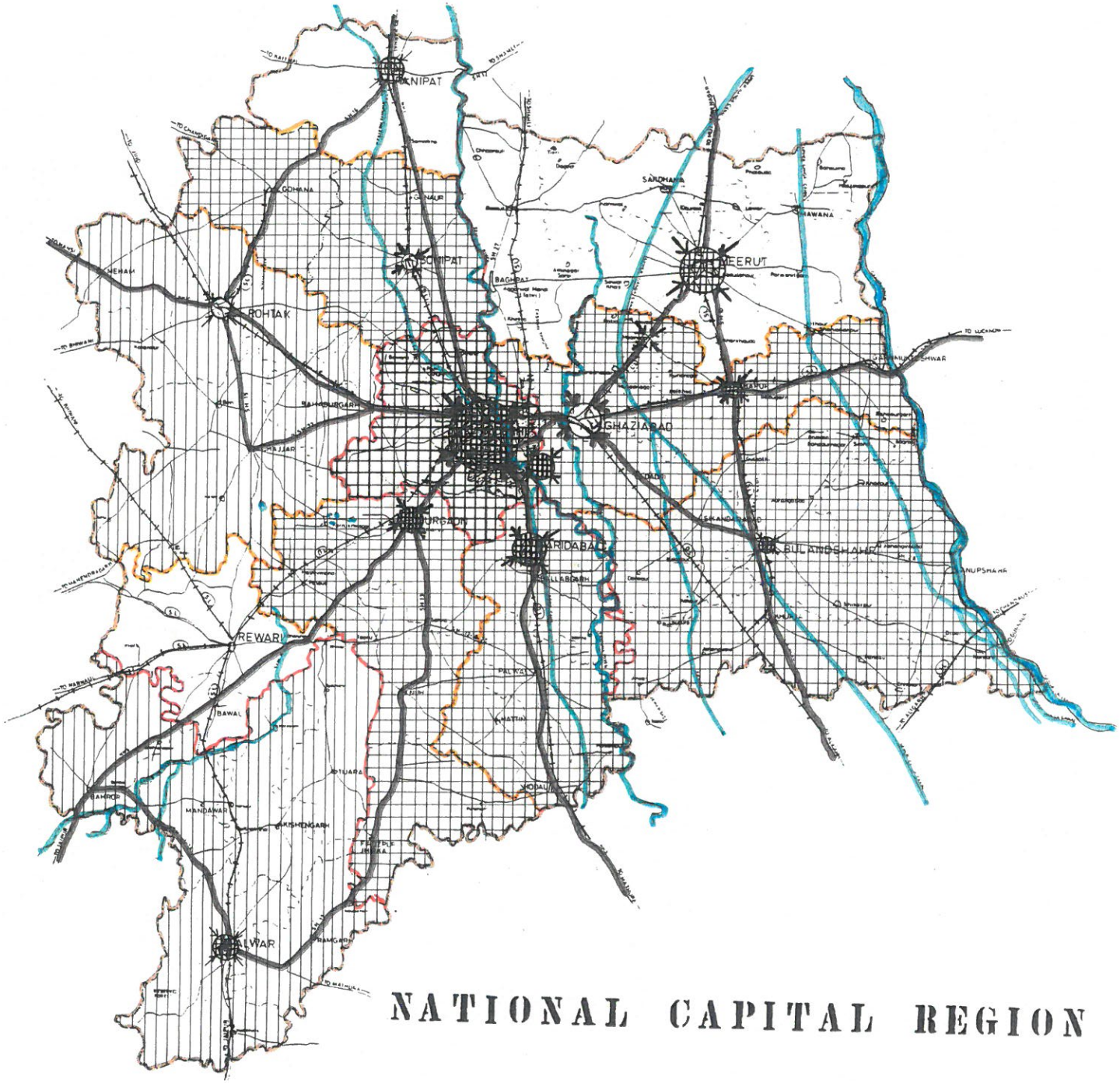

NATIONAL CAPITAL REGION

TRANSPORTATION INFRASTRUCTURE- SUPPORTIVE CARRYING CAPACITY

BOUNDARIES
- N.C.R.
- STATE
- DISTRICT
- TEHSIL

TRANSPORT NETWORK
- NATIONAL HIGHWAYS
- OTHER ROADS (SH — STATE HIGHWAY)
- RAILWAYS B.G. (DL — DOUBLE LINE)
- RAILWAYS M.G. (SL — SINGLE LINE)

TOWNS
- ALWAR DISTRICT HEADQUARTER
- KAMAN TEHSIL HEADQUARTER
- OTHER TOWNS
- RURAL SETTLEMENTS

PHYSICAL FEATURES
- RIVERS
- CANALS
- WATER SHEETS
- URBAN AREA

REGIONAL ACCESSIBILITY: NODALITY, ACCESS TIME, REGIONAL BUS SERVICE
- LOW
- MODERATE
- HIGH

DISTRICT LEVEL ROAD DENSITY
- LOW
- MODERATE
- HIGH

URBAN INTERNAL ACCESSIBILITY % ROAD AREA, ROAD LENGTH DENSITY ROAD PATTEN
- LOW
- MODERATE
- HIGH

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URBAN LAND RESOURCE SUPPORTIVE CARRYING CAPACITY

BOUNDARIES
- N.C.R.
- STATE
- DISTRICT
- TEHSIL

TRANSPORT NETWORK
- NATIONAL HIGHWAYS
- OTHER ROADS (SH — STATE HIGHWAY)
- RAILWAYS B.G. (DL — DOUBLE LINE)
- RAILWAYS M.G. (SL — SINGLE LINE)

TOWNS
- ALWAR DISTRICT HEADQUARTER
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- OTHER TOWNS
- RURAL SETTLEMENTS

PHYSICAL FEATURES
- RIVERS
- CANALS
- WATER SHEETS
- URBAN AREA

DISTRICT LEVEL URBAN LAND–MAN RATIO
- LOW
- MODERATE
- HIGH

TEHSIL LEVEL URBANISABLE LAND RESOURCE ('Waste' & 'Rocky' Land)
- LOW
- MODERATE
- HIGH

URBAN LAND MAN RATIO & ADDITIONAL POPULATION HOLDING CAPACITY
- LOW
- MODERATE
- HIGH

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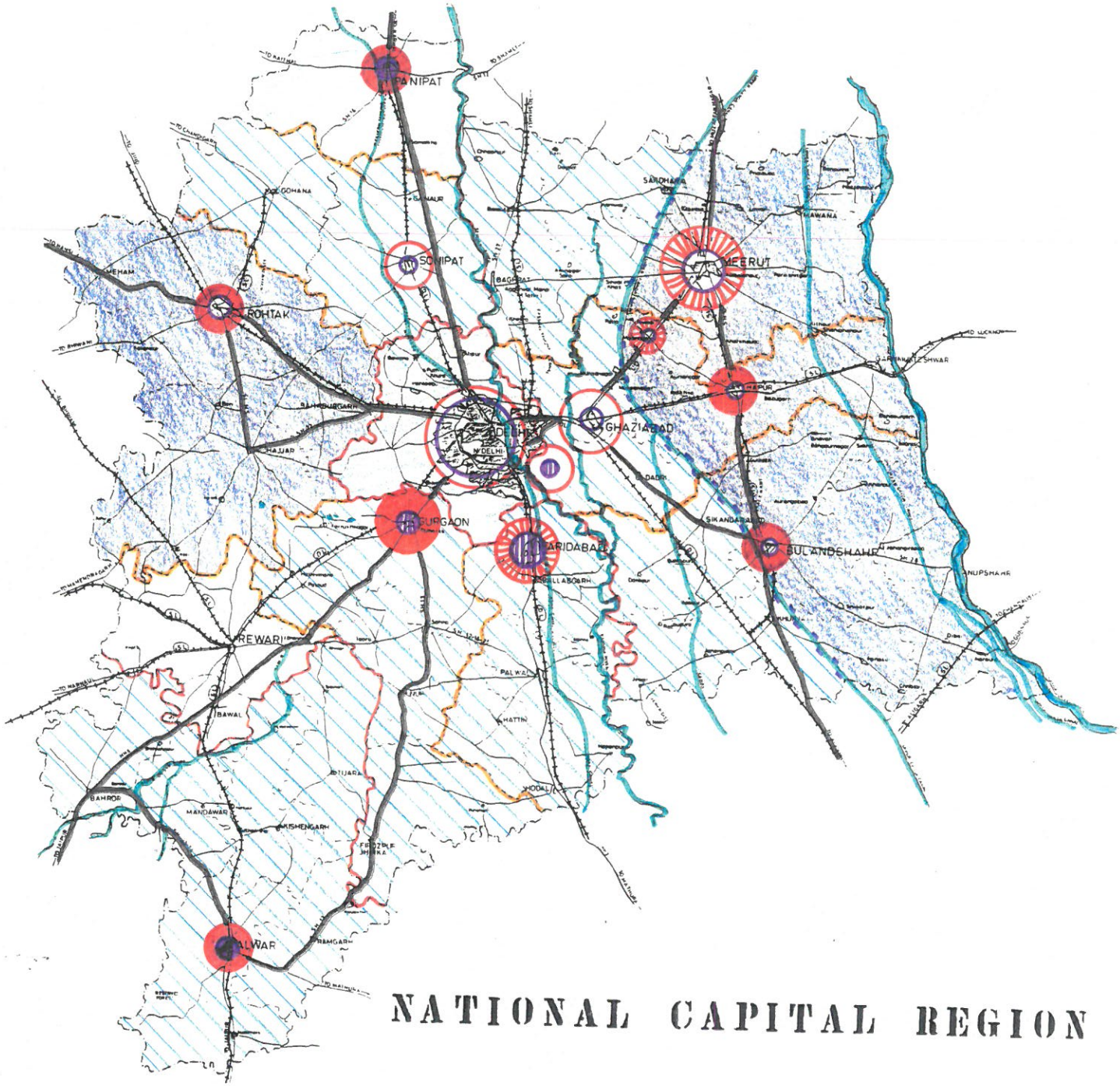

ENVIRONMENTAL ASSIMILATIVE CAPACITIES

BOUNDARIES
- N.C.R.
- STATE
- DISTRICT
- TEHSIL

TRANSPORT NETWORK
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- OTHER ROADS (SH = STATE HIGHWAY)
- RAILWAYS B.G. (DL = DOUBLE LINE)
- RAILWAYS M.G. (SL = SINGLE LINE)

TOWNS
- ALWAR DISTRICT HEADQUARTER
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- OTHER TOWNS
- RURAL SETTLEMENTS

PHYSICAL FEATURES
- RIVERS
- CANALS
- WATER SHEETS
- URBAN AREA

AIR ENVIRONMENT CAPACITY
- LOW (Pollution index & emission)
- MODERATE
- HIGH

WATER ENVIRONMENT CAPACITY
- LOW (Hot spot & ground water balance)
- MODERATE
- HIGH

ACOUSTIC ENVIRONMENMENT CAPACITY
- LOW (Day & night time dBas)
- MODERATE
- HIGH

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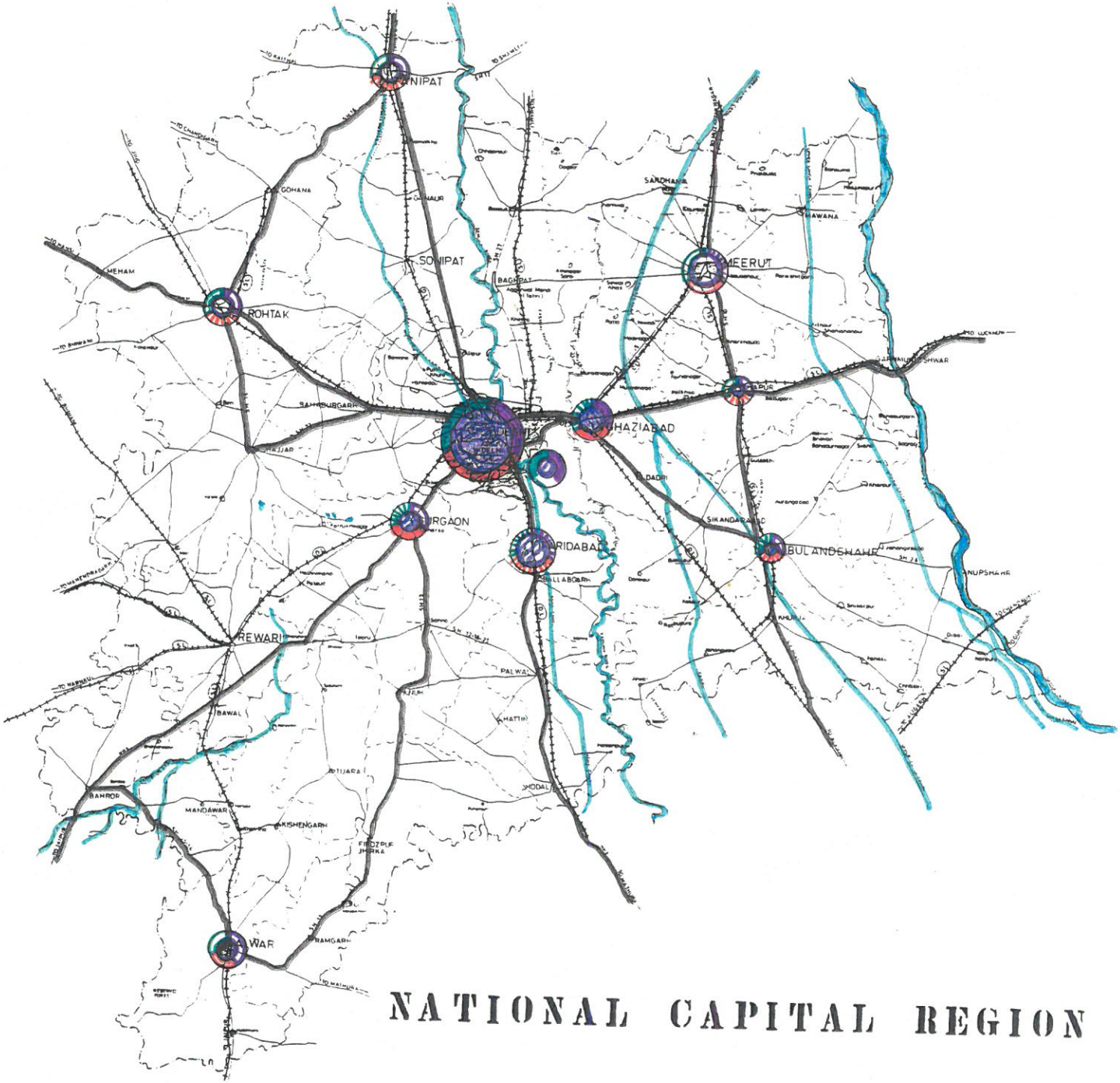

NATIONAL CAPITAL REGION

URBAN UTILITIES - SUPPORTIVE CARRYING CAPACITY

BOUNDARIES
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TRANSPORT NETWORK
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TOWNS
- ALWAR DISTRICT HEADQUARTER
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- RURAL SETTLEMENTS

PHYSICAL FEATURES
- RIVERS
- CANALS
- WATER SHEETS
- URBAN AREA

WATER SUPPLY LEVEL & COVERAGE
- LOW
- MEDIUM MODERATE
- HIGH

SEWARAGE COVERAGE & SOLIDWASTE COLLECTION
- LOW
- MODERATE
- HIGH

POWER SUPPLY-DEMAND RATIO
- LOW
- MODERATE
- HIGH

OVERALL URBAN UTILITY SITUATION
- LOW
- MODERATE
- HIGH

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