SOLID WASTE MANAGEMENT IN BHILWARA CITY, RAJASTHAN

A DISSERTATION

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

MASTER OF URBAN AND RURAL PLANNING

By

SUNIL CHAUHAN

DEPARTMENT OF ARCHITECTURE AND PLANNING
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE-247 667 (INDIA)

JUNE, 2010

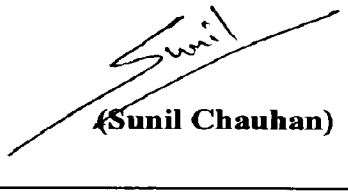
CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the Dissertation entitled **"Solid Waste Management in Bhilwara City, Rajasthan"**, in partial fulfillment of the requirements for the award of the Degree of **Master of Urban and Rural Planning**, submitted in the Department of Architecture and Planning, **Indian Institute of Technology- Roorkee**, Roorkee, is an authentic record of my own work carried out for a period of about one year from June 2009 to June 2010, under the supervision of Prof. R. Chandra, Associate Professor, Department of Architecture and Planning, **Indian Institute of Technology Roorkee**, Roorkee, India.

The matter presented in this dissertation has not been submitted by me for the award of any other degree of this or any other institute.

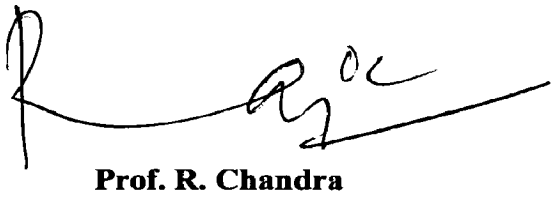
Date:

Place: **Roorkee**



(Sunil Chauhan)

This is to certify that the above statement by the candidate is correct to the best of my knowledge.



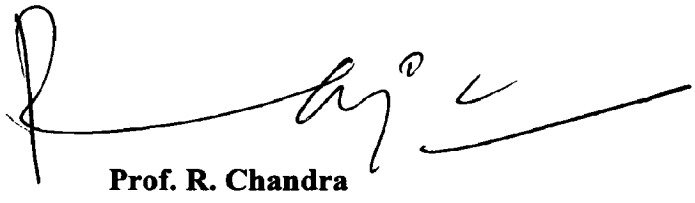
Prof. R. Chandra
Department of Architecture and Planning
Indian Institute of Technology, Roorkee
Roorkee- 247667 (INDIA)

CERTIFICATE

Certified that this report entitled **"Solid Waste Management in Bhilwara City, Rajasthan"**, which has been submitted by **Mr. Sunil Chauhan**, in partial fulfillment of the requirements for the award of the Degree of **Master of Urban and Rural Planning**, submitted in the Department of Architecture and Planning, **Indian Institute of Technology Roorkee, Roorkee**, is the student's own work carried out by him under my supervision and guidance. The matter presented in this dissertation has not been submitted by him for the award of any other degree of this or any other institute.

Date:

Place: **Roorkee**



Prof. R. Chandra
Assistant Professor
Department of Architecture and Planning
Indian Institute of Technology, Roorkee
Roorkee - 247667 (INDIA)

ACKNOWLEDGEMENT

I take this opportunity to thank all those who helped, encouraged and taught me from time to time and without whom this project would have been impossible.

First and foremost, I am extremely grateful to **Prof. R. Chandra** my thesis guide for motivation and constant guidance and help at every stage of thesis, without whom this project would have been difficult to deal with.

My sincere thanks also goes to **Dr. V. Devadas, Prof. R. Shankar** and all faculty members of Department of Architecture and Planning for their valuable suggestions and encouragement given to me during my tenure in Roorkee.

I am greatly indebted to **Dr. H.R. Parihar**, Sanitary Inspector, Bhilwara for all the help that he gave me in my data collection in Bhilwara.

I express my thanks to **Gaurav Singh** and all my friends who helped me in completion of my project.

Last but not the least I express my sincere gratitude to **my parents** who are my guiding force, for their perpetual inspiration, constant encouragement and support, to whom all my useful work is dedicated.

Sunil Chauhan

CONTENTS

List of Tables

List of Figures

LIST OF ABBREVIATIONS

SWM	**Solid Waste Management**
MSW	**Municipal Solid Waste**
BMW	**Bio Medical Waste**
MSWM	**Municipal Solid Waste Management**
ISW	**Industrial Solid Waste**
HSW	**Hospital Waste Management**
CPCB	**Central Pollution Control Boord**
SPCB	**State Pollution Control Board**
MCB	**Municipal Council of Bhilwara**
NEERI	**National Environmental Engineering and Research Institute**

EXECUTIVE SUMMARY

Solid wastes are all the wastes arising from human and animal activities that are normally solid and are discarded. There has been a significant increase in solid waste generation in India in the last few decades. This trend can be ascribed to the changing lifestyles, food habits, and change in the living standards.

Bhilwara the Cloth City is the fastest growing urban centre with an unprecedented rise in the population. Solid waste management is one among the essential services, which suffers the most in this city. The city produces 150 MT of solid waste per day with per capita generation as high as 200 gms/day. The lack of solid waste management & planning is degrading the quality of river Kothari with the location of dumping site close to it.

There are various types of solid wastes generated in Bhilwara city, which are municipal waste generated mostly from residential and commercial areas, bio-medical waste from all health care centers, industrial waste, and waste generated from religious activities, which is a peculiar type of waste generated here.

Solid waste management has become a major environmental issue in this city with the municipality as the sale authority responsible for it. With the burgeoning population and indifferent civic services coupled with wasteful consumerism and general apathy for cleanliness, the symptoms of strain on the environment and on the living conditions are conspicuously evident in many areas of the city. The city needs a change in the existing management practices keeping in view the diverse characteristics of waste and complex mechanism involved in the processes of management to enable the authority responsible to run this service efficiently in order to have an effective and sustainable waste management system.

Introduction

CHAPTER 1

1.0 INTRODUCTION

1.1 BACKGROUND OF STUDY

Rapid growth of population, industrialization and urbanization has resulted in increased generation of Solid waste over time. Out of various categories of pollutants, solid wastes contribute a major share towards environmental degradation. Over the last couple of years, there has been a growing concern about the problems associated with garbage management. Haphazard and unregulated disposal of waste have prompted the developed and developing countries to pay due attention to the problem of waste and to adopt strategies for solid waste management. Few years back, we woke up with a jolt to realize and face the direct consequences when plague broke out in Surat. The resulting publicity has been able to attract considerable attention to the issue of solid waste management. In spite of this, the problem seems to be insurmountable due to resource constraints, lack of awareness and a number of other factors.

Materials are considered "Waste" when they exhaust their utility and they cause nuisance due to aesthetic and environmental reasons. Of late, the problems of solid waste disposal, both domestic and industrial have become very acute in large cities of India because of the limited disposal facilities. As a result, the solid wastes are dumped in haphazard manner in various parts of city causing thereby not only environmental problems but also serious health hazards. Improper disposal of thrash material may cause and spread disease by harboring pathogenic microbes and disease vectors such as flies, mosquitoes, rodents, animals and even by attracting destitute and rag pickers. They can also contaminate land or water and emit foul odour. Recurrence of diseases like gastroenteritis, bacteria, jaundice, plague, etc. is a consequence of unsanitary conditions due to unhygienic disposal of wastes.

The urban limits are specified by municipal boundaries. In our country disposal and management of solid waste is the responsibility of the local municipal corporation/body. Such local authorities, even though committed to their services, are still unable to cope up with this giant problem due to lack of number of reasons which have resulted in poor

health, sanitation and environmental degradation. Immediate steps are therefore required for proper management of solid waste.

Solid waste management involves the management of activities associated with generation, storage, collection, transfer & transportation, processing and disposal of solid waste which is environmentally compatible adopting principles of economy, aesthetic, energy and conservation.

Solid waste can be a potential resource. Some components of garbage can be processed into compost or bio-fertilizer or bio-gas can be produced. Some items of thrash can be salvaged, recycled, and reused. Paper, plastic, glass, metal, etc. which find their way into the "waste" category can be readily recycled to produce similar or downgraded material. Organic material such as kitchen and garden waste, fruits and vegetable waste, etc. can be readily converted to bio-manure (compost) or be used for generation of bio-gas.

SOME SHOCKING FACTS

- According to WHO, every year in whole world 50-lakh people die due to diseases related to improper disposal of waste?
- India produces about 75 million tonnes of waste every year out of which in urban areas, only 50-70% is collected.
- The uncollected garbage just lying around on streets aggravated the plague outbreak in Surat.
- There are many potential infernos like Jwalapuri market, Deihl, which was gutted due to unsafe and improper plastic waste management.
- Since 1987, Bangalore has no official dumping site for its 2000 tons a day generation of garbage.

1.2 NEED OF STUDY

Bhilwara is one of the fastest growing urban centers with an unprecedented rise in the population due to migration, have increased the pressure on the existing infrastructure. Although some work has been done to improve the infrastructure facilities like water supply, road & transport, energy etc. but sanitation is still an area of concern. Solid Waste Management which is a part of the health segment which has been neglected in the City.

The present practice of Solid Waste Management includes only the collection and disposal of municipal waste, which is a cause of health and environment degradation. The step for the proper treatment of the waste and its safe disposal are lacking altogether.

The present study is not only an attempt to bridge the gap between waste collection and its safe disposal but also involve strategies to have sustainable Solid Waste Management system in the study area.

1.3 AIM & OBJECTIVES

The aim of the study is to propose solid waste management strategy for Bhilwara.

The objectives for this study are as follows:

- To identify the solid waste generation in Bhilwara city.
- To study the existing solid waste management practices in the study area.
- To forecast the solid waste generation in 2031 A.D in the study area.
- To involve sustainable solid waste management strategies for the development of the city.

1.4 SCOPE & LIMITATION OF THE STUDY

The scope of the study involves:

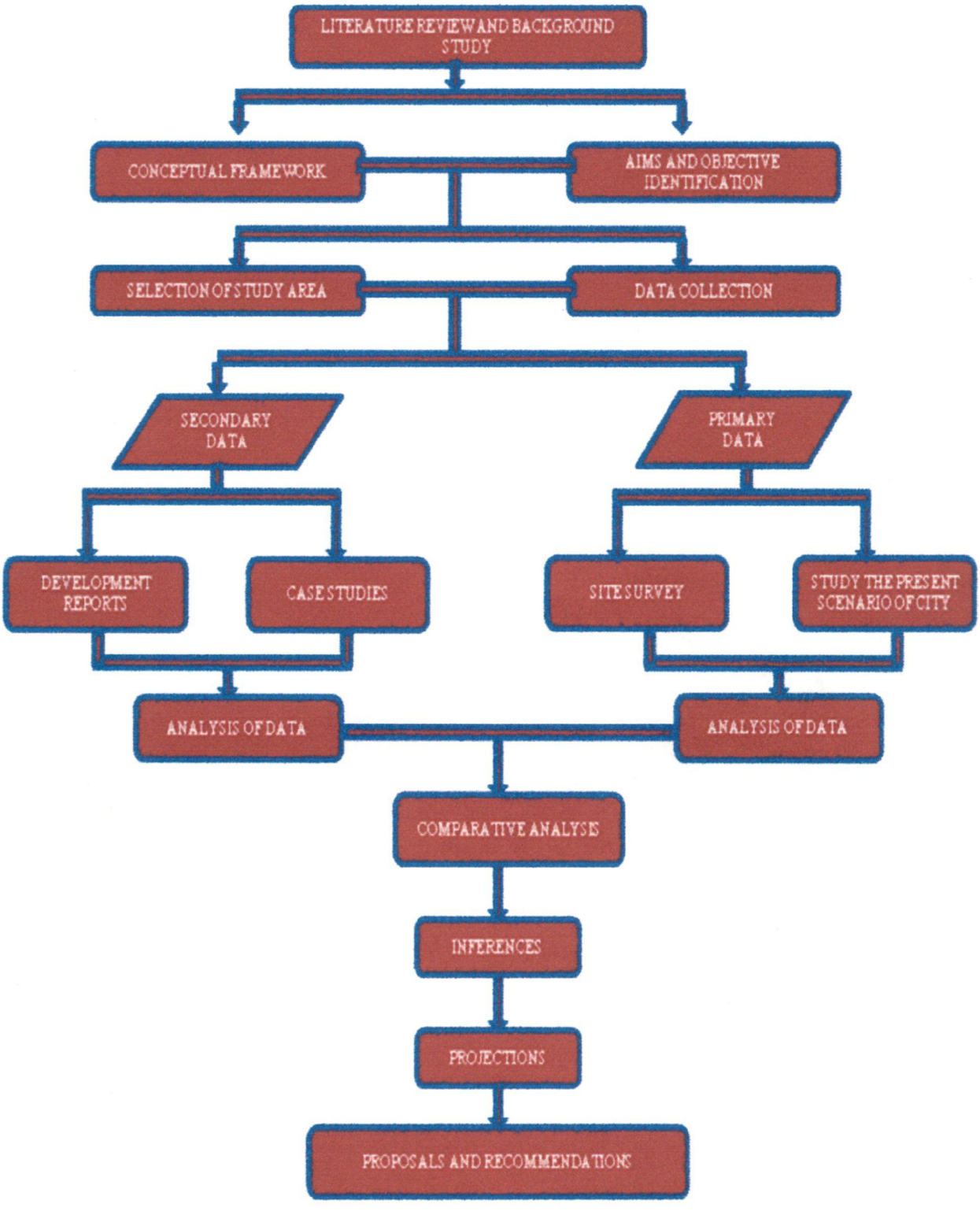
- The study of solid waste management includes municipal waste only that is:
  - ✓ Residential waste
  - ✓ Commercial waste
  - ✓ Waste from Open spaces and
- Review of the existing situation & practices in terms of generation, collection, storage, transportation, treatment and disposal of waste.
- Identification of problem areas and issues of solid waste management would pertain to functional, management and institutional aspects.
- Identification of recyclable wastes, minimization techniques for waste & finally suggesting appropriate technology for its management.

Due to constraint of time & data the study area is limited to the municipal boundary of the city.

1.5 METHODOLOGY

The study follows a systematic and step wise methodology, the various stages followed in the study are literature review & background study for conceptual frame work, problem identification, formulation of aims & objectives of the study. Then it leads to selection of the study area and data collection from the secondary sources. The identification of data gaps lead to the required site survey, interviews to complete the information base, which in turn leads to the comparative analysis, inferences, projections, proposals and recommendations.

Fig. 1.1: METHODOLOGY CHART



Literature review

CHAPTER 2

2.0 LITERATURE REVIEW

CLASSIFICATION AND SOURCES OF WASTE

The source of waste generation depends upon the ongoing activities within the municipal limits. The sources of waste generation can be categorized in various groups. The type of waste from different sources varies as per source of generation.

Table 2.1- Sources of Generation of Solid Waste:

Source	Type of generators	Type of Wastes
Residential	Single and multi-family units	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ash, special wastes (e.g., bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous wastes
Industrial	Manufacturing units, power and chemical plants	Housekeeping, packaging and food wastes, ashes, construction and demolition debris, hazardous wastes, special wastes
Commercial	Stores, hotels, restaurants, markets and malls	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Institutional	Schools, hospitals, prisons, government offices	Same as commercial
Construction and demolition	New construction sites, road repair, renovation and demolition sites	Wood, steel, concrete, dirt, stones etc.
Municipal services	Street cleaning, parks, beaches, and other recreational areas, treatment plants	Street sweepings, landscape and tree trimmings, general wastes from parks, beaches, other recreational areas, sludge

Agriculture	Crops, farms, orchards, vineyards, dairies, feedlots	Spoiled food wastes, crop and animal wastes, hazardous wastes (e.g., pesticides)

Source: CPCB Manual on Solid Waste, 2001

2.2 GENERATION OF SOLID WASTE IN INDIAN CITIES

The quantities and characteristics of solid waste vary from city to city, from region to region and from country to country. The factors that influence the quantities and composition are the average level of income, the population, social behavior, climate, industrial production and the market for waste materials. As economic prosperity increases, the amount of solid waste produced increases in weight and volume and a proportionally larger part consists of luxury waste, such as paper; cardboard, plastic and heavier organic materials.

As per Municipal Acts governing local bodies in India, solid waste management, which is a part of conservancy, is obligatory function for a local body. All wastes are solely the local body's property and it is its responsibility to clear, transport and disposes them off. It is one of the very important services provided to the citizens. Generally almost one third of the total municipal staff is employed for solid waste management. It is only recently that other non-governmental organizations have started involving themselves into the field and various innovative practices have succeeded either within their own framework or with little help from the local bodies.

In Indian cities the waste is generally not weighted. It is measured by volume to determine the quantity of waste disposed off. Several studies conducted by CPCS, NEERI and other consultants have shown that the waste generation rates are low in smaller towns whereas they are high in

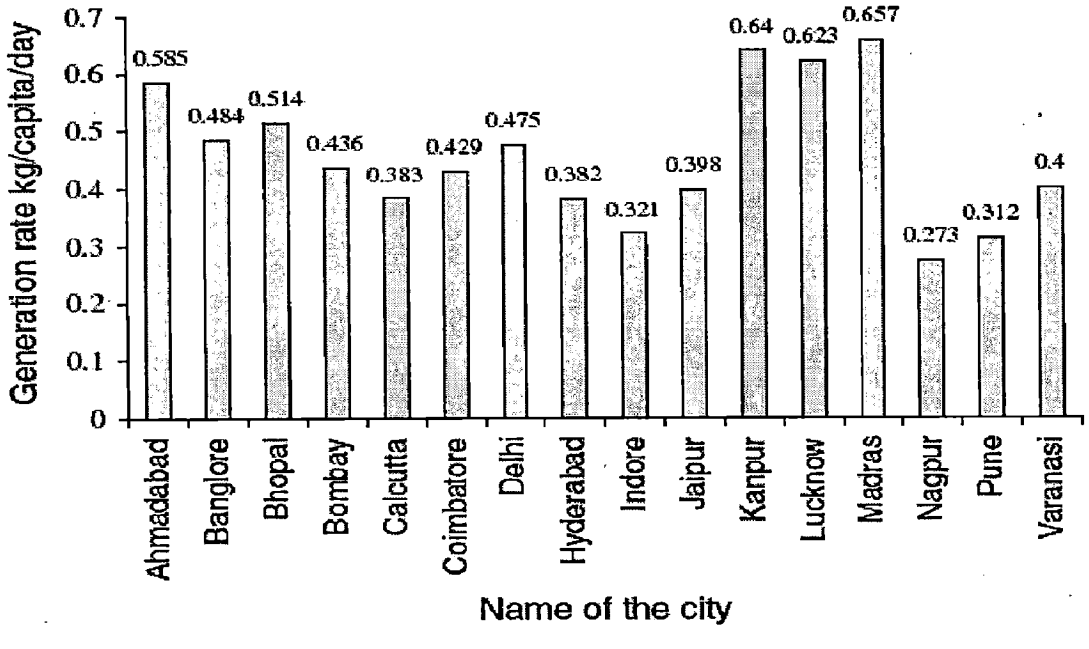
cities over 20 lakhs population. The range is between 250 to 600 grams per capita per day.

Table 2.2 Average per capita solid waste generation in Indian cities:

POPULATION RANGE (in lakhs)	AVERAGE PER CAPITA SOLID WASTE GENERATION IN (gms/Cap/Day)
1 TO 5	210
5 TO 10	250
10 TO 20	270
20 TO 50	350
50 AND ABOVE	500

Source: NEERI strategy paper on SWM in Indian cities

Fig. 2.1- Per capita generation rate of MSW for Indian cities



Source: CPCB, 2004.

2.3 PRESENT MANAGEMENT PRACTICES AND ITS PROBLEMS IN INDIA

Garbage is generated from residential, commercial and institutional complexes. Current practices in residential areas for collection of garbage differ from city to city and even within the city. Door-to-door collection is widely practiced. A few residential societies hire scavenging staff for door-to-door collection of solid waste.

The local authorities do not have proper provision to collect waste from narrow residential and commercial lanes, and in areas with high traffic.

The slums and squatters in cities also create insanitary conditions. Open defecation and disposal of sewage and garbage from such settlements need proper attention. Similarly, operation of dairy related activities in residential areas cause nuisance. Cow-dung and other waste are not properly managed. Vendors selling eatables, vegetables, fruits etc. also throw their wastes recklessly, which needs to be regulated.

2.4 STAKEHOLDERS IN WASTE MANAGEMENT

Municipal Authorities should evolve multi sectoral partnerships for the management of SWM. In many parts of the world today, municipalities are becoming responsible coordinators and facilitators, apart from carrying out some of the work themselves. However, the final responsibility lies with the Municipal Authorities themselves.

Here are some examples by which various' sectors can participate in handling solid waste.

2.4.1 Communities

Local resident welfare committees and samitis exist everywhere-from jhuggis to middle class housing. They should be actively engaged in segregation and collection of waste at the household level and community level. These committees should be given the collective responsibility of implementing various ongoing schemes of the SWM in their areas as part of a formal system. A core group must be formed and responsible contact

persons be identified. The Municipal Authorities may offer incentives to such communities and coordinate with them. Communities should also be able to participate in or influence policy making.

The example of the Ludhiana Municipality is a case in point. Here, the municipality has involved the residents in handling their own waste locally and has even made money available for this purpose, from the pool that would otherwise be spent by the municipality.

2.4.2 Non government and other organizations

NGOs have emerged as important players in SWM. Their work could include:

- Capacity building for the informal sector.
- Developing managerial, technical and other skills amongst other sectors required to be able to participate in new and innovative means of waste management.
- Capacity building for the Municipality.
- NGOs should also be able to participate in or influence policy making.
- Monitor the SWM systems.

Since there will be partnerships, rather than mere NGO driven efforts, they must be based upon formal contracts entered into between the Municipality and the NGO.

2.4.3 Informal sector

The informal sector comprises ragpickers, kabaris, middlemen and recycling factories, which pick up and recycle waste in a stream away from the municipality.

The Informal sector plays a crucial role and lightens the burden of government exchequer and municipality in many ways, by recycling, saving municipality costs of cleaning and by generating self-employment through entrepreneurship. Municipal authorities should specially ensure their involvement in:

- Collection, segregation, recycling in a more organized and safe manner.
- Creating better living conditions and basic rights to work, leading to higher productivity.
- Creating access to capacity-building programmes related to waste management.
- Their formal inclusion in plans for urban areas.

2.4.4 Municipal Authority

Apart from segregation, collection, transportation and disposal of MSW, the municipal authority should:

- Co-ordinate with other local civic bodies and NGOs and Community Based Organizations (CBOs).
- Implement punitive measures.
- Develop mechanisms by which smaller entrepreneurs, civil society etc. can participate in new waste management procedures and regimes.
- Equip itself to work with a wider section of society with different needs, such as slums.
- Move towards treating SWM as a multi disciplinary task.

2.4.5 Other Private Entrepreneurs

While the informal sector is able to function as a private entrepreneur, there are other such entrepreneur's too, who can be partnered as required. However, care must be taken to ensure that they do not displace or run over the informal sector, or depend on municipal subsidy for too long a time.

The Greater NOIDA authority, for example, now ensures that all municipal waste collection is being done privately through contracting.

2.5 INNOVATIONS & SCHEMES IN WASTE MANAGEMENT

2.5.1 Collection Mechanism

Collection of wastes can be done by:

- Municipal workers themselves.
- Contracting the collection of wastes to a competent organization.

In Hyderabad, the Municipal Corporation has allowed collection of garbage to be contracted out in a manner that anyone willing to do the work and acceptable to the corporation can undertake this work.

The Rajkot Municipal Corporation (RMC) has calculated a comparative cost between carrying out the work itself and contracting it. By contracting primary waste removal and street cleaning the RMC saves a total of RS.2.61 lakhs per annum.

2.5.2 Privatizing through rag pickers and kabaris

The informal sector has been trained as a private agency to collect and dispose off waste in many cities in India, such as Bangalore, Pune, Delhi etc. This not only improves their conditions but also enhances the efficiency of existing systems of waste handling. Moreover, the criterion of waste segregation and recycling is also simultaneously fulfilled.

In Bangalore, a tripartite agreement has been signed between the Municipality, the residents and a private agency, which comprises of ragpickers, for waste handling.

In Delhi, waste handling from Connaught Place, for example, is being increasingly handled by the informal sector along with Chintan in collaboration with the New Delhi Municipal Council.

Studies reveal that 7 per cent to 15 per cent of the total waste is recyclable. Studies in Delhi have shown that ragpickers and kabaris, the informal sector saves approximately between 6 to 7 lakhs of the 3 Municipalities of Delhi alone each day by collecting, segregating and transporting the wastes. Similarly, this sector in other urban areas saves the municipality money through their labour. This also saves the burden on scarce landfill space and other resources.

2.6 WEALTH FROM WASTES TECHNOLOGIES

In the recent past, private sectors have taken initiatives to use the garbage as profitable venture. Some of the technological options available are summarized below.

2.6.1 Energy recovery technologies:

a) Biomethonation

Anaerobic digestion (also referred as biomethanation) is the process used for biological decomposition of organic wastes. The organic wastes are hydrolysed, liquefied and gasified with the help of methanogenic bacteria. There is an appreciable saving in recurring costs in such processes because of the utilization of bio-gas.

In anaerobic digestion, the organics from the Solid Waste are first separated from the inorganics and then after size reduction are digested anerobically in large size digestors. The generated gas is directly used as a source of energy or fed to Dual Fuel Engines for generation of electricity. The digested residue is commonly used as manure.

In the conventional anaerobic digestion low solids concentration is used and hence large costly digestors are required. Some plants have been set up using higher solids concentration while some use two stage digestion and a few follow the dry batch digestion or leach bed process. In conventional digestion, the solids concentration in the reactor is kept at about 1 %. The pH is continuously monitored and maintained between 6.8-7.2, though variations between 6.5 to 7.5 are also permitted. The volatile acid concentrations is not normally allowed to exceed 2000 mgll and the VS loading rate for sewage sludge and Municipal Solid Waste are 1.25 - 1.6 and 4.81 kg/m3/day respectively. The contents of the reactor are continuously stirred and the digested sludge is withdrawn from the bottom and put on drying beds. The dried sludge is often used as manure. The drained liquid from the bottom of drying beds is again added to the plant influent. The digester may have either a fixed dome or a floating dome for the collection of gas.

b) Sanitary Land-Filling

Sanitary landfilling is a process of dumping of solid waste in a scientifically designed land area spreading waste in thin layers, compacting to the smallest practicable volume and covering with soil on daily basis. The methane rich biogas is produced due to anaerobic decomposition of organic matters in solid wastes. Garbage has a potential to generate about 150-250 cubic meter biogas per tonne waste depending upon the quality.

2.6.2 Options for Treatment and Disposal of Solid Waste

a) Pelletisation or Refuse Derived Fuel

Fuel pellets also referred as refuse derived fuel (RDF) are small cubes made out of garbage. Its calorific value, 4000-kcal/kg of the product is quite close to the coal, so it can be a good substitute for coal, wood, etc. The waste is initially dried to reduce its moisture content. It is then screened to remove sand, silt and soil. It is then processed to remove and separate glass, metal and other contraries. Sometimes the waste is further subjected to air separation and then shredded. The size reduced material can be directly used in boilers on site. If the material is to be used offsite, it is usually densified into pellets and then transported to the place where it is to be used. Previously RDF was used alongwith coal in coal fired boilers and a few plants were also set up, but now due to stricter air emission standards, it is burnt in dedicated boilers designed and built specifically for RDF.

b) Pyrolysis / Gasification

In this process, combustible matter of garbage is allowed to dry/dewater and then is subjected to shredding. Incineration of waste under oxygendeficient conditions is called pyrolysis. The objective of pyrolysis

has generally been to produce gas which would be stored and used when required.

c) Incineration

This is a process of controlled combustion for burning of wastes and residue, containing combustible material. Carbon dioxide, water vapour, ash and non-combustibles are end products. The heat generated during the process is recovered and utilized for the production of steam, heating water and generating electricity. Incineration is used to achieve maximum volume reduction of solid waste and when there is shortage of land filling facilities. It is usually cost effective method of disposal.

d) Composting

It is one of the methods of waste utilization. It is defined as the decomposition of the heterogeneous organic matter by a mixed microbial population in the moist, warm and aerobic environment. These micro-organisms convert organic wastes into humus, which has significant value to agricultural farming. Composting was standardized in India in the 1930s and the processes are known as Indore and Bangalore methods of composting. Bangalore method of composting is commonly used in rural areas, where land is readily available and the waste is composted in pits along with night soil.

However, in urban areas, the waste quantities are large and due to the adoption of the water carriage system of sanitation, night soil is not readily available. Further the available land space is also limited. Hence aerobic composting without the use of night soil is carried out in open windrows in such urban centers.

During the last few years, plants have been set up in 10 cities up till now. These plants have tried to avoid the causes that led to failure of plants earlier. These plants are of pre-fermentation type in which waste is deposited in the windrows and aerobically composted. For optimum composting an initial C/N ratio of 30-35 is desirable. In case it is too low, carbon will have to be added in the form of paper, straw saw dust and in

case of too high a C/N ratio add a source of N in the form of blood, slaughter house waste, fish scraps, night soil, sewage sludge etc. Table gives the C/N ratio of common material than can be used for such purpose.

The waste is turned after every 5-7 days by using front-end loaders and after three weeks is taken to the processing units. The processing units remove the contraries by using vibratory and rotary screens of different opening sizes. The compost is then packed in bags for marketing purposes. All these units are normally located in a shed. Some of their plants use a specialized microbial culture to prevent smell and odour formation during the decomposition in windrows. The plant capacities range from 100 tonnes to 500 tonnes per day.

Table 2.3- C/ N Ratio of some Organic Material:

S. No.	Organic Material	C:N Ratio
1	Night Soil	6-10
2	Activated Sludge	6
3	Grass Clippings	19
4	Raw Saw Dust	511
5	Blood	3
6	Mixed Slaughter House Waste	2
7	Farmyard Manure	14
8	Sheep Manure	10-15
9	Horse Manure	33
10	Cow Manure	18
11	Chicken Manure	15

Source: CPCB Manual on Solid Waste

The final product is only 20-25% of the input and the remaining non-compostable have to be landfilled. The compost is sold by the plant authorities to a marketing organization which in some cases is the firm which set up the plant and in other cases the concerned State Agro-Industries Corporation or an established private marketing agency.

e) Vermiculture

It is an aspect of biotechnology involving the use of earthworms as natural and versatile bio-reactors for cleaning up of environment by adoption of cost effective waste management technique. Vermiculture means culturing of earthworms in a scientific manner. It is a simple low cost and appropriate biotechnology using earthworms systematically. By providing them with optimum conditions for rapid multiplication and conversion of farm wastes and biodegradable urban wastes into bio fertilizers, it can preserve and improve the soil fertility.

Case Study-I (Surat)

CHAPTER 3

3.0 CASE STUDIES

The case studies is being done as part of literature review from City Development Plans of Surat, Ahmdabad and Jaipur, Rajasthan.

Criteria for Selection of Case Study

- Industrial profile must coincide.
- Employment structure must be coincide.
- Problem faced by both the cities must be similar in nature.
- Reason for the growth of the city must be same.

CASE STUDY – I

Surat, Gujrat

The city of Surat has a glorious history dating back to 300 B.C and owes its name to the old Hindu Town 'Suryapur'.

3.1 Location

The city is a pivotal centre on the Ahmedabad-Mumbai regional corridor as well as on the 225 km long industrial belt, having direct linkages with the industrial urban centers of Vadodara, Ankleshwar and Vapi. National Highw ay no.8 passes within a few kilometres of the SMC boundary and is one of the busiest inter-state trunk routes in the country.

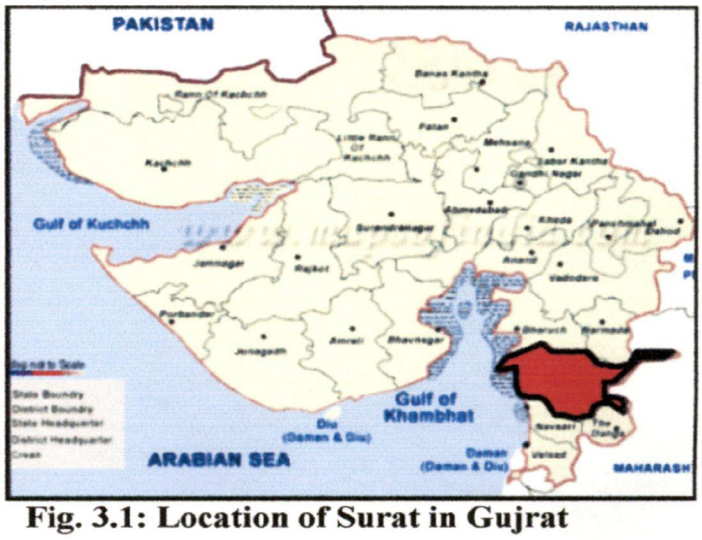


Fig. 3.1: Location of Surat in Gujrat

3.2 Topography and Climate

The city lies at a bend of the River Tapi, where its course swerves suddenly from the north-east to south-west. With the walled city at its centre, the city forms an arc of a circle, the bends enclosed by its walls stretching for about a mile and a quarter along the bank.

From the right bank of the river, the ground rises slightly towards the north, but the height above mean sea level is only 13 metres.

The summers are quite hot with temperatures ranging from 37° C to 44° C. The climate is pleasant during the monsoon while autumn is temperate. The average annual rainfall of the city is 1143 mm.

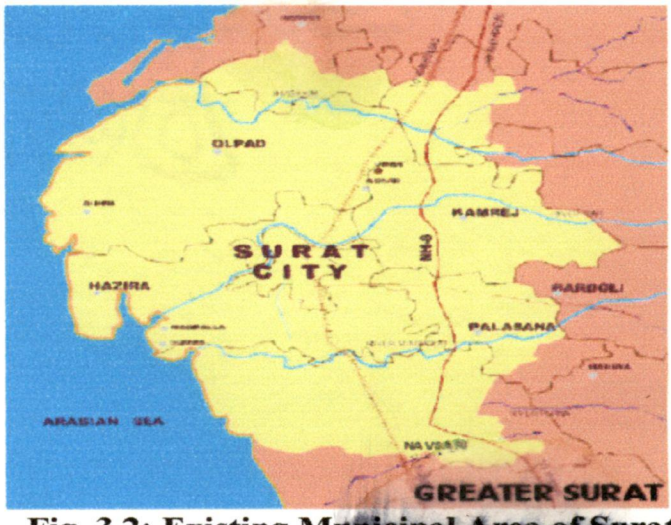


Fig. 3.2: Existing Municipal Area of Surat

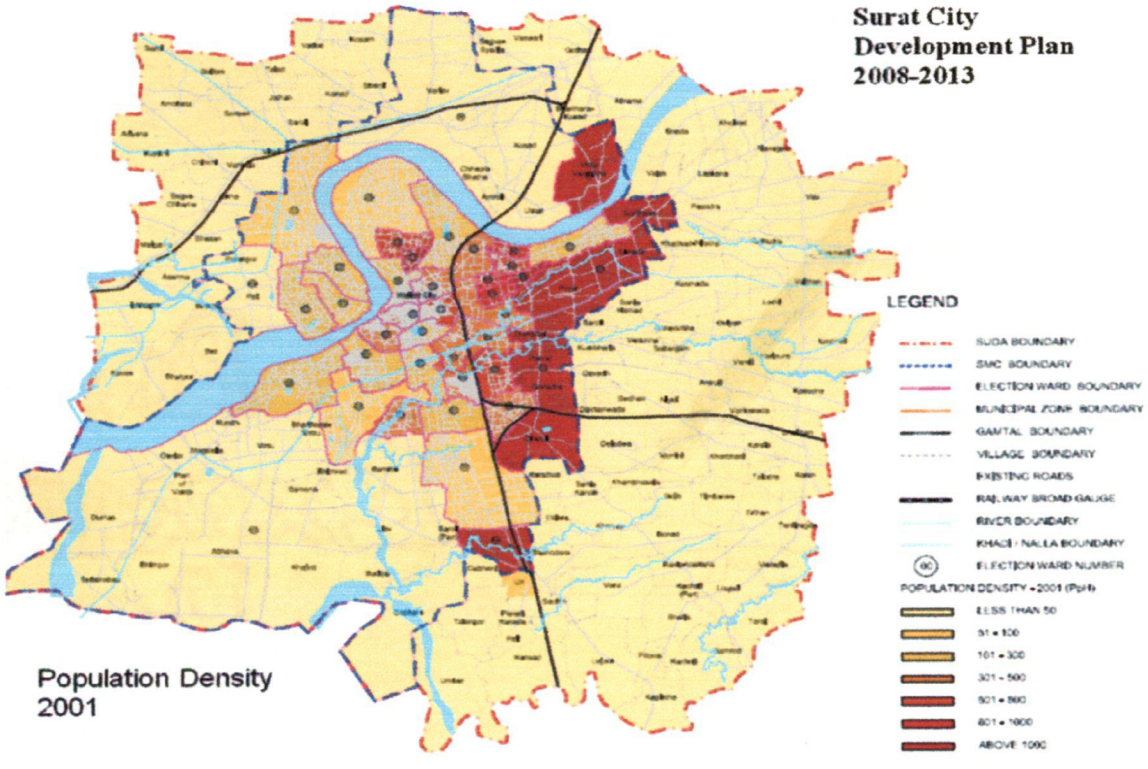


Fig. 3.3: Population Density of Surat

3.3 Some Facts and Figure's of Surat City:

	Surat City [Old City Limit]	Surat City [New City Limit]
Oldest municipality	1852 AD.	
Area	112.28 sq.km.	326.515 sq.km.
Population	1.49 Million (1991) 2.72 Million (2001)	1634605 (1991) 2876374 (2001)
Density	21676 Persons/Sq.Km.	8812 Persons/Sq.Km.
No. Of slum pockets	312	---
Zones	7	7
Ward offices	55	72
No. Of election wards	34	34 + 4 (for extended area)
No. Of councillors	102 (68 M, 34 F)	102 (68M, 34M) + 12 (for extended area - 8M, 4F)
No. Of employees	15,906	15,906
Sex ratio	773/1000 Male	764/1000 Male
Crude birth rate	19.09	18.25
Crude death rate	4.1	4.37
Infant mortality rate	19.65	16.08
Maternal mortality rate	0.61	0.41
Literacy rate	83.35%	82.91%
Male	88.41%	88.12%
Female	76.73%	76.00%
Decadal growth rate	62.30%	76.02%

3.4 SOLID WASTE MANAGEMENT IN SURAT

Efforts to improve solid waste management in the city of Surat were made by the health department after the havoc of the plague in 1994.

- It is the only city of its kind in Gujarat where private contracting and private participation in solid waste management is being done.
- The city is divided into 7 zones for efficient management and the waste generated is collected throughout the city and dumped at the Khajod disposal site (200 ha).

- Source segregation of recyclable waste is practiced and a large percentage of households practice storage of waste at source.
- About 96 percent of the households and 99 percent of the shops and establishment practice storage of waste at source.

3.4.1 Waste Generation & Collection

- Surat generates 400gms per capita per day of waste amounting to roughly 1280 metric tons. This is collected by SMC, private contractors and the rag pickers.
- About 70 percent of the waste generated every day is contributed by households, shops and other commercial establishments. Just over 30 percent of the total waste generated is recyclable. This comprises of paper, plastic, metal, brick stone and glass primarily. Combustible waste accounts for 22.75 percent of the total and organic waste is nearly 42 percent.
- There are 314 cradle type doorstep bins placed on roadside designated spaces.
- The total number of waste collection bins is 1170. These are mainly 4.5 cu.m in size with a capacity of 1.5 tonnes (4.5 cu. m)/ dustbin and cover the entire population of the city.
- The spacing between waste storage depots is about 100 m and there are about 5000 wheel barrows for carrying waste.
- For door-to-door collection of waste 3000 bins are installed by private agencies. The cradle type would be designed in such a way that revenue generation through advertisement is possible. There are also initiatives for segregation of waste at source including awareness generation through pamphlets.

- At present there are 4503 sweepers engaged in the collection of w aste across the seven zones of the city. Of the total waste collected, the corporation manages 96 percent while the rest is collected by rag pickers.

Table 3.1- Solid Waste Management – Existing situation

Head	2007
Refuse garbage collected per day (MT)	1280
% garbage handled by SMC	40
% garbage handled by contractor	60
Collection per person (gm/ day)	400
Generation per person (gm/ day)	400
% Efficiency (Collect/ Generate)	96
Density of waste (kg/ cu.m.)	533
% Moisture content of waste	60
No. of dustbins (2-3 cu.m capacity)	263
No. of dustbins (4.5 cu.m capacity)	1440
Total capacity of dustbins (Cu. m)	1703

Source: CDP of Surat

Table 3.2- Waste Generation & Collection

S.No.	Head	2007
1	Generation	
	a. Tons Per Day 1280MT	1280 MT
	b. Gms/ capita/ day 400 gm	400 gm
2	Collection	
	a. Corporation (TPD) 1280MT	180 MT
	b. Rag picker (TPD) 33 MT	33 MT

Source: CDP of Surat

In 2005 the solid waste generation per capita per day was 390gms which has increased to 400gms in 2007.

Table 3.3- Quantity of waste generated

Head	2007 Percentage
Households	53
Shops and Establishments	16
Vegetable/ Fruit/ Meat/ Fish market	14
Construction and demolition material	8

Water Resources Development Training Centre
Indian Institute of Technology Roorkee
Roorkee-247667 (UA) India

No: WR/SKT/
Dated.12/7/04

Assistant Registrar (Acd)
IIT Roorkee

Please find enclosed the M Tech. (IWM) thesis viva-voice exam marks along with a copy of their dissertation of the following students:

1. Mr Ramanand Prasad Yadav
2. Mr Roshan Kumar Pradhan
3. Mr A.K.Singh Kushwaha

Marks in 2 Envelopes + 3 Dissertations one of each

Receipt may please be acknowledged

12.7.04
S.K Tripathi

CC: Professor & Head WRDTC, with a copy of the marks for record.
OC library WRDTC with a copy of their dissertation

Biomedical waste	1
Hotel/ Restaurant waste	8

Source: CDP of Surat

Waste is majorly generated at household constituting 53% of the total. At household level there is partly segregation of bio-degradable & recyclable waste.

Table 3.4- Composition of waste:

S.No.	No. Type of waste	Percentage
1	Combustible - Wood	22.45
2	Recycle able	30.28
	Paper	12.75
	Plastic	4.12
	Metal	2.75
	Glass	2.05
	Brick Stone	8.61
3	Earth - Organic	41.97
4	Food waste	13
5	Vegetable, grass, leaves	24
6	Miscellaneous	5
	Cloth &fabric	13
	Ash	20
	Ph	6.61
	Moisture	60

Source: CDP of Surat

The major component in Solid Waste is Earth – Organic which consists of 42% of the total waste. The recyclable waste which majorly consists of plastic and paper constitute to 30%. The waste coming from vegetable market which is bio-degradable constitute to 24%

Table 3.5- Existing fleet of vehicles:

Type of vehicle	No.	Age (Years)	No. of shifts	Daily Capacity (in tonnes)
Medium Tipping Vehicles (152 No's)				
Trucks	49	8	2	330
Tractors	39	10	1	170
Dumper placer	67	6	2	250
Market Vans	4			
Heavy Machines (10 No's)				

Table 3.6- Zone wise Solid Waste Generation:

		Solid Waste Generation		
Zone	**Area (Sq. Km)**	**2001**	**2007**	**2021**
Central	8.97	150.1	140	116.2
North	34.35	121.7	180	220.6
East	35.42	210.7	289	337.7
West	52.67	90.9	166	224.5
South	53.12	177.6	295	383.1
South East	19.72	59.2	98	127.7
South West	117.48	73.2	112	139.9
Total	**326.51**	**883.5**	**1280**	**1549.7**

3.4.2 Waste Transportation and Disposal

Waste collected from all over the city is transported to the processing and disposal sites by 450 labourers and 104 drivers. The fleet of vehicles available for the purpose includes dumper placers, trucks, tractors, market vans and heavy machines which are 162 in total. 41 labourers are involved in processing and disposing waste at the Khajod disposal sites.

The frequency of transportation of waste from various waste storage depots is once or twice a day and the total capacity of the fleet is 980 M.T. The transportation process is partly mechanized in the form of loaders, bulldozers and breakdown vehicles. The mechanized process accounts for 27 percent of the total transported waste. The remaining 73 percent is manually transported.

The private sector is partly involved in the transportation of waste in terms of manpower or a transportation of garbage and vehicles. They are mainly involved in transportation of municipal solid waste by dumper trucks and by containers through dumper placers.

3.4.3 Processing and Disposal of Waste

Processing and disposal methods like incineration etc. are not used in Surat. Land available for treatment and disposal of waste, where the land filling is carried out, is about 10 km from the city. The life expectancy of land for the treatment and disposal of waste is 30 years at the Khajod final disposal site. There is sanitary landfill cell created and the cell is ready for its use for disposal of inert material obtained at the end of treatment process of MSW Treatment.

One Bio-Medical Waste Treatment Plant is working on a BOOT basis from 2003. The agency to which the work is granted is responsible for collection and treatment of Bio- Medical Waste. There are total 27 UHC, which are collection centers and Rs. 10 per kg is collected as charge.

3.5 Issues

- The havoc of plague in Surat helped to convert the city into one of the cleanliest cities of the country. This was made possible through a complete revamping of the entire solid waste management system. The system is working efficiently and effectively at present, wherein private sector is involved.
- Lack of effective technology for scientific disposal of solid as well as bio-medical waste.
- Bhatar waste disposal site is at present the only serving site and this site has reached the end of its life span now. Moreover, the location of the site right within the city limits has exposed the entire process to the open air and life threatening parasites.
- Surat Municipal Corporation has been efficient in collecting the solid waste from all over the city and maintaining cleanliness. The need of the day is maintenance of the system in an efficient manner.

For this purpose, it is required that the collection and disposal system be upgraded. To cater to the needs of the population in 2011 and 2021, w hen 1278 MT and 1550 MT of solid waste is expected to be generated everyday in the city, additional containers, collection and transportation vehicles, waste storage and transfer stations, and infrastructure at the new waste disposal site at Khajod are the immediate requirements.

3.6 Future Requirements

Solid waste has increased and hence there is a need to plan for more compost plant, and workout techno economic feasibility for waste to energy systems. Also various models for reducing the waste need to be reviewed.

Case Study-II (Jaipur)

CHAPTER 4

4.0 CASE STUDY – II

Jaipur, (Raj)

Jaipur is known as one of the first planned cities of India.

The population of Jaipur region is 2.7 Million as per 2001 census and has shown a consistent increase in the past 50 years. In fact, in the last decade, the population has increased by 8 lakhs. The area of Jaipur Municipal Corporation has grown from 200 sq.km in 1981 to 218 sq. km in 1991 to 288 sq.km in 2001.

Fig. 4.1: Location of Jaipur City in India

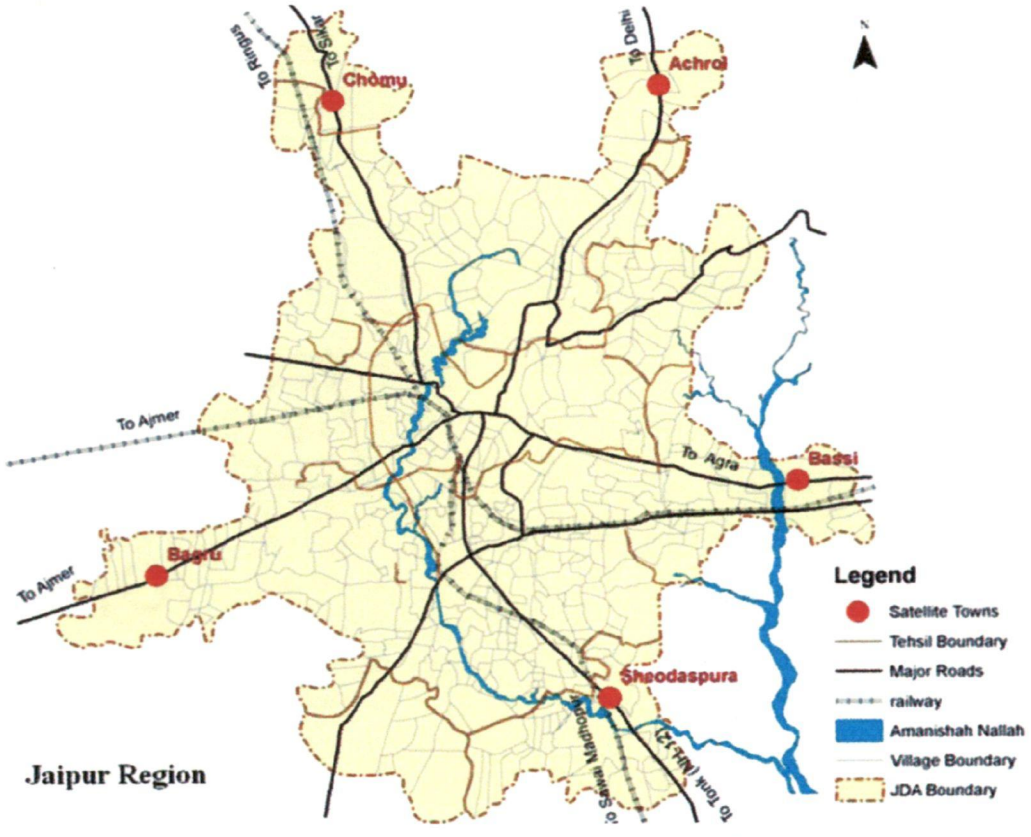


Fig. 4.2: Municipal limit of Jaipur City

4.1 Some Facts and Figure's of Jaipur City

City Population(2001)	23.24 Lac + 10% Floating
Area:	467 Sq. Km.
Density	Walled City-58207 person/sq.km JMC-8053 person/sq.km JDA-302 person/sq.km
Number of Houses:	4.5 Lac (BPL Families : 26127)
Zones:	City is divided into 8 geographical zones :
Wards:	77
Elected Members:	77
Co-opted Member:	3 (Presently None)
Ex-officeio Members:	8 (6 MLAs and 2 MPs)
Standing Committees:	18
Budget size:	380 Crore Rs.
Slums:	JNN : 164, JDA- 47, **Total** - 211
Surveyed Family:	JNN: 43718, JDA- 12753, **Total** - 56471
BPL Families:	26127

Source: CDP of Jaipur

4.2 SOLID WASTE MANAGEMENT IN JAIPUR CITY

Jaipur Nagar Nigam is responsible for solid waste management in Jaipur. Some of the work responsibilities have been contracted out. As estimated by JNN, 1040 metric tonnes per day of solid waste were generated in 2001-02 while RUIDP estimated it to be 1239 mtpd.

JNN does not have a door-to-door waste collection system. Contractors deploy their own sweepers and house-to-house waste collectors. From various secondary information and observations, it is estimated that nearly 50,000 households in the city have been covered by house-to-house waste collection.11 Stakeholder consultations with some Residential Welfare Associations (RWAs) revealed that house to house collection was being followed. This is done through JNN's " Swasta Mitra

Apke Dwar" programme. The wastes collected through this system are collected by the refuse vehicles. The zones and wards in which waste collection system works are Ward numbers 3,7 and 20 of Civil Lines Zone; Ward numbers 14 and 25 of Sanganer Zone and Ward numbers 9,10 and 68 of Vidyadhar Nagar Zone.

However, this is not a common practice in all the residential areas in the city. The house-to house waste collection system does not involve segregation of biodegradable from the nonbiodegradable. Waste is collected and stored in containers or left at road corners for JNN workers to collect and transport it from there. This creates a lot nuisance with stray cattle and dogs spreading the waste. Waste management is absent in slum and kacchi basti areas where waste is dumped into nallahs. At present, the disposal system is very poor in Jaipur. There is no sanitary landfill site for the city Solid waste collected from the city is disposed in Sewapura in the North and Mathura Daspura in the east. Earlier there were waste disposal sites at Sewage farm and Jagatpura, which have been abandoned now. One new disposal site proposed at Khori Ropara has not received the clearance from the State Pollution Control Board. . Under the RUIDP funding a new sanitary landfill site is also coming up at Lengriwasa at the east.

4.2.1 The Present SWM Service

Jaipur Nagar Nigam is responsible for the management of solid wastes within the municipal boundaries of Jaipur (518.30 sq. km). The municipal area is subdivided into 6 zones and is further sub-divided into 70 wards. The sanitation practices prevail in Jaipur is

(i) comprehensive sanitation

(ii) complete sanitation and

(iii) general sanitation.

Table 4.1- Prevailing sanitation practices in Jaipur

Sanitation Practices	Comprehensive	Complete	General
House-to-house waste collection	√	√	X
Street Sweeping and collection of sweeping wastes	X	√	√
Desilting of storm water drains	X	√	√
Desilting of sewer lines	√	√	X
Desilting of service lanes	√	√	X
Secondary waste collection	√	√	√
Transportation of wastes	√	√	√
Disposal of wastes	√	√	√
Zones covered	Hawamahal (east), Hawamahal (west) and Sanganer zones	Pratapnagar, Ward no. 21 & 23 of civil lines zone, 68 & 69 of V.D zone, ward no. 13 of Sanganer zone and Military area of Civil lines zone.	Civil lines Motidungri and Vidyadharnagar zone

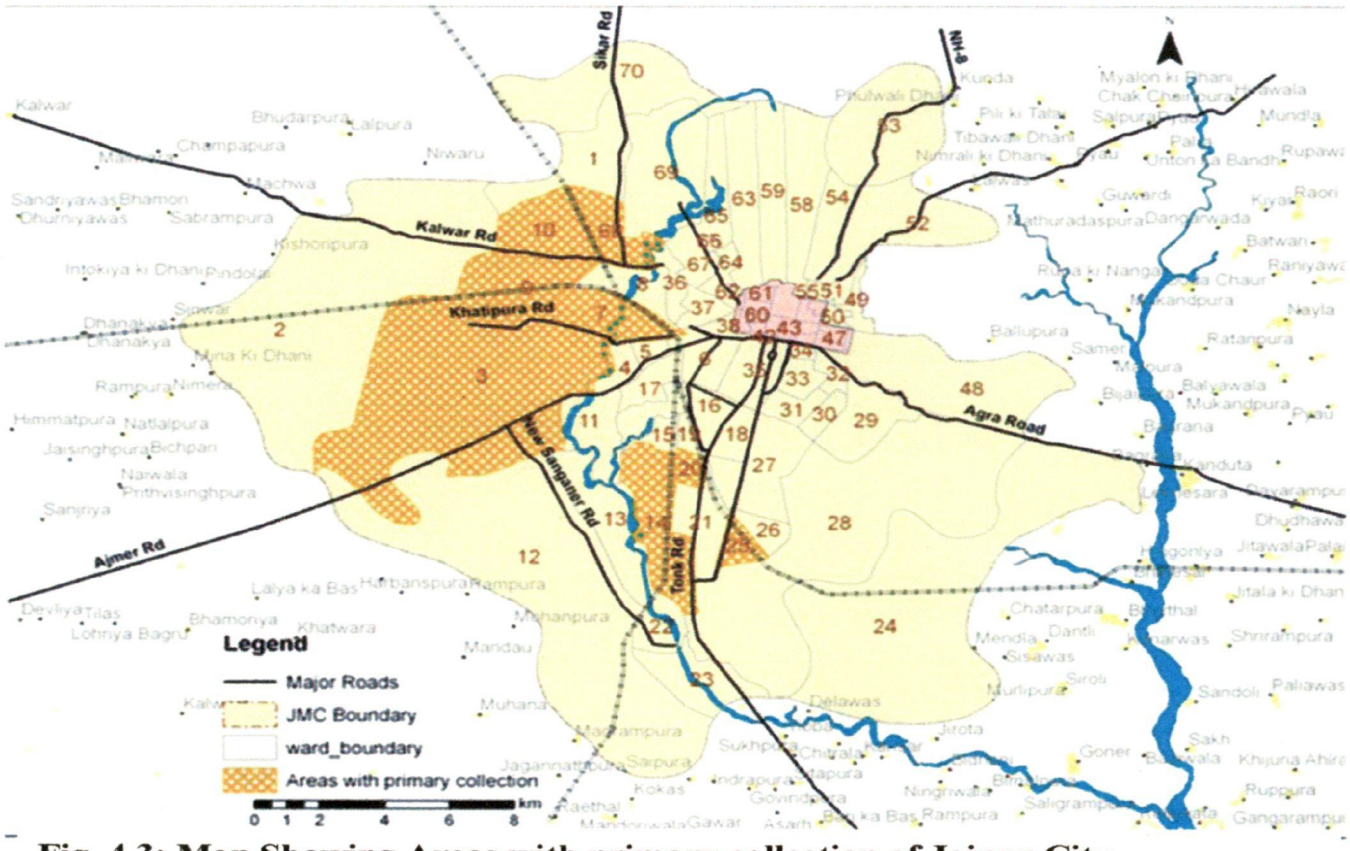


Fig. 4.3: Map Showing Areas with primary collection of Jaipur City

The comprehensive and complete sanitation practice has been contracted out. However in case of comprehensive sanitation practice the street sweeping and desilting of storm water drains are not done through the contractors and are taken care of by JNN. In the following subsections the detail MSW management system like waste generation, waste collection, waste transportation, and waste disposal has been narrated subsequently.

4.3 Solid wastes generation

The type of waste generated within the municipal areas can be largely classified as (i) MSW (ii) Biomedical Wastes, (iii) Industrial Wastes and (iv) Construction and Demolition Wastes.

Table 4.2 Waste Generation in 2006-2007

Type of waste generation	Quantity of Waste (mtpd)
Residential areas	1072
Commercial areas	321
Hotels	12
Markets and slaughter houses	88
Street Sweeping	134
Total MSW	**1628**
Biomedical Wastes	**20**
Industrial Wastes	**33**
Construction and demolition Wastes	**150**
Total Waste	**1831**

Source: CDP of Jaipur

4.3.1 Waste Generation projections

The waste generation projections have been done for the Jaipur. On an average a per capita waste generation of 0.46 kg per day has been considered for population within the JNN areas. Considering the strong potential for growth2 of Jaipur, an annual increase of 1.5% in per capita per day waste generation has been considered. The projected waste generation considering the population growth as projected on high growth basis.

Table 4.3- Waste Generation (mtpd) Projections for JNN

Years	2011	2016	2021
Population (High Growth Based)	3610233	4607674	5880690
Waste Generation (mtpd)	1927	2649	3643

Source: CDP of Jaipur

4.4 Waste Collection and Storage

In areas under complete sanitation programme, the primary collection of wastes is through (i) street sweeping and (ii) house-to-house waste collection.

Contractors deploy their own sweepers and house-to-house waste collectors. However areas covered under comprehensive sanitation, waste collection from households are arranged by contractors but the street sweeping and drain silt clearing are taken care of by JNN.

The collected waste is then deposited to storage bins or in open storage points. However, the areas covered by JNN do not have a house-to-house waste collection facility.

The organizations who are given permission for collecting waste from households need to have at least Rs. 9000 as bank balance and JNN provides them one tricycle and one mechanized container. These organizations have been allowed to take Rs. 20 from households and Rs. 25 from commercial areas.

There is no specific waste collection norm exist in the city. In areas under complete sanitation, normally 1000 running meter has been allotted to one sweeper for waste collection.

Table 4.4- zone wise waste collection coverage

JNN Zones	Number of containers provided by JNN
Motidungri Zone	190
Vidyadhanagar Zone	250
Civil Lines zone	
Sanganer zone	
Pratapnagar	20
Total	460
Total working containers	375
Total storage Capacity	=375*4=1500cu.m per day=975mtpd

Source: CDP of Jaipur

4.4.1 Storage

There are mixed type of storage facilities available in the city. Mechanized containers of 4.5 cubic meter (cu.m) capacity have been provided by JNN.

In addition, contractors also provided their own containers at Hawamahal (east) and Hawamahal (west) zones. However, attempt has been made to track the existing number of containers provided by JNN.

In addition there exist many open waste collection points. The percentage comparison of open collection points and containerized storage points is shown in following graph. It can be considered that an open collection point are higher in the Hawamahal (east) and Hawamahal (west) zone and on an average about 50% open collection points still exists in the city.

Number of containers provided in JNN zones

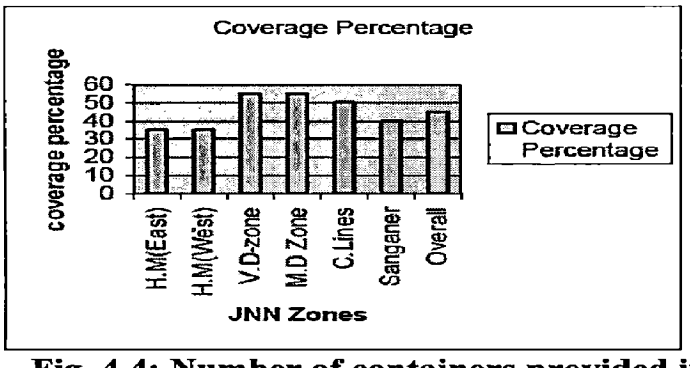


Fig. 4.4: Number of containers provided in JNN zones

Type of Storage Facilities

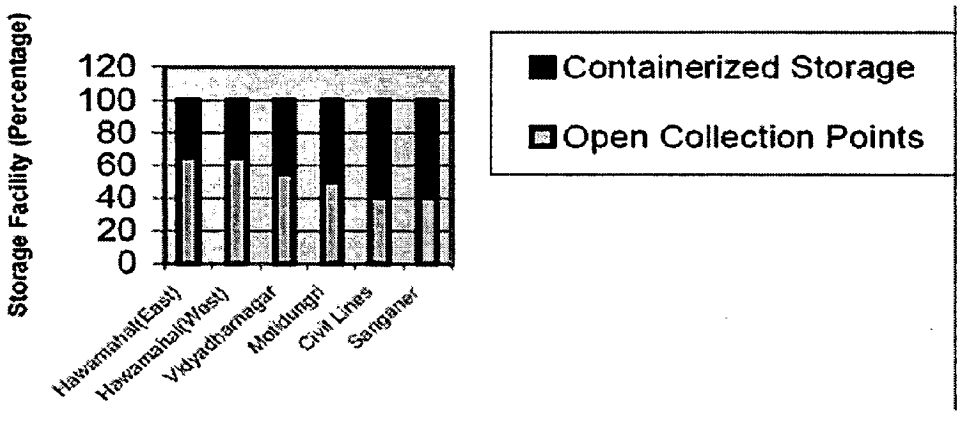


Fig. 4.5: Type of Storage Facilities in Jaipur City

In areas where open storage points exist the system of waste collection is through a manual/ multihandling system, which degrades public health and environment and is not in conformance to SWHR. Moreover, no waste segregation (biodegradable parts from nonbiodegradable) is practiced. In addition, wastes from industries and construction activities also get mixed with MSW. However, JNN has taken active role towards separate collection and treatment of biomedical wastes. The biomedical wastes are treated at a common treatment plant at Khori Ropara.

4.5 Waste Transportation

Waste accumulated in the community containers are removed by refuse vehicles. 71 vehicles are in working condition available with JNN.

Table 4.5- Vehicle details of JNN

Sl.No	Type of Vehicle	No. of vehicles	Year of Purchase	Waste carrying Capacity	Make
1	Loader (Total-10)	2	1993	5T	ECEL-710
		2	1995	5T	ECEL-710
		2	1997	5T	ECEL-710
		4	2003	5T	ECEL-770
2	Dumper Placers (Total 35)	7	1988	2T	TATA-1210
		5	1993	2T	EICHER
		4	1993		TATA-608
		2	2001	2T	TATA-1613
		1	1995	2T	ALL.NISS
		7	1993	2T	Ashoke Leyland
		3	2001	2T	Ashoke Leyland
		6	2003	2T	S.MAZDA
3	Tippers (Total 4)	3	1993	2T	ALL.NISS
		1	1995	2T	ALL.NISS
4	Tractors (Total 16)	6	1995	1T	HMT-Zetor
		3	1983	1T	Zetor
		6	2005	1T	Mahindra Tractor
		1	2003	1T	Esscort 435
5	JCBs (Total 6)	1	1991	Are used for taking wastes from the open collection points to load into the loaders	Esc.JCB
		2	1992		Esc.JCB
		1	2001		Esc.JCB
		2	2003		Esc.JCB
Total Waste Carrying Capacity (considering 2 trips)				288 mtpd	

Source: CDP of Jaipur

The waste carrying capacity considering both the JNN and contractors vehicles is about 1200 mtpd considering 2 trips for each vehicle. However, in absence of a weighbridge the actual quantity of waste going to the disposal site is not known but from secondary information it can be concluded that about 750mtpd of waste is actually transported to disposal sites.

4.6 Waste Disposal System

Three disposal site is working at present namely Sewapura at the North and Mathura Daspura at the east. Under the RUIDP funding a new sanitary landfill site is also coming up at Lengriwasa at the east.

Earlier there waste disposal sites at Sewage farm and Jagatpura, which has been abandoned now. One new disposal site proposed at Khori Ropara has not received the clearance from the State Pollution Control Board. Due to proposed physical growth of the city disposal site is not possible to be taken at the Western and North Western part of the city. And, in the southern part of the city due to the existing aero drum disposal site is not possible to be constructed. The waste collected from the Vidyadharnagar zone and part of civil lines zone are disposed at the Sewapura site. Wastes from other areas are disposed at Mathura Daspura. Once the sanitary landfill site at Lengriwasa get constructed a significant quantity of waste can be taken this site.

In absence of weighbridge at the disposal sites the quantity of waste going to the disposal site is not possible to be known. However from secondary data it is estimated that about 750-800 mtpd of wastes are actually disposed to these sites.

4.7 Processing & Recycling

At present there is no waste treatment facility available in the city. A compost plant was in existence at Mansarovar earlier, which has been closed due to some functional problems. The officials of Jaipur Nagar Nigam (JNN) are of opinion that compost plant is not a suitable treatment technology. With private sector partnership (Grasim Industries) a new

refuse derived fuel paletization unit is coming up Lengriwasa sanitary landfill site with 500mtpd capacity. The private partner also has planned to establish another unit of same capacity. The operation of these plants shall solve the waste disposal problem to a large extent as it is estimated that the plants can reduce the waste load to the disposal site by 45%.

4.8 INFERENCES

- There are no regulations governing the generation, segregation and on site storage systems, thus hindering optimum functional efficiency of the management of solid wastes.
- The wastes are transported, irrespective of their nature and hazard, by means that necessitate multiple handling at various points. This is not only dangerous for the persons handling the wastes but also reduces the overall efficiency of the collection system.
- There are no formal and/or institutional provisions for the recovery, reuse and recycling of the wastes, due to which there is no economic returns to any institution of the formal sector from the process of SWM. This leads to disinterest on the part of agencies involved in SWM. As a consequence the involvement of the agencies concerned is more on the lines of disinterested activity rather than active participation.
- The disposal practices of the SMC are not as per established norms, due to which the landfills of the SMC are a hazard for both the public health and the environment.
- The NGOs and CBOs have not been given the necessary incentive and impetus due to which the communities awareness and participation in the SWM process is much below par.

From the study of the composition and characteristics of wastes the following facts that are of significance to the SWM process in city emerge:

- Waste density is high.
- The moisture content of the waste is also high.

- The waste has a large percentage of organic contents with high portion of vegetable/putrescible materials.
- There is a substantial amount of dust and dirt where sweeping and open ground storage of wastes is part of the collection system.

Due to the above mentioned characteristics of the waste the following issues relative to various aspects of application of technology become evident:

- Due to the high moisture content of the wastes, incineration would generally not be self sustaining and would require energy input rather than produce recovery energy.
- Waste with high organic content, biodegradation techniques such as methane generation and composting are technically more viable.

The following inferences are drawn from the case study of SWM:

- Solid Waste Management may be improved to a significant extent through streamlining existing human and physical resources. Institutional and managerial reforms contribute a lot for improved performance. Hence, constraint of funds does not necessarily restrict the scope for success.
- The stakeholders such as CBOs, NGOs, Resident Welfare Associations, Merchants and traders Associations and various community groups are willing to participate and cooperate in the activities for Solid Waste Management.
- Consultancy support and specific recommendations of subject experts have proved to be of great relevance for understanding the issues in details and tackling SWM related problems.
- Workshops, training programmes and exposure visits have widened the vision and capacities of key personnel as well as elected representatives from Municipal Corporation. This is reflected in their attitude and behavior in matters concerning SWM.
- The options for extending SWM services in certain areas such as Hospitals, Nursing Homes, Market places, Hotels etc. on full/part cost recovery basis, may be tried, there exist vast untapped potential for these measures.

Bhilwara A Study Area Profile

CHAPTER 5

5.0 BHILWARA A STUDY AREA PROFILE

5.1 INTRODUCTION TO BHILWARA CITY

Bhilwara, the city known as 'Textile City of India', is a famous industrial town in Rajasthan. Located in the western part of Rajasthan, Bhilwara is well connected with all major cities in India. Bhilwara produces some major Garment brands like BSL, Mayur Suitings and Suzuki Suitings. Along with textile industry, Bhilwara is also famous for its Minral and Stone Industry.

Fig. 5.1 Location of Bhilwara in India

Bhilwara emerged as India's largest manufacturer of suitings, fabrics and yarn. Its share in the polyester/viscose fabrics (suiting) sector is around 50 per cent in India.

5.2 Regional Setting

Bhilwara City is located in the southern part of the state of Rajasthan, in the northwestern part of India. Bhilwara shares boundaries with Udaipur, Rajasmand, Chittorgarh, Bundi and Tonk. Bhilwara is situated between 25°.00' to 27°.50' North Latitude and 74°.03' to 75°.25' East Longitude, situated 100 meters above the sea level.

Distance from major cities:

- Jaipur-259 kms.
- Delhi - 520 kms.
- Ahmedabad - 472 kms.
- Mumbai (Bombay) - 1023 kms.
- Udaipur - 140 kms.
- Chittorgarh - 58 kms.

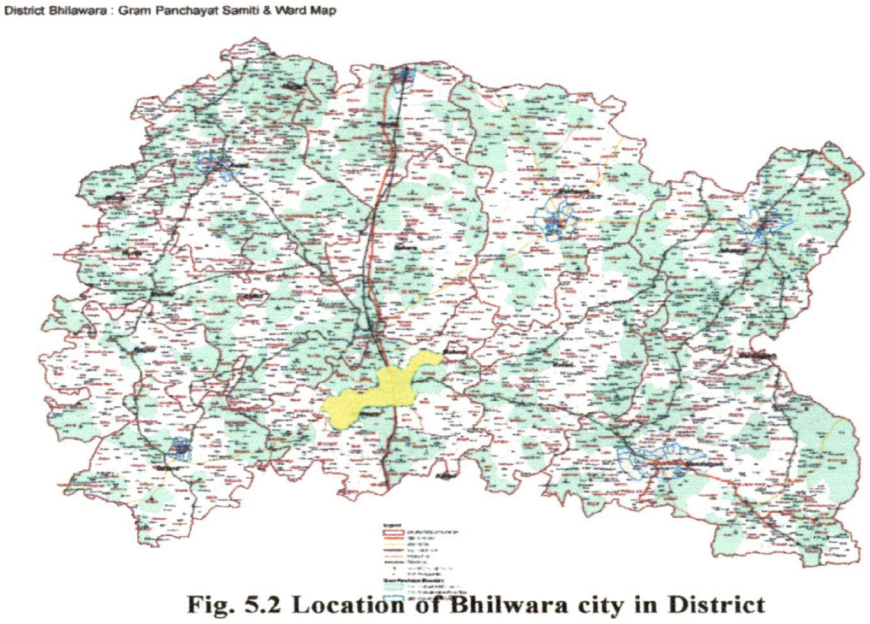


Fig. 5.2 Location of Bhilwara city in District

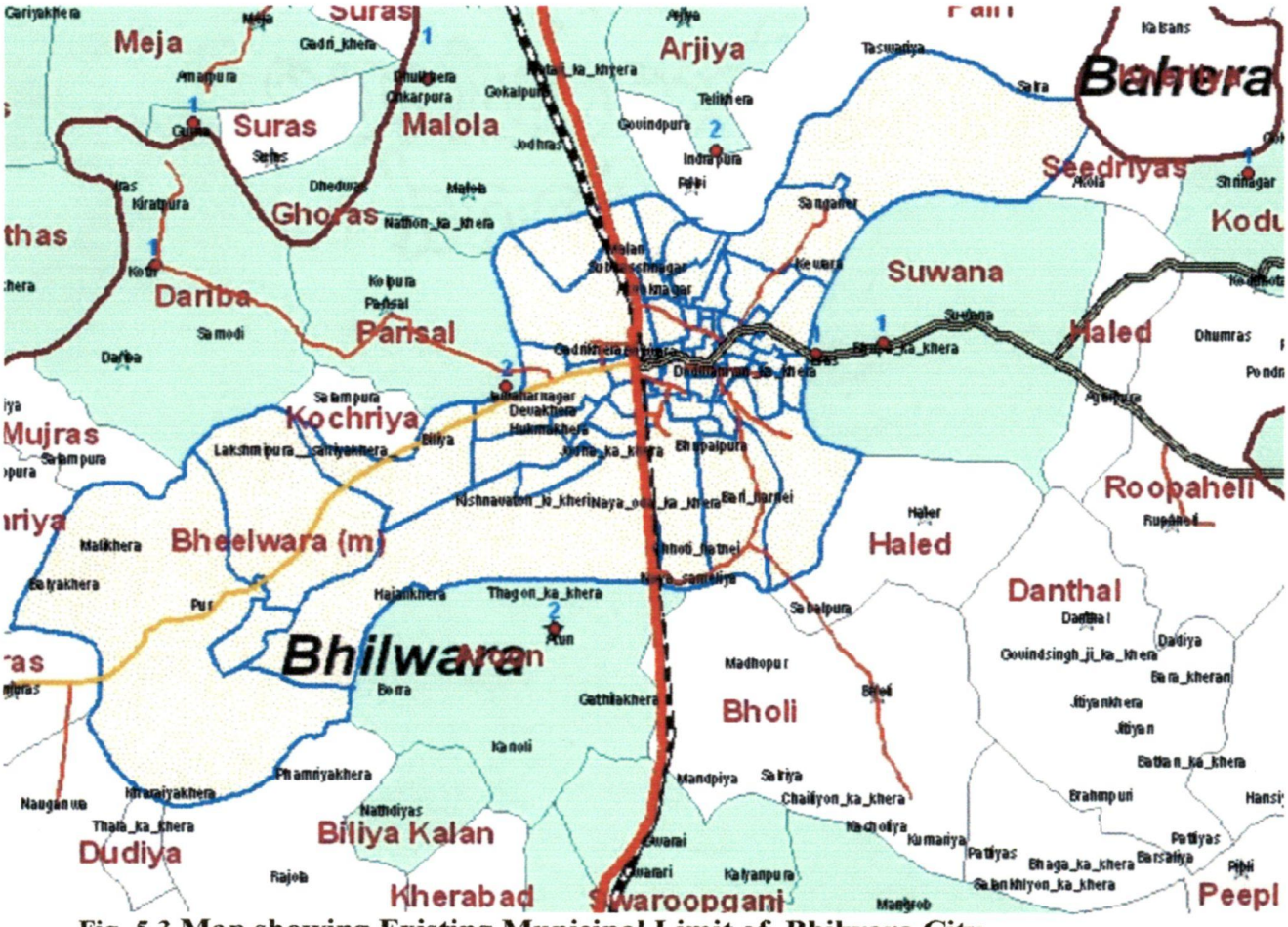


Fig. 5.3 Map showing Existing Municipal Limit of Bhilwara City

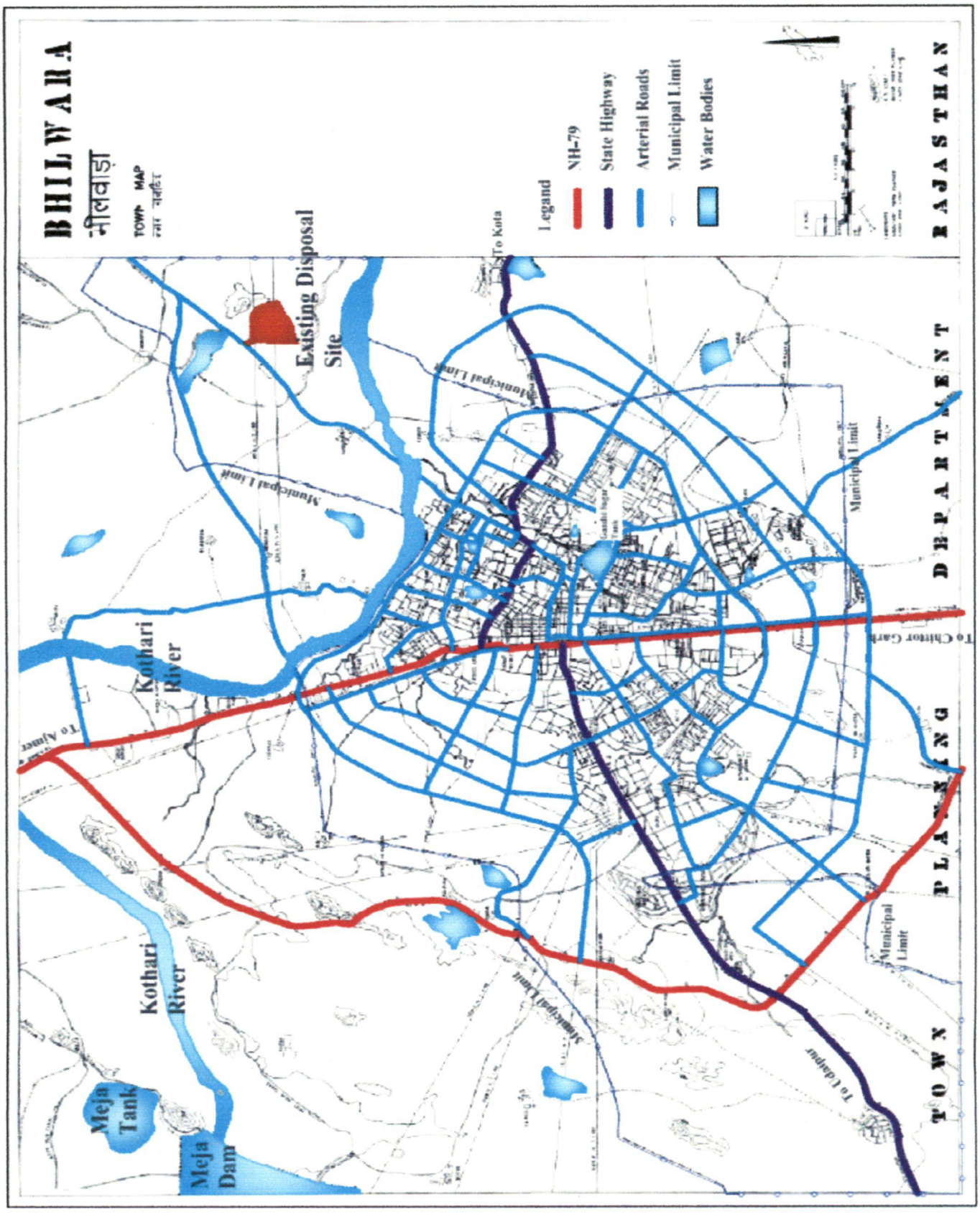
5.3 CLIMATE

The city has moderate climate, daily temperature ranging from 26.9°C to 39.4°C during May, and 7.6°C to 22.5°C during January, the coldest month. The average rainfall is about 50cm and average humidity is 57%. The rainfall in the region is very erratic.

5.4 HISTORY OF BHILWARA CITY

Bhilwara has a quaint story of origin, carefully preserved by the locals. It is said to have come up in the middle of the 11th century when a Bhil tribal, supposedly one of the first settlers, built a Shiva temple on the site of the existing Jataun ka Mandir. This is in the area called Junawas,

Fig. 5.4 Bhilwara City Map.



the oldest part of the town. And if we are to believe this, the town is more than 400 years old.

5.4.1 Developed as a Commercial Center By Britishers:

It was then that the British took up the task of building Bhilwara. They developed it as the chief commercial mart of Central India. And if Tod is to be believed, the present town was absolutely non-existent when they took upon themselves the task of building a bazaar with the required infrastructure that would support it. Both foreign and local merchants were encouraged to settle here, shops and houses were given out at moderate rates and fairs were hosted almost every week in which goods from distant lands were piled up in the streets. The entire project was taken up with utmost seriousness by the British who not only exempted Bhilwara from taxation for a full year but also posted guards to ensure a sense of security among the inhabitants. A kind of democratic set up was allowed for Bhilwara to stimulate growth. This gave Tod opportunity to say: "Bhilwara is perhaps the most conspicuous instance in all India of the change which our predominant influence has effected in four short years... With proper management this place might become the chief mart of Rajputana and ten thousand houses would soon find inhabitants, such are its local capabilities as an entrepot."

5.4.2 Developed as a Florishing Town:

Tod's forecasting was a bit too ambitious, though not completely unjustified. By 1822AD Bhilwara sprouted nearly 3,000 houses which were lived in by merchants, bankers and artisans. A road was also built in an attempt to make transport easy. But soon the town faced new problems. The merchants from Bhilwara were losing profits, as they were required to pay an additional town-duty of metage. This is lead to a lot of discontent among the local merchants. The local governing bodies were also plagued by differences often arising from religious issues. All these problems hampered the efforts made by the British. Trade and industry in Bhilwara did flourish, but not to the scale the British had intended.

5.5 GROWTH OF BHILWARA CITY

With the setting up of Municipal Council in 1928 and Urban Improvement Trust in 1967 new developments took place.

Establishment of Mewar Textile Industry in 1938 and Mahadeva Cotton industry in 1941 marked a turning point in the history of growth and development of the city in east side of railway line.

After independence Maali Kheda, Manikya Nager, Dadabaari, Gandhi Nager, Harijan Colony, Bapu Nagar, Rajendra Nager, Shastri Nagar, Aazaad Nagar, and R.K Colony etc. new residential project were developed by the Urban Improvement Trust.

5.6 DEMOGRAPHIC CHARACTERISTICS

5.6.1 Population Growth

The present population of Bhilwara is estimated at around 3.5 lakhs. Population of the city in the last six decades has grown more than three folds from 15,196 in 1941 to 2.8 lakhs in 2001.

After independence due to high migration which resulted 95.58% increase in population by 1951.

After that in 1961-1971, the population growth rate becomes 88.87% due to increase in industrial & commercial activities.

In 1971-2001, the growth rate reached 50% which is more than 23% of average national growth.

Table 5.1- Population Growth Trend of Bhiwara City

S.No	year	Population (Lakh)	Avg. Decadal Growth	Growth Rate
1	1941	15,196	-	-
2	1951	29,668	14,499	+95.58
3	1961	43,499	13,831	+46.62
4	1971	82,155	38,656	+88.87
5	1981	1,22,625	40,470	+49.26
6	1991	1,83,965	61,340	+50.02

7	2001	2,80,128	96,136	+52.27
Projected Population				
8	2011	4,20,000	1,39,872	+49.93
9	2021	6,10,000	1,90,000	+45.24
10	2031	8,00,000	2,10,000	+31.14

Source: Bhilwara Master Plan

5.6.2 Density

Bhilwara is a low density city with a very high density inner core, with population density of over 500 persons/ha. Outer core have the lowest density of less than 20 persons/ha. While the gross average density of the city is 240 persons/ha.

In 2001 there were 45 wards in Bhilwara, however the wards were increased to 50 and the wards was redistributed into 55 wards.

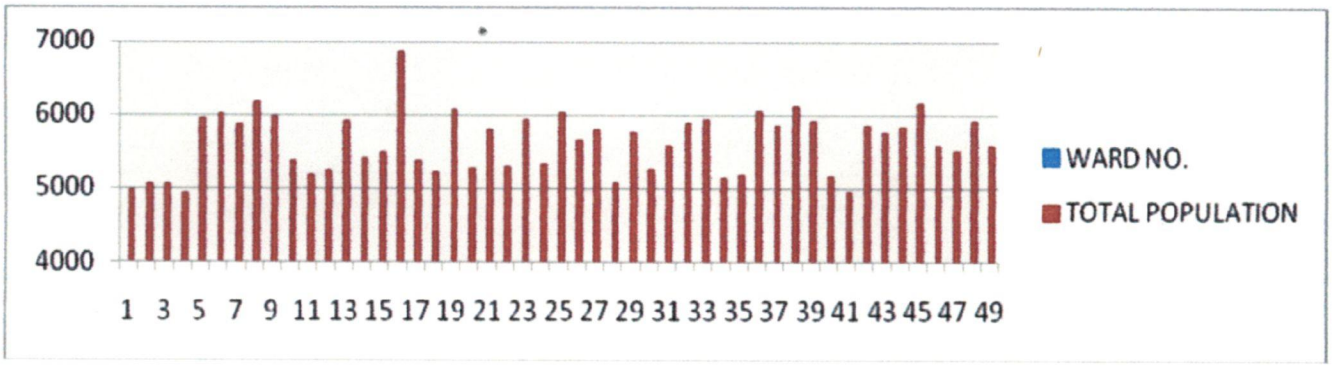


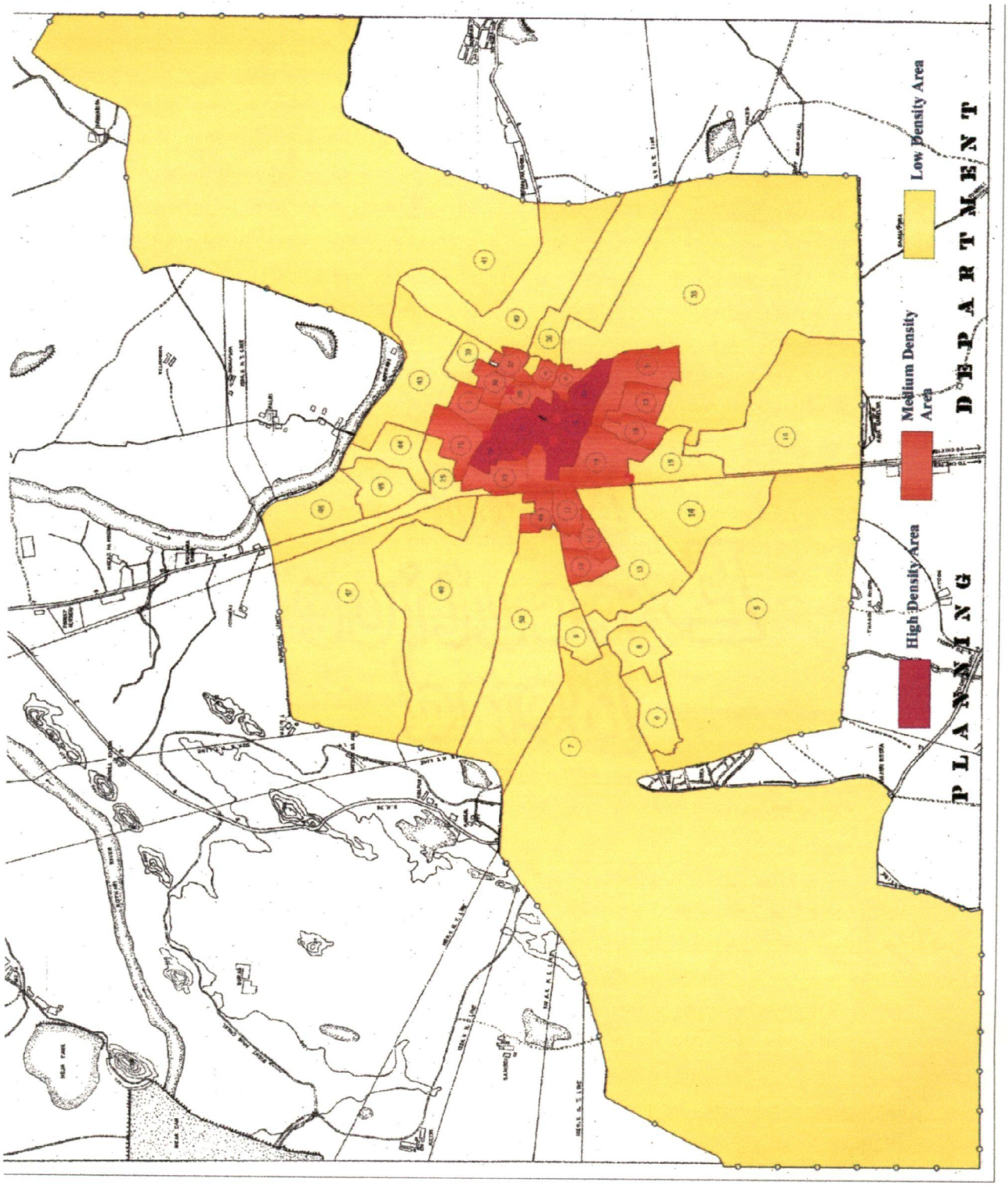
Fig. 5.5 Ward wise population distribution.

5.7 LITERACY

Bhilwara has an average literacy rate of 65%, higher than the national average of 59.5%; with male literacy of 74% and female literacy of 55%, 15% of the population is under 6 years of age.

There are around 192 primary and secondary schools in Bhilwara. For higher education there is Manikyalal Varma University, 2-Engineering College and Polytechnic College.

Fig. 5.5 Ward wise population density.



5.8 ECONOMIC DEVELOPMENT

5.8.1 Economic Base

The working population of Bhilwara comprises 32% of the total population of the city, of which 34% population comes under industrial activities, 20% working in commercial activities 20.25% working in govt. or other institutions.

5.8.2 Occupational Pattern

Traditionally, Bhilwara has been an important industrial, commercial, administrative, transportation and education centre of the region.

Table 5.2- Occupational Pattern 1991-2001

S.No	Occupation category	1991		2001	
		No. of workers	%	No. of workers	%
1	Primary sector	9,135	15.91	11,207	12.5
2	Industry	19,079	33.22	30,708	34.25
3	Construction	3,443	6	5,828	6.5
4	Trade & Commerce	11,272	19.63	17,932	20
5	Transport, storage & Communication	3,512	6.12	5,828	6.5
6	Others	10,978	19.12	18,157	20.25
	Total	**57,419**	**100**	**89,660**	**100**

Source: Bhilwara Master Plan

Table 5.3- Type of industries in Bhilwara

S. No.	Type of Industry	No. of Units	Labour Force
1	Agricultural Based	1059	2917
2	Forest Based	727	5183
3	Livestock Based	834	2842
4	Minerals Based	595	3959
5	engineering Based	136	1901
6	Cloth Based	1590	4396
7	Chemical Based	235	985
8	Transport Based	12	51
9	Others	295	688
	Total	**5523**	**22922**

Source: Bhilwara Master Plan

Table 5.4- Categorization of Industries

Sr. No.	Category of Industry	No.	Labour
1	Cottage Industries	1,532	4,287
2	Small Industries	3,210	7,210
3	Medium Industries	762	5,722
4	Large Industries	19	5,703
	Total	5,523	22,922

Source: Bhilwara Master Plan

5.8.3 Textile Industry in Bhilwara

The state of Rajasthan has a deep rooted tradition for textiles. **69 out of 892 spinning mills in India are located in Bhilwara district**, Rajasthan which consists of Spinning, Weaving, Dyeing, Processing and Printing units. Majority of these industries are affianced in the process of manufacturing synthetic blended yarn which accounts to 40 percent of the total yarn manufactured all over India. It has an investment of $ 53 million USD with an employment of 59,383 people in the textile industries. Bhilwara has emerged as India's largest manufacturer of fabrics. Also known as **Textile City** of India, it is a famous industrial town in Rajasthan. **It encompasses 50 percent of the total polyester fabrics and suitings manufactured in India.** The state Government of Rajasthan has proposed to allot 300 acres of land in Bhilwara and about 100 apparel companies have applied for land to start their industry over here.

The Rajasthan State Industrial Development & Investment Corporation has come up with schemes that would attract textile industries towards the state. It is promoting two garment zones in Bhilwara, the first zone already allotted with 80 acres of land, and the second one is estimated to have 1000 acres with allotments following soon. This is also a reason for the focus of textile industries towards Bhilwara. The Governments special scheme of offering 50 per cent exemption on sales tax is also an appealing factor for the textile focus.

Major Textile Industries:

- Fashion Suitings P Ltd (RCM Business)
- Janki Processors Ltd.
- BSL, Bhilwara Suitings and Shirtings Ltd.

- Sharda Spuntex
- Sangam Suitings.
- Suzuki Textiles ltd.
- Modern group of Industries
- Sugam Industries
- Nutech Global
- Birani Suitings

5.8.4 Mine Industry in Bhilwara

BHILWARA is called **"ZOO OF MINERALS"**. The main categories of minerals found in Bhilwara are as follows:

a. Mica

District is famous throughout the country as a mica mining centre. It is considerably found Bhilwara, Jahazpur,Mandal and Sahada tehsils. It is the most important major mineral of Rajasthan from the point of view of production, sale value and royalty. Apparently, it looks like a soft coloured glass sheets of different sizes. Chemically, however, it is a hydrated silicate of potassium and aluminum. It possesses some notable physical properties which makes it indispensable for the electrical industry. Mica has high insulating properties ,as such it is a bad conductor of heat. Mica in Rajasthan occurs in the pegmatite's intruding the aravali mica schists.

b. Soapstone

It is made out of soft and compact talcose rocks having a soapy feel that could be sawn and worked. It is medium of fine grained , greenish-Grey, generally massive variety of talc mineral which is a hydrous silicate of magnesia. It is found at Chainpura,Ghewaria, Bagore and Bhiwara. Soapstone is used commercially in paper, rubber, textile and toilet industries. Besides, it is used as talcum powder, polishing agent and asinsecticide and an insulating material.

c. Copper

Extensive slag heaps are lying in the district at Dariba, Chenpura. Here, old workings for copper exist along the range of quartzite hills. Generally the copper mineral found at all these places has been chalcopyrite i.e. copper pyrite. It is found disseminated in schist's and phyllites.

d. Felspar and Quartz

Good variety of these minerals are found in the pegmaties , specially at Jahazpur, Paroli and Sangod.

e. White Clay

A plenty of variety of this material is found at Mangrop (Suwana) in the district. It is used as base component in preparation of Mica bricks and pottery.

f. Garnet

It had one time much reputation as a gem stone but being common, it has lost its importance. In Bhilwara Garnet crystals occur near Kamalpura, Salaria, Deoria and Banera. Garnets have commercial importance as a cheap abrasive material used in wood working and glass industries.

g. Beryl

It is silicate of beryllium and alumna. Principally it is found associated with pegmatites and is produced in a large measure as a byproduct of Mica and Felspar industry. It is found in Jahazpur and collected by all the leases of mica in the area.

h. Asbestos

Asbestos is a fibrous variety of silicate minerals with are noted for heat resisting properties . The fibers are flexible and easy to separate. It is worked at Sojatgarh, It is first refined and then exported to Mumbai and Kolkata.

i. Glass Sand

Glass sand or silica is found in tehsil Asind. It is an extra ordinary mineral containing impurities of Alumina and Iron oxide to a small degree. It is exploited for use in various glass and steel industries in the country.

j.Sand Stone

The Building stone locally now as Balua is considerably worked at Mandalgarh and Bijolyan. It is found in slabs of varying colours. viz.white, red and gray. It is used in roofing of buildings. Bijoliyan stone slabs are considered to be the best in the area.

In addition to above minerals Flourite is available in Asind tehsil .It is used by steel plants and glass factories. Limestone is found near Jahajpur.

5.9 LAND USE

Table. 5.5- Existing Land Use

S.No	Land-Use	Area (Hectare)	% of Developed Area	% of Urbanized Area
1	Residential	1167.9	43.3	42.1
2	Commercial	193.9	7.2	7
3	Industrial	500.6	18.6	18
4	Govt.	24.3	0.9	0.9
5	Recreation	43.3	1.6	1.6
6	Public/Semi Public	306.8	11.4	11.1
7	Transport	460.1	17	16.6
	Total developed Area	2696.9	100	97.3
8	Green area/Open spaces(including dairies and poultry farms)	26.7	-	1
9	Waterbodies	48.6	-	1.7
	Total Urbanized Area	**2772.2**	-	**100**

Source: Bhilwara Master Plan

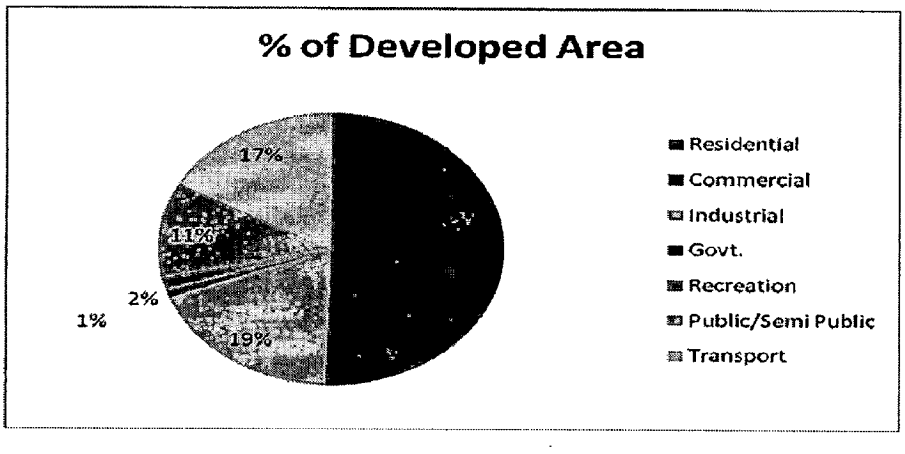
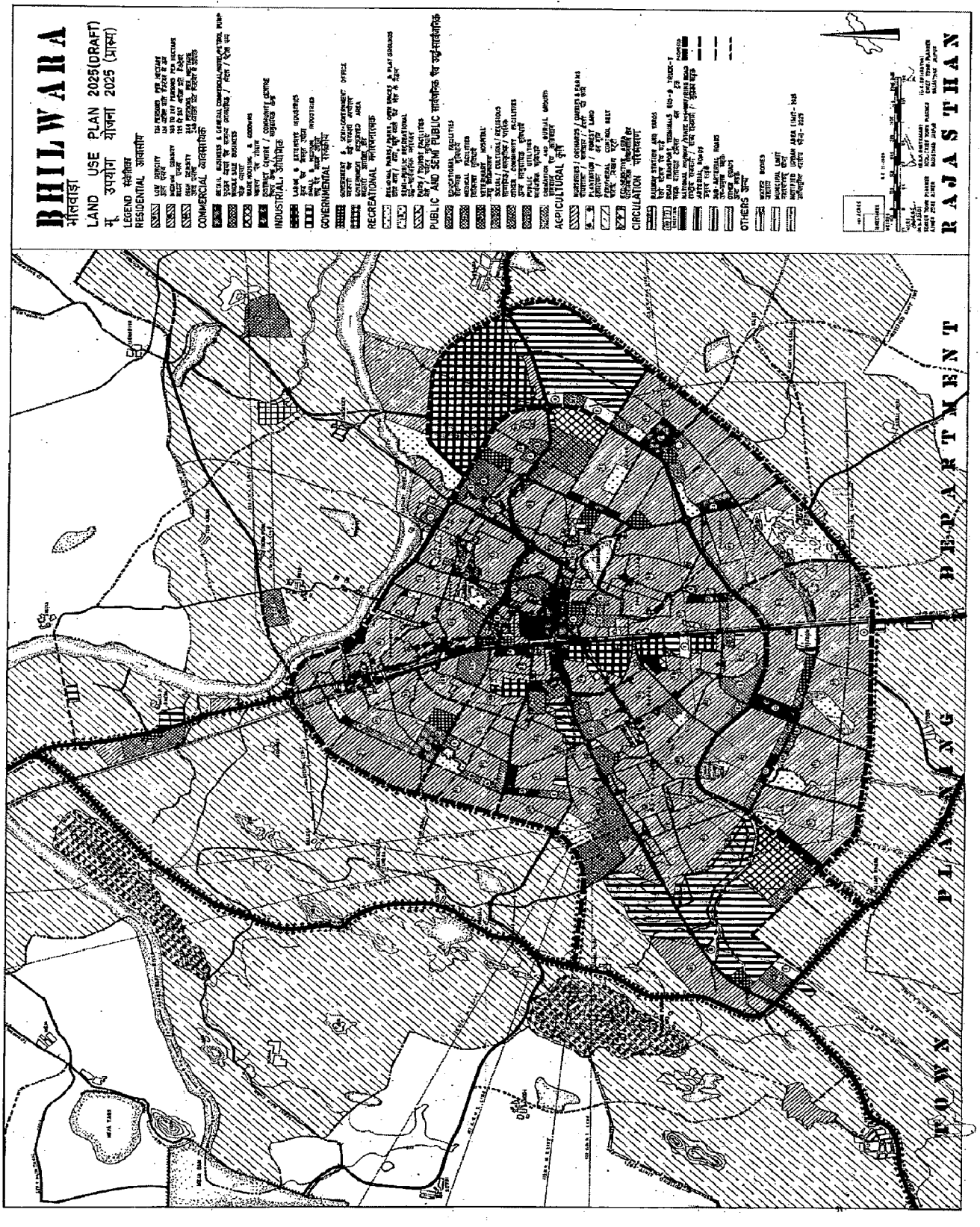


Fig. 5.7: Land Use Distribution 2005

Fig. 5.8: Land Use Map Bhilwara City 2025.



5.10 HOUSING

Urban Improvement Trust and Rajasthan Housing Board are the two agencies involved in planning various schemes and providing houses or plots for development. Most of the buildings in the inner city area are 2-3 storey high without proper access and poor or no ventilation at all. These houses lack basic amenities. UIT was developed about 20 housing and commercial schemes in outskirts of the city. Presently 13 slums exist in bhilwara city that not having adequate infrastructure facilities.

5.11 WATER SUPPLY

Subsequently the water supply to the Bhilwara city was augmented from ground water source, mainly from Meja Dem which is about 12 km away from the city. Other sources for water supply are Guwardi Dem and tube wells in Banas & Kothari rivers.

P.H.E.D is responsible for water treatment for water supply that is located on Udaipur road. Its capacity is 32.5 lackh per day. Here water comes from the Meja Dem through Canal and after water purification and chlorination, the water will distribute in the city. Treated water use gravity system to distribute water in the city. In the city 60 l/p/d is allocated for distribution.

Now day's the frequency of water supply is: 2hr water supply in each 3 days, 1hr with electricity and 1hrs without electricity. The quality of water supply is satisfactory. In summer time the duration of water supply will increase upto 4 days and additional water will come through the trains.

5.12 ELECTRICITY

Electicity supply is sufficient for present needs for bhilwara. Bhilwara receives electricity from Kota, Beawar, Rana Pratap Sagar and Nimbahera. Frequency of power cut is only 2-3hrs in summer season, otherwise no power cut in winters.

5.13 SEWERAGE & DRAINAGE

Bhilwara has no underground sewerage system, old area which is the most densely populated part of the city had very poor sanitation condition due to open drain system is used for sewerage and Drainage. Most of the city household has septic tank.

5.14 SOLID WASTE MANAGEMENT

The wastes from houses, shop and establishments are thrown on the road side (or sometimes on roads) and open drains as there is no door to door waste collection practiced in the city. Sweepers (cleaners) sweep the wastes to a certain point making heaps of wastes along the road side.

These wastes from depots are collected and transported to the waste dumping site. Transportation of the waste from 70 percent of the depots has been outsourced to private parties and remaining 30 percent is catered by municipality.

The study conducted under RUIDP estimated that at present Bhilwara produces approximately 125 TPD. Waste is collected manually from streets by the municipality. Waste is collected on daily basis.

No SWM system is there, only waste is collected and dumped on trenching site that is 15km far from the city near Sanganer that is approx. 28ha.

5.15 TRANSPORTATION

The city is connected by National Highway No. 79 through Jaipur, Ajmer and Udaipur, which makes the major cities accessible. The four lane highway is part of golden quadrilateral highway project of India and connects Bhilwara with major cities. In inner parts of city road width will vary between 20-30 feet and in outer area's it varies between 40-60 feet. It's also well connected by broad gauge railway line with delhi-ahmdabad.

For local traveling people use only their own private vehicles that is two/four wheelers. In addition to traveling they use private auto that are running on one major road that is only a public transport. For small distances people prefere to use cycle- rickshaw.

Presently 460 ha. land used for transportation purposes which is 17% of the total developed area of the Bhilwara city.

Solid Waste Management in Bhilwara

CHAPTER 6

6.0 SOLID WASTE MANAGEMENT IN BHILWARA

Waste in solid or semi-solid state excluding human excreta is called solid waste. Waste can be classified in various groups based on its source of generation. Quantity and characteristics of waste vary from waste to waste, place to place and season to season. Approach & methodology adopted for collection, transportation, process and disposal are different for different type of waste. Classification of waste is the first step towards overall planning of Solid waste management system. It helps in selecting appropriate and scientific methods for different activities related to solid waste management.

Bhilwara municipality area is spread over 31,096 ha, however its limit is likely to increase in the near future. Bhilwara municipal area divided into 8 zones and further divided into 50 wards for Solid Waste Management. 30 wards out of 50 are given on contract for SWM by the municipality.

Old City (ward no. 20, 21, 24 & 28) of Bhilwara consists of densely populated residential and commercial area. Some of the areas in old city are in physically bad condition and their sanitation is very poor. The streets and by lanes are very narrow, which prohibit the entry of medium and large size vehicles. There is open drainage system along the road. Due to lack of proper collection system solid waste is usually thrown in the open drain, which chokes the drain very often.

Aajad Nagar & Labour Colony (ward no. 12, 19, 34 & 35) are the extension of the city, originally planned for migrants affected by 1971 increase in industrial & commercial activities. These colonies have grown close to Nagar Parisad and railway station. In this area slums has also grown up along the railway line. Labour colony and Harijan Basti is densely populated area with lower income group. It has also grown along the nallah mostly on govt. land.

Shastri Nagar, R.C Vyas colony (ward no. 1, 10, 11, 12, 13, 18, 25 & 26) and its extension are comparatively new development and are properly planned. It is occupied by high-income group society. The basic facilities such as water supply and sanitation are good in this area.

Table 6.1- Zones for SWM in Bhilwara City

Zone	Ward No.
Zone-1	27, 37, 38, 39, 40 & 41
Zone-2	15, 16, 17, 31, 32 & 33
Zone-3	48, 50, 7, 1 & 2
Zone-4	5, 6, 8, 10, 11, 12, 13 & 14
Zone-5	26, 43, 44, 46 & 47
Zone-6	1, 23, 24, 25 & 45
Zone-7	18, 19, 20, 22 & 32
Zone-8	21, 28, 34, 35 & 36

6.1 CLASSIFICATION OF SOLID WASTE

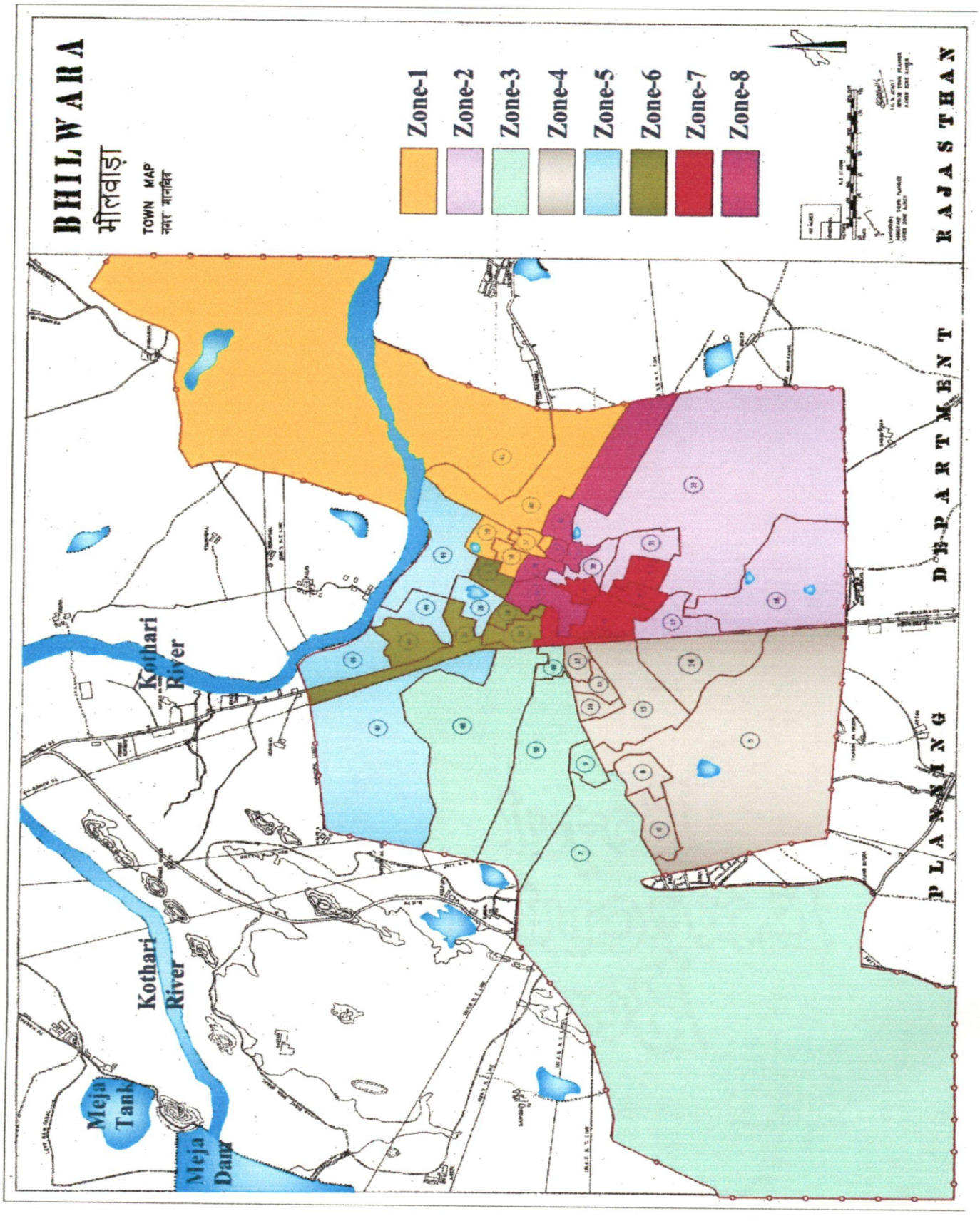
Based on the source of generation, solid waste can be categorized in four groups as mentioned below:

- Municipal Solid Waste (MSW).
- Industrial Solid Waste (ISW),
- Bio-medical Waste (BMW),

6.1.1 Municipal Solid Waste (MSW)

Municipal Solid Waste comprises wastes from residential and commercial sources. It does not include wide variety of other non-hazardous wastes such as municipal sludge, construction and demolition waste, combustion ash from power plant and industrial process wastes. Bio-medical waste, Industrial waste and Slaughterhouse waste are also excluded from MSW.

Fig. 6.1: Zone Map for SWM in Bhilwara Municipal area



Bhilwara municipality area is spread over 31,096 ha, however its limit is likely to increase in near future. This area has been divided into 8 zones and further divided into 50 wards for solid waste management point of view. The nature and extent of waste vary for different sources.

Residential Zone:

This zone includes purely residential areas, wherein no commercial or industrial activity is expected. The total residential area is approximately 42.1% of municipal area. The MSW from such area includes food waste, house and street pings, rubbish and garden trimmings etc. Based on population density the area has been further categorized in three groups as mentioned below:

High population density area	>500 person per hectare
Medium population density area	200-500 persons per hectare
Low population density area	<200 persons per hectare

Commercial Zone:

This zone includes markets, shops, offices, institutions, hotels, household industries etc. Total commercial area is approximately 7.2% of municipal area. MSW from this zone includes, packaging material, food waste and rubbish etc. excluding discarded solid waste from different industrial processes.

6.1.2 Industrial Solid Waste (ISW)

It includes waste generated from industrial and manufacturing processes. It also contains large number of chemicals, some of which are toxic. There are 1590 textile industries within Bhilwara municipality. Maximum textile industries located along Udaipur road.

In the outgrowth of the city of Bhilwara, there exists one industrial estate, viz. Bhilwara Municipal Council is not responsible for collection or disposal of industrial waste.

Table 6.2- Details of Registered Industrial Units with the District Industry Centre (DIC)

S. No.	Type of Industry	No. of Units	Labour Force
1	Agricultural Based	1059	2917
2	Forest Based	727	5183
3	Livestock Based	834	2842
4	Minerals Based	595	3959
5	engineering Based	136	1901
6	Cloth Based	1590	4396
7	Chemical Based	235	985
8	Transport Based	12	51
9	Others	295	688
	Total	**5523**	**22922**

Source: Bhilwara Master Plan

Table 6.3- Categorization of Industries

S. No.	Category of Industry	No.	Labour
1	Cottage Industries	1,532	4,287
2	Small Industries	3,210	7,210
3	Medium Industries	762	5,722
4	Large Industries	19	5,703
	Total	5,523	22,922

Source: Bhilwara Master Plan

6.1.3 Bio-medical Waste (BMW)

It comprises the waste from hospitals, medical institutions, nursing homes and other medical facilities. At present there are 42 Government / non government hospitals / nursing homes running in the city.

6.2 PRESENT STATUS OF MANAGEMENT

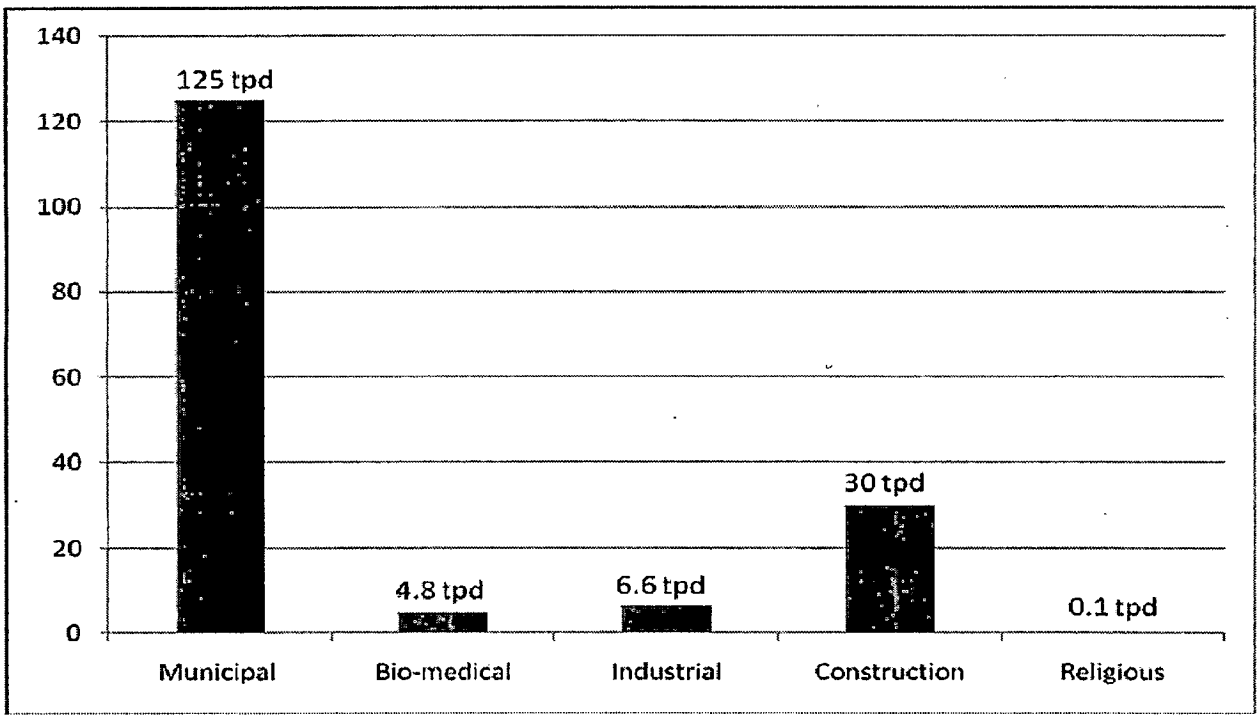
6.2.1 Generation of waste

The quantity of waste generated depends upon a number of factors such as, population & area of the city, food habits, standard of living, degree of commercial and industrial activities, climatic condition etc. A part of recyclable waste such as plastics, paper, glass, metals etc. is reclaimed by the rag pickers during different stages of collection, transportation and at disposal site. During monsoon due to high moisture content, the quantity increases, whereas quantity during winter and summer season is relatively less. Similarly during the festive season, the quantity of waste generated shows an increase.

The generation of the total solid waste of the city is divided into four components, which are:

- **Municipal waste:** The total quantity of municipal waste generated at present is 125 tonnes per day.
- **Bio-medical waste:** The quantity of waste generated from hospitals is about 2-4 Kg/per bed/day. Since the no. offends in various health care establishments are approximately 2400 beds so the total generation of bio medical waste is 4.8 tonnes per day. Total bio-medical waste are collected by the govt. approved company, Sales Promoters Bhopal.
- **Industrial waste:** The total waste generation from the small scale industrial units located in the city is 6.66 tonnes per day.
- **Construction & demolition waste:** The total waste generation from construction & demolition is 20-30 tonnes per day.
- **Wastes from religious activities:** The total waste generation from the religious activities is about 0.1 tonnes per day on normal days. This generation would be more on the festival days.

Fig. 6.2- Total Waste Generation in Bhilwara



Thus we see that in the total generation of waste the municipal waste is predominate but the significance of the effect of other kinds of waste cannot be neglected, which may be infectious and hazardous in nature.

6.2.2 Characteristics of Waste

Knowledge of physical as well as chemical characteristics of waste is very important for effective .and economical planning of collection, transportation, treatment and disposal of Solid Waste. The frequency of removal of the waste and other problems associated with collection & transportation of solid waste can be sorted out by knowing physical & chemical characteristics of waste. Waste characterization also helps in designing & selection of appropriate technology.

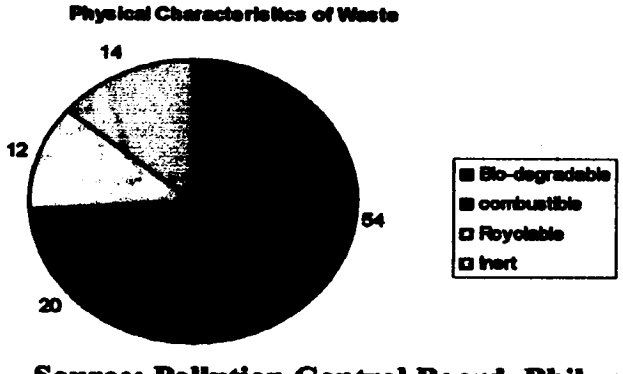
Table 6.4- Physical Characteristics of Solid Waste

S. NO.	Types	Description
1.	Food waste	The animal, fruit or vegetable residue Garbage) resulting from handling, preparation, cooking and eating of foods.
	Rubbish	Combustible and non-combustible solid waste excluding food waste.
2.	Combustible:	Paper, cardboard, plastics, textile, rubber, leather, wood furniture and garden trimmings.
	Non-combustible:	Glass, crockery, tin cans, aluminum cans, ferrous and non-ferrous materials, dirt and construction wastes.
3.	Street waste	Waste such as street sweeping, roadside litter, catch basin debris.

Source: CPCB Manual on Solid Waste, 2001

Solid waste of Bhilwara contains:
54% biodegradable,
14% recyclable and remaining
32% inert material on dry weight basis with 45% moisture content.

Fig. 6.3- Waste Characteristics in Bhilwara



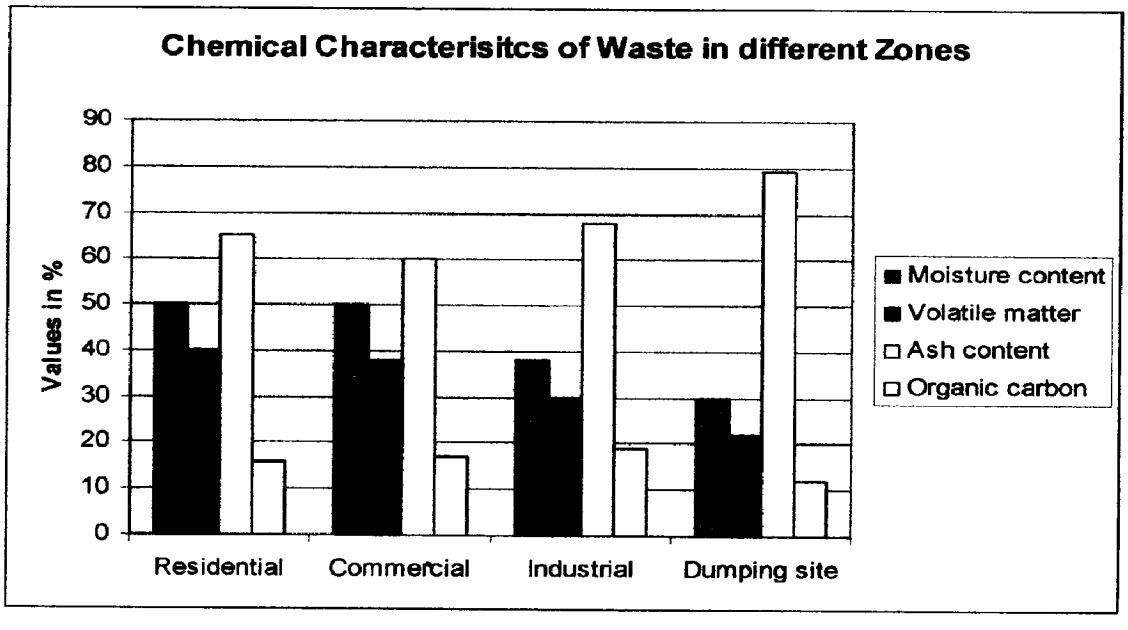
Source: Pollution Control Board, Bhilwara

Table 6.5- Physical characteristics of different kinds of waste

Characteristics	Types of waste
Biodegradable	Food waste, Grass / leaves, Rags, Paper.
Combustible	Paper/cardboard ,Wood Rubber/ leather, Plastic
Recyclable	Paper, Metal, Rubber/ leather, Plastic, Glass
Inert	Fine earth, Glass/ ceramics, Stone/ brick bats.

Source: CPCB Manual on Solid Waste

Fig. 6.4-



Source: MSW Cell, Pollution Control Board, Bhilwara

Chemical analysis done by the RPCB, shows 36% volatile matter, 19% Organic carbon. N, P, K values are 4.21%,0.8%,2.4% respectively. It has an average calorific value of about 1756 k cal/kg.

6.2.3a Storage of waste

The storage of all kinds of waste at the source of its generation is neglected. Presently there are no proper facilities for primary storage of waste at its source of generation. There is no proper segregation of waste at the source of generation. Most of the households, establishments, shops

and others do not have proper storage bins to store their waste. The composite wastes are stored in plastic/paper bags or in bins, which are maintained poorly. Sometimes waste collected in plastic/paper bags is thrown in community bins located nearby or on streets, footpaths, open spaces, drains and other water bodies. This creates nuisance, choking of drains and obstruction to traffic.

Fig. 6.5: Storage of Waste

Bhilwara Municipality has provided community bins, mainly Green bins/Refuse collector bins in some areas for secondary storage of waste, but these bins are not adequate.

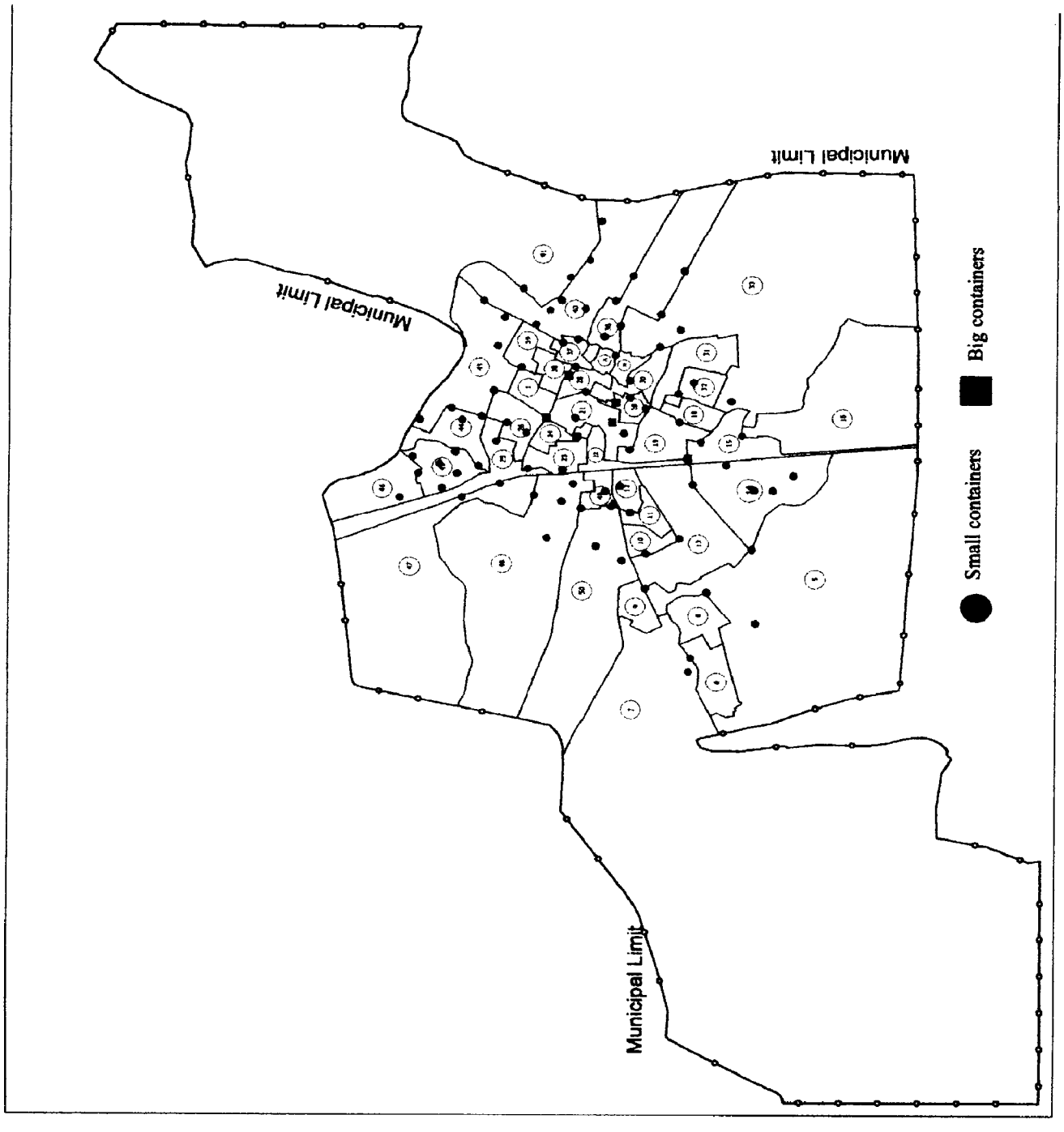
6.2.3b Collection of waste

Presently community bin system for collection of municipal solid waste is being adopted in Bhilwara. The waste generated at individual premises is removed initially by the owner or his employee. The waste is either, deposited in a community bin or at an open place from where it is put into the community bin by Safai-karamchari. Due to shortage of community bins, there are a number of places throughout the city where people deposit solid waste on open ground. Safai-Karmacharis also dump the waste collected from sweepings at such places. Municipal solid waste lying in open areas/ community bins is not collected regularly.

Fig. 6.6: Street Sweeping

Presently road sweeping is done manually in most of the areas. Safai-Karamchari (SK) sweeps the road using long handled broom and collects the waste in heap at suitable locations on the roadside. The waste thus collected is transferred to a wheel- barrow with the help of spade and then token to the nearest community bin or a collection point for further transportation to the disposal site. There are-no defined working norms for SKs. The road length to be swept varies from place to place. Sks clean the drain area allotted to them by pushing the waste forward. Again the same process is repeated by the sweeper in next zone. Due to this there is deposition of huge quality of waste at the outlet of Nallah.

Fig. 6.7: Map showing locations of collection bins and points in Bhilwara



6.2.3c Road Sweeping

At present only about 80% of the area under Bhilwara Municipality is attended regularly for road/street sweeping and collection of MSW, leaving unattended the remaining 20% area on the outskirts. Heaps of stinking waste can be seen at a number of places in such area, which is removed by the Municipality staff arbitrarily as and when the situation deteriorates. Other than a few exceptions the road cleaning/sweeping work was nowhere found satisfactory throughout the jurisdiction of Municipality of Bhilwara owing to various reasons such as insufficiency of cleaning staff, lack of community bins etc.

Presently there are total 1200 Safai Karamcharis employed in street sweeping in the city.

No. of Safai-Karamcharis	Status
514	Permanent
718	Contract basis

6.2.4 Transportation of Solid Waste

Municipal solid waste collected in the community bins and at other places is presently transported to the dumping site using a variety of vehicles. Different types of vehicles make a number of trips everyday to the disposal site on routes, which are unspecified. In spite of the instructions issued to the driver of transport vehicle to collect the waste from specific collection points, there is no proper schedule and record. There is no provision of Intermediate transfer station. Transport vehicles which collect waste from individual community bins take it to the disposal sites. The cost of transportation is more than 50 % of total expenditure incurred in solid waste management.

Table 6.6- Vehicles used for waste transportation

S.NO.	TYPE OF VEHICLE	NO. OF VECHICLES	VOLUME	AVG. QTY. OF WASTE/VEH./TRIP	TOTAL QTY. CARRIED
			Cum.	Tonnes	Tonnes/Day
1	Loader	3	6.8		
2	Dumper	5	2.8	3.5	88
3	Placer	1			
4	Tractors	3	3	1.8	12
5	JCBs	1			
6	Wheeler barrows	98			
	Total				**100**

Source: Bhilwara Municipality

Fig. 6.8: Existing system for waste transportation

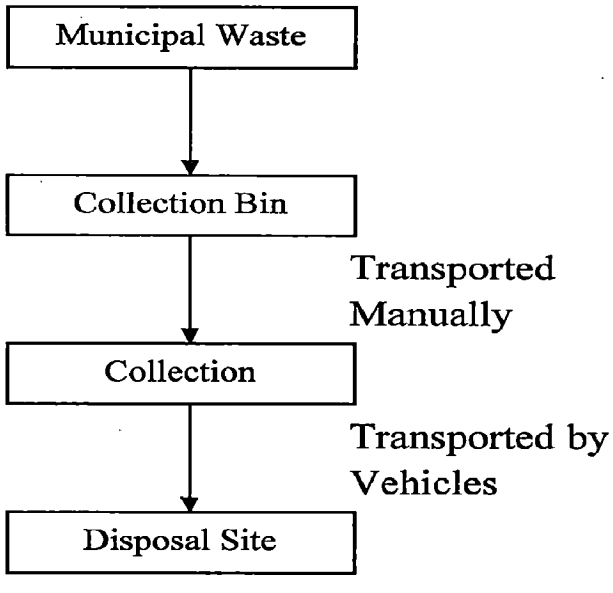
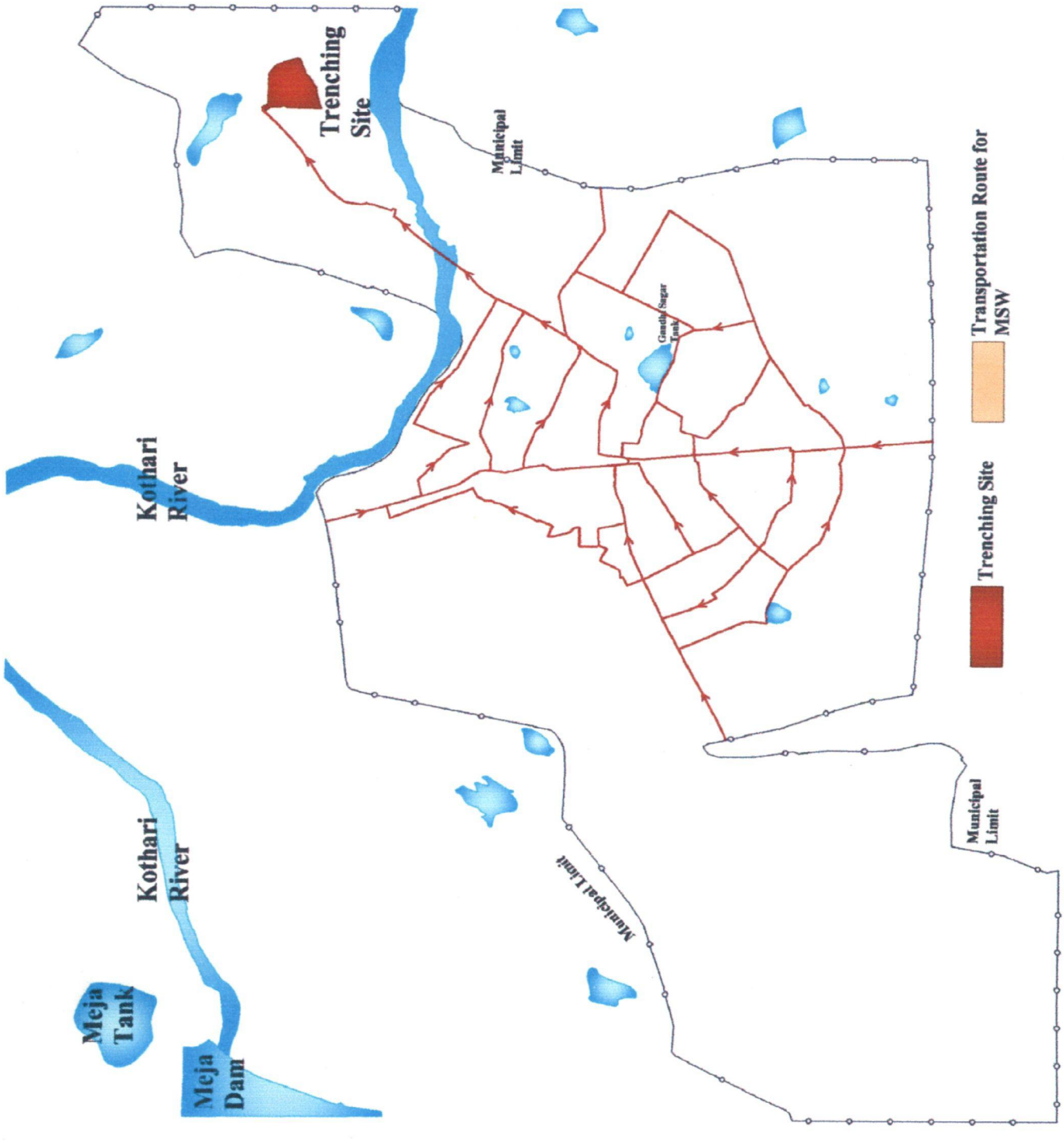


Fig. 6.9: Map Showing the Location of Disposal Site & Route used for Solid Waste transportation



During field surveys following shortcomings in the transportation system have been observed.

- Insufficiency of transportation vehicles.
- Maintenance of transportation vehicles/machinery is not preventive, which has increased the off road time of vehicles.
- Lack of planning and supervision.
- Due to shortage of vehicle divers, Safai Karamcharis have been deployed as drivers, which reduce the efficiency of the system.

Disposal of Waste

The method of disposal of waste in Bhilwara is of open dumping in a defined site that is situated 12km far from the city, where all the collected waste of the city is transported. The location of the dumping site is also objectionable as is close to the Kothari River, which may prove to be hazardous and lead to environmental degradation.

6:3 INSTITUTIONAL ARRANGEMENT

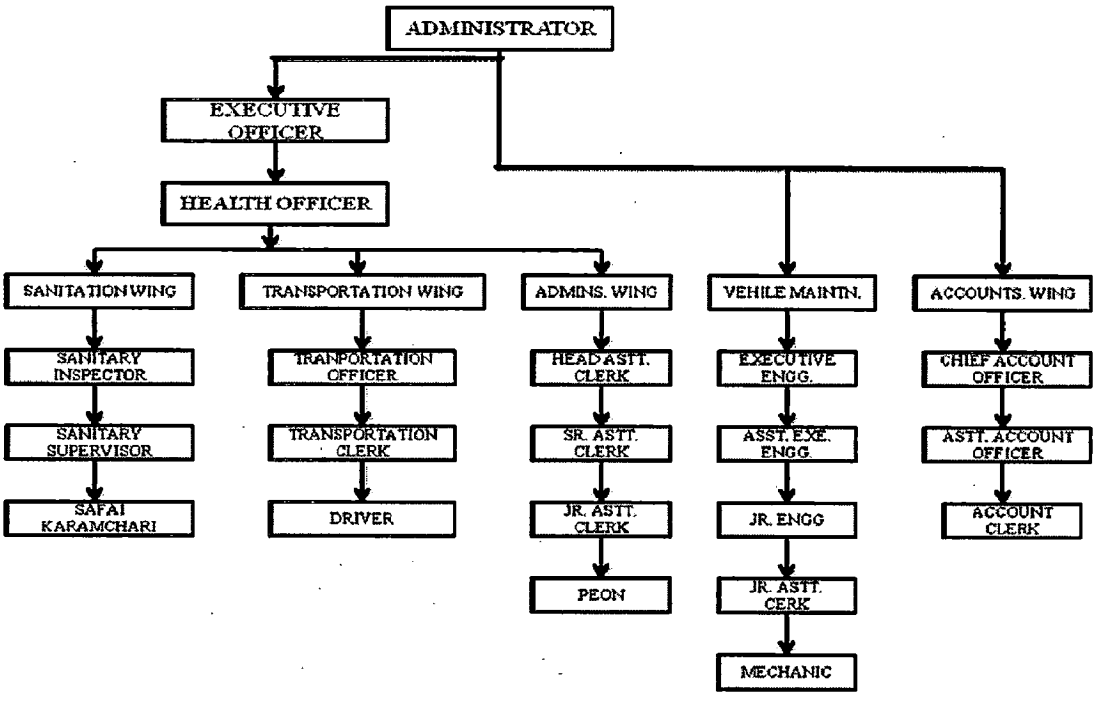
The overall management of Municipal Solid Waste (MSW) in Bhilwara is carried out by the Bhilwara municipality, headed by Administrator. The whole organization can be divided in five categories namely: **Sanitation, transportation, vehicle maintenance, administration and accounts wing.** Sanitation, transportation and related administration are executed under the overall supervision of Executive Officer. Health officer co-ordinates the work of garbage collection and transportation through Sanitation officer, Compost transport officer and other supporting staffs such as Food Inspector, Sanitary Inspectors, Sanitary Supervisors, Safai Karmachari etc. The health officer is also assigned other works related to public health problems like epidemics, birth and death registration, drain and sewer cleaning, night soil disposal, disposal of demolition debris from public premises and roads etc. Due to these additional responsibilities they are not able to devote full time towards solid waste management.

Bhilwara Municipality has been divided into 8 zones and further divided into fifty wards from solid waste management point of view. Sanitary Inspector / food Inspector is incharge of one zone. In the existing organizational set-up there are 7 Sanitary Inspectors. Sanitary Inspector is in-charge of 4-5 sanitary supervisors. Presently there are 34 sanitary supervisors and 1200 Safai Karamcharis deployed for collection of waste. Safai Karamcharis are also deployed on temporary/consolidated salary basis in addition to regular Safai Karamcharis from time to time as per requirement. The work of road cleaning, collection and transportation of waste to community bins is carried out by Safai Karamcharis.

Presently the overall management of Solid waste in Bhilwara is labour intensive. Their productivity is not utilized to full potential due to lack of planning. Large amount of expenditure is spent on labour. In the passage of time the quantity of waste will increase, which will need more manpower to cope up with the problem.

It can therefore be stated that the solid waste management organization of Bhilwara represents a system, devoid of accountability, multiplicity of functions and large work force with strong union and oblivious of the social responsibility associated with a public service.

Fig. 6.10: Existing setup of Municipality for solid waste management



Source: Municipal Council, Bhilwara

6.4 Primary Survey of Study Area

6.4.1 Questionnaire:

1. How many persons live in your home?
A. 1-3 persons B. 3-6 persons
C. 6-9 persons D. more than 9 persons

2. What is the estimated amount of waste produced by your home daily?
A. 0-500gm B. 500gm-1kg
C. 1-1.5kg D. 1.5-2kg
E. more than 2kg

3. Waste generated by your home consists of
A. Papers: (0-25%) (25-50%) (50-75%) (75-100%)
B. Disposables: (0-25%) (25-50%) (50-75%) (75-100%)
C. Food Items: (0-25%) (25-50%) (50-75%) (75-100%)
D. Garden waste: (0-25%) (25-50%) (50-75%) (75-100%)

4. Does anyone in your home buy beverages in aluminum cans?
- If yes, are these used cans separated for recycling?

5. Do you buy or receive the newspaper?
- If yes, is this newspaper saved for recycling or reuse?

6. Are pesticides used in your home for controlling roaches, ants, mice, or garden pests?

7. Are other materials besides cans, plastics, and paper collected in your home for recycling?

8. Do you have waste segregating bins at home?

9. Is there any waste collection mechanism provided by the Govt. or Private Business holders?

10. How do you dispose of items that are not collected by municipality?

A. Self dumping or B. By paying to other agencies

11. How often you find rag-pickers collecting recyclable materials in your neighborhood?

A. Daily B. Periodicly

12. In your opinion what is the best method to dispose of waste.

A. Door to door collection B. Community Bins

13. Will you be ready to pay some extra money to purchase recyclable products?

6.4.2 Survey Results:

Fig. 6.10: 70% of the respondents have 3 to 6 persons in their home.

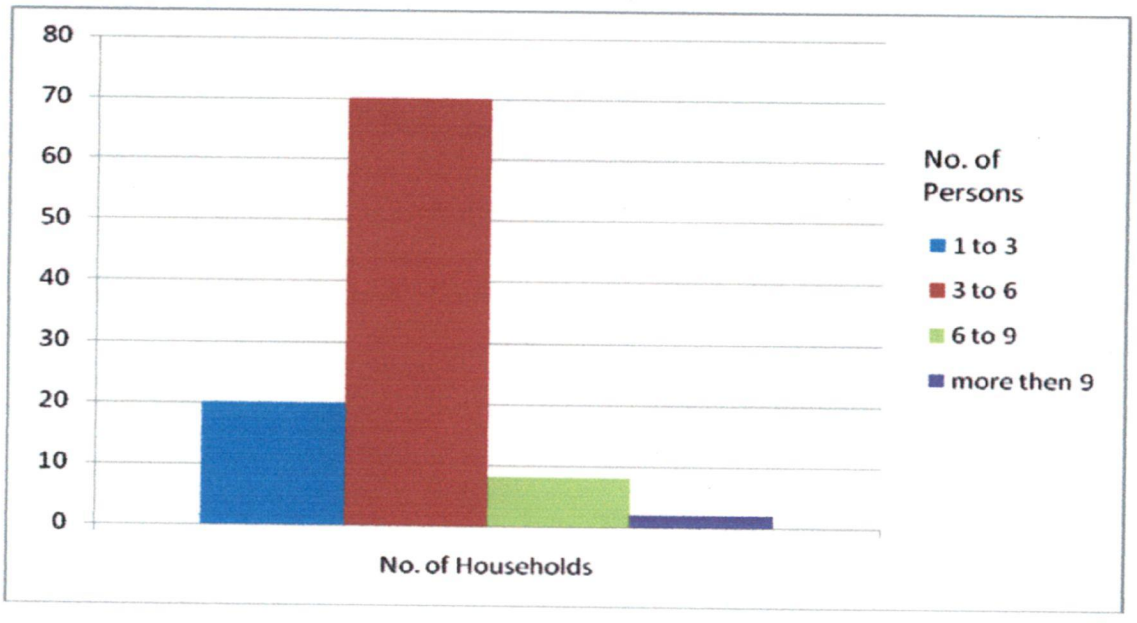


Fig. 6.11: 50% of the respondants generate 0-500gm of waste and 30% generate 500-1kg which are in high Income group whereas 4% generate 1.5-2kg and 6% generate more than 2kg which are self employed and have their business at home.

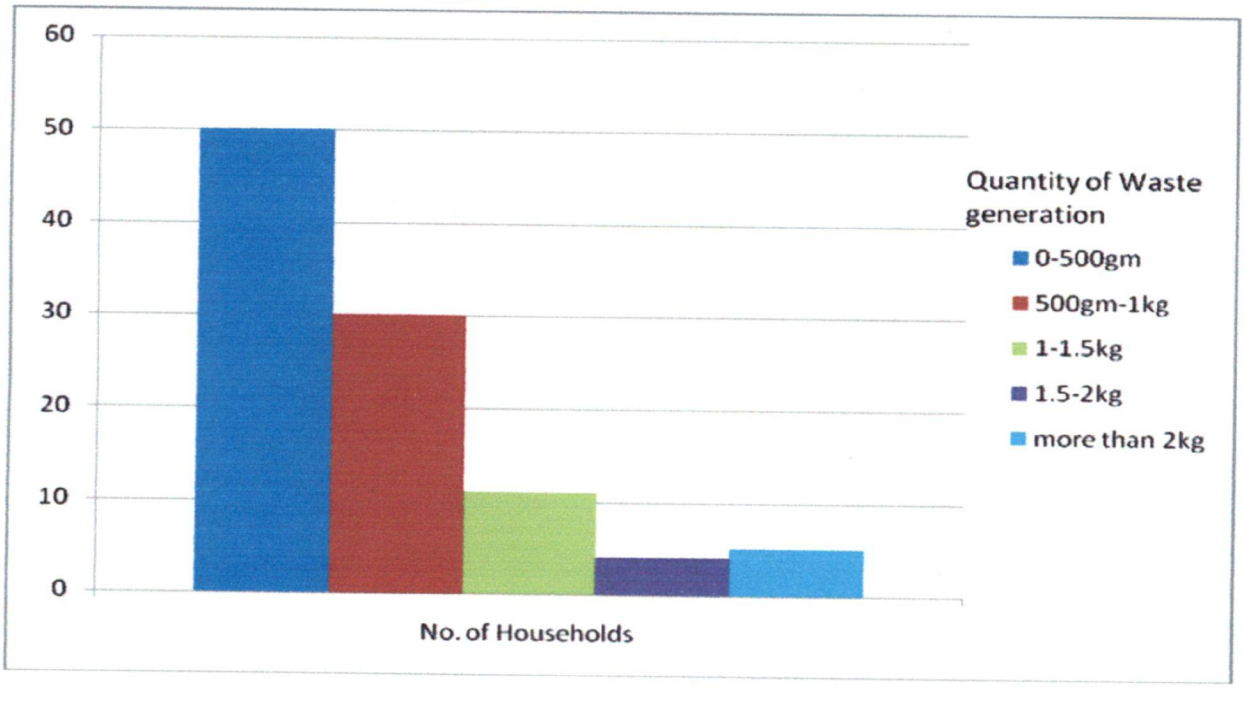


Fig. 6.12: The major component of household waste consists of food wastes then paper and disposable thereafter. Garden waste is not generated as the households do not have garden space.

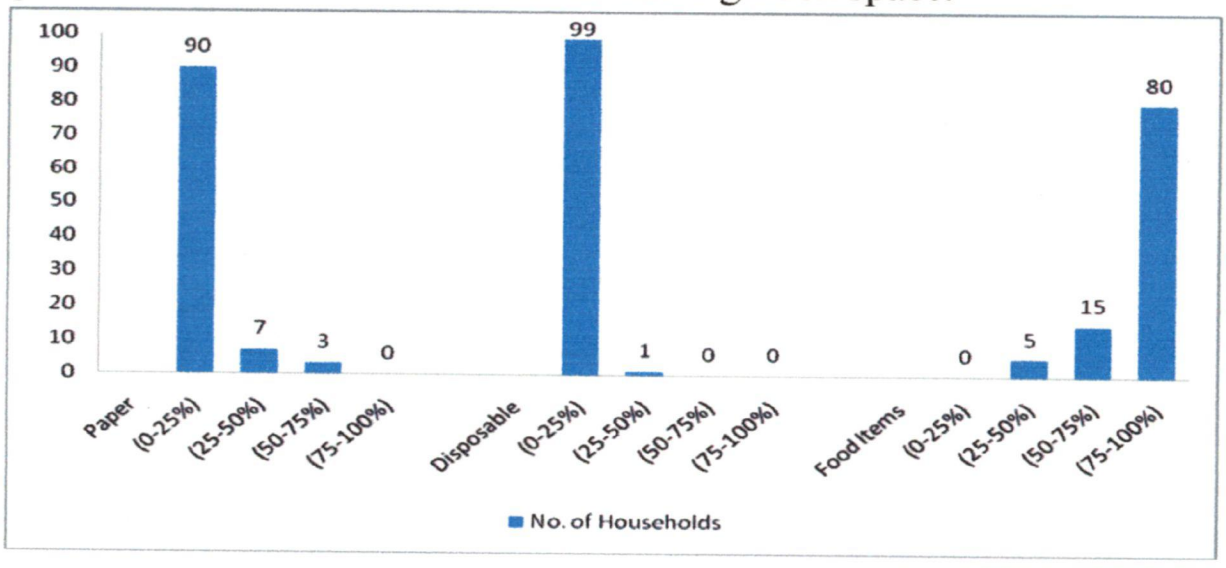


Fig. 6.13: 90% of the households store the cans and sell them for recycling where as 10% do not store them who generally belong to high income group.

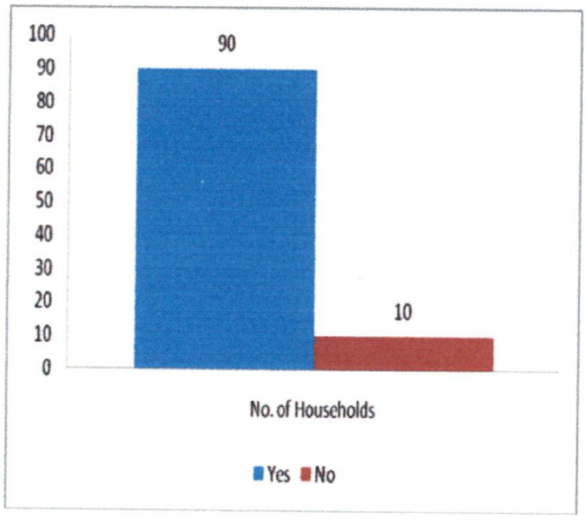


Fig. 6.14: All of them store the newspaper and sell them for recycling or resue.

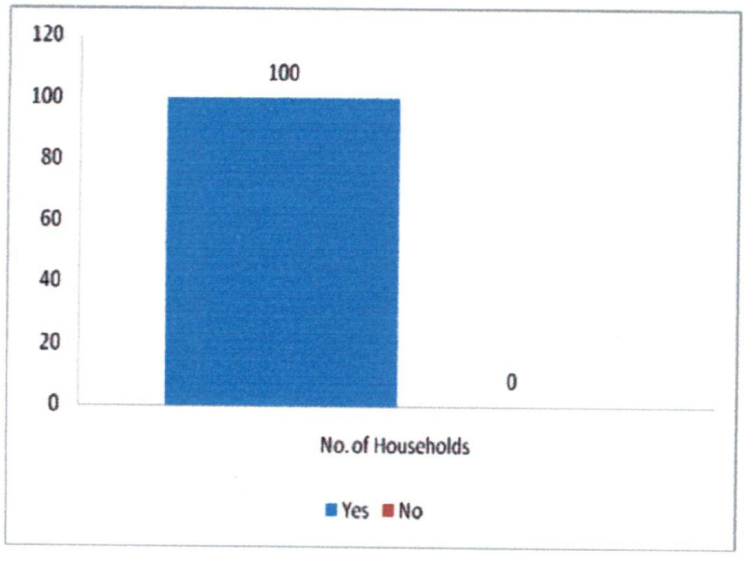


Fig. 6.15: 70% of the households use pesticides

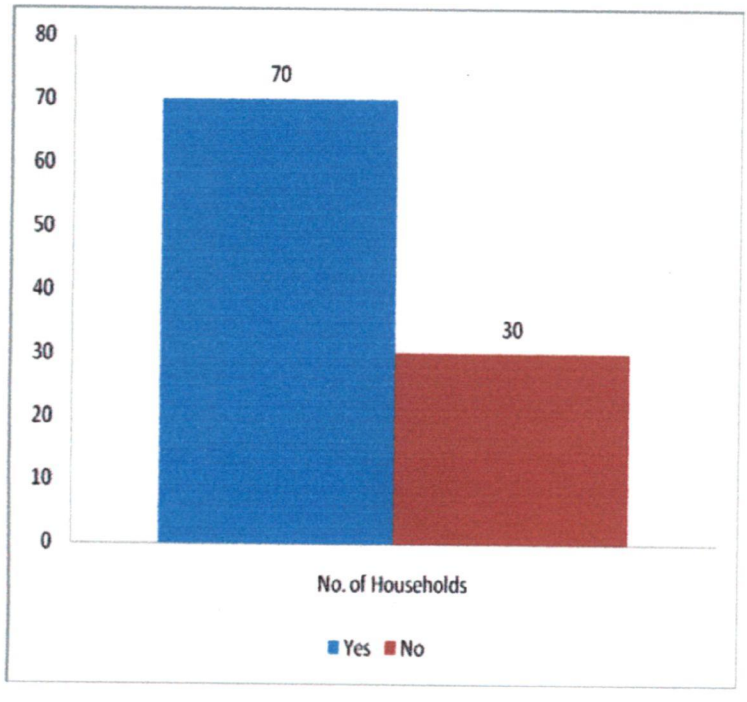


Fig. 6.16: Only 10% of the households generate other materials besides cans, plastics, and paper which include materials used in family businesses.

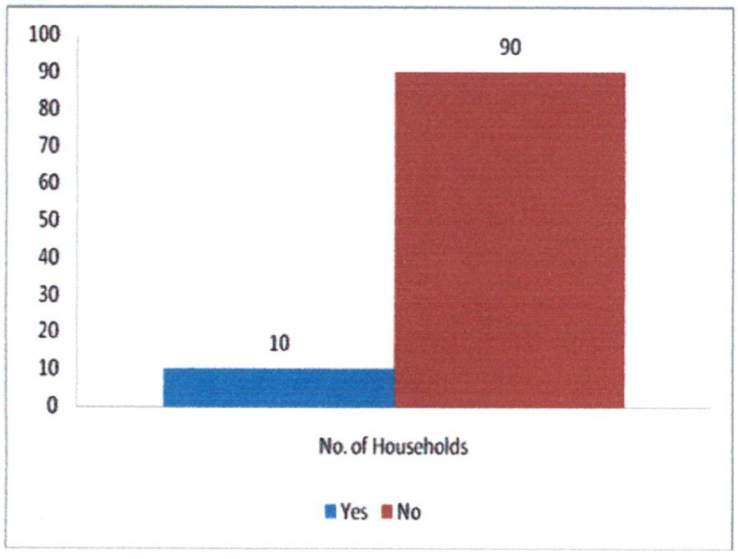


Fig. 6.16: Nobody have waste segregation bins at home.

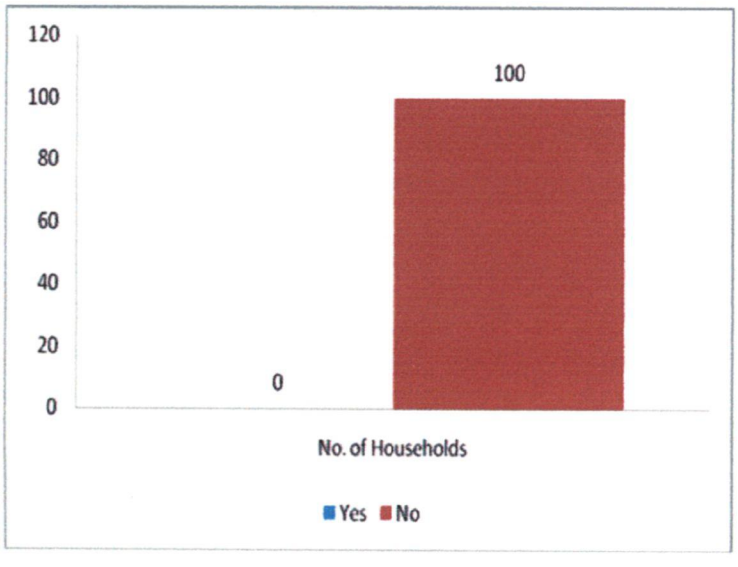


Fig. 6.17: No any waste collection mechanism provided by the Govt. or Private Business holders.

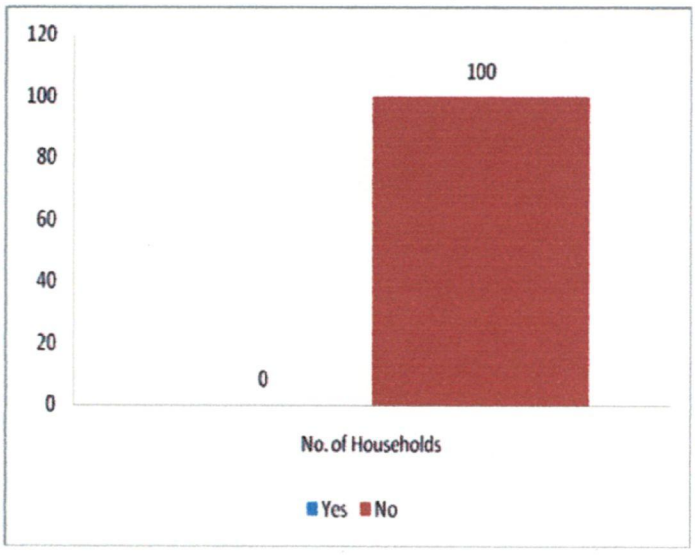


Fig. 6.18: 92% of the households dispose off items that are not collected by municipality by paying to other agencies.

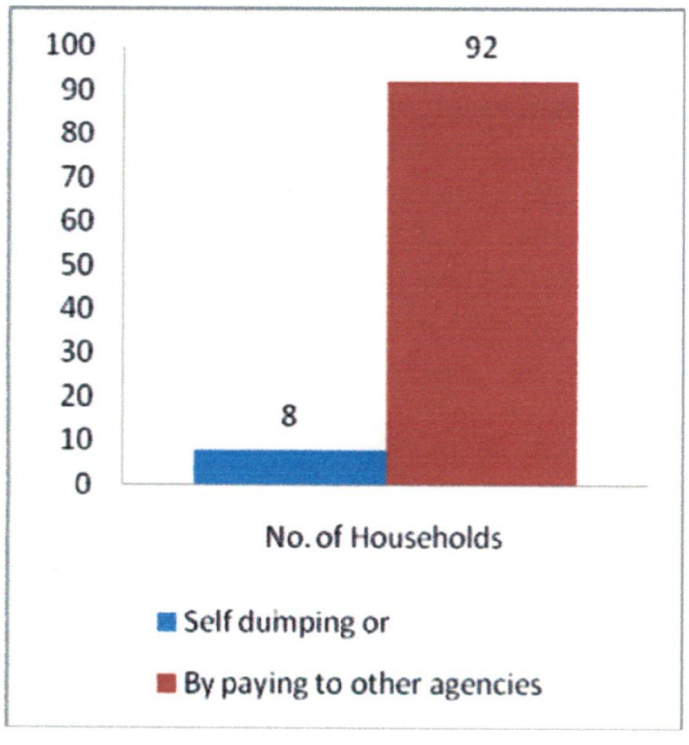


Fig. 6.19: Only 10% respondents find rag-pickers daily.

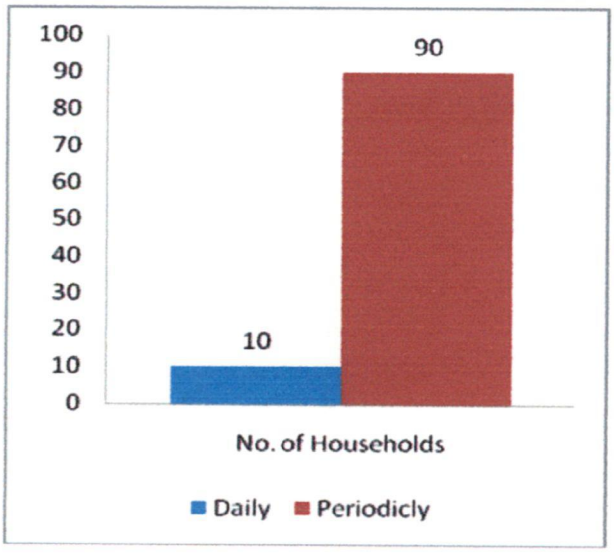


Fig. 6.20: Only 35% respondents are willing to use community bins.

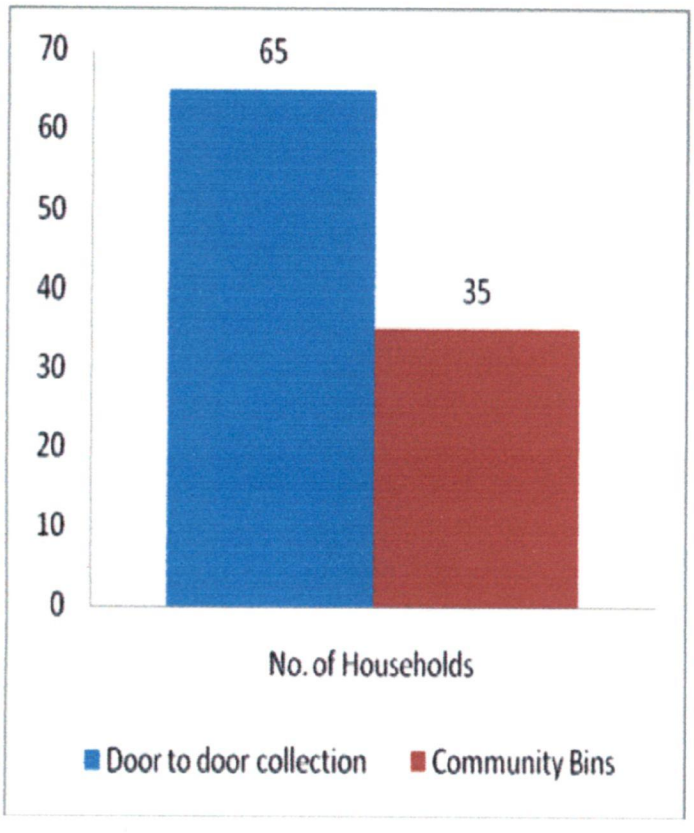
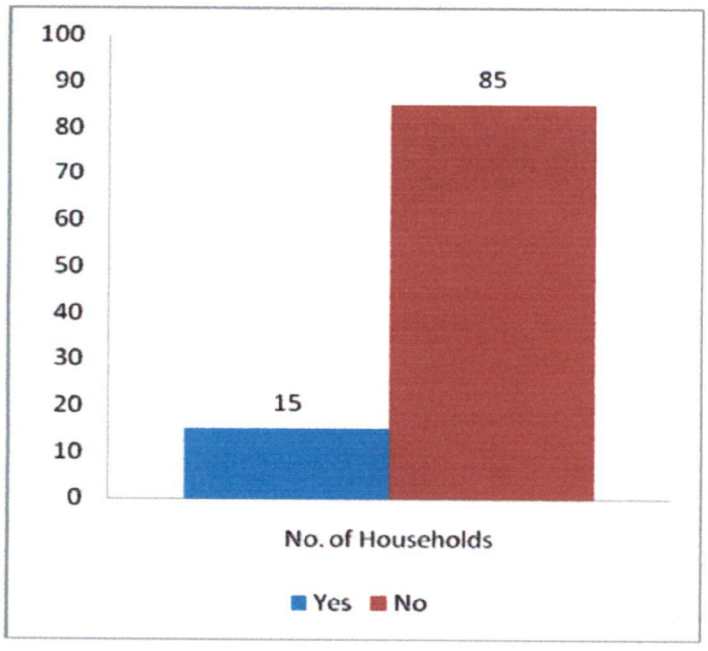


Fig. 6.21: 85% of the respondants are not willing to pay extra money for purchasing recyclable products as they are not affordable for them.



6.5 Conclusion

- The avrage family size is 3-6 persons.
- The major component of the generated waste is food waste.
- Majority of households generate 0-1kg of waste.
- People do not dipose off the recyclable materials they store it and then sell it to rag pickers.
- Composition wise the major components are the organic waste.
- Community level services such as community bins, door to door collection for waste collection are not prcticed at house to house level.
- No separate provision for collection and disposing of hazardious wastes like batteries, flourescent bulbs and pesticides etc.
- Rag pickers are playing major role in waste collection.
- Public awareness is needed about waste segregation, recycling, reusing etc.
- Public Private Partnership should be encouraged to evolve a new efficient system for waste management.

Identification of Critical Areas and Issues

CHAPTER 7

7.0 IDENTIFICATION OF CRITICAL AREAS & ISSUES

7.1 FUNCTIONAL AND MANAGEMENT ASPECT

- No **segregation** of waste at source of generation. Infectious and hazardous waste are also getting mixed with the municipal waste.
- **Negligence towards primary storage** of waste at the source of generation. Unavailability of suitable storage/community bins at desired locations.
- **Irrational distribution** of storage/community bins in various wards.
- **Poor maintenance** of collection points and community bins thus creating unhygienic conditions around the bins.
- **Irregular frequency** of road sweeping and collection.
- Multiple handling of waste.
- Primary and secondary **collection of waste is not properly synchronizing** with the lifting of garbage.
- Only about **70%** of the total area under Bhilwara Municipality is attended **regularly for sweeping & collection.**
- About 80-90% of **the total waste** generated is collected properly for final disposal at defined disposal site.
- Waste transportation is mainly by truck, tipper and refuse collectors.
- Manual loading is being practiced at maximum places.
- Existing number of transportation **vehicle is inadequate.**
- Vehicle routes are **not planned** properly.
- Manpower, equipment and resources are **inadequate.**
- There is **no scientific treatment** or processing of waste done before it is dumped on the site.
- The location of the **dumping site is improper** as it is close to the Kothari River.

7.2 SHORTCOMING IN INSTITUTIONAL ARRANGEMENT

Following shortcomings have been observed in the organization of the authority responsible for solid waste management.

- The health officer, who is overall in charge for solid waste management, is also assigned other works related to public health problems. Due to these additional responsibilities he is not able to devote full time towards waste management.
- Manpower deployment for sweeping & collection of waste in different wards is not rational.
- The work- of Solid waste management is assigned to personnel who are not professionally qualified in this field.
- Verbal communication and overlapping of duties have caused lack of accountability, which in combination with ill practices have made the system ineffective.
- There is no co-relation between manpower deployment and quantity of waste generation, population served or area of the circle. Irrational distribution of sweeping and collection staff in various wards is also evident.
- Staff is not well aware of the current technological developments in the fields of solid waste management, which puts limitations on planning and executing the work in a scientific way.
- Safai Koramcharis are promoted without proper qualification and training.
- Solid waste management services/facilities is provided on the basis of importance of the locality and has no relation with the quantum of waste generation or population served.
- Public complaints are not recorded on a register, which can be a good reflection of the level of services provided. In general the documentation with regard to staff deployment, collection, disposal and. public redressal is poor, which would otherwise be a good tool for management.

- Lack of regular monitoring and supervision for work completed.
- Lack of overall planning, co-ordination and supervision of work.
- Lack of training for key personnel.
- Lack of public participation/proper reporting facilities.
- Lack of legal punishment for offenders.
- Lack of public awareness.

7.3 CRITICAL ZONES IN THE CITY OF BHILWAR

Four critical zones have been identified in Bhilwara in regard to the problems pertaining to the solid waste management.

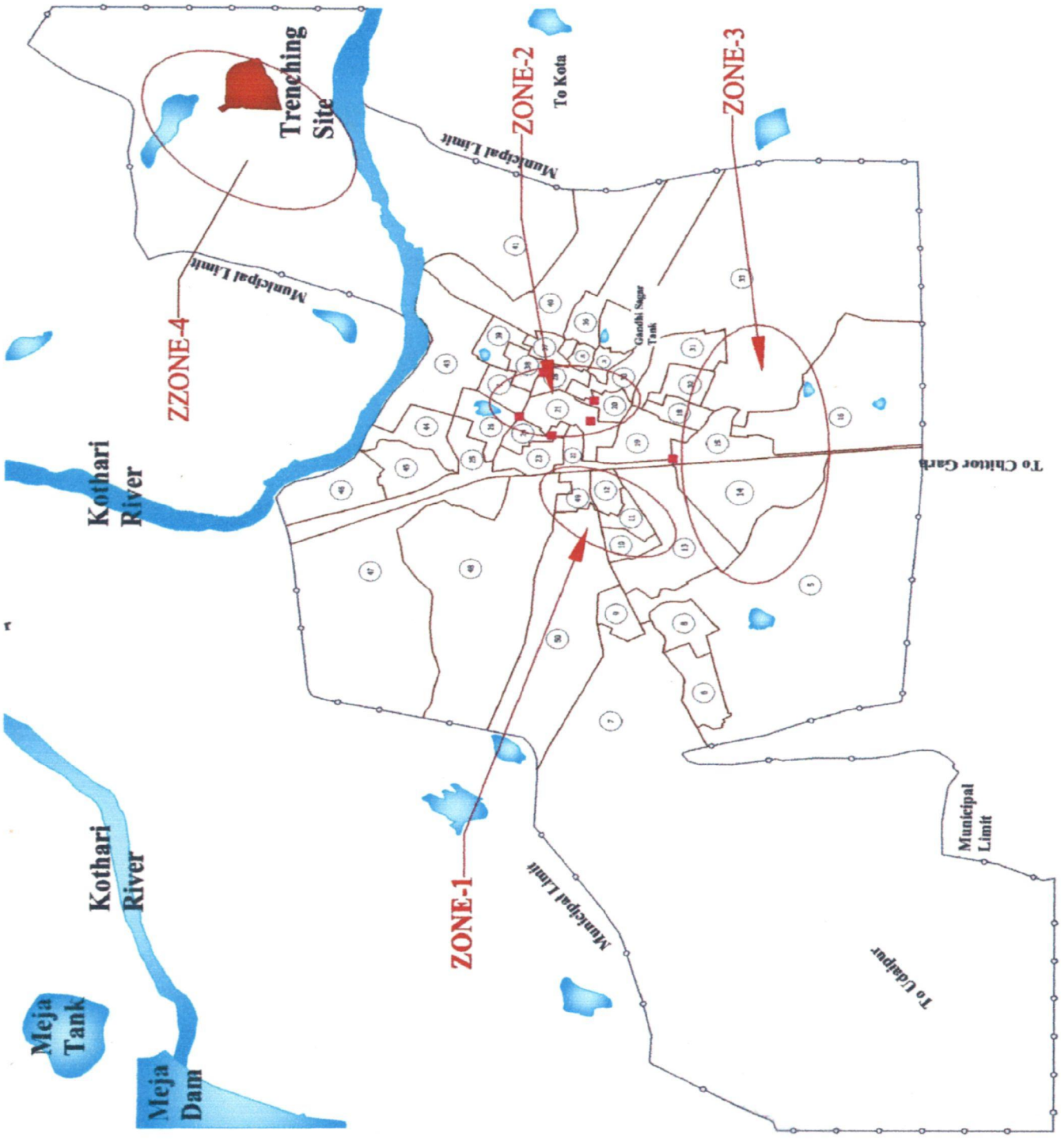
ZONE 1: There is irregular collection of waste in the wards here. The Number of collection points and the community bins are inadequate and not in proportion to the waste generated.

ZONE 2: This zone consists of high density residential areas and is the hub of trade and commerce. There is lot of generation of waste here throughout the day, even though the streets are not swept regularly so heaps of waste is always found littered on the roads.

ZONE 3: This zone consists of RIICO Industrial estate so there is possibility of Hazardous Industrial Waste being generated here. This zone may have a negative impact on the health of people apart from environment degradation due to contamination if stringent measures are not taken.

ZONE 4: This is a very critical zone as the dumping site lies here. The location of the site is improper due to proximity to the Kothari River. There is an adverse impact on river Kothari due to this.

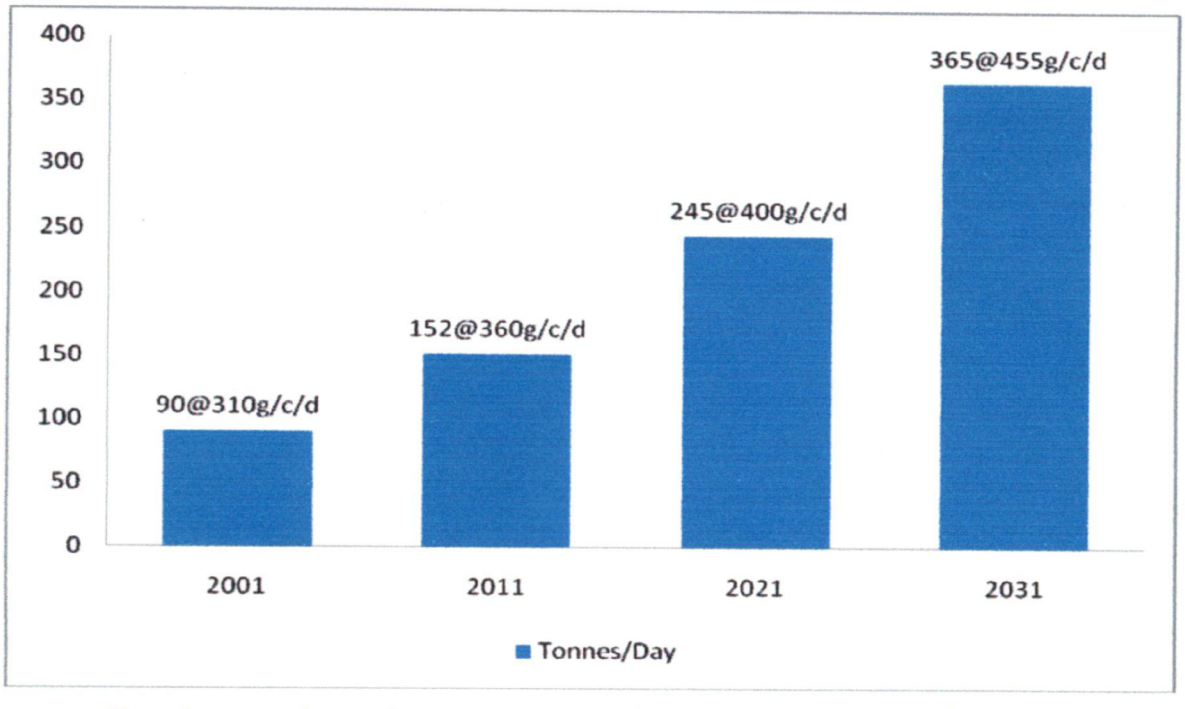
Fig. 7.1: Map Showing Critical Zone in Bhilwara City



7.4 FUTURE PROJECTION OF WASTE

The future projection of waste generation is necessary, for planning a processing disposal facilities as well as total solid waste management system. With increased commercialization and industrialization, per capita waste generation will also increase. Future generation of waste will depend upon growth of population as well as increase in per capita waste generation. Bhilwara City has vast scope for the future development of industries. Migration trend of population is increasing day by day. Urban population has increased up to 52% during the past decade. Based on the past population growth trends, future population has been projected. NEERI based on their studies has suggested an increase of 1.3% per annum in per capita waste generation for Indian cities, which has been adopted to calculate per capita generation for future in this case.

Fig. 7.2: Future Projection of Waste



Total quantity of waste generation at present is 125 tonnes per day @ 350gms/capita/day. With the present rate of growth, it would have a population of about 8 lacs and will generate about 365 tonnes of waste per day by the year 2031 @ 460gms/capita/day.

PROPOSALS AND RECOMMENDATIONS

CHAPTER 8

8.0 PROPOSALS AND RECOMMENDATIONS

Solid Waste is a heterogeneous mixture of various constituents. Uncontrolled decomposition of organic constituents of the waste results in various environmental problems. Certain constituents of the waste have a recycling potential and when recycled, besides reducing the pollution also yield some financial returns. It is thus able to offset, part of the large expenditure incurred on the collection, transportation, processing and disposal of the waste. Various processing technologies have been developed which decompose / stabilize the waste so that the load on disposal site is reduced and some returns also accrue. Some of these technologies are being used both in the developed as well as developing countries. However, the adoption of any processing technology is decided only after careful consideration of various aspects such as environmental impact, ease of Operation & Maintenance, land requirement, requirement of trained manpower, etc.

8.1 EVALUATION OF APPROPRIATE TECHNOLOGIES FOR PROCESSING OF WASTE

8.1.1 Composting

Composting is the process of waste disposal which our predominantly agricultural country must follow. It can be done by aerobic and anaerobic processes. The aerobic process is a biological oxidation process where the organic portion of the waste is decomposed and a material useful to agriculture having nutrient values is produced. This process can be completed in 45 to 50 days. An aerobic process of composting is very slow. It takes about 180 days to make compost. It is therefore not desirable to go for anaerobic composting. Besides it does not kill pathogens.

The aerobic composting is suitable under Indian conditions. Indian waste generally contains 30% to 50% of organic wastes. It also has the required moisture content, C/N ratio etc. It is a low cost option and does not require high skills. It has a market potential and land requirement for disposal of waste gets reduced. The process is quite rugged and simple to operate. Presently there are two good processes of composting in practice.

Microbial Composting

Aerobic microbial composting is a well known process and considerable experience is available in India. This process can handle the mixed waste in any form and quantity. Learning from the past experience, it is important to keep the level of mechanization and the production cost to the minimum and to produce a good quality of compost free from sharps, glasses etc. for the market.

Vermi Composting

In the vermiculture process, earth worms are used for converting the wastes into compost (vermi-castings). This process has been successfully used in a limited scale in Bangalore, Pune, Mumbai etc. but, there is no large scale centralized plant experiences in India. Hence this technology has a very good potential in the cities like Bhilwara where decentralized disposal is possible. Small quantities of waste can be composted with this process. This process is recommended for Bhilwara as one of the composting processes to tackle the problem of waste disposal.

8.1.2 Sanitary Landfilling

This is presently the commonest method of waste disposal. But it has associated problems of land and sub soil water contamination besides

availability of land is becoming scares from year to year for filling of waste.

Efforts have therefore to be made to minimize the wastes going to the land fill by resorting to composting of organic waste.

Landfilling shall be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. Land filling shall also be carried out for residues of waste processing facilities as well as pre-processing rejects from waste processing facilities. Lahdfilling of mixed waste has to be avoided, unless the same is found unsuitable for waste processing. Under unavoidable circumstances or till installation of alternate facilities, landfilling can be done following proper norms. This technology is recommended in the case of Bhilwara for the Industrial waste after suitable treatment is carried out for each of these wastes.

8.1.3 Incineration

This· is a thermal process for burning the waste at a very high temperature. Incineration requires high calorific value of the waste which could burn without any external fuels.

The Indian waste contains only 3 to 7% of paper plastic etc. when the waste reaches the disposal site. Its calorific value is found ranging from 800 to 1000 Kcal/Kg. which is very low. The system of incineration is therefore not suitable under the Indian conditions on account of low calorific value of waste as well as on account of the following constraints.

- High Capital cost.
- High Operation and Maintenance cost.
- The system requires high technical skill to man it.
- The system is not environmentally friendly.

- High ash and dust content

Incineration of biomedical waste is strongly recommended for the maintenance of health of the citizens. The use of the incinerator is crucial for the disposal of the pathological stream of bio-medical waste, which includes body parts etc. Other wastes are obliged to be disposed off through means using non-burn technologies. Thus the infectious waste that is generated in the health care establishments in Bhilwara has to be totally eliminated in order to reduce the impact of this highly infectious waste.

8.1.4 Fuel Pelletisation or Refuse Derived Fuel (RDF)

These processes are being advocated in some quarters and serious efforts are being made through research and development to generate power along with composting and also to reduce the time of the composting process. Efforts are also being made to produce fuel pellets from the waste. None of these processes are recommended at this juncture as an option for waste disposal as no such plants are installed or successfully working in India.

The merits of this technology are as follows:

- The process is quite simple and easy to operate.
- It does not require skilled staff for operation.
- It results in production of useful material which can be used either in industries or house-holds or even burnt in incinerator or pyrolysis plants. The capital cost of the plant is low.

But there are few demerits also which are given below:

- If the material has to be used as an industrial fuel, it requires modification in the design of the Burners and Boilers.
- The RDF is known to contain heavy metals and when burnt it may lead to air pollution problems.
- The operation of the plant poses aesthetic problems.

- The inorganic wastes are still to be disposed off and a land fill has also to be operated.

8.1.5 Biomethanation

Anaerobic digestion (also referred as biomethanation) is the process used for biological decomposition of organic wastes. The organic wastes are hydrolysed, liquified and gasified with the help of methanogenic bacteria. There is an appreciable saving in recurring costs in such processes because of the utilization of bio-gas.

The process results in the generation of Bio-gas which can either be directly used or converted to electricity. Use of the gas also helps reduce green house gas emissions. The digested residue can be used as compost. The land required for the plant is comparatively less. Power requirement is less. As the process is enclosed, environmental problems are less. But there are few demerits also such as the capital cost for setting up of the plant is comparatively higher and the operation of the plant requires trained personnel which makes the technology expensive in the long run.

8.1.6 Conclusions

The following technologies are recommended for processing of waste in Bhilwara after evaluating the various options available, on the basis of certain parameters like:

- Quantity of waste for treatment.
- Land Requirement for the process.
- Capital and recurring Costs of running the process.
- Operation and maintenance of the plant.
- Requirement of skilled personnel for the process.
- Impacts on environment.
- Output generated from the process.

Table 8.1 Appropriate Technological Options for Processing of Waste in Bhilwara

TECHNOLOGY	QUANTITY	LAND REQUIREMENT	OPERATION & MAINTENANCE	SKILLED PERSONS REQ.	ENVIRONMENT IMPECT	OUTPUT	RECOMND
MECHANICAL COMPOSTING AT CITY LVL.	60% OF TOTAL WASTE -150 TONNES/DAY	7.5 AERES FOR 150 T OF WASTE	BIO TECHNOLOGY APPROPRIATE FOR INDIAN CONDITIONS	HIGHLY SKILLED PERSONNEL NOT REQUIRED.	ENVIRONMENT FRIENDLY	SALE OF COMPOST TO AGRO BASED INDUSTRIES	1st Preference
VERMI COMPOSTING (AT N/H LVL.)	APPROX. 90 TONNES/DAY OF COMPOSTIBLE WASTE	300-500 AQ.M. OF AREA REQUIRED FOR EACH PIT.	SIMPLE & EASY TO OPERATE	HIGHLY SKILLED PERSONNEL NOT REQUIRED.	NO ADVERSE EFFECT ON ENVIRONMENT	COMPOST OF HIGH NUTRIENT VALUE WHICH CAN BE SOLD IN THE MARKET.	1st Preference
BIO METHANATION OR ANAROBIC DIGESTION	60% OF TOTAL WASTE 150 TONNES/DAY	LESS AREA REQUIRED	INDIGENEOUS TECHNOLOGY OPERATIONAL IN NAGPUR	HIGHLY SKILLED PERSONNEL REQUIRED.	LESS ENVIRONMENTAL PROBLEMS	COMPOST & BIO-GAS WHICH CAN PRODUCE ELECTRICITY	2nd Preference
SANITARY LANDFILLING	100 TONNES/DAY OF WASTE.	LARGE AREA REQUIRED	SIMPLE & EASY TO USE. MOSTLY PRACTISED IN INDIA.	HIGHLY SKILLED PERSONNEL NOT REQUIRED.	MAY HAVE ADVERSE EFFECTS IF NOT DONE PROPERLY	LAND CAN BE REUSED AFTER SATURATION.	1st Preference
INCINERATIN	80 TONNES/DAY OF WASTE.	LESS AREA REQUIRED, 2 ACRES FOR 80 T OF WASTE.	CAPACITY VERY UMITED. DEALING WITH SPECIFIC TYPE OF WASTE.	HIGHLY SKILLED PERSONNEL REQUIRED.	CAUSES ENVIRONMENTAL POLLUTION	POWER GENERATION	2nd Preference
PELLETISATION	80 TONNES/DAY OF WASTE.	LESS AREA REQUIRED	INNOVATIVE TECHNOLOGY.	HIGHLY SKILLED PERSONNEL NOT REQUIRED.	MAY CAUSE ENVIRONMENT POLLUTION	FUEL PELLETS WITH HIGH CALORIFIC VALUE	3rd Preference
RECYCLING	50 TONNES/DAY OF WASTE.	-	INDIGENEOUS TECHNOLOGY	HIGHLY SKILLED PERSONNEL NOT REQUIRED.	ENVIRONMENT FRIENDLY	RECYCLED PRODUCTS IN INDUSTRIES.	1st Preference

- At the city level, for treatment and disposal of waste the recommended technologies are as follows:
  - Mechanical Composting for organic waste.
  - Sanitary Landfilling for inorganic and inert wastes.
  - Incineration only for infectious bio medical waste.
  - Recycling for recyclable wastes such as metals, glass, ceramics etc.
- At the neighbourhood level, the recommended technology is Vermi composting.

8.2 PROPOSED WASTE MANAGEMENT PRACTICES

8.2.1 Storage and segregation

- All type of waste should be stored at source of waste generation after proper segregation. The waste should be segregated in three components Bio-degradable waste, recyclable waste and inert waste and should be stored in separate bins of required sizes.
- No waste should be allowed to be thrown on ill defined places such as open areas, roads/streets, drain/nallah, water bodies etc.
- The wastes generated from the religious activities needs to be segregated into organic waste and recyclable waste.
- Construction/ Demolition waste should be stored temporarily within premises or outside building without disturbing traffic with prior permission of the authority.
- Garden waste should be stored within garden and re-used as compost. Whenever it is practically not possible to reuse, it can be stored in bins/bags, which can be further collected, by private agency or municipality.

- Vegetable/Fruit market waste should be stored in separate container within premises.
- Slaughterhouse / Meat & Fish market shopkeepers should be directed to store waste within their premises.
- All hotels/ restaurants should be directed to store their waste in sturdy containers matching with the primary collection & transportation system.
- Street food vendors should be directed to have their own storage bins to store the waste generated during their activities.
- Waste generated during drain cleaning such as sludge etc. should be stored and disposed separately.
- Industrial waste should be stored separately within the premises of Industry. Strictly, it should not be mixed with municipal waste.
- Industrial waste needs to be segregated in three components which are general waste, recyclable waste and the hazardous waste.
- Bio-medical waste should be stored within premises as per directions of Govt. of India, MoEF Bio-medical waste (Management & Handling) Rules 1998.
- Bio-medical waste needs to be segregated in different components which are infectious waste, hazardous waste and the general waste.

8.2.2 Collection System

There are mainly three methods for primary collection of solid waste from different sources. The recommended method of collection of waste involves combination of following methods:

a) House to house collection system,

b) Door step collection system and

c) Community bin system.

a) House to house collection system

This system is proposed in those areas where daily collection of waste per unit is more and where better civic sense prevails as in high income group areas or in area having predominant commercial or industrial activity. This system is on cost recovery basis. In this system waste generated at individual premises is segregated and stored in standardized containers by producer or his employer. Resident associations can hire private contractor for collection of waste in defined area. The waste collector should have his own handcart or tricycle. He goes to individual house and inform house owner by ringing bell provided outside the door. Private waste collector collects the waste and unloads it in his bags or container. Same process is repeated for next house. After collection of waste from individual houses he puts it in his vehicle and unloads it in municipal vehicle or in community bins located near area.

b) Door step collection system

This system is proposed in middle-income group area where better civic sense is prevailed. This system may be either on cost recovery or no payment basis with the active participation of community. In this system waste generated at individual premises is segregated and stored in standardized containers by producer or his employer. Waste collector may be either municipal staff or private contractor. Doorstep collection can be carried out using containerized handcart or tricycle in case of narrow streets or by lanes otherwise motorized vehicle can be used.

To adopt house to house or door step collection system there has to be a good network of roads to decide the pattern of collection vehicle movement, a well developed infrastructure network with sufficient manpower and machinery and awareness in the public to make the system successful.

House owner should be provided with specific containers having specific size and airtight lids. Standard containers need to be used by individuals. The citizen should be educated first. The success of this system will depend on cooperation of community.

c) Community bin system

Bhilwara, like other cities of developing countries is an outgrowth of a town. Neither the road network nor the infrastructure facilities available at present (or with marginal improvement), permit the use of such collection system. Hence house to house or door step collection may not be possible in entire area.

Hence existing community bin system with some modification may be used for remaining area. This can be efficiently adopted in commercial areas and Low income residential areas.

8.2.3 Frequency of collection

The solid waste is generated continuously in residences, commercial and industrial establishments. It is the responsibility of municipal agencies to collect the Waste from community bins in domestic and commercial areas or street sweepings. The organic matter present in waste is high. This large organic fraction tends to decompose at faster rate at high ambient temperature. There is possibility of fly breeding if waste is stored in house or community bins for more than two days. It is thus necessary to collect the waste as quickly as possible on daily basis or at least alternate day. The dry waste such as recycled, inert may be disposed twice a week or weekly as per convenience.

The higher the density of waste, smaller would be the volume of waste at house. Hence lower volumetric capacity of vehicles will be required to collect and remove the material at greater frequency.

8.2.4 Transportation System

Proposed system for transportation of waste from collection point to final disposal site is summarized as below:

- Transportation of waste should be done regularly so that bins are cleaned before they start overflowing.

- Transportation system should appropriately match with the system adopted for the storage of waste and methods of collection.
- All manual loading should be discouraged and phased out expeditiously and replaced by direct lifting of container through hydraulic system.
- To ensure full utilization of the fleet of vehicles and to reduce the requirement of new vehicles, all vehicles should be utilized in two shifts for lifting the waste from bin.
- Where there is traffic congestion during daytime, transportation of waste should be done during night time.
- To avoid the spillage of solid waste during transit the existing vehicle with open top should be covered with good quality tarpaulin and new vehicles should be purchased with closed/covered body only.
- Existing Tractor, truck and other open body vehicles would be used for their serviceable life.
- Separate type of vehicle/ equipment should be used for narrow and wide lanes/roads.
- Work schedule should be made and followed for lifting of garbage from community bins from each location.
- Discrete solid waste generated from Bio-medical institutions, industries, hotels/restaurants, construction & demolition waste etc. should be transported and disposed by producer.
- The vehicle routes for the transportation of the waste from the collection point to the disposal site have to be planned properly so as to minimize the distances.

Fig. 8.1 Map Showing the Location of Proposed Disposal Site & Proposed Route use for Solid Waste transportation

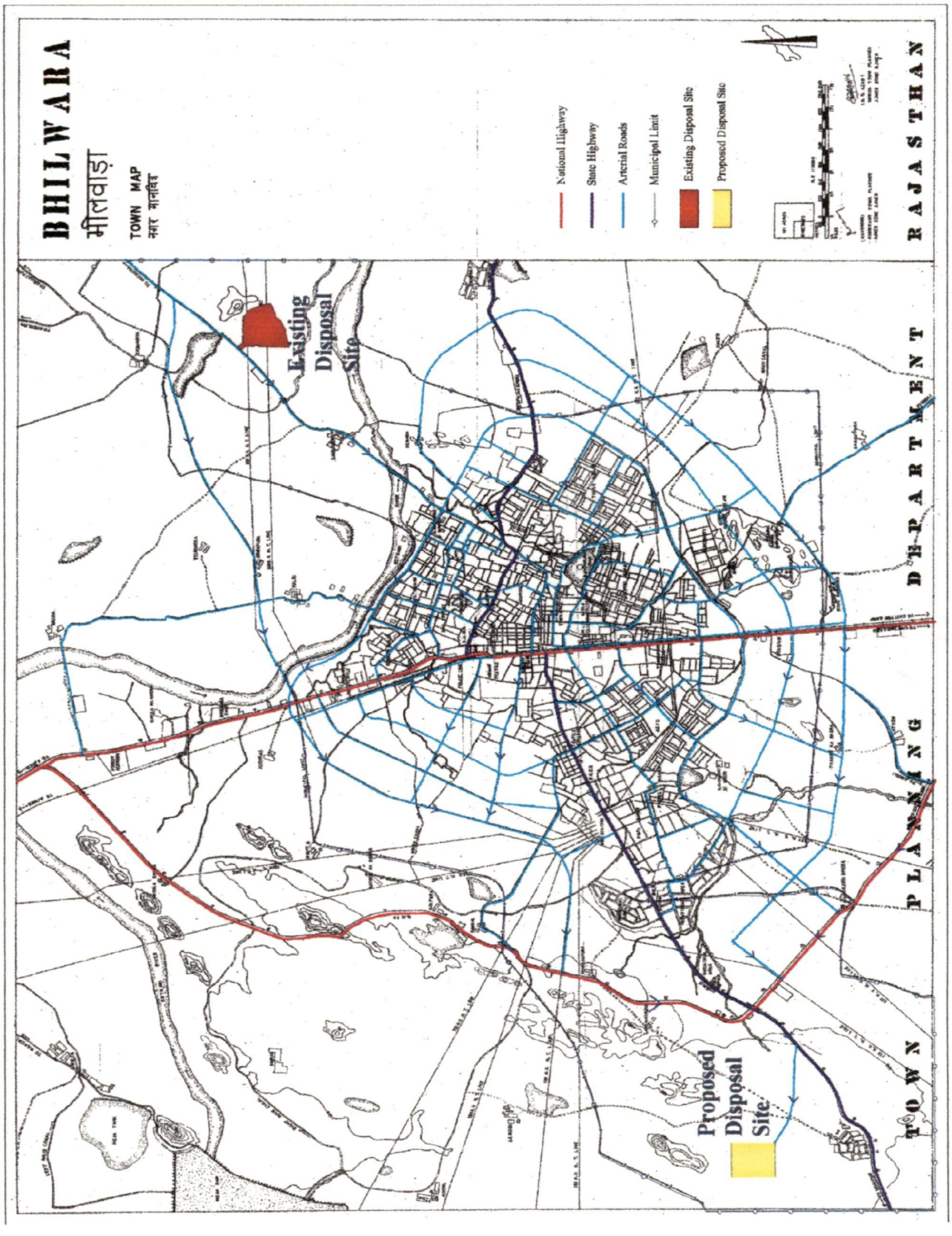


Fig. 8.2 Existing System of Waste Management Practiced in Bhilwara

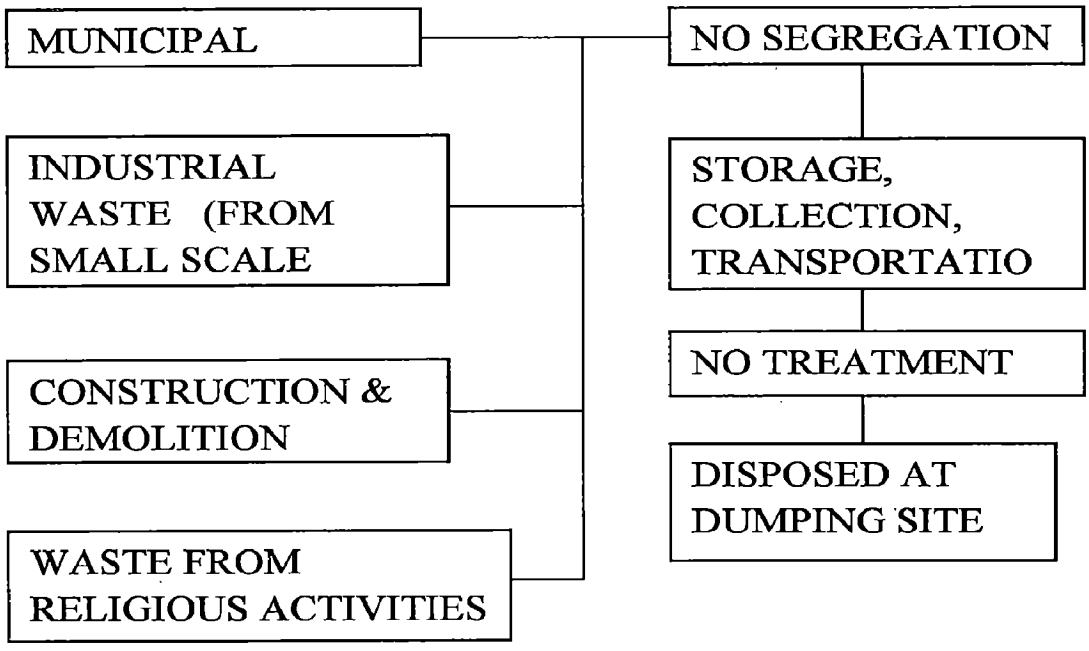
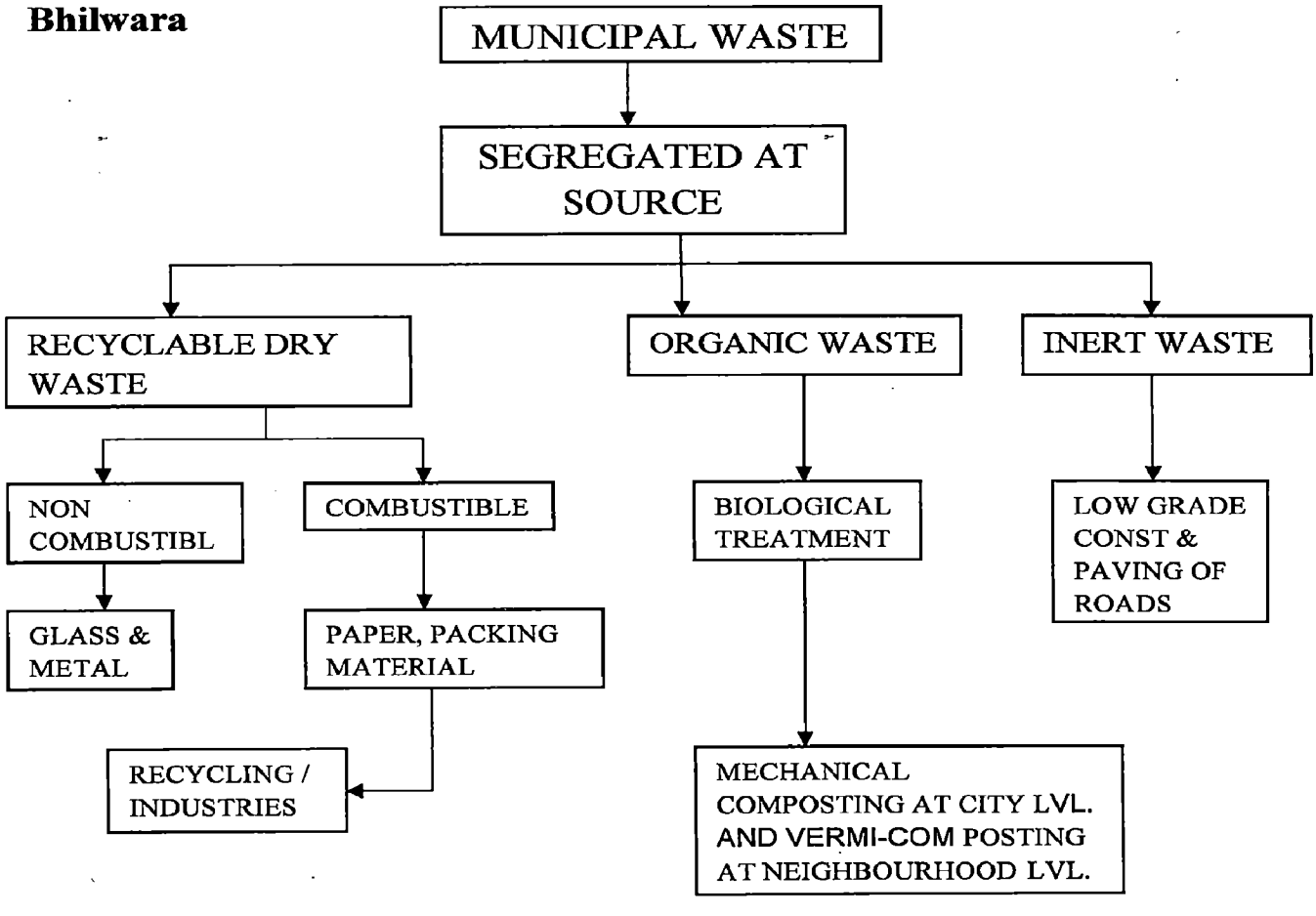


Fig. 8.3 Recommended management practice for Municipal waste in Bhilwara



8.3 STRATEGIES FOR THE CRITICAL ZONES

ZONE- 1

Here in this zone the collection points as well as the community bins are highly inadequate so they have to be increased in proportion to waste generation & population density of each of the wards lying in this zone. The deployment of the workforce for collection of the waste has also to be according to the population of the wards it is serving in.

ZONE- 2

The wards in this zone have high generation of waste, as they house commercial activities along with high density residential areas. So immediate action has to be taken in this critical zone in order to maintain cleanliness of the wards. Streets sweeping has to be done on regular basis and the waste has to be collected regularly.

ZONE- 3

This zone has a special waste i.e. Industrial waste generation apart from the municipal waste that comes from the residential as well as the commercial areas in these wards. The quantum of Industrial waste generated is not very high but the criticality is significant as this waste is hazardous in nature. Thus special attention has to be given to the waste management practices in this ward, as this waste may have an adverse effect on the health and environment if it gets mixed with the general waste.

ZONE- 4

This zone has the open dumping ground which is not properly located. So dumping has to be prohibited here as the location is not compatible with the surroundings and the method of disposal of waste is also not preferred. New technologies have to be adopted for treatment and disposal of waste.

8.4 RECOMMENDED INSTITUTIONAL ARRANGEMENT

Solid waste management is the part of public health and sanitation. Bhilwara Municipality can deliver this public service by the active participation and involvement of the citizens and various other agencies for an efficient functioning of the system. Besides finance, other resources such as manpower, equipment and machinery have to be utilized optimally. In the existing mechanism of waste management only the municipality was responsible to handle the diverse and complex nature of the waste.

In the proposed arrangement new players have been introduced to reduce the burden on the sole existing authority. **The MSW cell of the State Pollution Control Board (SPCB), Bhilwara** will monitor the handling and management of the municipal waste. For the treatment of this waste a Private operator can be contracted or hired by the authority. The industrial waste needs to be treated in a **Common Effluent Treatment Plant** (CETP) before it is finally disposed with other wastes. This common treatment plant will be operated by the **Rajasthan State Industrial Development & Investment Corporation** (RIICO), Bhilwara and the whole process will be monitored by the **SPCB, Bhilwara**. The temple trust will be responsible for the handling and management of the waste generating from the religious activities. The disposal will be done along with the other organic waste by the municipality.

In the proposed organization, each activity of solid waste management such as street cleaning and collection, transportation, process/disposal, finance and human resources development should be managed by qualified and experienced staff members separately.

8.4.1 Proposed Organization

- Strengthening of the existing organizational setup for the municipality for solid waste management.
- Regular monitoring and control of work at various levels to be carried out.
- There would be formal system of reporting of different kind of work at different levels. The report will include the quantity of waste

collected and transported, area swept, vehicles trip, incomplete work and reasons, additional resources required and other details.

- Special attention to be paid to solid waste worker by providing them adequate protective measures.
- Ward committee to be strengthened by involving citizens/representative of the area for efficient monitoring of work.
- Proper system to be enforced for complaints/suggestions in each ward related to solid waste.
- Phase wise extensive training to be given to all employees for enhancing their knowledge and improving their efficiency to ensure maximum productivity.

8.4.2 Requirement of Manpower for Road sweeping

Following guidelines have been adopted for evaluating the manpower requirement:

- One Safai Karmachari for serving population of approximately 500. The actual jurisdiction of each Safai Karmachqri would be decided by the Bhilwara Municipality depending upon the width, congestion of roads and other related factors.
- One Sanitary Supervisor would supervise the work of 20-30 Safai Karmacharis.
- Overall work of road sweeping would be carried out under the supervision of Assistant Director (Street Cleaning).

REFERENCES

- Asnani P. U. 1996, Municipal Solid Waste Management in India, Paper presented at the Waste Management Workshop, 24-28 June 1996, Common Wealth Science Council, Cyprus.
- Central Bureau of Health Intelligence 1993, Health Information of India, Directorate General of Health Services, New Delhi.
- Central Pollution Control Board (CPCB) 2009, Management of Municipal Solid Waste, Author, New Delhi.
- Central Pollution Control Board (CPCB) 2002, Municipal Solid Waste Processing Technologies: Reference Manual for Local Bodies, Author, New Delhi.
- Central Pollution Control Board (CPCB) 2003, Support manual for Municipal wastes (Management and Handling) Rules, Author, New Delhi.
- Ministry of Environment & Forests 2006, Municipal Waste (Management and Handling) Rules, Author, New Delhi.
- National Environmental Engineering Research Institute (NEERI) 2006 Strategy Paper on Solid Waste Management in Indio, Author, New Delhi.
- Sinha R.K. 2008, Solid Waste Management in India, Indian Publishers, New Delhi.
- Hina Zia, Solid Waste Management in A Metropolitan City-Kanpur, India, Ph.d Thesis, IIT Roorkee.
- City Development Plan of Surat City.
- City Development Plan of Jaipur City.
- Bhilwara Master Plan, 2005-2025.

Websites

- www.bhilwaranagarparishad.org
- www.uitbhilwara.org/home.htm
- www.ebhilwara.com
- www.riico.com
- www.jaipurjda.org
- www.suratmunicipal.gov.in