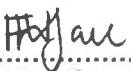


## DECLARATION


This Thesis is my original work and has not been presented in part or full fulfilment of a degree in any other university.

Candidate: Florence Wairimu Njau

Signed.....   
Date..... 25<sup>th</sup> Jan 2005.....

This Thesis has been submitted for the examination with my approval as the University supervisor.

Supervisor: Professor E. Ndegwa

Signed.....   
Date..... 10/02/05.....

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Cordial thanks to my relatives, friends and colleagues for their support.

## DEDICATION

*To Mom and Richard*

*For their love and support for me.*

*To My brothers Patrick, David and Solomon;*

*And my sisters Salome, Jacinta, the Late Susan and  
Catherine for their enduring support and encouragement  
in my life.*

## **ABSTRACT**

Solid Waste Management is one of the challenges facing human settlements, and indeed when well managed, it can ensure that various problems associated with poor solid waste management such as land and water pollution, blocking of access ways, reduced aesthetics of the environment, health related problems and loss of revenue among others are eliminated. Good solid waste management entails involvement of all actors right from the waste generation stage up to the waste disposal stage. These actors are the central government agencies, Municipal authorities, private firms, households, Community-Based Organisations, informal Waste Collectors, Non-Governmental Organisations and business enterprises.

This paper is a report of a research study that was done to assess the solid waste management practice in Kiambu Town, which is one of the satellite towns that have strong interactions with Nairobi City. The research was focused on the roles played by Households, the municipal authority, Informal Waste Pickers and the private firms.

The major findings of the research were that solid waste in Kiambu Town constitutes of all types of waste from various human activities and that there lacks a properly established waste sorting policy. There also lacks strong and adequate legal framework to govern the waste management. The actors are also faced with various technical, legal, financial, informational and institutional problems and challenges. These problems and challenges affect their efficiency to carry out their positive roles and also promote their negative roles, thus leading to environmental degradation. These can be solved by developing a framework that will promote co-operation among all the actors.

The report is organised into six chapters outlining the introduction, literature review, methodology, background to the study area, data analysis and conclusions and recommendations based on the findings of the study.

# TABLE OF CONTENTS

TITLE.....	I
DECLARATION.....	II
DEDICATION.....	III
ACKNOWLEDGEMENT.....	IV
ABSTRACT.....	V
DEFINITION OF TERMS.....	IX
LIST OF ABBREVIATIONS.....	X
LIST OF TABLES.....	XI
LIST OF FIGURES.....	XIII
LIST OF PLATES.....	XIV
<b>CHAPTER ONE: INTRODUCTION</b> .....	
1.1 INTRODUCTION – BACKGROUND TO THE PROBLEM.....	1
1.2 PROBLEM STATEMENT.....	4
1.3 OBJECTIVES OF THE STUDY.....	7
1.4 RESEARCH QUESTIONS.....	8
1.5 SIGNIFICANCE OF THE STUDY.....	8
1.6 SCOPE OF THE STUDY.....	9
1.7 ASSUMPTIONS AND LIMITATIONS OF STUDY.....	9
1.8 ORGANISATION OF THE STUDY.....	9
<b>CHAPTER TWO: LITERATURE REVIEW</b> .....	11
2.2 SOLID WASTE.....	11
2.2.1 <i>Characteristics of Solid waste as a public good</i> .....	11
2.2.2 <i>Categories of Solid waste</i> .....	12
2.3 SOLID WASTE MANAGEMENT (SWM).....	13
2.3.1 <i>Scope of Solid Waste Management</i> .....	14
2.3.2 <i>Factors affecting Municipal Waste Management Decision</i> .....	15
2.3.2.1 Local Factors.....	15
2.3.2.2 Multi – Jurisdictional Factors.....	16
2.3.3 <i>Criteria for a suitable solid waste management system</i> .....	16
2.3.4 <i>Stages of solid waste management</i> .....	17
2.3.4.1 Waste Generation.....	17
2.3.4.2 Waste Storage.....	18
2.3.4.3 Waste Collection and Transfer.....	18
2.3.4.4 Waste Treatment/Processing and Disposal.....	22
2.4 SYSTEMS OF WASTE REDUCTION AND MATERIALS RECOVERY.....	29
2.4.1 <i>The concept of Source Reduction</i> .....	29
2.4.1.1 Criteria for evaluating source reduction options.....	30
2.4.1.2 Economic and Environmental effects of source reduction.....	30
2.4.2 <i>Source reduction and resource recovery in industrialised Countries</i> .....	31
2.4.3 <i>Source reduction and resource recovery in Developing Countries</i> .....	32
2.4.3.1 Addressing waste picking in Developing Countries.....	33
2.4.4 <i>Experience in other regions with regard to facilitating Resource Recovery</i> .....	35
2.5 ACTORS AND PARTNERS IN SOLID WASTE MANAGEMENT.....	38

2.6	POLICY FRAMEWORK FOR SOLID WASTE MANAGEMENT IN KENYA.....	42
2.6.1	<i>Local Government Act of 1965</i> .....	42
2.6.2	<i>Public Health Act Cap 242</i> .....	42
2.6.3	<i>Environmental Management and Coordination Act, 1999</i> .....	43
2.7	CONCEPTUAL FRAMEWORK.....	43
<b>CHAPTER THREE: RESEARCH METHODOLOGY .....</b>		<b>46</b>
3.1	INTRODUCTION.....	46
3.2	DESIGN OF THE STUDY.....	46
3.3	SAMPLING DESIGN AND PROCEDURES.....	46
3.4	DATA COLLECTION INSTRUMENTS.....	47
3.5	DATA MANAGEMENT, ANALYSIS AND PRESENTATION.....	48
<b>CHAPTER FOUR: BACKGROUND OF THE STUDY AREA .....</b>		<b>49</b>
4.1	INTRODUCTION.....	49
4.2	FACTORS GOVERNING THE GROWTH OF SECONDARY TOWNS.....	49
4.3	EVOLUTION OF KIAMBU TOWN.....	50
4.4	NATIONAL AND REGIONAL SETTING.....	51
4.5	CLIMATE.....	56
4.6	TOPOGRAPHY AND DRAINAGE.....	57
4.7	SOILS.....	58
4.8	VEGETATION.....	58
4.9	POPULATION, DEMOGRAPHIC AND HOUSING CHARACTERISTICS.....	58
4.9.1	<i>Population</i> .....	59
4.9.2	<i>Housing</i> .....	62
4.9.2.1	<i>Housing Demand in Kiambu Municipality</i> .....	62
4.10	ECONOMIC BASE.....	63
4.10.1	<i>Commerce and Industry</i> .....	64
4.10.2	<i>Agriculture</i> .....	65
4.10.2.1	<i>Agriculture Supporting Systems in Kiambu Municipality</i> .....	68
4.10.2.2	<i>Problems faced by the agricultural sector in Kiambu Municipality</i> .....	69
4.11	TRANSPORT NETWORK.....	69
4.11.1	<i>Road Conditions in Kiambu Municipality</i> .....	71
4.12	COMMUNITY FACILITIES.....	72
4.12.1	<i>Education facilities</i> .....	72
	(C) Tertiary Institutions.....	73
4.12.2	<i>Health Facilities</i> .....	73
4.12.3	<i>Recreational and Worship Facilities</i> .....	73
4.12.4	<i>Police and Fire Station</i> .....	74
4.12.5	<i>Administrative Areas</i> .....	74
4.13	INFRASTRUCTURE SERVICES.....	74
4.13.1	<i>Water and Sanitation in Kiambu Municipality</i> .....	75
4.13.2	<i>Sewage System</i> .....	76
4.13.3	<i>Telecommunications</i> .....	77
4.13.4	<i>Storm Water Drainage System</i> .....	77
4.14	LAND.....	78
4.14.1	<i>Land Tenure in Kiambu Municipality</i> .....	78
4.14.3	<i>Land Use</i> .....	79
4.14.4	<i>Land Use Pattern</i> .....	80
<b>CHAPTER FIVE: DATA ANALYSIS AND RESEARCH FINDINGS .....</b>		<b>83</b>
5.1	NATURE OF SOLID WASTE GENERATED BY IN KIAMBU TOWN.....	83
5.1.1	<i>Main Generators of Solid Waste in Kiambu Town</i> .....	83
5.1.2	<i>Type of Waste Generated in Kiambu Town</i> .....	83
5.1.3	<i>Weight/Amount of Waste</i> .....	84

5.2	ROLES AND RESPONSIBILITIES OF DIFFERENT ACTORS IN SOLID WASTE MANAGEMENT.....	85
5.2.1	<i>Municipal Council of Kiambu</i> .....	85
5.2.1.1	The Legal and Institutional Framework.....	85
5.2.1.2	Financial Arrangement.....	95
5.2.1.3	Human Resources Management.....	96
5.2.1.4	The Technical Capacity.....	97
5.2.1.5	General management Issues and Future Plans.....	99
5.2.2	<i>Households</i> .....	99
5.2.3	<i>Businesses</i> .....	103
5.2.4	<i>Private Firm</i> .....	107
5.2.5	<i>Informal waste Collectors</i> .....	108
5.3	PROBLEMS ENCOUNTERED BY ACTORS IN SOLID WASTE MANAGEMENT.....	110
5.4	NATURE OF SOLID WASTE MANAGEMENT PRACTICE IN KIAMBU TOWN.....	113
5.5	ENVIRONMENTAL PROBLEMS ASSOCIATED WITH SOLID WASTE MANAGEMENT IN KIAMBU TOWN.....	114
5.5.1	<i>The problems associated with waste were listed as follows:</i> .....	114
5.6	SUGGESTIONS AS TO HOW SOLID WASTE MANAGEMENT CAN BE IMPROVED IN KIAMBU TOWN.....	115
	<b>CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS</b> .....	<b>117</b>
6.1	INTRODUCTION.....	117
6.2	SUMMARY OF THE FINDINGS.....	117
6.3	CONCLUSIONS.....	118
6.4	RECOMMENDATIONS.....	118
6.4.1	<i>Municipal Council</i> .....	118
6.4.2	<i>Informal Waste Collection</i> .....	119
6.4.3	<i>Privatisation of waste collection</i> .....	120
6.4.4	<i>Households and Business community</i> .....	121
6.4.5	<i>Solid Waste Management Education programs</i> .....	121
6.5	AREAS FOR FURTHER RESEARCH.....	121
	<b>REFERENCES</b> .....	<b>122</b>
	<b>APPENDICES</b> .....	<b>124</b>
	Appendix 1.....	124
	Appendix 2.....	127
	Appendix 3.....	128
	Appendix 4.....	129
	Appendix 5.....	131

## DEFINITION OF TERMS

**Disposal** – Refers to the final handling of waste following collection, processing or incineration. Disposal often means placement of waste in a dumpsite or landfill.

**Effectiveness** – The degree to which solid waste management system is able to achieve the goals of solid waste management.

**Efficiency** – This is the degree to which waste management system utilises the resources of time, equipment, land money, labour, and information optimally or cost effectively.

**Environment** - includes the physical factors of the surroundings of human beings including land, water, atmosphere, climate, sound, odour, taste, the biological factors of animals and plants and the social factors of aesthetics and includes both the natural and the built environment (*Environmental Act, 1999*)

**Waste Generation** – stage at which the material becomes unwanted and discarded. Waste generation takes place at the location of different human activities.

**Hazardous Waste** – This is waste that requires special care because their properties make them more hazardous in comparison to general waste. This includes waste like motor oilcans, slaughterhouse waste, car tyres, chemical wastes from industries like tanning, dry-cleaning and photographic processing, chemicals like pesticides and agrochemicals as well as health care wastes.

**Informal waste pickers/Scavengers** – Waste pickers that are private, small scale, labour intensive, largely unregulated and unregistered.

**Solid Waste** – Any solid material that has no value to the person responsible for it and it is not intended to be discharged through a pipe. It is generated by domestic, commercial, industrial, healthcare and agricultural activities.

**Solid Waste Management** – All activities that seek to minimize the health, environmental and aesthetic impact of solid waste. It refers to the collection, transfer, treatment, recycling, resource recovery and disposal of solid waste in urban areas.

**Stakeholder** – any person, group, or organisation that can place a claim on an organisation's attention, resources, or output or is affected by that output (*UNCHS, 1997*). Further definition by (*UNCHS, 2001*), states that stakeholders are those whose interests are affected by the issue or those whose activities strongly affect the issue, or those who possess information, resources and expertise needed for strategy formulation and implementation or those who control the relevant implementation instruments.

**Sustainable Development** – Development that will meet the needs of the current generation without compromising the ability of the future generation to meet their needs.

**Waste** - According to Environmental Act of 1999, waste includes any matter prescribed to be waste and any matter whether liquid, solid, gaseous or radioactive, which is discharged, emitted or deposited in the environment in such volume, composition or manner likely to cause alteration of the environment.



## LIST OF ABBREVIATIONS

AFC -	Agricultural Finance Corporation
CBD -	Central Business District
CBO -	Community-Based Organization
DURP -	Department of Urban and Regional Planning
DSO -	District Statistics Office
EMAC -	Environmental Management and Coordination Act
EPA -	Environmental Protection Agency
ETEU -	Economic, Trade and Environmental Unit
KIST -	Kiambu Institute of Science and Technology
LGA -	Local Government Act
MCK -	Municipal Council of Kiambu
MSW -	Municipal Solid Waste
MSWM -	Municipal Solid Waste Management
NEMA -	National Environmental Management Authority
NGO -	Non-Governmental Organization
NIMBY-	Not In My Back Yard
OECD -	Organisation of Economic and Cooperation Development
PPA -	Physical Planning Act
SERC -	Standards and Enforcement Review Committee
SWM -	Solid Waste Management
UMP -	Urban Management Programme
UNCHS-	United Nations Centre For Human Settlement
UNDP -	United Nations Development Programme
UNEP -	United Nations Environmental Programme

## LIST OF TABLES

	PAGE
Table 1: Comparison between private and public waste collection	22
Table 2: Summary of strengths and weaknesses of waste disposal methods	26
Table 3: Comparison of different waste Disposal methods	28
Table 4: Population projection for Nairobi and its metropolitan districts	60
Table 5: % Population growth rate for respective Nairobi metropolitan districts	60
Table 6: Kiambu Municipality population density projection to the year 2030	61
Table 7: Road condition in Kiambu Municipality	71
Table 8: Kiambu municipality Pre-primary school status – 2002	72
Table 9: Boreholes in Kiambu Town	75
Table 10: Types and sources of waste generated in Kiambu Town	84
Table 11: Community Based Organisations in Kiambu Municipality	95
Table 12: Financial Allocation to various MCK's Departments for the year 2003	95
Table 13: Waste sorting reasons by Households in Kiambu Town	99
Table 14: Methods of waste disposal employed by households in Kiambu Town	103
Table 15: Waste minimisation measures employed by business enterprises in Kiambu Town	104
Table 16: Methods of waste recycle employed by business enterprises in Kiambu Town	105
Table 17: Summary of the roles played by different actors	108
Table 18: Solid Waste Management problems faced by households in Kiambu Town	111
Table 19: Solid Waste Management problems encountered by business enterprises in Kiambu Town	111

## LIST OF MAPS

	PAGE
Map 1: Geographical scope of the study area	10
Map 2: Location of Kiambu Town in the National Context	53
Map 3: Location of Kiambu Municipality in Kiambu District	54
Map 4: Administrative Units of Kiambu Municipality	55
Map 5: Location of Coffee estates and Major Trading Centres in Kiambu Municipality	67
Map 6: Road Condition in Kiambu municipality	70
Map 7: Existing land Use pattern in Kiambu Municipality	81
Map 8: Environmental Sensitive Areas in Kiambu Municipality	82

## LIST OF FIGURES

	PAGE
Figure 1: Stages in Solid Waste management	28
Figure 2: Conceptual Framework	45
Figure 3: Kiambu Municipality Average Monthly Rainfall	56
Figure 4: Kiambu Municipality Mean Temperature	57
Figure 5: Housing demand projection for Kiambu Municipality	63
Figure 6: Water Supply in Kiambu Municipality	76
Figure 7: Projection for waste Water generation in Kiambu Municipality	77
Figure 8: Organisational Structure of Municipal Council of Kiambu	88
Figure 9: Organisational Structure of the MCKs Cleansing Section	96
Figure 10: Explanation for failure to sort waste by households	100
Figure 11: Pie chart showing the methods of waste storage for households	100
Figure 12: Waste Collection agencies in Kiambu Town	102
Figure 13: Waste collection agents for business enterprises in Kiambu Town	104
Figure 14: Methods of waste collection employed by business enterprises in Kiambu Town	106

## LIST OF PLATES

	PAGE
Plates 1 & 2: Location of dump site and conflicting land uses of the cemetery, Riara River, slaughter- house and the dump site	6
Plate 3: municipal's tractor with trailer for carrying solid waste	97
Plate 4: Waste collection depot constructed by the municipal council	98
Plate 5: Dustbins that the council used to provide before 1988	98
Plate 6: Dumping along Roadside	101
Plate 7: Blocking of open drains by solid waste	101
Plate8: Irregular dumping of waste outside business premises	102
Plate 9: Waste collection depots constructed by business entrepreneurs	106
Plate 10: Poor waste storage by informal waste pickers	112

## CHAPTER ONE: INTRODUCTION

### 1.1 INTRODUCTION ~ BACKGROUND TO THE PROBLEM

Protection of the environment is one of the main aims of urban and regional planning. It complements other aims of planning, which are inter alia: Promotion of accessibility; Promotion of economy; Separation of incompatible land uses and the grouping together of compatible land uses and maintenance of aesthetics.

Indeed, environmental quality is one of the nine components of public interest incorporated in land use planning; others being health, safety, convenience, efficiency, energy conservation, social equity, social choice, and amenity. (*Chapin & Kaiser, 1979*)

According to (*Habitat II agenda of 1996*), the key environmental problems facing human settlements in both urban and rural areas are mainly tied to the process of urbanization. These include: Poor solid waste management – which entails dumping in inappropriate land, overflowing of wastes, causing both bad sights and smells; Over crowding and unsanitary markets, tracks and bus parks; Groundwater pollution; Degradation of natural resources whereby forests are lost to agriculture, field, housing, industries, soil erosion, surface run-off pollution, poor drainage and stress on special eco-system; Obsolete infrastructure and over densification; Inadequate infrastructure in the fast growing urban fringe; land degradation through quarrying, poor solid waste management, overgrazing and invasive species; lack of financial and technological capacity on the part of municipal council due to weak level of municipal finance, low income and limited ability to pay of the city's population, high level of unemployment and lack of safety measures; lack of a sound legal framework to govern environmental management, and the failure to enforce the existing environment statutes by the relevant public agencies and, finally, Lack of community participation in environmental management.

Therefore, solid waste management, which in most countries is taken as a sole responsibility of municipal authorities, is a major concern in environmental management. The environmental problems associated with solid waste management are either related to generation, collection or disposal of the solid waste. In many cities, 30 to 50 percent of the solid wastes generated are not collected (*OECD, 2000*) \*About,  $\frac{1}{3}$  and  $\frac{1}{2}$  of solid waste generated in the urban centres

by households and business remains uncollected. Such wastes generally accumulate on open spaces, wasteland, and streets, bringing with them serious effects of health and environmental problems. **(UNCHS, 1996)**

The relative importance of the risks and problems associated with solid waste management depends very much on the local conditions. Some of these problems are: - Water pollution in cases where wastes are disposed in water bodies or where leachate from waste dump and disposal sites ends up in water bodies; creation of breeding places like blocked drains, discarded cans, tyres and other objects for disease causing vectors and pests like mosquitoes which cause diseases like malaria and dengue; flies and cockroaches, that are usually attracted by garbage, can contaminate food and are effective vectors that spread diseases. In addition, rats find shelter and food in waste dumps. Rats consume and spoil food, spread disease, damage electrical cables and other materials and inflict unpleasant bites. Large quantities of waste that have not been placed in a landfill according to good engineering practice can slip and collapse causing injury to life and property. Liquids and fumes, escaping from deposits of chemical wastes (or formed perhaps as a result of chemical reactions between components in the waste) can have fatal or other serious effects.

“Landfill gas can explode if it is allowed to accumulate in confined spaces such as the cellars of buildings. Methane, one of the main components of the landfill gas, is much more effective as green house gas than carbon dioxide is, causing interruption in the climate pattern. Fires on disposal sites can cause serious air pollution, illnesses. Such fires render disposal sites dangerously unstable and can cause loss of life and property in the adjacent neighbourhood.” **(Steven S, 1984)**

Further, **Smith et al (1994)**, state that poorly dumped and uncollected waste degrades urban environment, discourages efforts to keep streets and open spaces in clean and attractive condition leading to reduced aesthetic appearance and bad smells. Solid Waste Management is a clear indicator of the performance of a municipal administration – if the provision of the service is inadequate, large numbers of citizens are aware of it. Plastic bags are a particular aesthetic nuisance and can cause death to grazing animals that eat them. Uncollected waste often ends up in drains leading to blocked drainage channels which result in flooding and unsanitary conditions. Rain water retained in discarded containers is a health risk particularly to children. Exposure of waste pickers (scavengers and municipal or private sector employees) to

particular occupational hazards and risks such as strains from lifting, injuries from sharp objects, exposure to diseases particularly where medical waste and other hazardous waste is not treated specially. Blocking of roads of access to some areas, particularly in low-income areas is a major problem. Former disposal sites provide very poor foundation support for buildings, making buildings constructed on such grounds prone to collapse.

Poor SWM leads to practices like open burning of waste, an obvious cause of air pollution, and the products of combustion include dioxins which are particularly hazardous. Aerosols and dusts can spread fungi and pathogens from uncollected and decomposing wastes. Heavy refuse collection vehicles can cause serious damage to roads that were not designed for such weights. Waste items like bottles, cans and medical supplies that are recycled without being cleaned effectively or sterilised can cause infection to later users.

However, where solid waste is managed properly, it may generate some benefits such as: - generating income for waste pickers, municipal authorities and private companies dealing with solid waste collection and recycling; supporting agriculture for example by feeding livestock or making compost manure; it can support fishing and maintaining of the environment to ensure safety and health standards. Solid waste when recycled is also an important source of energy. "Where recycling is well organised, it serves as a major way of saving foreign exchange through import substitution. It also helps to conserve natural resources, to promote industrialisation and to reduce the costs of waste disposal." (*Cointreau S, 1994*). In addition, properly organised SWM systems provide a channel for inclusion of all stakeholders, and more importantly, the communities; promotion of environmental quality and general health of a population, and these are key components of sustainable development.

It is therefore important to develop and adopt policies and procedures that will help to reduce the negative effects of poor waste management and maximize the benefits of effective solid waste management. Some of the policies and procedures for effective solid waste management include: Participation by all stakeholders like municipal authorities, communities, NGOs, CBOs, business enterprises, scavengers and private firms offering waste collection services; empowering municipal authorities and all other stakeholders to be able to do their work; establishing a national policy of waste management and establishing reasonable but affordable charges for service delivery particularly by the municipal authorities so as to make



SWM sustainable. Participation of all stakeholders as a tool for effective waste management was the main concern of this study.

## 1.2 PROBLEM STATEMENT

Solid waste management is one of the essential municipal services, whose management has serious consequences in the protection of the quality and sustainability of the environment, safeguarding of public health and in improving the efficiency and productivity of the urban economy (*UNDP, 1993*).

According to *UNCHS (1998)*, only between 25 and 55% of all wastes generated in large cities is collected by municipal authorities. *UNDP (1999)* estimates that more than five million people die each year from diseases related to inadequate solid waste disposal practices. At least 60 % of the countries that submitted national reports to the United Nations in advance of the 1992 Earth summit indicated that solid waste disposal was among their biggest environmental concerns. More than half of the world's solid waste is generated in the developed countries; for example in the United States, EPA estimates that the average American produces well over 0.75 tons of trash per year (*EPA, 2001*), which approximates to 2.05 kg per day.

Kenya, just like the other parts of the world, is also experiencing the solid waste management problems and associated challenges. The main generators of solid waste are mainly industrial, institutions, Households and agriculture. In Kiambu Town, there are households of different income levels; farmers and agro-related businesses; institutions like schools, hospitals and the prison; industries and businesses of diverse nature such as carpentry, motor related enterprises, dry cleaners, photo processing enterprises, the market, petrol stations, hotels, shoe product enterprises, clothe shops, barber shops and hair salons as well as offices. These are the main generators of waste in Kiambu Town. The solid waste in Kiambu Town constitutes of plastic bags and containers, food remains and food by-products, human waste, cloths, bakery wastes, metal scraps, construction waste, papers, agro-based by products, hospital waste, glass, ceramics, tin, leather parts, wood and wood by products, old tyres, old batteries, hair products and others.

According to a field survey conducted in Kiambu Municipality by DURP in April 2003, it was found that 56% of the households resort to dumping their wastes on open ground, 22% rely on municipal council collection, 21% employ composting and 2% bury solid waste in their back

yards. Currently, unplanned disposal of solid wastes in the municipality has led to a number of problems whereby 62% of the households identified lack of regular collection of solid wastes as a major contributor to the problem and 30% felt that the disposal site was located too far, therefore making it difficult to quickly dispose of their waste. Further, the study revealed that 70% of the businesses in the municipality were not served by the municipal council in terms of refuse collection, only 30% were served. This implies that many of these businesses, especially the informal ones normally resorted to illegal dumping, all contributing to environmental degradation.

The main service provider of solid waste management services in Kiambu town is the Municipal Council of Kiambu. Waste collection is done manually by the use of tractors. At the domestic level, waste management begins with sorting in order to separate recyclable, organic and combustible wastes for recycling/reuse, composting, burning or final disposal. Waste disposal is mainly done by open dumping. The only private waste collection firm offers services to less than 10% of the residents in the town. There exists no NGO/CBO dealing with waste management. The scavengers are few and scattered. Waste disposal in Kiambu town is even more critical because the disposal site is the same site designated as a cemetery. The site is next to it is the slaughter house and Riara River. The river may probably be experiencing problems of leachate leaking from the dump site. This is a clear indicator of grouping together of incompatible and conflicting land uses (see plates 1 & 2 on page 6). **Municipal Annual Report of 1999** indicates that the dumping site is fully filled up and poses a health hazard to the residents.

However, despite the efforts by the different actors in the management waste, the field survey revealed mounting solid waste problems in the town such as filled up dump sites, littering of the water bodies and land with waste. Lack of proper sorting out of waste, whereby waste from different generators especially health are mixed with other wastes, blocked drainage channels, bad sights and smells. Unhealthy smoke from open burning of waste by residents, exposure to health hazards associated with metal, excessive levels of plastic containers and bags causing an eyesore. Vectors like flies and cockroaches and irregular dumping were also noted. Exposure to health risks to grazing animals and waste pickers were among the problems. These problems can be attributed to the lack of adequate participation by all stakeholders among other issues. The local authority, communities, private sector and different waste generators have failed to play their role effectively in waste disposal and waste collection.

*Sites 1 & 2 showing the location of dump site and conflicting Land uses in  
Klambu Town*



SWM does not comprise the mere loading solid waste into a vehicle and unloading it in a dump, which is a common practice in developing countries as is done in Kiambu Town. Otherwise, cities and towns would not be suffering all the environmental ills associated with waste. Successful SWM is rarely achieved without thought, effort and much learning from mistakes. SWM is much more than a technological issue for it involves managing a large workforce, and working together closely with all stakeholders. For a successful, effective and efficient solid waste management, various actors should be involved. These include households, NGOs, CBOs, private sector, informal sector, the local government, central government and indeed all stakeholders (*Mutai, 1997; pg 44*).

It is only when all these actors, if they play their respective roles effectively, that they will be able to attain sustainable waste management that aim to achieve the following four objectives as stated in (*Localising Agenda 21, pg 206*)

- (a) Minimization of waste generation;
- (b) Maximization of waste recycling and re-use;
- (c) Ensuring safe and environmentally sound disposal of waste; and
- (d) Extending waste service coverage

The purpose of this study, therefore, was to examine the role of different actors in solid waste management in Kiambu Town, and to suggest ways in which they can play their roles more effectively in order to achieve sustainable solid waste management in Kiambu Town in order to promote environmental protection.

### **1.3 OBJECTIVES OF THE STUDY**

The main objective of this study was to assess the nature of solid waste management practice in Kiambu Town. This was carried out by looking into the following specific objectives: -

- i. To examine the nature of solid waste in Kiambu Town
- ii. To investigate the roles and responsibilities played by different actors in solid waste management and to establish the key problems and challenges they encounter.
- iii. To investigate the environmental problems associated with solid waste management in Kiambu Town.
- iv. To suggest ways in which solid waste management can be improved with a view to mitigating the solid waste management problems in Kiambu town.

## 1.4 RESEARCH QUESTIONS

- i. Who are the main generators of solid waste in Kiambu Town?
- ii. What types and quantities of waste do they generate?
- iii. What roles and responsibilities, given their mandates and capacities, do different stakeholders play in solid waste management in the town?
- iv. Do these roles contribute positively or negatively towards SWM?
- v. What problems and challenges do the different stakeholders face in the course of dispensing their roles?
- vi. What environmental problems associated with solid waste management are encountered in Kiambu Town?
- vii. What can be done to strengthen the positive roles and to discourage the negative roles played by different actors?
- viii. How can both the environmental problems and the problems and challenges faced by the stakeholders in the course of dispensing their roles be solved/ mitigated?

## 1.5 SIGNIFICANCE OF THE STUDY

Waste is unavoidable in any society. The amount of waste is increasing and the quality of solid waste has become ever diversified with increased urbanisation. "The Age of convenience is also the age of waste around the world, and civilisation has been stuffing its refuse into abandoned mines, canyons and even dumping it in to the oceans. Some of it is being incinerated, releasing poisonous gases into the air. This problem is more pronounced in the industrialised countries than in the developing countries, but with the spread of technology, industrialisation and accompanying standards of living, the garbage factor is an unwelcome and often unnoticed side effect of 'development' "(UNEP, 1997)

Globally, numerous studies have been carried out in this area of solid waste management focusing on different aspects like the role of the municipal councils or the community in solid waste management, privatisation of the service provision, combustion possibilities, land filling, resource recovery, refuse collection vehicles among other aspects.

In Kenya studies on solid waste have been carried out, but have mainly been focused on major metropolitan areas like Nairobi. A few other studies have been carried out in secondary towns like Kericho and Eldoret. Such secondary towns are important in the urbanisation process because of the influx of the rural and other urban areas' populations into these towns, and, hence infrastructure development and provision in these towns need not be overlooked. Solid waste is one of the important infrastructure services that need to be provided in these towns.

No study had been done in this area of solid waste in Kiambu Town that the researcher was aware of. The research, therefore, was intended to fill this gap. In addition, the study was aimed at filling the gap of examining the integrative role of the different actors in solid waste management. The research findings are expected to be used by the Municipal Council of Kiambu to make their role in solid waste management more effective. It can also be useful to the different stakeholders; the local community, the CBOs, NGOs, Private sector and Businesses to enhance their waste management practices in order to promote environmental quality in Kiambu Town. It is expected that the findings will be useful to other towns for the same purpose and to other scholars working in this area of study.

## **1.6 SCOPE OF THE STUDY**

Geographically, the study was confined to the built up area of the Kiambu Town, defined by the Municipal Town offices to the west, the Indian Bazaar to the south, the road to Administration offices to the East and to the North by the road behind the Catholic Church all the way back to the municipal Town offices. (See Map 1 on page 10)

Theoretically the study is limited by the objectives and the research questions.

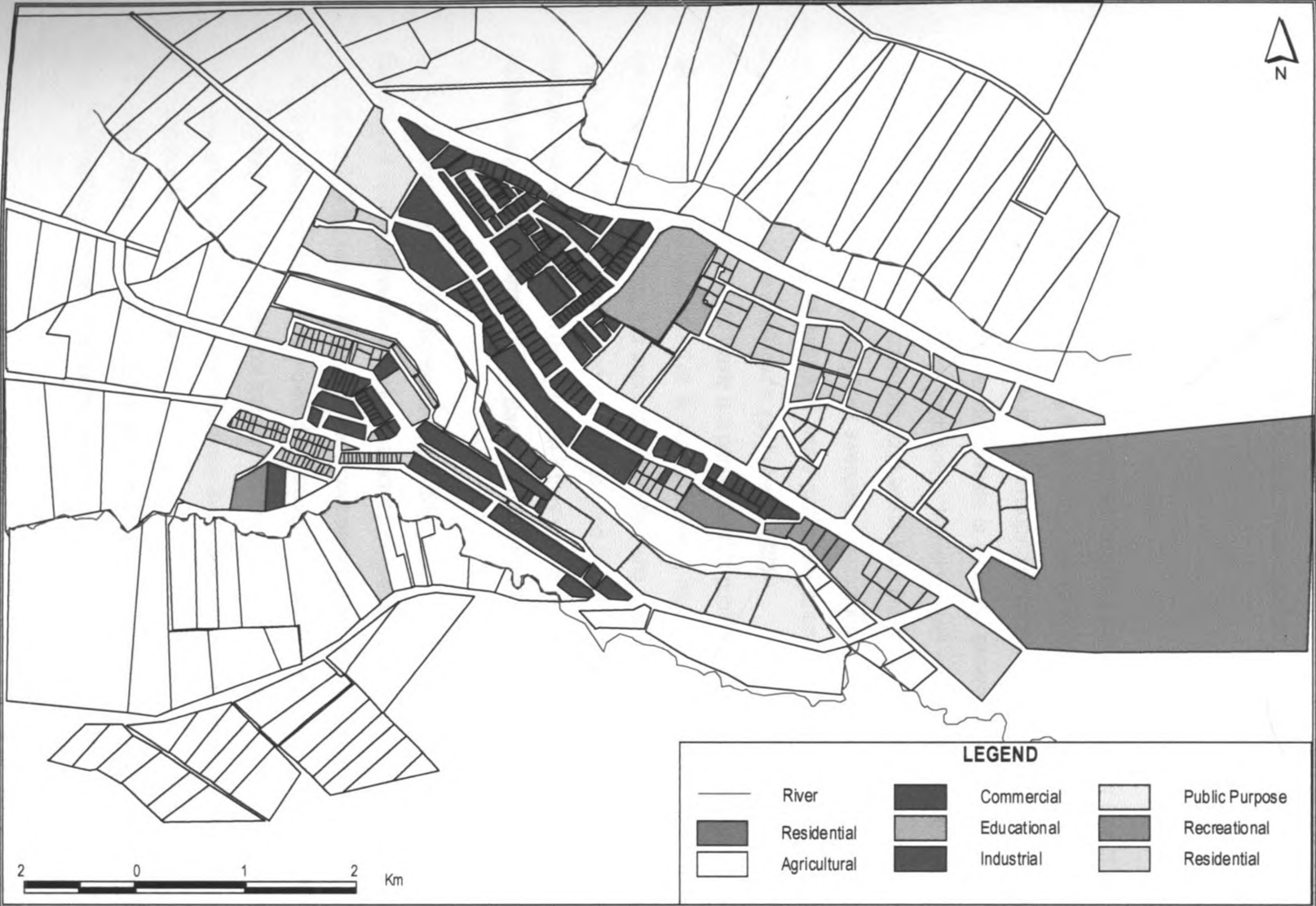
## **1.7 ASSUMPTIONS AND LIMITATIONS OF STUDY**

The major assumption of the study was that Kiambu Town will continue to serve as a secondary town to Nairobi City. Secondly, the study assumes that the town will continue to grow and achieve higher urban administrative status, and this will have the effect of strained infrastructure, unless planning intervention takes place. The main limitations of the study were lack of adequate time to collect larger samples, lack of co-operation from the respondents and limited information from the Municipal council. However, the findings of this study were considered valid subject to these assumptions and limitations.

## **1.8 ORGANISATION OF THE STUDY**

The report constitutes six chapters. The first chapter is a general introduction to the study and the second chapter constitutes the literature review on waste management. The third chapter outlines the methodology employed in the research. Chapter four covers information about Kiambu Town whereas the fifth chapter contains data analysis. Finally, the sixth chapter contains the syntheses of the research findings; conclusions and recommendations; and areas for further research based on the findings of the study.

**Map 1: Geographical Scope of the Study Area**



## CHAPTER TWO: ASPECTS OF SOLID WASTE MANAGEMENT

### 2.1 INTRODUCTION

This chapter is a review of work done on solid waste, and in particular those areas related to the core issues of study. This helped to clarify the gaps that the study was expected to fill as well as to obtain an overview of the experience from other parts of the world with regard to the main concerns of the study.

### 2.2 SOLID WASTE

Solid Waste is also referred to as refuse. Refuse is anything that is discarded for lack of any economic value to the person disposing it and is not intended to be discharged through a pipe. It does not include human waste, but in some developing countries, human excreta are a major constituent of municipal solid waste. Solid waste is generally generated by various human activities of the firm, households or institutions. "Municipal solid waste is defined to include refuse from households, non-hazardous solid waste from industrial, commercial, institutional establishments, market waste and street sweepings. Hazardous industrial waste and medical wastes also form part of the municipal waste particularly when their sources are small and scattered, especially in the small towns. (*Schubeler, 1996*)

According to ETEU 1996, Solid waste is a public good. "A public good is one that has non-rivalness in consumption and one that is non-exclusive – meaning that, once provided to a community in a given area, it is impossible to define who is to use it, and one person's use does not deprive others from using it. A public good is also non rejectable meaning that an individual can not abstain from using it even if they wish to. An example of pure public good is national defence." (*Hardwick, 1999 & Bannock G et al 1987*)

#### 2.2.1 Characteristics of Solid waste as a public good:

*Cointreau S 1996* outlines the following characteristics of solid waste as a public good

- I. It is mainly the responsibility of the local government to provide the service
- II. It is non exclusive – once provided for a given portion of the community, it benefits the overall public welfare, and not just the recipient.
- III. It is non-rivalled – Any resident can enjoy the benefits of the services without diminishing the benefit to anyone else.
- IV. Non-payers cannot be excluded as cleanliness and the safe disposal of waste are essential to public health and environmental protection.



However, what qualifies the degree to which a good is public is; the benefits that accrue to it, for example solid waste has environmental, economic as well as social benefits, otherwise it is an economic good. Other factors that determine whether a good is public or not are:

- The level of public awareness on the benefits of good sanitation;
- Existence and acceptability of sanitation laws;
- Ability and willingness to pay by the beneficiaries;
- Political power of those affected by poor sanitation;
- Quality of local governance;
- State of public finance; and
- Interests of private operators.

### 2.2.2 Categories of Solid waste

Solid waste can be categorised according to the different types of human activities – be they related to individuals and households; the firm; or institutions because they are the generators of solid waste. These categories include:

1. **Domestic waste:** This category consists of wastes that are as a result of household activities such as food preparation, sweeping, clearing of obsolete/unwanted clothing, utensils, furniture or other material. Other household activities that produce domestic waste are gardening and disposal of packaging and reading materials. The category may contain hazardous waste such as paint cans, plastics, radioactive wastes and perfume cans.
2. **Commercial waste** – This category includes waste from shops, retail stores, service stations, entertainment centres, offices, restaurants and hotels as well as markets. The waste comprises of packaging materials, office supplies, food waste, as well as hazardous components such as contaminated hazardous materials, radioactive elements, corrosive and combustible wastes.
3. **Municipal waste** includes street waste from street sweeping, spilled loads, animal manure, and dead animals. Street waste may also comprise both commercial and domestic waste, especially where waste collection from these two sources is poor. The other categories of municipal waste include market waste, demolition and construction, landscaping, parks, junk and train waste.

4. **Institutional wastes**: this category covers wastes from schools, government offices, hospitals, prisons, military stations and others. When the institutions involve residents, most of the wastes are similar to those of households. The waste from hospital constitutes infectious and hazardous materials.
5. **Industrial waste**: They come from processing and non-processing industries. Industrial waste constitutes by-products of mining and mineral waste processing, manufacturing wastes, construction and demolition wastes as well as food and chemical wastes. The composition of industrial wastes is site specific and depends on the natural resources and markets which provide the base for a given area's industrial activity.
6. **Agricultural waste** – waste from animal and crop husbandry such as manure and crop remains. May constitute hazardous wastes such as chemical containers.

The main differences between these various categories of waste are the activities that generate them and the quantities generated. Otherwise each category is capable of generating hazardous wastes, bio degradable wastes, non biodegradable wastes, combustible as well as non combustible wastes.

### 2.3 SOLID WASTE MANAGEMENT (SWM)

Solid Waste Management refers to the collection, transfer, treatment, recycling, resource recovery and disposal of solid waste. Solid Waste Management constitutes all activities that seek to minimize the negative impacts of solid waste on health, environmental and aesthetics. The goals of SWM are defined by Schubeler in his work as: to protect environmental health; to promote the quality of urban environment; to promote the efficiency and the productivity of the economy and to generate employment and income. (**Schubeler, 1996**) Waste management is an essential task, which has important consequences for public health and well being, the quality and sustainability of the urban environment, the efficiency and productivity of the urban economy. (**Mutai, 1996**)

Solid waste management is more than a technological issue. It involves managing a large workforce and working together closely with the public. For the goals of SWM to be achieved, there has to be an integrative sectoral approach, where all the different actors in urban management are involved. Sustainable waste management depends on the overall

effectiveness and efficiency of urban management, the capacity of responsible municipal authorities and other actors.

There are several risks and problems associated with poor solid waste management. These include blocked drains, which leads to flooding and unsanitary conditions. Blocked drains, discarded tyres and cans act as breeding places for mosquitoes, snails among other animals and insects that transmit malaria and other diseases to human beings. Rats found on food waste dumps to consume and spoil food; damage electrical cables and other materials, and spread diseases. Aerosols and dust can spread fungi and pathogen from uncollected and decomposed wastes. Reduced urban aesthetics caused by irregular dumping and poor collection of urban waste discourages efforts to keep streets and open spaces in clear and attractive conditions. Plastic bags are particular aesthetics nuisance; they cause the death of grazing animals should they feed on them. Blocking of streets and access ways by wastes dumped on the access ways is also a major consequence of poor solid waste disposal. Dangerous items such as broken glass, razor blades hypodermic needles and other health care wastes, aerosol cans and containers potentially explosive containers and chemicals from industries may pose risks of fire and poisoning particularly to little children and waste handlers. Polluted water and leachate flowing from waste dumps and disposal sites can cause serious pollution of water supply. Chemical wastes especially persistent organics may be fatal if inhaled, ingested and can cause widespread pollution of water supply. Methane, one of the main components of landfill gas is much more dangerous than carbon dioxide in global heat effect thus causing climatic change. Former landfills and disposal sites provide very poor foundation support for large buildings making them prone to collapse. Solid waste management is a clear indicator of the effectiveness of municipal administration; therefore, poorly managed waste indicates inefficiencies in the municipal administration. Poor solid waste management causes actual and potential loss of revenue for the service providers and other agencies that may be involved in waste treatment/processing. (*Glossdata, 2002; UNCHS 1996; Buckle & Smith, 1994*)

### 2.3.1 Scope of Solid Waste Management

According to *Schubeler (1996)*, SWM encompasses the following functions and concerns;

- Planning and Management - This entails strategic planning, legal and regulatory framework, public participation, financial management, institutional capacity, and disposal facility siting.

- Waste Generation - This constitutes the description of waste in terms of nature, source, amount, rates of generation and composition as well as assessing how waste can be minimised and separated.
- Waste Handling - This encompasses waste collection, transfer, treatment, disposal and treatment of special wastes such as that from medical and small industries.

Therefore, practical objectives and measures related to these areas as well as the roles of the different actors in these particular areas need to be developed for sustainability of any SWM system.

### **2.3.2 Factors affecting Municipal Waste Management Decision**

MSWM is an important entry point for integrated urban management system. A sustainable and effective SWM system will incorporate the technical, political, institutional, social and economic considerations with specific objectives focusing on each aspect of SWM.

#### **2.3.2.1 Local Factors**

For any decision regarding municipal waste management, it is important for the decision makers to consider the political, institutional, environmental and economic realities of both their own community and neighbouring jurisdictions.

*a) Political Setting* – usually very complicated. The various issues are parties interested in local municipal waste decisions – the councillors, news media among others. Citizens may have access to political process and have the ability to generate community support. Business and political interests – as well as community, environmental and neighbourhood groups will have particular points of view during the development of a municipal waste management plan. Entities within the solid waste management industry; for example, haulers, recyclers, facility vendors will also play an important role in the municipal waste planning process. An extensive agenda of other local issues and programmes compete for local resources. The local electoral cycle may affect waste management priorities.

*b) Economic and Fiscal concerns* – Responses to solid waste can be affected by various financial factors such as current monetary outlay requirements, sources of funds and expected future funding programmes for municipal waste management. The amount, structure and mode of collection of user charges; tax assessment, analysis of local recycling markets, energy and compost markets are all important factors.

*c) Institutional factors* -This entails an assessment of the existing framework for coordinating the activities of collection, processing and disposal systems and their ability to accommodate new changes in the SWM techniques. Decision makers have to evaluate the existing staff,

resources and technical expertise available and how to implement and administer new solid waste programmes or adjust to changes in the existing programmes. "Decision makers may find it worthwhile to incorporate into the waste management planning process an assessment of the roles and responsibilities of all concerned public and private agencies to determine whether the management of the solid waste programme resides within the appropriate office or agency." (EPA, 1989)

In contracting, it is important to adopt programmes that are within the financial means of the community; that meet the goals and objectives of the community as well as those that can accommodate changing circumstances.

d) *Liability Factors* – The entire process of SWM contains financial, legal, and environmental concerns. Decision makers must assess the amount of risk they are willing to take in each area and plan accordingly. Some legal and environmental impacts have a continuous effect even when facility has been closed down for example ground water contamination and production of methane gas by land fills.

e) *Public/ private co-operation* – state and local governments should work closely with private sector waste handlers, secondary material processors and other interest groups.

### **2.3.2.2 Multi – Jurisdictional Factors**

These factors constitute regionalisation where by different local authorities may cooperate in service delivery in areas of their jurisdiction. Such cooperation intensifies economies of scale so far as environmental protection, procurement, financing and management are concerned – in other words - utilisation of capital and management. Cooperation at the regional level may be difficult but can be achieved either by establishing a quasi governmental agency with independent bonding authority or by establishing a larger local authority in charge of the waste disposal programme. This also entails working closely with local co operatives and NGOs. (EPA, 1999)

### **2.3.3 Criteria for a suitable solid waste management system**

There are many factors that vary from place to place and that must be considered in the design of a solid waste management system. Amongst them are:

a) *The waste itself* – the nature and type of waste affects the weight and moisture contents of solid waste; for example, in the developed world, waste is light and less wet because products are packaged in paper, plastic, glass and food is mainly pre-processed. (Glossdata, 2002). In developing countries, construction and climatic factors, as well as purchase of fresh produce

such as vegetables and fruits; and products that are not pre-processed are other factors that often make waste dense and wet. Dense waste corrodes waste equipment, limits use of more efficient methods like incineration and makes waste collection very laborious, as large numbers of collectors is required. Recycling and salvaging operations often reduces the proportion of combustible paper and plastic in waste before it reaches the incineration stage.

*b) Access to waste collection points* – many sites where waste is stored or dumped for collection must only be reached by roads or alleys, which are often inaccessible to motorised methods of transport because of their widths, slope, surface and congestion.

*c) Public awareness and attitude to wastes* can affect either readiness to carry wastes to a shared container; willingness to accept the approximations of a shared container or to segregate waste in order to assist recycling. In addition, it may affect frequency at which waste should be collected, amount of litter that are left on the streets, the opposition to the siting of waste treatment and disposal facilities and willingness to pay for SWM services. Gender issues with regard to waste recycling and collection activities and the social groups from which waste management staff can be drawn are also factors that affect the choice of solid waste management system.

*d) Selection of Equipment and vehicles* – selection of equipment is influenced by the factors already mentioned above; financial capacity of stakeholders and the types of vehicles that are already widely used as well as availability of spare parts and maintenance expertise. Taxes, duties and import restrictions should also be considered.

*e) Institutional issues* - Current and intended legislation, and its enforcement standards and restrictions may limit the technology options that can be considered. The government policy with respect to private sector involvement affects technology choice. Strength and concern of trade unions can also have important influence on what can be done. The capacity of the different actors involved in waste management in terms of human resource, financial management, information management, legal framework, power and authority is a key institutional consideration.

### **2.3.4 Stages of solid waste management**

There are four stages in waste management namely: waste generation; waste storage; waste collection, transfer and transportation; and, finally, waste treatment/processing and disposal.

#### **2.3.4.1 Waste Generation**

This is the stage when the material becomes unwanted and is discarded. Waste generation takes place at the location of different human activities and, therefore, the main waste generators are households, firms and institutions.

#### **2.3.4.2 Waste Storage**

This relates to the keeping of solid waste in a place or container awaiting collection. Waste may be stored at communal or individual level. The various methods of refuse storage are: -

a) *Bins* – Bins are the traditional and still the cheapest method of refuse storage. They form an acceptable means of refuse storage if: adequate capacity in numbers and sizes is allowed; the placing of the dust bin is arranged conveniently for both the user and the collecting staff and adequate ventilation is allowed and an easy to clean standing place is provided especially in cases of wet wastes. The noise inevitably associated with metal bins is largely overcome by the use of rubber and plastic bins.

b) *Paper sacks/bags* – The labour involved in collecting refuse may be reduced by using paper sacks or bags rather than the bins. Sacks are advantageous because they are not emptied, therefore, collection is considerably more hygienic and simpler vehicles may be used. Paper sacks are increasing in use especially in the case of refuse collection firms. They may be used separately or they may be mounted in a container for easier usage.

c) *Refuse chutes* – In high-rise residential or commercial building it is not practical to require that all refuse to be carried by occupants to containers in the ground level. One way of overcoming this problem is by providing a chute, which will take refuse from higher floors and deliver it to a container at ground level. It is essentially a pipe, carried up to the roof level and is vented. Refuse is introduced into the chute through the delivery points. These points are arranged on the communal landings on each floor of the building. They are constructed of large diameter pipes usually about 450mm to reduce the risk of blockages. The ground floor container must be easily accessible for refuse collection. Also the possibility of a fire starting in a refuse container must always be borne in mind and preventive measures taken. Something else to be borne in mind is the inevitable noise when solid items fall down the chute and perhaps break in the container. Any type of refuse can be dealt with provided it will go into the receptacle.

d) *Constructed dump points* – These are mainly for communal use and are mainly constructed of stone. They may be raised or at the ground level.

e) *Irregularly established waste storage point* – These are waste dump arbitrary established by communities for temporary storage of waste awaiting collection by the responsible agency.

#### **2.3.4.3 Waste Collection and Transfer**

This is the process of picking wastes from the point of generation or storage, loading them into a collection vehicle and transporting them to a processing, transfer or to the disposal point. The methods of waste collection include: -

- a) *Collection vehicle* – should have a low loading height of say 1.6m. They may be covered or open, but covered vehicles prevent bad smells. They should have sufficient capacity.
- b) *Handcarts* – these are cheap, easy to maintain and suitable for narrow streets. They are limited in their range in terms of the distance they can cover, the quantity and the quality of waste they can carry.
- c) *Animal transport* – this mode of transportation is suitable for hilly areas, bad roads or where sophisticated collection vehicles are not available. For example, use of donkey carts in Cairo and bullock carts in Jakarta. They save on fuel and maintenance costs associated with sophisticated vehicles. **(Holmes, 1983)**
- d) *Trailer and tractor* – this method provides a lot of flexibility. A simple tractor may be used for several trailers. A trailer may be used as a communal storage unit and be removed when full.

According to **Kunitoshi (1990), and EPA (1989)** the method and system of waste collection used depends on:

- a. *Quantity of waste and type of waste* – For large volumes and bulky wastes such as appliances, furniture and tree branches, large capacity systems for example, the trailer will be required and a suitable plan for their collection should be established. Probable programmes are collection with other wastes, collection upon request, pick up along defined routes at various periods or pick up after report from collection crew. Other considerations are whether wastes are hazardous, liquid, or solid and also their shape.
- b. *Frequency of collection* – this is a factor of cost, customer service, population density, activities in the area and other factors. However, the major factors are costs, storage space and sanitation requirements. Small capacity vehicles and handcarts are suitable for frequently collected waste.
- c. *Access to the property/source of waste* – A combination of handcarts and trailers may be used for inaccessible waste generation points with large volume of waste. Collection routes need to be programmed in order to ensure that there is a reduction in person hours, vehicle mileage and energy as well as to achieve maximum collection crew safety. This is increasingly needed with rising improvements in waste management practices.



- d. *Affordability Cost of labour relative to cost of equipment* – the most feasible option should be employed with regard to resources of labour and equipment available.
- e. *Cost and ease of maintenance of equipment* – Equipment such as vehicles, trailers and tractors attract maintenance costs that are subject to availability of spares and qualified personnel to maintain the equipment.
- f. *Type of storage* - Proper container selection can save collectors' time, energy, increase the speed of collection, and reduce crew size. This should be covered by legislation. Criteria for container selection is as follows:
- Efficiency - containers should maximise the overall collection efficiency.
  - Convenience – for both the residents and collection crew. There should be weight limit specifications.
  - Compatibility – the containers should be compatible with the collection equipment.
  - Public health and safety should not be compromised.
  - Ownership – municipal containers are more trustworthy.
- g. *Point of collection* – affects crew size, storage, and ultimately cost of collection. The residential collection points include alleys, back yard/ on property and drop off centres. In Drop off centres, cost reduction is the most important aspect of collection rather than service provision. Commercial collection points are generally at the establishments themselves.
- h. *Housing market* – whether government dominated or private
- i. *Housing conditions* – age of estates and the planning of the estates affects collection systems/methods.
- j. *Collection Vehicles* - Vehicle selection is critical to the productivity and cost effectiveness of waste management. Collection vehicles come in a variety of sizes and shapes. Selection should be based on specific local needs. They could be automated or mechanised. The various types of trucks are: Rear loaders. Side loaders, front loaders, Roll-off and tilt frames, Transfer trailers and vehicles designed for recyclables. The factors to consider in vehicle selection are:
- Personnel qualifications, materials loading efficiency and entry and exit points.
  - Vehicle – storage capacity, fuel efficiency, capital outlay, operations and maintenance costs. In addition, local system and factors affecting the vehicle choice need to be evaluated. These are population density, street

configuration, traffic conditions and topography. Distance between point of collection to disposal points as well as the weight limits are further considerations.

- Flexibility of the equipment to adapt to changing collection demands.
- k. *Collection crew size and personnel management* – depends on existing equipment, distance between collection points, types of wastes collected and union contracts. Since there are no avenues for growth in the job, various other motivational incentives should be employed. These are training, safety clothing, and vaccination against transmittable diseases. For example **Holmes, (1983)** indicates that in Manila, workers have been motivated with attractive uniforms, free insurance, incentive payments and by the use of small handcarts with portable bins for collecting street sweepings.
- l. *Financing of the waste collection system/method* – This refers to the charges payable, when and how they are paid. According to **UNEP-ETEU (1998)**, the efficiency of any waste collection-charging mode depends on:
- The economic instrument to employ in the collection of waste – The collection charges should match with the choice and design of collection system so as to avoid problems associated with the implementation of the system. These problems are related to the nature of service whereby charging for solid waste is difficult, as it's purely a public good. High charges encourage illegal dumping. Expenditures could be met from general government funds or taxes. Cross- subsidization needs to be accompanied by higher willingness and ability to pay of the clients.
  - Charges for special standard consignments of domestic waste appear to work fairly well Pay As You Dump policy is unacceptable because it encourages free – rider behaviour.
  - Privatization of waste collection has proved to be successful both from environmental and economic viewpoint. The decision whether to keep private or public waste collection and transfer has become a major issue in SWM. The table below shows the pros and cons of public and private collection.

**Table 1 : Comparison between public and private waste collection**

PUBLIC COLLECTION	PRIVATE COLLECTION
<b>Advantages</b>	<b>Advantages</b>
1. Non profit oriented therefore charges do not constitute profit margin.	1. May be less susceptible to political interference.

2. Government operation results in purchasing advantages	2. Competition can increase system efficiency and improve services
3. Centralised operation allows standardisation of procedures.	3. More flexible management structure.
4. More flexible design procedures	4. can involve less strain on municipal budget
<b>Disadvantages</b>	<b>Disadvantages</b>
1. Susceptible to political interference	1. Profit structure and taxation costs may be passed on to customers.
2. Short term politics may favour cheapness instead of long term economies	2. Community dependence on one service provider may occur and thereby lower the advantages of competition.
3. capital expenditures take long to process	3. Third party administration requires Municipal oversight.
4. Personnel efficiency may be lower than that of private firms	4. Accountability – financial difficulties and contract problems can hinder services.

Source: EPA, 1999

#### 2.3.4.4 Waste Treatment/Processing and Disposal

This is the final destination of the waste. It appears that in most developing countries and many medium income countries, very little progress has been made in upgrading waste disposal operations. Open dumps where waste is unloaded in piles, make very uneconomical use of the available space, allow free access to waste pickers, animals and flies and often produce unpleasant and hazardous smoke from slow-burning fires. The various methods of waste treatment/processing and disposal are Incineration, Composting, Open Dumping/Crude Tipping, Controlled Tipping and Resource Recovery.

##### 1. Incineration

This is the process of burning solid waste under controlled conditions so that satisfactory temperature and timing are maintained in order to reduce combustible waste weight and volume and often to produce energy. The residual is disposed on land or in water. Incinerators when on site save on transportation costs but incineration is an expensive operation and the incinerators are expensive and difficult to maintain. Also, in most instances the wastes are too wet to burn by themselves. Incineration may be carried out at source or at a central depot. The former reduces the amount of storage space required prior to collection and turns offensive waste into sterile or harmless ash. It also reduces the actual labour collection costs. Incineration at a central depot reduces the final dumping problem. An effective incinerator can reduce the volume of collected waste by as much as 90-95% and at the same time changing the harmful material into harmless ash. In locating an incinerator, the site should conform to existing neighbourhood character. In general industrial and commercial areas are more compatible with incineration than residential

areas. It is also most suitable for hospitals where potentially dangerous wastes are disposed instead of mixing them with general municipal waste.

## **2. *Dumping/crude-tipping***

This is dropping of wastes in compost pits or on open ground. It is not satisfactory from any point of view but it is widely practiced in many countries. Many environmental problems associated with SWM arise from crude tipping.

## **3. *Controlled Tipping/ Sanitary Landfill***

This is an engineered method of disposing of solid waste on land in a manner that meets most of the standard specifications, including sound siting, extensive site preparation, proper leachate and gas management and monitoring, compaction, daily and final cover, complete access control and record keeping. The method aims at minimizing problems associated with crude tipping. The site is carefully chosen to prevent pollution of water resources and nuisance to the local inhabitants. The dumping of waste is conferred to a particular area such that one day's waste is covered with the next day's waste. The refuse is laid down in dense uniform layers and is covered with soil. The waste may be compacted by special vehicle. Compacting prevents formation of voids and reduces spatial consumption by the waste; as well as preventing littering of the waste. Fires are prevented by site discipline and by the cover material, which prevents the entry of oxygen, as well as preventing bad smell. Water pollution is minimized by sealing the site with a layer of clay when tipping level has been reached. The land can then be reused, for example, as a park because the refuse is laid down uniformly so that the settlement is uniform. However, such land can't be developed with buildings because it's already weakened and would be prone to settlement thereby rendering it unsafe. The sanitary landfill method has encountered less public opposition, as it has fewer nuisances.

### *Leachate Formation and Control in Landfills*

"Leachates are liquids that emanate from wastes carrying dissolved or suspended concomitants. Leachate emanates from precipitation entering the land fill and from moisture that exists in the waste when it is disposed." (*EPA, 1989 pg 110*)

Concomitants in waste result from disposal of industrial waste, ash, waste water sludge, household hazardous waste or from normal waste decomposition. Uncontrolled leachate leads to contamination of surface and ground water. Leachate composition varies from site

to site and in the same site from time to time depending on the age of the land fill, degree of decomposition, types of wastes disposed and the physical modification of waste. Liners made of low porosity soils like clay and synthetic materials are fixed in the land fill, where leachate collection pipes are placed above these liners and collected into a pump or treatment work. Leachate treatment may be in the form of: Public owned treatment works which is not always applicable because leachate may constitute concomitants that can interfere with operations or onsite treatment which is very costly or Recirculation. It is important to monitor the ground water and surface water in order to detect any concomitants.

#### *Methane Formation and Control*

Methane gas is a product of the anaerobic decomposition of organic refuse. At and around the land fill, methane can migrate through soil and accumulate in closed areas like building basements where it may explode when it is ill managed and controlled. Methane can be controlled through passive or active processes. Active methods entail use of blowers to extract land fill gases from the land fill. Passive methods involve digging of trenches around the perimeter of the land fill and are filled with gravel and perforated piping. Trenches may be lined with clay or synthetic material to prevent gas from escaping to other areas.

#### *Methane recovery*

Methane can be purified and used as fuel.

#### *Landfill Closure and Post Closure care*

Closure means capping the landfill with a low permeability material to prevent moisture infiltration and filling it with vegetation supporting top soil. Closure also entails maintaining the function of moisture and leachate collection and monitoring equipment. Post closure care usually involves inspections of the site; land surface care, leachate hauling and transport and methane control. Monitoring is a post closure activity designed to detect any adverse environmental impact.

### **4. Resource Recovery**

Resource recovery is the process of obtaining some economic benefit from material that someone has regarded as waste. Resource recovery/scavenging is carried out at different levels of waste management systems and in different ways. Some of the methods are carried out in large commercial areas or in residential areas at dumpsites. There are isolated cases where scavengers travel from house to house buying secondary materials. Sometimes, waste collectors sort out the waste before loading it into the vehicles.

Scavenging activities at the dumpsites cause health risks to the scavengers due to smells, likely fire outbreaks and exposure to injuries such as cutting. Scavenging is a useful activity particularly because it is a source of income for the scavengers. However, the methods used sometimes reduce the efficiency of waste management system, especially where informal waste collectors open up waste bags before collection, thereby pouring the contents on the streets. This increases the time required to collect materials by the formal collection sector. Therefore, there is need to modify the existing scavenging practices.

**Kozmiensky (1986)** in his work outlines the various modes of resource recovery as:

- a) Re-use - This is where waste material is used for same purpose again for example re-filing soft drinks bottles.
- b) Recovery – This refers to processing material so that it can be used as the same material but to serve diversified purposes for example, processing of waste papers to make pulp and then newspaper.
- c) Conversion – The processing of material to make something different such as producing of clothing from material waste; sleeping bags from plastic bottles or producing compost from food waste.
- d) Energy Recovery – Burning of waste so that the rest can be used for heating swimming pools or collecting gas produced from Very large sanitary fills and use it as fuel or generate electricity.
- e) Composting - This is the use of natural biological processes to change the organic portion of solid waste into stable humus material. Artificial fertilizers may be used as a source of nutrients but compost is valuable because it improves the structure of the soil and provides nutrients. The humus material acts as soil conditioner. Composting is eco-friendly but markets for the final products are a problem to find. In addition, many large scale and small scale composting schemes have failed because composting is regarded as a disposal process, and not a production process. A lot of land is required and composting can only be carried out on organic wastes.

According to **Flintoff (1984)**, the choice of resource recovery method depends on:

- (i) Cost of separated material and separating material
- (ii) Purity of waste
- (iii) Quantity and location
- (iv) Cost of storage and transport are major factors that determine economic potential for resource recovery.

- (v) Income levels or development level of a country - in low-income countries this may generate employment because it is done in a labour intensive way and for relatively low incomes whereas in high income countries the modes chosen are those that enhance the law related to environmental protection.
- (vi) Impact on the environment of the system for example composting is cheap ecologically safe but causes smells and other aesthetic impacts.

Table 2 below is a summary of the strengths and weaknesses of the various waste processing and disposal methods.

**Table 2: Summary of the strengths and weaknesses of the waste processing and disposal methods**

<b>Method</b>	<b>Advantages</b>	<b>Disadvantages</b>
Incineration	<ul style="list-style-type: none"> <li>▪ When carried out at source, it reduces the amount of storage space required prior to collection of waste</li> <li>▪ Incineration at a central depot reduces the final dumping problem</li> <li>▪ Requires minimum land</li> <li>▪ Refuse volume is reduced significantly</li> <li>▪ Reduces the harmful material into harmless ash that is stable and odour-free and is therefore environmental friendly</li> </ul>	<ul style="list-style-type: none"> <li>▪ Not suitable for dense and waste because equipment will corrode and the burning process may be ineffective</li> <li>▪ Very expensive because it requires huge capital outlay and incinerators are difficult and expensive to maintain.</li> </ul>

Resource Recovery	<ul style="list-style-type: none"> <li>▪ Source of employment</li> <li>▪ Less pollution of the environment</li> <li>▪ Cost effective</li> <li>▪ Environmental friendly because it is ecologically safe and aesthetically harmless</li> <li>▪ Composting yields natural organic fertilizer for agriculture and horticulture</li> <li>▪ Involves more actors and especially the informal sector</li> </ul>	<ul style="list-style-type: none"> <li>▪ Health risks to scavengers due to smells, likely fire outbreaks, exposure to injuries such as cutting</li> <li>▪ May reduce the efficiency of the waste management system especially where scavengers open up waste bags before collection, thereby pouring contents on the streets</li> <li>▪ Sometimes expensive e.g. composting when done on large scale</li> <li>▪ Some methods negate on the basic principles of occupational health and negative environmental effects such as those associated with recovery of automobile batteries at the home level</li> <li>▪ Vast amount of land is required for composting if done on large scale and it can only be done for organic waste.</li> </ul>
Dumping/crude tipping	<ul style="list-style-type: none"> <li>▪ Simple and cheap to establish and operate therefore inexpensive in the short run.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Not satisfactory from any perspectives, be it environmental, health, or economy because it is breeding site for rats, vermin, mosquitoes and other undesirable pests.</li> <li>▪ High rates of pollution due to smokes from burning and increases health risks</li> <li>▪ Waste of land and is a nuisance to nearby properties</li> <li>▪ Ground water and run off pollution</li> </ul>
Controlled Tipping/land filling	<ul style="list-style-type: none"> <li>▪ Reduces pollution of water resources and nuisance to the local inhabitants</li> <li>▪ Fires are prevented by site discipline and cover of material</li> <li>▪ Filled sites can be reused for other community purposes.</li> <li>▪ Reduces problems associated with crude tipping</li> <li>▪ Provides a final disposal alternative for remnants from all other disposal methods</li> </ul>	<ul style="list-style-type: none"> <li>▪ Land degradation</li> <li>▪ Requires technical expertise for planning, design and operation</li> <li>▪ Produces methane gas, which if not well managed may cause fires and global heating.</li> <li>▪ Requires vast amount of land</li> <li>▪ Produces leachate which may find itself into water bodies</li> </ul>

Source Author, 2004



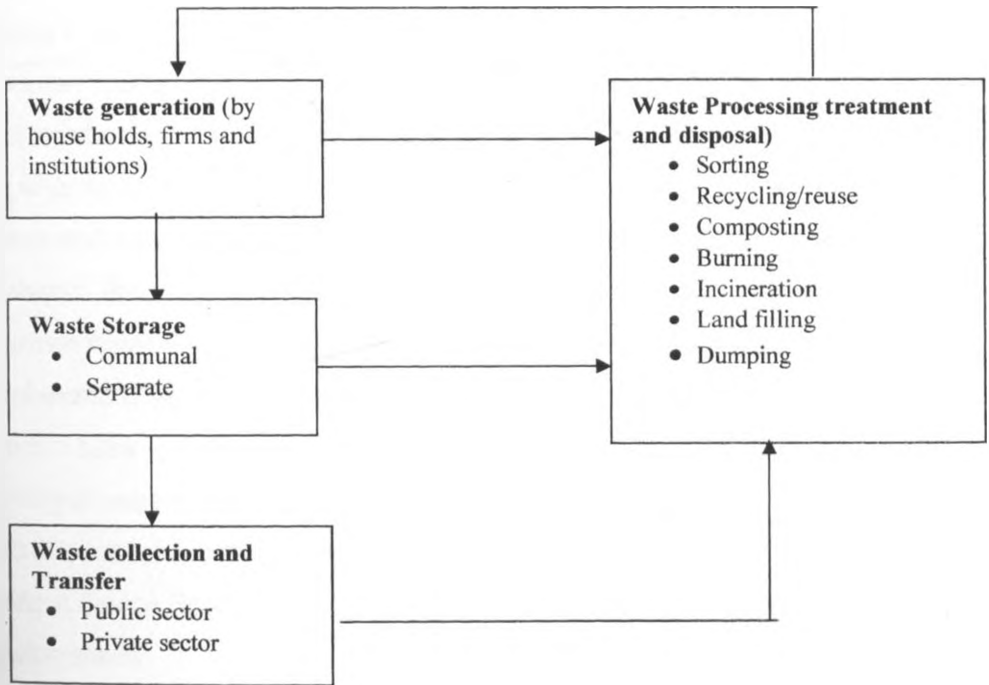
**Table 3: Comparison of different waste Disposal methods**

Criteria	Method			
	Incineration	Resource Recovery	Crude Tipping	Controlled Tipping
Environmental protection	Good	Good	Very bad	Good
Land Requirements	Minimal	Fair	Massive	Fair
Financial Requirements	High	Minimal	Minimal	High
Economic Benefits	-	Fair	-	-
Land Degradation	None	None	Massive	Massive
Health and Safety promotion	Good	Good	None	Fair

Source Author, 2004

Figure 1 below is a summary of stages involved in solid waste management:

**Figure 1: Stages in solid waste management**



Source: Author, 2004

## 2.4 SYSTEMS OF WASTE REDUCTION AND MATERIALS RECOVERY

### 2.4.1 The concept of Source Reduction

Broadly, source reduction may be defined as an approach that precedes waste management and addresses how products are manufactured, purchased and used. It is the “design, manufacture, and use of products so as to reduce the quantity and the toxicity of waste produced when products reach the end of their useful lives.” (EPA, 1993; Pg 51)

However source reduction can narrowly be defined to include all activities employed by waste generators with the aim of reducing the amount of waste that gets into the waste stream. For example, at the household level, source reduction may occur through selective buying patterns and reuse of products and materials. Business enterprises can also reduce waste by buying in bulk, buying durable goods, reuse of products among other simple methods. There are several Source Reduction Programs. These include;

- a) product Reuse for example reusable plastic bags
- b) Reduced material volume – refers to use of lighter aluminium cans, glass or even buying in bulk.
- c) Reduced Toxicity – for example substitution of lead and cadmium in ink and paints.
- d) Increased product life time – for instance use of longer lasting tyres, and designs that allow for repair rather than disposal.
- e) Decreased consumption – for instance buying in bulk or refusal to buy disposable materials like razor and batteries when reusable options are available. Reusing common materials such as plastic bags, repairing all kinds of materials from clothes to appliances, buying concentrates and powdered drinks, and using long life energy efficient bulbs.
- f) Sorting of waste is a key step in ensuring waste reduction. This is because waste is put into different categories and treated accordingly.

Implementing a Source Reduction Programme needs co operation by all stakeholders. The implementation entails:

- *Education and research* – the target groups are consumers, businesses, industry, government and other institutions such as schools. The aim is to provide and develop information about source reduction needs, goals and methods to elicit voluntary efforts by the public and private sectors to help to bring about specific changes. Activities may take the form of information

- sharing between industries, media campaigns and posters in departmental stores, incorporating solid waste management courses in school curricula, exploring funding sources to support such programmes, forming a council constituting of industry and government to develop source reduction message.
- *Financial Incentives and Disincentives* - Financial Incentives introduce an economic benefit to the increase of source reduction activities whereas financial disincentives introduce a cost to waste producing activities that can be reduced through source reduction activities. Target groups are consumers and the industry. Examples of these incentives and disincentives are tax credit and exemptions; variable disposal charges; product disposal charges which can either be charged on the manufacturer at the time of production or on the consumer at the time of purchase. It is difficult to assess the effectiveness of such charges though they can finance the correction and reduction of impacts associated with product disposal.
  - *Regulation* – This can be done by encouraging source reduction policies, establishing a program to inform consumers about a product's environmental impacts, durability, reusability and recyclability.

#### **2.4.1.1 Criteria for evaluating source reduction option:**

- i) Social and economic equity
- ii) Economic and administrative feasibility, efficiency and cost
- iii) Volume requirement and scarcity of materials and natural resources used in a product's manufacture
- iv) Volume of a product and it's manufacturing by- products that eventually must be disposed.
- v) Useful life, reusability or recyclability of the product.
- vi) Priority of source reduction of products from products more hazardous to products that are less hazardous to both human health and environment.

#### **2.4.1.2 Economic and Environmental effects of source reduction**

Source reduction saves disposal costs because reduced waste volumes means less is transported and managed. It also reduces pollution costs for example less land fill leachate, less ash to dispose of, fewer ecological impacts, and fewer aesthetical problems.

"From the point of view of waste reduction, the traditional practices of repair and reuse, and the sale, barter, or gift of used goods and surplus materials, are an advantage to the poorer countries. Quantities of non-organic post-consumer wastes would be higher without them.

These societies should be alert to socio-economic changes that threaten resource-conserving traditions. When standards of living rise, voluntary source separation tends to decline, unless it is either encouraged through an incentive program or the opportunities for waste generators to sell recyclables remain very convenient. Small waste trading enterprises which provide convenient redemption centres for households, shops and itinerant buyers are adversely affected by rising land prices, more high-rise accommodation, traffic regulation and NIMBY (Not In My Back Yard) objections. Imported, high quality recyclables can undercut the market for local materials resulting in a decline of waste recovery when economic motivations for separation and sale decline, public education should foster environmental charitable motives for waste reduction." (*Gloss data, 2002*)

#### **2.4.2 Source reduction and resource recovery in industrialised Countries**

Perhaps in no field of MSWM are the differences in the industrialised countries and developing countries so apparent as in waste reduction and materials recovery. Rising overall living standards and the advent of mass production have reduced markets for many used materials and goods in the affluent countries whereas in most of the developing world, traditional labour-intensive practices of repair, reuse, waste trading, and recycling have endured. Thus, there is a large potential of waste reduction in the former countries, and the recovery of synthetic or processed materials is now being emphasized. In developing countries, by contrast, the greatest potential for waste reduction currently rests with diverting organic and construction waste.

Subsidization of the full range of initiatives for waste reduction (from changes in manufacturing and packaging to source-separated collection and the promotion of recycling and composting) by governments is now becoming a norm in the affluent nations. Most cities in Western Europe, North America, Australia, New Zealand, Japan, and some in Korea have adopted municipally sponsored source separation and collection systems. In some cases, the separation of post-consumer materials by waste generators has been made mandatory.

The main motivation, from the point of view of municipal authorities, is to reduce materials that must be deposited in landfills. At the national level, under the rubric of producer responsibility governments have crafted agreements and legal frameworks designed to reduce the generation of waste. Typical components of municipal systems for source separation and materials recovery in industrialised countries are: First, source separation of different

categories of waste from households, offices, shops and institutions; collection at curb-side or drop-off by generators at bins or centres is subsidised by governments or private industries. Second, collection of organic wastes for large-scale composting, thirdly, promotion of backyard composting through education and sometimes through provision of a small compost bin, and lastly, public subsidisation of extensive and varied educational campaigns to sustain participation in all aspects of waste reduction.

### **2.4.3 Source reduction and resource recovery in Developing Countries**

Most developing countries have various processes aimed at recovering of materials from the solid waste stream. Local industries have a strong dependency on secondary materials for re-processing including cardboard, plastic materials and metal. However some methods negate the basic principles of occupational health and in some cases they cause significant negative environmental problems such as recovery of automobile batteries at home level.

“Most urban places in the developing world have yet to experience the decline of traditional recovery of recyclables and the corresponding increase in post-consumer wastes, which, together with scarcity of dump space, have led many affluent cities to sponsor materials recovery. The engines of waste recovery and recycling in the poor countries include: scarcity or expense of new materials, the occurrence of absolute poverty, the availability of workers who will accept minimal wages, the frugal values of even relatively well-to-do households, and the large markets for used goods and products made from recycled plastics and metals. Wastes which could be uneconomical to recycle or are of no use in affluent societies have a value in developing societies, for example, coconut shells and dung used as fuel. If one takes into account the use of compost from dumps sites as well as materials recovery in countries like India, Vietnam, and China, the majority of municipal wastes of all kinds are ultimately utilized.”

*(Kunitoshi, 1990)*

Waste reduction that could be achieved by legislation and protocols (such as agreements to change packaging) is not, at present, a high priority in these countries, although some are now moving in this direction. Because unskilled labour costs are low and there is a high demand for manufacturing materials, manufacturers can readily use leftovers as feedstock or engage in waste exchange. Residuals and old machines are sold to less advanced, smaller, industries. Public health is benefiting from plastic and boxboard packaging that reduces contamination of foods and much of the superior packaging is recovered and recycled.

The greatest amount of materials recovery is achieved through networks of itinerant buyers, small and medium dealers, and wholesaling brokers. The extent to which the waste trading enterprises are registered (formalized) varies in developing regions, for example in Latin America and Asia there is more formal registration than in Africa. The system is adaptive to market fluctuations, as the lowest level workers form a dispensable labour cushion and they must find alternative work, if they can, when there is reduced demand for the materials they sell. Due to the large numbers of people engaged in the activities of materials recovery, processing, and recycling and alternative work is scarce, governments and social welfare organizations are often more sensitive to employment needs than to environmental considerations in waste management. Thus, they are prepared to trade off some environmental and public health risks against employment generation.

Resource recovery/scavenging takes place in most urban areas in developing countries. The process is carried out at various stages of waste management system and in different manners. In offices and institutions, cleaners and caretakers organize the sale of paper, plastics, and other recyclable materials. At the household level, gifts of clothes and goods to relatives, charities, and servants are still significant in waste reduction.

#### **2.4.3.1 Addressing waste picking in Developing Countries**

The picking out of recyclables from mixed garbage at street bins, transfer stations, and dumps is very common in many developing countries. This practice is particularly risky where municipal wastes contain human excreta, and biomedical and industrial wastes, and where pickers do not have protective clothing or access to washing facilities. In addition, children and pregnant women are numerous among pickers. According to **Cointreau (1989)**, most municipal authorities do not have the capacity to enforce prohibition of picking, which is a sensitive topic in some cities where many thousands of poor people survive on earnings from this activity. In addition, very poor people obtain some of their basic needs from garbage. City demonstrations thus face difficult issues with regard to picking. The following actions have been suggested by NGOs and social activists:

- Subsidize protective clothing to reduce the health risks of picking (unfortunately, such clothing is usually sold by those to whom it is given);

- Provide access to basic health care and inoculations against diseases that can be contracted from the practice.
- Regulate picking, by the provision of designated picking areas at transfer stations and dumps;
- Enable pickers to organize cooperatives to improve their earnings and working conditions; and
- Control harassment of street pickers and itinerant buyers (since such harassment tends to increase dump picking).

There are numerous examples of partial attempts to achieve such goals, but no detailed evaluation of the results. Cooperative organization has helped some pickers to become buyers of source-separated, clean materials, particularly in the Andean countries. Many NGOs are assisting picker families in Africa and Asia; in fact, no large city is without some examples. The readiness with which materials taken from mixed garbage can be cleaned and dried can significantly improve the prices that pickers obtain for them, and can reduce the health hazards to which pickers are exposed. NGOs are therefore developing simple cleaning and processing techniques.

Dump picking is more hazardous than street picking. There are no reports of significant reduction in health risks for dump pickers except when there have been substantial improvements in their basic living conditions. The provisions of gloves and boots to pickers in Calcutta and other places failed, as they sold the clothes and continued to work as before. "Schemes for setting up conveyers belt plants at dump sites to facilitate sorting (as was done in Europe in the 19<sup>th</sup> Century) are often discussed. Mexico city and Ciudad Juarez have built such plants. In Seoul, on the other hand, NGOs have assisted dumpsite communities more broadly, with housing, sanitary facilities, medical care, and education. It is possible that establishing designated picking areas at dumps away from the tipping face would help dump management. In fact, at large dumps, pickers usually cooperate among themselves and with staff to avoid chaos and accidents." (*Kozmiensky, 1986*)

Technology decisions in solid waste management also affect the feasibility of waste picking for poorer families who depend on this source of income. Efficient collection of garbage in closed containers means that more recyclables are deposited in dumps, albeit in a much dirtier and

damaged condition. As a result, more people resort to dump picking. Cities with closed Municipal Solid Waste collection system that is to say, collection from lidded containers, is covered vehicles and substantial numbers of poor people often have dumps controlled by gangs or entrepreneurs, who exploit the pickers. The use of compactor collection trucks and compaction and cover at dumpsites damages many materials and renders them useless.

While societies should do everything possible to reduce the attractiveness of picking, it must be recognized that the decline of this activity has occurred in the past only when the general standard of living and employment opportunities for low-skilled people have reduced poverty and unemployment. Help for waste pickers must extend to their living conditions and primary health care; assistance confined to clothing or facilities at dumps may give insignificant returns in terms of health. Sorting sites, access to water, and some simple drying and baling machines are facilities that NGOs or municipal administrations can help picker groups to attain.

Recovery and recycling, although basic principles of sustainable development impose significant health risks on those involved, especially when carried out informally. This is particularly so in places where sanitary facilities are non-existent or deficient. Industries using recycled feedstock are in many cases more polluting than those using virgin materials. Such industries tend to be small-scale in developing countries, so they are often not subject to environmental regulation. Environmental improvement must encompass assistance to such small industries.

#### **2.4.4 Experience in other regions with regard to facilitating Resource Recovery**

There have been many attempts to form cooperatives and small enterprises in waste recovery elsewhere. They have beneficial environmental and social impacts. Cooperatives usually achieve stability in cities where decline of informal networks of waste buyers and sellers has left gaps in recovery systems. Co-operatives and small-scale enterprises that buy and sell recyclable materials have had some success in parts of Latin America.

Small enterprises and cooperatives need external support to start up and to be successful. It is helpful, if this support comes, at least in part from the local government. Ideally, the local government should provide a location where the recyclable material can be stored and sorted more thoroughly before being disposed or sold to wholesalers and dealers. Coordination with factories using secondary materials greatly helps the efficient flow of materials. The enterprises



also need follow up support and training. This is best done by NGOs, although in some cases, training by recycling industries is also possible. Eventually, an immediate point between assistance and independence may be found. Examples of this type of organisation are found in the Andean countries. The impetus for forming cooperatives came from NGOs working closely with waste pickers who had been displaced from dumping sites thus rendering them unemployment. The government supported efforts to create alternative sources of employment. Local stakeholders, particularly industries, were willing to collaborate. The first cooperatives dealt with clean materials that were abundantly available from industries but were not recycled because no one had taken the initiative to tap the resources. Once established as middle dealers, the waste cooperatives expanded to door-to-door buying of source-separated recyclables from homes and shops. As they are more organised than the individual itinerant waste buyers, cooperatives have been able to find a niche in resource recovery networks where the activities of the former have declined.

Where these cooperatives are multiplying in countries like Colombia and Peru they are reviving earlier traditions of separating and selling recyclables. Displaced pickers who have joined the cooperatives are doing socially acceptable work under much better working conditions. The materials they sell to industry are much cleaner, which reduces the further cleaning (and consequent pollution) required by the recycling factories.

Urban management analysts in Latin America agree that all such small recovery enterprises (and itinerant buyers and dealers) are more economically and technically viable than municipally managed source separation and curb-side recovery. They use human-powered or semi-motorised front-loaded carts, which are far much cheaper and less polluting than trucks. The administrative costs are lower than for municipal management. Also, the collectors are members of poor communities, thus jobs are created where they are most needed.

Another best-documented case is of the recovery and composting enterprises run by families of Zabbaleen in Cairo. There, a small industries program was assisted at the Manshiet Nasser Zabbaleen settlement. There were loans for small processing units and skill training, a literacy school, and guidance from a management specialist. The families were able to improve the quality of the reprocessed materials, to improve their income, to establish a community organization to run a loans program, and to sort and process much more material than before. The assistance was given for about three years, through a local environmental consulting firm.

Waste Consultants (of the Netherlands) concluded from an independent evaluation that: such communities do not and cannot spontaneously set up industrial establishments without some form of external stimulus, regardless of the potential that may exist. Their general advice regarding technical programs to assist waste sorting and processing is: initiate the work through pilot programs that are highly visible; make it as inexpensive as possible; and tune the program to the potential of the market.

Metro Manila provides another example. Waste dealers in several cities have been enabled to form cooperatives by women's organization. In this case, it was not a matter of creating enterprises, as the waste leaderships existed, but they have been helped to expand and improve in efficiency by gaining access to small loans by registering a cooperative. The Metro Manila Women's Balikatan Movement has undertaken community education for source separation, and the Centre for Advanced Philippine Studies has created a database to facilitate communication between the enterprises and factories requiring materials.

In Asia and Africa many NGOs are assisting waste pickers to organize, and in some cases they aim to move pickers into the work of buying source-separated materials. An example is the cooperative supported by the Self-employed Women's Association in Ahmedabad, India. The experience with organizing pickers suggests that it is difficult to attain a stable and profitable organization of the lowest workers in waste recovery systems; usually these groups require the continuing support of NGOs.

In any waste reduction action, municipal departments can enter into partnerships with environmental and community organizations, whose members are keen to reduce waste collection and disposal problems. Many examples of such cooperation are being developed. For instance, in Bangalore, the Bangalore City Corporation has provided the land for community-based composting and vermiculture.

The advantages of these organisations are that, first, the enterprise or cooperative has much more negotiating leverage with the intermediary or the receiving industrial plant than individual dealerships have. Thus, their profits tend to be higher. Second, as part of an organisation, workers receive better training ; they can obtain health benefits and operating loans routinely,

whereas the itinerant buyers are usually very dependent on a client-patron relationship with a particular dealer.

In summary, assistance to small enterprises and informal workers in waste recovery, trading, and recycling can enhance waste reduction for a whole city. At the same time, working conditions in small undertakings can be improved and adverse environmental impacts reduced. The kind of assistance required is not costly compared to big businesses, while potential benefits for the urban environment and social welfare are considerable. Some policies such as waste reduction legislation must be selectively tried according to the local context. Isolated places with very low recycling potential are virtually limited to exploring the opportunity of exporting high-value recyclables and vigorously promoting reuse.

## 2.5 ACTORS AND PARTNERS IN SOLID WASTE MANAGEMENT

Strategies to address urban environmental challenges like solid waste management provide key roles for city and municipal authorities, citizens, private sector, NGOs and national government at various levels. The benefits resulting from such partnership are shared resources, support implementation and sustainability. Local authorities should act as facilitators, coordinators and regulators. The different actors in waste management play different roles which all constitute an integrative system. These actors are:

- The Central Government
- Municipal Authorities
- Households
- Community Based Organisations
- Non-Governmental Organisations
- Business sector
- Formal Private sector firms offering waste services
- Informal waste collectors/Scavengers

**The Central Government** – The role of the Central Government is to make policies at the national level to guide waste management. In Kenya there are no express laws governing waste management but there is the Public Health Act Cap 242, the Local Government Act Cap 265, the Planning Act of 1996 and the Environmental Act of 1999. The Central Government also extends grant to the Municipal authorities, which may be invested in waste management.

**The Municipal Authorities** have been, world-over, the major stakeholder in waste management. They provide the collection, transfer/transport and disposal services. Municipal authorities are also a major waste generator in terms of street sweeping and markets. Where waste management is privatised, the Municipal authorities play supervisory roles. Most local authorities in the world particularly in the developing countries have faced various problems in the course of waste management. Some of these problems include lack of equipment, frequent breakdowns of equipment and the subsequent lack of funds to repair them or to obtain spare parts, poor collection of charges from their clients, failure to employ appropriate technology and weak legal framework to govern waste management. These problems lead to poor service delivery and subsequent dissatisfaction of the citizens. The resultant effect is either to leave the system to operate as it is, privatisation of certain aspects of SWM or the treatment of waste by the citizens themselves.

**Households / communities** are major generators of waste. They are interested in waste management in three fold: as residents whereby they need a clean environment; service users and tax payers. In most places, households have always played the role of recipients of waste services but this attitude should change, to that of facilitators and active participation. Households may form community based organisations in order to address various waste management aspects. In low income areas, residents organise CBOs in order to improve their income levels as well as to promote direct use of materials. In high income and middle income areas, residents may hire services from formal or informal collectors; or provide primary waste collection systems. Waste management should start at home level where individuals should adopt the following activities as suggested by **UNEP 1997**;

- Avoid disposable products – products like paper, plastics, utensils, cigarette lighters and razors contribute tremendously to landfill problems and should therefore be avoided.
- To enhance public awareness of the importance of proper and safe waste management as well as buying products from firms that are environmental conscious.
- Reduce waste generation – products that minimize waste particularly in form of packaging should be encouraged. Households should avoid non-biodegradable packaging.

- Recycle – most household waste household is potentially recyclable. The household contribution to recycling is a critical one involving basic changes in attitudes and habits. Glass, paper, aluminium, steel cans and plastics are a resource and they should be sorted out from non-recyclable waste at the household level.
- Reuse – Households should look for items that they can use for tasks other than that for which they were originally intended. Reuse prevents the item from entering the waste stream.
- Shop Smart – Households by buying only what they need will minimize waste volumes. Giving preference to only those products that are durable or can be reused, recycled, reliable, repaired or refilled.
- Compost organic wastes – composting is a means of recycling organic wastes such as leaves, grass. Clippings and food and vegetable scraps by combining them in a pile so that they can undergo microbial decomposition. Since up to 30% of household waste consists of organic wastes, composting makes good environmental and economic sense.

**Community Based Organisations** play the role of information dissemination and teaching the residents how to compost, reuse or employ other eco-friendly as well as economical methods of waste management. Community Organisations are in a perfect position to make a major impact on the amount of waste that is generated in their societies. The collective voices of such groups can persuade government officials to notice the problem, and can influence the industry to be more mindful of its responsibilities. Communities can do the following (*ibid*)

- Coordinate activities with other organisations - Work with international organisations and existing international networks to develop a permanent inventory of accidents, transportation routes and potential problems related to hazardous and nuclear waste including locations, dates, perpetrators solutions and outcomes.
- Pursue partnerships with government – work with local government to encourage evaluations and environmental impacts studies prior to the establishment of any activity likely to generate waste of any kind. CBOs could also encourage local regional and national governments to establish legal, financial and monitoring mechanisms that guarantee the strict prohibition of imports of exports of wastes. Encourage local and national governments to create comprehensive and effective waste management

policies and regulations for the communities and the country at large in accordance with the highest international environmental and health standards.

- Monitor Waste activities in the community – CBOS should monitor their country's policy of selling waste relocation permits to industries from other countries. CBOs should derive more sustainable alternatives for foreign exchange earnings for their governments.

**The Non-Governmental Organisations'** role is very close to that of the CBOs. They offer advocacy services to residents, help in creating awareness and they can act as partners whereby they offer direct assistance. NGOs in waste management play the role of sensitizing people and businesses of the importance of good waste management practices as well as educating them how to do it. They also offer credit facilities and financial assistance to CBOs dealing with waste. They also liaise with the government at the local, national and regional level to promote regulations governing waste management. NGOs also offer financial and technical assistance to the municipal authorities for improved waste management. They also assist scavengers and the informal sector waste handlers by offering safety clothing and making communities aware of the importance of the informal sector in waste management.

**The Business community's** role in promoting sound waste management is vast because both commercial and industrial activities, both in the formal and in the informal sector are major waste generators. In the offices, employees should be educated about the importance of solid waste management. Practices like recycling and reuse of material should be encouraged. Sorting of waste so as to separate recyclable and non-recyclable waste should be encouraged. Waste minimization for example double-sided photocopying should be practiced. Industries generating hazardous waste should take proper measures of disposing off of such waste. Dumping of waste in the water bodies and on inappropriate areas on the land should be avoided in order to eliminate water and land pollution.

**The private firms** offering waste collection and disposal services have become very common, particularly in the developing countries due to the inability of the local authorities to provide these services. In the course of carrying out their duties, such firms should abide to the legal provisions at the national and local level. They should also educate communities about sound practices such as sorting, recycling, reusing and waste minimization. They should also dispose the waste only on the designated areas. Private firms, under appropriate conditions can provide

waste services more effectively and at lower costs than the public sector. This is however not guaranteed particularly where privatisation is poorly conceived and regulated more particularly, where competition between suppliers is lacking. "For successful privatisation, there must be competition, transparency and accountability." (*Gloss Data 2002*)

## **2.6 POLICY FRAMEWORK FOR SOLID WASTE MANAGEMENT IN KENYA**

The main statutes that govern waste management in Kenya are the Local Government Act Cap 265, Public Health Act Cap 242 and the Environmental Coordination and Management Act of 1999.

### **2.6.1 Local Government Act of 1965**

Section 160 (a) states that every municipal council shall have power to establish and maintain sanitary services for the removal and destruction of, or otherwise dealing with all, kinds of refuse and effluent and, where any such service by persons to whom the service is available

Section 210 empowers the Local authority to make by laws in respect of all matters that are necessary or desirable for maintenance of health, safety and well-being of the inhabitants of its area or any part thereof and for the good rule and government of such area or any part thereof and for the prevention and suppression of nuisances therein and, more particularly, but without prejudice to the generality of the foregoing- "for controlling any of the things which it is empowered by or under this Act to do, establish, maintain or carry on."

Therefore, local authorities have power to make by laws to govern the management of solid waste.

### **2.6.2 Public Health Act Cap 242**

Part IX makes provision for the Local authorities to provide sanitation and housing. Section 116 outlines that it is the duty of the local authority to take all lawful, necessary and reasonably practicable measures for maintaining its district at all times in clean and sanitary condition and for preventing the occurrence therein of, or for remedying or causing to be remedied, any nuisance or condition liable to be injurious or dangerous to health, and to take proceedings at law against any person causing or responsible for the continuance of any such nuisance or condition.

Section 118 (h) and (j) define as nuisance any accumulation or deposit of refuse, offal, manure or other matter, which is injurious or dangerous to health. Nuisance also constitutes accumulation of stones, timber or other material which in the opinion of the health officer is

likely to harbour rats and vermin. All these constitute solid waste and there is therefore the need to handle them appropriately as per the provisions of the Act.

### **2.6.3 Physical Planning Act, 1996**

Section 3 classifies deposit of refuse, scrap or waste materials and other matters on land as change of use of land thereof, and thus considers it a Class A development. In that case waste disposal forms part of development (as it makes a material change in use of land) of which development permit must be secured before its commencement. The local authority is in charge of controlling development in its area of jurisdiction as mandated by section 29 of the same statute. Sections 30, 33 and 36 of this statute deal with application and approval of development permits. In the case of refuse management, local authorities in Kenya are usually the main actors. The provisions of this act therefore fail to be enforced by the local authorities on themselves.

### **2.6.4 Environmental Management and Coordination Act, 1999**

Section 42 prohibits any person from depositing any substance in a lake, river or wetland or in on or under it's bed if that substance would adversely affect the river, lake or wetland.

Section 86 outlines the standards for waste and empowers the NEMA to authorise any person to operate a disposal site or plant.

Section 87 deals with prohibition against dangerous handling and disposal of waste. Sub section 1 states that no person shall discharge or dispose of any waste whether generated within or outside Kenya In such a manner as to cause pollution to the environment or ill health to any person.

Section 88 provides for the application of licence for managing wastes. It also prohibits transportation of solid waste within the country without a licence.

The legal provisions for solid waste management in Kenya are therefore scattered in different statutes and there lacks a national policy for solid waste management. There are also different implementing agencies leading to duplication of effort and lack of coordination in SWM.

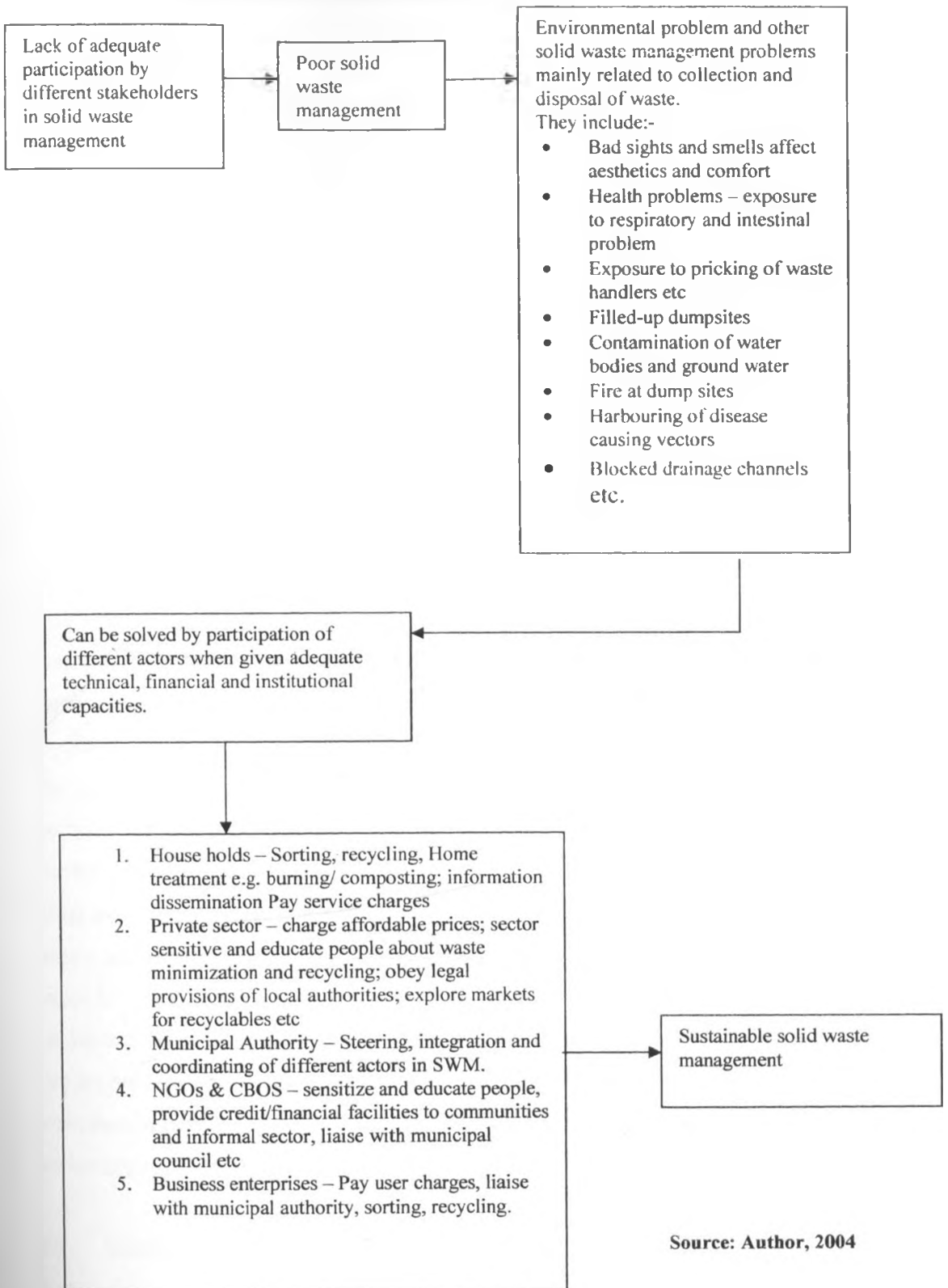
## **2.7 CONCEPTUAL FRAMEWORK**

The main assumption behind the study was that lack of adequate participation by all stake holders in SWM had led to the increase in environmental problems associated with poor solid waste management in Kiambu Town. The main problems associated with poor solid waste



management in Kiambu town included bad sights, bad smells, health hazards of a variety of forms, presence of vectors and insects, filled up dumpsites and dilemma as to how hazardous waste should be handled as well as where future dumpsites should be located. These problems were caused by lack of performance of both the implied, assumed and expected roles by the different stakeholders given their financial, legal, and institutional (Human resource management, technical, marketing and awareness) capacities. However, with improved performance of their roles, the solid waste management practices in Kiambu could be improved and thereby reduce the level of these environmental evils emanating from poor solid waste management practices.

**Figure 2: Conceptual Framework of the study**



Source: Author, 2004

## CHAPTER THREE: RESEARCH METHODOLOGY

### 3.1 INTRODUCTION

Research is a systematic, objective and scientific investigation of phenomena directed towards a specific area for the purpose of discovering, applying or interpreting facts, principles or theories. It is therefore concerned with the development of knowledge about a phenomenon in order to improve current practice. (*Marshall et al 1989*) For this to be done, some systematic process has to be followed. This chapter outlines the process involved in the research. It describes the design of the study, description of units of observation and analysis, sampling design, data collection procedures and methods employed in data analysis and presentation.

### 3.2 DESIGN OF THE STUDY

Survey design was employed in the research. The reason for this was that the research displayed descriptive characteristics. 'Descriptive research refers to the scientific method of investigation in which data is collected and analysed for the purpose of describing a problem in its current status or condition.' (*Adams G et al, 1985*) Survey design is the process of investigating a large population by selecting a small portion of it (sample) for measurement and observation. The results from the sample are used to make interpretation for the whole population. This was done for the households and business enterprises.

The target population of the households was also the accessible population. This comprised of the high-income, middle income and low income households residing in the built up area of Kiambu Town. This constituted 60,605 people, and was approximated to be 15151 households, taking an average household size of 4 persons per household<sup>1</sup>. This was because there lacks definite classification of residential estates as per income levels in Kiambu Town. This therefore helped to reduce the risks of failure to collect a representative sample. The target population for the informal waste pickers was unobtainable because there was no sampling frame because they are not centralised in any one place and they are not formally registered. For the business enterprises, a sampling frame was not easy to obtain because some units of observation were not formally registered. Therefore, the researcher was forced to use simple random sampling.

### 3.3 SAMPLING DESIGN AND PROCEDURES

A total of 40 households were interviewed. The selection of samples was by stratified random sampling. Stratified sampling was useful in obtaining a representative sample from each subgroup of the households. A total of 9 low income, 16 middle income and 15 high income

households were interviewed. Five (5) male and thirty five (35) female respondents were interviewed. The average household size was four (4). The largest household size was 12 and the smallest size 1 whereas the mode was 3.

A total of 30 business enterprises were interviewed. They were selected by way of simple random sampling. In the selection of the sample, the businesses had been put into the following major categories; General household goods suppliers; agro-based shops; Hair and beauty; clothing and textile; bar and restaurant; petrol stations; Food dealers; Light industries; Medical enterprises and offices. The oldest business enterprise in the sample was 51 years old, followed by one that was 40 years old, and the youngest was ½ year old.

The only private waste collection firm is called Cergh Community Services and had been in operation for 1½ years.

A total number of 9 informal waste pickers were interviewed. Sampling was done by use of snow ball and convenient sampling methods. This was necessary because there was no centralised place from which they operated. The average length of time of operation in Kiambu town and its surrounding region was about 1 to 30 years.

### **3.4 DATA COLLECTION INSTRUMENTS**

The study was carried out by use of questionnaires and interview schedules. These helped to obtain primary data from the field. For the Households and business enterprises, semi-structured questionnaires were used. For the only formal private firm in the waste industry, a semi-structured questionnaire was used. The questionnaire was aimed at investigating the role of the firm and the various problems and challenges they encounter in the course of their work. The researcher was able to obtain information about environmental problems caused by poor waste; challenges faced by the households in solid waste management as well as possible solutions to these problems. For informal recyclers and municipal authorities, interview schedules addressing all the objectives of the study were used.

Secondary data was obtained by a review of books, journals, theses, reports and other published material in relation to solid waste management. The secondary data enabled the researcher to obtain data related to solid waste management in other areas in the country and

in other parts of the world and thereby make inferences for solid waste management in the case study.

Field observation and photographs were also employed to assist the researcher to collect information about the visible problems of solid waste management, waste storage methods, the waste collection equipment and vehicles as well as waste disposal sites. A weighing scale was also used in order to weigh the different amounts of waste generated by the households and the businesses.

### **3.5 DATA MANAGEMENT, ANALYSIS AND PRESENTATION**

Data analysis was guided by objectives of the study. Descriptive statistics was employed. Measures of central tendency such as the mean, median mode and frequency distribution tables and curves were used to analyse and present data related to problems identified among different respondent groups, nature of waste collected and other information. Data is presented in form of tables, charts, curves, percentages and photographs.

## CHAPTER FOUR: BACKGROUND OF THE STUDY AREA

### 4.1 INTRODUCTION

Kiambu Town is classified as a secondary town in Kenya. These secondary towns are formed to promote a balanced urban growth and to reduce the urban problems in the primate towns in Kenya – Nairobi and Mombasa.

### 4.2 FACTORS GOVERNING THE GROWTH OF SECONDARY TOWNS

One of the main factors contributing to the emergence and development of secondary towns is the government policy and political reasons. One such main government policy is the decentralisation of the urban functions; by naming some centres as towns followed by different incentives to induce urban development in such areas. The main reason behind such policies is to reduce the primacy of certain cities and to evenly distribute development in a region. In Kenya, the development of small towns is an issue that has been addressed by all national development plans from immediately after independence policies aimed at "Shifting emphasis towards the rigorous growth of small towns and smaller urban centres throughout the country." (*Sessional Paper No.1 1986*) have been developed.

Secondly areas located very near prime cities evolve as centres of trade because primate cities' population densities usually lead to unemployment and high land values which force people and firms to relocate to the periphery areas where land values are lower and unemployment is less acute. Deterioration of prime cities in terms of infrastructure, existence of old functionally and economically obsolete buildings which renders them unsuitable for commercial and industrial use paves way for households and firms to relocate to nearby areas with modern buildings.

Accessibility to a primate area through good road network, communication network and trading relations leads to fast urban growth of smaller centres. Good transportation network allows people to own land in less expensive peri urban land, hence the growth of the peripheral urban regions. If accessibility in terms of convenience and time taken to reach prime areas is hindered probably due to traffic jams, people, firms and industries will tend to locate in peri urban areas.

Social economic changes related to increased literacy levels, increased population densities which lead to landlessness in rural areas, increased agricultural production leads to changes in

economies from predominantly rural farming or primary activities to secondary and tertiary activities which generally leads to growth and expansion of secondary towns.

Availability of infrastructure and facilities such as water, good housing, sewerage, electricity, schools, churches, road network and communication network often leads to emergence of towns in areas where they exist. This is because such services attract investors into the area.

Other centres will emerge as a result of having unique resource endowment be they minerals, recreational facilities, forests, certain raw materials or other. Such resources attract multinational corporations, and other large companies and industries to set up branches in such areas. Existence of specialised institutions such as universities, research institutes, colleges and international agencies also lead to growth of secondary towns.

Secondary towns usually face certain problems and constraints among them including land tenure conflicts, population increases, total lack of or inadequately supplied infrastructure, poorly maintained infrastructure, unemployment, planning problems and economic bias problems, where households and firms prefer to settle in larger centres which have higher returns among other problems. These problems greatly affect the growth of such towns.

Despite these problems and challenges, secondary towns continue to emerge out of the reasons stated above. They are important in the urbanisation process, and urban managers have to plan for their growth and management. By addressing solid waste management in Kiambu town, the research will contribute some insights for infrastructure management in the town, which is one key problem facing the town as well as other urban areas.

### **4.3 EVOLUTION OF KIAMBU TOWN**

Kiambu became a township in 1903 when the Township Ordinance was passed. This ordinance empowered the governor to declare any area urban if he thought it suitable. Other towns that came to be at that time are Mombasa, Machakos, Nairobi, Naivasha, Nakuru and Eldoret. (*Gathoni 1978*). In 1963, the town acquired urban council status, and in 1974, it was made a town council, which gave it a higher degree of financial and managerial autonomy from the Kiambu County Council, which was its former financial and administrative manager (*Municipal annual Reports, 1999*). In 1984, it acquired the municipal council status. The town has maintained headquarter status for both provincial administration and Kiambu County Council since it came to be. Kiambu, together with other towns began under the influence of white settlers who occupied predominantly agricultural hinterland, and later attracted Indian

"Wallahs" who established a trading centre in the town, popularly known as – "The Indian Bazaar". The town is divided into eight electoral wards namely Kangoya, Kanunga, Biashara, Hospital Ward, Ndumberi, Riabai, Kanunga and Turitu. The Gazetted town constitutes of an urban area and a rural settled area. The main reasons why Kiambu Town was developed were

- To develop the surrounding agricultural rural areas according to the Kenya's National Urbanization and Rural Strategy (*National Development plans: 1970-74; 1974-78*).
- To serve as an important service centre in order to ease Nairobi of its housing and employment problems.

For these reasons, Kiambu's growth strategy is separate from that of Nairobi, and Nairobi was designed to grow towards the west and northeast along the axis of Thika Road, away from Kiambu Town. (*Nairobi Metropolitan Growth Strategy, 1973*) Owing to these reasons, Kiambu urban structure plan was drawn within the context of a predominantly rich agricultural environment – Both the rural and urban aspects were incorporated in the same development framework of the town.

One of the assumptions of the study is that the town will continue to grow and achieve higher urban status administratively, particularly in view of population projections described later in this chapter. The town will increasingly face problems outlined above among others, unless planning intervention takes place. Therefore, addressing solid waste management is one way of supporting the projected growth of the town positively.

#### 4.4 NATIONAL AND REGIONAL SETTING

Kiambu Town is located in the Kiambu Municipality, Kiambaa Division, Kiambu District, in Central Province, Kenya. Kiambu Municipality is located at about 13 Km from the city centre of Nairobi and borders Nairobi on the north-eastern periphery, with Kiambu Town being its main centre, situated about five kilometres from the City of Nairobi boundary. The town is at an altitude of 1800m above the sea level and is accessible from Nairobi via Muthaiga through the main Nairobi – Githunguri Road. Its other major road network is Ruiru-Limuru Road, which intersects through the town. The town lies between the equator (10° 11' South) and longitude 36° 62' east of Greenwich Meridian. (*Gathoni 1978*) The Municipality is divided into three main regions:

- **Settled Area:** is the part of the former European settled area, and constitutes about 65% of the town area. It is predominantly large- scale coffee farming area towards Ruiru, Githunguri, and Kanunga with subsistence and horticultural farming at areas not

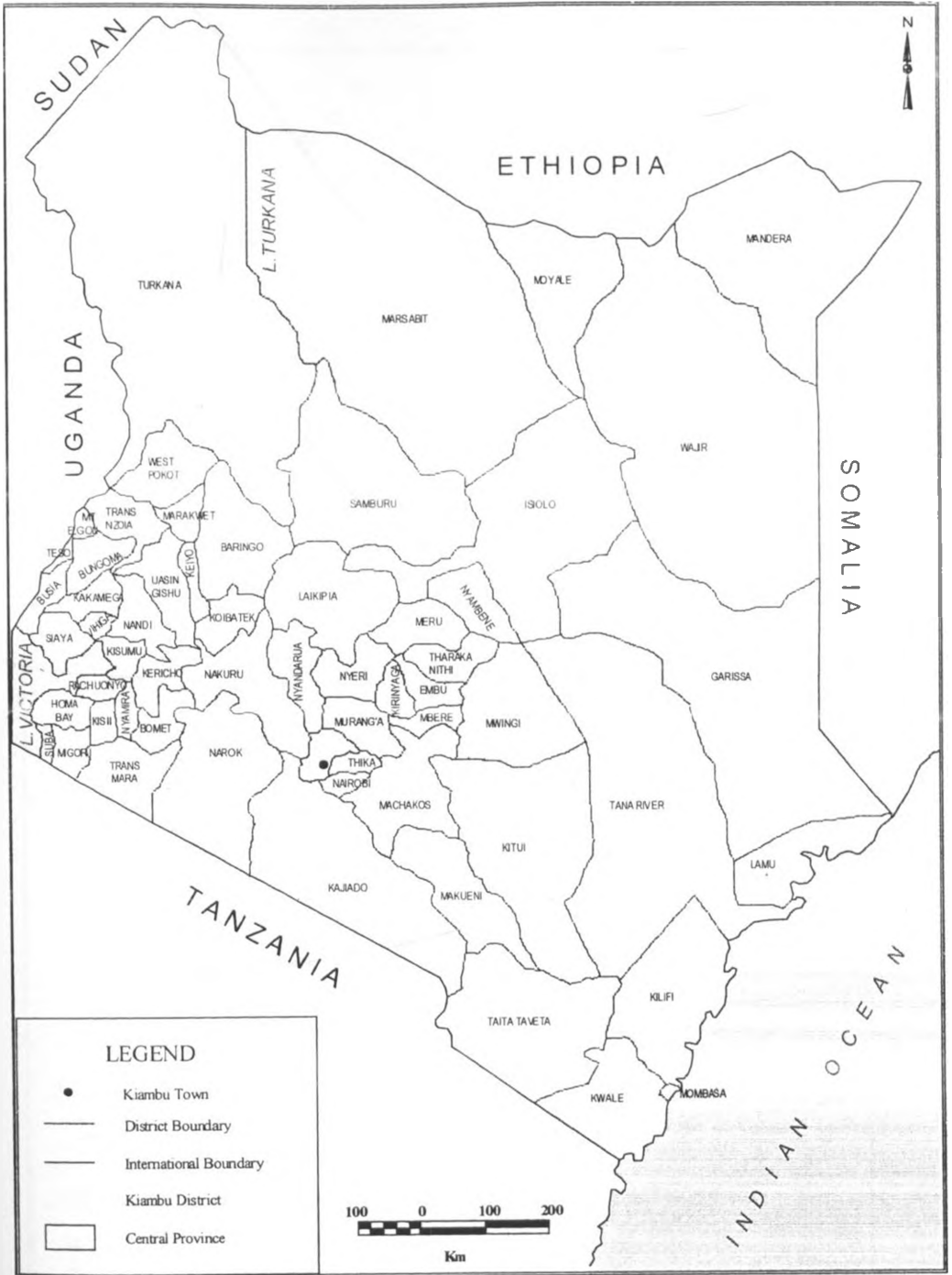


covered by coffee along the river valleys. Settlement patterns are in the form of a few isolated homes and small-scale agricultural villages. KIST and Kiambu High school are situated in this region.(*Njau, 2000*). However, from about early 1990s, the coffee plantations are gradually being replaced by high income residential estates.

- **Rural Area:** is primarily rural villages of Kanunga, Turitu, Ngegu, Raibai, Ting'ang'a, Ndumberi and Kangoya. These centres have either little market or trading centres. Main activities include small-scale farming and coffee farming mixed with food crop farming.
- **Urban Area/Town:** This constitutes the main town. It caters for all land uses – namely-administrative, commercial, residential, industrial, public purpose and public utilities. It serves as the administrative headquarter of Kiambu District and local government (Kiambu County Council and Kiambu Municipal Council). As the district headquarter, Kiambu town caters for the interests of all government ministries and departments, houses the offices and residential quarters of the District Commissioner, children's remand home, a general hospital, divisional police headquarters, law courts and the prison.

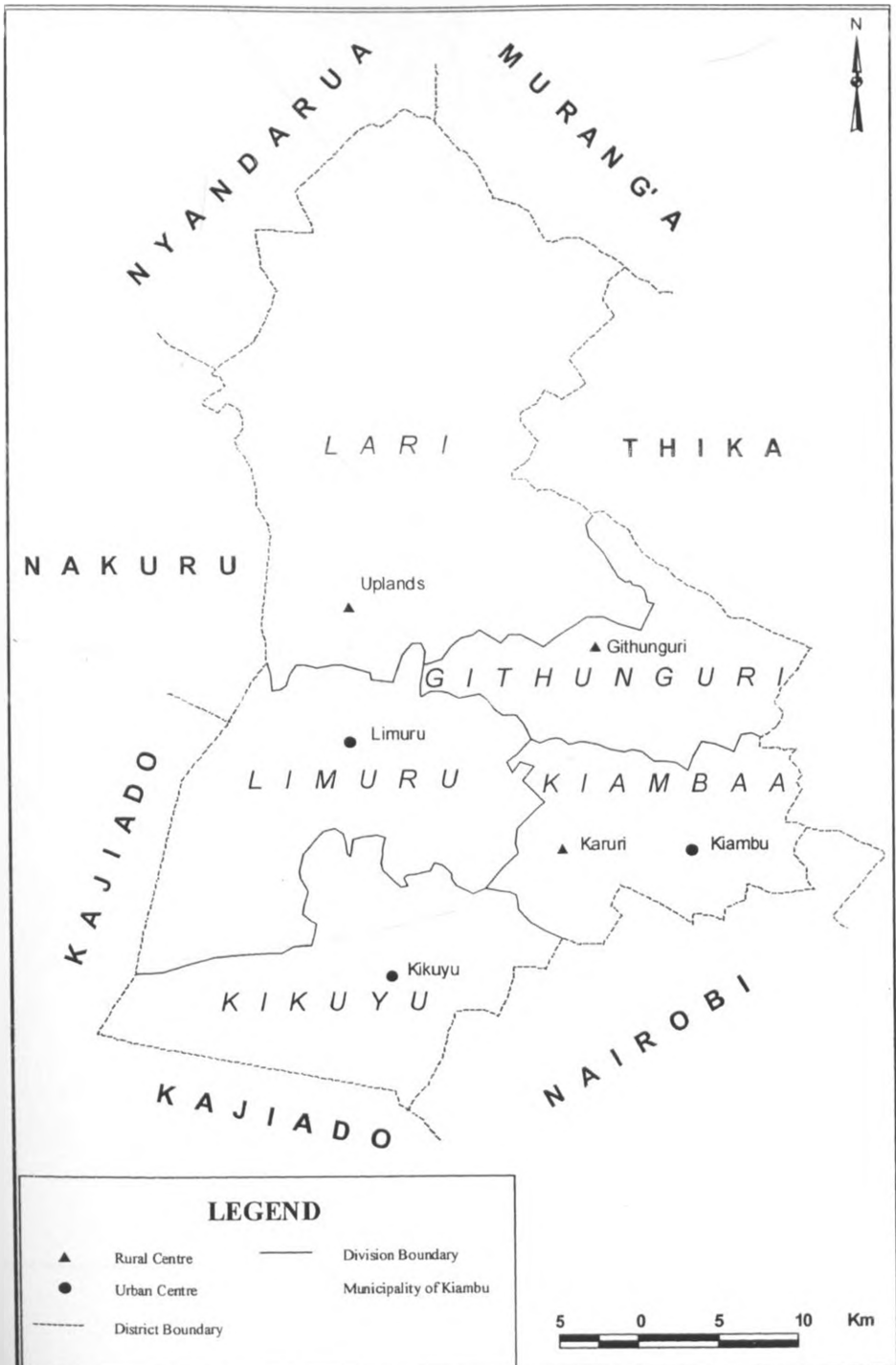
The town was the focus of the study because it provides a setting that would address the concerns of the research. (*Maps 2 and 3 on pages 53 & 54 show the National and regional setting of Kiambu Town whereas Map 4 on page 55 shows the administrative units within Kiambu Municipality*).

Map 2: Location of Kiambu Town in the National Context



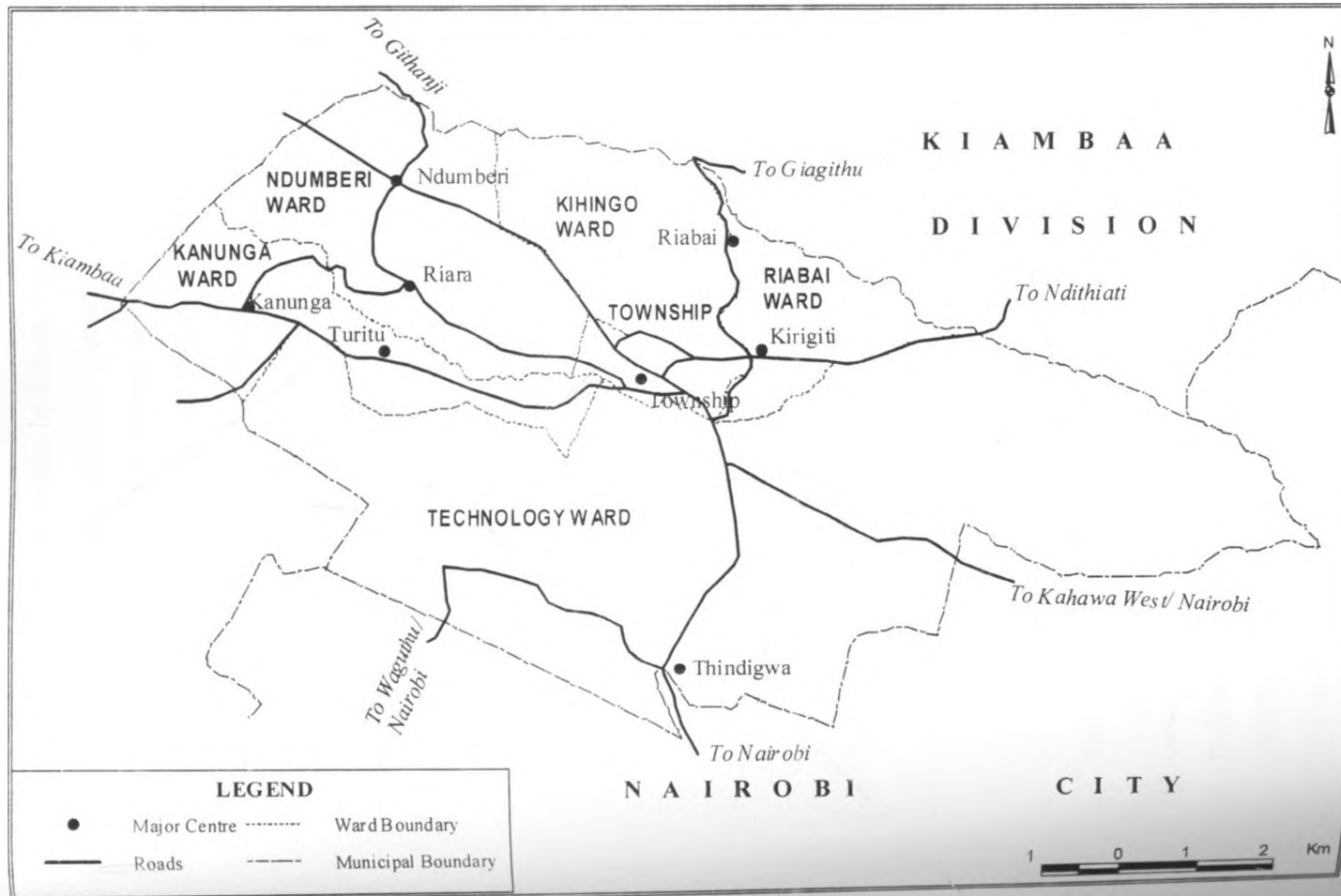
Source: Kiambu District Development Plan, 1989-1993

Map 3: Location Kiambu Municipality in Kiambu District



Source: Kiambu District Development Plan, 1989-1993

Map 4: Administrative units of Kiambu Municipality

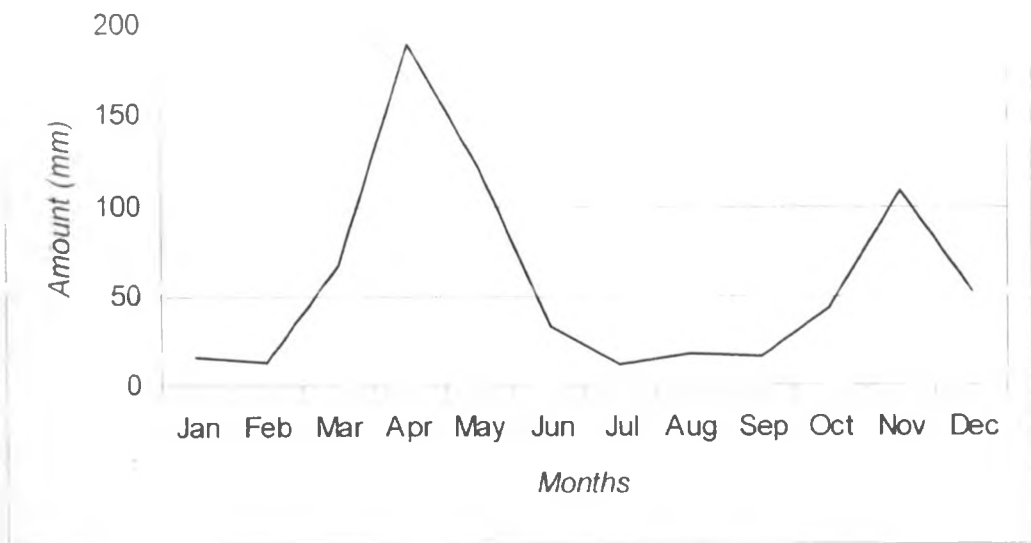


Source: Kiambu District Survey Office, 2003

#### 4.5 CLIMATE

The climate is largely influenced by altitude. Annual rainfall therefore varies from 500mm in the lower areas and increases gradually to cover 1500mm in the upper region of the district. The rainfall regime is bimodal with the long rains falling between April and May followed by cool season during July and August, which culminates to the short rains falling between October and November. There are several rainfall-recording stations in the district. For the high potential are, stations are established in Gatundu, Kikuyu, Kiambu and Limuru, while Ngoriba and Munyū stations represents the low potential areas.

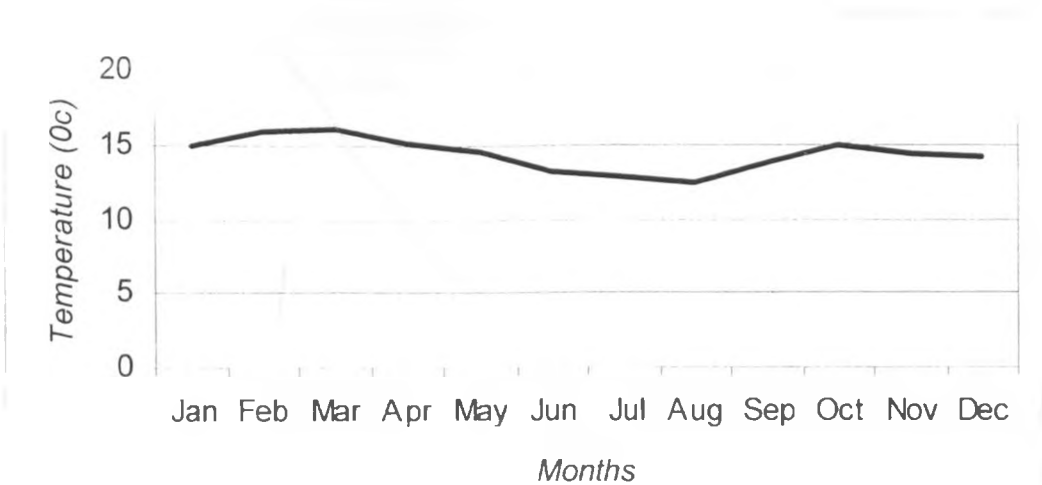
**Figure 3: Kiambu Municipality Average Monthly Rainfall**



Source: Farm Management Handbook

Generally, Kiambu district experiences moderate temperatures. These temperatures and humidity are modified by altitude getting cooler in the higher areas of Kikuyu, Lari, Limuru and Githunguri Divisions, but the lower areas are generally warmer throughout the year. Average temperatures in Kiambu Town ranges from 22<sup>o</sup> C to 27<sup>o</sup> C, it is chilly in July and August when the lowest temperatures are experienced. Hottest months are January through March. Apart from the soils, rainfall and climate are major determinants of the land use patterns in the district. Rainfall is reliable and favourable for agricultural activities in the area, and for the location for the agro based industrial activities. As a result, there are several coffee processing factories, which employ many Kiambu residents.

**Figure 4: Kiambu Municipality Mean Temperature**



Source: Farm Management Handbook

#### **4.6 TOPOGRAPHY AND DRAINAGE**

All human activities take place on land. As such, topography influences and delimits the land use. Generally, Kiambu District may be divided into three broad topographic regions: the highland zone, the midland and the low land zones. The highland zone, which is the extension of the Aberdare Ranges lies at an altitude of 1800m and above. It is dominated by highly dissected ridges running from north-west to southeast. This gives way to midland zone which lies at an altitude of 1500-1800m above the sea level. In this zone, the general topography profile is less pronounced with fairly wide spaced parallel ridges. The low land zones lies below 1500m above the sea level. This zone is generally flat except for the areas around Kilimambogo. The main urban centre of the municipality of Kiambu is surrounded by rolling hills and valleys with coffee growing on most of this land. It is also covered by several rivers, which could provide a reliable and long-term source of water supply.

The drainage system in the district is largely influenced by topography. In the upper highland zone, which serves as an important water catchment area in the district, the land is well drained by several natural surface channels running parallel to the ridge. Although this gives an impression of a high stream density in the area, many of these do not have a permanent water flow throughout the year. Stretches of marshy land and swamps can be found in some areas. These help to stabilize and maintain the flow of water from the catchment area. The midland zone is also well fairly drained by several major permanent streams and their tributaries. These

include the Chania, Ndarugu, Theta, Mugitha, Ruiru, Kamiti and Gatharaini Rivers. In contrast to lowland is poorly drained with just few major streams. This could be attributed to the generally flat topography and occurrence of black cotton soil in most of the areas vulnerable to water logging during the wet season

#### **4.7 SOILS**

Wide variations in altitude, rainfall and temperatures between the highland and the lowland areas, combined with differences in the underlying geology, give rise to a variety of soil types in Kiambu District. These variations of soils render a difference in the general fertility and hence the land potential for agriculture. As a whole, soils in the district fall under four broad categories namely high fertility, moderate fertility, low fertility and variable fertility soils. The study area falls in the region with high fertility soils, which are mainly found in the north-western part of the district. These soils are developed from volcanic rocks (mainly basalts) and are well-drained, very deep dark reddish brown, friable with humic top layer. Most of this area is covered by forest and is suitable for sheep rearing, dairy cattle, pyrethrum and vegetables like kales, carrots, potatoes, and temperate fruits such as plums.

#### **4.8 VEGETATION**

Natural vegetation, especially forests, is important in modifying both micro and macroclimate. There are virtually no forests within the municipality's area of jurisdiction and individuals who are either small-scale peasant farmer, or large scale coffee farmers own most of the land. The main vegetation is in the form of coffee plantations, subsistence crops, hedges and shrubs. Although one may come across isolated cases of indigenous trees such as wattle and blue gum, they are not predominant, and saw milling activities within the municipality depend on supply of wood from the forest areas. Kiambu Forest is under threat from the high income residential pressures. The study area is covered with natural bushes especially in the area near the disposal site (see plates 1 & 2) and also with trees found in the open spaces such as the Golf Club, DC's grounds as well as in the prison farm.

#### **4.9 POPULATION, DEMOGRAPHIC AND HOUSING CHARACTERISTICS**

Rapid population growth is a basis of economic development and planning. The purpose of development is to enhance living standards of individuals, groups and communities. Of the many variables that influence the pattern of physical development and progress, population growth, distribution and characteristics are most decisive. An obvious consequence is that as population continues to increase the high potential areas and less and people spread out into

marginal lands, thereby, disturbing the ecological balance, which is already fragile. Others migrate to urban areas where social and physical infrastructures are already strained

#### **4.9.1 Population**

For the first time in history, humans are predominantly urban. Cities occupy less than 2 % of the Earth's land surface, but house almost half of the human population and use 75 % of the resources we take from the Earth. The statistics of urban growth in the late 20th century surpass any other demographic indicators. The United Nations had anticipated that by the year 2000, almost 50 % of the world's total population would be living in urban areas, and for the first time in history, urban dwellers will outnumber those in the traditionally rural areas. *(UNCHS, 1996)*.

The key demographic variables indicate that the quality of life of the population has been on the decline in Kenya despite the gains made in the demographic transition. The demographic gains made in the 1970s and 1980s were not sustained in the 1990s. The life expectancy has declined substantially while both infant and mortality rates are in the increase. Kenya's population is estimated at 30.4 million in 2001 and is increasing by 2.4% per annum up from an estimated 26.5 million in 1997 when it was growing at 3.1% it is projected to increase to 35 million by the year 2008. In 1990s, the population growth rate outstripped economic growth rate. The challenge now is to reverse this trend so that Kenyans can enjoy higher standards of living. The high population growth rate in the municipality has made it difficult for the council to effectively provide for both social and physical infrastructure such as health, education and employment opportunities. Environmental degradation due to competing interests in land is also a common phenomenon in the area. Urban population has grown from 3.8 million in 1989 to 9.9 million in 1999, constituting 34% total population and is projected to grow to 16 million by 2005. Women form about 49% of urban dwellers *(CBS, 1999)*.

Table 4 below outlines the population growth of the Municipality of Kiambu in respect to other regions within the Metropolitan area of the City of Nairobi.



**Table 4: Population Projection of Nairobi and its Metropolitan Districts**

Region	Years							
	1999	2000	2005	2010	2015	2020	2025	2030
Nairobi	2143254	2246130	2839497	3589614	4537892	5736679	7252154	9167975
Thika	89232	93247	116203	144810	180460	224886	280249	349241
Kajiado	406054	424732	581831	665936	833855	1044117	1307397	1637065
Ruiru	37384	39178	49928	62612	79153	100063	126497	159914
Athi R.	21696	22824	29409	37892	48824	62909	81057	104440
Kbu Distr.	744,010	763057	844246	936785	1087049	1233500	1399681	1588251
Kbu Mun	71928	75050	88951	110003	136038	168234	208051	257290
Kbu Urban	60605	63235	74948	92687	114623	141751	175299	216787
Kbu Rural	11323	11814	14003	17316	21415	26483	32752	40503

Source: Field Survey, DURP, 2003

From Table 5, the Municipality of Kiambu has currently a population growth rate of 4.34% per annum; this is relatively higher than that of the Kiambu District (2.56%) and slightly below the rate presented by Nairobi (4.8%). This is a clear indication of rapid urbanization in the municipality. Urban rural migration and natural population increase are the main determinants of this.

**Table 5: (%) Population Growth Rate of Respective Nairobi Metropolitan Districts**

Area	Nairobi	Thika	Kajiado	Ruiru	Athi River	Kiambu District	Kiambu Municipality
Growth Rate %	4.8	4.5	4.6	4.8	5.2	2.56	4.34

Source: Central Bureau of Statistics (1999)

It is worth noting that the population growth rate of the municipality is very high compared to that of the Kiambu District. Infact the municipality is the most urbanized town in the district, thus explaining the reasons behind its high population growth rate for the past few years. The following section describes population structure within the district.

#### **(a) Primary School Age (6-13)**

In 1999, the population of this age group was 142,669. This population is projected to be 179,635 at the end of 2008. With 137635 pupils enrolled in primary school there is an indication that the district will need to invest in the provision of additional education facilities to cater for the growing number of children in this age group.

### **(b) Secondary School Age (14-17)**

In 1999, the population of this age group was 67755 and it's projected to be 85310 at the end of 2008. Many children drop out of school after the primary level of education due to the high cost of education and limited number of places in secondary schools. About 50% of the children in this age group end up in the labour market, youth polytechnics and the informal sector. The most affected gender in this age group is the male child. Out of about 35308 boys falling within this age group, only 16378 are enrolled in secondary schools.

### **(c) Female Reproductive Age (15-49)**

The female population in the reproduction age group makes up 26.4% percent of the district's population. They are perfected to increase from 211887 in 1999 to 247304 by 2008. The increase in population of this age group calls for increased and improved maternal and child health care services, as well as improves nutrition standards in areas where the nutrition status is poor.

### **(d) Labour Force (15-64)**

The potential labour force is a very important aspect of a district's development. On the basis of the existing age structure, persons born in the last 15 years are now joining the labour force in large numbers. The labour force in the district is increasing rapidly. The potential labour force stands at 468,624, which comprises 232711 males and 235913 females by the end of 2008. With the steady growth of the labour force, there is a major challenge for creation of job opportunities in the informal sector as employment opportunities in the formal sector have been dwindling. A large portion of the labour force however comes from outside the district. This is also typical in the Kiambu Municipality

### **(e) Dependency Ratio**

Since the age groups 0-14 and above and above 64 years are considered to be dependent on the labour force, then the district has 334001 dependants with a dependency ratio of 100:71 (*DSO, 2002*). A high dependency ratio for the age group 0-14 would imply investing more by the households in the provision of basic necessities. It would also prompt the government to avail the facilities such as hospitals, schools and even provision of adequate recreational facilities.

From the table below, it is clear that due to the increase of population in Kiambu Municipality, the density of land use is also expected to increase towards the planning horizon assuming that the size of the municipality would remain constant at 57Km<sup>2</sup>. This would not only lead to pressure on the existing limited land, but would also cause wanton environmental degradation.

**Table 6: Kiambu Municipality Population Density Projection to 2030**

Density (Km <sup>2</sup> )	Years							
	1999	2000	2005	2010	2015	2020	2025	2030
	1262	1317	1560	1930	2387	2951	3650	4514

Source: DURP, 2003

## **4.9.2 Housing**

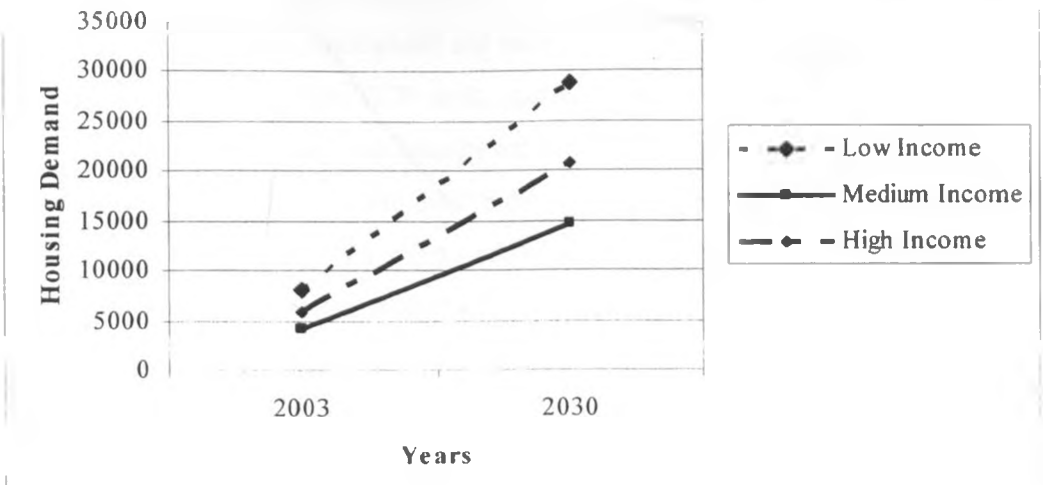
Shelter and housing are basic needs. According to the National Development Plan (2002-2008), the quality of housing in Kenya has now become as important as ownership. In urban areas of Kenya, 76% of poor and 80% of non-poor rent their dwellings. In rural areas, 95% of the poor and 83.5% of non-poor own their own dwellings. Over 47% of the Kenyan urban dwellers seek shelter in informal settlements, which are poorly constricted and are in areas of high unemployment, high crime rates, and increasing cases of HIV/AIDS. There is broad consensus on the fact that housing has central importance to everyone's quality of life and health with considerable economic, social, cultural and personal significance. The way in which housing is produced and exchanged impacts development goals as well as environmental sustainability and the mitigation of natural disasters. Design of dwellings and neighbourhoods reflect and protect important elements of values and culture. The important role of housing production in employment generation, particularly for unskilled labour, is recognized globally. High population in the municipality has led to poor housing, mainly due to lack of income by the households to put up better structure. Currently, most of the areas of the municipality have begun experiencing the establishment of informal settlements, all of which are of poor quality. This is typical in the Township area, leading to poor dwelling conditions. In addition, the Municipal Council of Kiambu has not been in a position to develop housing stock because of limited financial base.

### **4.9.2.1 Housing Demand in Kiambu Municipality**

From the field survey carried out by DURP 2003, it was evident that there are no housing programmes for the low-income cadres who mainly occupy high-density houses. And from the survey result the low income earners was defined as those individuals who earn less than Kshs. 5000.00 per month whereas the middle income earners comprise those individuals who earn between 5000.00 to 10000 Kenya Shillings, and high income earners comprise of those who earn more than 10000 Kenya Shilling's per month. The present housing demands stand at 8082 housing units for low income, 4122 for middle income and 5776 housing units for high income. In the next 30 years the demand will be 28,880 for low income, 14,730 for middle and

20,712 units for high income, if the current trend is maintained. Figure 5 below illustrates the projection for housing demand for various income groups in Kiambu Municipality.

**Figure 5: Housing Demand Projection for Kiambu Municipality**



Source: DURP, 2003

The current population growth rate (4.3% per annum) in the Municipality is one of the highest in Kiambu District. This has made it difficult for the Council to effectively provide various services to serve the residents, one of them being solid waste management. High population growth rates have also led to a high population density resulting in wanton sub-division of land. This has led to a decline in agricultural productivity, especially in the coffee farms. In addition, the high population has led to scarcity of employment opportunities. This has led to social vices such as high crime rates in most areas of the municipality.

Environmental degradation and particularly that related to poor solid waste management has also been manifested due to this rapid population increase. All these problems are likely to be compounded in future if necessary planning interventions are not adopted.

#### 4.10 ECONOMIC BASE

Sessional Paper No. 2 of 1996 on Industrial Transformation to the year 2020 clearly details policies aimed at making the country a Newly Industrialized Country (NIC) by the year 2020. The 8<sup>th</sup> National Development Plan for the period 1997 to 2001 whose theme is Rapid Industrialization for Sustained Development lays the foundation for the transformation of

Kenyan Economy. The main economic activities within the town and the municipality are as follows:

#### **4.10.1 Commerce and Industry**

Industry and trade play a very important role in the country's economic development in terms of foreign exchange earning, employment and income generation. Trade, restaurants and hotels contribute about 12.4% of the GDP while manufacturing contribute about 13%. Other sub-sectors that are closely linked with industry are mining, micro and small-scale enterprises, film industry and finance. The Micro and Small Enterprises Sub-sector (MSE) is currently estimated to generate employment for 4.2 million people (*National Development Plan, 2002-2008*). Commerce and industry is the second most important sector in Kiambu after agriculture. It employs slightly over 20% of the labour force.

In Kiambu District and the town itself, trade and industry plays a significant role. This includes various activities such as micro finance services, micro and small scale enterprises (including 'jua kali'), trade and industrial activities. The various businesses include hotels, restaurants and cafes, licensed businesses 'jua kali' artisans and informal sector entrepreneurs. These provide employment to a large number of people thus contributing towards poverty reduction. The 'jua kali' sector is increasingly becoming the largest employer in the district. Due to retrenchment, people tend to join the informal sector which is easy to enter. The common informal activities are hawking, motor vehicle mechanics, tailors, vegetable vendors among others. Within Kiambu municipality, informal sector accounts for 64% of the employment, while formal employment is 36%. The business specifications are quite diverse which include confectionaries, hotels, bars, general shops, welding salons and barber shops, butcheries, petrol stations, dress making, cobblers, bicycle repairs and garages, golf club, transport and animal feeds, general shops are the most popular within the municipality and account for 20% of all the business specified (*DURP, 2003*).

An increasing number of households in Kiambu Municipality have been depending directly or indirectly for their livelihood on incomes from commercial and small/scale trade. Kiambu Town remains the hub around which all commercial activities revolve. Kirigiti is just adjacent to Township, it also an important commercial area. Thindigua does not have a lot of business establishments mainly due to its proximity to the City of Nairobi. Most critically, the Indian Bazaar (old CDB) has very little establishment due to the influence of the Central Business District which is served by the major trunk road in the town. Infact, a lot of shops have been closed due to lack of customers who prefer the CBD.

#### 4.10.2 Agriculture

Agriculture is the main economic activity of the district, with 75% of the district's population relying on agriculture for their livelihood. Most of the population engaged in agriculture, practice small scale farming as evidenced by the number of small farm holdings in the district. There are 174,165 small farm holdings in the district, an indication of the population employed in small scale farming. There are 442 large scale farms within the district. Agriculture's contribution to the district's GDP is enormous and is bound to remain so. Favoured by good soils, climate, a relatively well developed infrastructure and close proximity to the country's largest market, Nairobi, Kiambu is one of the most economically viable farming districts in Kenya. The area of the Kiambu Municipality is very fertile in the production of both cash and food crops. It is supplemented by rich agricultural hinterland. The combined outputs of food crops from the two areas find their way to Kiambu Town, which is one of the major markets in the district. Currently, a total of 54.7Km<sup>2</sup> of land in the municipality is under agriculture, mainly coffee farming. Out of this, the large scale coffee estates occupy 36.48 Km<sup>2</sup>, while small-scale holdings occupy 18.24 Km<sup>2</sup> of land.

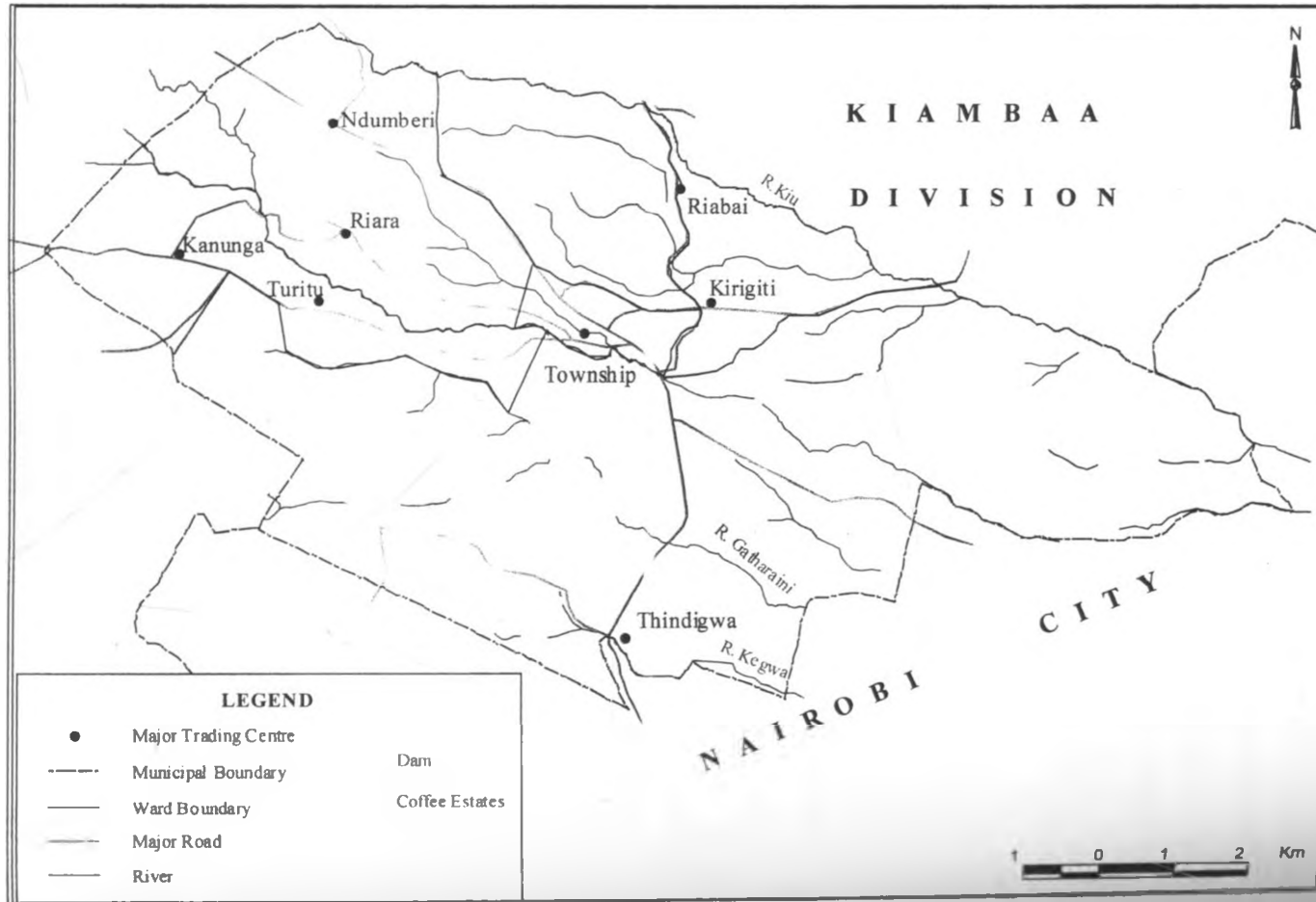
The main food crops grown in the district include maize, beans and Irish potatoes while the major cash crops are coffee, tea, pyrethrum, horticulture and flowers. Tea is grown both under small scale and large scale estate farming. Coffee is grown both by the co-operative sector and the estate sector. The main tea areas are Lari and Limuru, while the main coffee areas are Githunguri and Kiambaa divisions. The total area under coffee growing is 11,392 hectares. The coffee industry has however been faced with the serious problems of low payments in the world market (*District Development Plan, 2002-2008*). This has led to neglect of the crop so as to invest in other more paying agricultural enterprises such as dairy and horticulture.

Coffee, tea and sisal are growth both in small and large scale. Coffee in Kenya (including in Kiambu Municipality and District) is currently under crisis and thousands of poor farmers facing destitution. The production of coffee has decreased especially between the year 2000 and 2001. This is due to continued decrease in coffee prices. It is recorded that coffee prices reached a 30 year low on the world market in April, 2003 (*Daily Nation, May 6, 2003*). Schemes aimed at raising the price of coffee have failed. Such schemes include coffee retention scheme, quotas and weeding out of poor coffee. There is a massive surplus of over 21 million bags which have seen prices falling to a low of 50 cents per pound. The drop has

been severe in the last five years, with coffee prices falling by 28.5% in 1998, 23.2% in 1999, 18.1% in 2000 and 27.2% in 2001 (*ibid*). For these reasons, unemployment in the district and the municipality has been adversely affected because coffee-farming has been a major source of employment in the District. Therefore there is need to look for other alternative employment opportunities.

Area under tea has increased with a decrease in production due to unfavourable weather. Another major hindrance to the expansion of tea output have been the poor rural road infrastructure, poor management of the collection network, inadequate processing capacity, low fertilizer use and poor crop husbandry. The horticultural industry is currently the third most important foreign exchange earner after tea and tourism. The main horticultural crops include fruits, vegetables, herbs and spices, cut flowers. Smallholder production contributes 80% of all growers and produces 60 % of horticultural exports. In 1996, total production was estimated at 2.4 million tonnes valued at Kshs. 37.6 billion.

**Map 5: Location of Coffee Estates and Major Trading Centres in the Kiambu Municipality**



Source: Survey of Kenya (1997)



The main horticultural crops in Kiambu are passion fruits, pineapples, plums, cabbages, tomatoes, carrots, pears and oranges. Much of these are consumed locally, and some directly marketed to Nairobi and other urban centres.

Livestock industry contributes approximately 10% to the GDP. Livestock development has increased steadily and accounts for 24% of all arable land in the district. A variety of livestock is kept in the area. Whereas the number of exotic cattle has increased over the years, that of indigenous cattle is decreasing rapidly due to the farmers' change of attitude against this type of breed which is uneconomical in the view of shortage of land. Hence, farmers have been encouraged to intensify zero grazing on their small-scale holdings. Poultry keeping is also a viable enterprise due to close proximity to Nairobi. The trade is carried on individual and group basis. The latter approach being mainly carried by unemployed women, and is crucial in minimizing the cost per individual involved in the enterprise. Pig rearing is also an important activity; however, this has been on a decline due to high costs involved in construction of sheds, purchase of feeds, and transportation to the market. Rabbit and bee keeping is being encouraged mainly among the unemployed people to give them an alternative source of income. Prospectus for sheep and goat rearing is likely to decline due to rapid reduction of pastureland caused by the prevailing population pressure in the town.

The main livestock enterprises are dairy, poultry, pigs and sheep. Production trends for livestock and livestock products have been increasing over the last few years. This has been encouraged by a ready market both in Kiambu and Nairobi and the availability of local food processing factories such as Farmer's Choice Limited, Kenchic Company and Limuru Dairy Processors (*District Agriculture Office, 2003*)

#### **4.10.2.1      *Agriculture Supporting Systems in Kiambu Municipality***

The main supporting systems for agriculture in Kiambu Municipality are; Marketing Channels particularly through the cooperatives; Availability of adequate finance and credit facilities procured from the Agricultural Finance Cooperation, commercial banks, and non-bank financial institutions; proper infrastructure system like roads; availability of markets in Nairobi and elsewhere; and research and extension services.

#### **4.10.2.2 Problems faced by the agricultural sector in Kiambu Municipality**

A number of factors continue to hamper agriculture development in the municipality these include:

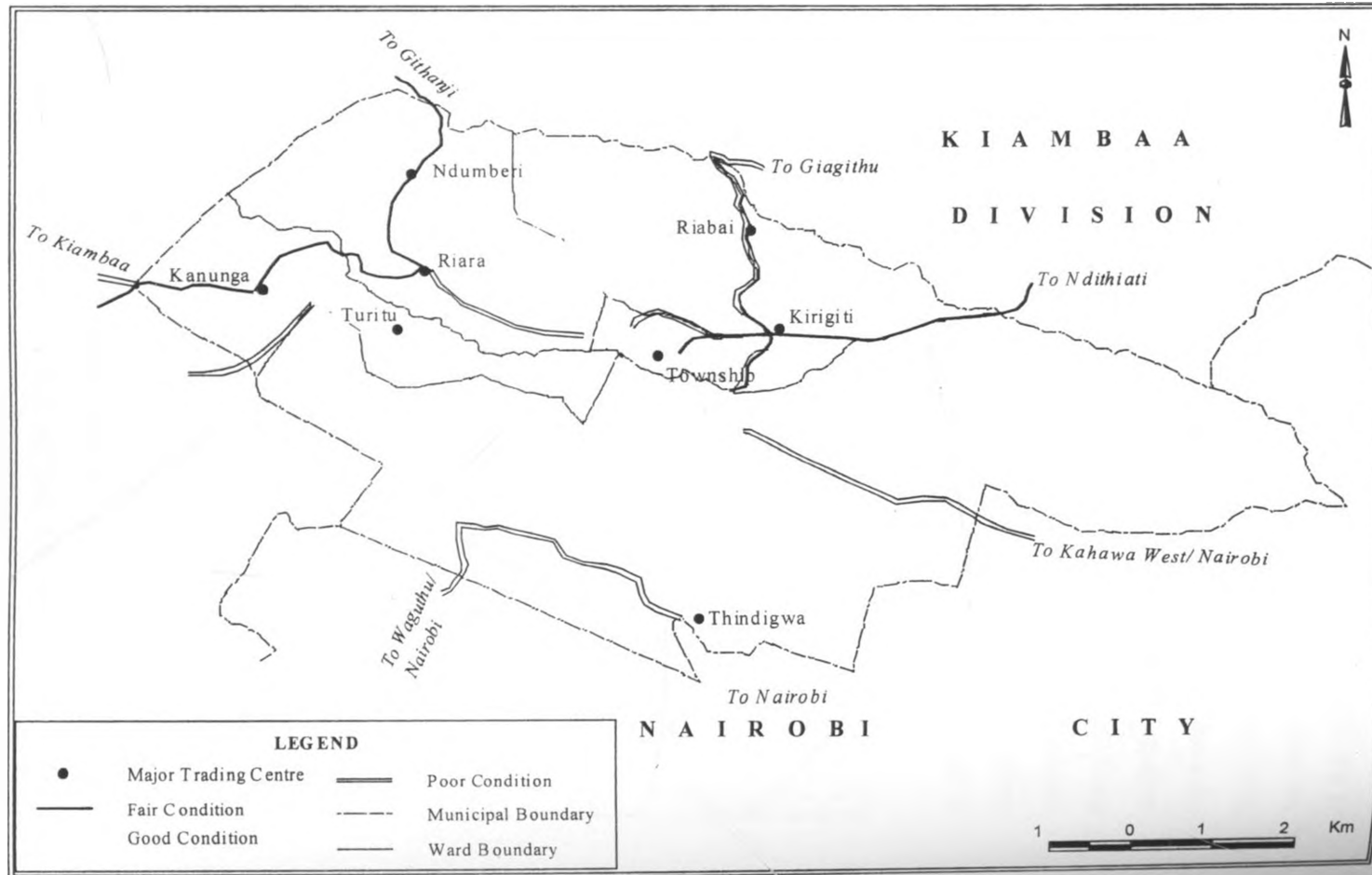
- Small holdings due to unplanned land subdivisions in the municipality,
- Poor roads that are impassable during heavy rains,
- Mismanagement of the available cooperative societies,
- Inappropriate unsustainable agricultural production methods by farmers,
- Inadequate and unreliable rainfall also limits the range of productivity of crops,
- Lack of credit facilities to the farmers, especially small-scale farmers,
- High cost of farm inputs limiting intensive production coupled by poor marketing channels

Therefore, solid waste management has potential for improving the economic base of the municipality and the town. This is because of the declining employment opportunities in the farming sector, particularly in the coffee industry. Therefore, the surplus labour can join informal waste picking. Composting of waste should also be encouraged in order to support small scale farming, particularly because they face the problems of expensive inputs and other challenges. Recycling of waste by way of feeding livestock and building of pens for livestock such as rabbits and poultry using cans and timber has potential in the study area. Other wastes such as timber shavings and charcoal dust from timber-related enterprises can be used to line the floors of the livestock pens. In addition, the growing business sector is a good source of waste, which can be subjected to recycle.

#### **4.11 TRANSPORT NETWORK**

The main purpose of transport is to facilitate the circulation of people and the movement of goods within and between settlements. The transport modes integrate the various production and population centres and facilitate mobility in both rural and urban areas. Most of the required transport facilities in Kenya are already in place, but in poor conditions due to poor maintenance, inadequate funding and inefficient operations and management. Urban transport is critical to the attainment of high productivity in the manufacturing and other sectors of the economy. The Government has already made various efforts to restore efficiency in transport sector, which it anticipates to intensify in the course of 2002 to 2008 planning period

Map 6: Road Conditions in Kiambu Municipality



Source: Survey of Kenya, 1997

#### 4.11.1 Road Conditions in Kiambu Municipality

Roads in Kiambu District can be classified under three broad classes: Class A, B, C and D. Out of these, Kiambu Municipality is served by both Classes B and D. It is the road C64 that links the Municipality directly with the City of Nairobi (see map 6). The municipality has a good network of roads including its rural areas, however due to lack of proper maintenance, most of them are in a poor condition. Table 5-1 below gives a summary of various roads that are in a poor condition and need rehabilitation. These are loose surface roads that have never been tarmaked.

**Table 7: Road Condition in Kiambu Municipality**

Road Name	Length (Km.)
Riabai- Ruthiruini Road	5
Road opposite Riabai Coffee Factory to chief Wandie	4
Riabai Coffee Factory via Kihingo to Ndumberi	5
Kanunga- Kihingo –Karinguri Road	2
Ndumberi Coffee Factory Road	4
Mbureria (free area) Ndumberi Road	2
Kangonya –Kiwanganyi Road	6
Kangonya Karambaini Road	2
Kirangiini –Ndumberi through Kamindi Estate	3
Gitangiini- Kihingo Road	2
Kanunga Cemetery to join Kiambu Ndumberi Road	2
Kanunga High School- Gituamba Road	4
Turitu- Riara Mission Road	3
<b>Total</b>	<b>44</b>

Source: Municipal Council of Kiambu Annual Report, 1999

In addition to the above roads, the road at the Indian Bazaar, the road from the CBD and to Kirigiti, and from Kirigiti to Riabai is also in a bad state. These are roads that were initially tarmaked, but have never been rehabilitated, as they are characterized by potholes. Some of these roads lead to high agricultural potential areas, such as coffee estates and other small-scale farms, hence need to be improved to facilitate accessibility to these regions. In addition to the mentioned roads, the road linking the Indian Bazaar with the CBD need to be improved, at least if not tarmaked, it should be gravelled. This would enhance the interaction between these two areas. This could also open up business opportunities in the Indian Bazaar. Currently, most of the businesses in the Indian Bazaar have been closed due to lack of profitable economic returns accelerated by the influence of the C64 road traversing the CBD. Access roads leading to most residential areas, both in town proper and all major trading centres should be improved to enhance accessibility- an important element of public interest in any urban area.

The major problem is the state of most of the roads within the Municipality. Only Nairobi-Kiambu Road, Kiambu-Githunguri Road and Kiambu-Kanunga Road are tarmaked. All the other roads are murram, in a pathetic state and require to be repaired. Due to the state of roads, public transport has reduced in this roads and the few remaining charge expensively to cater for maintenance costs of the vehicles.

The poor status of the roads hampers the accessibility of waste collection vehicles. This can also have an impact on the possibility of privatisation of waste collection because the vehicle maintenance costs will affect the profitability levels. However, appropriate technology can be employed; for example, use of animal and hand drawn carts.

#### 4.12 COMMUNITY FACILITIES

Community facilities play a very critical role in the human settlements because they provide recreational, health, educational, emergency, religious and social human development avenues. These facilities cover schools, libraries, stadiums, fire stations, churches, and cemeteries among others.

##### 4.12.1 Education facilities

###### a) Pre-Primary School Education

From Table 8 below, most of the pre-primary schools are privately owned (37), the mission owns 33, council 10 and communal owns 3. The number of teachers at the private schools is also higher than in other categories, with the communal schools having the least numbers.

**Table 8: Kiambu Municipality Pre-Primary School Status-2002**

Item	Operator				Total
	Council	Mission	Private	Communal	
Number of Schools	10	33	37	3	83
Enrolment	-	-	1200	-	-
Number of Teachers	27	111	121	4	262

Source: District Education Office, 2003

Kiambu Town Nursery school is located within the study area and is owned by the council.

###### b) Primary and Secondary Schools

The municipality has 13 primary schools and 14 secondary schools. Among the ones located in the study area are Kiambu Primary and Kiambu Township Secondary.

### **(C) Tertiary Institutions**

The municipality has got one major tertiary institution - the Kiambu Institute of Science and Technology. There are other Youth Polytechnics, among the Ndumberi Youth Centre and Kiambu Catholic Church Youth Training Centre. There are several commercial colleges in the main town offering computer and business related courses.

### **(d) Special Educational Institutions**

There exists the Juvenile Remand home and the Kirigiti Girls Rehabilitation Centre in the town.

The education facilities form a good basis for environmental education and particularly in the area of solid waste management as they are major generators of waste. The schools and training institutions can be encouraged to continue with or embrace cleaning campaigns as well as source separation and recycling programmes.

#### **4.12.2 Health Facilities**

The District hospital is hosted at Kiambu Municipality in the Township Ward. Kiambu Municipality has also one nursing home that accepts both in and out patients. Other private clinics and health care centres including chemists and pharmacists are available in the town. The council has only one main cemetery, in the main town, which serves as the waste disposal site as earlier mentioned.

#### **4.12.3 Recreational and Worship Facilities**

Kiambu District has various recreational grounds, among them, a golf club and picnic sites such as Paradise Lost. Several clubs and hotels are also found along the Nairobi-Kiambu route and this has boosted commercial activity by increasing demand for commercial goods and services. The Municipality's major recreational facilities are Kirigiti stadium, Kiambu Golf Course, Ndumberi sports ground and the community Centre which has the community hall and the public library.

The municipality has also several churches distributed within the six wards. The dominant ones in the study area are the Anglican Church and the Catholic Church, which have additional facilities like halls, nursery schools and training centres. There is no mosque in the municipality. The churches can serve as major solid waste educational centres as well as cleaning campaign organisers.

#### **4.12.4 Police and Fire Station**

The Municipality has a police station within the Township Ward. The station also serves as the headquarters for the entire district. It also has several police posts within other wards such as Kanunga. In conjunction to this, there is also a District Prison in the town, also within the Township Ward. Presently, fire services are only available from Thika and Nairobi which are a long distance away. The council proposes to construct a fire service station on availability of funds.

The prison is a generator of solid waste and farm can act as a market for compost from organic solid waste. The prisoners are also key players in the cleaning of the town. The prison staffs housed in the staff quarters also forms a major potential resource in the organisation of cleaning campaigns in the town.

#### **4.12.5 Administrative Areas**

These are areas where public buildings/ offices are sited for the purpose of administering public matters and rendering services to the general public. In Kiambu Municipality, these include the DC's offices, Law Courts, County Council's offices, Municipal Council's offices and several government ministries such as Lands, Agriculture, Education and Public Works just to mention a few.

These are key solid waste generators in the town. The administrative grounds form potential market for compost from solid waste for their flower gardens. The institutions can also form a major information dissemination centres to the members of the public with regard to solid waste, for example through hanging of posters and other informational material.

### **4.13 INFRASTRUCTURE SERVICES**

An efficient network of the infrastructural facilities in both urban and rural areas is paramount for the country to emerge from the current recession and achieve substantial GDP growth rates. In the last decade, poor infrastructure led to increased production costs and reduced competitiveness. The factors responsible for deterioration of the infrastructure include inadequate resource allocation for construction, maintenance and rehabilitation of the facilities, poor contractual work, rapid urbanization and high population growth.

#### 4.13.1 Water and Sanitation in Kiambu Municipality

Water trunk pipes traverse Kiambu town from Sasumua, Chania and Ruiru Dams to Nairobi. Water in Kiambu town is a problem and serious water shortages are experienced because the total water supplied is 1958 cubic metres per day despite the 6000 cubic metres required in a day. The main source of water is borehole water, which constitutes 54% of the total water consumed. There are 7 boreholes to serve the entire municipality. The municipality also obtains water amounting to 900 m<sup>3</sup> per day from the City Council of Nairobi's water pipe originating from Sasumua Dam. This constitutes 46% of water consumed in the municipality (see Figure 6). Table 9 presents total capacity of water supply from the 7 boreholes in meters cubic per day. 4 of the boreholes are in the Township Ward with a capacity of 676m<sup>3</sup> per day.

**Table 9: Boreholes in Kiambu Municipality**

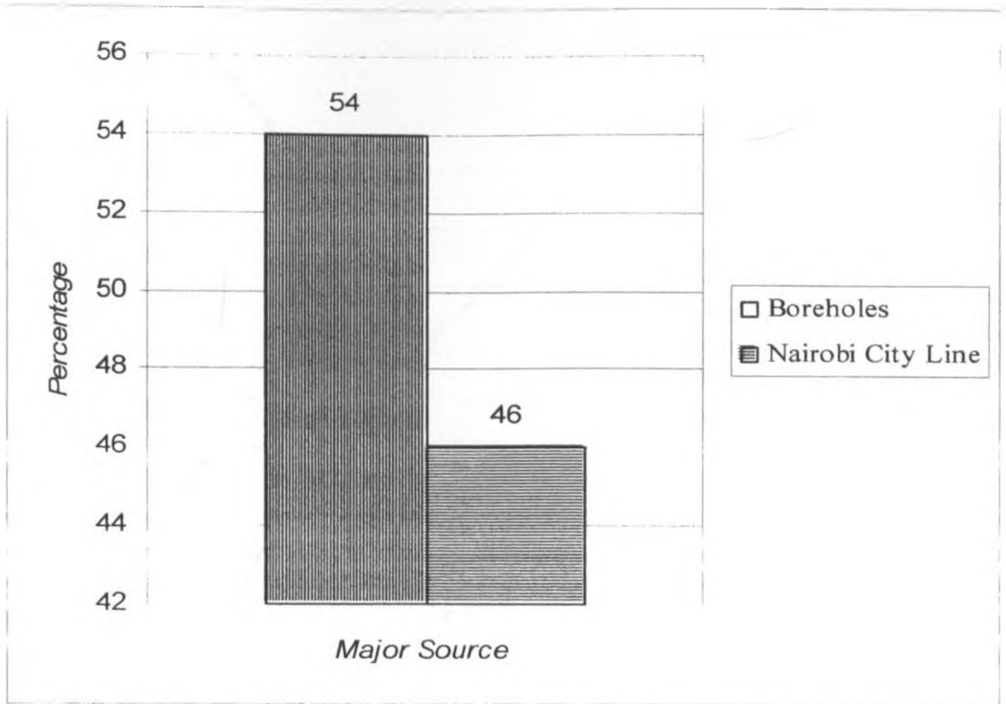
Borehole Name	Location	Capacity ( m <sup>3</sup> /day)
Thuku	Township*	500
Kangoya Market	Kangoya	240
Kangoya Primary School	Kangoya	84
Town Hall	Township*	84
Borehole Number 5	Township*	68
Ndumberi	Ndumberi	58
Borehole Number 4	Township*	24
<b>Total Capacity</b>		<b>1058</b>

Source: The MCK Engineering Department, 2003

It is imperative that proper solid waste management practices have to be adopted in order to protect the underground water sources in the municipality from being contaminated by the leachate from the waste.



**Figure 6: Water Supply in Kiambu Municipality**

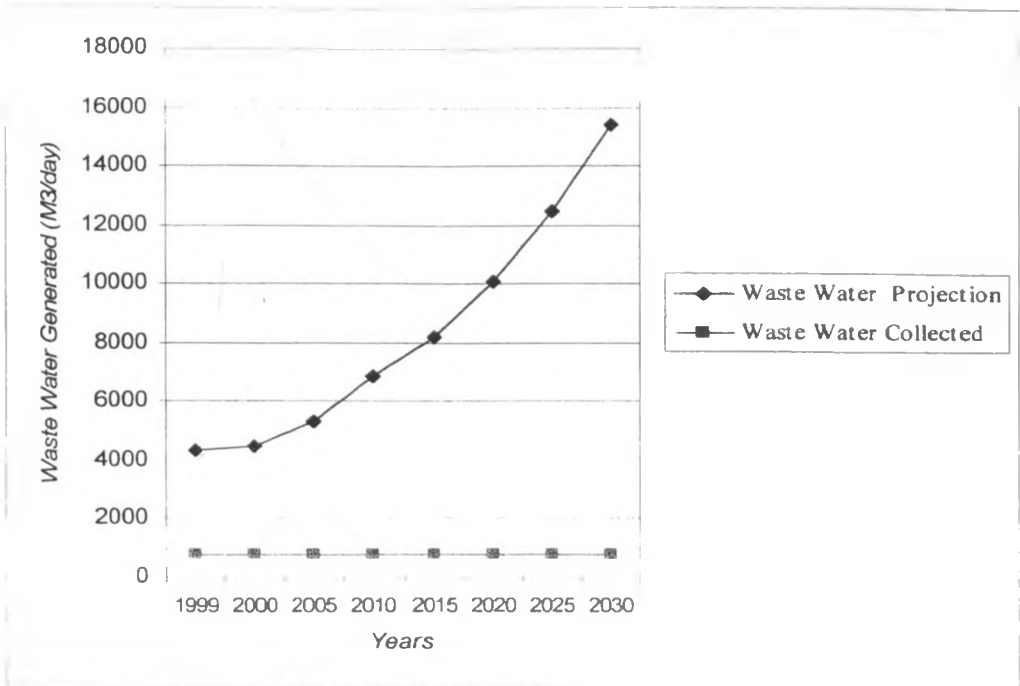


Source: DURP, 2003

#### **4.13.2 Sewage System**

Most people within the municipality use pit latrines partly due to the old design of the houses and due to the lack of adequate water supply to provide toilets. Septic tanks are also in great use and the area is therefore in dire need of an exhauster service. The sewage services are connected only to the main urban centre and the sewerage treatment is only about 60% utilized. The sewerage system covers about 2 kilometres. The area covered by the sewer is about 3.5% of the total area of the municipality although the sewerage treatment works is designed to a capacity of 8000 persons. The plant receives approximately 800m<sup>3</sup> of waste water per day, and can hold up-to 1200 m<sup>3</sup> of waste water per day. Currently, the municipality generates approximately 4316m<sup>3</sup> of waste water per day (Figure 7). This is projected to increase to 15384m<sup>3</sup> per day in the year 2030. In addition, the sewer plant has one oxidation pond which is mechanically aerated. This problem has mainly resulted due to the expansion of the municipality's boundary. This meant that the former rural hinterland has now been incorporated in to the municipality. However, when this was done, considerations were never made for expanding the sewer reticulation. This rendered the Municipal Council with an up hill task of planning for a modern reticulation.

**Figure 7: Projection for waste Water Generation in Kiambu Municipality**



Source: Field Survey, 2003

#### 4.13.3 Telecommunications

An efficient and modern communications system in the era of globalization is today the key for the achievement of rapid economic development. A reliable and efficient system contributes directly and indirectly to poverty alleviation and by facilitating economic growth. Telecommunications is important in facilitating the integration of domestic economy and contributes to promotion of trade and economic development. The municipality is well covered by Kencell and Safaricom cell phone service providers. Several public phone booths are found within the Township area. Postal Service Corporation of Kenya provides postal services. Kiambu Municipality is currently served by one post office located at the Township Ward. Access to radio and television, newspapers and computers have also increased over the years. This offers high potential for environmental education for the Kiambu community.

#### 4.13.4 Storm Water Drainage System

The Kiambu Municipality has no well developed storm water drainage system. The drainage systems that exist in the CBD do not perform well especially during heavy rains because most of them are blocked by wanton dumping of solid wastes. Most of them have also been silted, due soil erosion. However, not all parts of the Township have storm water drainage system.

## **4.14 LAND**

### **4.14.1 Land Tenure in Kiambu Municipality**

Land tenure touches deep emotions because it often plays a crucial role in the individual's sense of participation in a society, as well as in the investment of labour and capital likely to be made on any parcel of land. Land tenure system has an important implication in the development of a region since it determines how land, as a basic natural resource is distributed and utilized for the welfare of the local population. Land tenure also affects land values. Historically, Kiambu was almost exclusively reserved for European ownership and therefore except for Government land reserved for various uses, all other land was large European farms under agriculture or livestock production depending on the agro-ecological zones. Land tenure in Kiambu Town fall under three categories: Government, trust and private land.

#### **a) Government Land**

This is land owned by the Government for her own purpose and which includes unutilized or un-alienated Government land reserved for future use by the Government itself or may be available to the public for various uses. This is administered under the Government Lands Act (Cap 280). The current development plan of Kiambu Town has earmarked about 8 acres of public land of which most is occupied by the Government offices. This hardly leaves any room for expansion of industrial, economic or public service like solid waste disposal site activities. The council is therefore trying to convert private land into commercial and residential plots by the owners.

#### **b) Trust Land**

This is held under trusteeship of the Municipal Council of Kiambu under the constitution of Kenya for the benefit of the people who are ordinarily resident on that land. In Kiambu Town, trust land is found in the upper side, the municipal hall, and the bus park.

#### **c) Private Land**

This is land owned privately in freehold or leasehold tenure after the registration and issue of titles following Government or Trust land allocations or because of land consolidation and/or adjudication and re-settlement programs. In Kiambu Municipality, private land is mainly freehold lying outside the town in the form of smallholdings in Kanunga, Ndumberi and Raibai. Others are large coffee estates, which are leaseholds. Under the leasehold category also fall the commercial plots in the council's major trading centres. A total of 10Km<sup>2</sup> of private land is

under leasehold, and 32.06Km<sup>2</sup> on freehold. Given the increased need to meet the increased demand for land, the council proposes to acquire land in the Kiambu Forest to cope with industrial and other public infrastructural development.

#### **4.14.2 Land Values**

Rental levels for commercial units range between KShs15-25/square foot; and between Kshs 3,500-7,500 per room. For residential units, the values range between KShs1,500 and KShs8,000 per room. Plots are selling at KShs1.4-1.8 million in the town for 1/8 acre plots. (District Lands Office, 2003)

#### **4.14.3 Land Use**

Land use in Kiambu Town can be classified as residential, industrial, commercial, educational, public purpose, public utilities, transportation and recreation.

##### **a) Commercial**

Comprise of both wholesale and retail shops. Major products sold here include general consumer products like food, cloths, books and drugs. Services such as hairdressing and medical care are also provided. Supermarkets selling a wide variety of products also exist. Agro based supplies like farm implements, chemicals, seeds, animal feed are also sold at a larger extent in the town. Offices mainly occupied by lawyers, accountants, banking institutions, Government agencies, cooperative societies and other small-scale professional firms also exist.

##### **b) Residential**

There is no defined residential regions within the town as the units are intermixed with both commercial and/ industrial units in the same block or region. Rental houses mainly available are found on the outskirts of the town in the surrounding privately owned land. Other residential units belong to the Government and are found behind the district hospital and district administrative office blocks. These are mainly for the middle-income group. Low-income residential units are found in the valley behind the Indian Bazaar and towards Kirigiti Stadium. High-income residential estates include Thindigua and Village.

##### **c) Administrative, Public Utility and Public Purpose**

The town serves as the administrative headquarters for the Kiambu District, hence it caters for the interests of all Government ministries, and houses the offices of the DC and other Government departments, divisional police headquarters, law courts, prison and other

parastatal bodies with offices like AFC. It houses both the municipal and county council offices and halls. Public utility and public purpose land uses include children's remand home, a general hospital, matatu/ Bus Park in the upper part of the town, cemetery, stadium, golf course, churches, and Kiambu forest and a market at the centre of the town (both open air and covered stalls).

#### **e) Industrial and Agriculture**

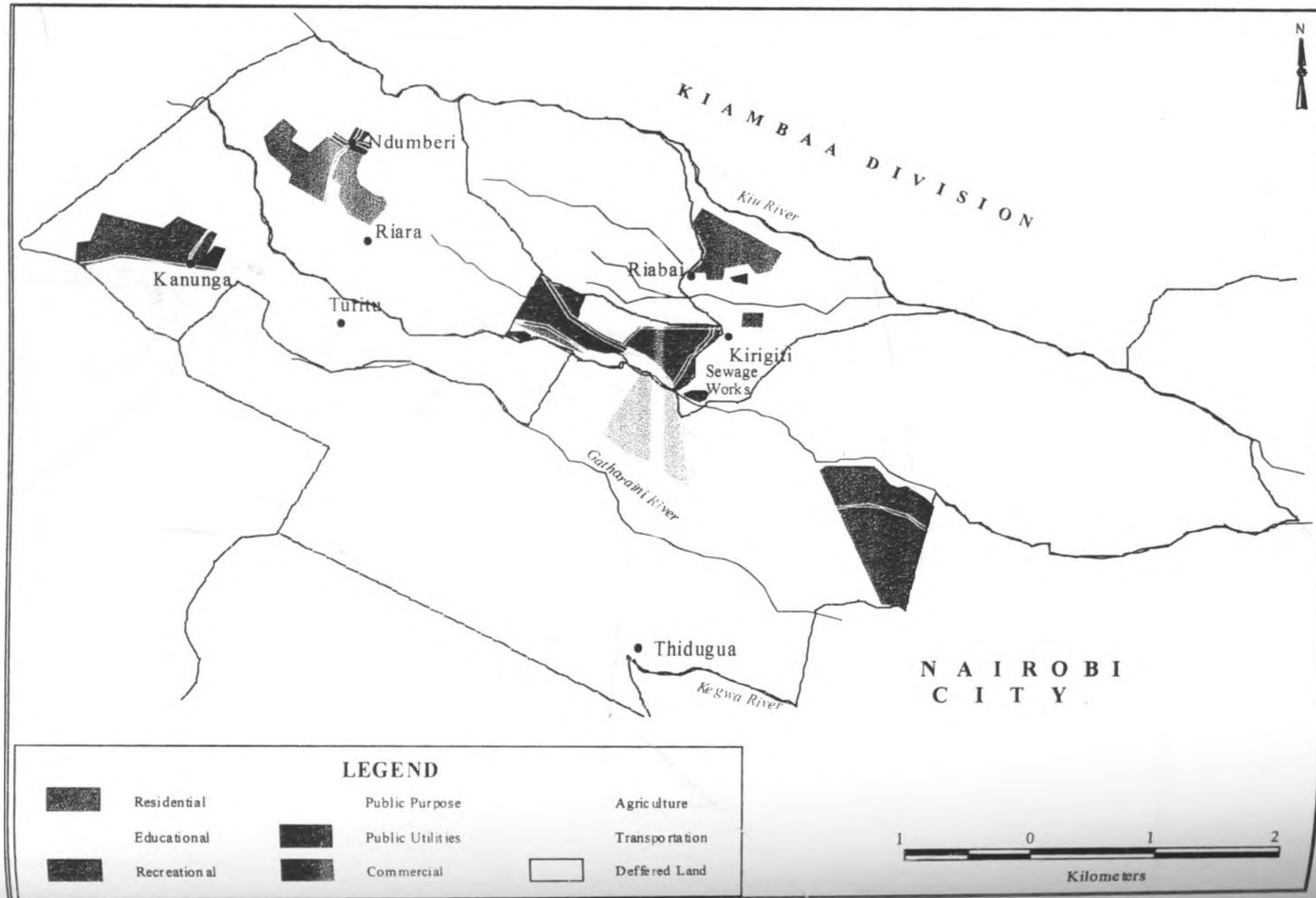
The industrial land users are scattered in several parts of the town; within the Indian Bazaar and also in the upper part of the town near the matatu/bus park; towards Ruiru; around the market place. The industrial land use has been allocated the area between the commercial blocks and the Indian Bazaar. The main industrial activities are light weight and they include metal work, carpentry and joinery, car repair, bakeries, coffee husking factories, bicycle repair and warehousing activities. Agricultural land use in the Municipality is the most prevalent, these mainly constitute of coffee estates and small holding farms.

The land uses prevalent in the study are give indication of the diversity of solid waste generated in the area.

#### **4.14.4 Land Use Pattern**

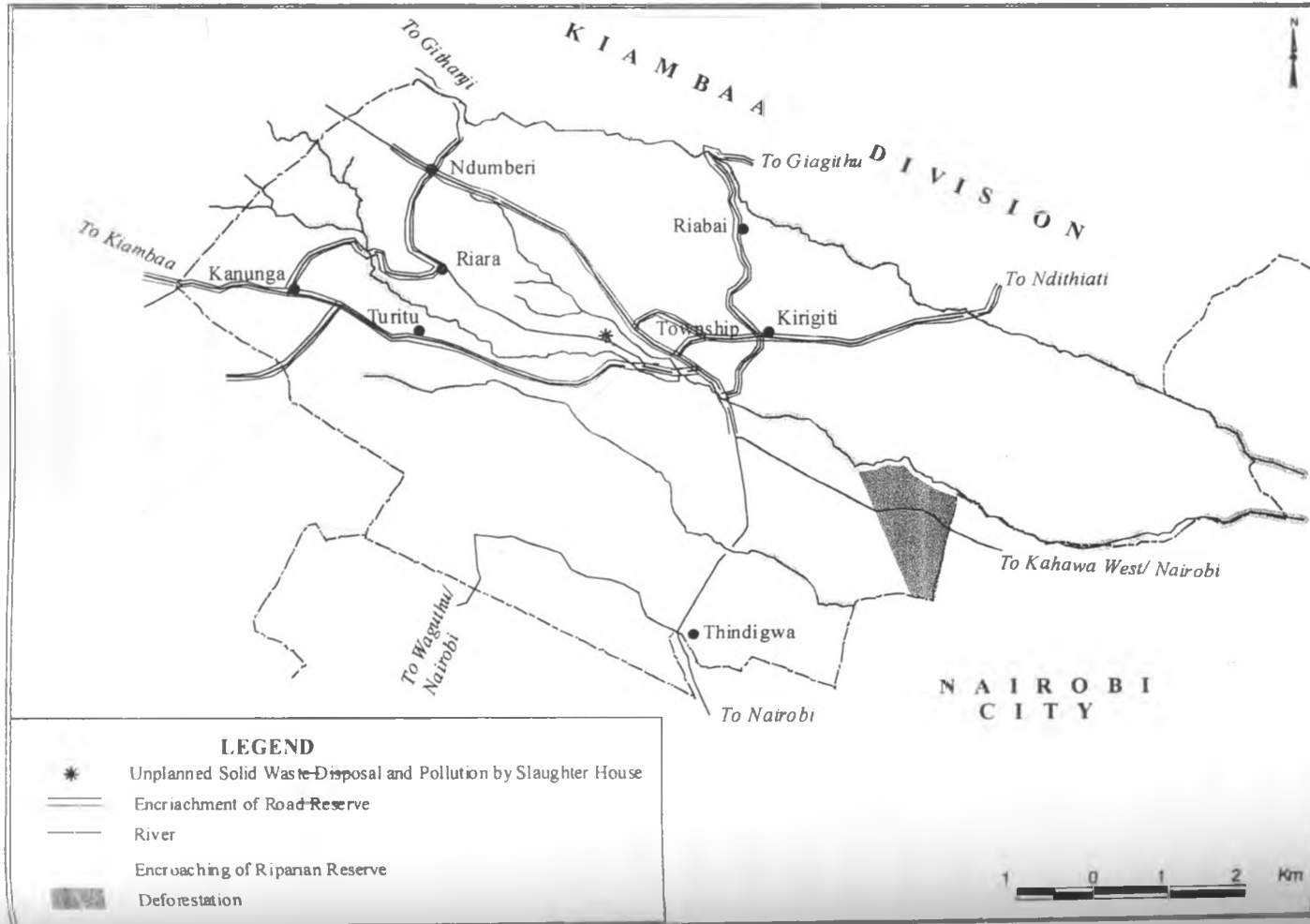
The land use pattern in Kiambu can be described as scattered and uncoordinated. This is evidenced by the grouping together of incompatible land uses resulting to the creation of inefficient and uneconomical urban structure. The pattern also creates land use conflicts and reduces flexible expansion of such facilities such as hospitals, commercial and administrative facilities (*Gathoni, 1978 & Njau, 2000*). One of the examples for this is the controversial location of the dump site in the cemetery

Map 7: Existing Land Use Pattern-Kiambu Municipality



Source: District Survey Office, 2003

**Map 8: Environmental Stress Areas-Kiambu Municipality**



## CHAPTER FIVE: DATA ANALYSIS AND RESEARCH FINDINGS

This chapter outlines data obtained from the field. It is organised to match the research issues which emanate from the research objectives. Thus, it addresses the nature of waste generated in Kiambu Town; the roles, responsibilities and capacities of actors in solid waste management; the environmental problems encountered in Kiambu Town as a result of poor waste management and possible solutions for improved solid waste management.

### 5.1 NATURE OF SOLID WASTE GENERATED BY IN KIAMBU TOWN

#### 5.1.1 Main Generators of Solid Waste in Kiambu Town

The main generators of solid waste in Kiambu Town are households, commercial enterprises, municipal council, institutions like schools, hospitals and the prison, industries and agriculture through their different activities. All households generated similar types of waste. The variation was observed in amount of waste, frequency of production of particular types of waste and in the lack of particular types of waste among households of different income levels. The Municipal Council does not have any waste sorting or separation policy, therefore all the waste from the different sources is mixed during collection, transfer and disposal. There is no provision for specialised waste treatment for any type of waste, except for the incineration of the hazardous waste from the district hospital, which often finds itself into the mainstream when the incinerator breaks down. However, there are future plans to collect hazardous waste from the medical clinics in separate bags, though no provision for special treatment is planned.

#### 5.1.2 Type of Waste Generated in Kiambu Town

The main types of waste generated by the households were food remains, paper, plastic papers, plastics, clothes, shoes, beauty containers, food cans, broken ceramics, glass, newspapers, wood, broom and brush pieces, ash, electronic disks and pieces, sanitary waste, aluminium pieces, iron sheet parts, metal and pieces. The main types of waste produced by low income households were food and vegetable wastes. The middle income households and high income households produced the same types of waste.

The main types of waste generated by the commercial enterprises included; Papers, plastic containers, plastic papers, glass, ceramics, metal, food and vegetables, hair, tin, leather parts, cloth, wood and wood by products, old tyres, old batteries, rubber, photo films, bottle tops, car parts, needle pieces bones,



charcoal waste and ashes. Hazardous waste includes medical waste like syringes and needles; biological samples like blood, faeces, urine and bandages from enterprises like hospitals, clinics and pharmacies. Other hazardous waste includes plastic and metal containers for dyes and thinners from dry cleaners and textile shops, paint and varnish cans from carpentry and metal workshops, photo films from photo studios, plastic and tin containers from petrol stations as well as metal pieces. The following table summarises the categories of wastes generated in Kiambu Town:

**Table 10: Type and Sources of wastes generated in Kiambu Town**

CATEGORY OF WASTE	SPECIFIC WASTES	SOURCE/GENERATORS
1. Organic Waste	Food remains, animal wastes, dead animals, wood	Households, businesses, municipal, agriculture
2. Inorganic Wastes	Plastics, metal, leather, cloth, glass, ceramics, tin, bottle tops	Households, businesses, municipal, agriculture, institutions, industries
3. Hazardous waste – are either flammable, combustible or non-combustible	Chemical containers; thinners, dyes and other solvent containers; perfume cans; paint containers; old tyres; old batteries; syringes, needles and other biological wastes from medical institutions; used sanitary towels; broken ceramics, glass and other sharp objects; Photo studio wastes; dead animals	Hospitals, schools, municipal, businesses, industries, households, agriculture
Bulky Waste	Dead animals, metal, trees	Agriculture, municipal, industries

Source: Author, 2004

### 5.1.3 Weight/Amount of Waste

Low Income households produced about 1kg per day, with middle income households producing about 2 to 3 kg of waste per day and the high income households producing between 2.5 to 4 kg of waste per day. The survey revealed that the average weight of waste generated by a household in a day is 1.4 kg. The maximum amount was 4kg, the least being 0.7kg and the most common amount was 1 kg. The private firm collected 2 cart loads every week which approximated at 1000kgs from about 90 households. This yields approximately 1.5 Kg per household per day. The average weight of waste produced by businesses per day is 15 kg, with the least weight being 0.1 kg and the heaviest being 30 kg per day.

The municipal council lacked any documentation about the weight of waste they carry, but was approximated at 2 no. 7 tonne tractor loads per day, for all types of waste except that from institutions and the Jua Kali Sector.

From the field data, the following could be approximated to be the amount of waste generated in Kiambu excluding institutional waste per day:

Household waste: 15151 households x 1.4 Kg = 21,211 kg

Waste collected by municipal 7000kg x 2 = 14,000Kg, thus total weight is 35, 211Kg or about 35 tonnes.

It can be observed that there is potential for composting organic waste and recycling the recyclable products as will be discussed later in the roles and responsibilities of the actors. Hazardous waste also needs to be addressed.

## **5.2 ROLES AND RESPONSIBILITIES OF DIFFERENT ACTORS IN SOLID WASTE MANAGEMENT**

The roles and responsibilities of the actors refer to the express and assumed roles and are further categorised into positive and negative ones, given the legal, financial, technical, human resource and management capacities of the actors.

### **5.2.1 Municipal Council of Kiambu**

#### **5.2.1.1 *The Legal and Institutional Framework***

This section outlines the organisational structure of the municipal council of Kiambu as well as how it relates to other government offices and other actors in development issues.

##### **a) Municipal Council of Kiambu Organizational Structure**

The Municipal Council of Kiambu is divided in to six electoral wards, each represented by a councillor who is elected by the public during the general elections. There are two nominated councillors to represent special interests. The District Commissioner is also a nominated councillor by virtue of his office.

The Municipal Council has two arms - the policy arm and the executive arm. The Policy arm is composed of committees whose work is to formulate policy to guide the functioning of the council. The executive arm is charged with the responsibility of day to day running of the Council's business and to ensure that policy is complied with.

## 1) The Policy Arm

The mayor is the head of the policy makers and by virtue of his position, the chairperson of the full council committee, which is the overall organ in the decision making of the council. The policy arm is structured in to five committees each of which is chaired by a committee chairman. The committees are as follows:

- I. **Finance, staff and general purpose committee** - This committee is charged with administration of the council's finances, public relations with regard to finance, Legal matters and staff matters.
- II. **Town Planning, Works and Housing Committee** - controls and administers town planning, developments within the municipality, gives guidance in maintenance of all council infrastructural facilities and legal matters pertaining to housing and physical development.
- III. **Education and Social Services Committee** - This committee administers schools, social services, and exercise development controls over all issues pertaining to educational standards and maintaining social programs.
- IV. **Public Health Committee** - deals with public health issues within the jurisdiction of the municipality
- V. **Environmental Committee** - This committee administers and addresses environmental issues regarding sanitation and protection of watershed areas in conjunction of with other government institutions dealing with environmental matters.

All the committee resolutions and recommendations are passed to the full council for approval and adoption. All the five committees and full council meet about thrice a year. However, in an emergency any committee including the full council can be called as a special meeting. The council is also represented in the following district committees:

- District Development Committee (DDC)
- District Executive Committee (DEC)
- District Liquor Licensing Board (DLB)
- District Plot Allocation Committee (DPAC)
- District Agriculture Committee (AC)
- District Education Board (DEC)

## 2) Executive Arm

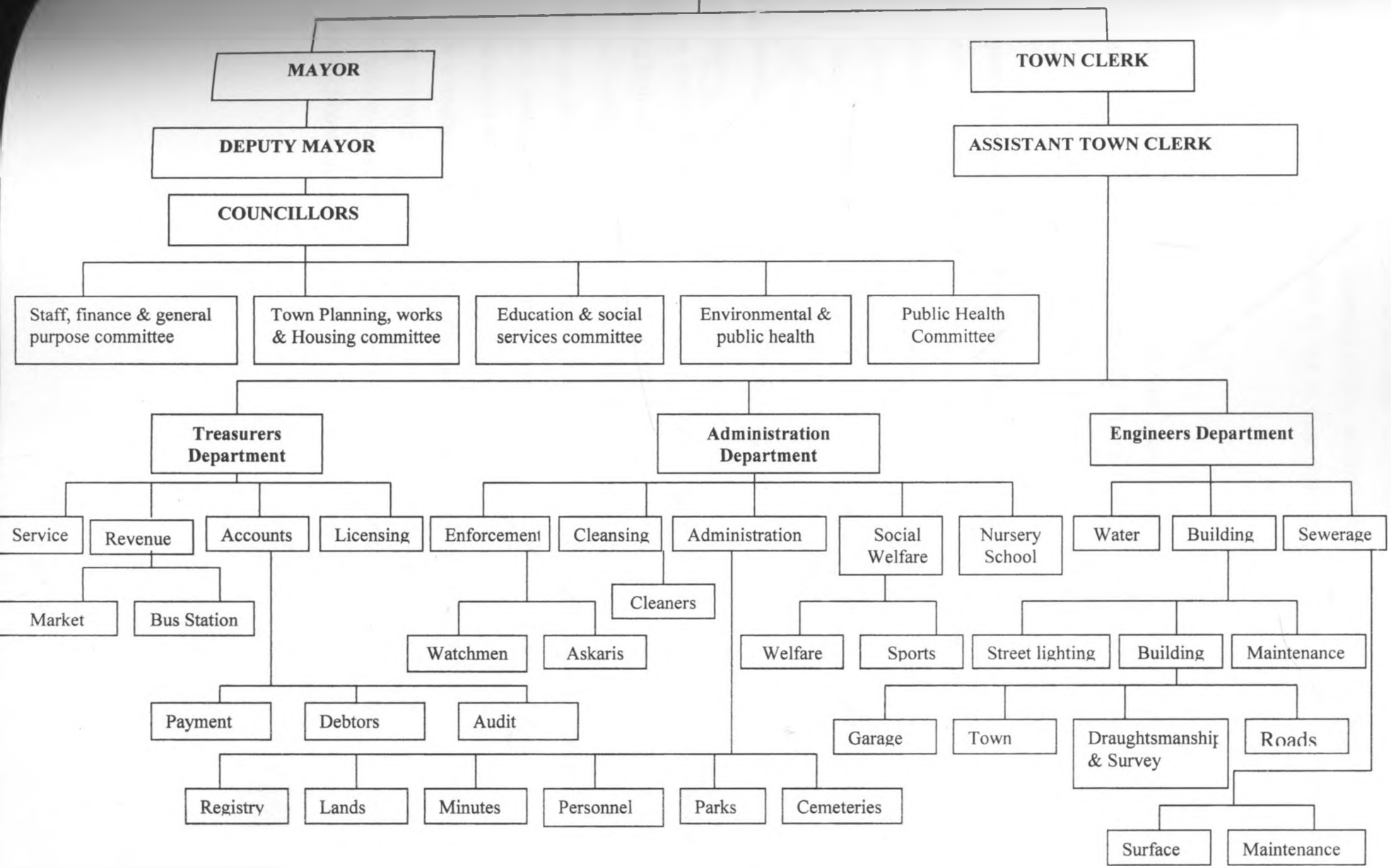
The council is also organized into three departments that form the executive arm as follows:

- Administration Department
- Finance Department
- Building and Works Department

All the departments and sections report to the Town Clerk who is the chief executive of the council. All the departments are headed by head of departments, while sections are headed by section heads. These represent their departments/ sections in relevant committees as advisors during the committee proceedings and implement the council's resolutions. The functions of the departments are outlined below:

- I. Administration Department* - The Town Clerk is the Chief Executive of this department and acts as a liaison officer between the policy makers and the departmental heads. His department is in charge of administrative functions, enforcement and general responsibility of coordinating the overall activities of the council.
- II. Finance Department* - Headed by the Town Treasurer who is the Chief Finance Officer of the council. The department has a duty of maintaining all necessary accounting and finance records. As the chief finance advisor, he is expected to liaise with finance, staff and general-purpose committee on the financial position of the council. The department initiates the preparation of the council's annual estimates and expenditure for the full council and ministerial approval. The department is also responsible for writing of books of accounts and preparation of abstract of accounts.
- III. Building and Works Department* - This is the technical department of the council headed by Town Engineer who is responsible for general development control including approval of building plans, maintenance of roads and implementation of development programmes within the municipality. The department liaises with Town Planning, Works and Housing Committee of Physical Planning matters and development control issues.

Figure 8 on the next page shows the organisational structure of the Municipal Council of Kiambu.



Source: MCK, 2004

Therefore, solid waste management is not under one department but is scattered among various departments and sections namely cleansing section, administration, revenue and engineer's department. This causes managerial problems due to lack of clear chain of command to facilitate sound decision making.

## **b) The Legal Framework**

The municipal council of Kiambu does not have adequate capacity to control development in the municipality as mandated by the PPA and the LGA. The council has no development by-laws, development plans or building codes to guide development control in the municipality. Development and building plans for the municipality are approved by the district physical planner who serves the whole district and may not be fully aware of special development needs of the municipality.

The specific roles the Municipal Council of Kiambu is supposed to play with regard to solid waste management are laid out in the following by laws:

- Conservancy By laws of 1976, later repealed in 1989
- General Nuisance Bylaws of 1976
- Cemetery Bylaws of 1977

**I Conservancy by laws** - relate to refuse collection and waste water. The provisions for refuse collection are as follows;

1. In the introductory part, Part I of the bylaws, Refuse is defined as garbage, tins, bottles, ashes, and sweeping from premises but does not include liquid refuse, garden or stable refuse or waste products from factories or workshops.

Premises are defined to include both a dwelling and a hotel, and a dwelling is taken to mean a building designed or used for the purpose of human habitation but does not include a hotel as defined in the Hotels and Restaurants Act of 1971.

There is a weakness here in that the Municipal Council has not committed itself to collect waste from business concerns of other type except hotels, yet the actual situation on the ground is contrary. The Council collects refuse from the market, offices, medical concerns and even from carpentry shops, the latter of which constitute workshops.

2. In Part II, it is provided that the council, through the Medical Officer of Health, has obligation to provide receptacles (a bin provided by the council for the deposit of refuse and includes a lid) of adequate number to premises.

This does not happen and indeed, the council stopped this service back in late 1980s. The explanation for this was that it was an expensive undertaking. The current practice is to deposit waste irregularly in arbitrary collection points established by the residents and business concerns on bear ground. There are some collection points constructed by some volunteers (see plate No. 9 on page 107) or the council, but there lacks monitoring as to what is deposited, contrary to section 4 of the bylaws that states that any liquid refuse or un-extinguished ashes or other material that is likely to cause fire; or any liquid or solid material that is likely to cause injury to any person should not be deposited in the receptacles, otherwise the depositor is guilty of an offence. As there lacks any sorting policy in Kiambu, any form or type of waste is deposited in the arbitrary or constructed collection points.

3. Section 6 deals with charges as follows:

(1) "The occupier of any premises or part thereof in respect of which refuse removal service is provided by the council shall pay to the council a fee as prescribed in the approved fees and charges of the council for that calendar year"

The weakness in this part is that from the field survey, the households do not pay any charges to the council, and this indicates loss of revenue for the council. As for the business concerns, field survey revealed that the charges for refuse collection are comprised in the single permit Trading License and the amount was not specific as it is charged as a lump sum service charge. This therefore indicates that there is no proper accounting system for the separate services provided by the council in its jurisdiction. This affects the efficiency with which services are provided.

(2) "The occupier of any premises or part thereof other than a dwelling, shall in addition to the fee payable under paragraph 1 of this bylaw, pay to the council a fee as prescribed in the approved fees and charges of the council for the hire of such receptacle together with a further fee as prescribed in the approved fees and charges of the council for the service of emptying such receptacle in excess of one."

The weakness in this subsection is that the occupier has not been defined in the preliminaries of the bylaws; and that the phrase "*paragraph 1 of this bylaws*" should actually read as "*paragraph 1 above*"

because the actual paragraph 1 of the bylaws is not related to charges. In addition, the council no longer provides the receptacles, and therefore the flaw in this part of the bylaws, as the council does not have the basis on which to charge the occupants of the premises. This therefore indicates possible loss of revenue for the council.

(3) "The occupier of any premises in respect of which the council have provided one or more trade refuse receptacles shall pay to the council a fee as prescribed in the approved fees and charges per month for the hire of each such receptacle together with a further fee as prescribed in the approved fees and charges per month for the service of emptying each such receptacle."

This subsection is similar to the first two, as the council does not provide any receptacle to business premises or households. A *trade refuse receptacle* is defined in the bylaws as 'a receptacle with a volume of not less than 33 cubic feet'. The Bylaws have not distinctly differentiated this type of receptacle from the other type, and it is not clear to whom it is supposed to be provided.

4. Other inherent weaknesses of the bylaws are:

a) Part IV section 17 of the bylaws state that "any person who is guilty of an offence under these bylaws shall be liable to a fine not exceeding two thousand shillings or in default of payment of the fine, to imprisonment for a term not exceeding six months." This section is partially in line with the LGA, section 201(2) (a) for the first offence but it lacks the provisions for imposing both penalties for a first offence as well as the provision for charging penalties for a second or subsequent offences, which as per the latter Act should be subject to a fine of three thousand shillings or imprisonment for a term not exceeding nine months or both such imprisonment and fine.

In Section 201(2) (b) the LGA provides that in case of a continuing breach of such by-law, a fine not exceeding twenty shillings for every day during which the offence continues should be charged provided that such an aggregate sum does not exceed two thousand shillings, and that the council can charge the offender for any expenses it incurred in consequence of breach of the bylaw. The Conservancy By-laws of MCK have not embraced this part of the penalty. This places the council in a vulnerable position.

b) The By laws are very old, and do not therefore match today's requirements particularly for a Municipal Council. A wider perspective needs to be adopted, and emphasis should not only be laid on charges,



penalties, provision of dust bins and their use. The entire process of waste management should be incorporated in the bylaws, to include issues of waste generation and sorting; waste recycle; possible privatisation aspects; waste collection; waste transportation; provisions for dealing with liquid and hazardous waste; equipment, machinery, vehicles and other tools of operation; management of disposal site; among other important issues of the waste management process. Further, the definitions of terms should be expounded to include terms such as hazardous waste, Domestic refuse, garden/stable refuse, occupier, refuse collection service, solid waste, liquid waste, market waste among others. A broader definition of term premises should be adopted to include other business concerns apart from hotels. The capacity, material and location of dustbins should be defined.

c) There lacks any evidence for the enforcement of these by laws as the council has failed in some aspects, for example, provision of dustbins and in monitoring of waste deposited in the collection points. This leads to general apathy particularly on the part of businesses and the residents with regard to better waste management.

d) The greatest weakness is the fact that the bylaws were repealed in 1989 by way of crossing over the relevant clauses with a pen, and there lacks the signature of the Minister of Local Government at the time. There was no fine copy at the time of field study.

**II General Nuisance By-laws of 1976 of the MCK** revealed the following issues;

1. Section 9 states that "Any person who shall without lawful authority deposit or cause to be deposited any soil, vegetation, refuse or any debris on any land in the township shall be guilty of an offence." Contrary to this section, the residents and business community deposit refuse on arbitrarily established points for collection by the council because they claim lack of dustbins. No action is taken against them, and actually, the council collects waste from these points, regardless of the numbers.

2. Section 16 (a) "any person who shall wilfully obstruct the free passage of any street shall be guilty of an offence." This is contravened by the business fraternity by way of leaving heaps of refuse, and no action is taken against them.

3. Section 21 Any person who shall in any street or public place

(a) Ignite any fire work

(g) Place or deposit any glass, china, earth ware, carton, paper, sawdust or other rubbish so as to create or tend to litter

(h) Throw down or leave any orange peel, pineapple peel, banana skin, or other substance likely to cause a person to fall down

(r) Without the consent of the town clerk, light or maintain or suffer to be lit or maintained any fire or brazier; shall be guilty of an offence.

On the contrary, residents and business operators do burn openly their wastes particularly plastics and papers. Market operators, fruit vendors and general public do throw fruit and vegetable peels on the ground, and this was one of the main problems cited by some households who were interviewed. The type of wastes condemned by clause 16(g) are actually major constituents of solid waste in Kiambu Town. No action is taken against offenders of these provisions.

4. Section 29 deals with penalties. It states "Any person who is guilty of an offence under these by-laws shall be liable to a fine not exceeding one thousand shillings or to imprisonment for a term not exceeding six months or to both such fine and such imprisonment, and if the offence is a continuing nature, to a further fine not exceeding thirty shillings for every day or part of a day during which such offence shall continue provided that the total amount of any such fine shall not exceed one thousand shillings.

The provisions in the LGA section 201(2) (a) extend to a fine of two thousand shillings or 6 months imprisonment or both for the first offence, therefore the fine in these by-laws fall short of what is provided by the legitimate Act governing actions of local authorities.

For the second and continuing offences, the Act provides for a fine of Three thousand shillings or imprisonment for a period not exceeding 9 months or both; but the by laws have sanctions of lesser effect.

**III Cemetery Bylaws** – A review of the cemetery bylaws was necessary for the case of MCK because the Municipal Waste Disposal Site is at the Cemetery grounds. The following clauses of the bylaws were seen as useful as far as waste management is concerned;

1 Section 4 "Every Cemetery shall be under the sole control of the council, and shall be open to the public during hours only as may from time to time be prescribed by the council as the council may from time to time resolve" The issue of contention is whether such control entrusted in the council constitutes the right to dispose of the waste at the cemetery grounds. Further, with wastes being deposited at the cemetery

grounds, it becomes impossible to control the entry of scavengers into the disposal site, which is part of the cemetery grounds, as there are no security measures put in place to enforce this part of the bylaws.

2. Section 6 (1) "Every cemetery shall be surrounded by a wall, fence or hedge so constructed as effectually to prevent dogs, cattle or beasts of prey from entering the cemetery" This has not happened in Kiambu, and with the disposal of waste at the cemetery grounds, it is difficult to control the entry of the category of animals listed in this section.

3. Section 12(1)"No person shall cause a nuisance during any interment in a cemetery" The issue here is whether the council is able to uphold this provision, particularly when waste has to be emptied from the collection vehicles. Even the activities of scavengers can cause nuisance if carried out during interment.

4. Section 15 "Any person who is guilty of an offence under these by-laws shall be liable to a fine not exceeding two hundred shillings or to imprisonment for a term not exceeding one month or to both such fine and imprisonment." These penalties are way below the provisions of LGA section 201(2) (a) and (b); and the greatest question is whether the council is able to impose these penalties on itself as it is the greatest offender of these by laws.

In addition to the existing By laws, in order for the council to improve the process of waste management in Kiambu Town, certain relevant Bylaws need to be made. These include; Market Bylaws, a repeal of Hawkers Bylaws to include clauses related to waste management, slaughtering by laws and Environmental Management by laws.

### c) Community Based Organisations in Kiambu Municipality

Table 11: Community Based Organizations in Kiambu Municipality

Ward	Type of Community Based Organization									
	Merry go Round	Agro based	Plot Buying	Water Project	HIV/AIDS	Handcraft	Investors	Sports	Salaam Clubs	Vigilante Groups
Township	28	3	1	-	-	-	-	1	1	1
Kilimo	6	2	1	-	-	-	-	-	-	-
Mumunga	14	-	4	-	-	-	-	-	-	-
Ndumberi	15	-	2	-	1	-	-	-	-	-
Riabai	23	7	-	-	-	-	2	1	1	-
Technology	4	2	-	1	-	1	1	-	-	-
<b>Total</b>	<b>90</b>	<b>14</b>	<b>8</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>1</b>

Source: Municipal Council of Kiambu Social Services Officer, 2003

Even though the municipality has several cooperative societies and CBOs, coordination between these cooperatives and the relevant planning agencies or institutions is very poor. They rarely participate in matters relating to physical planning in the study area. Most of them have been formed with an objective of seeking financial assistance. Those that participate in community development such as water projects rarely interact with the council, thus leading to a poor institutional framework.

The agro based CBOs can be very useful in the development of solid waste composting programmes. Existence of these CBOs indicates MCK's support for the formation of such organisations, therefore opening an avenue for the informal waste pickers to form their own.

### 5.2.1.2 Financial Arrangement

The municipal council has financial problems with average annual revenues of 999,980 and annual expenditures of 1,086,223. It is clear that that the expenditures are more than revenues; hence the council is currently operating at a deficit. The revenue and expenditure per department is as shown with the administration department being the lowest revenue and highest expenditure as it covers workers salaries.

**Table 12: Financial Allocation to Various MCK Departments for the year 2003**

Department	Revenue (K.£)	Expenditure (£)
Town Clerk	118,666	419,496
Treasurer	605,344	282,121
Engineer	275,970	384,606
<b>Total</b>	<b>999,980</b>	<b>1,086,223</b>

Source: Municipal Council of Kiambu Financial Estimates, 2003

As said, much of the Municipal Council's budgetary allocation is normally directed towards settling the personnel wages, and meeting other overheads. Very little funds are allotted for improving infrastructure and community facilities.

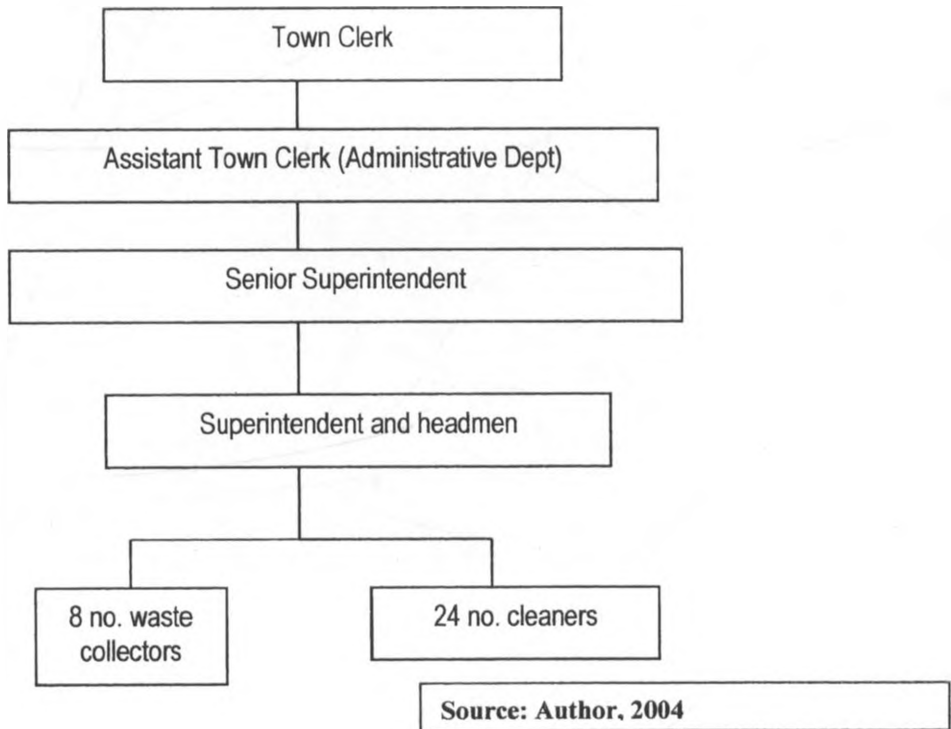
Due to the failure of the Municipal Council to do its part as per the By-laws, the financial returns from the services it provides to the residents and business community within it's jurisdictions are not optimal. From the field survey conducted, it was found out that households do not pay any fees to the Council for refuse collection. The fees charged to the businesses are comprised in the Trading Licence, and no specific amount is apportioned to Solid waste management. A review of Council annual reports from 1994 to 2002 indicate that refuse collection is merged with sewerage, public place cleansing and street sweeping. This

comes as a lump sum, with no breakdown for the specific aspects of cleansing. There lacks no special charges for the dischargers of hazardous waste. There also lacks evidence from these documents of the fines charged for the breach of these bylaws.

### 5.2.1.3 Human Resources Management

The council lacks adequate qualified staff with 1% being of university level, 15% tertiary level and 84% being of primary level and below. The employees in the cleansing department are dealt with in general, to include even those who clean public offices. Currently, the specific number of crew involved in waste collection is 8, four people for the tractor and the other four for the lorry. The organisational structure of the cleansing section is as follows;

**Fig 9 Organisational Structure of the Cleansing section**

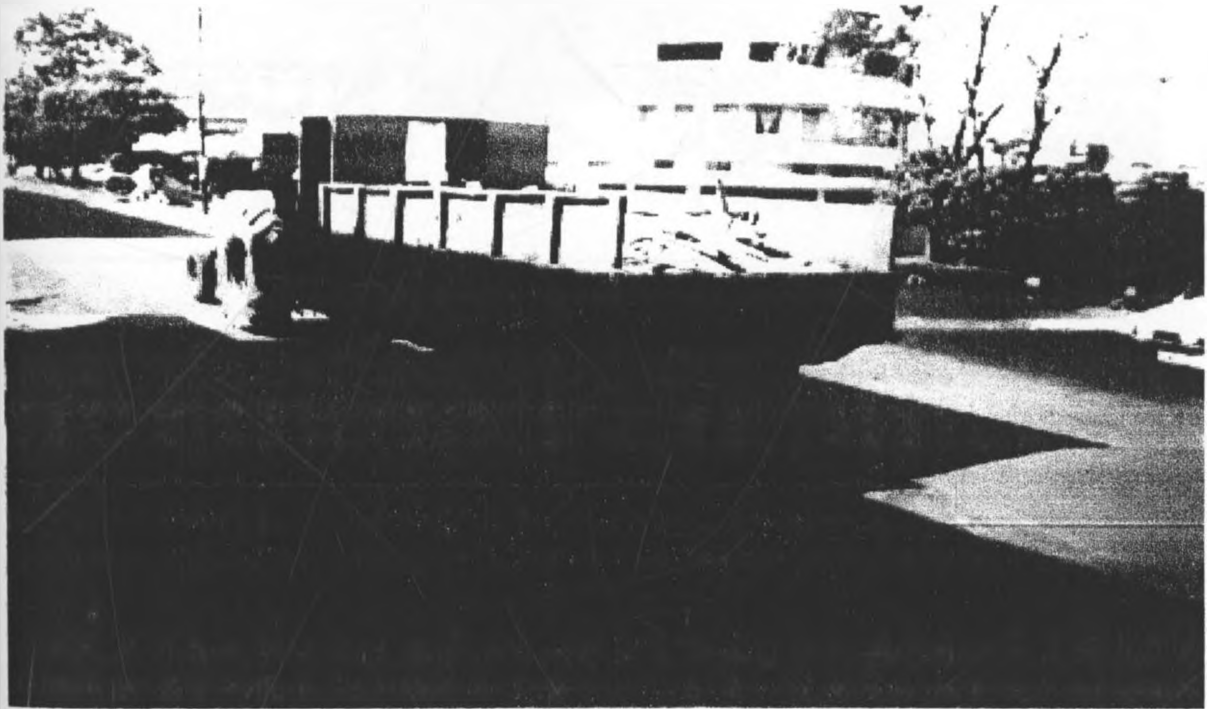


The Waste collectors are men aged between 25 and 40 years. The cleaners are all female. There is no formal training given to the lower cadre employees except the senior superintendent.

#### **5.2.1.4 The Technical Capacity**

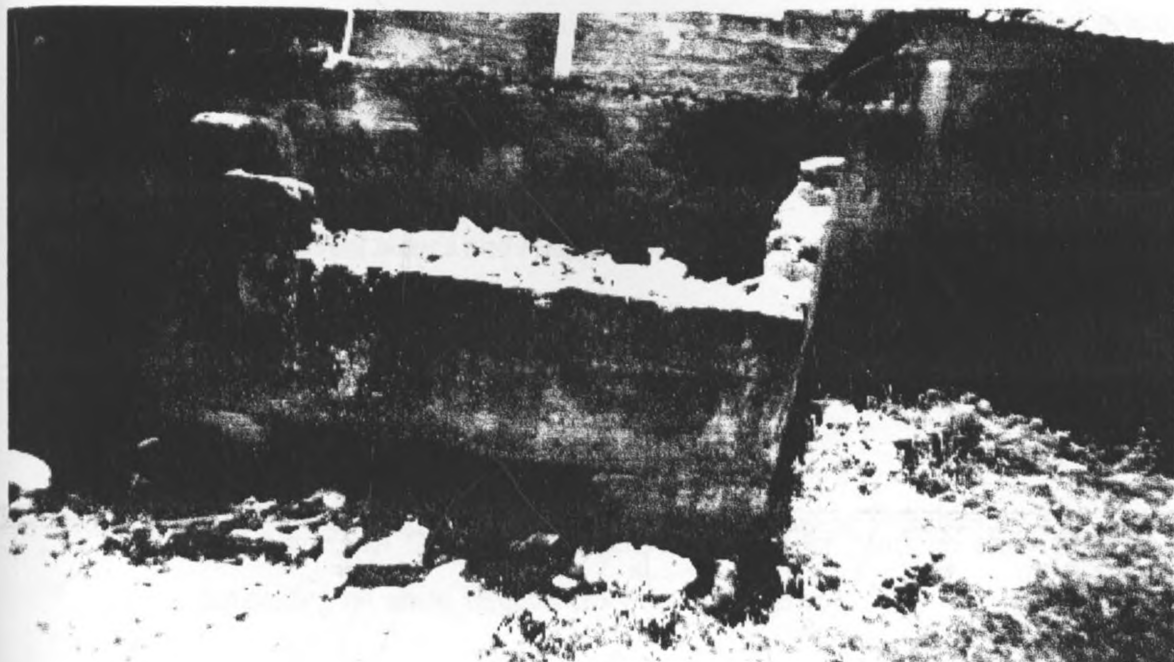
The municipal Council has only one tractor whose capacity is 7 tonnes. (See plate 3 below). The tractor is also shared with other departments. It also frequently breaks down and the repair takes long due to long procurement procedures and lack of funds to buy spare parts. This means that the council is not able to provide collection services during the breakdown periods and when the tractor is in use in other departments.

**Plate 3: municipal's tractor with trailer for carrying solid waste**



The council is able to buy uniforms for their workers as well as provide soap for cleaning the uniform. They also provide gumboots, nose pads, gloves, spades/shovels, brooms and fork jembe to their sweepers and waste pickers though not on a regular basis. The council has also constructed collection depots like the one shown on plate 4 on the next page. The municipal council used to provide dustbins for waste storage like the one shown on plate 5 on the next page, but it ceased due to their high costs.

*Plate 4: Waste collection depot constructed by the Municipal Council*



*Plate 5: Dust bins the council used to provide before 1988*



However with regard to technical aspects of waste treatment like composting, treatment of hazardous waste, sorting and separation of waste among others, the council does not have the technical know how, and thus does not employ any of these technologies. The council's role in waste treatment is basically limited to collection and disposal in the central dump site.

### 5.2.1.5 General management Issues and Future Plans

The municipal council offices are a former club belonging to the County Council and are congested. The council does not keep proper records and does not have relevant maps.

The council's future plans are:

- a) Looking for land to relocate the dump site.
- b) A certain Youth Group from Embu had applied for permit to study the possibility of composting the waste. Negotiations were still underway.

### 5.2.2 Households

The households play different roles which are both beneficial and destructive to solid waste management. The positive roles include sorting of waste, storage of waste, recycling of waste, composting of waste and burning of waste. The negative roles include burning of some hazardous waste, irregular dumping and failure to minimise waste through sorting and recycling. With regard to sorting of waste, 20 (50%) of the respondents sort their waste whereas the remaining 20 do not sort their waste. The following are were the responses of the households with regard to sorting of waste and reasons for sorting the waste;

**Table 13: Waste sorting reasons by households in Kiambu Town**

TYPE OF WASTE	REASON	NO. OF RESPONSES	% RESPONSES
Clothes	Donations or resale to scavengers	6	15
Plastics and glass	Recycle at home level or resale to recyclers or informal waste collectors	4	10
Papers	For burning purposes	8	20
Food and vegetables	For feeding livestock	6	15
Food	Given to livestock farmers	8	20
Food and other organic waste	Composting	5	7.5

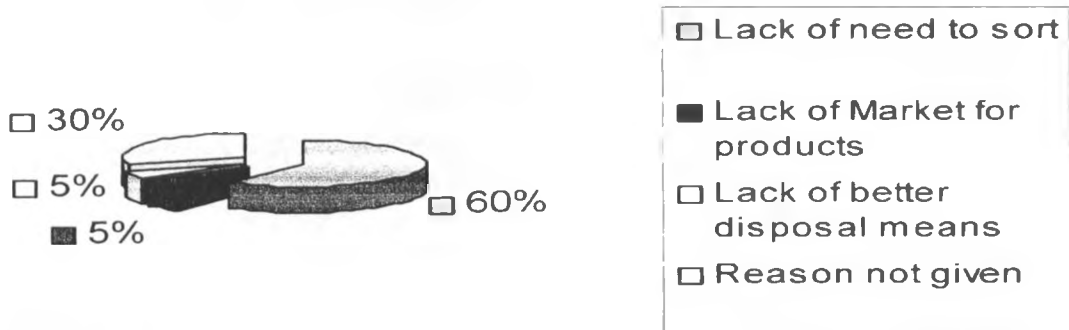
Source: Author, 2004



Some of the reasons for failure to sort waste are shown in the listing and pie chart below:

<b>Reason</b>	<b>No of respondents</b>
Lack of need to sort	12
Lack of Market for products	1
Lack of better disposal means	1
Reason not given	6
<b>Total</b>	<b>20</b>

**Figure 10: Explanation for failure to sort waste by Households**



Source: Author, 2004

Households employ different methods of waste storage. The ones identified were as follows:

29 households use dust bin, 8 polythene bags, 2 store their waste in the rubbish pit whereas 1 household had no means of waste storage. This is depicted in figure 11 below;

**Figure 11: Pie chart showing the methods of waste storage for households**

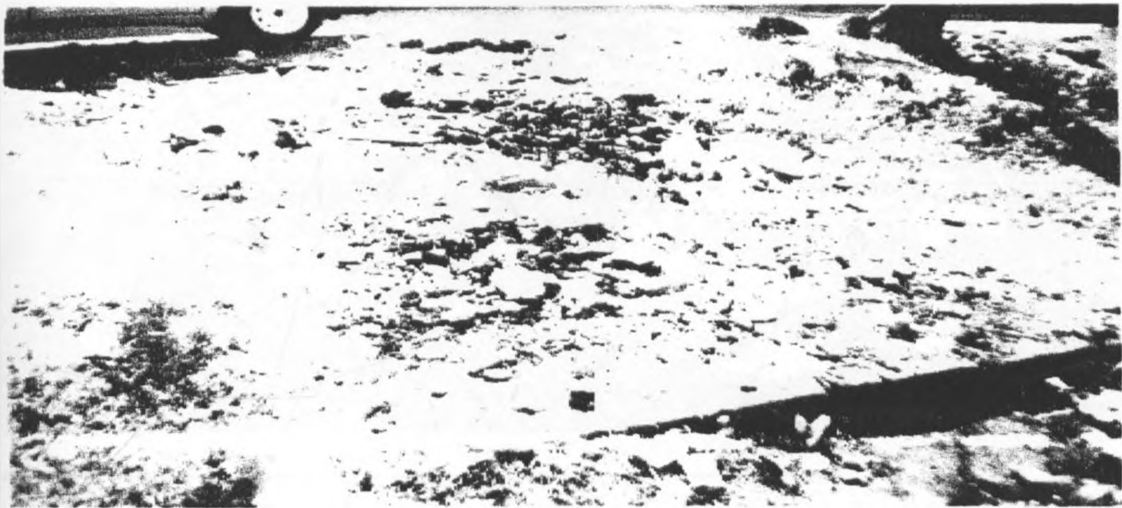


Source: Author, 2004

The main ways in which waste is recycled in Kiambu is depicted in Table 13 above. These ways include making of compost manure, reuse of plastic containers and cans, feeding of livestock including cattle, poultry, pigs and goats with food and vegetable remains, reuse of plastic papers and donations of clothes.

The negative contributions which households make to solid waste management in Kiambu town include dumping along the roadside as depicted by the plate 6 below. They also burn waste, and this produces harmful and offensive fumes. The irregular dumping of waste by residents also leads to littering of town with waste, especially polythene papers. This affects the aesthetics of the town as well as being a predisposing factor to accidents like falling. The dumped waste also produces bad smells, is a breeding place for vectors like mosquitoes, flies, rats and safari ants. These effects are shown in plates 5& 6 below.

***Plate 6: showing dumping of waste by the roadside***



***Plate 7: Blocking of open drains by solid waste***



**Plate 8: Irregular dumping of waste outside business premises. It's an eyesore and potential health risk.**



30 (75%) of the respondents collect waste for themselves though some also combine with the municipal collection services. 8(20%) of them strictly rely on the private firm. The remaining (2)5% relies on individuals or caretakers to collect their waste as shown in the chart below:

**Figure 12: Waste collection agencies in Kiambu Town**



Source: Author, 2004

The residents also practice waste disposal at the household level. However, households combine different methods of waste disposal depending on the type of waste. Field survey revealed the following methods of waste disposal:

**Table 14: Methods of waste disposal employed by households in Kiambu Town**

<b>Method of disposal</b>	<b>No of households</b>	<b>% Households</b>
1. Take it to a bulky container or a collection depot	30	75
2. Burn it in the compound	12	30
3. Throw into the garden	9	22.5
4. Throw into open space, river or road side	3	7.5
5. Bury in the ground	0	0
6. Feed animals	9	22.5

Source Author, 2004

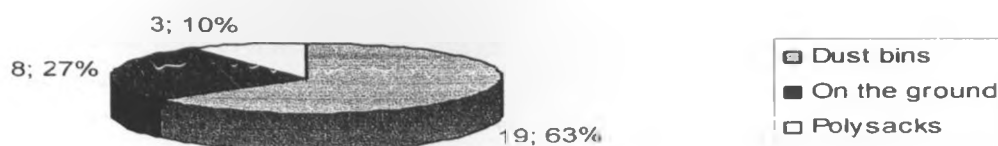
With regard to attitude, behaviour and general awareness of the households, the following observations were made:

- i) 14 (35%) of the respondents had never heard of cleaning campaigns whereas 22 (55%) respondents had heard of some cleaning campaigns. 4 (10%) of the respondents gave no comment.
- ii) The main organisers of such campaigns were cited as schools, KIST, church groups, and Boys Scouts.
- iii) None of the respondents had ever participated in the cleaning campaigns mainly because they were not members of the organising groups and members of public were never invited to participate.
- iv) The respondents felt that though the campaigns were successful as they reached areas that were not cleaned by the council; their impact was not great as it lasted only for a short time.

### **5.2.3 Businesses**

1. The business entrepreneurs are involved at all the stages of waste management including generation, storage, collection, treatment and disposal. Each business enterprise has waste that is unique to itself though all the waste can be put into broad categories. With regard to storage of waste, 19 out of 30 (63%) business enterprises interviewed used dustbins that were mainly improvised from broken plastic buckets and jelikans. Most of these dustbins did not have lids. Others particularly offices and other businesses that did not produce wet waste had commercially obtained plastic bins mainly with perforations. 8 (27%) business enterprises stored their waste on the ground in their premises. The remaining 3 (10%) business enterprises used polythene sacks/papers. This is shown in figure 13 on page 105.

**Figure 13: Methods of waste storage employed by business enterprises in kiambu Town**



Source Author, 2004

As far as sorting of waste is concerned, 10 of the businesses did sort their waste whereas 20 of the thirty businesses did not sort their waste. The following were the reasons as to why they sorted their waste:

<u>Reason for Sorting</u>	<u>No. of respondents</u>
1. Need to resell or recycle some products	4
2. To burn combustible waste	2
3. For reuse of some products	3
4. Separation metal is necessary because metal Prices vary in the market	1

Of the 20 businesses that did not sort their waste, 13 of them found no need for it whereas the remaining 7 did not give their reasons for not sorting their waste. In response as to the measures that business concerns took to minimise the amount of waste that they generated, the following information was provided: 24 out of 30 (80%) businesses did not take any measure to minimise their waste levels. The remaining 20% had the following ways in which they minimised their waste:

**Table 15: Waste Minimisation Measures employed by business enterprises in Kiambu Town**

WASTE MINIMISATION MEASURE	NO OF RESPONDENTS	% RESPONDENTS
Prevention of breakage of fragile products by putting gauze and warning signs	1	3.33
Purchasing of right quantities and quality	2	6.67
Resale and reuse of products	4	13.33
Keen measurement to avoid waste	1	3.33
Avoidance of products with very low or no demand at all	1	3.33

Source Author, 2004

Business enterprises were found to be playing a major role in the recycle of waste. 12 out of 30 (40%) businesses did not practice any waste recycling measure. The following were their reasons:

<u>Reason for not recycling</u>	<u>No. of respondents</u>
Non-recyclability of waste products	7
Lack of markets for recyclable products	1
Lack of need to recycle products	2
Reason not given	2
<b>Total</b>	<b>12</b>

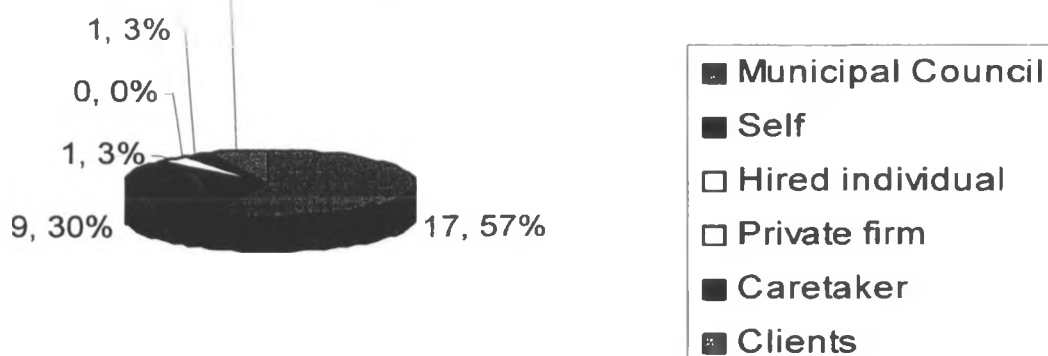
The following were the ways in which different wastes were recycled or reused by the business enterprises:  
**Table 16: Methods of waste recycle employed by business enterprises in Kiambu Town**

WASTE	RECYCLE METHOD	NO. OF RESPONDENTS	%RESPONDENTS
1. Polythene sacks	Resale to secondary users like farmers and informal dealers	2	6.67
2. Cartons	Resale to Chandaria industry	1	3.33
3. Plastics, old batteries, metal and car parts	Resale to informal waste dealers and other secondary users	3	10
4. Old Tyres	Used as a source of fuel	1	3.33
5. Plastic containers	Reuse at the domestic level	3	10
6. Saw dust and wood pieces	A source of fuel at home or in business	1	3.33
7. Medicine containers	Used to take laboratory samples at clinic	1	3.33
8. Papers	For fuel purposes	3	10
9. Saw dust and charcoal dust	To support livestock farming by covering the floor of pens/sheds	2	6.67
9. Food remains	For feeding livestock	5	16.7
10. Cloth pieces	To make repairs and pillows	1	3.33
11. papers and newspapers	As drafts or to wrap goods	2	6.67
12. Bones	Resale to bone industry	1	3.33

Source Author, 2004

With regard to waste collection, 9 business entrepreneurs collected waste for themselves to the collection depots, 1 hired and individual but occasionally, 17 relied on the municipal services, 1 relied on the caretaker and 2 relied on their clients. None received services from private waste collectors.

**Fig 14: Waste Collection Agents for business enterprises in Kiambu Town**



Source Author, 2004

The following were the ways in which different wastes were recycled or reused by the business enterprises:

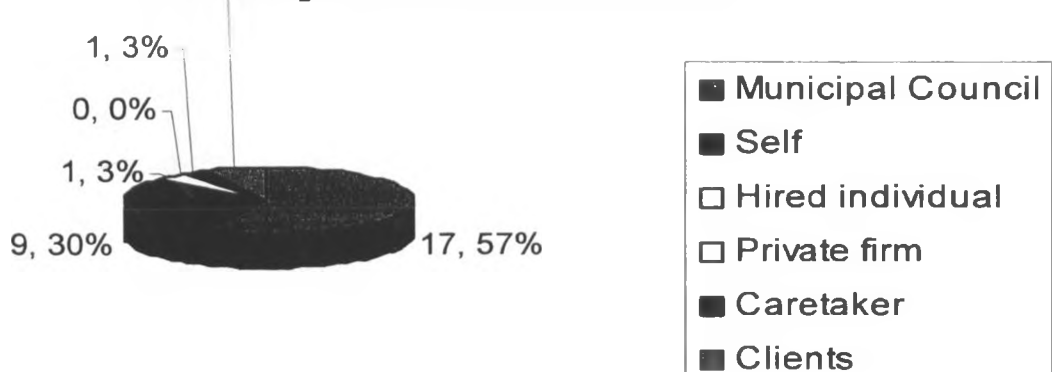
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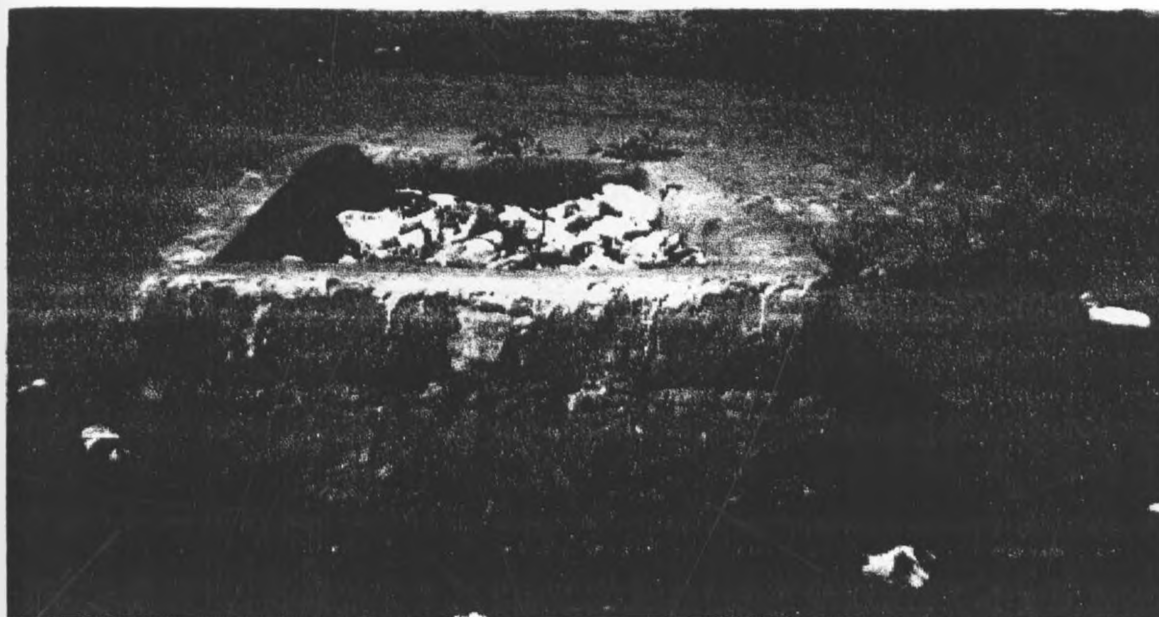


Source Author, 2004

With regard to waste disposal, 10 business enterprise took their waste to a central depot, 1 threw onto the street, 9 burnt in the open air while the remainder (10) waited for collectors to empty their filled up containers.

Business entrepreneurs do construct waste collection depots as shown on plate 9 below

**Plate 9: Waste collection depot constructed by a business entrepreneur**



Concerning the general attitude, behaviour awareness and other participatory measures of the business entrepreneurs, several observations were made as follows:

1. Only 2 respondents were aware of the existence of private firm's involvement in waste collection and the rest were not.
2. 15 respondents had heard of cleaning campaigns in Kiambu whereas 15 had never heard of any cleaning campaign. Only 2 of the respondents had participated in the cleaning campaigns though in the capacity of their membership in the cleaning groups but not as business entrepreneurs.
3. Of the 15 respondents who had heard of the cleaning campaigns, 9 felt that they campaigns were successful because they reached areas that were not served by the council, 1 respondent felt that the campaigns were not necessary because their impact was not long lasting.
4. 3 felt that campaigns were a good way of creating awareness among the residents as to the need for a healthy environment, and 2 had no comment anything about the campaigns.



#### 5.2.4 Private Firm

Legally, the firm was aware of the existence of some MCK bylaws governing solid waste but not the specific ones. There was no legal contract between the firm and the council, because the council was yet to develop a standard contract document to govern privatisation of waste collection. However, there was an agreement between the firm and the council for the former to conduct business until the time that a formal contract shall be drawn between the two parties, upon which the firm would pay to the council all arrears since the time of operation.

Cergh Community Services entrepreneurs were two young men aged about 23 and 25 years who did the work for themselves. They used gloves and nose pads as their protective devices. They had uniform but no gumboots. They had no other tool as these were not necessary in their view.

Refuse collection was on a weekly basis from house to house, whereby clients place the waste at strategic points, mostly along the corridors, for the crew to collect. As such, there was no apparent disturbance caused to the clients. Clients were usually provided with four (4 no.) plastic bags per month, which they felt were sufficient. Therefore, the firm's activities in solid waste management are limited to collection, transportation and disposal to the municipal disposal site. Waste was collected and transported by only two hand carts which the firm hires for Kshs100 each. Some scavengers accompanied the firm's crew in the course of their work in order to separate food wastes from the other waste, which they sold to pork farmers. Charges varied among the clients depending on an individuals negotiating power. The older clients paid Kshs 70 whereas the new ones paid Kshs. 100, which they felt was affordable. The collection fee was payable in advance, on cash basis, and was collected from door to door. However, this was about two or three times higher compared to Nairobi whereby they charge as low as 30/= particularly in the middle income estates like Umoja, Kahawa and Zimmerman due to price cutting competition among the service providers.

The firm was still very young and small to involve itself in social responsibilities like cleaning campaigns or others that would lead to improvement of waste management in the town. In addition, the community's attitude was still a barrier for undertaking such activities as this would probably lead to loss of business for the firm. However, the firm had helped to improve waste management it had helped to reduce the rate of

irregular dumping in those estates that they serve, and they are also able to collect from those areas not served by the council. All their clients were satisfied with their services. The firm was not aware of other agencies involved in waste management except MCK. There lacked proper coordination between the firm and the council due to lack of contractual arrangement, except that the firm's target market was those areas that are not served by the council at all or those that are poorly served mainly due to their interior location.

### 5.2.5 Informal waste Collectors

The type of waste collected by scavengers mainly constitutes plastics, bones, tins and cans, scrap metal, polythene sacks, food remains and food by products and glass bottles from households, petrol stations, hair salons, hotels, butcheries, carpentry workshops, motor garages, dump site and collection depots and other sources.

The quantity of waste collected varies from time to time, and it is difficult to tell the amount. Quantity is also dependent on the individual and whether he is known to the community.

**Table 17: Summary of the roles played and problems faced by different actors in SWM in Kiambu Town**

ACTOR	POSITIVE ASPECT	NEGATIVE ASPECT	PROBLEMS AND CHALLENGES	COMMENTARY
Household	<ul style="list-style-type: none"> <li>▪ Waste generation</li> <li>▪ Waste Storage</li> <li>▪ Sorting (50%)</li> <li>▪ Recycle/Reuse</li> <li>▪ Burying of hazardous waste*</li> <li>▪ Burning of waste*</li> <li>▪ Eagerness to participate in better methods</li> </ul>	<ul style="list-style-type: none"> <li>▪ Irregular Dumping</li> <li>▪ Lack of sorting</li> <li>▪ Lack of recycle habits</li> <li>▪ Failure to pay MCK charges</li> <li>▪ Waste burning</li> <li>▪ Throwing of waste into the river</li> <li>▪ Ignorance of importance of informal waste collectors</li> </ul>	<ul style="list-style-type: none"> <li>▪ Excess levels of plastics</li> <li>▪ Lack of storage space in the house</li> <li>▪ Lack of better disposal methods of wastes like clothes and shoes</li> <li>▪ Rotting of garbage before collection</li> </ul>	<ul style="list-style-type: none"> <li>▪ Irregular dumping encouraged by council as there are no sanctions and collection is free</li> <li>▪ Lack of awareness of effects of poor/better waste management processes</li> </ul>
Businesses	<ul style="list-style-type: none"> <li>▪ Waste generation</li> <li>▪ Waste sorting</li> <li>▪ Waste recycle</li> <li>▪ Transfer of waste to central depots</li> <li>▪ Waste burning</li> <li>▪ Waste minimization measures</li> <li>▪ Construction of</li> </ul>	<ul style="list-style-type: none"> <li>▪ Open dumping</li> <li>▪ Waste Burning</li> <li>▪ Lack of waste sorting (<math>\frac{2}{3}</math>)</li> <li>▪ Lack of proper storage methods</li> <li>▪ Lack of waste minimization measures (80%)</li> <li>▪ Ignorance of</li> </ul>	<ul style="list-style-type: none"> <li>▪ Lack of storage space</li> <li>▪ Bad smells and untidiness in the premises</li> <li>▪ Heavy containers</li> <li>▪ Delayed collection</li> <li>▪ Lack of better</li> </ul>	<ul style="list-style-type: none"> <li>▪ General apathy leads to irregular dumping</li> <li>▪ Lack of awareness of the effects of poor/useful waste management processes</li> <li>▪ Lack of</li> </ul>

	<ul style="list-style-type: none"> <li>collection depots</li> <li>Willingness to improve</li> </ul>	informal waste collectors	methods of disposal of certain wastes	invitation by council and communities to participate in better waste management processes
Private Firm	<ul style="list-style-type: none"> <li>Extending services to areas not covered by council</li> <li>Gives scavengers chance to select waste</li> <li>Creation of employment</li> <li>Willingness to cooperate with MCK</li> <li>Use of appropriate technology</li> </ul>	<ul style="list-style-type: none"> <li>Disposal to the general waste site</li> </ul>	<ul style="list-style-type: none"> <li>Hostile customers</li> <li>Unfair weather conditions combined with poor roads</li> <li>Defaulters</li> <li>Lack of better vehicles</li> <li>Household attitude that waste collection should be free limits market expansion</li> </ul>	<ul style="list-style-type: none"> <li>Lack of legal support from the council</li> <li>Important in demonstrating applicability of privatization and use of appropriate technology</li> </ul>
Informal waste Collectors	<ul style="list-style-type: none"> <li>Reduction of waste volumes</li> <li>Income generation measure</li> <li>Display of emerging trends in waste management</li> <li>Eagerness to formalize activity</li> </ul>	<ul style="list-style-type: none"> <li>Littering of waste</li> <li>Health hazard for themselves</li> <li>Environmental hazard promotion through pre-treatment processes like burning of waste</li> </ul>	<ul style="list-style-type: none"> <li>Harassment from residents and business operators</li> <li>Storage space</li> <li>Transportation problems</li> <li>Technology issues</li> <li>Exposure to health risks</li> <li>Lack of protective clothing</li> <li>Hazardous waste</li> </ul>	<ul style="list-style-type: none"> <li>Their role needs to be strengthened by making it formal and creating awareness among community members of the importance of informal waste picking.</li> </ul>
Municipal council	<ul style="list-style-type: none"> <li>Collection of waste</li> <li>Accommodation of informal and private waste pickers</li> <li>Provision of collection depots</li> <li>Sweeping of streets</li> </ul>	<ul style="list-style-type: none"> <li>Failure to enforce existing by laws</li> <li>Failure to update existing bylaws</li> <li>Flawed accounting procedures</li> <li>Inappropriate technology</li> <li>Poor human resource management</li> <li>Limited service coverage</li> </ul>	<ul style="list-style-type: none"> <li>Lack of adequate finances</li> <li>Poor finance management</li> <li>Lack of land to dispose waste</li> <li>Lack of appropriate technology to deal with hazardous/toxic waste</li> <li>Long, bureaucratic procurement processes</li> <li>Legislative weaknesses</li> </ul>	<ul style="list-style-type: none"> <li>Municipal council faced with the challenge of enhancing their role as facilitator, coordinator of solid waste management.</li> </ul>

Source: Author, 2004

### 5.3 PROBLEMS ENCOUNTERED BY ACTORS IN SOLID WASTE MANAGEMENT

#### i) *Municipal council of Kiambu*

The main problems experienced by the municipal council in the course of their work include:

1. Lack of adequate finances to support the following solid waste management activities:
  - To purchase equipment, spare parts and relevant tools
  - To repair and maintain existing tools and equipment
  - To provide dustbins/construct collection points to their clients
  - To satisfactory salaries to their workers
  - To train workers and hire trained personnel
  - To provide their workers with protective clothing and relevant tools at all times, and to meet their other obligations.

These problems affect the motivation of their workers resulting in poor work.

2. Lack of land to locate dumpsite as the one already existing is filled up
3. Long and bureaucratic processes in the purchase of spare parts, tools, equipment and other material required for service provision
4. Sharing of the collection tractor with other departments leading to delays in collection.
5. Irresponsible behaviour of their clients, whereby households and business premises establish an overwhelming number of collection depots, as well as failure of the business concerns to sort their waste thus exposing their workers and general public to health problems.
6. Lack of current policy guidelines, bylaws and failure to enforce the existing bylaws.
7. Lack of technical know how of how to improve solid waste management.

#### ii) *Households*

The following were the problems raised by the households in the process of solid waste management:

**Table 18: SWM problems faced by the households**

<b>PROBLEM</b>	<b>NO. OF RESPONDENTS</b>	<b>% RESPONDENTS</b>
Excess polythene and plastics	2	5
Lack of storage space in the house	2	5
Rotting of garbage before collection	7	17.5
Clothing and shoes in excess	1	2.5
None	28	70
<b>Total</b>	<b>40</b>	<b>100%</b>

Source: Author, 2004

### iii) **Business Enterprises**

The following problems were cited by business enterprises in Kiambu Town:

**Table 19: SWM Problems encountered by business enterprises in Kiambu Town**

<b>Problem</b>	<b>No. of respondents</b>
<i>During Storage</i> <ul style="list-style-type: none"><li>• Lack of storage space when collection is delayed</li><li>• Bad smells and untidiness in the premises</li><li>• None</li></ul>	2 3 25
<i>During collection</i> <ul style="list-style-type: none"><li>• Heavy containers</li><li>• Delayed collection</li><li>• None</li></ul>	1 17 12
<i>During Disposal</i> None	30

Source: Author, 2004

### iv) **Private firm**

The firm outlined the following problems and challenges:

- Hostile customers
- Unfair weather conditions interfere with collection and transportation of waste because of poor road conditions.
- Breakage of hand carts leading to loss of time.
- Defaulters - some clients fail to pay their fees.
- Size of the firm limits the level of activity, and the ability of the firm to employ better vehicles.
- Fluctuating market size due to moving out levels of households
- Households' attitude that waste collection should be free and the fact that council collects waste from irregular collection points established by the households, at zero monetary cost.

### v) **Informal waste Collectors**

The following problems were raised;

1. Harassment from residents and business community for example open abuse, being turned away by people and security personnel pouring of dirty water on the scavengers or throwing of stones at them. This restrains their ability to source products particularly from the residential areas.

2. Lack of proper storage spaces – those who store in their homes do not have properly constructed stores. (See plate 10 below). Others store by the riverside

**Plates 10: poor storage of waste by the informal waste pickers-which poses as health hazard.**



3. Transportation problems from source to the markets due to the bulkiness of products in terms of weight and shape.
4. The scavengers walk for very long distances with a view to collecting economic sizes of waste. This causes fatigue.
5. Lack of essential tools and equipment like wheelbarrows, carts, and shovels makes sourcing and transportation difficult.
6. Lack of protective clothing like aprons, gloves and nose pads further restrains their activity.
7. Lack of markets for some products like glass because of the increased use of plastics.
8. Exposure to health risks during sourcing of materials particularly from the dumpsites, pre-treatment processes of burning and beating of material exposes them to piercing, cutting respiratory problems and other health problems.

9. Sometimes, the handling of hazardous waste from petrol stations, carpentry workshops and from households can expose them and the environment to destructive fires and other health problems.

#### **5.4 NATURE OF SOLID WASTE MANAGEMENT PRACTICE IN KIAMBU TOWN**

The following were the opinions of different respondents about the nature of solid waste management given the capacities, roles and responsibilities of the different stakeholders and possible ways of improving it in the town:

1. Fair because all stakeholders have tried their best
2. The local community is irresponsible and the youth particularly need to be sensitised about importance of proper waste management
3. The local community and businesses have done well but the council has failed because it has not provided dustbins and it has not expanded service provision to match the spatial and demographic growth of the town thus encouraging irregular dumping and other poor ways of managing waste
4. Landlords need to improve waste management practice in their premises
5. There is need to encourage recycle of products and to establish markets for recyclable products
6. Waste collection by the council has improved in the NARC era
7. Pathetic, all stakeholders need to play their role more positively
8. There lacks integration of sorting and separation of waste at source, and these need to be encouraged
9. Waste collection improves only when senior government officials visit the town
10. Not well managed by the council due to lack of adequate equipment and personnel. The council should therefore look for solutions to these problems
11. Need to create awareness among the stakeholders about their respective roles.

#### **5.5 ENVIRONMENTAL PROBLEMS ASSOCIATED WITH SOLID WASTE MANAGEMENT IN KIAMBU TOWN**

##### **5.5.1 The problems associated with waste were listed as follows:**

1. Littering of the town with waste and irregular establishment of collection depots by the roadsides. This has partially been encouraged by the council because the council workers always collect waste from the irregular dump sites and no effort is made to enforce legal sanctions. In addition,

apathy of the residents and lack of properly constructed or formally established collection points contributes largely to this problem. This causes bad sights and general untidiness

- II. Poor location of the dumpsite which leads to water pollution at the Riara River and the conflicting land use with the cemetery and the slaughter house. Thus there is likely seepage of leachate into the river from the central dump site
- III. Vectors like rats and insects like mosquitoes, safari ants and spiders that are likely to cause diseases and other forms of nuisances
- IV. Bad smells caused by rotting of garbage
- V. Health hazards particularly due to non-separation of hazardous waste like medical waste, female sanitary waste, metal waste and hazardous chemical containers from other non hazardous waste. Some health problems could also arise from recycling of hazardous waste such as batteries, burning of tyres as a source of fuel among others.
- VI. Excess levels of plastics and the associated problems of non-biodegradability
- VII. Offensive and hazardous smoke from burning of waste like plastics, tyres, medical waste among others
- VIII. Dumping into rivers
- IX. Blocking of drains where dumping is done in the drains or when waste is swept by rain-water into the drains
- X. Predisposition to accidents like falling caused by irresponsible dropping of vegetable peels and slippery waste

## **5.6 SUGGESTIONS AS TO HOW SOLID WASTE MANAGEMENT CAN BE IMPROVED IN KIAMBU TOWN**

The following suggestions were raised by respondents as to how the solid waste management can be improved in Kiambu Town:

- I. Personal effort to improve waste management at the individual household/ business level for example through burning, composting, sorting of waste and recycling of waste so as to encourage others
- II. Frequent and timely collection by the council to avoid rotting and littering of waste and spatial expansion of collection services by the council
- III. Privatisation of waste collection services –



- IV. Encourage frequent cleaning campaigns
- V. Research into ways of creating awareness for proper waste management among stakeholders
- VI. Composting of waste
- VII. Provision of rentokil services or other alternative to improve female sanitary waste management
- VIII. Discourage irregular establishment of collection points along the road side through legal sanctions.
- IX. Provision of dustbin to business enterprises or properly constructed collection points by the council
- X. Legally, the council should enforce the Public Health Act and the council bylaws as well as review their by laws in order to match today's requirements and incorporate issues such as hazardous and construction waste management
- XI. Council to improve their management practices so as to cater for vehicle and equipment breakdown periods
- XII. Creating awareness and environmental education among all the stakeholders for better solid waste management through cleaning campaigns, the media and announcement in churches
- XIII. Opening up of markets for recyclable products and encourage recycling of products
- XIV. Participation by all stakeholders to improve solid waste management for example landlords should provide their tenants with clear waste handling services.
- XV. Encourage sorting and separation of waste at source and during disposal
- XVI. Strengthening of informal waste collection through sensitising the community to develop respect for the waste pickers. It was also suggested that the council could allow the waste pickers to form a formal group so as to help them obtain finances to expand their business activities as well as helping them to operate economically.
- XVII. Consistent provision of protective clothing and relevant tools to council workers in order to ease their problems and to motivate them.
- XVIII. Development of a National Solid Waste Management policy.

## CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

### 6.1 INTRODUCTION

This chapter outlines the summary of the findings, conclusions, recommendations and areas for further research, based on the findings of the study.

### 6.2 SUMMARY OF THE FINDINGS

From the study the following findings were obtained.

1. Solid waste in Kiambu Town constitutes waste from all categories – namely domestic, commercial, industrial, institutional, municipal waste and agricultural waste. Thus, the waste constitutes of organic, non bio-degradable, hazardous (flammable, infectious or other hazardous form), bulky, combustible, non combustible and recyclable components.
2. There is no properly established waste sorting mechanism, and all waste from all sources are indiscriminately collected together and taken to the council's dump site.
3. The Municipal Council was the expressly known major player in the solid waste management in Kiambu Town. However, in the course of its work, the council is not able to deliver the services as expected due to financial, technical, human resource and institutional problems that it faces. This had therefore led to the involvement of households, business enterprises private sector (both formal and informal) in collection, treatment and disposal of solid waste. The council had no sound legal provisions governing solid waste management, as the existing bylaws date back to the 1970s. There is therefore need to repeal these laws. There also lacks a way of enforcing the existing bylaws.
4. The local resident and business communities play certain positive roles in waste management in order to fill in the gap left by the municipal council. However, there is need for improvement on their part. The informal waste pickers' role should also not be underestimated despite the problems which they faced like lack of recognition and low opinion held by the residents and the council. They also lacked legal protection and financial capacity to help them operate economically. The private firm's contribution to solid waste management can not be over-looked, because positive issues like reduction of irregular dumping, extending services to areas not served by the council as well as creation of employment were identified. In addition, the firm was able to apply appropriate

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technology, and was able to demonstrate that privatisation of waste collection in Kiambu town is possible. However, in order to make the firm's activities more formal, it is important for the firm to enter into contract with the municipal council and with its clients as well.

### **6.3 CONCLUSIONS**

Solid waste management in Kiambu Town is a key contributor to environmental degradation, and this is not only caused by lack of adequate participation by stakeholders as the study had proposed, but also due to lack of proper coordination of the activities of all actors. There is therefore the need to develop this coordination as well as the improvement of the participation by all actors in order to improve the situation.

In order for the different actors to be able to play an integrative role in solid waste management, there is need to establish a framework that will accommodate them all. Such a framework will call for the municipal council to act as a regulator, a coordinator, a catalyst and a partner for all other actors in order to develop a sustainable solid waste management system for Kiambu Town. The suggestions as to how the situation can be improved are outlined in the following section of recommendations.

### **6.4 RECOMMENDATIONS**

A sound partnership needs to be developed amongst different actors in order to promote pooling and sharing of resources as well as diversification of risks for sound service delivery. The specific ways for developing such partnership are outlined below:

#### **6.4.1 Municipal Council**

In order for the municipal council to strengthen its operations and to manage the institutional, technical, financial and social constrains that it is facing, the following measures could be taken:

- a) To develop partnership with other neighbouring local authorities like Urban Council of Karuri, Town Council of Githunguri and Town Council of Ruiru whereby they could acquire a common disposal site, share collection vehicles and other equipment, search for external aid, search and share information related to solid waste management and train workers among other things. This can greatly reduce operation costs for each of the local authority as well as offering access to resources that would otherwise have been inaccessible.

- b) Develop new by **laws** governing solid waste management. These bylaws should address issues like waste sorting, hazardous waste management, provision of dust bins, roles of other actors, charges for **services**, sound fines and penalties for violation of the by laws among other key issues. The laws should **be** enforced. The laws will enable the council to act as a catalyst.
- c) Strengthen their **financial** base by re introducing the user fee charges and charging fines on law defaulters. There **should** be a clear way of collecting the fines and charges. Partnership with the private sector **may help** to supplement the lacking capital for purchase of equipment and financing other solid waste **management** activities.
- d) Seek for external **aid** in form of finances as well as other capacity building aspects such as the training of their **workers**, creation of awareness, drawing of solid waste management plans amongst **communities** among others from NGOs, central government departments and donors.
- e) Within the organisational structure, the council should group all the waste management activities in one department.
- f) Train their workers **on** certain specific areas such as public relations, health hazards associated with SWM, **importance** of simple processes like sorting, separation and composting of waste
- g) Develop contract **documents** for the private waste collectors.
- h) Collect and sell **organic** waste and food by products from the market to farmers in order to strengthen their **financial** base as well as reduce amount of waste that gets into the waste stream.
- i) Collect and compost (using appropriate technology) the organic waste from street sweepings and use the product for **their** lawns as well as sell to other government authorities.
- j) Liaise with other **actors** in order to promote solid waste management education through cleansing campaigns, **announcements** in churches and during public meetings, distribution of educational leaflets among other **ways**.

#### 6.4.2 Informal Waste Collection

In a town like Kiambu and its surrounding regions where the main source of income and employment was from the coffee plantations, **which** recently have been replaced by commercial and residential buildings, scavenging has a lot of **potential** of growth as a major source of income and employment. In addition, other conventional means of **handling** waste like land filling, incineration and crude tipping are increasingly

becoming uneconomical and environmentally unsound. Therefore scavenging and recycling are alternative means for solid waste management. This should be facilitated by the Municipal Council of Kiambu.

The following are the possible, simple and appropriate ways in which informal waste picking can be incorporated in Kiambu Town.

- a) Recognition of the importance of scavenging by the Municipal council. The possible way of doing this is through the department of Social welfare of the council, whereby the scavengers should be encouraged to register a CBO with the department. The researcher discussed the possibility of this option with the scavengers and the social welfare officer, who in turn spoke to a few other scavengers and all parties were in support of the idea.
- b) Creation of Public awareness of the importance of scavenging in the process of solid waste management by the municipal council.
- c) Once the scavengers have formed a group, it is possible for them to organise collection of waste from the residential areas and from the business premises, whereby they can provide containers for putting different recyclable products, and then specify days of collection. This may address the harassment problem as well as ensure that economic sizes are achieved efficiently. This will also assist them in the process of marketing as they can bargain for better terms as a group than they would as individuals.
- d) Once organised in form of a CBO, it is possible for them to solicit for support from other agencies like CBOs or even the industries to which they sell either in form of funds or in form of support equipment like wheelbarrow and carts and protective clothing.

#### **6.4.3 Privatisation of waste collection**

The firm's contribution to solid waste management can not be under-estimated, as positive issues like reduction of irregular dumping; extending services to areas not served by the council as well as creation of employment were identified. In addition, the firm was able to apply appropriate technology, and was able to demonstrate that privatisation of waste collection in Kiambu town is possible. However, in order to make the firm's activities more formal, it is important for the firm to enter into contract with the municipal council and with its clients as well.

#### **6.4.4 Households and Business community**

These should be encouraged to continue playing the positive roles that they already are playing including sorting of waste, composting of waste at household level, recycling of food products and other recyclable products, disposal of waste among others. They should also be encouraged to form CBOs in order to improve waste management in the town. The negative roles of waste management should be discouraged through legal sanctions.

#### **6.4.5 Solid Waste Management Education programs**

This can be done through cleaning campaigns, announcements over the radio and in churches as well as holding talks in schools by the already active groups like the scouts, schools and churches. The residents can participate in cleaning campaigns based on their 'estates' of residence – for example the police quarters, hospital quarters, Posta line, Council line and Biashara Street. The agro-based NGOs should also be trained how to make farm yard manure from organic waste. This can be organised by the municipals social welfare office in conjunction with the relevant department in the ministry of agriculture.

#### **6.5 AREAS FOR FURTHER RESEARCH**

1. Treatment of non biodegradable wastes
2. Treatment of hazardous waste
3. Marketing strategies for recyclables

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## APPENDICES

### Appendix 1

#### 2.2.3 Household questionnaire

*The information provided in this questionnaire is confidential and shall be used for the purposes of this research only.*

#### Part I: Background Information

1. Name of Respondent (*optional*).....
2. Date and Time of interview .....
3. Gender  Male  Female
4. Length of stay in Kiambu town .....
5. Name of building/estate .....

#### Part II: Household Characteristics

6. Household size .....
7. Ownership of the house  owner occupier  government  rented
8. Rent payable per month .....
9. Is rent inclusive of service Charge?  
 Yes  
 No
10. Income level of the household per month  
 Below 2000  
 2001 – 5000  
 5001 – 10000  
 Above 10000

#### Part III: Waste Generation and Storage

11. What are the types of refuse generated in this house  
 Food remains  Cloth  Electronic goods  Paper  perfume cans  
 Plastics  Other (specify)

12. Approximately how many kilograms in total does this household generate per week?

13. a) Do you sort your waste before it is collected by the collecting agency or before you dispose of it?

Yes

No

b) If yes, how do you sort it and why?

c) If no, please Explain?

14. What method of storage do you use?

Dust bin

polythene sacks/bags

other Specify

#### Part IV Waste collection and disposal

15. Who collects your waste?

Municipal council

Individuals

Private firms

Self

16. How efficient is the collection agency in terms of:

(i) Frequency

once a week

twice a week

other

(ii) Provision of dustbins/bags

A given number per month

Never

Upon request

(iii) Reliability

Fixed Schedule

On call

(iv) Disturbance

Least Disturbance

Moderate

High disturbance

17. What can be done to improve their efficiency?

18. Waste disposal is done at household level, how is yours done?

Take to bulky container or a central dumping area

Burn in to compound

Throw in the garden

Throw away into open spaces or river

Bury in the ground

12. Approximately how many kilograms in total does this household generate per week?

13. a) Do you sort your waste before it is collected by the collecting agency or before you dispose of it?

Yes

No

b) If yes, how do you sort it and why?

c) If no, please Explain?

14. What method of storage do you use?

Dust bin

polythene sacks/bags

other Specify

#### Part IV Waste collection and disposal

15. Who collects your waste?

Municipal council

Individuals

Private firms

Self

16. How efficient is the collection agency in terms of:

(i) Frequency  once a week  twice a week  other

(ii) Provision of dustbins/bags  A given number per month

Never  Upon request

(iii) Reliability  Fixed Schedule  On call

(iv) Disturbance  Least Disturbance  Moderate

High disturbance

17. What can be done to improve their efficiency?

18. Waste disposal is done at household level, how is yours done?

Take to bulky container or a central dumping area

Burn in to compound

Throw in the garden

Throw away into open spaces or river

Bury in the ground

Feed animals

Other (specify)

19. a) Do you practice any recycling or reuse of waste?

Yes

No

20. What Problems do you experience in

(i) *Waste generation and storage*

Excess polythene and plastics

Inadequate space in the house/compound

Inadequate size of dustbin

Rotting of garbage before collection

Other Specify

(ii) *Waste collection and disposal*

Delays in collection

littering of the compound

High charges

Smells from dumping site and dropping

During collection

Lack of disposal sites

other (specify)

Smoke from burning

### Part v: Attitude, awareness and participation

21. a) Has there ever been cleanliness campaign in this town?

Yes

No

b) If yes, have you ever participated in the cleaning?

Yes

No

Please explain your answer

c) How effective are these campaigns?

22. a) What are the main environmental problems associated with the solid waste management?

b) How can these problems be solved?

23. What would you comment about the nature of solid waste management in Kiambu Town?

24. What can be done to improve the general process of solid waste management in Kiambu town?

Thank you.

## INFORMAL WASTE PICKERS INTERVIEW SCHEDULE

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The information provided in this questionnaire is confidential and shall be used for the purposes of this research only.

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### Part I: Back Ground Information

1. Date and Time of Interview.....
2. Name of Respondent *(optional)*
3. Name of the CBO/NGO .....
4. Number of years of operation in Kiambu.....

### Part II: Role of the CBO/ NGO

5. What is your Role in Solid waste Management in Kiambu Town?
6. What problems and challenges, if any, do you encounter in the course of your work?
7. a) In Your opinion, are there any environmental problems associated with solid waste management in Kiambu Town?

A. Yes

B. No

b) If Yes, which ones?

8. What other agencies are involved in solid waste management in Kiambu Town, and what are their respective roles?
9. What would you comment about the general state of solid waste management in Kiambu Town?

Thank You

## MUNICIPAL COUNCIL INTERVIEW SCHEDULE

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*The information provided in this questionnaire is confidential and shall be used for the purposes of this research only.*

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1. What are the main types of waste generated in Kiambu town?
2. How much is collected per day?
3. a) Do you sort the waste before you dispose of it?  
A      Yes                                      B      No  
b) If yes, into what categories and why?
4. a) Does the Municipal have waste recycling / reuse programmes?  
A      Yes                                      B      No  
b) If Yes, which ones and how effective are they?
5. a) How much do you charge for the waste collected?  
b) Is the revenue generated from the waste collection directed towards supporting waste management?  
A      Yes                                      B      No  
c) If yes, is it adequate?
6. a) What other agencies are involved in Kiambu Town in waste management and what are their respective roles?  
b) How efficient are they?
7. a) Are there any bylaws governing waste management in Kiambu Town?  
A      Yes                                      B      No  
b) If yes, how do you ensure that these bylaws are followed?
8. a) What problems and challenges do you encounter in solid waste management in the town?  
b) In your opinion, how can these problems be solved?
9. a) What environmental problems, if any, are associated with solid waste management in Kiambu?  
b) How can these problems be solved?

**Thank You**

## PRIVATE WASTE MANAGEMENT QUESTIONNAIRE

*The information provided in this questionnaire is confidential and shall be used for the purposes of this research only.*

### PART 1 BACK GROUND INFORMATION

1. Date and time of the interview.....
2. Name of the Firm *(Optional)*.....
3. No. of years of operation in Kiambu.....

### PART 2 WASTE MANAGEMENT ROLE OF THE FIRM

4. What are the major types of waste collected in Kiambu town?
5. How much do you collect per day?
6. What methods of waste collection do you employ?
7. How and do you dispose the waste so collected?
8. How much do you charge for the services?
9. a) Do you offer any education and awareness programmes about sound waste management?  
A      Yes                                      B      No

b) If Yes, which ones? Have they proved to be effective in improving waste management?

10. What problems and challenges do you encounter in the course of your work?
11. Who are the other actors in solid waste management in Kiambu and what are their respective roles?
12. What laws, if any, laws that govern solid waste management in Kiambu?
13. What environmental problems associated with solid waste in Kiambu?
14. What would you comment in general about solid waste management in Kiambu Town?

**Thank You**



**Appendix 5**  
**BUSINESS QUESTIONNAIRE**

*The information supplied here is purely for the purpose of this research and will be treated with confidence*

**Part I: Back ground information**

1. Name of respondent (optional)
2. Date and time of interview
3. NO. of years in business
4. Location of business
5. Type of business

	Tick	Specify
Trade		
Manufacture		
Service		

**Part II: waste generation, storage and collection**

6. What are the main types of waste generated by your business
7. Approximately how much waste do you generate (kg per day)
8. What measures if any, do you take to minimize amount of waste generated by the business?
9. a) Do you sort your waste before it is collected and/or disposed?

Yes                       No

b) Please explain your answer?

- 10.(i) Do you recycle or reuse any waste?

Yes                       No

(iii) Please explain your answer

11. How do you store your waste

Dust bin               Polythene bags/sacks               other (specify)

12. Who collects your waste?

Private firm               Municipal council               Self               individuals

Others (specify)

13. How much do you pay for the service?

.....

14. What would you comment about the efficiency of collection agency in terms of:

(i) Frequency of collection

(ii) Provision of dustbins  A given no. Per month  Upon request

Never

(iii) Reliability  Fixed schedule  On call

(iv) Disturbance  least  Moderate  Extreme

15. How do you dispose your waste when the container is full

Take it to bulk container/central dumping

Throw into the street

Burn in the open air

Throw away into open area/water bodies

Wait for collectors to empty it

Other (specify)

16. What problems do you encounter in the waste management process:

(i) During storage

(ii) During collection

(iii) During disposal

17. What is the solution to these problems?

18. What environmental problems are caused by solid waste management in Kiambu town?

19. How can these problems be solved?

**Part III: Awareness and role of other actors**

20. What other agencies apart from municipal council are involved in solid waste management.

21. Has there been any cleaning campaigns in Kiambu Town

b) Did you participate in the  Yes  No

a) Please explain your answer

22. What would you comment about the general state of solid waste in Kiambu town.

Thank you.