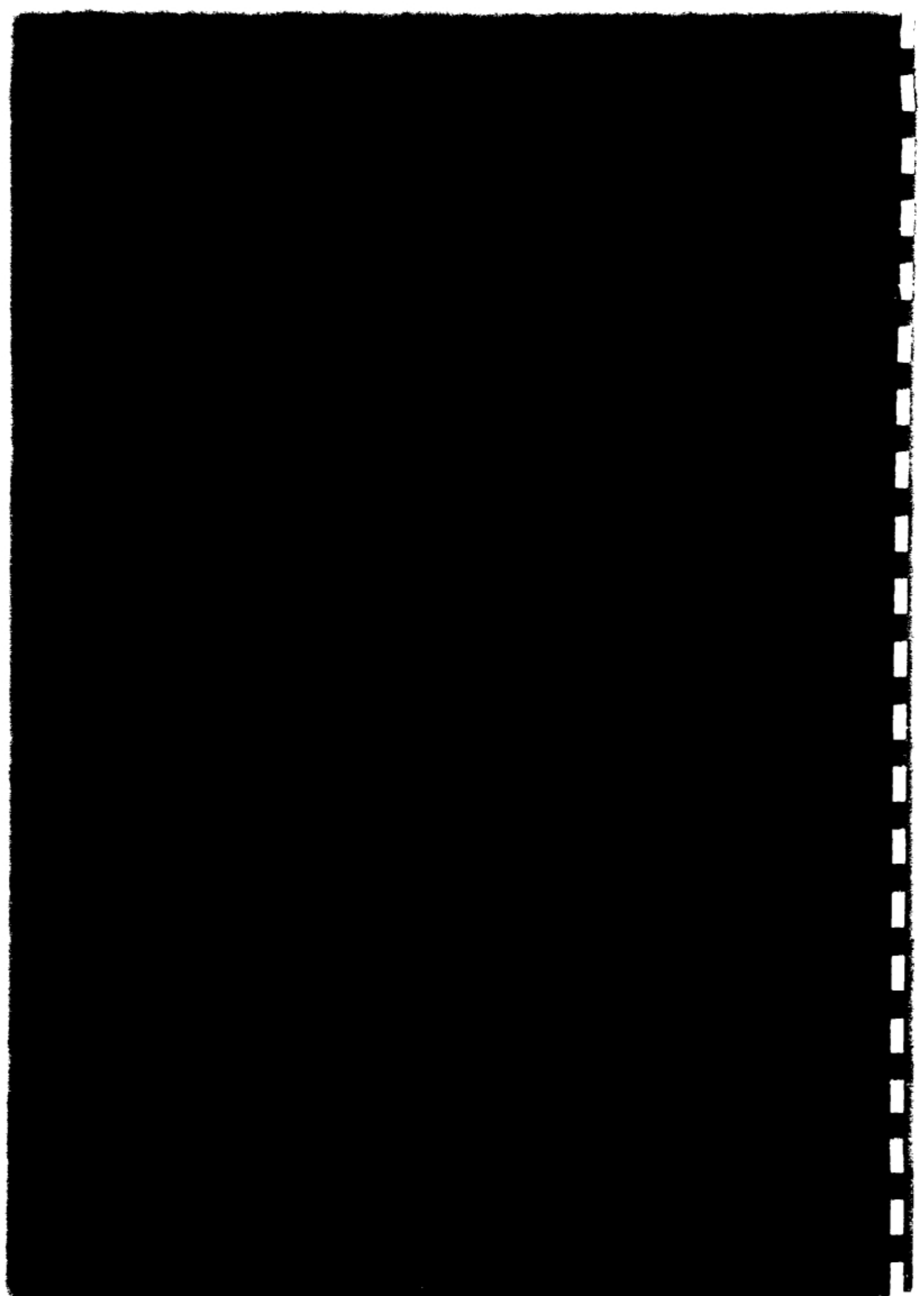
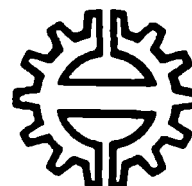




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Tampere University of Technology  
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IN NAIROBI**

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# SANITATION OPTIONS FOR KIBERA LOW-INCOME AREA IN NAIROBI

by Lucy Macharia

	Page
<b>TABLE OF CONTENTS</b>	1
<b>ABSTRACT</b>	2
<b>1 INTRODUCTION</b>	3
<b>2 OBJECTIVES AND METHODOLOGY</b>	5
2.1 Objectives	5
2.2 Methodology	5
<b>3 PHYSICAL AND SOCIO-ECONOMIC CHARACTERISTICS</b>	8
3.1 Location	8
3.2 Background history and growth of Kibera	8
3.3 Infrastructure in Kibera	13
3.4 Socio-economic status of Kibera residents	24
3.4.1 Demographic data	24
3.4.2 Ability and willingness to pay for basic services	29
3.4.3 Willingness to pay for basic services	30
<b>4 ROLE OF PARTICIPATION GROUPS</b>	31
4.1 Government policy and role	31
4.2 National Housing Corporation	33
4.3 Nairobi City Commission	34
4.4 Non-governmental organizations	36
4.5 Politicians	39
4.6 External support agencies	39
4.7 Kibera dwellers and community participation	40
4.7.1 Kibera dwellers	40
4.7.2 Community participation	40
4.8 Mode of interaction and intervention	43
<b>5 SANITATION ALTERNATIVES FOR KIBERA</b>	45
5.1 Preambles to provision of adequate sanitation	45
5.1.1 Planning	45
5.1.2 Access	46
5.1.3 Land tenure	47
5.2 Water supply	47
5.3 Excreta disposal	50
5.4 Sullage disposal and stormwater drainage	62
5.5 Solid waste management	65
5.6 Summary of sanitation options	71
5.7 Financing and cost recovery	73
<b>6 CONCLUSIONS AND RECOMMENDATIONS</b>	74
<b>7 REFERENCES</b>	77
<b>APPENDICES</b>	80

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#### ABSTRACT

Kibera is a roughly 2.5 km<sup>2</sup> squatter settlement about 7 km from downtown Nairobi. The population is about 450 000 people, and the population density is 180 000 per km<sup>2</sup>. The houses are made of temporary materials. The area is poorly served with basic infrastructure. The residents are mainly tenants of very low socio-economic status.

The main objectives of this study was to propose practical alternatives to improve sanitation in Kibera. The study involved carrying out interviews among the residents. The aim of the field survey was to identify the needs of the residents and to find out their ability and willingness to pay for basic urban services. Possibilities of community participation and management were looked into. Population density was estimated using field methods.

The results show that residents have the willingness and ability to pay for basic services provided at a level that they can afford. The scope for community participation is wide in Kibera.

Roles of various possible participants in a Kibera sanitation upgrading programme were studied. This includes the government, Nairobi City Commission (NCC), National Housing Corporation (NHC), non-governmental organisations (NGOs), external support agencies (ESAs), local politicians and Kibera tenants and landlords. The roles of all these parties are very important and success of any upgrading programme will depend on the level of cooperation between them. An Informal Settlements Department is proposed within NCC to oversee developments in informal settlements.

In the development of Kibera, provision of access and solving land tenure issues are prerequisites for adequate success of any sanitation methods. Shallow sewers with either communal ablution blocks or plot toilet and bathroom are proposed. Main water reticulation by NCC is proposed while the community or individuals could construct the minor water pipes. Stormwater drainage should be either open unlined earth drains or lined earth drains. Sullage disposal should be arranged either with excreta or with stormwater disposal. Solid waste management could be either partially or fully community based.

These alternatives were analysed and costs were estimated. The choice will depend on further analysis and preparation of bills of quantities. Community participation should be an integral part of the project while total cost recovery in the long term is recommended. The project is adduced to be considered financially viable. The government has to facilitate the provision of infrastructure in Kibera.

## 1 INTRODUCTION

The majority of the urban poor in Nairobi live in slum and squatter settlements; areas are characterized by overcrowded, disorganized and often temporary houses, lacking basic services. They have inadequate water supply, systems of excreta disposal, surface water drainage, solid waste disposal and electricity. The dwellers have low socio-economic status and are often prone to exploitation, e.g. in the case of official/unofficial water vending. Security of tenure is also always very poor.

Although making a bad sight of the city, slum and squatter settlements are to stay in Nairobi. This is obvious because of their rapid expansion both in size and population. Also evident is the growth of many small pockets of squatter settlements in Nairobi especially in recent years. Evictions of these settlements only result their transfer and waste of resources rather than their eradication.

Because of the permanent nature of slums, the role of sanitation and health in these areas can no longer be overlooked. Neither can the restoration of human dignity through provision of adequate housing. There is a need to preserve meagre resources, because of the need for slum upgrading by providing or facilitating provision of adequate sanitation.

To improve infrastructure in Kibera, it is crucial to study the area in both social and economic terms. Land ownership and security of tenure should provide the limits within which to operate, but should never be used as an excuse not to provide adequate sanitation. Adequate shelter, which includes adequate sanitation is a basic human right.

Nairobi City Commission (NCC) has been rigid on the standards of infrastructure. High standards are stressed for formal housing. Conventional sewerage systems are viewed as the only solution to excreta and sullage disposal. In unsewered high and middle class residential areas septic tanks are considered adequate. While the convenience of conventional sewerage systems cannot be denied, their immense capital outlay must be recognized as well as the high quantities of water required for efficient operation.

Kibera slum area, situated in the heart of the city, is a typical slum area in Nairobi characterized by lack of basic infrastructure. It has a population of about 450 000 people and occupies an area of about 2.5 km<sup>2</sup>. It started mainly as a settlement of former Nubian soldiers of the British colonialists, but today it is one of the most cosmopolitan areas in Nairobi with most of the tribes well represented. The population growth rate is estimated to be about 14 % which is much higher than the population growth rate of Nairobi which is about 5 %.

The study looks at Kibera in the socio-economic context with an aim of improving the quality of life in the settlement. This has been done by carrying out interviews of the residents, visual observations and interaction with the non-governmental organizations working in Kibera. Applicability of several sanitation alternatives have been studied some of which have been recommended for further consideration. The long term objective of this study is to propose guidelines for the improvement of the quality of life in urban low-income areas in Kenya through the provision of sanitation services.

Community management of the systems is an area that needs to be studied. Other areas that need to be tackled in the management of sanitation in Kibera slum area are: housing standards, land tenure, land use planning, institutions and mode of intervention, equity and affordability, financing, applied technology and uplifting of socio-economic status. These areas are looked at in this report.

In this study, the word "sanitation" will include: water supply excreta disposal, sullage disposal, stormwater drainage and solid waste disposal.

Where the term "Kibera" will be used, it will exclusively mean the Kibera informal settlement area only.

The objectives of the study and methodology of field investigations are discussed in Chapter 2. A brief summary and evaluations of the results are presented in the same chapter. The rest of the report is written so that literature survey corresponds with the results obtained from the field investigations. A discussion of the most important aspects is presented at the end of each chapter.



## 2 OBJECTIVES AND METHODOLOGY

### 2.1 Objectives

The main objectives of the study were to:

- 1) propose practical and feasible alternatives to improve sanitation in Kibera slum area
- 2) create awareness of possibilities of improving living conditions through the provision basic urban services
- 3) collect and review data and experiences in order to improve sanitation facilities in similar low-income areas elsewhere
- 4) propose the alternatives that are technically feasible, acceptable to the communities concerned, healthy in application and within the economic means of the communities
- 5) propose the institutional framework viable within the institutional set up of the City of Nairobi.

### 2.2 Methodology

#### Literature survey

The study involved the collection of literature on Kibera, other low-income areas and literature survey on sanitation: several maps, soil investigation results and other documents were obtained from Nairobi City Commission and National Housing Corporation.

Roles of various participants in slum and squatter upgrading programmes were studied. This included the government, the National Housing Corporation (NHC), the Nairobi City Commission (NCC), non-governmental organizations (NGOs) and external support agencies (ESAs), the local politicians and Kibera tenants and landlords.

#### Field data collection

The second part of the study consisted of field data collection. Appendix 1 shows the questionnaire that was prepared for field survey.

The first aim of the questionnaire was to identify the needs of the dwellers of Kibera. The second objective was to study the dwellers' ability and willingness to pay for provision of basic infrastructure.

The materials used in building the houses, the sizes of the rooms/houses, number of rooms per family as well as the number of occupants per room were used to estimate the socio-economic status of the dwellers and to determine the

ability of the dwellers to pay for urban basic services. Ownership of basic household appliances like radios or television were also used to assess the economic status of the dwellers.

The distribution of the population in terms of male and female, age, marital status, education level, profession, monthly income, etc. were determined, in order to know how to cooperate with the dwellers in the implementation of a slum upgrading project.

Many people were unwilling to reveal their real income and therefore it was asked how much an individual or family spent on food per day. This was a better approximation of the household income.

Tenants/landlords relationships are an important issue to consider in slum upgrading projects. It is presumed that if a landlord comes to collect rents himself then it is easier to contact him if necessary. Absentee landlords who have agents who come to collect the rent may be more difficult to deal with. This is especially important when it comes to the issue of land tenure, sacrifice of rooms for the purposes of improved sanitation, etc.

Other issues in the questionnaire were water demand, evaluation of existing sanitation methods, possible sanitation proposals etc. The scope for community participation and management was also studied. The residents were asked if they were willing to participate in the upgrading of the area by improving sanitation. The type and success of the organization the member belonged were assessed as a possible tool that could be used in the promotion of community participation. The success of the organization was also used in estimating the maturity of community management already existing in the area.

The questionnaire was tested in the field and adjustments made accordingly. After that the interviewers were selected. Five of the interviewers were qualified civil engineers, and five were university students studying social sciences. After the training they carried out 1 042 interviews among the dwellers of the Kibera settlement within seventeen days.

Four local guides were recruited in each village to help them. In many instances the efficiency of the interviewers depended on how well the guides knew the dwellers of the respective villages. Interviews were simultaneously carried out in two villages with the interviewers and the guides divided into two groups. One major disadvantage of having local guide was that they took the interviewers to more popular village dwellers and these were people of generally higher socio-economic status.

Compiling and analyzing of the data obtained from the interviews was carried out partly manually and partly by computer using the lotus programme. Compilation sheets of the interviews carried out are in Appendix 2.

Estimates of population densities were made by field methods. A small area was demarcated using as much as possible natural boundaries like footpaths or rivers, etc. Small areas were taken, i.e., 50 m by 50 m. The distances were just estimated by engineers' judgment rather than by measurement hence this could have been a source of error. All the people living in this demarcated area were counted. Where there was nobody in the house and nobody could advice on the number of people living in that house/room it was assumed that two workers lived in the room.

The number of people was divided by the area of the demarcated area and population density was obtained. This was repeated two times per village and population densities recorded. A local person who could read and write was enrolled to help with the counting exercise.

To estimate the total population in Kibera, the population density was multiplied by the total area of Kibera. The total area was estimated from Figure 1. A specimen calculation of population density is presented in Appendix 3.

#### Assessment of obtained data

1. The total number of people interviewed was 1 042. The total population of Kibera is about 450 000 people.

Percentage of Kibera residents interviewed is 0.23 %

Of the total number of people interviewed 99 % were cooperative while only 1 % was not.

2. Kibera is composed of several villages within itself. These are Makina, Mashimoni, Katwikira, Laini shaba, Kianda, Kisumu ndogo, Lindi, Soweto, Salama ngome and Silanga, Kambi muru and Makongeni. Except Silanga, Salama ngome, kambi muru and Makongeni interviews were conducted in all the other villages giving quite a good distribution of the interviewees. Population counts were carried out in all the villages except Salama ngome.
3. As mentioned earlier, the local guides who were guiding the interviewers tended to take them to fairly well known people within the villages. These were people of fairly higher socio-economic status. It was not surprising then that more landlords were interviewed than would have occurred in a random sample of the residents. Other discrepancies could occur in other data due to this reason. Using the guides is part of the requirements of the local administration.

### 3 PHYSICAL AND SOCIO-ECONOMIC CHARACTERISTICS OF KIBERA

#### 3.1 Location

Location of Kibera is shown in Figure 1. The physical site is bounded by Kibera drive to the North, Nairobi National Park to the south and some new housing developments and Kenya prisons to the west. It lies about 7 km from Nairobi Central District.

According to a World Bank study 49 % of the site had slopes of 10 % and above with 20 % slopes fairly common. Since 1978 the increasing house construction utilized the steeper valley sides and poorly drained valley floors. Building on such sites was especially dangerous for sanitation and flooding reasons as flash-flooding was quite common in Nairobi during the rainy season. However, in general Kibera was assessed to be a ridge rather than a valley site (Amis 1983). It was found during the current study that Kibera is basically the same as described earlier except that there has been extensive construction of housing structures on the river valleys in recent years.

The site has a high alternative land use value which increases the prospects of its redevelopment instead of upgrading. Conventionally slums and squatter settlements occupy marginal sites such as areas prone to flooding or steep slopes. While Kibera includes such sites, the majority of the area consists of land that can easily and economically be redeveloped for middle and high income housing as well as other purposes.

#### 3.2 Background history and growth of Kibera

##### Population growth in Nairobi

In Nairobi the population increased from 8 000 in 1901 to 118 976 by 1948. At the time of independence in 1963, the population had grown to 350 000. From then on the number has increased at a rate of 7 - 9 % per annum, reaching 827 775 people by 1979. The official population figure for Nairobi was 1.42 million in 1989 census. Current trends and government estimates now predict a population growth rate of about 5 % per year giving a figure of about 2.2 million by the year 2000 (NCC 1984/88 cited by Odada and Otieno 1990).

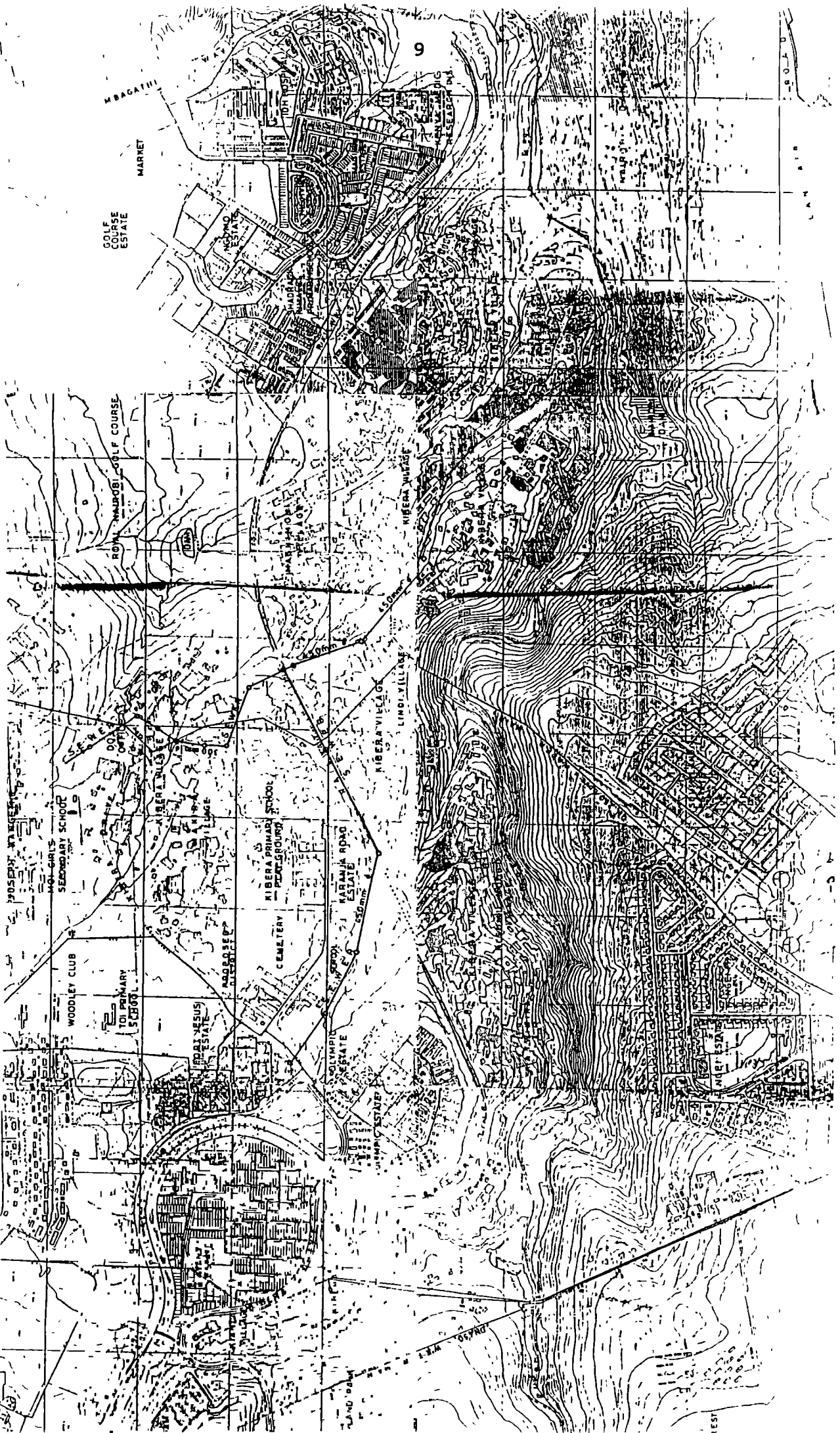


Figure 1. Map of Kibera (Nairobi City Commission).

Table 1. Nairobi population and population growth rate (compiled by the author from Obudho 1984 and Odada and Otieno 1990).

Year	Population	Annual population growth rate %
1948	118 976	
1962	266 974	5.9 (1948-1962)
1969	509 286	9.7 (1962-1969)
1979	827 775	5.1 (1969-1979)
1989	1 420 000	5.5 (1979-1989)

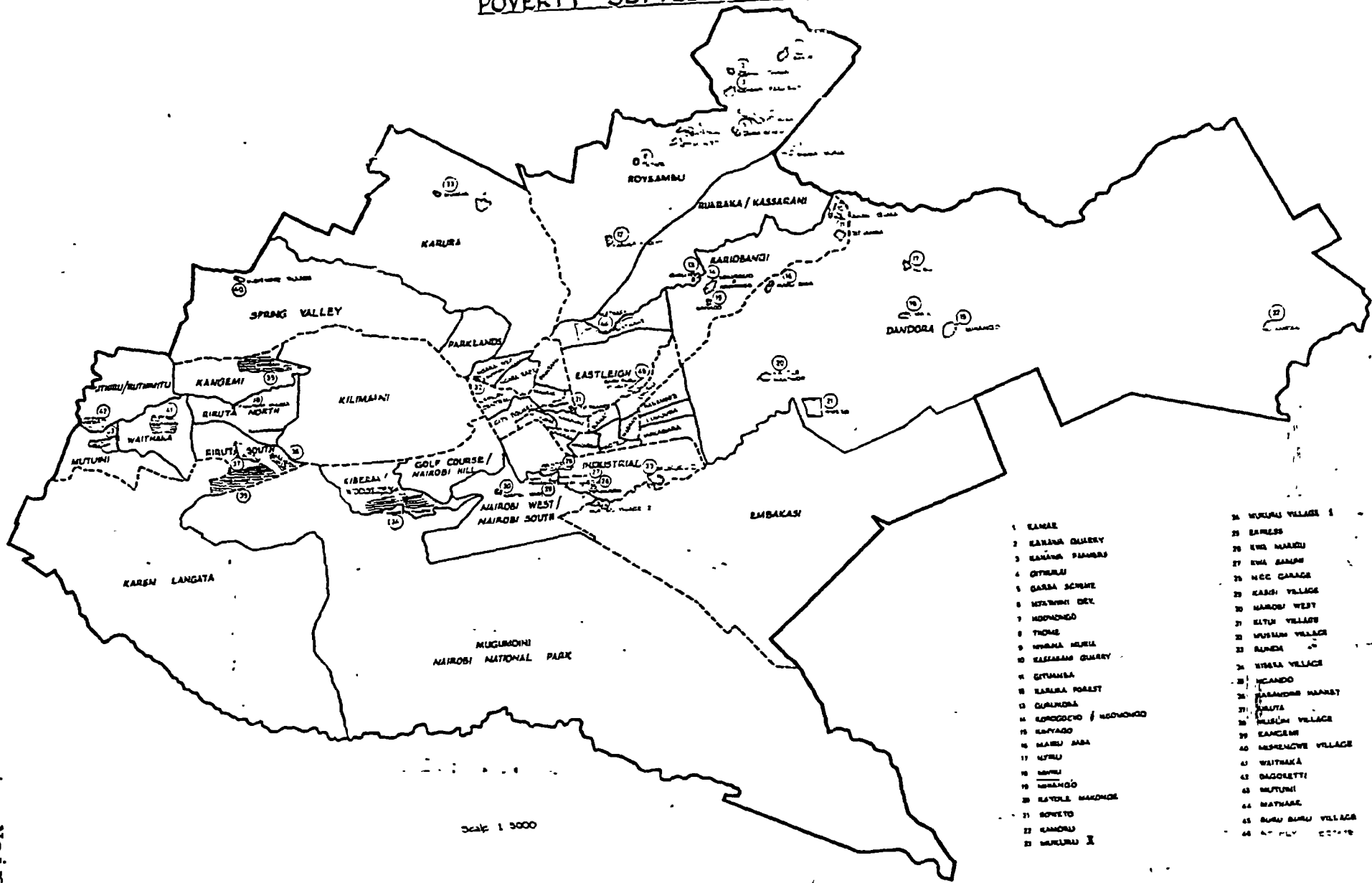
As the city has grown the provision of adequate low-income housing has not been able to meet demand. Immigration into the city, lack of sufficient employment opportunities for the majority as well as inadequate housing has resulted in the unabated growth of spontaneous squatter settlements. In 1983, over 20 % of Nairobi residents were reported to be living in substandard housing in slums and squatter settlements (Odada and Otieno 1990). Obudho (1984) estimates the population in slum and squatter settlements to be about a third of the population in Nairobi. Figure 2 shows a map of slums and squatter settlements in Nairobi.

While the population in Nairobi has been growing at a fairly steady rate of between 5 - 9 %, the rate of growth of the urban poor has been tremendous. Existent slums and squatter settlements have greatly expanded, while new ones are mushrooming up every now and then. Growth rate of the urban poor was estimated at 22.5 % in 1983 (Amis 1983). The study found the population growth rate in Kibera to be 18.3 %.

The number of the women-headed households are increasing significantly. These households are normally the poorest having less access to income generating activities (Harpman et al 1988). The sanitation survey revealed that there are about 2.2 % single women headed households. The actual figure may be higher than expected as many women may be unwilling to admit that they are not married.

# POVERTY SETTLEMENTS IN NAIROBI

Figure 2. Slums and squatter settlements in Nairobi (Nairobi City Commission).



- |                        |                      |
|------------------------|----------------------|
| 1 KANGA                | 26 WUKURU VILLAGE I  |
| 2 KARANA QUARRY        | 27 EARLESS           |
| 3 KARANA PAMBERS       | 28 KWO MAJIDU        |
| 4 OTHURU               | 29 KWA SANGU         |
| 5 GABA SCHWABE         | 30 MCC GARAGE        |
| 6 NORTHERN DEY         | 31 KAROH VILLAGE     |
| 7 KOOHONGO             | 32 KAROH WEST        |
| 8 THOMAS               | 33 KITU VILLAGE      |
| 9 NYURUA MURU          | 34 MUSHAM VILLAGE    |
| 10 KASSAMAM QUARRY     | 35 KUNDA             |
| 11 GITUMBA             | 36 NYARA VILLAGE     |
| 12 KARURA FOREST       | 37 MCANDU            |
| 13 QUARANDA            | 38 KASANDAM MARKET   |
| 14 KOROCHVO / KOOHONGO | 39 KIRUTA            |
| 15 KINYAGO             | 40 MURUM VILLAGE     |
| 16 KARU SABA           | 41 KANGEMI           |
| 17 NYRU                | 42 MASHINGWE VILLAGE |
| 18 MARI                | 43 MATRUKA           |
| 19 MURANGO             | 44 DAGOLETTI         |
| 20 KAYOLE MAKONGE      | 45 MUTUNI            |
| 21 KONYO               | 46 MATNARE           |
| 22 KANDRU              | 47 BUKU BUKU VILLAGE |
| 23 MUKURU II           | 48 AT PLY CORNER     |

Kibera started as Nubian enclave in 1928 when the British colonial government settled its Nubian soldiers there. In 1933, the government reclaimed the land as government land and encouraged gradual eviction and compensation for the dwellers. By then the land was basically agricultural. Progressively as the other tribes joined the Nubians and with the advent of commercialization of informal housing and industrialization, the agricultural activities gradually ceased.

By 1952 the Kibera population was about 2 000, composed of mainly Nubians and Kikuyus. Later there was the settlement of other tribes and today Kibera is one of the most cosmopolitan areas in Nairobi. By the 1950s, commercialization of housing in Kibera had began, with the Nubians building unauthorized rental housing. By 1972, the population had grown to about 17 000 composed of predominantly Nubian landlords, their tenants and some squatters on the periphery (Temple cited by Amis 1983).

Table 2. Population in Kibera (HRDU 1971, Hake 1977, Landlord survey 1983 cited by Amis 1983)

Year	Population	Annual population growth rate %
1960	3 000	
1965	6 000	14.9 (1960-1965)
1970	11 000	12.9 (1965-1970)
1975	20 000	12.7 (1970-1975)
1980	60 000	24.6 (1975-1980)
1992	>450 000	18.3 (1980-1992)

Today Kibera slum area is composed of 11 villages namely; Makina, Mashimoni, Lindi, Katwikira, Kisumu ndogo, Kambi muru, Makongeni, Laini saba, Silanga and Soweto. Appendix 2 will show that Makina, Lindi and Kianda have got residents of higher socio-economic status. In these villages more resident landlords are to be found. It is also worth noting that these are the villages which now have most of the Nubian landlords.

After the independence National Housing Cooperation (NHC) has been carrying out limited demolitions and building new housing estates like Salama (1963-4, 1967-8 and 1969-70), and Olympic Estate (1970-71). Unfortunately houses in these estates are not allocated to the squatters, mainly due to their high cost and also because landlords would prefer areas where they can earn money by renting (Amis 1983).



The latest estate to be constructed by NHC was Kibera High Rise Estate (1988-89) which was shrouded with a lot of misgivings. It was built south-east of Soweto after considerable demolitions of other structures. The houses after completion could not be afforded by the squatters of Kibera and were mainly purchased by middle income residents of Nairobi. Extension of the estate was stalled in 1989 after there was a futile attempt by Nairobi City Commission to evict squatters in Mworoto settlement in Nairobi by demolition.

Extensive unauthorized housing (mostly rental) has been expanded mainly with the landlords having patronage of senior government officers or politicians. Protection from demolition is normally provided by administrators who are the ones who allocate unauthorized plots.

### 3.3 Infrastructure in Kibera

The public sectors involvement in Kibera was very limited. The local administration had effectively abdicated responsibility for service or infrastructure provision, hence letting Kibera be devoid of adequate basic infrastructure (Amis 1983). Today the same situation still prevails, this time with a much larger population living in the area.

#### Housing

The houses were found to be mainly made of mud walls and floor and covered with corrugated iron sheets. Some of the houses are made of wooden wall while some have cement lined mud walls. Most of these also had cemented floors. Figure 3 shows the distribution of houses according to types of building materials. The housing density is also very high considering that access between plots is restricted to narrow footpaths and the room coverage per plot in most cases was beyond 80 %. Figure 4 shows Kianda village in Kibera.

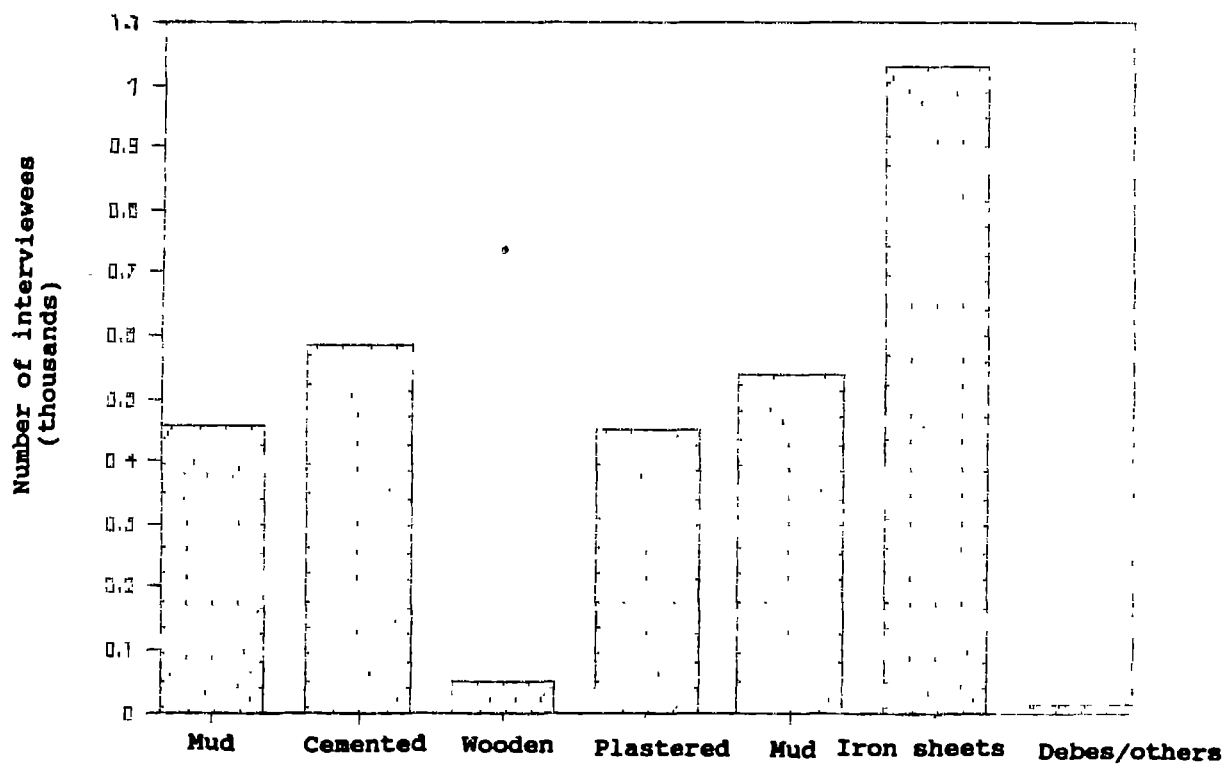


Figure 3. Distribution of houses according to types of building materials.



Figure 4. Katwikira village photographed from the railway line.

The average size of the rooms was about 13.5 m<sup>2</sup> and most families only rented one room. Figure 5 is a graph showing in how many rooms each family lives. Rooms which were unplastered and had mud floors were generally much larger than the ones with plastered walls and concreted floors.

Most of the rooms were found to be occupied by 3 people. Figure 6 shows the number of occupants per room as per the people interviewed. The average number of occupants per room is four.

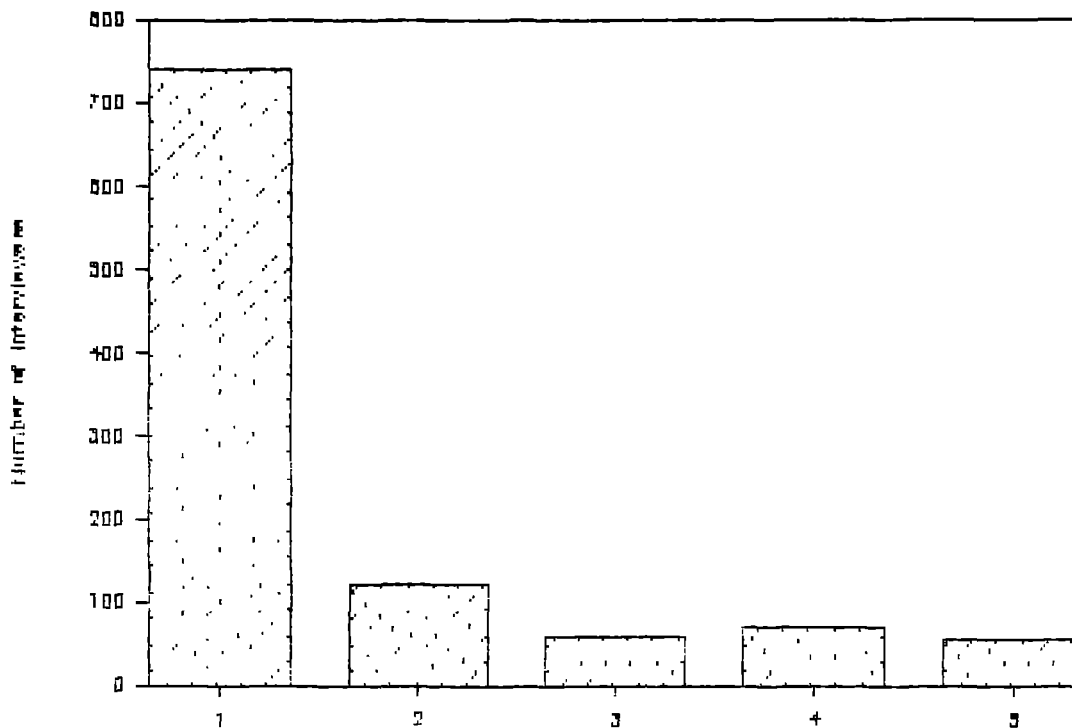


Figure 5. Number of rooms per family.

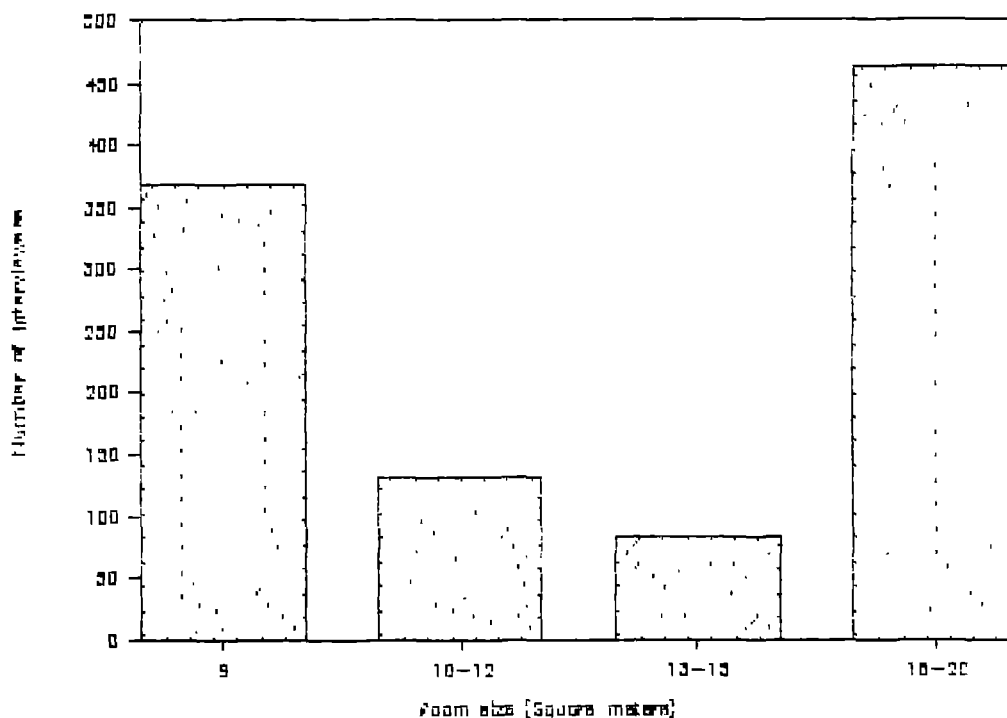


Figure 6. Number of occupants per room.

### Access

The road system which is very necessary for the provision of vital services such as fire protection, police and ambulance is completely inadequate. Even the emptying of pit-latrines is not possible due to the lack of access. The settlement is served by few murram roads and several footpaths. One of the main streets is shown in Figure 7.

Vehicular access is exclusively by Kibera drive to the north or from Mbagathi Way into Laini saba village. From these two entry points there are tracks on both ridges where most economic activity takes place. From these tracks there is an elaborate and well defined network of footpaths. In the dry season, access by foot is easy, albeit dusty. In the wet season access is simply impossible with flooding of sullage, stormwater and sewage from pit latrines. Lack of adequate access was a common complaint among the residents.



Figure 7. One of the main streets in Kibera.

### Water supply

NCC supplies water to Kibera through licensed water kiosks owned by individual entrepreneurs. Normally the kiosk owners are buying the water at about 10 cents per 20 litre container from the Nairobi City Commission (Odada and Otieno 1990). They sell the same at prices ranging from 30 cents to KES 1.20. The average price of water per 20 litre container was found to be 66 cents. Figure 8 shows the distribution of prices of water. Appendix 2 shows that the price of water is cheaper in some villages than in others. Mashimoni (M2) village has the lowest water prices. The

price of water was found to depend on amount and reliability of supply. One water vendor who was questioned confessed that she earned KES 200 to KES 300 per day from the water sales alone. This is the earning of an upper middle class worker in Nairobi today as classified in the Kenya Housing Policy (Kenya 1990/91).

While some Kibera residents buy water from the neighbouring high income estates, most have access to water kiosks at close proximity. The average distance to a water kiosk was found to be about 40 m. Figure 9 shows proximity of water points. It was found that though most people collected water in closed containers which could be free of contamination, they were sometimes uncleaned which may lead to contamination. 30 % of the people interviewed were found to keep the water containers uncleaned.

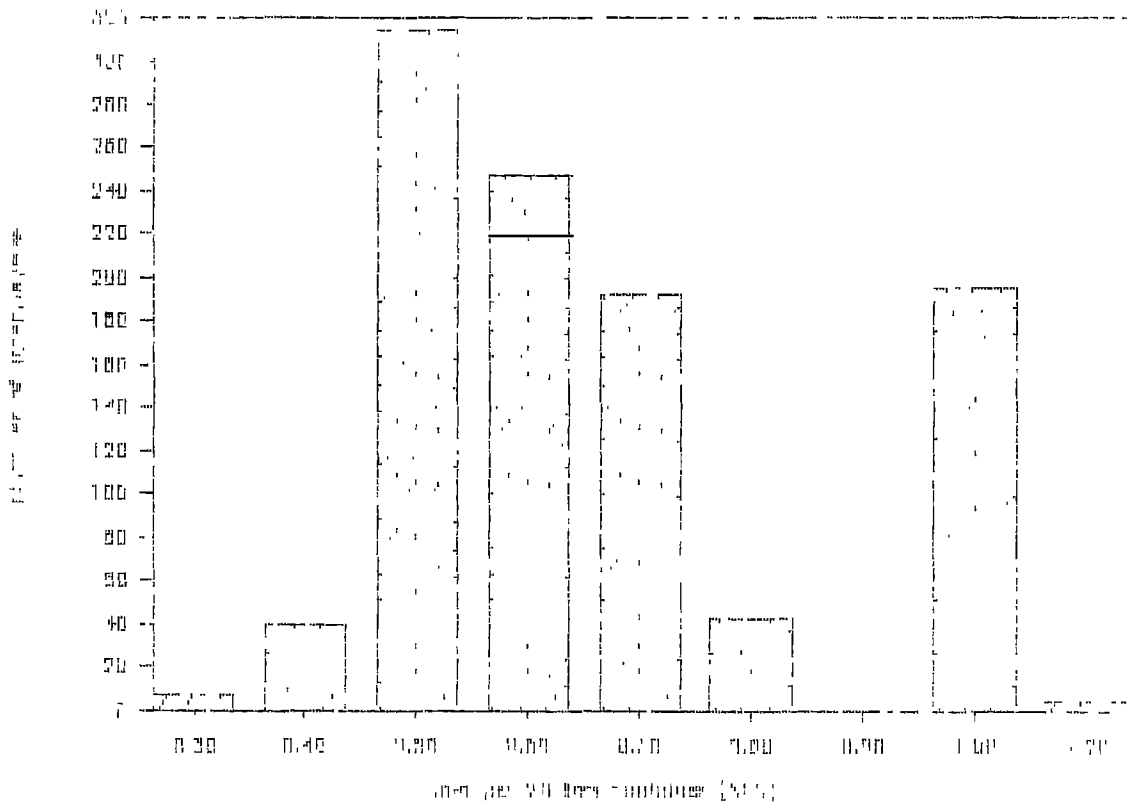


Figure 8. Prices of water per 20 l container.

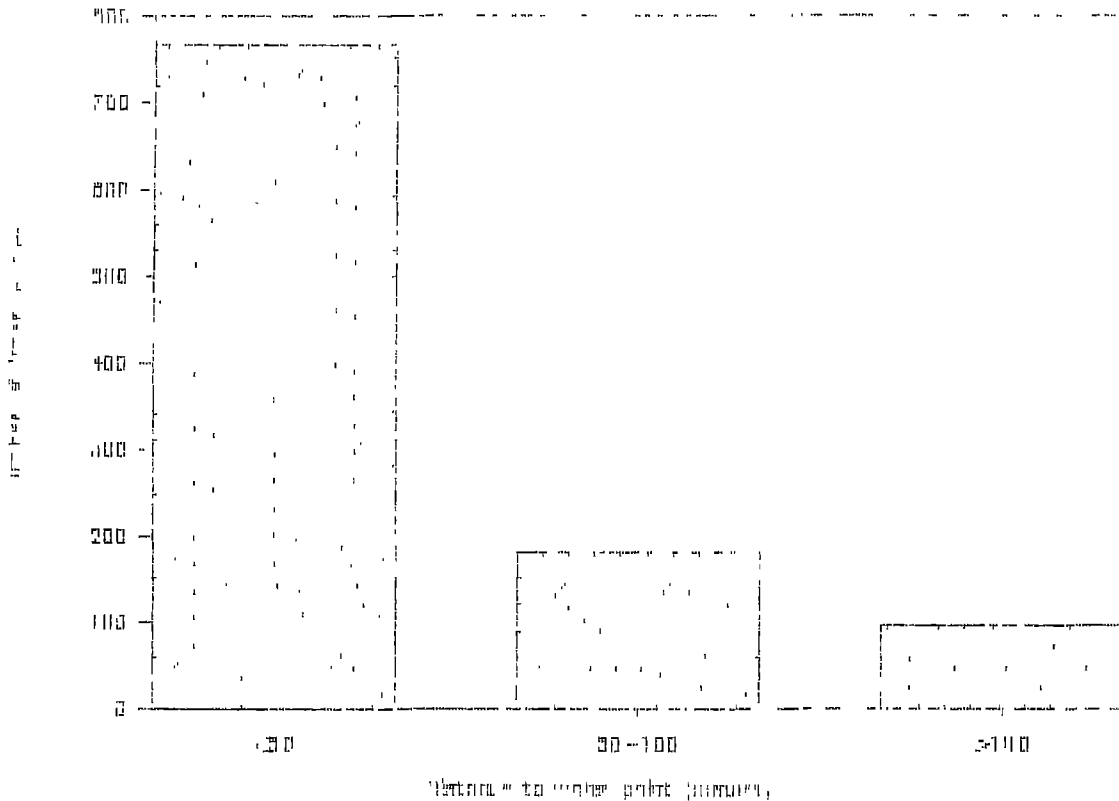


Figure 9. Proximity of water points.

Water supply in Kibera is not reliable. Out of 1 042 people interviewed, 28 % (297 people) could obtain the water when they needed it. Many of the water vendors have built water tanks in order to have water for more hours during the day. Some taps were known to run dry for months. The problem of unreliability applies to Nairobi as a whole since the total demand has far exceeded the total supply. Figure 10 shows some of the water pipes in the area.

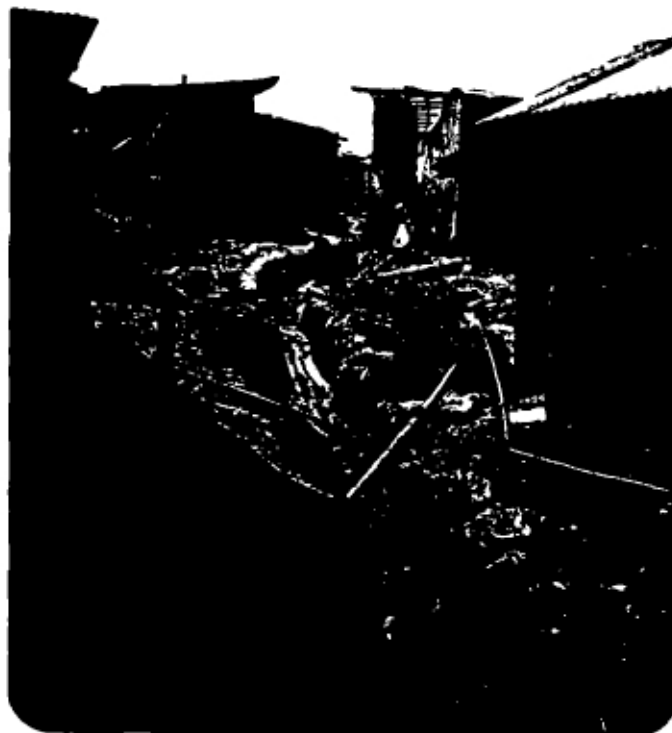


Figure 10. Water pipes in Kibera.

Each household unit spent about 90 l water per day. If the average number of members per household unit is 4, then the per capita consumption is about 22.5 l per capita. Figure 11 shows the distribution of water consumption of the households.

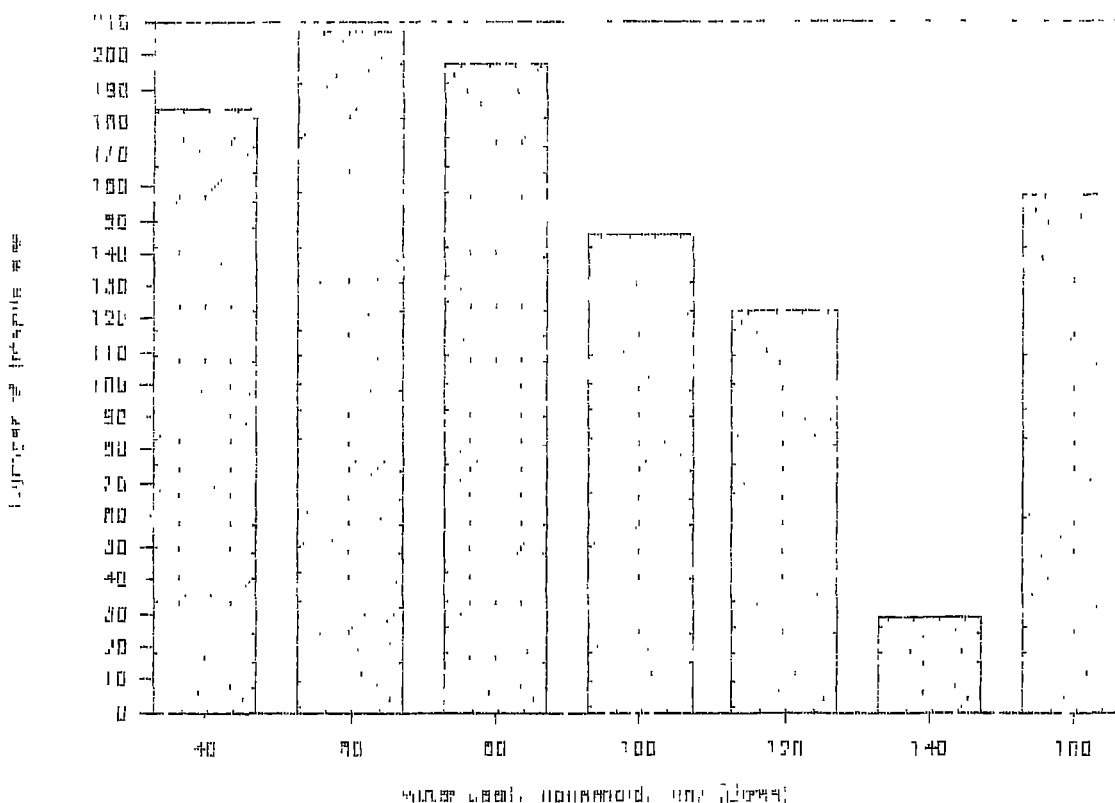


Figure 11. Households' water consumption.

The interviewees used for other sources of water burst water pipes, roof catchments and the motoine river. 34 % of the dwellers used roof catchment, while 10 % used water from burst water pipes. Only 1 % used river water. The river water is badly polluted, and the residents use it for other purposes and not for drinking.

#### Excreta disposal

There is no water borne sewerage system in Kibera. Excreta disposal is by pit-latrines constructed by landlords. These pit latrines are shared by the tenants. Often no latrines are provided at all so that the tenants have to either go to toilets in bars or to request to use neighbours' latrines. A study carried out in 1983 showed that 10 % of the plots have no pit latrines (Amis 1983). During this study 9 % of the interviewees said they had no pit latrines.

This study revealed that an average of 60 people were using each pit latrine. The average proximity of the pit latrines was 42 m. Figure 12 shows the distribution of distance to pit latrines.



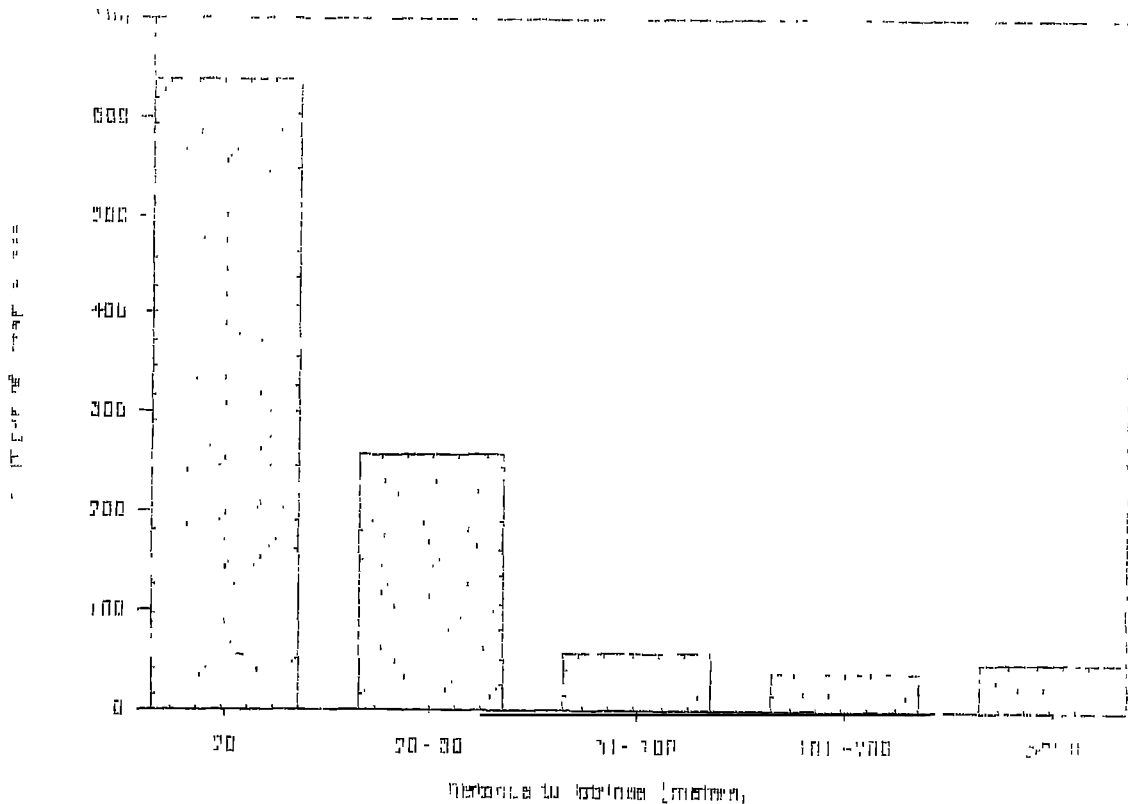


Figure 12. Proximity of pit latrines

In a 1985 study, Howard Humphreys Consulting Engineers showed that lower Kibera had the worst pit latrines in Nairobi. The pit latrines had very poor super structures and the timber floors of most of the pit latrines seemed like they could collapse easily. The pit latrines were estimated to be of an average depth of 3 m. Today the situation is not only restricted to lower Kibera but extends to whole Kibera. In many cases the pit latrines discharge into the river. When it rains, it is common for landlords to open the pits so that sewage flows into the drains outside with the storm water and sullage. Communal use of the latrines is very poor, with children defecating outside the latrines. There is excreta around most of the pit latrines. This makes the place extremely messy. Personal pit latrines where they existed were normally very well maintained. Figures 13 and 14 are examples of the situation in Kibera.



Figure 13. Pit latrine pouring into the river.



Figure 14. A pit latrine in Kianda village.

There are few public ventilated improved pit (VIP) latrines built by UNICEF and KWAHO. They have good super-structure and sub-structure and they do not smell, but many of them had become personalized with padlocks and keys perhaps due to maintenance. Some of them were not emptied when full.

Emptying the pit latrines is done by NCC exhausters or the KWAHO community exhauster vehicle. KWAHO charges KES 160 and NCC charges about KES 350. When there is inadequate access to empty the pit latrines, they are either abandoned or emptied in the ways described above. Sometimes chemicals are used to react with the pit contents.

#### Sullage disposal and stormwater drainage

65 % of the residents interviewed discharge the sullage into unlined mud drains. 10 % discharge sullage into dug pits while 25 % discharge on the ground indiscriminately. In 75 % of the cases interviewed stormwater was drained into dug or erosion formed mud channels. In the other 25 %, the stormwater flooded uncontrolled into the neighbouring house yards.

While disposal sullage indiscriminate is not a big problem in the dry season, in the wet season sullage combined with sewage and stormwater causes flooding around the houses. In some areas well built concrete lined channels have been dug. In some instances they are covered with crossed pieces of wood, but these types are not common. Most of the existing channels are mud lined and prone to erosion on hill sides. On even ground the channels have no slope enough and therefore the water in them becomes easily stagnant. Sometimes stormwater flows through the houses due to soil erosion.

6 % of the interviewees use pit latrines for bathing while 27 % use the rooms they live in. 64 % have constructed bathrooms which either have a pit or discharge into the pit latrine or into the drains outside. The rest either never take a bath or have it at their workplaces.

#### Solid waste disposal

There is no infrastructure to help the management of solid waste disposal. 36 % of the residents interviewed dispose solid waste indiscriminately on the ground, especially near pit latrines. 27 % of the interviewees dispose the solid wastes into rubbish pits. Some landlords (6 % of the total interviewees) collect the rubbish and burn it. A very large percentage of the interviewees (30 %) dispose the solid waste into the river.

### Electricity and telephone services

There is no street lighting within Kibera, but there are electrical wires crossing through the villages. A few rich Nubian landlords have connected electricity to their homes. Some have even telephones. There are public telephone booths distributed within the villages. These are normally placed near the Kanu offices.

### Education and health services

There are four government schools within the proximity of the informal settlement of Kibera. There is one private primary school: mashimoni primary school, but no secondary schools. Private facilities include several nurseries/day care centres and special schools for disabled children, street kids, adult education and technical skills.

Health services are provided by NGOs. The nearest government facilities are the Maternal, Child Health and Family Planning Centre, Kenyatta National Hospital, Ngong road dispensary and Woodley Clinic. The NGOs operate several clinics and dispensaries with professional health workers. There are also several traditional medicine men/women and traditional birth attendants. NGO operated facilities charge more for their services than public facilities which are further away (Kunguru and Mwiraria 1991).

### Recreation

There are a few recreation facilities in Kibera. Through self help efforts the community has built a social hall. Undugu Society provides a playground, sports facilities, and a hall for communal use. There are several churches and a mosque (Kunguru and Mwiraria 1991).

## 3.4 Socio-economic status of Kibera residents

### 3.4.1 Demographic data

Low income communities are characterized by high population densities, high-household densities and high population growth rates. Many dwellers are rural immigrants and a high proportion of the dwellers are young people. Unemployment is a serious problem. The areas lack adequate sanitary services and other types of services like electricity, medical, and educational facilities. There is often no security of tenure. Community organisation is normally quite strong. Each slum area is unique in its own way due to different social backgrounds of the dwellers. Improvement of any of these dwellings should be carried out in the context of that area (UNCHS 1981). Kibera is a typical low-income area as described above.

### Population data

Like most low-income settlements, Kibera has a high total population as well as population density. As mentioned earlier in the text, most of the residents live in one room units with their families. The average number of residents per room is 4. 19 rooms have 10 or more residents each. The average population density is 180 000 people per km<sup>2</sup>.

### Distribution of ages and marital status

The survey in Kibera shows that 33 % of the total population are married. The rest 67 % are single. Of the people over 18 years of age only 30 % are still single. Single mothers represent 2.2 % of the total population. Kibera has a big percentage of young people. Even the married people are very young couples. The number of people under 18 is almost equal to the number over 18. The number of females is also almost equal to the number of males. The actual percentages are shown in Appendix 2.

### Educational level

Most of the residents are not very highly educated. 51 % of the residents over 18 have reached standard 8 level of education and below. Only 5 people have gone to a college or to the university. 22 % of the residents over 18 are in formal employment, while 33 % are in informal employment. The remaining 45 % are either unemployed or still in school.

### Individual and household income and expenditures

The average individual income is about KES 1 640 per month while the average household income is about KES 2 170 per month. The average savings per interviewee per month is about KES 200. Figures 15 and 16 show the financial situation in Kibera. Only 26 % of the interviewees have a bank account. As Figure 15 indicates some of the residents can be considered to be financially well-to-do.

In order to check the reliability of the data on income, data on each family' spending on food was obtained (Figure 17). The average spending on food and other daily household contingencies like soap etc. is KES 54 per day. This is about KES 1 620 per month meaning that the households are using about 75 % of their income on food. The average rent per month is KES 210. This is about 10 % of the household income.

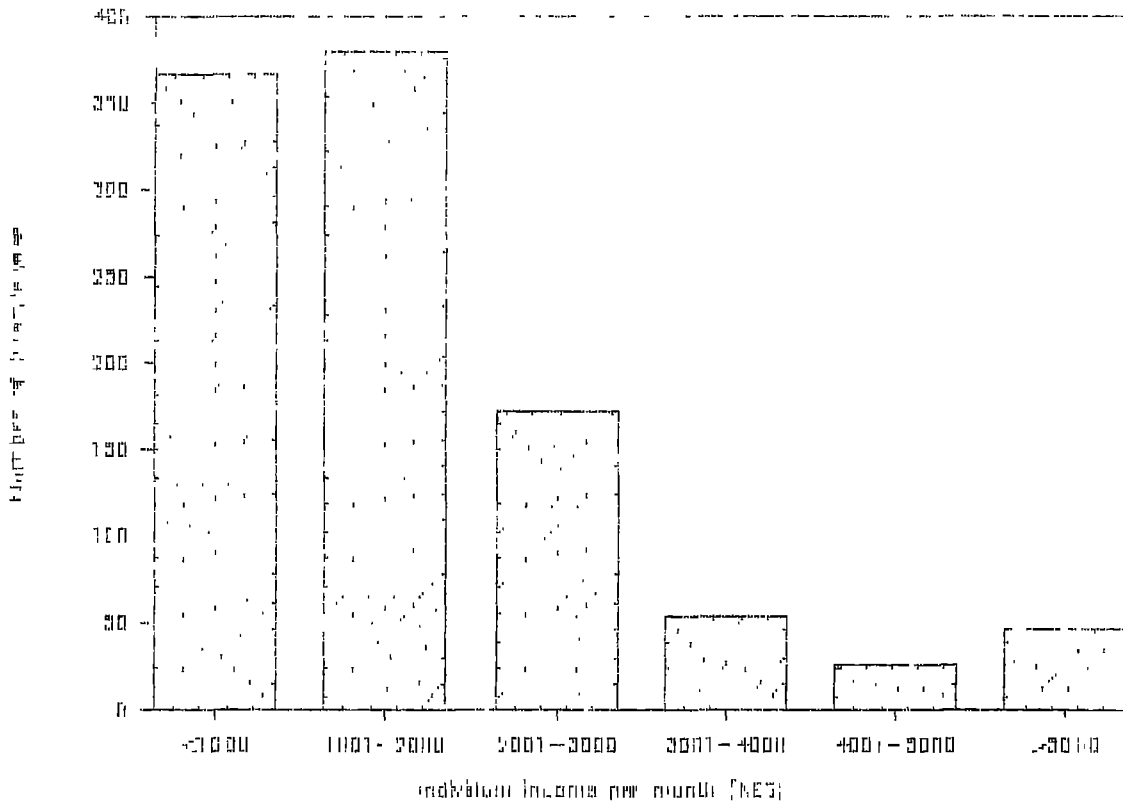


Figure 15. Individual income per month.

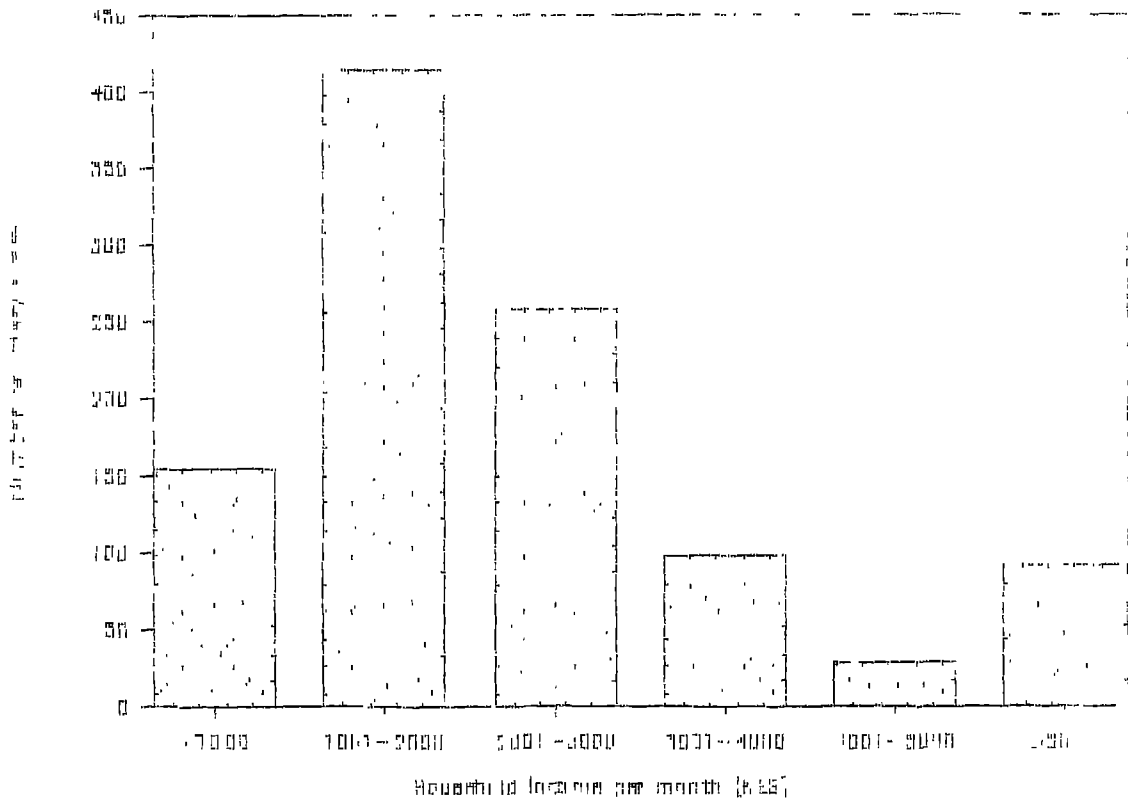


Figure 16. Household income per month.

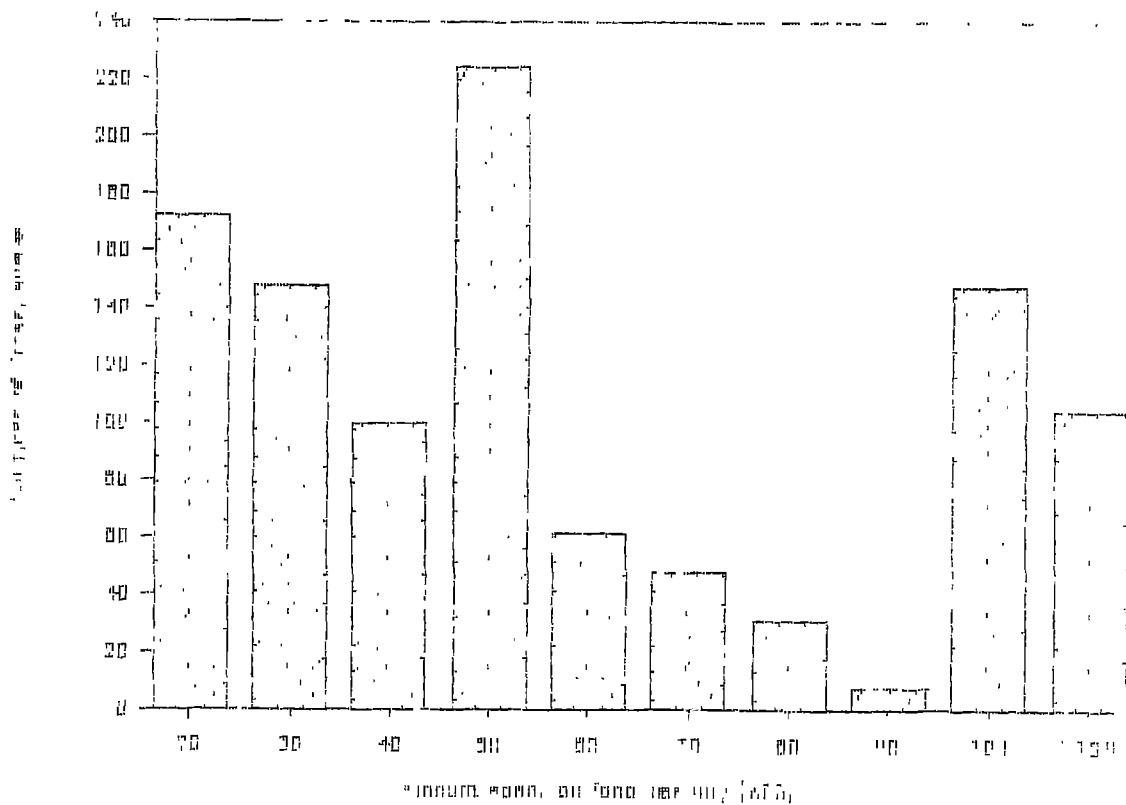


Figure 17. Amount spent by each household on food per day.

598 (57 %) of the interviewees own radios. A radio is normally one of the basic requirements of any family in Kenya. This shows that quite a high percentage of the interviewees (43 %) are too poor to afford a radio. Some of the interviewees (11 %) own televisions, telephones and have even electricity in their premises. Hence some of the residents are fairly well-off.

### Landlords and tenants

According to the survey landlords represent 23 % of the people interviewed and 4.7 % of the total population. More landlords than what is their actual share were interviewed for reasons discussed in Section 2.3. A study by Amis (1983) revealed that most landlords owned about 12 rooms. If this is the case and each room is assumed to accommodate 4 people, then landlords are making about 2 % of the total population. From field observations in Kibera during the interviews, this figure seems to be more reasonable.

Landlords who normally came to collect the rent themselves were more easily available than those who sent their agents. This kind of landlord represents about 63 % of all the landlords.

Landlords who are resident in their plots had positive attitudes towards improvement of sanitation in this area. Temporary tenancy and absentee landlords could be blamed for poor housing maintenance. 70 % of the resident landlords are willing to give up some rooms if needed for the improvement of sanitation in the area. They said they would not seek compensation for the rooms. Public education and discussion with the residents could raise this percentage.

Whilst the most of the tenants consider themselves temporary in Kibera 57 % of the interviewees had lived there for at least five years. Hence the residents can be considered quite permanent in the area.

### Public Health in Kibera

Many of the interviewees were reluctant to admit that their children frequently had diarrhoea. This is why 14 % of the interviewees said that their children never had diarrhoea while it is not normal in Kenya for a child to grow without having contacted diarrhoea at least once in its infancy. 27 % of the residents said their children had diarrhoea frequently.

Diarrhoea is one of the five leading causes of morbidity in children in Nairobi. Reports from NCC in 1986 rated it as the third leading cause of mortality among all the age groups (Odada and Otieno 1990). Other health problems included malaria, common colds, meningitis, worms infestation, measles and other contagious diseases. This was due to the overcrowding in the area as well as poor sanitary conditions.



Analysis of the level of public health education information among the residents, show that 51 % of the resident are informed while 49 % are not. Only 29 % admit being visited by public health workers. Many of the residents complain of poor use of latrines and indiscriminated disposal of solid waste which could be seen everywhere. Hence it can be said the level of public health consciousness is low among the residents.

Personal and domestic hygiene depend on hygienic behaviour as much as hygienic facilities. While only few have the best of the facilities, education on the best hygienic use of the facilities that do exist can contribute to protection against disease (WHO 1989).

### Organizational capacity

At least 61 % of the interviewees belong to at least one organization. A majority of them belong to self help, women and church organizations. Of those who belong to any organization, 70 % say that their organizations are successful in the attainment of its goals. This shows that there is a high level of organizational capacity in Kibera. This means community participation could be very successful in this area. It would be good to utilize the already existing organizations in Kibera.

### 3.4.2 Ability and willingness to pay for basic services

#### Ability to pay

The total annual income per household for the poorest 40 % of population in the 'Low Income Countries' is approximately USD 700. With affordability normally in the range of 20 % for housing and services the total available annual expenditure is USD 140 (Cotton and Franceys 1990). This figures compare well with the average household income in Kibera which is about USD 868, considering that currently one USD is about KES 30.

As discussed in Section 3.4.1, while several of the Kibera residents earn quite a high income per month the majority of them have a very low socio-economic status. Several of them are unemployed or in casual employment. This does not mean that they are unable to pay for basic services. Amount of water used per household is about 90 l/d. The average cost of water is about 66 cents for 20 l (KES 33/cum). Hence the monthly cost of water is about 90 shillings.

Many residents in the city receive water bills of similar magnitude every month from the NCC. The bills include the sewer charges. It is therefore logical to conclude that the residents of Kibera are able to pay monthly charges for water from the NCC. They are also able to pay for sewer charges if they are connected to the sewerage system. In fact considering the amount that they are already paying for water cross-subsidisation across the population will not be necessary on account of the Kibera people.

Considering that the residents could be willing to spend 20 % of their income on housing and services, after paying a monthly rent of KES 210 and water and sewerage monthly bill of KES 90 from KES 434 (20 % of the monthly household income), a balance of KES 134 is left monthly for payment of other services. This is a considerable quantity of money that is enough to pay for the other services.

Although they can afford the monthly payments for services, most of the residents cannot afford the capital charges associated with the provision of these services. Most of the residents have no bank account at all. The average savings per month is about KES 200 with 50 % of the residents not having any savings at all.

Ability to pay can be increased by increasing the economic status of the residents. This is by introducing income generating activities amongst the residents.

### 3.4.3 Willingness to pay for basic services

The survey shows that 72 % of the interviewees are willing to contribute labour for upgrading of sanitation services while 52 % are willing to contribute financially. 74 % of the interviewees are willing to be involved in full cost recovery sanitation projects. It is therefore obvious that the residents of Kibera are willing to pay for basic services.

The objectives of infrastructure are to obtain, primarily through the built environment health benefits, security and social benefits, convenience and status. Housing and infrastructure standards reflect differing costs, risks and benefits. Normally health benefits are used to justify investments while little is done to explain what benefits accrue from what benefits (Cotton and Franceys 1990).

Willingness to pay can be greatly increased by increasing public health awareness. An understanding of the other benefits that could be accrued from provision of infrastructure would increase the residents willingness to pay for higher standards of infrastructure as well as appreciation of other non-conventional forms of infrastructure.

The question of land tenure requires an urgent but careful decision. It is important to give at least some degree of security of tenure so as to realize improvement of sanitation in the area. In the government plan to address the problem of land tenure in this area, the biggest problem is: What to do with over 450 000 tenants many of whom are extremely poor. If the government would make a wrong move and would provide tenure to rich landlords, automatically the land would be used for middle income housing and the problem of unhoused 450 000 tenants would still remain. The landlords comprise only about 2 % of the total population in Kibera. While there are some wealth landlords in Kibera, there are also several who depend on the few rooms they rent for their income.

#### 4 ROLES OF PARTICIPATION GROUPS

In upgrading slum infrastructure, it is necessary to define the objectives of the programme. There are several participants in these programmes, each having its own objectives. The success of infrastructural programmes in low-income settlements depends on generating enough interest among the various participants. It crucial to search for a clear understanding of the objectives to mobilize the support of potential partners, as well as circumventing opposition (Angel 1983).

One of the main causes for limited development in Kibera has been the inappropriate cooperation amongst the possible participants in Kibera upgrading. One important aspect in Kibera is that the population is a very large one: over 450 000 people. Hence the institutional requirement to handle such a project is tremendous. Towns with municipality status have such populations or less. There is a need set up functioning institution to oversee the developments in Kibera.

##### 4.1 Government policy and role

###### Government policy

In general government housing policies fall into three main categories namely, laissez-faire, restrictive and supportive policies. Under laissez-faire policies governments basically ignore housing problems and places financial resources into other development sectors (Obudho and Adowol 1988).

Under the restrictive policy governments attempt to solve the problem by eliminating low-income communities. Exclusion from urban services such as water, electricity, sewerage systems and educational and health services and demolitions are the methods employed. This method was advocated in Kenya by the housing policy paper no. 5., of 1966/67 (Obudho and Adowol 1988).

Since then the government has adopted the third category of policies. Supportive policies evolve to improve the living conditions of the urban poor. This includes the support for public housing estates, sites and service schemes and in recent times, community upgrading programmes (Obudho and Aduwol 1988). Apart from community upgrading programmes, the first two have been applied in Kibera.

In community upgrading programmes, the government, if necessary, formalizes land tenure rights in squatter settlements, aligns dwellings with organized thoroughfares, installs drains and storm ditches, and amenities such as latrines, piped water and electricity are provided. Others such as educational facilities, health care and income generating activities can also be provided.

Upgrading projects have the advantage of not dislocating large communities away while providing basic services to improve the living conditions of the communities. However, the problem of large population densities still prevail. Another big problem of squatter upgrading programmes is that once land tenure problems are resolved and probably services are provided with public funds, the rents always will increase (Obudho and Aduwol 1988). An example of this is Kawangare area in Nairobi (Ondiege and Syagga 1990).

The Government of Kenya has since the independence been committed to provide housing for all Kenyans and especially for the low-income people. This move was hindered by the high building standard and high costs of building materials. Hence squatter settlements increased despite frequent demolitions (Kenya 1966/67 quoted by (Obudho and Aduwol 1988).

The government is now relaxing building standards and advocating upgrading of slum and squatter settlements. It is now advocating upgrading of slum areas with minimal displacement to allow for proper planning and provision of the necessary infrastructure and related services. The government also advocates the use of local materials in building and further research into housing development (Kenya 1990/91).

Although the government advocates slum upgrading programmes in its latest housing policy paper, it still has not set up enough machinery to facilitate the upgrading in most of the slum areas including Kibera.

### Government role

In Kibera, the land is planned for low and middle income houses. Several estates have been built in the past following demolitions of some of the slum structures. The latest estate has been Kibera High Rise Estate which has become too expensive for the Kibera residents. With the unsuccessful demolition of Mworoto in Nairobi in 1990, the project has been suspended and the authority in charge of the construction of this estate (National Housing Cooperation) is now waiting for further instructions from the Ministry of Lands and Housing.

The government has been playing a very interesting role in Kibera. The government through its local administration there has actually been responsible for the growth of Kibera. The power to give rights to squat are vested on the local administration. The 'squatters' have the blessings of the local administration. This has been the cause of massive commercialization of housing in Kibera as well as in other informal settlements (Amis 1983). This process is still going on and perhaps it is also the cause of the very poor landlord to tenants ratio in the area and especially the resident landlords to tenants ratio.

The local administration gives the rights to squat with no ground planning. This may be partly due to ignorance on their part as they may not have the technical knowhow as well as no understanding about the need for planning.

Every settlement must be planned whether it is formal or informal. Planning of informal settlement will help in the subsequent provision of basic services. The government can help to facilitate settlement planning in the informal settlements. This can be done either through training of its local administration or by discharging this duty to organizations which have the technical capacity to do this. This include Nairobi City Commission and the National Housing Corporation.

The government should facilitate provision of infrastructure in Kibera. This it can do by solving land tenure problems as well as mobilizing other government machinery for the attainment of this goal.

#### 4.2 National Housing Corporation

The National Housing Corporation (NHC) is mainly interested in housing improvements and sees slum infrastructure as a mean of increasing land tenure security, thus directing more of people's savings towards building their own houses. Infrastructure improvement programmes in slum and squatter settlements are an essential component of integrated housing programmes which should, in principal as well as in practice, support and complement the efforts of people themselves in the gradual development of human settlements over time (Angel 1983).

Specifically, NHC is a government parastatal designed to implement and administer the policies of the Ministry of Lands and Housing in the field of housing construction and finance. Out of 732 NHC housing units built in Nairobi in the period of 1967-71, 593 (81 %) units were built in or around Kibera while only 139 units (19 %) elsewhere in Nairobi. The land is deeded to NHC after existing structures (such as squatter houses) have been removed. The charges to the tenant purchasers include the land acquisition, materials and labour costs, infrastructure, planning and design etc.

Normally a minimum monthly household income that was four times the monthly repayment was required from allottees. Normally priority to buy a house was given to the qualified Kibera Nubians and other Kibera residents.

The houses built by NHC were considerably more expensive than anticipated and due to the increased cost fewer Nubians are able to qualify for voluntary allocation. Therefore fewer Nubians are voluntarily vacating their old homes in the slums, which would enable demolition to proceed ahead of construction. This has led NHC to subvert the original goal of slum clearance and rehousing with the second stage goal of providing middle income housing. This is depicted by the construction of Kibera High Rise estate which has been stalled for further instructions from the Ministry of Lands and Housing.

In Kibera upgrading, NHC could have the same role as before; financing, designing and constructing infrastructure and obtaining instructions from its parent ministry.

### 4.3 Nairobi City Commission

Municipal engineers are primarily interested in public health, and see slum infrastructure as a flagrant waste of resources. The municipal engineers prefer high infrastructural standards, even though they may imply high initial costs. There is a lower risk of failure and less potential embarrassment, and there could also be lower maintenance costs. And anyway why should standards be lower in slums and squatter settlements and all people should be equal? (Angel 1983).

To them the essence of a successful infrastructure programme is its long term systematic planning and gradual execution followed by regular maintenance. The 'project approach' to slum infrastructure development tends to introduce many discontinuities to this plan.

The municipal engineers see the improvements of infrastructure in these low-income areas as a problem lying entirely in their domain, which is made difficult by the other participants. As far as they are concerned, all that is required is a mandate to proceed, an adequate budget, and a proper mechanism for acquiring the necessary land. The rest is best left for them to worry about (Angel 1983).

This has been the attitude of Nairobi City Commission (NCC) for a long time. Even when other towns adopted lower standards of infrastructure, NCC was adamant that it would be bad to lower standards in the city. The current standards of a house in Nairobi are: two rooms, a kitchen and a toilet, constructed with suitable materials and occupied by a maximum of five persons.

In the absence of heavy government subsidy formal housing becomes far too expensive for the city poor. In 1985, the cabinet recommended lower standards in urban areas for the poor, but these are still to be implemented, and subsequently formal housing continues to be beyond the means of the urban poor (Obudho 1987).

As the primary agency involved in Nairobi urban development and the provision of services, NCC should play an important role in regulating the growth and upgrading of informal settlements. As an arm of the government, the NCC role should be to enforce the Local Government, Public Health and other relevant acts. NCC is, however, legally restrained from operating in unplanned or unauthorized areas, and is therefore often unable to enforce relevant legislation. The argument is that resources should only be invested in planning and developing those areas of the city for which the future land use has been identified. The Architecture and Planning Department (APD) in NCC views Kibera area as land planned for middle income housing for which the area is zoned.

During the 60s, the Water and Sewerage Department (WSD) considered that the provision of water to unauthorized settlements would legitimize their illegal situation. In 1971 there was a cholera outbreak in the city and this led to connection of water kiosks. By 1978, licenses for operating water kiosks in informal areas were issued by the WSD. Since then the number of connections in Kibera has increased to about 500, the only restriction being the current severe water shortage in Langata area where Kibera is. WSD's view is that as long as there are people living in an area, they must be provided with basic services such as water. Water connections are therefore provided when they are requested and paid for in advance (Odada and Otieno 1990).

In 1988/89, NCC and UNICEF agreed to undertake a water supply reticulation project in Kibera where NCC was to finance water pipes of 100 mm diameter, and above, and UNICEF was to finance pipes of 75 mm and below. Water was to be provided through kiosks to women groups. The immediate objectives of the project was to make water abundant and cheaper. Unfortunately the project had to be stopped as there is currently a water shortage in the whole of Nairobi. NCC and UNICEF are to be commended for the initiative.

Although being very positive towards the need of water in the slum and squatter settlements, WSD does not include the population of informal settlements in estimates for future water requirements and in developing plans for increasing water supply to Nairobi.

Kibera lies along the sewer line, but due to the informal nature of the settlement, no connections are allowed. Most residents use poorly maintained pit latrines. WSD has allowed Kwaho vehicle to empty latrine waste collected into the sewer for a fee. Earlier WSD used to be very efficient in emptying of the pit latrines at a fee, but now the action is hindered due to lack of access as well as lack of adequate lengths of hose pipes.

The need for planning is important in Kibera; planning even the squatting of squatters. There is need to show a squatter that you may settle on this plot of land and at least done some form of surveying, even if it is done with a piece of string (Cairncross and Ouano 1991). The NCC has the institutional capacity to handle such a job. This will facilitate provision of infrastructure, but NCC has to have the mandate of the government to do this. NCC can also through its social workers promote communal organization in Kibera.

There was a workshop in Naivasha, organized by NCC on improving environmental sanitation in informal settlements, in 1991. NCC was very well represented by most of the relevant departments. This shows the willingness and commitment of NCC to handle the problems of slum and squatter settlements.

No matter how much of the scheme is managed and funded by the community there is a need for a well organised and committed institution. Institutions are required to advise on the management, design and construction. They must be able to finance and maintain all the communal parts of the systems such as trunk sewers. They may also have to supply appropriate financing arrangements for the community to overcome their lack of working capital (Reed 1991). In Kibera this institution could be formed within NCC.

During the Naivasha workshop on improving environmental sanitation in informal settlements in 1991, a good proposal was made to form an Informal Settlements Unit (ISU) within the NCC. This will be to facilitate the use of Rural Development Funds in Nairobi in the affected areas and to simplify administration procedures necessary for an integrated approach to the informal settlements problem (NCC 1991).

As proposed in the same meeting an Informal Settlements Steering Committee (ISSC) will be formed to co-ordinate and oversee improvements in informal settlements under the Nairobi District Development Council (DDC) to ensure an entry point for the many agencies presently involved and willing to support developments in this area. It will also be responsible for co-ordination of developments in areas of land policy and tenure, resource mobilization and data collection, storage and dissemination. Its secretariat will be based at NCC.

The Informal Settlements Unit to be initially attached to the public health department will function as an implementing unit and mobilize resources from both the NCC and the Central Government. This unit and the Informal Settlements Steering Committee should lead to the formation of the Informal Settlements Department at the Nairobi City Commission.

#### 4.4 Non-governmental organizations

Non-governmental organizations (NGOs) are basically community builders who are concerned with community organization and development, and see infrastructure improvements as issues of common interest around which slum dwellers can be organized effectively. To them a slum improvement has physical, social and economic components, all basically entwined with each other. The quest for improved infrastructure is a quest for social justice, and working together on the execution of an infrastructure programme is a quest for the revival of a village community spirit in an urban setting (Angel 1983).

Several NGOs (about 16) have shown concern for the situation in Kibera. Crescent Medical Aid, Church of the Province of Kenya, Kibera Catholic Mission, Kenya Water for Health Organisation, Family Planning Association of Kenya, The Undugu Society, Young Men Christian Association, Don Bosco and World Vision etc. are now involved in various community activities. Most of the NGOs



are involved in a whole range of activities which include health, water and sanitation, education and many others (Kunguru and Mwiraria 1991).

There is currently no formal procedure for NGOs wishing to establish themselves in the community. Some have simply facilities and commenced activities without the knowledge or acceptance of the community and its administrators. Many start up and disappear within a short time, thus contributing to the general feeling of distrust and skepticism towards outside assistance felt by the community (Kunguru and Mwiraria 1991). A resident said that once some people came posing as health officers and took stool, urine and blood samples of herself and her children but they never came back to give her the results of the tests.

Co-ordination of NGO activities has been identified as one of the primary missing links between the NGOs engaged in development work in Kibera. Some NGOs involve themselves in a variety of activities which often overlap and sometimes bear conflicting messages to the community. Co-ordination with local authorities is also weak. Often NGOs seek help from local authorities or assistance before implementing a project but thereafter do not inform local government of their progress (Kunguru and Mwiraria 1991).

In order to co-ordinate activities among themselves, NGOs have formed co-ordinating committee which aim to resolve some of these problems.

Two NGOs which are of special interest in this study are: KWAHO and Undugu Society of Kenya.

#### Kenya Water for Health Organisation (KWAHO)

KWAHO was founded as an independent NGO in 1983 with full support and assistance from the Ministry of Water Development which initially provided it with office space, transport, materials and staffing assistance. Currently KWAHOs goal is improvement of water and sanitation in rural and urban communities through community mobilization. Community participation and ownership are important objectives of their strategy which aims to ensure that the community is involved in the planning, implementation and management of projects. A further objective of this strategy is to ensure sustainability of development activities. KWAHO has had notable success in the use of community participation techniques.

The specific objectives within Kibera have been to improve sanitation as a whole in the area as well as encourage income generating activities. Also included is training in construction and maintenance of water kiosks and VIP latrines and monitoring the progress towards the attainment of these goals.

With KWAHO's assistance, the community has been able to acquire a latrine emptying vehicle which can access difficult areas and service pits. The emptying vehicle is managed by a team of community members who try to cover all the villages on weekly basis. Residents pay KES 150 in advance for a full load. This fee is designed to cover operations and maintenance of the vehicle as well as the capital cost. This fee is half of KES 300 charged by the NCC for their exhaustor service.

Unfortunately in some areas this vehicle, though smaller than the NCCs exhaustor vehicles, cannot operate due to lack of access. Also the officials operating the vehicle sometimes overcharge for the service hence making the residents resentful. However, in general KWAHO has achieved considerable success (Kunguru and Mwiraria 1991).

### Undugu Society of Kenya

Undugu Society of Kenya is a non-governmental organization engaged in community development activities in Nairobi informal settlements.

The overall objectives of the organization are to enhance the socio-economic status of people in low-income areas through an integrated approach to community and small scale business development as well as to enhance the sense of responsibility in low-income areas for their own development. Non-financial assistance is provided to other organizations that are involved in similar activities.

Their main area of operation is Lindi and they are conducting an integrated project involving water, housing, sanitation, education and business sectors. Undugu has prepared detailed plans for low cost housing which are based on the use of cheap building materials and techniques, and take into account the problems facing Kibera which include the land tenure system, the hostile relationship between tenants and landlords, and the regulatory framework which only allows construction of temporary housing (Kunguru and Mwiraria 1991). Like KWAHO, Undugu Society of Kenya has a strong base in Kibera slum area.

NGOs are important groups acting as links between the various participating groups. Depending on the amount of respect they have from the slum dwellers, the administration and the government ministries they can accomplish much. The main thrust in a slum upgrading programme is not so much the quantifiable output in terms of so many pit latrines or so many water kiosks, but rather to enhance the public health awareness of the residents. Once they learn to appreciate high standards of public health willingness to pay for services will increase. NGOs are useful in providing the necessary public health education and awareness.

#### 4.5 Politicians

Generally, politicians are primarily interested in extending and consolidating their ability to rule. They perceive slum infrastructure as an effective way to assist the poor visibly without incurring vast public expenditures and without alienating the support of the middle class or the land-owning group (Angel 1983).

They have to reassign themselves gradually to the cancellation of public construction programmes and to the development of slum upgrading and sites-and-services programmes in stead. Regarding the land issues they prefer programmes that do not fundamentally change the status quo. While they perceive slum upgrading to be both realistic and fashionable, it fails to excite them as it clearly lacks the lustre and the substantial personal and political benefits that accrue from massive construction projects (Angel 1983).

Some of the past Members of Parliament have tried to raise the issue of Kibera in the Parliament but nothing much has yet been accomplished. It is difficult for a politician to manage to please both the landlords and the tenants in Kibera as their interests are so conflicting.

Politicians, like all the other groups of participants are very important. The way they perceive and say something is very important as they play an important role in opinion development. Many of them are also very good organizers and could set projects going in the right direction.

#### 4.6 External Support Agencies

The External Support Agencies (ESAs) who are primarily concerned with disbursing capital for development projects, see such programmes as a means of providing international assistance which can reach the poor. For them such programmes are appealing because of their low capital expenditures, and because they do not want to distract attention from rural development efforts. To them, these projects can be justified economically as generating increased property values in improved areas, over and beyond the initial capital investment in infrastructure. Cost recovery for sustainable development is their motto (Angel 1983).

Many ESAs e.g. UNICEF have been active in Kibera. The ESAs are keen to finance slum upgrading programmes. The ESAs, while they provide the necessary financing to overcome sanitation problems, should be only facilitators. Their advice though invaluable should not be a condition. The community and the government should be the most important players in these programmes to benefit the urban poor.

## 4.7 Kibera dwellers and community participation

### 4.7.1 Kibera dwellers

The community dwellers are primarily interested in not getting hurt by high-handed government intervention and see infrastructure programmes as an effective way of getting something out of the government, which is clearly better than nothing, but still falls short of what they can see as possible to have. They cannot understand why they should pay for infrastructure, yet the government provides it free in richer suburbs and then the beneficiaries pay monthly charges on the services. On the other hand these programmes are beneficial to them as they can expect tenure and maybe land titles with the programme (Angel 1983).

The low-income families have the financial capability to pay for basic urban services and therefore increased coverage by the municipality would be cost effective provided that the costs are within their means. They are capable of forming their own management groups for the efficient dispatch of these services if required to do so. Women involvement as well as other groups in the areas is advocated as they are more receptive to community development activities (Kunguru and Mwiraria 1991).

Local organizations within the community may be equipped to handle activities related to programme design and maintenance effectively. A study of their capacity will show the feasibility of such alternatives (UNCHS 1989a).

The study carried out in Kibera found that the residents are willing to pay for the provision of basic services. Ability to pay was a different issue. While some of the residents have the financial capacity to pay for the capital costs involved in the provision of infrastructure, many of them cannot afford to pay. Majority of them can afford to pay rate such as water, sewerage and dustbin rates to the NCC if the services were provided.

It was found that there were several people without regular jobs within the community, especially women. Also many of the residents worked in shifts. Many of these people were willing to contribute labour for the improvement of sanitation in Kibera. Even those in regular employment were willing to contribute both labour and some money.

### 4.7.2 Community participation

A community based upgrading programme consists of several phases, from the initiative to the design, through the planning, financing and construction to operation and maintenance. In all these stages the involvement of the community is a key element to ensure a successful project. When the community is fully informed through all the stages of the project and has contributed to the project within a wide range of proposals and activities, then the project will attain a high degree of commitment from the beneficiary community (UNCHS 1989a).

Adopting a community participation approach in an upgrading programme may require quite some changes to the existing infrastructure and organizational structures. At the level of the community, organizational and technical skills have to be developed. At the level of the relevant authorities e.g. of NCC, personnel will have to be trained in participatory activities and at the national level, organizations may need restructuring to incorporate a community based strategy. At all these levels, the commitment to involve the communities genuinely in development projects must exist.

Training and education at all levels is required to ensure a successful implementation of participatory community projects. Various types of participatory training can be distinguished: technical training, communal organization training, administrative training, user education and health education (UNCHS 1989a).

#### Participation in project initiation

Slum upgrading can be initiated either in total or in part by the government, local or foreign agencies, politicians or the community itself. Whoever is the initiator matters, but in the long run, of most importance is how the idea is sold to the community if the community is not the initiator (UNCHS 1989a).

#### Participation in planning and design

This is the stage where the project is defined in detailed technical and organizational form and where choices are made between the various options for each project element. Planning of mobilization of materials and labour is done at this stage. All the information collected from the dialogue with the community should in principle be used for planning adaptations and evaluation (UNCHS 1989a).

Traditionally, planning of low-income community projects was restricted to engineers only. Sometimes a financial analyst was included, but rarely economists, behavioural scientists or the community members themselves. The process of consultation with the users requires time and the recruitment of additional personnel, but the returns, in terms of reduced resource wastage, outweigh the implied increase in planning costs (UNCHS 1986).

#### Participation in construction

The community can contribute to physical construction works in different ways. This could be in a way of voluntary labour or carrying out all the construction work by community members on a paid contract basis. Depending on the situation and community organization, different levels of community participation can be obtained (UNCHS 1989a).

When a community is involved in the construction process, it will feel responsible for maintaining the facilities afterwards. It is also easier to maintain and repair the facilities, since the community has been directly engaged in the construction works, which gives more understanding of the systems. In an area like Kibera, there are many people, even tenants who are willing to contribute both money and labour for upgrading of the settlements. In ordinary construction projects it is estimated that the cost of labour is about 30 % of the total cost of the project (Kenya 1990/91). In slum upgrading this figure may be about 50 % if community and bought labour are quantified in monetary units.

#### Participation in operation and maintenance

The participation of the community in operation and maintenance (O&M) of an upgraded slum settlement is vital for smooth functioning. Community participation at this stage requires well organized financing and communication with the authorities, for instance for the regular supply of spare parts and other services (UNCHS 1989a).

#### Participation in financing

Four potential sources for funds exist; government/municipal budgets, foreign loans, institutional funding within the country, and communities themselves.

Municipal taxes, assessed on the size and value of the property being served, are the usual sources for water, drainage and solid waste disposal investments. Low income communities, because of their illegal status pay no municipal taxes and this has been used as the principal argument against providing these communities with municipal services. Issuing title deeds or at least a declared intention to provide title deeds is necessary before municipal revenues may be derived from these communities (UNCHS 1989a).

Participation of the beneficiaries in the financing of the project is far-reaching as it may commit low-income families for many years. Financial arrangements between the beneficiaries and the project should therefore be kept as simple and as flexible as possible, so that they can easily be adopted to the wishes, needs and resources of people.

Although the development costs of a community upgrading programme should by definition be kept low, the beneficiaries are generally not in a position to pay all the costs from their own resources.

Beneficiaries are only willing to pay if they receive what they want; in other words the project should meet the most urgent needs and priorities of the beneficiaries. It is therefore necessary that the beneficiaries are involved in the planning of the project and the selection of the technology (UNCHS 1989a).

Proper organization is required for financial management. It is important to have strict accountability and transparency in the management of community funds. Also favourism of any kind must be avoided. Community funds must only be committed to those ventures that are well planned and whose chances of success are very high. A good plan of how funds can be disbursed and repaid need to be well studied. Collection of rates is another sensitive area, especially when it comes to penalizing of defaulters.

#### Project monitoring and evaluation

Monitoring and evaluation is an essential part of an upgrading programme. It is a continuous process that start with the commencement of the project and continues up to the operation and maintenance phase. It is important to study the effectiveness of construction, cost and service, social, economic and health impacts. It supports the call for improvement of community participation and education (UNCHS 1989a).

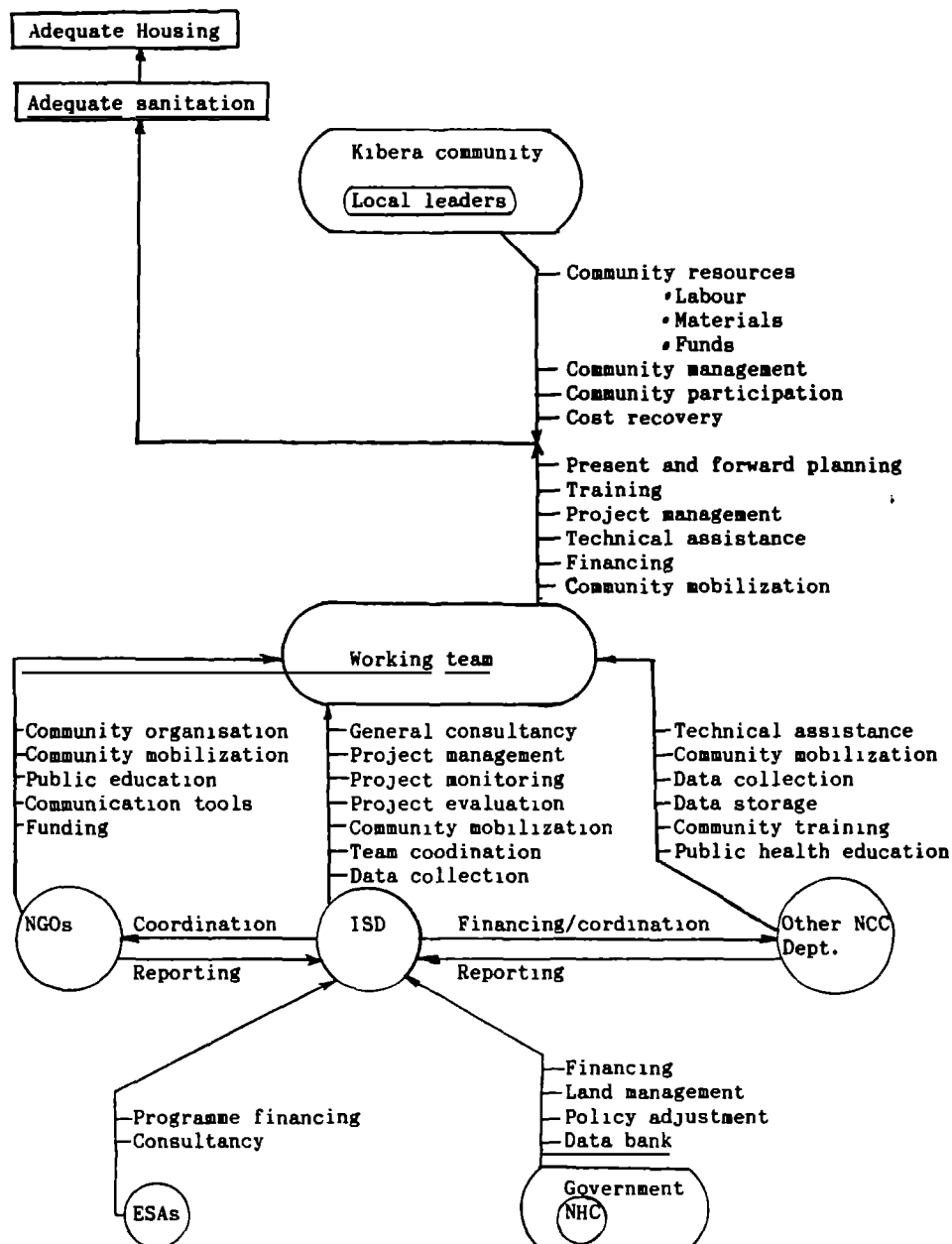
#### 4.8 Mode of interaction and intervention

One of the main causes of modest development in Kibera has been the lack of cooperation amongst the possible participants in Kibera upgrading. Cooperation between the various interested parties in Kibera is vital for the success of a Kibera upgrading programme. One important aspect in Kibera is that the population is a very large one, over 450 000 people. The institutional requirements to handle such a project are tremendous. Towns with municipality status have such populations or less. There is a need to have a well functioning institution to oversee the developments in Kibera. The NCC of NHC are best equipped to form this institution which will be the nucleus for all the other participants in charge of upgrading Kibera slums.

The proposed Informal Settlements Department (ISD) within NCC ideally should be an independent department to oversee the developments in informal settlements as well as to act as the financier. It should be a kind of consultancy unit consisting of community social workers, engineers, architects, planners and administrators. These professionals should be able to co-ordinate other relevant departments like Water and Sewerage, Housing Design and Development, City Engineers, City Planning for optimum manpower and financial resources utilization. It could also help in coordination of activities of NGOs so that projects are not duplicated or overlapping.

The role of collective responsibility must be realized and accordingly the need to involve the community in all aspects of the development in Kibera. This also includes cost recovery. The role of collective responsibility calls for cooperation between the seven participants discussed earlier in this chapter. A participation chart has been designed specifying a possible mode of interaction amongst

the participants. This is presented in Figure 18. The arrows in the figure indicate cooperation between the agencies and not relinquishing of duties.



**KEY**

- Activities
- ▭ Objectives
- Participants

ISD Informal Settlements Department  
 NCC Nairobi City Commission  
 NGOs Non-governmental Organisations  
 ESAs External Support Agencies  
 NHC National Housing Cooperation

Figure 18. Proposed participation chart.



## 5 SANITATION ALTERNATIVES FOR KIBERA

The process of selecting technology begins by identifying all the technological alternatives available for providing the goods or service desired. Some technologies may be excluded on the basis of technical, health or social reasons. The remaining alternatives are subject to Worth/Cost analysis. The alternatives clearly beyond the affordability for the consumer are excluded. Those alternatives which have passed technical, health, social and economic tests are presented to the community with their corresponding price tags, and the users may decide the level of service they are willing to pay for (Kalbermatten et al 1980).

### 5.1 Preambles to provision of adequate sanitation

#### 5.1.1 Planning

One of the weakest elements of settlements management is forward planning. As mentioned earlier, planning is crucial, even when letting squatters to squat in Kibera or in any other squatter settlements. The local administration allocates squatting space to squatters, and this should include some planning.

Planning would make sure that wayleaves are left behind to facilitate access, building of service lines such as sewerlines, water pipes and drainage. Educating the community on the need to preserve these wayleaves will ensure their existence. Since the past developments have been mainly unplanned, it is good for any new developments to make sure that they are planned. It is also possible for the local administration to halt the growth of Kibera albeit temporarily.

Low income communities are normally excluded in Sector Planning hence an *ad hoc* approach is applied to provision of basic infrastructure in informal settlements (UNCHS 1986). It is imperative that the government and its organs recognize the existence of low-income settlements, both in writing and in actions. Only then can a good solution be obtained to the sanitation problem in Kibera. The permanency of Kibera must also be realized. During planning for provision of services in the city e.g. water supply, the demand in Kibera should be considered and designed for.

Unplanned settlements have gone out of control in the past because the government refuse to accept their permanency. They could have been planned earlier. Now Kibera population has already grown, and any planning for Kibera must be done with the full participation of the residents in order to achieve any sustainable development within the area. It is imperative to have a map of the area.

This type of planning needs to be included in the municipality overhead costs. The costs need to be charged as land and survey fees and rates directly from the individuals concerned.

### 5.1.2 Access

For any sanitation method to succeed there has to be adequate access within the village. Although provision of access was beyond the scope of this study, it is a basic and paramount requirement. Through adequate access pit-latrines can be emptied, solid waste can be transferred, water supply lines can be constructed and serviced, emergency vehicles like ambulances, fire fighting trucks can be driven etc. A lot of water is normally wasted when NCC repair crews cannot locate water leaks within the area. Also it is easier to construct service lines along well mapped access roads. When new roads are constructed, some of the houses have to be demolished. However, the number of such houses should be kept minimum. A survey of the estate has shown that landlords are willing to sacrifice some rooms without compensation.

In the provision of access, the main roads in the estate should be retained as much as possible. Even the major pathways should be retained but widened. A survey comprehensive of the area should be carried out and good access roads demarcated. These access roads should also be named and numbered so that they can easily be referred to on a map and on the ground.

The access roads could be lined with any stabilized road pavement materials. Major access roads could be as much as 6 m wide but the minor ones could be as narrow as 2 m. Obtaining a map of Kibera with all the existing and proposed main access roads and paths was beyond the scope of this paper and hence will not be dealt with further. It must be noted though that access is an immediate need of the residents of Kibera and a prerequisite to any successful sanitation works in Kibera.

Most of the labour needed for this work could be obtained within the village. The landlords could do the required demolition themselves and most of the residents may be willing to help in the road making. The residents to contribute labour willingly must be actively involved in the decision making aspects of the project. The residents are very much aware that access is a vital necessity. When the interviewees were asked if there was anything else they would like to add, 6.5 % said they would like to have improved access.

Financing of this aspect of settlement upgrading can be done by the agency initiating the project. Subsequent cost recovery can be realised through charging of land rates. Community participation is highly recommended in all the phases of the project as up to 50 % reduction in project costs can be estimated.

### 5.1.3 Land tenure

The problem of land tenure is a serious one. The squatters are actually squatting on the government land, earmarked for development of middle income housing. The descendants of the Nubians who initially settled in Kibera believe they have a right either to the land in Kibera or in an equal settlement. The non-Nubian landlords also believe that the government owes them land either in Kibera or elsewhere in Nairobi as they are the government's poor. Some of the landlords earn their living only from renting out the rooms. Other landlords are very wealthy and live elsewhere in Nairobi. There are more than about 450 000 tenants who live in Kibera simply because that is one of the places they can afford.

The granting of outright ownership to landlords has proven to be quite unsuccessful in many cases (UNCHS 1981). If security of tenure is provided to the landlords in Kibera the same what is happening in Mathare, Ngei I, Ngei II and Baba Ndogo could occur. These later settlements unlike Kibera were on private land. Land tenure issues were solved for at least a part of Mathare slums, and landlords are demolishing most of the slums and constructing multi-storey buildings. These buildings will be going for high rents as found in the free market private housing. The slum tenants will have to move to other slums within the city. While this may have solved part of the housing problem in the city, problems for the many low-income tenants have still not been entirely solved.

Since Kibera lies on public land, the land tenure should be provided to the tenants. This can be done in several ways. The tenants need not be allocated the plots but they could be guaranteed no rent hikes with the improvement of sanitation in the area. They should also be guaranteed non-eviction from the premises. A solution to absentee landlords should be searched for. A landlord squatter if genuine should at least stay with his tenants and should be able to attend meetings to discuss the plight of the area.

The government through its local authorities leases municipal land to individuals or groups. The individual or group need to pay some nominal fees for the allocation and for land rates per year. The amount paid per year is normally quite little and most low-income people can afford it.

### 5.2 Water supply

At the moment not only Kibera has unreliable water supply, there is an acute water shortage in the whole city. Still Kibera is more so affected since adequate water supply design has never been carried out for the slum area in the past. This has been aggravated by the rapid increase in population.

Nairobi City Commission has always had a surplus in its water account and this has been used to subsidize other services (Odipo cited by Odada and Otieno 1990). Yet most of the spontaneous settlements are poorly supplied with water. The City Commission provides stand-pipes and charges for water at a rate lower than the usual, but water vendors sell at three to ten times the usual rate. The average cost of water is 66 cents per 20 l container (KES 33 per cum).

### Possible improvement of water supply

Figure 3 shows that most of the residents (39 %) prefer yard tap connection to water kiosks as an improvement to water supply. Table 3 indicates that more people prefer a higher level of service than reduced price of water. A high percentage of residents would also prefer increased reliability of water supply.

Table 3. Recommendations to improve water supply.

Recommendations	Interviewees	
	Number	%
Reduced price	214	21
Yard tap	409	39
Increase reliability	312	30
No suggestions	109	10

In order to have a reliable water supply in Kibera, it is important that NCC recognizes Kibera as part of the city. It should also recognize the dwellers right to a reliable and safe water supply especially when the residents are able and willing to pay for the service. It is also a right of the residents who can afford a yard connection to obtain it.

It is not disputable that Kenyans have the idea of free market prices and in many instances gross advantage is taken from the public's ignorance or monopoly. Most of the people owning the water kiosks are entrepreneurs bound with maximization of profits. In the villages where water was more abundant and reliable the prices were lower.

The price of water should be lower perhaps allowing the residents to use more water. Although there is no proved relationship between health and per capita consumption many diseases are eliminated by higher levels of personal hygiene (WHO 1989).

67 % of the residents said they would use more water if the price of water would be lower. With cheaper water the average consumption would be 120 l per household per day. If the average size of household is 4 members, then the consumption would be about 30 l per capita per day. Present and future water demand are presented in Table 4.

Table 4. Water demand/supply.

Demand/supply	Water consumption l/capita/d
Present	22.5
Future demand with reduced cost of water	30

Many of the water kiosk owners have had to construct long stretches of water pipes in order to obtain their single water-point. This is because the City Commission main water pipes are so far. No wonder they charge such high prices for the water in order to cover their capital costs. NCC could build larger diameter water mains in the area so that residents only need to construct short distances of small diameter pipes. This will realize economies of scale and more people will be able to apply for water kiosks. Hence monopoly will be reduced and the price of the water will eventually be lower because of the natural market forces. Of course the price will never go as low as that stipulated by the City Commission but it will go low enough as more and more plots have their own water points.

Landlords could be requested to buy the necessary water pipes and the tenants if approached well would be willing to contribute labour on condition that the house rents would not be increased.

According to a NCC/UNICEF sanitation project - Child Survival & Development Project - Kibera low-income area - the agreement on water supply for Kibera was that NCC would provide technical advice on the project. Nairobi City Commission was to provide all pipes 100 mm diameter and above while the UNICEF was going to provide 75 mm pipes and below for the community. Community participation was to be mobilized all along the project. Unfortunately the project had to be stalled due to inadequate supply of water to Langata area where Kibera is. This project is to be applauded and with the completion of the Third Nairobi Water Supply project, it is hoped that the project will continue.

Kibera should be included in the design of the project before it is over to ensure adequate supply in the area. Nairobi City Commission needs to provide a main water reticulation system to Kibera and the Government needs to give at least periods of Security of Tenure to ensure Nairobi City Commission that the investment will not be wasted before realization of the capital cash outlay. NCC is encouraged to involve the community and NGOs in the project to use the community resources as well as to lower the costs.

### Financing

Nairobi City Commission should look for funds to be able to provide the water reticulation. It is expected that many landlords especially resident ones will be willing to have individual connections on their plots. Hence they will finance the operation themselves.

External support agencies could help the dwellers to have water connections to their plots. The idea of UNICEF assisting women groups to get water kiosks was a very good one. However, the price of water did not go low enough in the water kiosks owned by women groups. A price of 60 cents for a 20 l jerrican is still 6 times more than the price the women pay for the water from the City Commission.

Cost recovery will be executed so that the residents pay water bills monthly.

### 5.3 Excreta disposal

Field studies in Kibera indicate that the residents mainly complain about overflowing pit or collapsed latrines, poorly maintained and badly used latrines. Some of the residents complain not having any latrine at all. 45 % of the interviewees say they are not satisfied with the distance to the latrines.

Table 5. Recommendations to improve excreta disposal.

Recommendations	Interviewees	
	Number	%
More pit latrines	161	15
Good maintenance	150	14
Conventional sewerage	360	35
Public health education	7	1
No recommendations	364	35

The highest percentage 35 % of the residents preferred conventional sewerage system. While a large majority had no recommendations to improve the situation in Kibera, 29 % preferred either construction of more pit latrines or better maintenance of the existing ones. 1 % of the residents recommended that public health education would improve the use of the existing facilities.

#### Possible excreta disposal alternatives

Factors affecting choice of excreta disposal technology include:

- physical environment
- level of water supply service
- housing density
- complementary investment
- potential for home-owner construction
- hygienic habits of users
- institutional constraints
- users ability to pay

All sanitation projects should serve as much of the population as possible within the shortest time possible in order to maximize health benefits (Sinnatamby 1983 cited by Vines et al 1989).

A very high percentage of interviewees (35 %) prefer conventional sewerage system. Also a similar percentage is satisfied with the existing system of pit latrines. 15 % of the interviewees would like construction of more pits and another 14 % would like well maintained pit latrines. These are probably those who do not have any at all.

#### Conventional sewerage system

Conventional sewerage investment costs per household in eight major cities in developing countries have been reported to range from USD 600 to USD 4 000; the annual cost of this system (including the cost of water used for flushing) was observed to vary between USD 150 and USD 650 per household; whereas the total annual household incomes in the same countries were reportedly less than USD 500 and often less than USD 200. (Kalbermatten et al 1982 cited by Vines et al 1989).

Therefore for the great majority of the urban poor, the cost of the system is not proportional to their income, to the value of their property and to the priority they place upon sanitation compared with other services (Pickford 1979 cited by Vines et al 1989).

If well operated and if water supply is sufficient it is an answer to many engineers problems in terms of convenience and solution to excreta disposal problems (Harpman et al 1988).

There is a sewer line crossing through Kibera villages (Figure 1). The diameter of the sewer line is 450 mm and it is connected to a 675 mm diameter main sewer pipe. These sewer lines are not adequate to serve the Kibera population of over 450 000 people. In order to construct further reticulation within Kibera a duplication of Kibera trunk sewer would be needed. Therefore sewer reticulation for Kibera cannot be an immediate solution to the excreta disposal problem. The capital outlay is too big for the near future. In the long run, when land tenure problems will have been solved, this will be one of the possible solutions considering that the population density in Kibera is 100 000 - 250 0000 persons/km<sup>2</sup>.

### Small bore sewerage system

Small bore sewers have been used successfully in Australia and USA where they have shown considerable savings over conventional sewerage systems. They are designed only to receive the liquid part of household wastewater for off-site treatment and disposal. Grit, grease and other troublesome solids which might cause obstruction of the sewers are separated in interceptor tanks installed upstream of every connection to the sewers. The solids which accumulate into the tank are removed periodically for safe disposal. Stormwater is excluded from the system. The layout is shown in Figure 19 (Otis and Mara 1985).

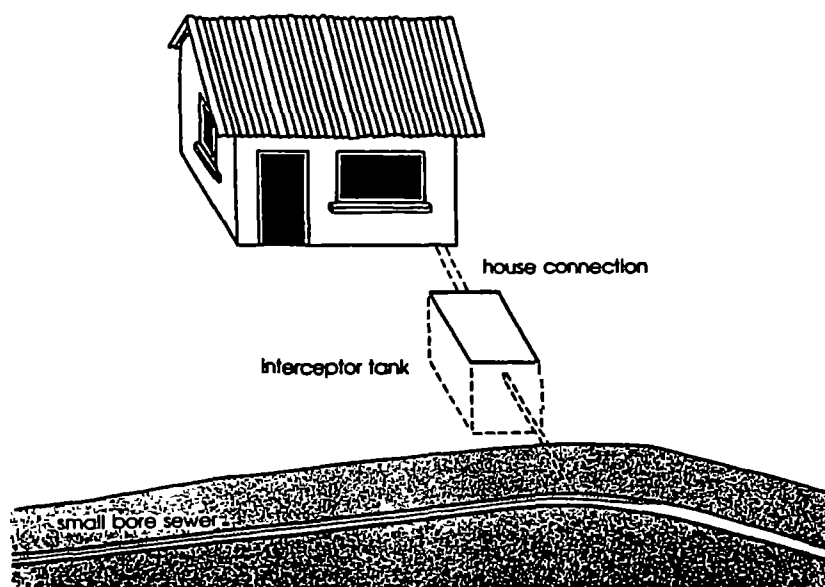


Figure 19. Schematic diagram of small bore sewer system (Otis and Mara 1985).



Advantages of small bore sewers include;

- 1) Reduced water requirements (30 - 80 l/c/d)
- 2) Reduced excavation costs
- 3) Reduced treatment costs
- 4) Reduced material costs
- 5) Can be applied in upgrading on-site sanitation systems such as pour-flush latrines when changes in water use, housing densities or other conditions occur leading to difficulties in on-site effluent disposal.

Disadvantages include:

- 1) Need for periodic evacuation and disposal of solids from each interceptor tank in the system.
- 2) Need for strong organization for effective operation and maintenance. There is need for the organization to exercise control on illegal connections which might be done to the system without adequate interceptor tanks.
- 3) If pumping stations are required within the system, costs are considerable and conventional sewerage could be a better alternative (Otis and Mara 1985).

Small bore sewers have been implemented in Nigeria and Zambia. Unfortunately these have performed very poorly. Some of the reasons cited for this are poor maintenance. The current position in Zambia is that most planners and engineers are unenthusiastic about them because they are prone to institutional neglect (Vines et al 1989).

The capital outlay of small bore sewers is still comparably high. Due to the experience of other African countries in this field, and because the experience in Kenya with this system is very limited, small bore sewers will not be advocated in Kibera. Funds from the low income communities are very precarious and should not be invested in the systems whose probability of failure is high.

#### Shallow sewers

In areas where population densities exceed 25 000 people per km<sup>2</sup>, and large heavy vehicles are unlikely to pass through, shallow sewers can be installed. The only difference is in the minimum cover to the sewer lines. A cover of 250 mm on a 230 mm diameter pipe and 325 mm on a 150 mm diameter pipe have been installed in North-East Lahore in Pakistan and they are operating efficiently. Large manholes are not required due to the shallow depth. Shallow sewers have a considerable saving compared to conventional sewers (Tayler 1990). Figure 20 shows the layout of shallow sewers and conventional sewers.

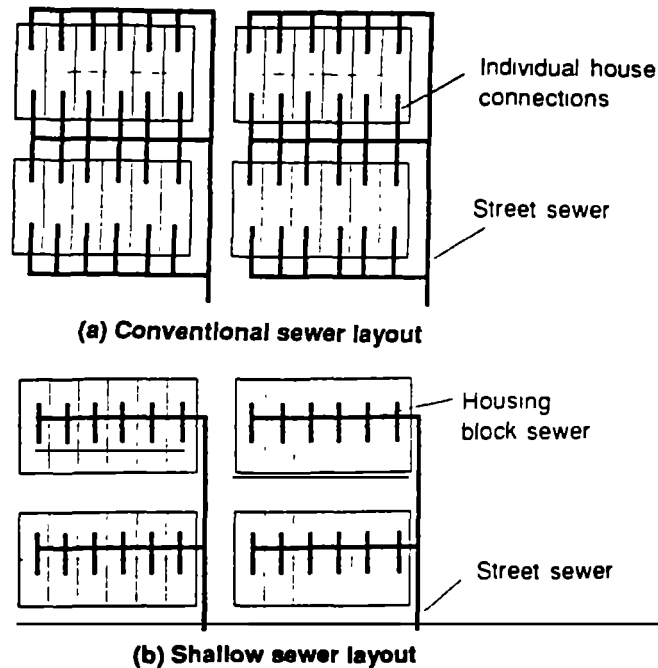


Figure 20. Schematic layout of conventional and shallow sewer systems (Vines and Reed 1990).

Shallow sewers are already existing in several areas in Nairobi. Compared to conventional sewerage shallow sewers require more maintenance. This is due to the frequent blockages. Shallow sewers will be considered in the long term solution for Kibera sewerage, because vehicles will not be expected to be passing on the access roads very frequently.

#### Traditional pit latrines

This is the most common form of excreta disposal system in Kibera. Normally they are very poorly maintained. This latrine is used in many parts of the world and construction involves digging a pit about 1 m wide, 2 m long and 3 - 4 m deep. The super structure is constructed using simple locally available materials. When the pit is full another one is dug and new shelter built above it.

For efficient operation the soil must be deep, stable and permeable and the groundwater table must be lower than the depth of the pit. These conditions are often overlooked resulting in pit collapse, especially when heavy rains have destabilized the soil. Large scale mosquito breeding results when liquid matter accumulates in the pit because of soil impermeability or high groundwater table. Breeding of flies and hookworms may also occur. The odour from the pit may be extremely offensive. The lifetime of the pit is often a few years.

Under favourable conditions, the pit latrine can be an excellent solution to excreta disposal. In Omduema in the Sudan there are latrines which have been in operation since time immemorial. Some of the pits are 20 m deep. But this is a rare exception (Winblad and Kilama 1980).

If the pit latrines could be emptied efficiently in Kibera, they could provide a good enough solution temporarily to the excreta disposal in Kibera.

#### Ventilated improved pit latrine (VIP)

This is an improved version of the traditional pit latrine. Figure 21 shows that the pit of the VIP is slightly offset from the superstructure to permit the installation of a vertical screened vent pipe. Both fly and odour nuisances are controlled by the vent pipe; in all other respects, VIP latrines are similar to traditional pit latrines. Some recent developments allow for double pits as well as making the pit emptytable so that the latrine can have a permanent structure (Mara and Morgan 1982).

For maximum odour control, the vent pipe should be at least 150 mm in diameter, painted black and located on the sunny side of the latrine so that the air inside the pipe will heat up and create over-drafts. If the vent pipe is letting enough light into the pit, and if the superstructure is fairly dark, flies will try to escape through the vent rather than back into the super structure. Covering the vent pipe with a gauze screen will prevent the flies from escaping through that route and thus minimize the health hazards from the insects (Kalbermatten et al 1980).

It is important to keep sullage away from the VIP latrine. Also closing the squatting hole is not recommended as free circulation of air should be ensured. Pit latrines are most suitable in low and medium density areas - about 30 000 persons per km<sup>2</sup> (Kalbermatten et al 1980).

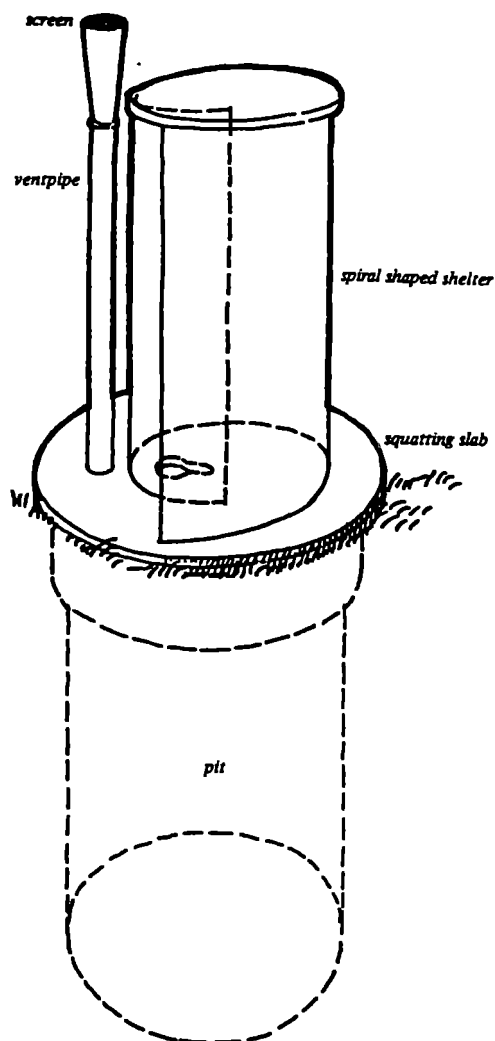


Figure 21. Ventilated improved pit latrine (Winblad and Kilama 1980).

There are several VIP latrines within Kibera. They are normally built by NGOs. They perform relatively well although they too have to be emptied frequently. In most of the cases they are built for institutions. The cost of building a VIP latrine is relatively high considering the materials used in the cubicle construction. Possibility of emptying of latrines could encourage more construction of these toilets.

The only big problem of VIP latrines is that with the population density in Kibera, pit latrines are no longer a technically feasible means of excreta disposal. VIP latrines should be able to handle population densities of a maximum of 35 000 people per km<sup>2</sup> after which they not only become technically unfeasible but also financially unviable.

### Communal latrines

Communal toilets are not well maintained except when an attendant is paid to keep them clean and in good order. In Patna in India, an attendant is paid from the revenue of a small usage charge, and distributes a small soap to each user. Lighting and water supply can also be provided (Harpman et al 1988). Considering the high population density in Kibera and the poor economic status of the residents, communal latrines offer a good alternative to excreta disposal.

Mathare informal settlement, one of the few sewered slum areas in Nairobi with communal toilets is sometimes used to discredit communal toilets. The communal toilets in Mathare perform extremely poorly. Generally the toilets are blocked and there is always an overflowing manhole in the area. The blame does not go to Nairobi City Commission operation and maintenance staff, but rather to a myriad of factors. The toilets have been vandalized so that many of the taps and valves missing. Big objects normally get into the sewer lines, causing blockages. The daily use of the toilets is very poor with excreta strewn all over. The community needs to be trained on the effective use of the toilets. An automatic flushing system ought to be used so that adequate amount of water is always available for flushing the sewers. Residents should also be controlled not to build on the sewerlines or on manholes by the administration which has a lot of control in the area. With adequate training and education communal latrines is a possibility but it needs to be studied further in Kibera.

### On-site sanitation versus off-site sanitation

Given the economies of scale to all pipe networks, the household cost of water-borne sanitation becomes less expensive as the density of population increases. Depending on site condition and on the sewerage design, there will be a watershed population density above which a reduced cost sewerage is cheaper than on-site alternatives. For certain sites in Brazil this figure is as low as 16 000 people per km<sup>2</sup> when the sanitation alternatives under consideration were shallow sewers and twin-pit latrines with a soakaway. (UNCHS 1986 quoted by Vines et al 1989). Figure 22 compares the costs of different types of excreta disposal technology against population densities. In the case of Kibera, the very high population density favours shallow sewerage systems.

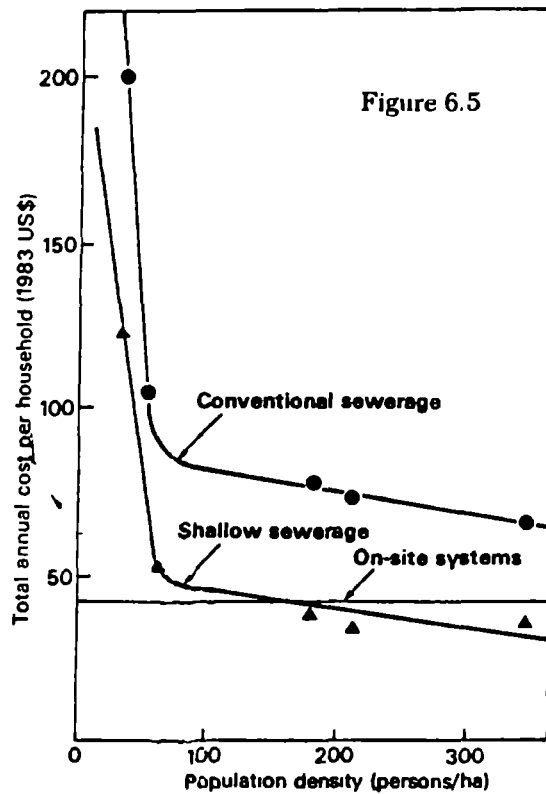


Figure 22. Comparison of total annual cost per household (TACH) for various types of excreta disposal technologies against population densities (Sinnatamby 1983).

#### Temporary solution to excreta disposal

A temporary solution to excreta disposal in Kibera is to provide access or exhauster vehicles to empty the pit latrines. Subsequently the administration could ensure that every landlord provides a latrine to his tenants by enforcing legislation. This alternative is quite expensive in the long run due to the constant emptying of the latrines. The KWAHO exhauster and the Nairobi City Commission exhausters will not be adequate to serve the whole community. Also it is quite expensive for the residents.

It was found that KWAHO undercharges for their exhauster service. KES 160 they charge only covers the maintenance costs. The exhauster vehicle was purchased at KES 900 000 in mid-1991. This is an extremely high capital expense considering that one exhauster is not adequate to serve the community. The Nairobi City Commission charges KES 350, which is quite expensive if it is charged more than twice a year. An NCC exhauster vehicle costs more than KES 4 000 000 today.

Therefore individual traditional pit latrines and VIPs are not a viable permanent option in Kibera. In the meantime the residents could be encouraged to build VIP latrines without necessarily using permanent materials for the superstructure. This would lower the costs considerably.

Permanent solution to excreta disposal

## Design data:

Total area	1.1 km <sup>2</sup>
Population	over 300 000 people
Population density	150 000 to 250 000 people per km <sup>2</sup>
Terrain	varied, sometimes rocky
Soil	medium permeability
Rock level	near the surface in some areas.

## Other design parameters:

Availability of water	medium
Ability to pay (capital costs)	low
Ability to pay (monthly rates)	high
Willingness to pay	high

Figure 23 shows a guide to selection of excreta disposal systems.

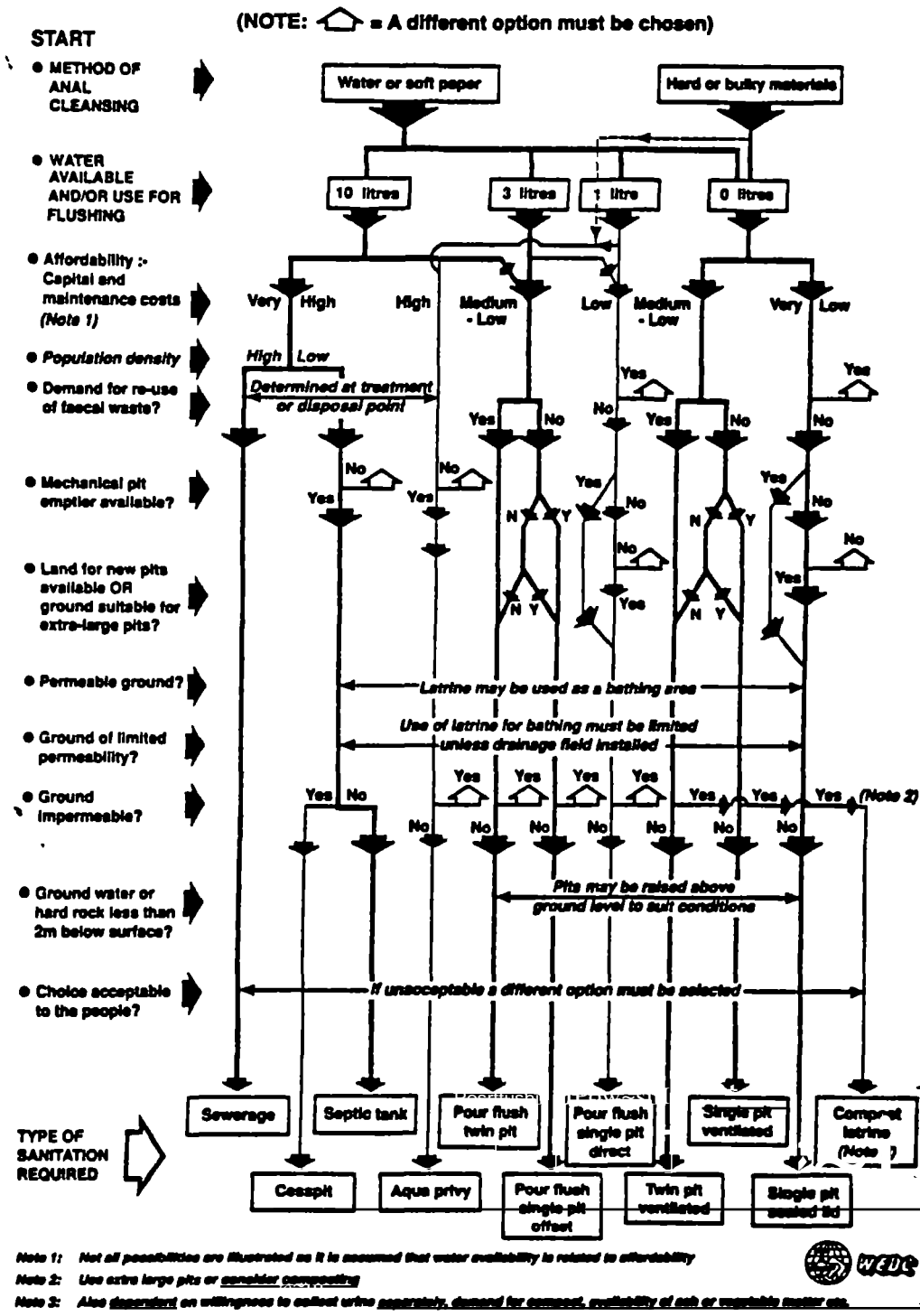


Figure 23. A guide to selection of excreta disposal systems (Cotton and Franceys 1991).



With the Kibera design data, it is impossible to recommend on-site sanitation system, since the population density makes on-site excreta disposal systems totally infeasible.

Apart from the water borne alternatives, the only other off-site systems are the bucket latrines and the vault latrine system. These two require very extensive institutional set-up. Their daily operation is also quite expensive. Such systems were used in areas like Makadara and Eastleigh estates, but they have eventually been phased out and replaced with conventional sewerage system.

Technically, according to Figure 24, the only solutions to the sanitation of Kibera is conventional sewerage. The low affordability in Kibera is not favouring conventional sewerage. Hence other forms of waterborne sanitation systems should be considered. These are either smallbore sewerage or shallow sewers. When interceptor tanks are included smallbore sewers could be more expensive. There is no need to place the sewers at very great depths, and thus shallow sewers could be a more viable option.

If shallow sewers are considered for excreta disposal in Kibera, then the Kibera trunk sewer need to be duplicated. Also some form of shallow sewer reticulation need to be constructed. A heavy capital outlay is implied but this seems to be the best option especially with the very high population density. To reduce the costs communal toilets would be a better idea than personal toilets.

The case of Mathare (discussed earlier) cannot be used to discredit sewerage communal toilets in all informal settlements. What is needed with communal toilets is an acceptable method of payment agreed upon with the community and a system of operation and maintenance. Several communal ablution blocks (toilets and bathrooms) designs are available with the NCC.

While the proposal should be studied further, private latrines and bathrooms (one latrine and bathroom per plot) could be better especially as this brings easier operation and maintenance as well as simplified cost recovery in terms of water and sewer rates. Private toilets need to have its own water connection. Those who have yard taps and can afford to build their own sewer connections should be encouraged to do so at their own additional costs.

It is important that the community is fully involved in the planning of the excreta disposal system. Only then it will be possible to estimate the resources that are available amongst the dwellers. Some form of tenure, either permanent or temporary (10 - 20 years or more) must be ensured to justify the heavy investments and to make the project viable.

The standard designs of ablution blocks available from the NCC can always be modified to suit the situation or individual toilets, a standard pour flush toilet with a low water capacity cistern is recommended. The bathroom

needs to be only a small private room. Shallow sewers require less water than conventional sewerage, although they require more routine maintenance.

Shallow sewers are recommended for excreta disposal. Either communal toilets or plot toilets can be constructed with the shallow sewers. In plot toilets, toilet-bowls of the type used in pour flush toilets are preferred. This is because they require less water to flush, although more care. These plot toilets can either be operated with low capacity water cisterns or manually.

#### 5.4 Sullage disposal and storm water drainage

58 % of the interviewees preferred unlined earth drains for sullage disposal and 75 % preferred unlined earth drains for stormwater drainage. 27 % recommended concrete drains for sullage while 25 % preferred the same for stormwater drainage. 14 % preferred dug pits for sullage disposal. This aspect of sanitation is difficult, because it is the most expensive sanitary service. Yet people are willing to pay very little for it as the benefits are not tangible. The community will need to be involved in all stages of the project in order to see the benefits from undertaking such a project.

While the community still depends on traditional pit latrines and VIP latrines for excreta disposal, a temporary solution to sullage disposal has to be sought. The sullage should be discharged into stormwater drains. The community should be told that they should remove any removable solid wastes from the sullage before discharge into the drains. Where the drain leaves the property, a wooden screen should be installed to retain the solids. These solids can be disposed with the solid wastes. The maintenance of the screens can be carried out by the plot dwellers.

Dug pits are normally used in Kibera to discharge sullage. Unfortunately the pits observed were badly maintained and posed a health hazard. In some areas KWAHO advocated that dug pits should be filled with stones to improve the effectiveness of this method. These dug pits were said to clog with time and the ground stopped absorbing the liquid waste. This alternative still needs further investigation and modifications.

In the long run, with the installation of shallow sewers connected to private latrines, sullage could be disposed through the sewer system. It will still be important that solids are removed as much as possible in order to reduce blockages in the system. If communal ablution blocks are installed sullage has to be disposed with the stormwater.

The residents who have no bathrooms prefer a bathroom while a majority of those who have one would prefer a better one. A remedy of this aspect of sanitation is discussed with excreta disposal.

Many low income communities in developing countries consider stormwater drainage their most urgent need as far as infrastructure is concerned. This is often because their houses are built on unsuitable land; on hillsides subject to erosion and landslides, or in low lying, marshy land subject to flooding (Cairncross and Ouano 1991). Without the proper management of stormwater to prevent flooding and ensure ground stability, many on-site sanitation methods are practically impossible (Harpman et al 1988).

Kibera has a mixture of many kinds of terrain. It has steep slopes, flat ground and even marshy areas in recent developments near the river. Slopes of more than 5 % can be considered steep slopes. Different types of slopes need different types of drains, and therefore different types of drains will have to be applied in Kibera depending on the ground conditions.

There are three basic options in the provision of stormwater drains; open channels, road as drain and pipelines. Open channel drainage networks are relatively easy to construct and maintain. The simplest open channel drain is hand dug, unlined ditch. Although there are limitations on its use, they are usually much cheaper than open channels lined with masonry or concrete. Open channel drains require a lot of space and pose a hazard to road users, especially if the drain is wide or deep, or passes along a busy thoroughfare. In such cases the drain can be covered with removable slabs (Cotton and Franceys 1991).

In densely populated settlements, paved roadways and alleys can be used to carry stormwater short distances to drainage channels; that is, water is deliberately allowed to flow along the paved surface and there are no channels alongside. This works where the surfaces are fully paved and well maintained. It is only applicable if adequate sillage disposal facilities exist. In general is not recommended other than for small, fully paved areas.

Buried pipeline drainage systems have regularly spaced inlets or gulleys along the roadside, through which stormwater enters the drains. This option is commonly used in many western towns and requires the road to be constructed and surfaced to a high standard. Serious problems arise if the pipelines become blocked (Cotton and Franceys 1991). This system therefore requires also an efficient solid waste disposal.

The principal problem in the design and implementation of drainage relates to the slope of the the ground. Difficulties are encountered on ground that is either flat or excessively steep (Cotton and Franceys 1991). In Kibera open channel drainage channels are recommended to the other two types as they are cheaper. They are also easier to maintain. Most of the residents interviewed prefer unlined drain channels for sillage and stormwater drainage.

In some areas in Kibera, there are landlords who have built cement lined drains in their compounds. These are extremely neat. In other areas drains are covered with foot bridges to facilitate movement across as well as to keep neatness. This should be upheld and encouraged.

Figure 24 shows a drain which can be implemented in Kibera. It is much better to have lined channels unless there are cost limitations. The width of the channel could be adjusted with variation in slopes. Ideally the drains will run from the property drains in the plots to the communal drains on the access roads. Each plot should be charged with the duties of maintaining the drains nearest to them.

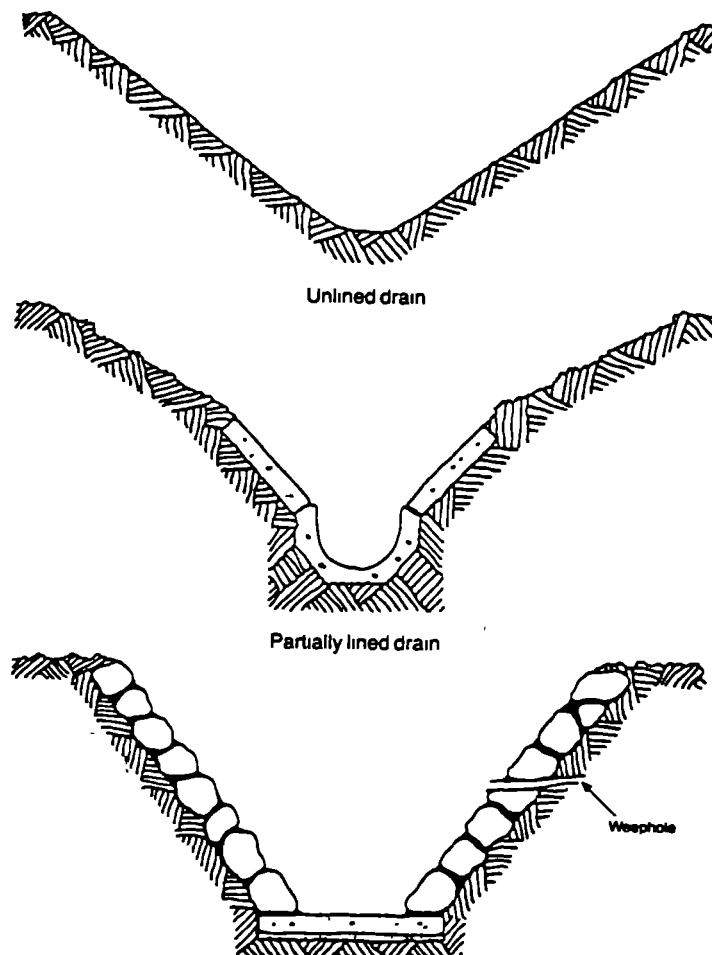


Figure 24. A lined drain (Cairncross and Ouano 1991).

### Financing

Drainage is a communal service from which everybody benefits. The recovery of capital costs and maintenance cost could be charged directly with the other land rates. The amount of the charge could depend on size of plots.

## 5.5 Solid waste management

When addressing the problem of solid wastes in Kibera, one must remember that Nairobi city has a big problem with solid waste management. In fact the sector has been semi-privatized in some areas especially in the high income areas. While it is a good idea, it adversely affects the service to the poor. They tend to be neglected, since they cannot afford to pay private investors and their influence on the local authorities is very limited (UNCHS 1989b).

Solid waste management is very difficult mainly because it is not a problem of only low income communities but of whole cities in developing countries. This is aggravated by the rapid urban population growth-rate and limited financial resources (Flintoff 1976).

Unlike other urban infrastructure, the major cost of solid waste disposal is in day to day operation, rather than in the capital investments. Whereas the central government or international agencies can help with finance for investments, the operation of a refuse collection system has to be paid largely from the municipal recurrent budget. Although a smaller amount of refuse is created compared to developed countries, the rate at which flies breed in the warm climates, and the mainly vegetable refuse of Third World cities means that collection has to be made more often, usually daily or three times a week (Flintoff 1976). Certainly the economic demands of developing countries require less capital intensive methods.

An effective refuse collection service requires good organization, and depends on the co-operation of the public. If communal rubbish containers are not regularly emptied, people will cease to use them. On the other hand, poor urban communities have been known to make remarkable efforts, even in sweeping their own streets, if they know that a vehicle will arrive at the agreed time to collect sweepings (Harpman et al 1988)

Many of the urban poor earn their living by recycling solid wastes, and often suffer from exploitation. They could benefit directly from the income generated by a neighbourhood manual composting unit, or from a guaranteed price for their recycled products (Harpman et al 1988).

Community participation in the field of waste disposal does not come easily and much consciousness is required in order to create a feeling of responsibility. It is not uncommon for slum-dwellers to keep their own houses very clean, yet, throw all waste into the nearest street (UNCHS 1989b).

Some of the key factors to address in solid wastes management in low income areas are collection options, transport choices, storage requirements, recycling, disposal and financing.

### Methods of collection.

There are four main methods of refuse collection; communal, block, kerbside and door-to-door collection.

Under the system of communal collection, households discharge their waste at predetermined locations containing some form of communal storage facility. Refuse collection vehicles visit these sites at frequent intervals, usually once daily to remove accumulated waste. The advantage gained from reduced number of sites could easily be eroded by use of large, widely spaced storage sites which need very high discipline from the users in order to maintain them clean (UNCHS 1988).

Under the system of block collection, a collection vehicle travels a predetermined route at prescribed intervals, usually once every two or three days, and stops at selected locations where a bell is rang. Upon hearing the bell, householders bring their refuse containers and hand them over to the crew, who empty them and hand them back to the householders.

Kerbside collection involves collection of refuse containers which are at the kerbside at fixed intervals. This take place usually twice a week in specified days.

In the door-to-door collection system, the collection crew enters each premise, takes out the container and sets it back after emptying the waste into the collection vehicles. Figure 25 compares the various methods of solid waste collection (UNCHS 1988).

Description	Communal collection	Block collection	Kerbside collection	Door-to-door collection
Householder co-operation in carrying refuse bins	Yes	Yes	Yes	No
Householder co-operation in emptying refuse bin	Yes	Optional	No	No
Need for scheduled service	No	Optional	Yes	No
Susceptibility to scavenging	Very high	None	High	None
Average crew size	1-2 (portable) 2-4 (stationary)	1-3	1-3	3-7
Complaints regarding trespassing	No	No	No	Yes
Level of service	Poor	Fair	Good	Good
Collection cost	Low	Medium	High	Very high

Figure 25. Comparison of various methods of solid waste collection (UNCHS 1988).

#### Temporary solution

In order to clean up the village, as a temporary measure, it is proposed to have a Kibera Cleanliness Day. This could be organized at least once a year. On this day, people are mobilized to clean their compounds and neighbourhoods. The rubbish collected could be taken to central points where it is sorted. Newspapers and other reuseable papers could be kept aside for recycling as well as tins and bottles. The rest of the waste could either be buried or burnt depending on the facilities available. The day could be graced by a few dignitaries like the local members of parliament. On this particular day, the NCC could help the residents by making available its refuse vehicles to collect away the rubbish. The residents themselves would use their own containers for cleaning on this day.

Subsequently it is important that an efficient system of solid waste collection is arranged in order to complement Kibera Cleanliness Day and also in order to motivate the people.

### Permanent solution

The waste is primarily composed of putrecible matter, such as vegetables and other foods, which in hot and humid climate decomposes yielding acidic compounds. Acids can cause serious problems of corrosion in collection vehicles. Therefore this has to be taken into account in vehicle design and operation.

The road network in Kibera is extremely poor. Vehicle transportation within the estate is virtually impossible especially during the rainy season. Hence collection vehicles, unless they are four wheel driven are impossible to use except on main tracks. Manually pulled carts seem to be the best alternative this area.

A separate study should be carried out on the composition of the solid. It should also give the waste generation rate per household or per individual as well as the weight density. Information about possibilities of reuse of some of the materials is also required. It is important also to find out the maximum distance that the dwellers are willing to take their rubbish. Normally the dwellers use their own small containers for this purpose. This should be upheld.

Out of the four collection methods outlined earlier, communal collection will be encouraged as it is the cheaper option. Community education and appreciation can raise the level of service considerably making the method quite efficient.

Community solid waste management mostly concerns primary waste collection (neighbourhood-wide collection and storage) and a management system, which administers and finances primary collection. Planned co-operation with municipal service agencies ensures a reliable transfer of waste from the primary to the secondary collection which involves dumping at a communal depot or where recycling takes place. It also concerns development of recycling activities within the community and the development of income-generating activities, through processing and upgrading of waste material and development of local industries, based on that material.

### Communal collection

Assuming the dwellers are able to take the materials to a central point with a maximum distance of 100 m from their plot. From these points people can carry the rubbish with manual carts or wheelbarrows or mkokotenis to peripheral points where municipal vehicles will come to collect the rubbish from.

About 100 collection points will be needed in the area so that the maximum distance to a primary collection point will be 100 m. These collection points should be on the main access roads. Collection from the primary centre, there will be two options:



- 1) Collection by NCC. Instead of taking the waste to other communal collection points, it is cheaper for NCC to collect the waste from these primary centres. Containerized depots would be the most economical system so that NCC picks the full container and deposits empty one on the site. NCC should search for another dumping site nearer Kibera, other than Dandora (Mukuru) which is far away in order to save on transportation as well as increase the efficiency of the solid waste collection vehicles.

Solid waste collection charges are normally paid with the water charges to the NCC in formal settlements. This charge is in the form of dustbin rent, about KES 10 per month. It is no wonder that there is no sustainability in solid waste management as the fee charged is too low. The difference is met through municipal taxes.

A system is recommended whereby costs incurred in solid wastes disposal service are directly met by the consumers. This should include the low income communities. The charges could depend on frequency of waste collection as well as class of consumer in order to simplify costing process.

Since the residents in Kibera do not pay land rates and do not pay for solid waste disposal, a system of payment should be discussed with the community. If on the other hand there will be yard tap connections to every plot, this charge could be included in the water bill. Full cost recovery is always very important as it is impossible to subsidize all the poor in Nairobi whilst they make up more than 50 % of the population. This proposal needs to be well discussed with the NCC and all the technicalities should be worked out.

- 2) *Mkokotenis* are hand-driven carts which are popular means of transportation in Nairobi. These can be used to transport waste from the primary collection centres to the treatment areas. A specially adapted mkokoteni can wait at the primary depots to be loaded. Each depot can have about 5 such mkokotenis, hence there would be a total of 500 mkokotenis manned by one man each. Segregation of wastes could occur at these centres. Also the dwellers could be requested to bring the waste already segregated. Sale of the waste paper, bottles, tins etc. could provide good money for the mkokoteni workers. There are additionally two alternatives:
  - i) The solid wastes can be treated either by composting or incineration. Unfortunately within the community there is not adequate room/land for composting. The surrounding areas have a very high land value, and reuse of the compost as land fertilizer is not easy. Still this is an area that needs further research in Kibera. Although it is an illegal activity, there is extensive farming along the river bank, where there is no constructed areas. The compost could be used by

'these farmers' on their gardens. If local methods of waste treatment are preferred, the mkokoteni workers can take the wastes straight to these sites.

- ii) Introduce piggeries through women groups to consume the organic wastes. This will be sold to them at a very small fee. Piggeries would be a very good idea as the total weight of solid waste would be reduced substantially. The remaining waste can be further disposed either by the NCC or through local treatment of the wastes by incineration or burning. The high threat of tapeworms should not be overlooked with introduction of piggeries. The mkokoteni workers can make the idea of piggeries more feasible by transporting the organic wastes to the piggeries for a fee.

### Financing

At the primary centres, some segregation of the wastes could be done by one mkokoteni carrying bottles and tins, by another one carrying one papers and by a third one carrying organic food waste. A reliable market can be found to purchase the bottles and tins and also the waste paper. The marketing could be done through an organization of the mkokoteni workers. In addition the community will be obliged to contribute some money every month to the mkokoteni workers.

Assuming each household gives KES 10 per month, the revenue could be as follows:

The average size of household in Kibera	= 4 members.
The number of households	= 450 000/4
	= 112 500

This means that about KES 1 125 000 will be collected every month. If there are about 500 mkokoteni men, the money is enough to pay them about KES 1 500 per month each and to save KES 375 000 per month for capital investments. The mkokotenis will initially be bought on loan. It is recommended that a grant is made available to finance the project initially. Money could be generated through the other solid waste activities to keep the project sustainable in the long run.

Of course the idea needs a lot of modification, and consultation with the community dwellers and with NCC.

Further studies need to be carried out on these alternatives to compare their cost effectiveness and applicability.

## 5.6 Summary of sanitation options

All developments need to be planned in Kibera. Provision of access is a prerequisite to success of any sanitation methods in Kibera. Several houses will need to be demolished, access roads demarcated and named. Residents will be required to help with this matter under supervision of NCC. The government will need to solve the problem of security of tenure. Below is a summary of the proposed sanitation options.

1. Water supply To be planned and designed by the NCC. NCC to provide all main reticulation while the community will build the yard connections. The residents to pay water rates like all the other city residents.
2. Excreta disposal Temporary provision with pit/VIP latrines which should be frequently emptied. Subsequently shallow sewers should be installed with either
  - (i) Communal toilets and bathrooms or
  - (ii) plot toilets and bathrooms.
 Monthly rates for these services should be paid to the NCC.
3. Sullage disposal
  - (i) Disposed together with stormwater in the case of communal toilets or
  - (ii) with excreta disposal in the case of plot toilets and bathrooms.
4. Stormwater drainage Disposed through lined earth drains. Drains on minor access roads need not be lined. These drains should be constructed by the community, supervised by NCC. Maintenance should be done by the community.
5. Solid waste Kibera communal cleanliness day annually. Subsequently:
  - (i) Collection of solid wastes by NCC from communal primary collection centres. Collection centres to be maintained by community. Payment of rates to NCC.
  - (ii) Total community management of solid waste collection, transportation and treatment. Use of handcarts; mkokotenis for transportation. Reuse of materials. Piggeries. Payment of rates to a community body having the duty of collecting the rates.

Community participation in all aspects of the project is an intergral part leading to maximum utilization of resources and sustainability.

Various options can now be formed from a combination of the above proposed alternatives. Compatibility of the systems will need to be evaluated. In estimates the

comprehensive cost of the alternatives the bill of quantities have to be prepared. In the final selection cost-benefit analysis should be done. Ability to pay should always be an important criteria.

Estimated costs of the various alternatives in millions of Kenyan shillings (KES):

1. Planning	5
2. Provision of access	75
3. Water supply	43
4. Excreta disposal	
(i) Communal ablution blocks	40
(ii) Plot toilet and bathroom	80
5. Stormwater	14
6. Solid waste	
(i) Nairobi City Commission	10
(ii) Communal management	5
7. Community mobilization	8
8. Contingencies	5

### Possible options

Table 5. Various sanitation options.

Option	1	2	3	4
Planning	1	1	1	1
Access	2	2	2	2
Water supply	3	3	3	3
Excreta disposal	4(i)	4(i)	4(ii)	4(ii)
Stormwater drainage	5	5	5	5
Solid waste disposal	6(i)	6(ii)	6(i)	6(ii)
Community mob'tion	7	7	7	7
Contingencies	8	8	8	8
Cost (million KES)	200	195	155	160

The cost of the various options will range from KES 155 000 000 to KES 200 000 000 depending on the type of access roads and the level of service provided. The labour component in these figures is a minimum of 30 %. The higher the level of service the lower the percentage of labour component in the cost. Option 2 is recommended due to easier maintenance of the toilets and more reliable management of solid wastes (communal).

(Note: These cost estimates are based on Appendix 3 which was prepared with the assistance of Engineer L.T. Kuria of Nyakio General Contractors (Kenya) Limited).

A mode of interaction and intervention between the various possible participants involved in such a project is important. A possible participation chart is presented in Figure 18.

## 5.7 Financing and cost recovery

A system whereby the consumer rather than the taxpayers pay for the services is preferred. This will ensure sustainability of the services. Kibera residents have the willingness and ability to pay for basic urban services. Low rates for small quantities of water will help the poor to afford the water.

Water bills could include sewer charges as well as charges for solid waste disposal. They should be separately indicated and then summed up for easy accountability. Cost recovery in the case of provision of access as well as stormwater drainage should be a part of the land rates. They too should be quantified.

As community participation is expected in all the phases of the project, there will be considerable cost recovery and hence the rates payable will be little especially if payable over a long period of time.

Provision of capital funds presents a problem. Funds may be obtained by the NCC either from ESAs or locally. Big loans to the low income families may not be advisable unless the amount of repayment and the repayment period are well discussed with the community and agreed upon. In the past, loans have been extended to low income communities who have been unable to repay back the loan leading either to cancellation of the loans or auction of their property.

As the provision of most of the services will be community based there will be a need to form well functioning local institutions. A well debated tariff structure for the systems will need to be designed.

### Project viability

The cost of the project seems to be initially very high but it should be remembered that an average household spends about KES 90 per month on water. If this money was paid to NCC, then NCC would get an income of KES 10.125 million per month and KES 121.5 million per year. Hence complete cost recovery should be a reality in this project.

## 6 CONCLUSIONS AND RECOMMENDATIONS

"Well planned housing and at reasonable standard when combined with essential services affords dignity, a sense of security and proper status in society for the individual" (Kenya 1966/67 cited by Obudho and Aduwol 1988).

### Conclusions

1. The rate at which Nairobi has been expanding both in terms of population and size is alarming. The current population growth rate is about 5 %. As the City of Nairobi has expanded, it been difficult to provide urban services to the dwellers, and therefore slum and squatter settlements are mushrooming. Kibera is now the largest squatter settlement in Nairobi with over 450 000 people and a population growth rate of 18 %. It is occupying an area of about 2.5 km<sup>2</sup>.
2. The government is committed to community upgrading programmes, and the government housing policy shows that the government still considers itself a provider rather than a facilitator in the provision of infrastructure and services.
3. Security of tenure remains a problem in Kibera. While Kibera is an informal or unplanned settlement, it is not a temporary settlement. It has been existing for the past 64 years despite the governments abdication of all responsibility for it. There is need to convert it into a planned settlement.
4. Most of Kibera residents have low socio-economic status. They have the ability to pay for basic services. They, however, may not be able to pay high capital costs associated with provision of basic infrastructure but they have the ability to pay rates like all the other residents in the city. They are also willing to pay for basic services.
5. The scope for community participation in Kibera is very high. The residents are willing to contribute financially and by labour in order to improve sanitation in the area. The resident landlords are willing to contribute land without recompensation to improve sanitation. The community members have the capacity to form successful organizations in the area.
6. Standards normally set for basic infrastructure by NCC are very high.
7. Various sanitation options presented are technically feasible, socially acceptable, healthy in application and within the economic means of the community.
8. Adequate upgrading of sanitation in Kibera would cost about KES 200 million. With this amount complete cost recovery is possible.

### Recommendations

1. Associated with them the government needs to acknowledge the existence of slums and squatter settlements, the problems, and initiate possible solutions to these problems. It needs to begin and consolidate a process by which the initiatives of Kibera residents are encouraged, supported and built upon for basic infrastructure upgrading.
2. All developments in Kibera need to be planned.
3. Access must be provided within Kibera if any sanitation method is to be successful.
4. Security of tenure will need to be provided by the government. Security of tenure needs to be provided to the tenants rather than to the landlords. Only then can full utilization of tenants' resources be utilized in the provision of basic infrastructure. The rights of the genuine landlords should not be overlooked.
5. The sanitation options recommended include provision of a main water reticulation within the Nairobi City Commission (NCC) and construction of the minor lines by the community. Shallow sewers are recommended for excreta disposal while lined major drains and unlined minor drains are recommended for stormwater drainage. Sullage disposal could be either with excreta disposal or stormwater drainage. Community management of solid wastes is recommended. Small plot toilet and washrooms are preferred to communal ablution blocks serving many plots. The project is estimated to cost about KES 200 million. Bills of quantities will need to be prepared for the various alternatives in order to give a more critical analysis of the systems. Labour whether community or paid must be mentioned and specified. Community education, participation and management should be an integral part of the project. The existing organizations should be utilized to in the mobilization of the community.
6. A department within NCC Informal Settlements Department (ISD) is recommended to be established to coordinate the developments in Kibera. Other participants in the upgrading of Kibera are the NGOs operating in Kibera, the government, External Support Agencies (ESAs), the politicians, and Kibera community. The amount of cooperation between these groups of people will determine the level of success achieved in upgrading sanitation in Kibera.
7. Total cost recovery needs to be a must in the provision of basic infrastructure in Kibera.
8. NCC needs to revise standards of infrastructure in order to make basic infrastructure affordable to the city poor. Continued research on appropriate technology needs to be encouraged.

9. There needs to be a programme approach to the problems of slum and squatter settlements rather than a project approach sometimes applied or an *ad hoc* approach frequently applied. This will not only ensure provision of basic infrastructure in Kibera but also in similar informal settlements in Kenya.



## 7 REFERENCES

- Amis, P.H. 1983. The commercialization of unauthorised housing in Nairobi 1960-1980. PhD Thesis. Urban and regional studies unit. University of Kent. Canterbury. p. 175, 244.
- Angel, S. 1983. Upgrading slum infrastructure. Third World Planning Review. Vol. 5, No.1 p. 5-17.
- Cairncross, S. and Ouano, E.A.R. 1991. Surface water drainage for low income communities. WHO, Geneva. p. 25.
- Cotton, A. and Franceys R. 1990. Putting services in their place. Planning, shelter and services for the urban poor. 7th Inter-School Conference on Development. Loughborough University of Technology. p. 86-89.
- Cotton, A. and Franceys R. 1991. Services for shelter. Infrastructure for urban low income housing. Liverpool Planning Manual 3. Liverpool University Press. p. 77.
- Flintoff, F. 1976. Management of solid wastes in developing countries. WHO. New Delhi. p. 1-4.
- Harpman, T., Lusty, T. and Vaughan, P. 1988. In the shadow of the city. Oxford University Press. p. 5-23, 300-306.
- Howard Humphreys Consulting Engineers. 1987. Sewerage and sewage treatment study. Vol. 2. Third Nairobi Water Supply Project. p. 57-68.
- Kalbermatten, J.M., Julius, D.S. and Gunnerson, C.G. 1980. Appropriate technology for water supply and sanitation. Technical and economic options. The World Bank. p. 1-32, 110-114.
- Kenya. 1990/91. Housing Policy for Kenya. Sessional Paper No. 10. Government printers. Nairobi, Kenya.
- Kunguru, J. and Mwiraria, M. 1991. NGO support to informal settlements. A case study of Kibera, Nairobi. UNDP/World Bank Project. p. 26.
- Mara, D.D. and Morgan, P.R. 1982. Ventilated improved pit latrines. Recent developments in Zimbabwe. World Bank Technical Paper, No. 3. p. iv 1.
- Nairobi City Commission. 1991. Improving environmental sanitation in informal settlements. Naivasha Workshop, September 10-13, 1991.
- Obudho, R.A. 1984. National urban and regional planning policy in Kenya. Third World Planning Review. Vol. 6, No. 4 p. 365.
- Obudho, R.A. 1987. Urbanisation and low income housing in Kenya: Towards a Planning Strategy. Paper presented at the International Conference on Urban Shelter in Developing Countries. London, April 1987. p. 11.

Obudho, R.A. and Aduwol, G.O. 1988. Slum and squatter settlements in urban centres of Kenya: Towards a Planning Strategy. Paper presented at the International Research Conference on Housing Policy and Urban Innovation, Amsterdam, Netherlands June 27-July 1, 1988.

Odada, J.E., and Otieno, J.O. 1990. Social economic profiles. Government of Kenya, Ministry of Planning and National Development and UNICEF. p. 175-202.

Ondiege, P.O., and Syagga, P.M. 1990. Urban basic services. Housing Research and Development Unit. University of Nairobi. p. 15.

Otis, R.J. and Mara, D.D. 1985. The design of small bore sewers. TAG Technical Note No. 14. The World Bank. p. iv-7.

Reed B. 1991. Sewerage for the urban poor. Developing world water. Water Waste and Development Centre. Grosvenor Press International. p. 84-88.

Sinnatamby, G. 1983. Low cost sanitation. Chapter six in: Housing and Health in Third World Cities. Edited by Hardoy, J.E., Cairncross, S. and Satterthwaite, D. p. 153.

Taylor, K. 1990. Sewerage for low income communities in Pakistan. Waterlines. Vol. 9. No. 1. p. 21-24.

UNCHS (Habitat). 1981. Upgrading of urban slums and squatter settlements. 4chs/op/81/4. p. 17-28.

UNCHS (Habitat). 1986. Delivery of basic infrastructure to low income settlements: Issues and options. HS/101/86/E. p. 19-21.

UNCHS (Habitat). 1988. Refuse collection vehicles for developing countries. HS/138/88 E. p. 7-14.

UNCHS (Habitat). 1989a. Water supply in low income housing projects: The scope for community participation. HS/152/89/E. p. 27-33.

UNCHS (Habitat). 1989b. Solid waste management in low income housing projects: The scope for community participation. HS/96/86/E. p. 2.

Vines, M., Reed, B. and Pickford J. 1989. Reduced cost sewerage for developing countries. Overseas Development Administration: Water Engineering and Development Centre. England.

Vines, M. and Reed, B. 1990. Low cost unconventional sewerage. Waterlines. Vol. 9, No. 1. p. 26-27.

Winblad, U. and Kilama, W. 1980. Sanitation without water. Offsetcentre AB, Uppsala 1981, Sweden. p. 50-53.

WHO (World Health Organization) 1989. Health principles of housing. WHO. Geneva. p. 2-8.

**Further reading**

Dwyer, D.J. 1979. People and housing in Third World cities. Longman. London. p. 120-227.

Franceys, R. 1990. Paying for urban water tariffs. Waterlines. Vol. 9. No. 1. p. 9-12.

Hardoy, J. and Satterthwaite, D 1989. Squatter citizen. Earthscan Publication Ltd. London. p. 18-26, 300-306.

Perrett H. 1983. Social feasibility analysis in low-cost sanitation projects. TAG. Technical Note No. 5. World Bank. p. 6-7.

Pickford, J. 1990. Urgent urban water and waste problems. Waterlines. Vol. 9. No. 1. p. 2-5.

Rybczynski, W., Polpasert, C. and McGarry, M. 1982. Appropriate technology for water supply and sanitation. Low cost technology options for sanitation. World Bank. p. 81.

Simpson-Hebert M. 1983. Methods of gathering socio-cultural data for water supply projects. TAG. Technical Note No. 1. World Bank. p. 1-19.

UNCHS (Habitat). 1989. Community participation in low cost sanitation. Sanitation HS/94/86/E. p. 1-35.

A questionnaire to determine improved sanitation alternatives sanitation for Kibera, Nairobi

Date ..... Time .....  
 Area ..... Village .....  
 Name of interviewer .....  
 Comments on Interview/Interviewer .....

1. Description of dwelling (To be filled by interviewer partly by observation and by asking interviewee)
  - (a) Floor Material .....
  - (b) Wall Material .....
  - (c) Roof Material .....
  - (d) Size of room/rooms .....
  - (e) Rooms per household .....
  - (f) Presence of electricity .....Yes/No.
  - (g) Presence of Telephone .....Yes/No.
  - (h) Water supply by house connection .....Yes/No.
  - (i) Water supply by yard connection .....Yes/No.
  - (j) Personal/own toilet .....Yes/No.
  - (k) Ownership of Bicycle, Radio, TV .....Yes/No.
  - (l) Mode of cooking ..... charcoal/paraffin Yes/No
2. Total number of occupants per room/house .....  
 (indicate if family or only room-mates)
  - (i) Male .....
  - (ii) Female .....
  - (iii) Aged over 18 (married ..... ) (single ....)
  - (iv) Aged under 18 .....
3. Education levels of those above 18 (summary)  
 .....
4. Do you live with your husband/wife/children?
5. Occupations of the earning member in the room/house
  - (i) .....
  - (ii) .....
  - (iii) .....
6. (a) How much do you earn per day/month? .....  
 (b) How much do the other members of the household earn per day/month? .....
7. (a) Are you able to save anything at the end of each month? ..... Yes/No  
 (b) If so, about how much? .....  
 (c) Do you have a bank account .....Yes/No
8. Do you have any other source of income ..... Yes/No
  - (i) Renting rooms,
  - (ii) School bursaries
  - (iii) Others (specify)
9. How much do you spend on food daily? .....

## Appendix 1 2(4)

10. (a) Do you own the house? ..... Yes/No  
 (b) If not do you know who owns it? ..... Yes/No  
 (c) If yes, specify .....  
 (d) Does he collect the rent himself? .....
11. How much do you pay for the house monthly? .....
12. Are you comfortable with the house? ..... Yes/No
13. How many containers of water do you use daily per household?.....
14. How much is each container?.....
15. Is the water always available when you need it?  
 Yes/No .....
16. (a) Apart from the water-kiosks, where else do you obtain water from?  
 (i) Roof catchment  
 (ii) River  
 (iii) Burst City Commission pipes? (specify)  
 (b) Are they safe and healthy to use?  
 (Interviewer to determine by observation)  
 .....
17. How far is the water point/water-kiosks? .....
18. Is that convenient enough? ..... Yes/No
19. Do you think the price of water is too high?  
 Yes/No .....
20. If the water was cheaper, how many more containers would you use per day? .....
21. What are the possibilities of water contamination between the collection point and final usage?  
 (For the Interviewer to comment after observation)  
 .....
22. What ideas can you propose to improve the water supply?  
 .....
23. Where do you normally help yourself?  
 (i) Pit latrine  
 (ii) Bushes  
 (iii) Others (specify)
24. How far is the nearest pit-latraine?.....
25. Is that convenient enough? ..... Yes/No
26. How many people use the pit latrine? (Interviewer to deduce) .....

## Appendix 1 3(4)

27. (a) How often is the pit latrine emptied?.....
- (b) How is it done .....
- (c) How much does it cost? .....
- (d) What happens if the pit is not emptied? .....
28. What are your major complaints regarding use of these toilets? .....
29. Where do your children defecate? .....
30. Do you think the excreta disposal system is healthy enough? .....
31. (a) Would you prefer another system of disposal?....
- (b) What are your recommendations on this? .....
32. (a) Where do you dispose your household rubbish?.....
- (b) How healthy do you think that is? .....
- (c) If not healthy, what do you propose can be done about it? .....
33. (a) What are the types of solid waste?  
     (Interviewer to deduce).....
- (b) What are the approximate quantities per household per day? (Interviewer to deduce).....
34. What happens to sullage? (Interviewer to observe and comment).....
- 35.(a) Where do you take a bath or shower?  
     Pit latrine/Room/Away from Estate (specify)
- b) Is that good enough? .....
- c) What do you propose to improve the situation? ...
36. How is the stormwater drained from premises?  
     (Interviewer to comment by observation) .....
37. How often are your children having diarrhea?.....
38. What are the other common ailments especially among children? .....
39. (a) What do you think is the main cause of these ailments?.....
- (b) Why do you think so? .....
- (c) Are you often visited by public health workers? .....
- (d) What do they tell you? .....
40. Do you belong to any local organization?  
     Women groups/Kanu Youthwingers/Church/Charitable organizations/None of the above (specify)
41. (a) What are its objectives? .....
- (b) How successful has it been in the fulfillment of the objectives .....
42. Are you willing to contribute to the improvement of sanitation in this area? .....

43. In what way are you willing to contribute Labour/Finances (specify)
44. What other information are you willing to communicate for the purpose of this study?.....
45. Are you willing to sacrifice loss of some rooms for the improvement of sanitation in this area i.e. for way leaves? (For landlords only) .....
46. In what way are you willing to help in the daily management of water supply, excreta disposal, solid waste management, sullage disposal and stormwater drainage?.....
47. What form of sanitation would you prefer in this type of dwelling place?
  - (i) Excreta disposal.....
  - (ii) Water supply.....
  - (iii) Sullage disposal.....
  - (iv) Stormwater drainage.....
48. Are you in agreement with the idea of full cost-recovery in such a project even if it means loan system?.....
49. How long have you lived here? .....
50. How much longer do you think you will continue staying here?.....

## Compiled results of the interviews

Description		Makina	Mashimoni	Lindi	Kisumu ndogo	Kianda	Laini saba	Katwikira	Soweto	Total
Interviewees	Total	98	114	113	139	145	166	103	164	1042
	Cooperative	91	109	104	126	140	153	91	144	958
	Uncooperative	7	5	9	13	5	13	12	20	84
Floors	Mud	44	35	48	46	27	111	32	115	458
	Cemented	52	78	67	92	113	55	70	57	584
Walls	Wooden	3	7	1	0	17	6	9	7	50
	Plastered	27	107	39	71	77	38	43	51	453
Roof	Mud	64	40	75	65	34	109	36	116	539
	Iron sheets	90	113	114	135	142	164	98	171	1027
	Debes/others	7	0	0	2	2	0	2	2	15
Room size square meters	9	21	24	38	53	43	45	53	90	367
	10-12	18	13	15	23	25	9	9	19	131
	13-15	2	4	59	3	8	1	2	3	82
	16-20	45	66	53	52	61	102	29	54	462
No. of rooms per family	1	47	78	56	92	111	138	76	144	742
	2	13	10	19	21	20	9	11	19	122
	3	13	4	14	4	6	5	7	4	57
	4	10	4	11	6	0	5	24	8	68
	5	8	5	11	10	5	6	3	5	53
Occupants per room	1	9	4	8	6	14	10	11	27	89
	2	12	31	39	29	15	29	21	28	204
	3	27	26	32	29	37	35	30	32	248
	4	10	21	19	23	29	37	12	19	170
	5	4	10	3	32	20	20	11	32	132
	6	5	9	3	13	15	15	6	15	81
	7	4	11	7	4	5	8	6	13	58
	8	8	4	4	0	5	2	4	3	30
	9	3	0	1	0	2	1	0	4	11
	10	1	0	1	2	2	6	2	5	19



## Appendix 2 2(11)

Description		Makina	Mashimoni	Lindi	Kisumu ndogo	Kianda	Laini saba	Katwikira	Soweto	Total
Bicycle		7	4	12	11	7	12	9	20	82
Radio		60	66	80	86	71	94	61	80	598
TV		12	5	13	6	5	6	6	8	61
Electricity		10	0	12	0	3	2	2	8	37
Telephone		5	0	7	2	0	1	1	4	20
Water	Water Kiosk	97	117	115	139	148	168	104	112	1000
	Personal	5	4	2	5	7	4	8	7	42
Latrine	Personal	25	8	23	19	9	8	7	10	109
	Communal	64	104	87	111	120	137	92	129	844
	none	10	10	8	19	10	16	1	15	89
Married		149	198	199	256	230	249	149	268	1698
Single	Over 18	70	61	123	118	100	94	54	111	731
Single mothers		21	10	12	19	15	19	3	15	114
Over 18		219	259	322	374	330	343	203	379	2429
Under 18		367	306	375	380	337	392	237	288	2682
Male		254	308	333	351	327	354	217	348	2492
Female		332	257	364	403	340	381	223	319	2619
Education level	< std 8	111	120	179	126	146	141	95	120	1038
	Std 8	21	16	20	36	34	28	25	27	207
	Form 1-2	9	21	20	25	20	30	15	28	168
	Form 3-4	53	56	55	86	94	61	48	63	516
	Form 5-6	4	1	3	4	0	3	2	7	24
	College	1	0	0	0	0	1	1	0	3
	University	1	0	1	0	0	0	0	0	2
Occupation over 18	Formal	57	72	64	71	75	82	59	52	532
	Informal	98	66	97	101	114	91	67	163	797
	Unemployed	64	121	161	202	141	170	77	164	1100

## Appendix 2 3(11)

Description		Makina	Mashimoni	Lindi	Kisumu ndogo	Kianda	Laini saba	Katwikira	Soweto	Total
individual	<1000	33	46	34	51	51	64	35	52	366
income	1001-2000	33	45	32	55	53	60	39	63	380
per month	2001-3000	16	10	27	17	23	29	19	31	172
(KES)	3001-4000	7	4	7	9	6	9	5	6	53
	4001-5000	1	2	9	2	4	1	3	4	26
	>5000	10	5	4	5	8	3	2	8	45
household	<1000	9	18	10	19	27	18	21	31	153
income per	1001-2000	34	47	33	44	61	81	36	79	415
month	2001-3000	26	28	34	29	34	41	30	36	258
(KES)	3001-4000	13	15	15	20	5	14	4	11	97
	4001-5000	3	1	7	2	1	6	5	3	28
	>5000	13	5	14	25	17	6	7	4	91
Savings	None	57	84	87	88	98	117	65	104	700
per month	<500	20	21	14	39	26	30	25	43	218
(KES)	501-1000	13	4	7	7	12	12	9	9	73
	1001-2000	7	1	4	4	2	3	2	4	27
	2001-3000	1	4	1	1	7	4	2	4	24
Bank account	With	23	21	27	36	41	44	30	51	273
	Without	75	93	86	103	104	122	73	113	769
Other	Rent	30	5	24	32	12	13	12	13	141
sources	Bursaries	0	0	0	0	3	0	2	0	5
of income	Others	9	4	8	15	10	6	10	7	69

Description		Makina	Mashimoni	Lindi	Kisumu ndogo	Kianda	Laini saba	Katwikira	Soweto	Total
Spending on food/day (KES)	20	5	25	19	18	23	28	22	32	172
	30	10	14	12	24	16	37	14	21	148
	40	7	16	8	5	8	19	13	24	100
	50	27	21	21	27	49	30	18	31	224
	60	3	9	8	8	7	8	10	8	61
	70	8	4	4	13	3	4	2	9	47
	80	1	8	3	2	3	5	2	7	31
	90	3	0	1	0	0	3	0	0	7
	100	22	9	19	25	24	21	7	21	148
	>100	12	8	18	17	12	11	15	11	104
Tenants		50	95	64	97	123	149	83	141	802
Landlords	Present	48	19	49	42	22	17	20	23	240
	Available	73	100	70	65	119	105	61	59	652
Rent per month (KES)	100-150	1	4	2	11	7	0	10	15	50
	151-200	9	33	19	13	27	63	24	48	236
	201-300	23	40	28	53	48	67	39	67	365
	301-400	13	9	7	11	31	13	6	8	98
	401-500	4	9	8	9	10	6	4	3	53
House	Satisfied	53	62	61	63	87	68	46	67	507
	Not satisfied	45	52	52	76	58	98	57	97	535
Quantity of water used/ day/household (litres)	40	14	14	17	19	20	35	18	47	184
	60	13	21	9	22	38	43	17	44	207
	80	14	36	14	25	28	33	24	23	197
	100	9	21	21	15	20	28	13	19	146
	120	13	10	12	25	20	10	15	17	122
	140	2	2	2	4	9	0	7	3	29
	160	33	10	38	29	10	17	9	11	157

## Appendix 2 5(11)

Description		Makina	Mashimoni	Lindi	Kisumu ndogo	Kianda	Laini saba	Katwikira	Soweto	Total
Cost/20 litre container (KES)	0.30	0	5	0	0	2	0	0	0	7
	0.40	0	23	4	7	2	3	0	0	39
	0.50	2	35	38	64	113	48	4	11	315
	0.60	26	41	36	61	17	20	47	0	248
	0.70	53	7	35	7	4	39	47	0	192
	0.80	4	3	0	0	2	21	5	7	42
	0.90	0	0	0	0	0	0	0	0	0
	1.00	13	0	0	0	5	35	0	142	195
	1.20	0	0	0	0	0	0	0	4	4
Reliability of water	Poor	88	105	99	78	65	117	95	101	748
	Good	10	9	14	61	80	49	8	63	294
Other sources of water	Roofs	35	40	51	65	27	38	34	68	358
	River	1	3	0	0	3	0	7	0	14
	Burst pipes	1	1	24	17	0	15	22	21	101
Pollution	Prone	29	40	56	61	22	41	50	64	363
	Free	9	0	0	8	7	0	2	12	38
Distance to water point (metres)	<50	75	94	81	116	125	116	46	113	766
	50-100	13	6	28	15	13	38	37	31	181
	>100	10	14	4	8	7	12	20	20	95
Distance to water point	Satisfied	77	83	72	101	128	109	41	92	703
	Not satisfied	21	31	41	38	17	57	62	72	339
Price of water	Satisfied	29	36	24	51	43	45	32	38	298
	Not satisfied	69	78	89	88	102	121	71	126	744

## Appendix 2 6(11)

Description		Makina	Mashimoni	Lindi	Kisumu ndogo	Kianda	Laini saba	Katwikiria	Soweto	Total
Usage with cheapness	Increased	76	89	52	80	104	116	61	99	677
	Same	22	25	61	59	41	50	42	65	365
New usage (litres)	20	0	0	0	0	0	4	3	30	37
	40	4	3	9	4	3	8	3	43	77
	60	1	7	3	13	15	24	9	26	98
	80	5	10	7	6	15	25	17	21	106
	100	8	14	27	31	12	27	19	23	161
	120	18	21	19	25	14	25	14	8	144
	140	0	9	7	6	21	10	6	2	61
	160	8	14	12	8	24	17	10	4	97
	180	1	10	1	2	9	2	7	3	35
	200	53	26	28	44	32	24	15	4	226
Water	Contamination	17	9	76	61	19	57	67	11	317
Proposals to improve water supply	Cheaper price	14	3	4	15	31	8	3	32	110
	Yard tap	30	42	41	61	58	49	42	56	379
	Reliability	42	40	35	36	29	40	35	55	312
	No idea	14	20	9	4	0	11	2	7	67
Excreta disposal facilities	Pit latrines	97	113	113	139	130	149	99	160	1000
	Others	1	1	0	0	15	17	4	4	42
Distance to latrine (meters)	Convenient	75	86	68	74	97	88	54	27	569
	Inconvenient	23	28	45	65	48	78	49	137	473
	20	57	79	76	106	85	109	57	70	639
	20-50	26	24	33	25	32	36	33	51	260
	51-100	8	4	3	4	14	5	3	18	59
	101-200	4	4	1	2	7	4	3	12	37
>200	3	3	0	2	7	12	7	13	47	

## Appendix 2 7(11)

Description		Makina	Mashimoni	Lundi	Kisumu ndogo	Kianda	Laini saba	Katwikira	Soweto	Total
Number using latrine	<10	18	19	20	19	12	9	9	12	118
	10-50	56	73	78	92	103	91	66	93	652
	51-100	12	10	7	26	14	47	19	29	164
	>100	12	12	8	2	16	19	9	30	108
Latrine maintenance	Good	35	26	60	53	44	46	59	35	358
	Poor	63	88	53	86	101	120	44	129	684
Complaints on latrines	Overflowing	5	5	4	13	5	12	7	34	85
	No emptying	3	3	4	6	2	4	7	15	44
	Collapsed	7	10	12	6	3	15	14	17	84
	Poor usage	50	68	42	66	96	84	33	77	516
	None	33	27	52	48	39	51	42	21	313
Children use	Pit latrines	55	62	34	46	65	60	19	56	397
	Waste paper	22	20	39	36	29	41	36	39	262
	Others	10	9	13	15	20	15	15	7	104
E-disposal	Healthy	33	26	84	72	27	53	56	48	399
	Unhealthy	65	87	30	67	118	113	47	116	643
Full pits	NCC empty	26	10	7	19	15	10	8	4	99
	KWAHO empty	13	5	16	8	9	22	4	9	86
	Discarded	8	10	59	36	20	27	40	59	259
	drains or river	26	35	12	21	22	52	3	55	226
	Chemical	3	1	4	4	9	0	1	7	29
Prefer other methods		65	77	39	71	109	95	61	37	554

## Appendix 2 8(11)

Description		Makina	Mashimoni	Lindi	Kisumu ndogo	Kianda	Laini saba	Katwikira	Soweto	Total
Recommendations	More pits	17	4	2	23	27	18	18	52	161
	Conventional sewerage	42	65	20	40	78	52	23	40	360
	Maintenance	18	23	4	6	12	30	18	39	150
	PH education	1	1	1	0	0	0	0	4	7
Rubbish disposal	Dumped	37	44	37	34	22	60	33	105	372
	Rubbish pit	18	26	57	83	12	11	40	40	287
	Burning	16	4	17	11	3	2	2	12	67
	River	27	40	2	11	108	93	28	7	316
Rubbish disposal	Satisfied	34	21	39	59	43	34	37	48	315
	Not satisfied	64	93	74	80	102	132	66	116	727
Recommendations	NCC to c'lect	56	61	32	51	96	70	38	59	463
	Rubbish pits	34	45	64	51	36	76	56	80	442
	Burning	5	3	4	14	5	3	4	17	55
	Others	3	5	13	23	8	17	5	8	82
Sullage disposal	Drained	39	90	54	92	116	128	48	112	679
	Dug pit	18	5	11	15	3	4	20	24	100
	Discriminate	41	19	48	32	26	34	35	28	263
Bathing	Pit latrines	3	0	13	8	0	7	14	14	59
	Room	29	20	40	2	53	49	32	55	280
	Bathroom	61	93	59	118	85	105	50	92	663
	Others	5	1	1	11	7	5	7	3	40
Bathing	Satisfied	63	58	61	63	43	60	41	63	452
	Not satisfied	35	56	52	76	102	106	62	101	590

## Appendix 2 9(11)

Description		Makina	Mashimoni	Lindi	Kisumu ndogo	Kianda	Laini saba	Katwikira	Soweto	Total
Recommendations	Provide bath	38	47	21	13	46	35	33	52	285
	Better bath	20	36	32	80	60	63	11	12	314
	No idea	1	1	2	3	3	5	1	7	23
Stormwater	Drains	88	98	82	114	109	128	76	102	797
	Floods	10	16	31	25	36	38	25	48	229
Diarrhoea	Frequent	26	40	28	25	49	47	19	52	286
	Infrequent	31	27	47	55	46	55	36	52	349
	Never	23	20	11	17	24	18	15	17	145
Other common ailments	Malaria	38	73	39	65	75	71	39	79	479
	Common colds	52	75	44	46	78	71	34	59	459
	Meningitis	0	0	0	0	0	0	2	0	2
	Others	13	17	7	25	32	29	10	11	144
Public health awareness	Good	63	69	64	70	98	76	47	44	531
	Poor	35	45	49	69	47	90	56	120	511
Visited by PH officers		48	36	36	55	34	31	21	8	269
local Organisations	Kanu	5	4	8	4	5	4	3	1	34
	Church	40	47	32	80	58	49	56	87	449
	Self help and women groups	14	10	21	34	24	29	25	60	217
	Others	5	3	11	15	5	8	4	7	58
	None	42	69	49	36	70	79	31	35	411
Organisations	Successful	40	40	59	59	60	55	42	87	442
	Unsuccessful	7	4	11	27	9	17	4	7	86



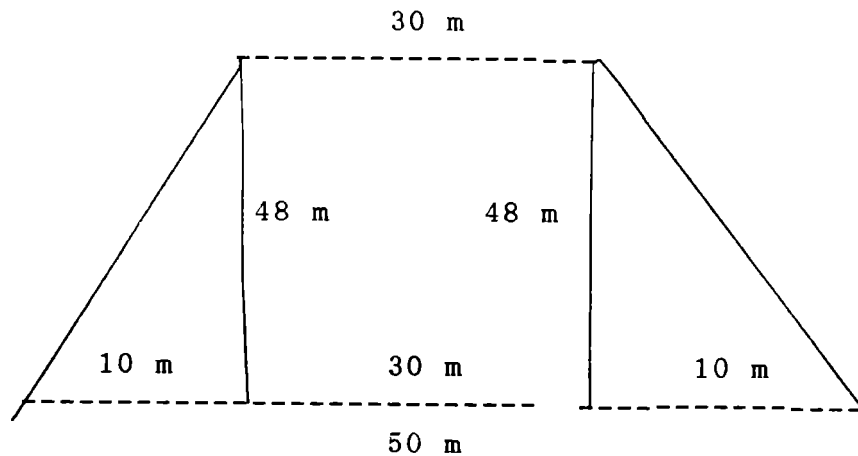
## Appendix 2 10(11)

Description		Makina	Mashimoni	Lindi	Kisumu ndogo	Kianda	Laini saba	Katwikira	Soweto	Total
Willing contributions to sanitation	Labour	69	109	72	101	119	107	62	116	755
	Finance	62	68	51	92	94	66	36	72	541
	None	9	4	24	15	7	30	25	7	121
Sacrifice rooms	Willing	31	16	25	31	18	12	14	20	167
	Unwilling	17	3	24	11	4	5	6	3	73
Help in management	Labour	79	108	79	90	114	114	66	112	762
	Finance	14	4	31	38	20	20	24	48	199
	None	12	5	24	23	19	35	30	13	161
Sanitation preference										
Excreta disposal	Well maintain pit latrines	39	25	28	27	7	36	37	68	267
	Conventional sewerage	25	36	40	44	46	63	32	61	347
	Pit latrines	35	56	47	65	88	66	28	31	416
Water	Yard tap	53	90	80	116	119	141	66	72	737
	Cheaper water	13	4	16	2	19	5	10	16	85
	Reliability	35	21	13	23	5	19	26	56	198
Sullage	Pits	25	9	33	4	9	14	32	15	141
	Co'ete drains	12	10	35	71	24	41	23	63	279
	Mud drains	56	92	47	63	116	109	40	84	607
Stormwater	Co'ete drains	12	10	34	44	17	24	26	59	226
	Mud drains	87	107	80	95	122	141	68	79	779
Cost recovery	Positive	84	104	77	103	131	120	55	100	774
	Negative	14	10	34	36	14	46	48	66	268

## Appendix 2 11(11)

Description		Makina	Mashimoni	Lindi	Kisumu ndogo	Kianda	Laini saba	Katwikira	Soweto	Total
Lived in area	0-1 years	15	25	10	27	31	52	25	26	211
	2-3	14	20	10	39	41	41	29	41	235
	4-5	17	26	16	18	27	21	8	28	161
	5-10	20	17	20	31	29	29	15	50	211
	>10	32	26	57	24	17	23	26	19	224
Permanency		89	99	112	104	111	113	67	144	839
Other information	Cleaner place	35	20	41	53	41	37	32	47	306
	Better access	7	10	4	15	14	8	2	7	67
	PH education	12	21	19	11	26	12	9	8	118

## Population calculations.

Sample calculations

Village: Katwikira  
 Demarcated area: 1,92 km<sup>2</sup>  
 Population: 473 persons  
 Diagram: Below  
 Population density: 236 500 persons per km<sup>2</sup>

Table 2: Population densities in Kibera villages.

Village	Population density in persons/km <sup>2</sup>		
	First trial	Second trial	Average
Katwikira	213000	236500	224800
Kisumu ndogo	152000	208600	180300
Laini saba	220800	190800	205800
Silanga	175000	168000	171500
Mashimoni	125600	121400	123500
Lindi	197700	204600	201200
Soweto	164000	224000	194500
Kianda	180200	-	180200
Makina	254600	-	254600
Makongeni	152500	-	152500
Kambi muru	100400	-	100400

Average population density for Kibera informal settlement is about 180 800 persons per km<sup>2</sup>.

Area of Kibera is given as 1.1 km<sup>2</sup> (Kunguru and Mwiraria 1991) but estimation of the area from figure 3 showed the area to be about 2.5 km<sup>2</sup>. This latter estimate will be adopted as it is evident that a lot of new construction has occurred on the margins of the area. Hence total population in Kibera is about 450 000 people.

## Estimation of cost of upgrading sanitation in Kibera.

Planning parameters

Total population	= 450 000
Number of members per household	= 4
Number of households	= 112 500
Assume 12 households per plot	
Number of plots	= 9375
Plot size (assume rectangular)	= 264 m <sup>2</sup>
Let built up area be 80 %	

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Water requirement per plot	= 1.44 m <sup>3</sup> (based on 30 litres/capita/d)
Waste effluent	= 0.72 m <sup>3</sup> (based on 50 % release)
Solid waste	= 0.24 m <sup>3</sup> (based on 0.005 m <sup>3</sup> /capita/d)

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Distribution of ablution blocks

1. Consider a plot consisting of 2 bathrooms and 1 toilet plus 2 tap outlets for washing and cleaning of utensils and clothes. Such outlets located along outer block wall.

Number of ablution blocks = 9375

2. As an alternative consider a large ablution block consisting of 5 toilets and 5 bathrooms with about 5 tap outlets to serve every 10 plots.

Number of ablution blocks = 938

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Access roads

Assume that the settlement has the shape of a 3:1 rectangle. Further consider the roads crisscrossing at right angles. Consider 4 m wide pavement for minor access and 6 m wide for major access. Access to individual plots could be 2 m wide.

Total length of major access roads	= 10 000 m
Total length of minor access roads	= 50 000 m
Plot access roads	= 150 000 m

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Dimensioning and cost estimatesWater reticulation

Pipe diameter mm	Length m	Rate/meter KES	Total amount KES)
100	10 000	900	9 000 000
50	20 000	500	10 000 000
25	30 000	300	9 000 000
12	75 000	200	15 000 000

(Note: It is assumed that the existing water pipes will be utilized in the improved water reticulation.)

Sewers

Pipe diameter mm	Length m	Rate/meter KES	Total amount KES
450	10 000	1000	10 000 000
225	50 000	500	25 000 000
100	150 000	300	45 000 000

(Note: Rate in sewers and water reticulation is inclusive of material costs, excavation, fittings, jointing and commissioning).

Access roads

Type	Length m	Rate/meter KES	Total amount KES
Major access	10 000	2000	20 000 000
Minor access	50 000	500	25 000 000
Plot access	150 000	200	30 000 000

(Note: Rate inclusive of excavation, surfacing in stabilized material for major access. Minor and plot access roads need not be stabilized).

Surface drains

(Lined in stone along roads)

Item	Length m	Rate/meter KES	Total amount KES
Main drains	60 000	100	6 000 000
Minor drains	150 000	50	7 500 000

(Rate for excavation is based on murrum)

For pipelines and sewers; labour is about 30 %  
For roads and drains ; labour is about 50 %

(These cost estimates have been prepared with the assistance of Engineer L.T. Kuria of Nyakio General Contractors (Kenya) Limited).

