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***PLANNING FOR WATER SUPPLY AND
SANITATION SERVICES IN LOW INCOME
SUBURBS OF NAIROBI :***

***A Case Study of Kawangware Location, Dagoretti
Division, Nairobi.*** //

By

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***Thesis submitted in partial fulfilment for the degree of Master of Arts in
Planning in University of Nairobi***

-2004-

DECLARATION

This thesis is my original work and has not been presented for any degree in any university.

Signed.....

Jean Pierre M. MATATA

This thesis has been submitted for examination with my approval as the principal University Supervisor.

Signed ..... Date : *7th Oct. 2004*.....

Mwalimu Zachary MALECHE

DEDICATION

This work is dedicated to my children; my sweet heart, as she used to say Janet Espérance KITUMAINI, my first-born and girl friend Diana MANIRAKIZA and my father and son David Hope Mponoye who have missed their paternal affection all through the years of my studies.

Your Daddy,

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Any shortcomings of facts and interpretation remain my own responsibility and should not be interpreted as reflecting the views of those who assisted in elaborating this work.

ABSTRACT

Kawangware Location of Dagoretti Division is one of the low-income residential areas where about 60 percent of the people of Nairobi live. Before 1963, the Division of Dagoretti was under Kiambu District jurisdiction. As the colonial authorities prohibited African Local people to reside in the city unless they were employed. Indigenous people took the advantage that Dagoretti was a rural setting but near Nairobi and they massively came in. The City Council planning powers only covered the area within the city boundaries thus leaving out the rural periphery outside the official boundaries. Therefore, People settled in Dagoretti without any planning intervention at all supporting their livelihood.

In Kenya, the provision and management of infrastructure like Water Supply and Sanitation services are under the responsibility of the Government agencies. In Nairobi, Nairobi City Council (NCC) is in charge of managing those services. From 1963, the city boundary was extended to cover the entire division of Dagoretti. Thus formal Planning intervention by the city council was extended to cover Dagoretti Division.

In 1984, NCC assisted by European Economic Community¹ (EEC), undertook the upgrading of slums project. Kawangware was one of the selected slums to implement the water supply and sewerage reticulation projects scheme. Because of the flat terrain of the area, the sewer system laid out was a combined sewer to drain both runoff and wastewater. The Water project covered almost $\frac{3}{4}$ of the location while sewerage reticulation covered only $\frac{1}{4}$ of the location. Despite that effort, the sewerage project was beneficial only to a small part of the area; and the facilities that have been set up are in a deplorable state because they lack proper maintenance.

This study set out to examine the system of water and Sanitation disposal in this Suburb of Nairobi, and come up with ways of improving those services. The analysis

¹ Now known as EU, European Union

of the sources of water of Nairobi's people found that water supply is adequate and enough to satisfy water demand for the entire city up to 2007 projection.

In Kawangware, the study revealed that among other water sources (i.e. rainwater, well, etc), Water provided by Nairobi City Council is the major source of water for the residents. However, most people were complaining that they only got water once or twice in a week. That lack of adequate water supply has had significant impact on sanitary conditions in the area.

Owing to the inadequate supply of water, the sanitation conditions of the area were very poor indeed. Sewerage got blocked and sewage was diverted into open surface drains that were obstructed due to poor urban management and the habits of local people. Residents mostly used pit latrines to dispose off their night soils. When they filled, exhausters or labourers emptied pits and exposed the excreta to the eye of contaminant agents.

After a critical analysis of the worsening water supply and sanitation situation, the study has recommended that the Government and public sectors should pay special attention to the protection of the Nairobi water catchment area of Aberdare Forest and enforce the development control powers of the City Council of Nairobi. The study has recommended further the need for a clear and strong partnership of the public, private and community effort in water supply and sanitation provision within the study area. The research has also recommended the construction of more storage water tanks in the location, the improved layout of sewerage system (in the entire location) to which both private and public toilets should be connected.

The construction of tanks, toilets and layout of sewerage reticulation would be beneficial to residents by increasing the capacity of water supply and the access to modern sanitary facilities, and indeed, create the healthy living environment urgently needed in the area. Furthermore, the project envisages that the implementation of the above mentioned policy strategies would eventually create increased job opportunities for the residents of the study area.

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LIST OF ABBREVIATIONS

UNCHS	: United Nations Centre for Human Settlement
UNCED	: United Nations Conference on Environment and Development
WSSD	: World Summit on Sustainable Development
UNDP	: United Nations Development Programmes
WHO	: World Health Organisation
NWCPC	: National Water Conservation and Pipeline Corporation
MOW	: Ministry of Water
IPRSP	: Interim Poverty Reduction Strategy Paper
CBD	: Central Business District
GDP	: Gross Domestic Product
WSS	: Water Supply and Sanitation Services
CAP	: Community Action Plan
NGO	: Non Governmental Organisation
RBO	: Religious Based Organisation
CBO	: Community Based Organisation
NCC	: Nairobi City Council
CWP	: Communal Water Point
IC	: Individual Connection
FH	: Fire Hydrant
ITPA	: Indian Transfer of Property Act
RLA	: Registered Land Act
RTA	: Registration of Titles Act
B - Coli	: Bacterium Coli-forms
pH	: Potential of Hydrogen (Hydrogen ion ⁺ concentration)
SPSS	: Statistical package for Social Scientists
BOD ₅	: 5 days Biochemical Oxygen Demand
COD	: Chemical Oxygen Demand
DO	: Dissolved Oxygen
p.p.m	:Suspended matter <i>per million parts of water</i> (2.5 to 10 ppm drinking water)

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.1. INTRODUCTION

Year by year, urban centres continue to grow both physically (in size) and in population size. This urban growth has been partially caused by natural increase of the internal city population and the massive movement of people from rural to urban areas due to the deterioration of rural living conditions. The proportion of the world's urban population was between 40 and 55 % (Habitat, 1996) depending on the criteria used to define urban centres. At this rate, it is estimated that more than half of the world's population would be living in urban areas. This increased population in urban areas will overwhelmingly increase the demand of services necessary to support these increased settlements.

In developed countries, urbanisation has led to improvement in the quality of living¹ of the population, but this situation is worse in developing countries. Rising levels of urbanisation and rapid growth of cities have been problematic (Habitat, 1996). The growth of the population in urban areas implies an increased demand for services enabling them to meet their basic needs. Those services include water supply, sanitation facilities, appropriate drainage and sewerage systems among others to deal with the health of the urban populace.

The Governments of the third world countries fail to ensure that service delivery² keeps pace with the growth of population. Also they fail to enforce regulations needed to protect the quality of life especially in urban areas. (Habitat, 1994) (Habitat, 1997),

¹ New attitude, awareness, Social change, scientific information and technical knowledge, decreased fertility, increased income, etc.

² Housing, infrastructure, transportation, environmental sanitation and environmental pollution, water supply among others.

In line with the General Assembly of United Nations November 1980 decade: *“To provide all people with safe water quality and adequate quantity and basic sanitary facilities by 1990”* Governments of the world are trying to provide services to better conditions of life in the urban areas and the number of reached people has increased significantly. The rate of economic growth is low and the role played by the governments is more pervasive in African countries comparing to other countries of the world. They invest about 4 per cent of their national output and one fifth of their total investment in new infrastructure (World Bank, 1994). Nevertheless, the majority of the population in the developing world still lack access to clean water and adequate sanitation.

In developing countries, Kenya in particular, the infrastructure services, including water and sanitation, have been distributed and provided inequitably. In urban areas, large populations living in informal settlements within the towns and cities have no access to safe water (IPRSP-Kenya, 2000). The poor urban areas have been neglected because they are not able to pay for those services. In addition, they are not considered in the political planning process. Although the majority of urban households obtain water from the main piped network – 90 % in Nairobi – poorest households, particularly those in informal settlements, receive this water through indirect means such as water illegally connected, kiosks and handcart vendors.

Kawangware, our study area, is one of the slums of Nairobi that had been upgraded. During the upgrading program, only a part of the sub-location had been covered with sewer. Water supply had been provided in a way that a standpipe source was located at least at hundred metres distance from each dwelling unit. In spite of the upgrading exercises, residents still experience serious water problems. People get water once or twice in a week at very low water pressure.

Sullage and sewage which flow by gravity, require a certain quantity of water (10 litres to evacuate the waste of one person in a flush toilet). Therefore, due to the inadequacy of water supply, drainage and sewerage often get blocked.

The purpose of this study is to find out causes of these problems and to come up with appropriate strategies to resolve the shortage of water supply in Kawangware. This is seen as the most critical factor constraining the process of development in the area. It is thus assumed that with improved water supply in Kawangware, the provision of other water related services such as sewerage and sanitary facilities would be improved thus facilitating better standards of living and overall development possibilities. The successful and acceptable outcomes of this research can be useful in other urban areas where they will be found relevant.

1.2. PROBLEM STATEMENT

Lloyd Rodwin (1965) argued that in urbanisation strategies, planning method and political process are ideologically linked in terms of world view which involves both the perception of urban problems and the specification of goals to be achieved, and practically linked in terms of the power to implement the means thought likely to achieve the ends.

In Kenya, like in other developing countries, the provision and management of a variety of public services such as water supply and sanitation are under the responsibility of the Government Agencies: Local Authorities and National Water Conservation and Pipeline Corporation, (Aligula, 1999). Also, Private Institutions and Self-Help Projects are active in the process of infrastructure management and provision.

In Nairobi, although the majority of households obtain water from the main piped network – 90 % in Nairobi – poorest households, particularly those in informal settlements, receive this water through indirect means such as water kiosks and handcart vendors at a price much higher than the price fixed by Nairobi City Council despite the presence of water pipes at few metres distance from their doors.

In Kawangware, residents experience serious shortage of water. When it is supplied, it comes once a week and with low pressure. It makes women and other drawers

spending hours, queuing to fetch water. This time would be spent in more valuable economic activities.

Poor urban residents do not have access to conventional waste and sanitation services. The majority rely on on-site technology, ranging from the wrap-and throw method to communal septic tanks systems, many of which have proved inadequate in the face of growing urbanisation and rapid densification.

The condition of sanitation is very poor: during the rainy season, roads become inaccessible for both vehicles and walkers, water lying stagnating in ponds and ditches, inadequate garbage collection, residents use drainage and foot paths as their dumping sites. In short, inadequate control of development activities in the area might have contributed to the deterioration of services such as roads, water supply, sewers, drainage systems and other services.

The key question is on how to improve the water supply and sanitation in the study area through enabling, supporting policies and technical strategies. The study is also concerned with the responsibility for the provision and management of these services and how these services can be used to improve the quality of environment in the area and general development.

1.3. RESEARCH QUESTIONS

1. What is the existing state of water supply and sanitation in Kawangware?³
2. Who is responsible for the provision and management of these services?⁴
3. How can these services be used to improve development in the area?

³ How poor is it?

⁴ Performance of Responsibility.

1.4. STUDY GOALS

The overall goal of this study is to examine the system of water supply and sanitation disposal in Kawangware, a low-income residential suburb of Nairobi and come up with ways of improving water and sanitation services.

1.5. STUDY OBJECTIVES

In order to reach the goal stated, the following specific objectives have been formulated:

1. To evaluate the existing situation of water supply and sanitation in the study area;
2. To identify the problems and constraints in the provision of these services;
3. To identify the agencies involved in the provision of water supply and sanitation services⁵;
4. To examine the role of those services in the development of the area.
5. To suggest appropriate policy guidelines (or priorities) for the development of the area.

1.6. ASSUMPTIONS

- **As₁**: Inadequate development control has led to the deterioration of services provided such as water supply, sewer and drainage system;
- **As₂**: Improving Water supply and sanitation services will significantly enhance the quality of life of the residents⁶.

⁵ The Role, capacity, limitations and performance of the agencies in provision and management of wss.
⁶ Quality of life in terms of household income, people's health, decreased diseases/illness, environment pattern, aesthetics (the area will be clean) etc.

1.7. SCOPE, ORGANISATION AND STRUCTURE OF THE STUDY.

In Kawangware location, Dagoretti Division of Nairobi Province, the main emphasis was examining water supply and sanitation services and how these affect living conditions and general development in the area. The study also looked at the agencies involved in the provision and management of these services and their performance. It also examined the possibilities of improving development in this area through the improvement in water supply and sanitation services.

The study is structured into six chapters: Chapter one outlines the introduction of water supply and sanitary services in low-income settlement, it includes also problem statement, the objectives of the study and the study methodology applied.

Chapter two reviews the information from other studies carried out in relation to water supply and sanitation services taking into account poverty issues especially in urban low-income areas. Also the issues of urbanisation, landownership, infrastructure services and water and sanitation services are emphasized in this chapter.

Chapter three deliberates over the background of the study area and the existing situation with regard to water supply and sanitation services (constraints and problems).

Chapter four presents data analysis and deals with agencies involved in management of water supply and sanitation services in the study area, their limitations and roles.

Chapter five examines the role of water supply in development of the area and suggests appropriate policy priorities for the development.

Chapter six includes summary and conclusions of recommendations of strategic solutions for the efficient management of water supply and sanitation services in order to keep the environment safe and sustain urban development.

1.8. JUSTIFICATION OF THE STUDY

In urban areas, the high cost of housing pushes the majority of the urban dwellers to seek residence in low-income human settlements⁷. The conditions of infrastructure services in general, and water supply and sanitation in particular are very poor.

Majority of urban people in Nairobi, live in suburban areas like Kawangware and other such as Kayole, Mukuru, Kibera, Kangemi, Waithaka, Dandora, Korogocho, Mathare, Kariobangi⁸, areas with high concentration of population and of course inadequate provision of such services as water supply, sanitation facilities, drainage and garbage collection amongst others.

It is very necessary to assess new ways of meeting public needs for water supply and sanitation systems from services that are more efficient, more use responsive, more environment friendly, and more resourceful in using public, private sectors and stakeholders.

The problem of inaccessibility to water and sanitation is most apparent in the urban fringe areas of Nairobi and the low-income residential areas where majority of the urban poor live. Lack of public water taps has forced the urban poor to purchase water at more than 10 times the cost of piped water services owned by Nairobi City Council (NCC).

Because of the unreliability of water supplied by NCC, people (middle and high income) have tried to provide residents with water through shallow wells and boreholes at high cost.

The inaccessibility to sewer has pushed the poor people to rely on their traditional pit latrines. Though shallow wells or/and boreholes and pit latrines are very incompatible in the sense that seepage of waste from pit latrines can contaminate those water supply sources. In this case, there is a strong need for the people to access to sewer

⁷ Map 3.2. shows different Informal Settlements and the Study Area

⁸ See Map3.2 Informal Settlements in Nairobi.

system despite their meagre resources. Otherwise, people will use or consume water that is highly polluted.

The sanitation problems in Kawangware, low-income settlements, are varied: piped water had been distributed but in unreliable quantity. People get water once and for only 8 or 12 hours a week. Sewer and Drainage systems, where they exist, are blocked and overflowing, and burst water and sewer pipes take a long time to be attended to. To cope with that shortage of water, residents have bought containers to store water. During rainy season, roads become inaccessible both for vehicles and walkers. Water lying and stagnating in dirty ponds and ditches due to inappropriate drainage, the type of soil and the flat terrain of the area. Because of inadequate garbage collection, residents use open drainage as their dumping site. All these are partially caused by the fact that the development is not adequately controlled. Residents had been given the title deeds for freehold land tenure before the boundary expansion of Nairobi City in 1963⁹, a plot, which was expected to house one family, has now 20 to 30 families occupying back-to-back houses. (Ondiege, 1989 quoted by R.A Obudho)

The study done by Mulinge (1986) revealed that despite the upgrading exercise that had been done in Kawangware, a lot was left unaccomplished and the drainage system was neglected. The upgrading exercises had then increased the level of services but due to the ill development control and inadequate maintenance, those services are deteriorating day by day (Aligula, 1999).

In urban areas, large populations living in informal settlements within the towns and cities have no access to safe water. In the IPRSP, the government of Kenya seeks to improve the quality of life of the poor; and increase the ability of the poor to raise their incomes. And thus the provision of Water and Sanitation is one of the strategies for this end.

To ensure efficient, effective and responsive delivery of water services in Kawangware, operation and maintenance of the services must be efficient and

⁹ See Fig. 2.4. (Expanding boundary of Nairobi). p.19

effective, and incentives need to be changed through the application of management, competition, and stakeholder involvement. The role of the government and the private sector must be transformed as well.

During this study, the researcher intends to examine the performance of infrastructure services¹⁰, and, in particular, find out the root causes of the shortage of water supply as well as the condition of sanitation services. And finally, the study ends up by recommending means to improve water services in Kawangware location. The location is 10 Km away from the Central Business District of Nairobi. Kawangware location has the population of about 90000 (Kenya Population Census 1999). It is located in Dagoretti division, Nairobi District.

1.9. RESEARCH METHODOLOGY

1.9.1. Sources and methods of data collection

Data collection method includes a range of participatory and social analysis tools. To collect information, both primary and secondary sources were used. Primary data were gathered through the use of questionnaires, observation and key informant interviews. Primary sources have been mainly: The consumer/ household questionnaire, Nairobi City Council, Water and Sewerage Department and Community Water Projects operating within the area of study. Information was collected with respect to:

- Demographic characteristics of the households;
- Socio-Economic indicators of the households (income, expenditure, employment);
- Dwelling characteristics;
- Infrastructure services;
- Community Organisations (CBO's, NGO's, RBO's);

¹⁰ Housing, Water Supply, Sewerage, Roads, Public and private Transport, Electricity, Telecommunications, Educational and Health Sectors, Solid Waste collection, Recreation Facilities, commercial activities, etc.

- Water and Sanitation performance (Water Supply, Sanitation, Drainage, Sewerage and garbage).

The target respondent was the household head, but in his absence, the spouse or another family member of age above 18 could give information. Somehow, all questions might not be asked; the researcher or his assistants used the on-site observation and informal interviews (direct questions).

Secondary data were obtained from the Internet and library materials such as documentation from different libraries based in Nairobi. Library material set up on urbanisation, land uses, infrastructure facilities, water supply and sanitation, housing and human settlements, and environmental issues at international, national and local levels.

1.9.2. Sampling and Sample size

Kawangware location covers an area of 4 square Kilometres. According to Housing and Population Census 1999 for Kenya, the location houses 86824 people distributed in 29918 households. It is divided into Kawangware and Gatina Sub-locations with 52117 and 34707 people respectively. In order to get a representative sample, the study considered the two sub locations separately. When time and resources allow, most research should take as big a sample as possible to represent salient characteristics of the accessible population (Mugenda, (1999). Gay (1981) in Mugenda says that for experimental studies, at least 30 cases are required. To avoid repetition due to the fact that the residents were almost homogeneous, the researcher randomly administered 147 questionnaires (Random sampling is when the choice of the individuals for inclusion is left entirely to chance. The probability of inclusion in the same sample must be equal and independent for each individual). And based on the number of population in each sub-location, 60% of the questionnaires were administered in Kawangware and 40% in Gatina. Consumers are domestic, agricultural, commercial and institutional.

1.9.3. Data analysis

The process of data analysis involved:

- Coding the data
- Data entry into the computer using SPSS Package.
- Data analysis

In data analysis, the researcher used SPSS “the Statistical Package for Social Scientists” and Excel Software for displaying graphs and pie charts; furthermore both quantitative and qualitative techniques were used to analyse the field survey data. Those techniques also included computation of frequencies, percentages and cross-tabulations of different variables.

1.9.4. Data representation

At the end of the time, graphs, charts, photographs, maps, and tables were displayed in different sections of study; that were environment, population and human settlement characteristics, socio-economic indicators (income), infrastructure conditions etc. Also different theories in relation to Physical Development Planning were observed.

1.10. LIMITATIONS OF THE STUDY

One of the limitations of the study was budgetary constraint, which made it difficult to utilise a more detailed design. Also it was not easy to gather information especially from public institutions and from some residents due to suspicion because of my foreign status. Despite those difficulties, the researcher helped by his assistants was able to gather diverse information of households’ characteristics. From the Internet the author managed to get some information lacking for public institutions.

CHAPTER TWO

LITERATURE REVIEW

2.1. URBANIZATION

2.1.0. INTRODUCTION

In spite of declining rates of growth¹, the world's population continues to grow. This implies that more people will demand more services (Habitat, 1996).

Malthusian principles of population revealed the law of nature that "all population, at all times and places tend to go on expanding until they reach the "limits of subsistence" (Thomas Robert Malthus, 1798). Population, Malthus claimed, tended to increase in geometrical progression, while on the other hand, the growth of the productivity of agriculture could only be in arithmetical progression. This being so, increasing population must eventually overtake any conceivable supply of food, existing land and any service provided including water services; in brief, population growth does threaten to overtake "the means of subsistence".

The population of Kenya is about 33 million and is projected to increase to 46 million by 2020. The projections assume a moderate decline in fertility and death rates, and also have to take into account the AIDS epidemic (Okeyo, et al., 1999). Despite the decline of the growth rate of population over past decades, Kenya's annual population growth rate is still higher at 1.71 % in a fixed area of about 569,137 km². Due to the urbanisation rate of about 7.05 %, it is clear that more than half of Kenyan population will be living in urban areas in the years to come. Still, this will overstretch resources in urban areas decreasing standards of land management. Infrastructure, water and sanitation and municipal services will lead to a steady decline in health and environmental standards.

¹ Africa population growth rate in 20 century was 1.9, while in 21 century it is expected to be 1.1 %

2.1.1. Urban spatial organisation

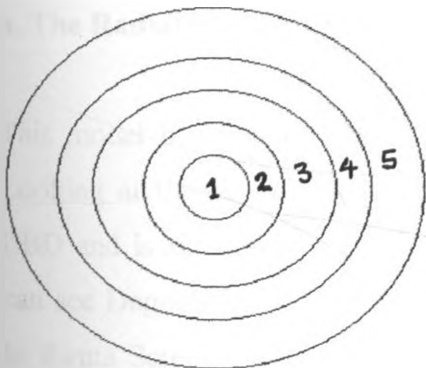
a. *Concentric zone concept*

This concept was developed by Burgess in the early 1920's to explain ecological processes in the city. According to him, the city is a series of five concentric zones. In the core is the Central Business District (CBD) characterised by commercial activities and public services such as shopping areas, lodging, banking and other businesses that seek a central location such as retailing and wholesale and similar activities. The second zone is "the zone of transition". It is identified by the variety and changing character of its uses. It is occupied by warehousing, wholesaling, light manufacturing etc.

The third zone is the workers housing and factory whose location is determined by the convenience of the workers that wish to live near their place of work. High-rise apartments with cheap rents per unit dwelling and high overall rental return per acre of housing characterise this zone.

The fourth zone is the higher-class residential area where are found single-family dwellings occupying a large parcel of land.

Figure 2.1. Concentric zone concept



Finally, comes a commuter zone for residential suburbs and satellite commercial and shopping centres. Burgess revealed that as urban areas expand, each inner zone would extend its area by invading the next outer zone. This fact depends on the urbanisation rate of the city in terms of economic growth and population increase.

In trying to relate Burgess' concept with Nairobi's structure, although the Burgess' conception of land use location purely depends on economic variables, the growth of Nairobi tends to follow the Burgess's pattern despite a few contradictions and discrepancies mainly due to physical, social and political factors. The land use location has been determined by the colonial government on racial lines rather than by economic considerations.

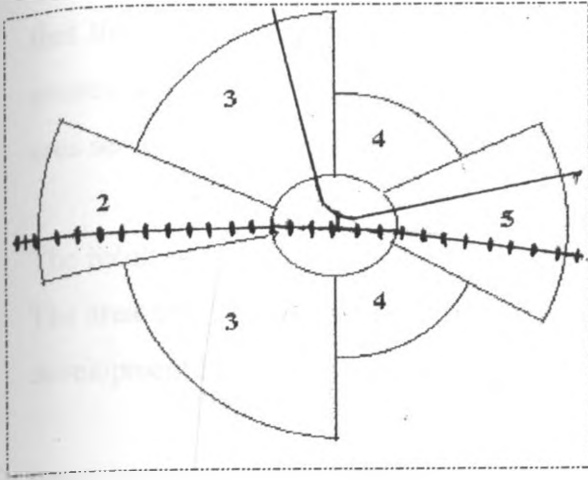
Due to restriction of the colonial government policy forbidding indigenous communities to settle in town, people from rural areas have found the outer area of the city their area of concentration and settlement without any control and services.

Before 1963, Dagoretti division was within Kiambu District. And as the city invaded the outer zones, Dagoretti was annexed to the city in 1963 following the 1963 boundary extensions. So Kawangware's location was supposed to fall in the commuter zone of the city of Nairobi because of its position beyond the zone of the high-class residential area called Lavington. But normally due to the city's change of boundary, the location found itself in the third zone inhabited by workers where there were and still are generally found cheap, woody and iron sheet built houses despite high rise apartments that are apparently developing more and more at a higher speed as part of invasion process.

b. The Radial Sector Model

This model of H. Hoyt (1939) focuses on the residential structure and land value. Looking at this model, Dagoretti does not fall in each sector. It does not touch the CBD and is situated beyond high-income low density as mentioned earlier. Also, one can see Dagoretti Division as the extension of Kibera slum that is near the city centre to Riruta Satellite. The development of Dagoretti Division and Kawangware Location is explained better by the concentric zone concept than the sector concept.

Fig.2.2. Radial Sector of land use Pattern (After H. Hoyt 1939).

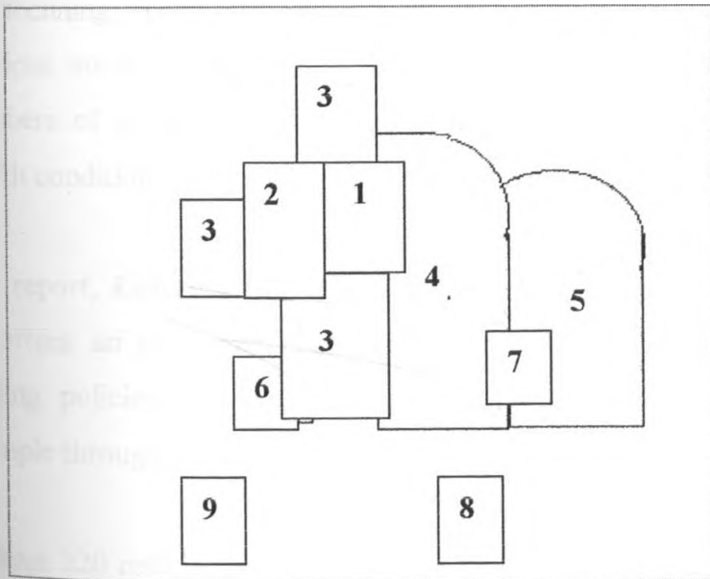


1. CBD,
2. High Income Low Density Residential,
3. Medium Density Residential,
4. Low Income High Density,
5. Manufacturing and Warehousing Zone.

c. Multi nuclei model (Harris and Ullman 1945)

Conceptualised by Harris and Ullman, this Model is more or less an elaboration of the first two models: Modern cities are seen as having essentially cellular structures in which homogenous types of land use tend to develop around certain specialised nuclei with an urban area encouraged by agglomeration economies.

Figure 2.3. Multi nuclei model (after Harris and Ullman 1945)



1. CBD, 2. Wholesale and light manufacturing,
3. Low class residential,
4. Medium class residential
5. High class residential,
6. Heavy manufacturing,
7. Outlying business District,
8. Residential Suburbs,
9. Industrial Suburbs.

Dagoretti (Kawangware) is seen to be a typical residential suburb of the Western part of Nairobi housing the low-income class. The presence of low-income people and a lot of illegal water connections have strained the supply of Water and Sanitation

conditions. In addition to this the relief form of the area, the poverty state, and the fact that the area is not planned. The high pressure of population has pushed landlords to construct houses using temporary structures to cope with the demand of housing as the area serves as the dormitory for some workers of the city.

The result was that the area received inadequate water and this implied poor sanitation. The area appeared as one of the urban areas, which required great attention in terms of development in general, and water and sanitation services provision in particular.

2.1.2. Urbanization and Development

Urban Centres have continued to grow both in area and in population size. Gunn (1978) argued that urban areas are developing so rapidly due to natural growth of population and the migration of people from the countryside in search of a better life.

Evidence is now that the advantage urban areas previously had over rural areas on various health, social and economic indicators was wiped out or even reversed (World Bank, 2000). The unprecedented shift in rural-urban population distribution in the face of declining economies raises new challenges in the campaign to improve basic services such as Water Supply and Sanitation facilities for the rapidly growing numbers of urban poor in Africa because probably those services will improve the health conditions and enhance the outcome of the beneficiaries so as to reduce poverty.

The report, **Entering the 21st Century**, argues that "localisation" will prove just as important an economic phenomenon as globalisation, and the World Bank's own lending policies will focus increasingly on improving social welfare of cities, for example through the provision of clean water and sanitation in urban poor.

At least 220 million urban dwellers or 13 per cent of the population in the developing world, lack access to clean drinking water and twice as many lack access to proper sanitation. Domestic and industrial waste is piled in streets and waterways, spreading disease. (World Bank, 2000)

The World Bank places great emphasis on working in partnership with local authorities and community groups to improve the amenities of urban life. This is a pronounced change from its past policy of lending for big projects to national governments either directly or through nationalized industries or agencies.

In Kenya, the rate of urbanization is one of the highest in the world. While the estimated annual rate of growth of the urban population in Kenya is at about 7.05 %, the average for African cities is 4.37 % and 2.5 % for the world (Obudho, 2001). This has overstretched the capacity of infrastructure and services in the large towns, to the extent that large sectors of the population have to live in slums, exposing themselves to numerous hazards such as fires and epidemics. More than half of the urban residents live in poverty. They dwell in peripheral urban areas, have limited incomes, education, and poor diets and live in unsanitary and overcrowded conditions. Safe drinking water, decent housing and transportation are particularly inadequate. Poor construction and the unplanned nature of these informal settlements expose dwellers to effects of numerous calamities.

Nairobi exemplifies the crises of rapidly growing urban population and rapidly deteriorating health conditions throughout the African region; the city's population has been growing at five percent per annum since the 1980s, and it is estimated that more than half of its population lives in slum settlements. While the proportion of people living below the poverty line in Kenya increased from 45 to 52 percent between 1992 and 1997, in the city of Nairobi it doubled during the same period (26 to 50 percent).

Table 2.1.-- Nairobi: Population for selected years, 1928-2030

Year	Area (km ²)	Population	% increase p.a.	Density
1928	25.37	29,864	17.1	1177
1969	689.45	509,286	9.8	739
1979	689.45	827,775	5.1	1200
1989	689.45	1,324,570	4.8 ^a	1921
1999	696.00	2,143,254	4.7	3079
2005	696.00	2,810,000	-	4037
2010	696.00	3,536,000	-	5080
2020	696.00	5,597,792	-	8042
2030	696.00	8,861,018		12731

Sources: East African Statistical Department (1986), Republic of Kenya (1966, 1971, 1981, 1994, 1999 Housing and Population Census). And (a.) Estimated.

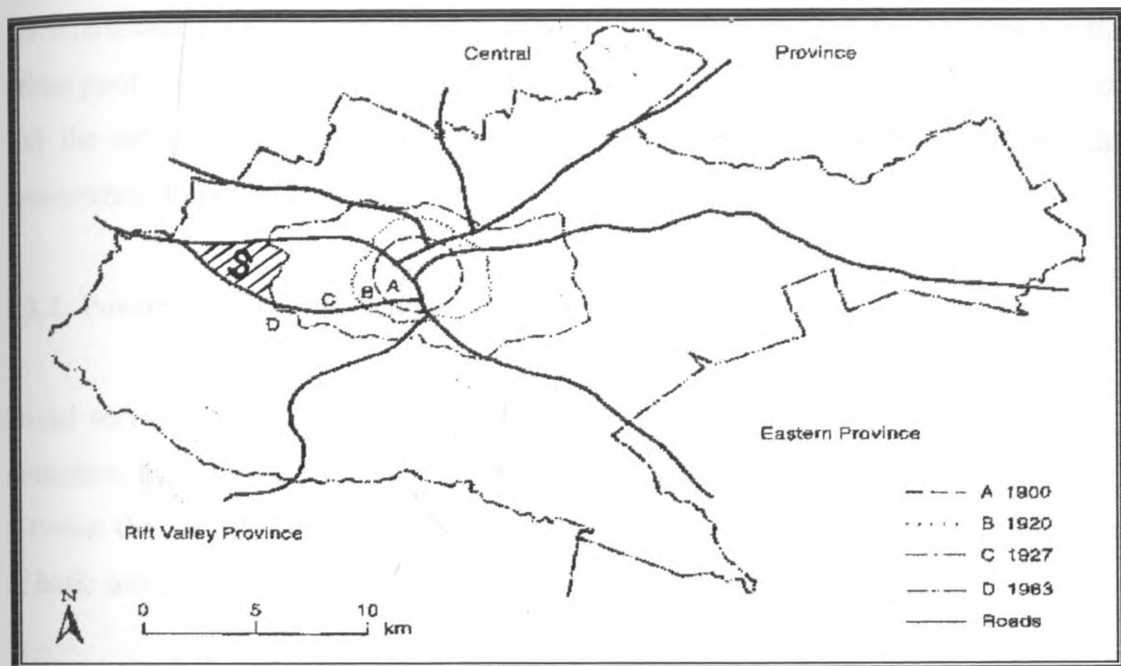
This increased population in urban areas has overwhelmingly increased the demand for services necessary to support these increased settlements and protect the environment.

Gunn (1978) revealed that in the world, the urban poor settlements are located on the fringes in form of huts and hovels and sometimes no shelter at all. These settlements are known by different names in different places: gecekondu in Turkey, shanty town in Manila, bustee in India, favela in Brazil, barriadas in Peru, colonias proletariats in Mexico, bidonville in Morocco, sharifa in Southwest Asia, and Slum in Kenya. The general term to describe these kinds of human clusters is “slums and squatter settlements”.

Based on Burgess' Concentric-zone concept, Nairobi's boundary was expanded in 1963 to include areas that had been neglected in providing public services _ i.e. Kawangware, and other surrounding areas. People in that area have freehold titles. Landlords had constructed houses in the sense that plots that were expected to house one family each, today serve 25 or more families each a fact that has strained the provision and accessibility of essential services such as water and sanitation. This had created serious challenges to planners and other developers so as to face those illegal tendencies.

Earlier government policies of forced evacuation and bulldozing have given way to a realization that squatter settlements fulfil a social function. They need upgrading in order to provide them services to support their livelihood. In line with those policies, some of slum areas of Nairobi, 33 percent of the population of Nairobi have been upgraded (Habitat, 1978).

Fig. 2.4. Nairobi: Boundary changes, 1900-1963



(Source: Obudho and Aduwo, 1992, p. 53)

2.2. POVERTY AND SERVICES PROVISION

Poverty is multidimensional; it is dynamic, complex, institutionally embedded, and a gender and location specific phenomenon. (World Bank, 2000). It is the lack of multiple resources that leads to hunger and physical deprivation (housing, land and other assets).

The poor are those who cannot afford basic food and non-food items, they constitute slightly more than half the population of Kenya (52% according to the 1997 Welfare Monitoring Survey). Both the number of absolutely poor people and the incidence of poverty are increasing. The number of poor people increased from 12.5 million in

1997 to about 15 million in 2001. The same survey shows that poverty reached 49 percent of the urban population.

Many researches have been formulated in order to find out the nature and causes of poverty, leading to exchange of ideas, sharing of experiences and as a partnership building for a sustainable poverty reduction (Ngau, 1995).

To strengthen plans and strategies on poverty reduction, there is need to involve the urban poor themselves that are target group and to know their economic characteristics and the roles of the local Community Based Organisations 'CBOs', NGOs and the Government in poverty alleviation.

2.2.1. Poverty and the challenges of development

Social services and infrastructure needs are obvious and immense and include water, sanitation, transport, energy, housing, education and health. There is a close correlation between the economic performance of urban centres and the availability and reliability of basic services. Productive cities need adequate provision of infrastructure.

Still, the situation remains unsatisfactory in many cities. For instance in the water sector, Africans living in cities consume 35 litres per person per day – compared to more than 300 litres per person per day in the United States (UNCHS, 2000). Only 60 percent of the urban population have direct access to water services. And obviously, the poor are disproportionately represented among those who are not served. They often have to rely on informal providers (vendors, tankers, and neighbours) to obtain water. They end up paying much more than those who are connected, for a much smaller quantity of water, and a much lower quality of water supplied.

What we can highlight in this study is that, when helping to improve the delivery of basic infrastructure services, the "how" is often more important than the "what":

In water sectors, external resources to finance the necessary effort are mostly from the World Bank. Over the last three years, the World Bank committed about \$600 million for new urban projects (World Bank, 2000). The assistance includes hands-on

technical advice to regulators, utilities, and also to other stakeholders, in order to disseminate international best practices. It includes also forging solid partnerships with local governments, private sector, NGOs, and other donors – such as the Cities Alliance and the African Water Utilities Partnership

For an urban water and sanitation project to be successful, simultaneous action is needed along four directions: improving governance and management, creating an investment climate in urban areas for private sector led growth, ensuring adequate financing and provision of sanitary, water and other services.

Low-income settlements lack completely services or those services are inadequately developed and managed, as is the case of the study area. They are termed uncontrolled, unplanned, spontaneous, illegal, squatter, and temporary, among other terms.

2.2.2. Slum and Squatter Settlements

Slum settlements comprise older areas of existing urban centres undergoing deterioration and decay. Slum settlements may be either rented or owner occupied, either legal or illegal. They include shanties, cabins, dens, dug-out, sheds, stalls and other manifestation of poverty.

Mabogunje, (1970) quoted in Obudho, (1989), defining slum as “ a collection of insubstantial housing constructed of recuperated waste materials of wood or corrugated iron sheet, mud wall and thatch-roof or iron-roof”. Those slums serve as reception areas for migrants since they offer relatively cheap accommodation and are centrally located. On the whole, they represent poor housing and deplorable environmental conditions.

Squatter settlement is thought to be temporary in nature. Squatter settlements reflect effort of the occupants providing themselves with shelter. Most of squatter settlements, however, have very few (or no) urban amenities such as schools, roads and electric facilities, water and refuse disposal services and drainage systems. They are usually

located on land or in buildings, which are occupied without the consent of the owner (Peil, 1976:15).

Many countries have addressed themselves to the problem of slum and squatter settlements. In Africa, slums and squatter settlements have been multiplied as unemployment and poverty have risen sharply. Their conditions are inextricably connected to the unprecedented rates of urbanisation caused and fuelled by rural to urban migration, urban population natural increase, increase of urban boundaries, economic and political conflicts in neighbouring countries and a combination of these factors. Poor health of slum dwellers is due to poor housing conditions, poor nutrition, inadequate medical attention and the last but not least is the wilful disregard of personal hygiene (Clinard 1966), and Marris (1961) in Murison and al 1979) in Mairura, 1988)

In Nairobi, slum and squatter settlements have been multiplying and deteriorating at a fast rate due to lack of environment care and economic inability of dwellers to afford housing standards and also lack of security of land tenure.

Based on the description above the study area is a mixed settlement: some areas are developed while other are so far behind. Roads had sufficiently provided but they lack maintenance and they were deteriorated. Even the said developed area had anarchically been developed. The description of the study area is broadly discussed in the following chapter.

2.3. LAND MANAGEMENT IN KENYA

2.3.1. Introduction

Land is the core of the existence of many people. Many of them depend on the produce from the soil for food and other needs. It is therefore very important that they know the legal framework within which they own, transfer or deal with the land.

In Kenya land is predominantly managed under British law. The colonialists were interested in Kenya land because of its great potentialities in agriculture. They then introduced their law to govern the manner in which land was to be owned and used for agricultural purposes.

Before colonialism, land in Kenya was owned communally and governed by customary law. The introduced English law describes a situation where an individual person owns a piece of land to the exclusion of all other.

The government of Kenya has retained both systems of law governing land in order to satisfy traditional and modern values.

*Under customary law, **land** means only the soil or ground that is used for farming. While under English system, **land** is defined so as to include not only the ground, but also everything under or above it. Hence, everything below the ground to the centre of gravity and everything above it to the sky are included.*

2.3. 2. Land Ownership in Kenya.

Much of English land law is expressed in Acts of Parliament. Customary law, one of the sources of land law in Kenya, is not written and differs from ethnic group to another. That means that for one to be a landowner in Kenya, he must own it under a particular system of law.

The concept of ownership in land needs to be understood, this enables the owner to know the extent (size and scale) of his interest in land and the cause of action to be taken in case of any dispute. Owning land implies holding a specific interest in land or in other words, that an individual has the totality of rights on, in and over a given piece of land. Many laws concern themselves with these interests, their definition and the manner of their creation. Even under customary law, different members of a community had different rights over communal land: grazing one's domestic animals, picking firewood, tilling (preparing and using land for growing crops) etc.

There are two main Acts of Parliament that embody the English system of land ownership in Kenya:

- Indian Transfer of Property Act, 1882 (ITPA). This Act was introduced to govern landownership in the areas then called “White Highlands”. This law defines the various interests that exist and can be held over and the manner in which these interests may be created and transferred.
- Registered Land Act (RLA) (Chapter 300 of the laws of Kenya). This Act governs land formerly held under customary law. It was enacted in 1963. in a reform programme aiming to replace the customary law system of communal ownership of land with the English system of individual ownership.

The process of registration of Trust Lands under RLA is in three stages:

- a) Adjudication whereby the relevant officers from the Ministry of lands and settlement with the help of the inhabitants of the area, go about ascertaining the rights of ownership to a given piece of land in that area. Adjudication takes place with regard to land which is unregistered and is still held under customary law;
- b) Consolidation, this is the combining of small pieces of land to which rights of ownership have been identified into larger economic units;
- c) Registration to bring the land no registered under the regime of the RLA. This process is still going on in Kenya. (Smokin Wanjala, 1990)

Customary law governs the ownership of land where Adjudication, Consolidation and Registration have not taken place. That is the land which has not yet come under the regime either the ITPA or RLA and therefore it has no provision for registration.

In modern land law of Kenya, land is registered under a particular Act of Parliament. Registration enables individuals persons to deal with land more easily as a commodity which they can transfer, sell, buy, lease or mortgage as they wish. There are two systems of land registration namely the *registration of deeds system* and the *registration of titles system*. The latter is the more preferable as the title is guaranteed by the government.

2.3.3. Interests in land under Kenya law

Land is a commodity. When registered, there are many things the owner can do with it, he can sell it, lend it out to other people for sometime, as well as mortgage it to other people in return for a loan. In so doing, he creates legal rights and interests in favour of those other people which can be enforced against him. Because land is immovable, the law has devised many interests that can be created over it.

In term of **Ownership**, one talks of holding or owning an interest in land rather than the land itself. This is because in English law, nobody owns the land except the Crown. These interests in land were called “**estate**”. The relationship between an estate holder and the crown is called “**tenure**”.

In Kenya, we have three main categories of interests in land: *Estates, encumbrances and servitude*.

Estates in land, they are those interests that are held by individuals and group of persons for a period of time. They are either estate of *freehold* or of leasehold. Estate is simply interest in land that runs for a specific time.

A person who holds an estate of *freehold* in land is said to own it until the time when all his descendants will have died and the land remained ownerless and reverts back to the *Government*, the overall owner of land. This estate of freehold is recognised by both the ITPA and the RLA.

Estates of *leasehold* are those interests in land that an individual or group or persons holds for a definite period of time. They are generally called leases or tenancies between two the landlord and tenant. The lease between the Government (landlord) and private persons (tenants) are usually for a long period of time ranging from 30 to 99 years. Most of land owned by individuals within the Nairobi area is held as leasehold interest granted for the period of 99 years.

Encumbrances arise in a situation where a landowner (interest holder) who is in need of some money offers his land (as security) to another person so that that person may lend him the money and hold the land as a security until the money is repaid. These arrangements are called encumbrances because they are burdens on the part of mortgagors and chargors.

They are burdens because until the borrower (mortgagor/chargor) repays the loan plus interest, the lender (mortgagee/chargee) will have an interest over the land. If the borrower fails to repay the money and by so doing redeem his land, then the lender can sell the land at a public auction or privately, so as to recover the money he has lent. The lender of money are not necessarily individuals, he may be a financial institutions.

The laws governing these transactions between landowners and lenders are again the RLA and the ITPA. These two laws define the rights and duties of the mortgagor and mortgager.

Servitudes, they are the rights that a person acquires over another person's piece of Land. In Kenya, three main categories of servitudes are recognised. These are *Easements, Profits and Restrictive covenant*.

Easements are arrangements that allow a landowner to use an adjoining piece of land for the benefit of his land (i.e. rights to way, light, water, air, etc.). There must be two adjoining pieces of land owned by two persons (dominant tenement and servient tenement). And the easement is to be for the benefit of the dominant tenement.

Profits, in other hand are rights that allow someone to go over another person's land and take something from the land for his own benefit. The thing may be the soil itself or the produce of the soil for example grasses, firewood, fish, wild animal, etc). The owner of the profit need not be the owner of any adjoining land or indeed of any land at all.

Finally, *Restrictive covenant* in land law means an agreement between two landowners whereby one of them (the covenanter) promises the other (covenanted) that he will not

do some certain thing on his land. It has the effect of limiting the manner in which a landowner may use his land. This limitation is necessary for the benefit of an adjoining piece of land.

To end this section, the life of many people depends on land. Many of them do not know the right they hold over this commodity. It is with this line that the author of this work has pointed out some of laws governing land in Kenya.

In the study area, majority of owners of land still have estates of freehold. They have been given those estates because the area was rural setting. They do not have enough money to develop or build houses with acceptable housing standards and they have not yet registered their land under leasehold interests. They do not know or they seem to ignore that all lands in the city of Nairobi must be converted into leases to enable the government to control the urban development.

It is therefore very important that they know the legal framework within which they own, transfer or deal with the land. Fortunately, some of the landowners have bought land (from former landowners) and government officers have converted their pieces of land in leasehold interests. Change of uses, land subdivision and allocation are highly needed in the study area for further development and to better the living conditions of low-income residents.

2.4. INFRASTRUCTURE SERVICES

In defining infrastructure, focus is given to economic infrastructure the long lived engineered structures, equipment, facilities, and the services they provide that are used in economic production and by households. This infrastructure includes:

- Public utilities – power, telecommunications, piped water supply, sanitation and sewerage, solid waste collection and disposal, and piped gas;
- Public works _ roads and major dam and canal works for irrigation and drainage;
- Other transport sectors _ urban transport, ports and waterways, airports and urban and inner-urban railways.
- Security and social services.

2.4.1. Planning for Infrastructure Services

The role and ideological paradigms of Planners and other developers are the identification of problems in order to plan for/with the people. For any development, the number of population is of paramount importance. This number is determined through population projection based on previous population censuses, and public documentations.

On the basis of the long term growth prospects and advice from the regional unit a long term structure plan is prepared and designed to show the amount of land necessary to accommodate this growth, how the transportation system will serve it for accessibility, how will necessary services be for the living of people (residents of that land). And this plan must be flexible so that it withstands fairly major changes in growth rates. The long-term plan is for 20-25 years depending on the country.

In Kenya, both the short and long term Plans are circulated to appropriate authorities for comments. Approved at national level, the long-term plan is a policy guideline of national development. While the short-term plan, after amendment is sent to the Director of Physical Planning Development to be approved. Once approved by the Director, the short-term plan is circulated for the use of appropriate authorities.

Viewing the people as primarily responsible for their conditions in bound up with a preference for a social services strategy. For example: To improve their condition of life they need *Infrastructure* enabling their daily activities.

2.4.1.1. Housing Services

Tenure is of major importance in housing. Tenure requirements are determined by the interaction of needs, demands, preferences, and the policies and actions of local authorities and other agencies involved in providing and financing housing.

The demand for housing derives from the evidence of preferences and willingness. But essentially derives from the affordability of households to pay. The effect of income plays great role in choosing dwellings one is able to access. That is why you may find the urban area is structured according to the level of income: inhuman settlements or

“slum” low income, middle income and high-income housings. In urban area, density of population is inversely proportional to the income of household. This means that, if people are poor they accept whatever condition they live in. And if the income increases, people tend to occupy better housing in better surroundings.

As planner, when it arrives the case of planning for housing, it is necessary to meet all requirements as stipulated by Physical Planning Handbook, Building Codes and Public Health Acts and other relevant laws.

2.4.1.2. Educational and health Facilities

Educational and health Facilities, in their operation, require amount of water in relation to the number of people attending them. The number of facilities required for a certain population is determined by the following formula.

$$(E, H) = k f_{e,h}(p)$$

Where, **E, H** : Education and Health facilities

k : Constant for education or health facilities

f : function

p : population

For example a residential area of 5000 people should have 2 nursery schools and one primary school (2 streams).). For a neighbourhood of 25000, we should have: 1 secondary school (1- 4 streams), 4 Primary schools (2 streams) and 10 Nurseries schools.

As far as health facilities are concerned, the level of health services depends not only on the number of patients but also the services offered. In the long term context, one health centre and two to four dispensaries could be planned to serve about 35 to 40 thousands people.

Also any facilities or services should be located at a reasonable distance from the people they serve.

In terms of water supply and sanitation conditions, health and educational facilities require more than 25 litres/head/day and more than 5000 litres of water per day respectively. These figures significantly depend on the living styles of the community.

2.4.1.3. Road Network Design

According to the Physical Planning Handbook (1996), system of roads is provided for a growing town which:

- Will accommodate growth and change in the urban fabric,
- Will differentiate between through traffic and local traffic at various levels in a hierarchy or classification of roads by functions. For major and big cities, road functions can range from local street class to freeway so as to withstand high capacity of vehicles that congest roads and hamper the traffic as well as the environment.
- Will protect environmental standards where residential, recreational and shopping centre are concerned.

Road Reserves are defined depending on the level or class of the road. For example, Local Street should have 15 metres width of reserve while Freeway and Regional Truck have 35 to 40 metres of road reserve.

Roads network is very important and facilitates the transport of water by lorries, trucks, etc. Road reserve accommodates not only water supply pipes, but also other utilities such as sewage pipes and open drains, telephone, electricity lines and so forth.

This section comes in to enable the author of the study to find out types of roads in the study area and services provided along them. And therefore see how to upgrade them accordingly so that they fulfil all requirements that are standards and accessibility.

2.4.2. URBAN WATER SUPPLY

2.4.2.1. Sources of Water

The success of a water supply scheme depends on two aspects: the amount of available water from the source, and the quantity of water actually needed by the area and the extent of water demand in the future. The source of water should be such that it may provide adequate quantity of water even during severe drought conditions. (Gurcharan Singh, 1999)

A. Rainfall and Runoff

Rainfall is a natural feature, which may be more in one year and very slack in the next. It depends on so many factors such as nearness of the area to the sea, hills and altitude of the place. The average rainfall is estimated by making observations for the rainfall for the past 5 – 10 years at a particular place. It is expressed in millimetres over the entire area for certain fixed intervals of time that may be a day, month, season or year.

All the water falling in the form of rainfall is not led to the surface water systems (river, lakes, etc). Some of its quantity is lost by evaporation, percolation and transpiration. The net quantity of water that remains on the surface, after the losses have taken place, is termed as **Surface runoff**.

The surface runoff flows in form of streams and rivers. In the case of rivers, the upstream area, surrounded by ridges and which contributes its runoff to the river, is called the **Catchment area**.

Runoff depends on precipitation patterns and thus on meteorological, geographical, topographical and geological conditions of the catchment area. It depends also on the size of the area and the intensity of the rainfall.

B. Classification of Sources Of Water

Sources of water may be classified into two categories such as Surface sources and underground sources. The quantity of water from both sources should be adequate while its quality should not hamper the environment nor affect human health.

In order to protect the water sources and maintain water safe, some measures may be taken for example to prevent any contaminating source like runoff, vegetables and animal waste. In urban areas, the source of contamination may be effluent from nearby septic tanks, pit latrines, etc.

a. Surface Sources

As stated above, surface sources may be: lakes, streams, rivers, impounded reservoirs, stored rainwater and seawater and waste water reclamation.

Rivers form the principal source of water supply schemes for some cities. Before adopting river as source of supply, the discharge at various times of the year is recorded. River water contains a lot of suspended, colloidal and dissolved impurities. Such water requires very elaborate analysis and purification before it can be supplied for use. River water in the area is highly polluted. It is therefore not used as a source of domestic water supply.

Wastewater reclamation, if water available from the source is not adequate, wastewater can be reclaimed through treatment. This could provide an alternative source of water supply particularly for non-domestic purposes. However, there is no established process of wastewater reclamation in the study area at the moment; therefore, this has not been recognised as possible source of water supply.

Stored rainwater, this is used where neither ground water is easy to get, nor surface water is available. Although rainwater is pure, this source may not be suitable in urban areas because of the high air industrial pollution. But in the study area, this source is currently used due to inadequate supply of water.

b. Underground Sources

In these sources, the water that percolates into the ground at the time of rains is stored as groundwater at hard stratum where it begins to move in lateral direction. This is liable to vary throughout the year, depending on the rainfall, temperature, season, pressure rate of pumping, soil characteristics and other natural conditions. It is brought to the surface in different ways such as *Springs, Wells, Infiltration galleries* that is a nearly horizontal tunnel that directly collects water from water bearing strata through porous pipe drains. A new method from France has been developed for obtaining larger amounts of water from underground strata. In the method, several horizontal radial water collectors may be installed at different levels and in different water bearing layers if possible. So far, only wells are used in the study area but not considered as reliable by providers.

Natural water sources such as streams, rivers, lakes, aquifers, and oceans, etc. have been considered almost exclusively by those desiring to expand their water supplies. Up to about 75 % of the treated potable water is returned to a discharge point after its use. The infrastructure needed to reuse all of these waters efficiently is not yet in place due to the economic and public health factors, but these potential water sources should be taken into account in water supply planning strategies.

This section has been emphasized in order to see how, if possible, one or another water source can be used in the study area to improve the supply of water. The only additional water source to consider in the study area is 'wells'. This would help residents increase the quantity of water supply in the area.

2.4.2.2. Water Supply Treatment

Water from various sources cannot be used unless it is made safe. The object of treatment of water is to eliminate all such impurities that cause troubles and make water unsafe. All the harmful impurities may not be fully eliminated, but should be reduced to such an extent that water becomes suitable for the intended purposes.

a. Purification process

Treatment process depends on the quality and nature of the raw water. Only for any raw water disinfections may be done before it is supplied to the consumers.

Purification processes include screening, plain sedimentation, sedimentation with coagulants, filtration and aeration to remove floating debris, fine particles, some bacteria, and bad taste and colour. Disinfections are the last process done to make water safe against bacteria diseases.

b. Location of Water Supply Treatment Plants

Treatment plant should be located near the city it serves. By such location, the treated water reaches the consumers immediately and chances of its contamination during transmission from treatment plant to the consumers are reduced. This will reduce also the length of the rising main. If the city is large, the city may be divided into zones and each zone provided with a separate main with all the necessary treatment plant attached to it. The process of treatment should be located in such sequence that water flows from one plant to another by gravity. At water treatment site, adequate place should remain available for the future extension.

A complete layout of treatment plants consist of and namely: intake works including pumping plants _ Plain sedimentation _ Sedimentation with coagulation _ Filtration _ Disinfection _ Pure water storage tanks _ Pumping plant for purified water to the elevated service reservoir _ If water is hard, sometimes, softening plant is used before filtration plant _ Distribution system.

2.4.2.3. Water Quality

The quality of water generally depends upon the source. And this depends on the geological conditions of the soil in which water underground percolates. The concept of pure water, potable water or wholesome water is related to its various uses. This

concept is simply theoretical and therefore not applicable in our country because water is supplied for all uses.

Generally, water of good quality is one free from organisms that cause of diseases (pathogen) and must not contain chemical substance at concentration that may affect the human health. In addition, water free from taste, odour, colour and turbidity, not causing corrosion or encrustation of the water supply system not staining clothes washed in it. It is desirable to maintain pH value of water very close to 7. Also, potable water after treatment should have pH value of alkalinity characteristics of above pH 7.

The assessment of chemical and biological states of water consumed in the study area was not carried out. The fact is that people of the entire Nairobi do not trust the quality of water supplied and some of them boil it before consumption.

2.4.2.4. Water and Health

“Half of the infants that die in the World each year die from water borne. 80% of all diseases in the World are water related.”(UNDP, 1981). All diseases require for their spread a source of infection, a transmission route and the exposure of a susceptible living organism. Water mostly plays a great role in that means, once it is not well treated. Control of disease is based on curing sufferers, breaking the transmission route and protects the susceptible population. Former Director General of WHO argued that the number of water taps per 100 population is a better indication of health than the number of hospital beds. In his comparison, he wanted to stipulate that taps delivering safe water and the sanitation provision are measures of preventing diseases.

A. Water related diseases.

Diseases associated with water rob people of health, nutrients, and livelihood. This problem is most serious in developing countries. For example, about 90 per cent of the diseases occurring in developing countries result from a lack of clean water (Pimentel et al., 1996). Bradley (1977) developed a more specific classification system for water related diseases that differentiate between the various forms of infections and their

transmission routes. These diseases may be due to viruses, bacteria, protozoa or worms.

Table 2.2. The main water-related diseases

Disease	Type of water relationship	Estimated annual deaths
Cholera Infectious hepatitis Leptospirosis Tularaemia Typhoid	Water borne	4 million
Amoebic dysentery Bacillary Gastroenteritis	Waterborne or water-washed	1 million
Ascariasis Conjunctivitis Diarrhoeal diseases Leprosy Scabies Skin sepsis and ulcers Tinea Trachoma	Water-washed	Relatively few deaths but large numbers of cases
Dracunculiasis (Guinea worm) Schistosomiasis (Bilharzias)	Water based	200 thousand
Malaria Onchocerciasis (River blindness) Sleeping sickness Yellow fever	Water washed related	1 million]

(Source: Bradley (1977), Principles of water quality control)

B. Chemical related illness

Because of the solvent properties of water many substances may be found in solution in natural water and some of them are potentially hazardous to human life. This means that in some cases the allowable concentrations may be close to the limit of delectability. It is advisable to ensure that the concentration of certain harmful chemical in drinking water is kept as low as possible. (See Table 2.3)

Table 2.3. Chemical related illness

Chemical	Quantity	Infection
Lead	-	Poison
Aluminium	-	Kidney failure
Nitrate (Nitrogen)	> 10-20 mg/l	Methaemoglobinaemia (blue body disease)
Iodine (deficiency)	-	Goitre and cretinism
Arsenic	Regular consumption	Skin pigmentation, Gastrointestinal, Haematological and renal disorders.
Fluoride	> 1.5 mg/l	Yellow staining of teeth

(Source: Bradley (1977), Principles of water quality control)

2.4.2.5. Water Demand and Uses

A. Planning for Development of water services

The supply of water to town requires knowledge of the people who will be living in that town by the time the water supply is complete. Water demand projection should normally, be made for the initial (4years), the future (10 yrs), and the ultimate (20-25 yrs) from the date of the commencement of the preliminary design. .

In this case all population characteristics² including Migration pattern must be taken into account to cope with the demand at a time projected. The water source should be adequate to cater for the projected population.

B. Water Demand

The water required may vary according to actual local conditions. It may differ from country to country, region to another, community to another and/or even from individual to another. It significantly depends not only on the uses but also on the culture, living standards and local climate. Personal use of water may be for drinking, cooking, washing, flushing, irrigation etc.

Water demand may be divided into five categories, namely: *Domestic use, Public use, Industrial use, Business uses, and Losses and waste from water supply.*

To estimate the requirements of water, the demand is calculated on an average basis, which is expressed as so many litres per head or per capita per day.

a) **Domestic use**, it includes water requirements for drinking, cooking, bathing, washing, and household purposes. Although the quantity is hardly 2 to 3 litres per day per head, the amount of water required for household depends on the level of living of the family. Also, it depends upon the type of connections; the individual connection users (IC) for the rich and communal water point (c.w.p.) _ (or Kiosks) for the poor.

In brief, water required for domestic purposes should not be estimated at below 100 litres per head per day taking into account the population as a whole. And water

² Characteristics: population growth, fertility, mortality, age, household size, income distribution, attitudes etc.

requirement for domestic purposes is about $\frac{1}{3}$ to $\frac{2}{3}$ of the total amount of water required for the whole town.

b) **Public uses**, water required for fire fighting, road washing, sanitation purposes, and ornamental purposes for general public uses are included in this uses. Amount of water required for road washing may be taken as 3 to 5 litres per head per day. As far as fire fighting is concerned, provisions should be made in public water supply schemes. Fire Hydrants (FH) are installed on water mains, where fire-fighting pumps can be attached. (Water Supply and Treatment Manual, 1976). The minimum water pressure available at fire Hydrant should be 1 kg/cm^2 to 1.4 kg/cm^2 .

c) **Industrial use**, Since each industry's requirements vary, it is preferable to work out separately the quantity of water required for specific industry. Water supply and treatment manual of 1976 has given the water requirements in kilolitres per units for some of the industries.

Table 2. 4. Water requirements in kilolitre per unit of some industries.

Industry	Unit of production	Water required in kilolitre per unit
Automobile	Vehicle	40
Distillery	Kilolitre (Proof Alcohol)	122 – 170
Fertilizer	Tonnes	80 – 200
Leather	100 kg (tonned)	4
Paper	Tonne	200 – 400
Special quality paper	Tonne	400 – 1000
Petroleum refinery	Tonne	1.5 – 2.0
Steel	Tonne	200 – 250
Sugar	Tonne (sugar)	1 – 2
Textile	100 kg (goods)	8 – 14

Source: *Water Supply and Sanitary Engineering*, by Gurcharan Singh(1999)

d) **Business use**, Water required by hotels, laundries, restaurants, stables, dairies, bars, etc. comes under trade purposes. For a town that have moderate facilities of hotels, laundries, etc. an average value of water required depends on the class/state of those facilities. (See Table 2.5)

e) **Losses and waste**, All the water supplied into water mains does not reach the consumers: some of it is lost in pipelines due to defective pipe-joints, cracked pipes, and loose valves and fitting; some water is lost due to illegal connections. If the system is 100 % metered and well maintained, the uncounted water may be reduced

to less than 15 %. In India, however, water lost due to waste is assumed to be about 30 to 40 %, while in Nairobi the lost is about 60 to 80 %. Those illegal connections generally occur in low income and slums residential areas.

The water supply schemes are used for domestic, civic, industrial and trade purposes. If all those uses are added to some percentage allowance for waste is also added, we get the total requirements of water per head per day. That demand varies from town to town due to variable factors mentioned above. The above section has been reviewed in order to help the author to find out all uses and their water requirements to guide the study

The table 2.5 The amount of water required for different activities and operations such as agriculture, commerce, and industry, etc.)

CONSUMER	UNIT	RURAL AREAS			URBAN AREAS				
		High Potential	Medium potential	Low Potential	High Class Housing	Medium Class Housing	Low Class Housing		
People with individual connections	l/head/day	60	50	40	250	150	75		
People without connections	l/head/day	20	15	10	-	-	20		
Livestock unit	l/head/day	50			-				
Boarding schools	l/head/day	50							
Day schools with WC	l/head/day	25							
Without WC		5							
Hospitals	l/bed/day					} litres per patient and day (minimum 5000l/day)			
Regional							400 + 20		
District							200		
Other						100			
Dispensary and health centre	l/day	5000							
Hotels	l/bed/day								
High class		600							
Medium class		300							
Low class		50							
Administrative offices	l/head/day	25							
Bars	l/day	500							
Shops	l/ay	100							
Unspecified industry	l/ha/day	-			20000				
Coffee pulping factories	l/kg/coffee	25 (when reticulation of water is used)							

(Source: Engineering Planning Course, 2000)

2.4.2.6. Distribution of Drinking Water

Water distribution systems are ordinarily designed to satisfy water requirements for a combination of domestic, commercial, industrial, and public purposes, etc. The system should be capable of meeting the demands placed on it at all times and at satisfactory pressures.

Water distribution network is a collection links that includes water source (Intake), pipes systems, pumping stations, fire hydrants, house connections, meters, valves and other appurtenances. It includes also tanks and/or reservoirs. Water tankers, lorries and trucks also facilitate water distribution especially in low-income residential urban areas.

Conveyance of water

If the source is at higher level, water can flow under gravity from the intake point to the treatment plant. Similarly, after water is purified, it has to be conveyed to the consumers. These two exercises of transferring water from one place to another are accomplished through open channel, aqueducts or tunnel and pipes. The latter is made from various materials and mostly used throughout the world.

As depicted in the following Chapter, water distributed in Nairobi is drawn from a higher-level Chania River intake and flow to Kabete treatment plants through pipes.

2.4.3. Water Supply and the Environment

In 1992, the United Nations Conference on Environment and Development (UNCED) held the Earth Summit in Rio de Janeiro. There were discussion on many environmental and development challenges facing humanity. The international community agreed on a framework for global sustainable development, which came in the form of two agreements:

1. Rio Declaration on Environment and Development, set out the principles for human interaction with the environment and;
2. Agenda 21 formed the international guideline and action plan for sustainable development. All nations should take the initiative to undertake Agenda 21 at a local level in the achievement of sustainable development;

World Summit on Sustainable Development (WSSD) that took stock of the progress since the Earth Summit held in Rio in 1992, on *environment, social, and economic development*_ the three pillars of sustainable development.

Agenda 21 explains that population consumption and technology are the primary driving forces behind environmental change. It offers policies and programs to achieve a sustainable balance between consumption of population and the earth's supporting capacity. The Summit recognizes the vital role that all levels of society including local communities, the private sector and local authorities can play in the successful implementation of Agenda 21 through the formation of local agenda 21's.

The key goals of the Local Agenda 21 are among others:

- To raise awareness of environmental and sustainability issues among citizens
- To reduce the consumption of all natural resources,
- To minimize levels of pollution,
- To minimize environmental impact of waste and to promote the *re-use* and *recycling of resources*. (Manual for Sustainable Neighbourhood and Development, 2000:8)

In other hand, during the WSSD held in Johannesburg (South Africa, 2002.) the following points had been highlighted:

- *Halving the number of people without access to sanitation by 2015;*
- Achieving the United Nation Millennium goal of reducing by half people living on less than one dollar per day by 2015 (Poverty Alleviation);
- Implementing food security strategies on the African continent by 2015;
- Establishment of Poverty Eradication Fund; and
- Need for regional and national targets for renewable energy, and commitment to funding. (Uganda High Commission, Newsletter No. 8 of August-October, 2002)

Based on the definition of Sustainable Development that it is such "development that meets the needs of the present without compromising the ability of the future generation to meet their own needs". It is necessary to stress that the rapid spread of cities results in widespread use of water, which unless properly monitored, may lead to environment degradation. The growth of population compounds the problem by contaminating water supplies by various means and creates the sanitation haphazard: solid waste, sullage, human and other household wastes.

2.4.4. Sanitation Services

Sanitation is viewed as *systems* that protect people's health, especially those that "*dispose efficiently of human waste*" (Singh, 1999). Sanitation includes open drains and both *public sewerage* system and *traditional* system that is the use of *cesspools*, *septic tanks* and *streams*, and *pit latrines*. Sanitation is also the introduction of a new way of life through education, behavioural change and personal hygiene practices.

Generally, Sanitary facility concerns with the cleanliness of the cities. It is divided into collection, conveyance, treatment and disposal of refuse.

2.4.4.1. Sources of sanitary sewage and storm water

The sewage may be classified into Sanitary Sewage and Storm Water. Sanitary Sewage is also called the dry-weather flow. It depends on water supply and can be subdivided into domestic, commercial, institutional, and industrial sewage. After water supply has been used, 70 to 80 % of it is converted into sanitary sewage. The loss (20 to 30 %) is due to leakage, consumption, evaporation, gardens and lawns watering.

In other hand, Storm Water consists of run-off available from roofs, streets, yards, and open spaces, during rainfall.

A. Sources of sanitary sewage

Consequently, quantity of sanitary sewage gets affected by the increased population, type of the area to be served and the rate of water supply in the sense that it is assumed to be fully available in the form of sewage after consumption..

Table 2.6. The rate of Sewage, function of umber of population

Population of the town	Water supply in l/c/d	Sewage production in l/c/d
50000 to 200000	135-160	115
200000 to 500000	160-180	135
500000 to 1000000	180-200	160
More than 1000000	200-225	180

(Source: *Water Supply and Sanitary Engineering*, p. 24, II)

B. Sources of Storm Water

During rainfall, a part of rainfall water percolates into the ground and a part is evaporated in the atmosphere. The remaining part flows over the ground surface and is termed as surface runoff, floodwater, or **Storm Water**. This storm water has to be disposed off, out of the city through open surface drains or through underground sewers. Stagnating storm water that takes a long time in area may cause hazardous situations.

The quantity of storm water depends on the intensity of rainfall and the nature of the surface over which rainfall takes place. In some cases, storm water is allowed to flow with sanitary sewage (Combined sewerage). But because sewers cannot handle storm water at peak storm, it is diverted into open drainage including rivers and streams.

2.4.4.2. Systems of sanitation

To collect and dispose the refuse from urban areas, two methods such as *conservancy* and *water carriage system* are mostly used.

- I. **Refuse Conservancy system** is an old and outdated system of collection and disposal of the refuse. The collected refuse is carried in carts, trucks, etc., outside the city and dumped in one place; combustible garbage is burned while non-combustible is dumped in low-lying area for reclamation (land filled). Sewage and sullage are allowed to flow in surface open drains and are disposed off into nearby streams or rivers. Human excreta is collected from latrines and carried by labour in carts or trucks, etc. It is buried into the ground and thus converted into manure. Industries in such cities make their own arrangement for disposal off their sewage. Liquids from latrines get soaked into the ground causing contamination of underground water. This system is not recommended in urban area where population is dense.
- II. **Refuse Water Carriage System**, a system where collection, conveyance, and disposal of the wastes are done with the *help of water*. The amount of water is mixed with solid matter so that mixture behaves like liquid. Every person using Water closets (W.C.) uses 5 to 10 litres of water to flush away with the excreta into

underground drains. The wastewater from W.C. gets mixed with sullage from kitchens, baths, basins, etc. and forms sewage.

The sewage flows out the city area where it is disposed off by irrigation or by dilution, after treatment in sewage treatment plant, if necessary.

In anyway, Water Carriage System is the most modern system of drainage and therefore as far as possible this system should be adopted especially in urban areas.

The sewerage system should be designed to serve each building in every street that is already in existence or are likely to be constructed in the future. It should also be so designed that expansion will be simple and can be accomplished at a reasonable cost and when needed.

2.4.4.3. Sewage quality

The characteristics and composition of sewage keep on changing both with time and position. Sewage contains suspended and dissolved solids that may be organic or inorganic, inert or reactive, stable or unstable. Dissolved organic matters in the sewage are classified as *nitrogenous and carbonaceous*.

Sewage also contains various types of microorganisms and bacteria such as virus, protozoa, algae, fungi, etc. some of them are pathogen and harmful to human and animal life.

The tests conducted for sewage examination are physical, chemical and biological tests. The Biochemical Oxygen Demand (B.O.D₅) of sewage is the amount of oxygen required for the biological decomposition of dissolved organic solids under aerobic conditions at a standardized time (5days) and temperature (20⁰C). It serves as a measure of the amount of clean diluting water required for the successful disposal of the sewage by dilution without treatment. The biological decomposition of such organisms can be either in presence or no of oxygen (*aerobic and anaerobic decompositions*).

The quality of sewage has lot influences in planning for sewage treatment plant. It is taken into account whether to decide on various treatment units to adopt.

2.4.4.4. Sewage disposal and self-purification of sewage

Scientific disposal of sewage will protect the health of the community and save it from bad smell, mosquitoes, obnoxious gases, and other foul conditions. This will reduce the danger of the spread of diseases like typhoid, dysentery, diarrhoea, etc. The sewage disposal may be done using two methods such as natural (dilution or/and land treatment) and artificial methods. Amount of diluting water should be such that a minimum dissolved oxygen concentration of 4 to 5 mg/litre (4 to 5 p.p.m.) is maintained. In land treatment of disposal the raw sewage or partly treated is applied to land.

Table 2.7. : Classification of standards for polluted water as per Imhoff and Fair classification.

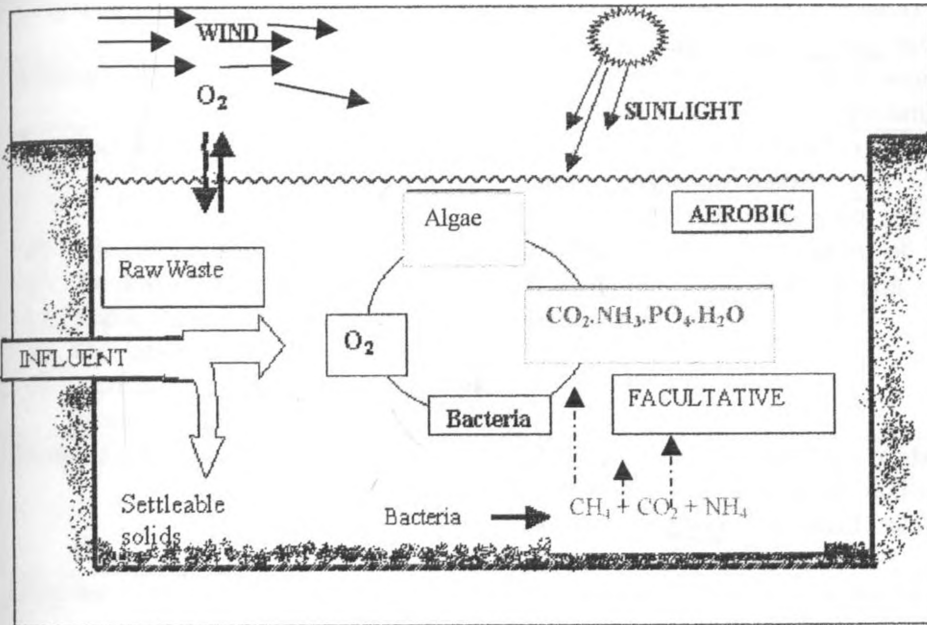
Use	Standard
Drinking water after chlorination	Without filtration, bacterial standard less than 50 B-coli per 100 centilitres
Bathing, recreation and shell fish culture	No visible sewage matters. Bacterial standard less than 100 B-coli per 100 centilitres
Fishing	Dissolved oxygen content not less than 3 and preferably 5 p.p.m. Carbon dioxide not more than 40, and preferably 20 p.p.m.
Rough industrial use and irrigation	Absence of nuisance, odours, and unsightly suspended floating matters. Dissolved oxygen present

When sewage is discharged into the natural waters, they get polluted due to organic and other foul matters present in the sewage. But polluted conditions do not remain forever. Natural forces of purification, in the form of dilution, sedimentation, oxidation, reduction, sunlight, wind etc. bring polluted water almost to its original degree of purity. This phenomenon is called *Self-purification*.

The oxygen from the atmosphere is utilized by the aerobic bacteria in oxidizing the putrescible matter in the sewage in satisfying its B.O.D. During oxidation nitrate and carbon dioxide are formed. Then algae utilise the carbon dioxide in the presence of

sunlight and liberates oxygen through photosynthesis process. For their decomposition, aerobic bacteria utilize a part of that oxygen and the remaining oxygen content is utilized to create and maintain aerobic conditions for bacteria. The operation that takes place is termed as “*Bacterial-algal symbiosis*”. This operation is shown in the following figure.

Figure 2.1. : Sewage purification through Oxidation process



Author's construct, 2003

In artificial methods, before discharging the effluent into the natural body waters sewage is given treatments that may be primary and secondary (if necessary). This method is nothing but proper sewage treatment methods.

2.4.4.5. Sewage treatment.

The object of sewage treatment may be to reduce the sewage strength so that it may not pollute the receiving waters, or cause sewage sickness to land, and to remove or kill the pathogenic bacteria from sewage, so that it can be safely disposed off without causing any health hazard.

The three basic categories of treatment processes such as *mechanical or physical, chemical and biological* may be employed. The following table (2.7.) summarizes those processes.

Table 2.8. Sewage treatment process

Process employed	Purification affected
1. Screening	To remove dead animals, tree branches and large size solid matters
2. Grit chamber and detritus tanks	To remove heavy settleable inorganic matters.
3. Skimming tanks	To remove grease and oily matters and also to remove other small floating matters
4. Settling tanks	To remove large suspended organic solids by settling at the bottom of the tank
5. Chemical sedimentation	To remove dissolved and colloidal form of organic suspended matters
6. a) Intermittent sand filter b) Trickling filters c) Septic tanks d) Oxidation ponds e) Activated sludge process and secondary settling tanks	Removal of fine suspended and dissolved organic matters by means of biological flocculation and precipitation and then settling out.
7. Sludge digestion tank	Digestion of sludge by oxidation and reduction. The sludge is collected from primary settling, chemical sedimentation and activated sludge process.
8. Chlorination	To remove disease producing bacteria and other organisms. To control odour

(1, 2, 3, 4 & 6_{a,b}) are mechanical processes; (5, & 8) are typically chemical means; (6_{c,d,e} & 7) are biological processes.

2.4.4.6. Location of sewage treatment works.

Sewage treatment works should scientifically be designed, located and operated. Depending on the volume and strength of the sewage, more than one treatment plants can be set up. It is not better to set up only one sewage treatment plant.

To avoid nuisance from faulty operation and also cost of costly outfall sewage, the treatment plants should not be located either too close or too far off from the habited area.

First of all, the area occupied by sewage treatment plant depends on the volume of sewage to handle and the treatment method applied. The plant site as a whole should provide the place needed for lawns, roads, and walks, pumping stations, laboratory and supervisory buildings. There should also be space for future expansion.

2.4.5. Policy to guide the process of Water Supply and Sanitation development

Background information and some local experience are necessary for successful planning of Water Supply and Sewerage Development projects. Water Development projects especially large ones bring both benefits and environmental problems. After the implementation of water supply scheme, the problem is how to drain the wastewater generated from the pure water that gets consumed by way of washing clothes, bathing, cooling and other uses. Since the projects are very costly, they are installed in stages. Therefore the locality is divided into suitable zones, and one by one zone is taken for the installation of those facilities.

The following points have to be emphasized when planning for water supply and Sanitation services:

- Large areas of the developing countries are still without safe drinking water or proper sanitary arrangement. One of the best results of development is the arrival of safe drinking water, which reduces health hazards. This requires a source, a treatment system, and a distributory network. The requirements are twofold: ensuring the supply of water to meet the total demand, and maintaining the quality of the water needed for the specific demand.
- Demand for water increases directly with rise in population and with economic development. Certain types of water uses are consumptive, while water from other uses can be reutilised after treatment. The water supply and sanitary projects are designed for the served population up to three or four decades. Population when multiplied by per capita water or sewage allowance gives the total amount of water to provide or sewage to be handled by the sewer line.
- Water is polluted from a variety of sources: human sewage, animal wastes, mining, industry, pesticides, fertilisers, detergents, and so on. Rivers are capable of purifying themselves of a limited of oxygen demanding wastes. But the fact that rivers can

cleanse themselves is not the reason of discharging anything into the rivers. The clearing up of the water body would involve among others treating the wastewater of settlements and enforcing the riverbank industries to treat their effluent much more stringently. The quality of sewage has lot influences in planning for sewage treatment plant. It is taken into account whether to decide on various treatment units to adopt.

- Water supply and Sewerage development are related to one another and related to the city's economic development. No work can be done unless sufficient funds are available. This difficult can be minimised by taking the project in stages. By taking advantage of available natural conditions and technical known how, every effort should be made to economize the project.
- Physical development_ Rainfall water has to be disposed off along with sanitary sewage. The rainfall data for the locality may prove to be useful to determine the quantity of storm water to be handled. Besides, rainwater can be utilised for different uses along with other water sources. Also, Topographical features of the area must be taken into account. In the proper design of the scheme, the position of ridges, low lying areas, density of population, type of soil, etc, should be emphasised for zones establishment for sewerage and water supply and
- Socio-Political Development_ Future development trends of the city is significant in the design of both water services and sanitary projects. The trend of expansion of the city is not uniform. New industries, new residential colonies might be developing on one direction of the city. Water pipes and Sewer of bigger size should be laid on the development side of the town, so that they may cater the increased demand of water and increased load of sewage expected in the future.

2.4.6. Providers of Water Services

2.4.6.1. State _ Provider of Infrastructure Services

“Water is life, and because we have no water, life is miserable”; “The poor live at the whim and mercy of nature” (GoK, 1977).

“When a road passes, development follows right on its heels” (Cameroon, 1995.)

Poverty is about access and consumption of state provided commodities. Community poverty is related to infrastructure and service provision. Is poor the community that lacks basic services such as road network, electricity, roads, schoolteachers, and more (Nigeria, 1995), Uganda, 1998). The poorest communities are identified as those most isolated and located farthest from roads and from other key infrastructure (Cameroon, 1995, Uganda, 1998).

In addition to transportation, two other issues distinguish the poor from the non-poor; water security, and, to a lesser extent, sanitation. Access to water is important for bathing and drinking, as well as for agricultural production. In Bangladesh and India, lack of safe drinking water is identified as one of the most important problem for the poor (Bangladesh, 1996, India, 1997).

Although the government's role in providing infrastructure, health, and education services is recognized by the poor, they feel that their lives remain unchanged by government interventions. Since the time of independence, governments of developing countries have been considering the issue of poverty among their people. It is with this line that majority of infrastructure services like water and sanitation and other services have been for long provided by government's agencies. In Nairobi, water and sanitation services are under the responsibility of Nairobi City Council. Private sectors come in to fill a small gap that occurs mostly in low income residential during shortage time schedule.

2.4.6.2. Private Sectors and Infrastructure services

Private sector participation is often associated with profit motive and therefore seen as negative for the poor. However private sector participation in water and sanitation is based on the separation of the ownership of assets from the management of those assets. It helps to improve the quality and the availability of services leading to a reduction in the high prices currently paid by the poor households under poorly managed public sector water and sanitation utilities. In absolute liberalism system, this is applicable in the developed countries. Paradoxically, people in developing countries still need the intervention of the government in prices fixing. This is to say that the

state should control the water services delivery even if they are given to private sector. Therefore a policy that defines a clear partnership between the community, public, and the private bodies is highly needed.

The type of private sector involvement in the water and sanitation services can take different forms such as: Full Divestiture, Build-Operate-Transfer/Build-Operate-Own, Concession, Lease and Management Contract.

- **1. Full Divestiture** _ The full transfer of assets to private sector through asset sales, share sales or management buyouts. Private sector is responsible for all capital investment, maintenance, operations and revenue collection.
- **2. Build-Operate-Transfer/Build-Operate-Own** _ Contracts are issued for the construction of specific infrastructure, such as a bulk supply reservoir or treatment plant. The private sector is responsible for all capital investment and owns the assets until transferred to the public sector.
- **3. Concession** _ Government lets a long-term contract, usually over 25 years, to private company, which is responsible for all capital investment, operations and maintenance. The asset remains public sector property.
- **4. Lease** _ Long-term contract (10-20 years but can be longer). The private sector is responsible for operations and maintenance and sometimes for asset renewal. Assets remain in public sector and major capital investment is a public responsibility.
- **5. Management Contract** _ Short-term contracts (5 years). Private company is only responsible for operations and maintenance.

As water utilities provide less number of poor households direct access to water through a private connection, a thriving market for water and sanitation services exists in most urban areas. The gap left by formal utilities has to be filled by numerous formal and informal privates and community organisations offering a range of different services often at a much higher cost to users. The intervention of the government in controlling and minimizing the cost is appreciated.

2.4.7. CONSEQUENCES

Many countries are introducing radical decentralisation in attempts to create accountable and responsive governments. Governments, International Development Agencies, Non-Governments Organisations, and the Private Sector need to support Community Driven Development Strategies on large scale. Community Driven Development involves giving community group's authority and control over funds, resource allocation, and decision-making.

This radically changes the incentives of service providers to be accountable to community groups that are representative of poor men and women. Neither radical decentralisation nor community driven development will work effectively, however, unless poor people's organisational capacity is strengthened for effective bargaining, and methods are found to encourage the rich to support the poor or at least to minimize their negative impact on poor communities.

Government and most development assistance have focused on the rules, resources, and capacities of the formal systems of governance, and not on mechanisms to build the capacity of poor people to participate in local governance. There are promising examples of programs that invest in local organizers and organisations chosen by the poor that are unlocking information about budgets and wages and putting them in the public domain, and that are developing government procedures that deliver timely assistance without distorting local priorities.

The provision of water and sanitation services in Kawangware should not be only the issue of NCC but should address the effort of all stakeholders and especially the community groups to manage and keep facilities sustainable.

2.5. URBAN DEVELOPMENT

Urban development is the set up of mechanism of looking on how to provide infrastructure and other services to support the day-by-day living conditions of urban residents. This development has to follow up a plan done for that purpose. A town that

has no plan for its development and future extension is difficult to develop. Urbanisation without development is a worse combination (Unesco report in Breese quoted in Mairura, 1987).

According to World Commission on Environment and Development (WCED) quoted in Kerry (1993) says "Sustainable Development is that development that meets the needs of the present without compromising the ability of future generation to meet their own needs". Kerry adds that Sustainable Development must allow for an increase in people's standard of living with particular emphasis on the well being of poor people, while at the same time avoiding uncompensated and significant costs on future people.

Sustainable development in any area must include everybody. It includes international, national, and local bodies. It has to reach even the individual level in order to foster the interaction between environmental elements. As Kerry said above, sustainable development should improve standards of living. Planning and management of any development must take into consideration the issue of sustainability. This can be possible with proper development control and effective maintenance of assets. The latter can be possible with adequate awareness of the community.

2.6. CONCEPTUAL FRAMEWORK

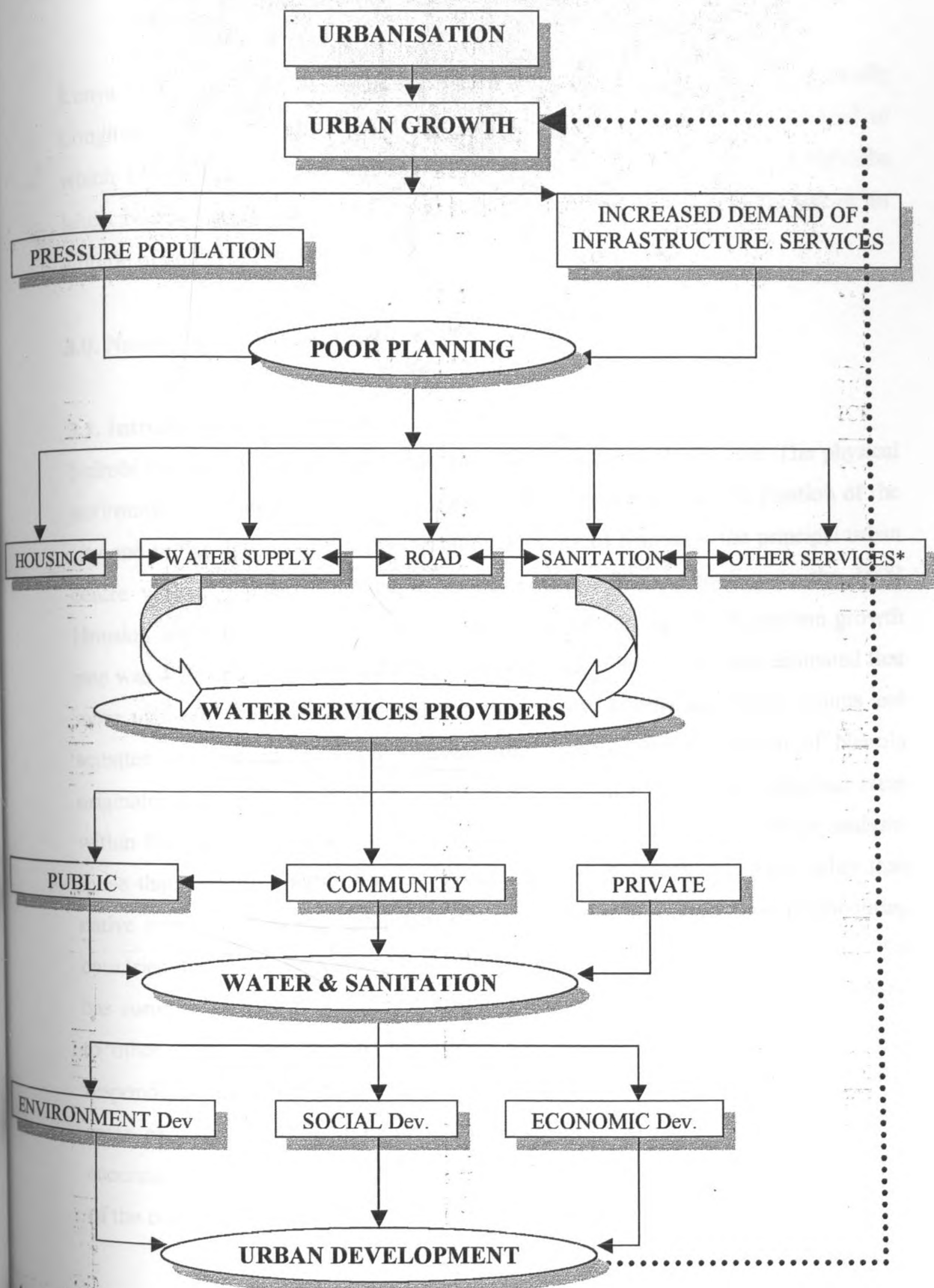
In Kenya, the rate of urbanisation is 7.05 per cent. This urbanisation is making Kenyan urban areas grow tremendously. Urban growth is influenced by many factors (i.e. immigration). People are leaving rural areas to town seeking the opportunities that they lack in their area of origin (e.g. Employment). The migration from rural areas makes urban areas overcrowded and increases the demand for infrastructure services.

Planning affects people by proposing means and strategies of providing them with services that will support their livelihood. Those services are amongst others Shelter, Communication, Water Supply and Sanitation.

Water Supply and Sanitation services, which are subjects of this study, have also been constrained by increased population. The provision of the two has been for a long time honoured by the Public Sector. But the public sector is now unable to provide those services efficiently. It needs the contribution of both the community at large, and the private sector. In this line, especially in rural areas, people have organised themselves to provide water supply through “Community Self-Help Water Projects”, drilling boreholes and using artesian wells, etc. Also, private individuals have come in to provide infrastructure services. Private bodies are always profit-oriented and their products are therefore highly priced which poor people cannot afford. Sixty per cent of Nairobi residents are low-income people. Public water supply neglects this group in providing inequitably Water service. So they are the most affected and the victims of that scenario.

There is need for all bodies, public, private, religious, and community based to create a real partnership in order to plan and provide effectively for water supply and sanitation, especially in suburbs of Nairobi where many people live. And this must be done taking into account physical, social and economic issues for the urban development to be sustained.

CONCEPTUAL FRAMEWORK



Author's construct, 2003

*Other services: Social Services, Recreational Facilities, etc

CHAPTER THREE

BACKGROUND OF STUDY AREA

Kenya is situated along the Equator between latitude 4° 30' North and 4° 30' South; Longitudes 34° East and 42° East. The territory covers an area of 581,677 Km² of which 13,396 Km² is water surfaces at the seaside, Victoria, Turkana and Naivasha lakes. Nairobi is located at 1° 16' South latitude, 36° 50' East longitude, and at an altitude of 1600 metres above sea level.

3.0. Nairobi in the national context

3.1. Introduction

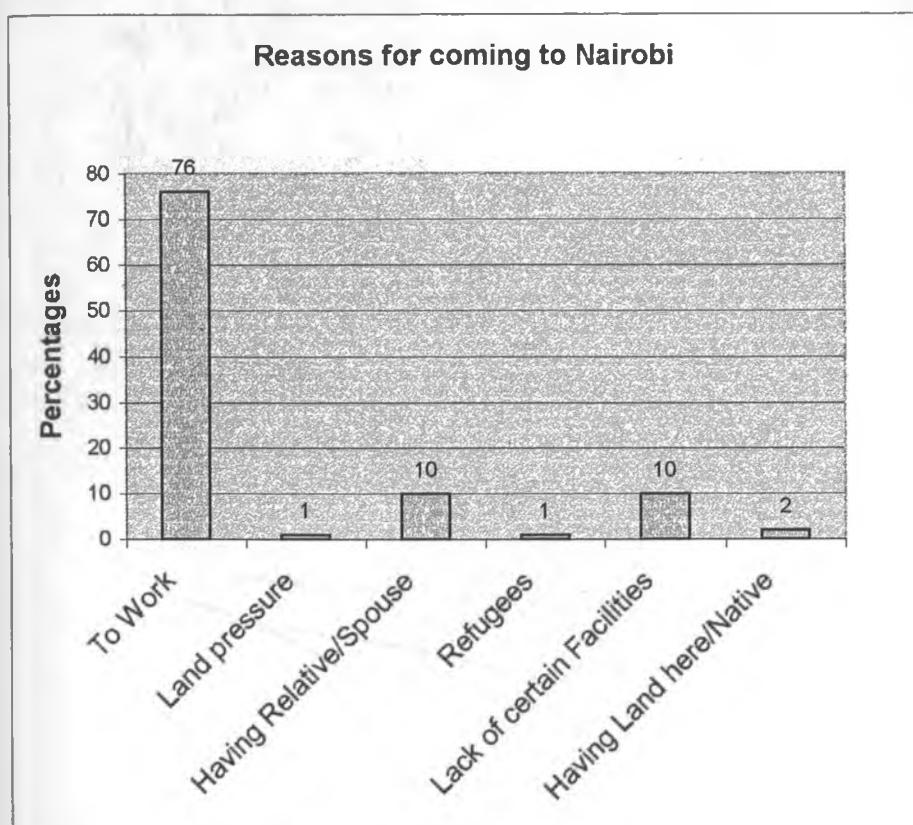
Nairobi has been the capital of Kenya since the period of colonial rule. The physical environment of Nairobi has played a significant role in establishing the location of the city and in the shaping of the city structure. The city of Nairobi is the principal urban centre with a population of about 3 million (2.1 million according to the 1999 Housing and Population Census figures) in an area of 689 sq Km. Population growth rate was 4.7 % per year (Central Bureau of Statistics, 1999). It has been estimated that more than 60 % of Nairobi's population lives in low-income settlements (slums and squatter settlements). This study reveals that most of the population of Nairobi originated from rural areas. In the study area 50 % came from other suburban areas within Nairobi. 40 % of respondents said they came from rural areas. From analysis, those that came to Nairobi for employment opportunity are 81 %. Also, other than native population, another small part of the population has come from neighbouring countries due to the critical political situation they are facing. Another section (7 %) has come in Nairobi from different town. This shows how Nairobi spreads its effects to other towns. Their reasons for coming into Nairobi are various; more than ¾ of respondents have come into Nairobi to work. 10 % lack certain opportunities in their areas of origin, and about more than one percent are refugees looking for peace according to their response. As it is, most people come to Nairobi from different parts of the country and world and are still coming at an increasing pace.

Table 3.1. Residents' area of origin

Where Residents were staying before their coming in the study area		
Origin	Frequency	Percent
Other suburban areas of Nairobi	72	50
Different towns	11	7
Rural areas	59	40
Natives of Nairobi	4	3
Other countries	1	1
Total	147	100

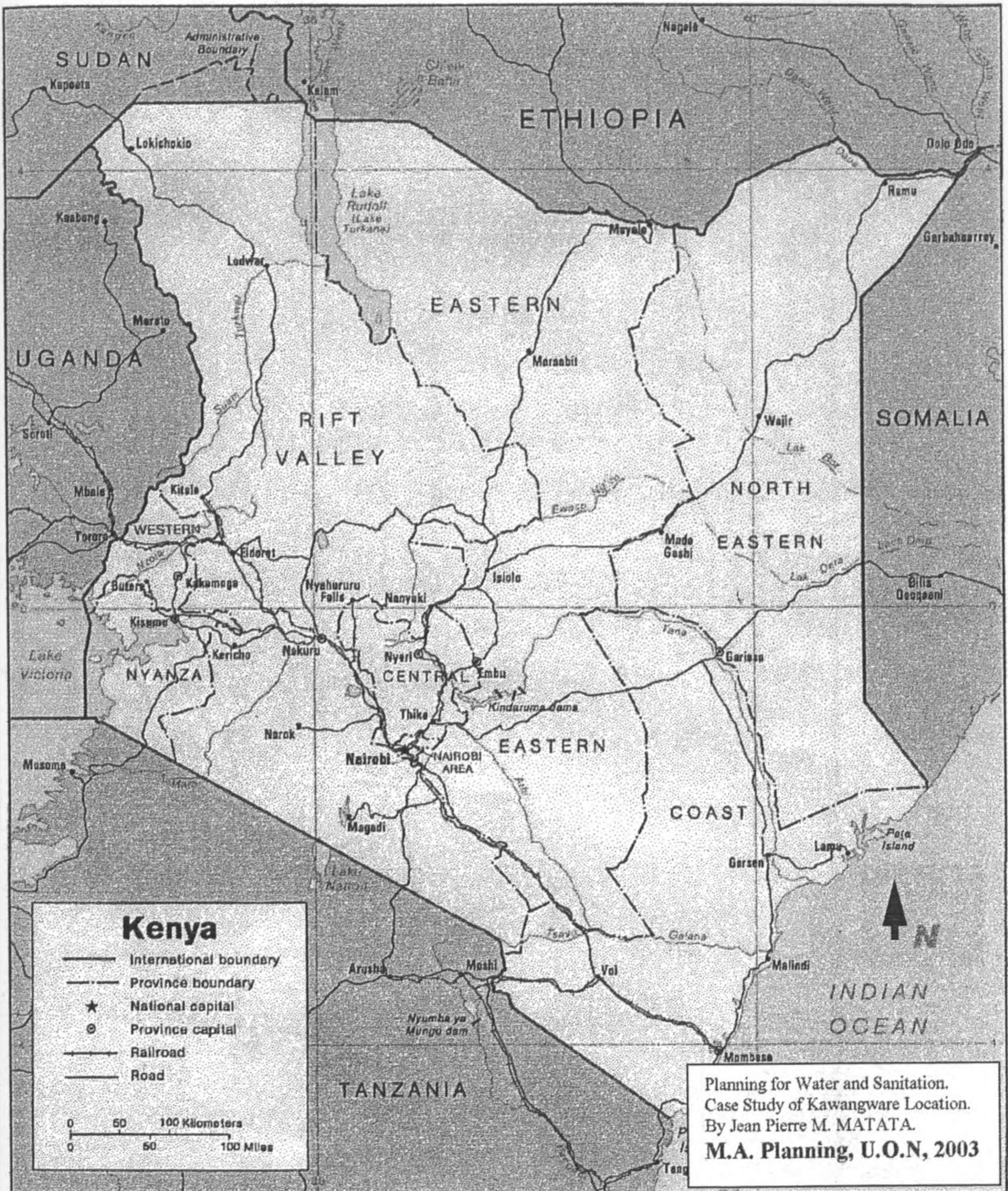
Source: Fieldwork, 2002

Figure 3.1. Reasons for coming to Nairobi



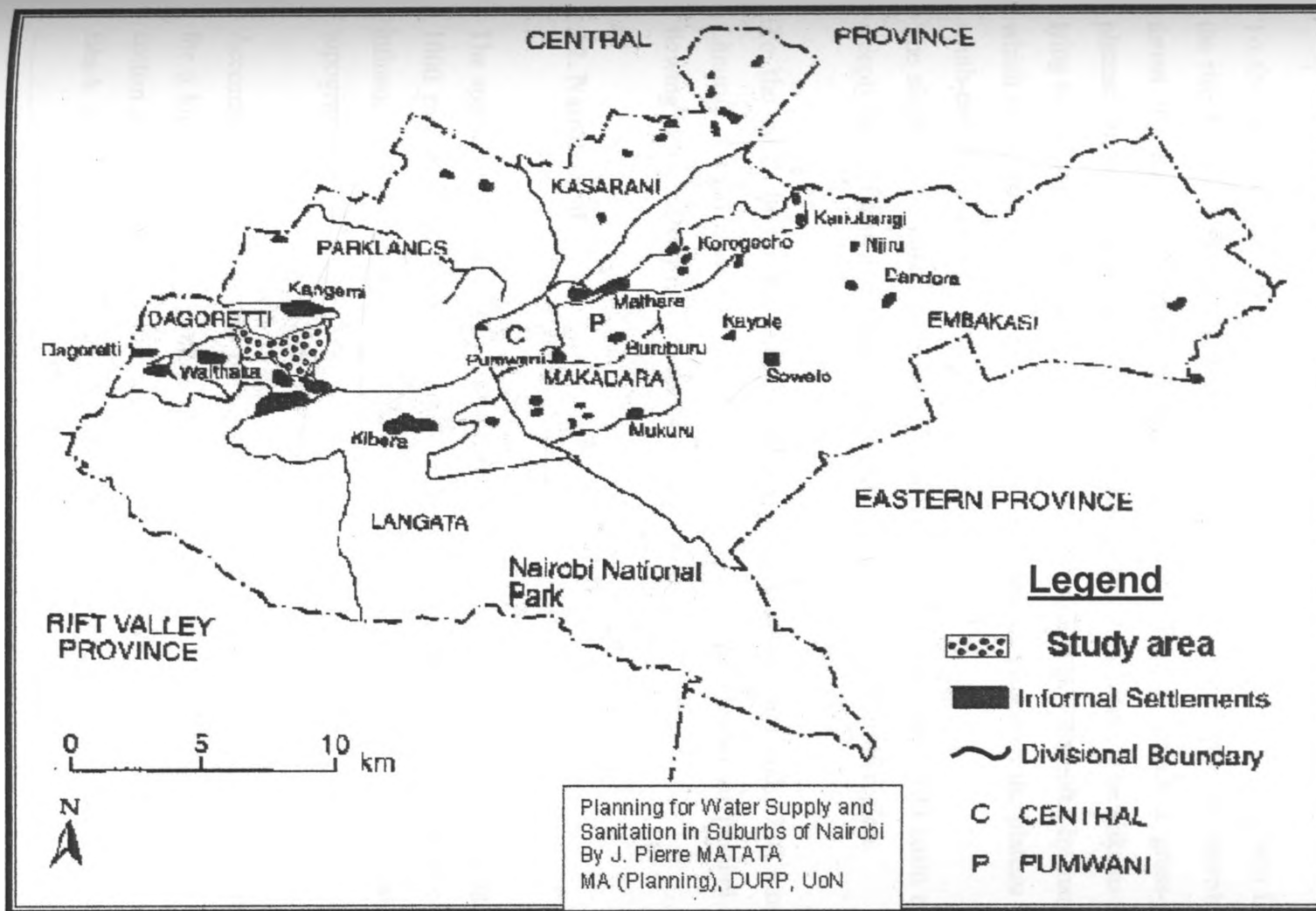
Source: Fieldwork, 2002

Map 3.1. THE STUDY AREA IN THE NATIONAL CONTEXT



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Map 3.2.: Location of Study Area



Source: Fieldwork, 2002

Nairobi is a focus of local routes. Much of Nairobi, however, is climatically unsuitable for agriculture. To the south and east of the city are open, grassy plains where rainfall averages under 800mm per annum, and in which the only large-scale crop that can be grown is sisal.

To the West, the land rises steeply onto the mountains forming the eastern flanks of the rift Valley. These are the Aberdare range, whose southern tip in the Nairobi region forms the Kikuyu plateau and the Ngong Hills. This is mainly a grass-covered plateau, an ecological extension westwards of the Athi plains. The Kikuyu plateau, lying to the north of Ngong Hills, is a forested mountain side dissected by many rivers which flows from the higher slopes of the Aberdare range across the plateau on their south-eastern courses towards the Indian Ocean.

The slope of the land rises gradually on the edges of the upper Athi basin and then steeply up the Kikuyu uplands to the north and west of the Nairobi region.

To the north higher rainfall (975mm p.a at Kabete_Nairobi and 1250 mm p.a at Limuru) and an even slope have given rise to a large number of parallel streams flowing in the easterly and southeasterly direction.

3.2. Nairobi Soil

The spatial distribution of soils is related to the rainfall of the area that averages about 1000 mm p.a and the mean annual temperature of about 26° C. Another element influencing the nature of soils over the Athi Plain is their flat, or nearly flat topography.

According to Scott quoted by Kingoriah, conditions of impeded drainage persisting for a long time over volcanic rock parent material is the main causal factor of black cotton soil formation. Nairobi area is largely covered by clay soil locally known as the Black Cotton soil. This soil has smaller coefficient of permeability¹ of less than

¹ Permeability is defined as the velocity of flow which occurs through the total cross-sectional area of the soil under a unit hydraulic gradient.

0.00001 cm/sec. And it has a higher porosity of about over 60 %. This implies how much the water is retained by this soil.

Most of the land around the city is fertile, and coffee, tea and pyrethrum are common cash crops. Maize and various kinds of beans form the staple foods of the inhabitants. These areas also serve as one of “the market garden” zones for the city of Nairobi, and specialize in dairy products and green vegetables.

The towns of Thika, Kangundo, Machakos, Athi River, Ngong, Kikuyu, Limuru and Kiambu are largely dormitory towns, whose economy depends on the city’s influence. They are located in the radius of about 40-50 Km away from Nairobi along major Highways and good communication links with the city.

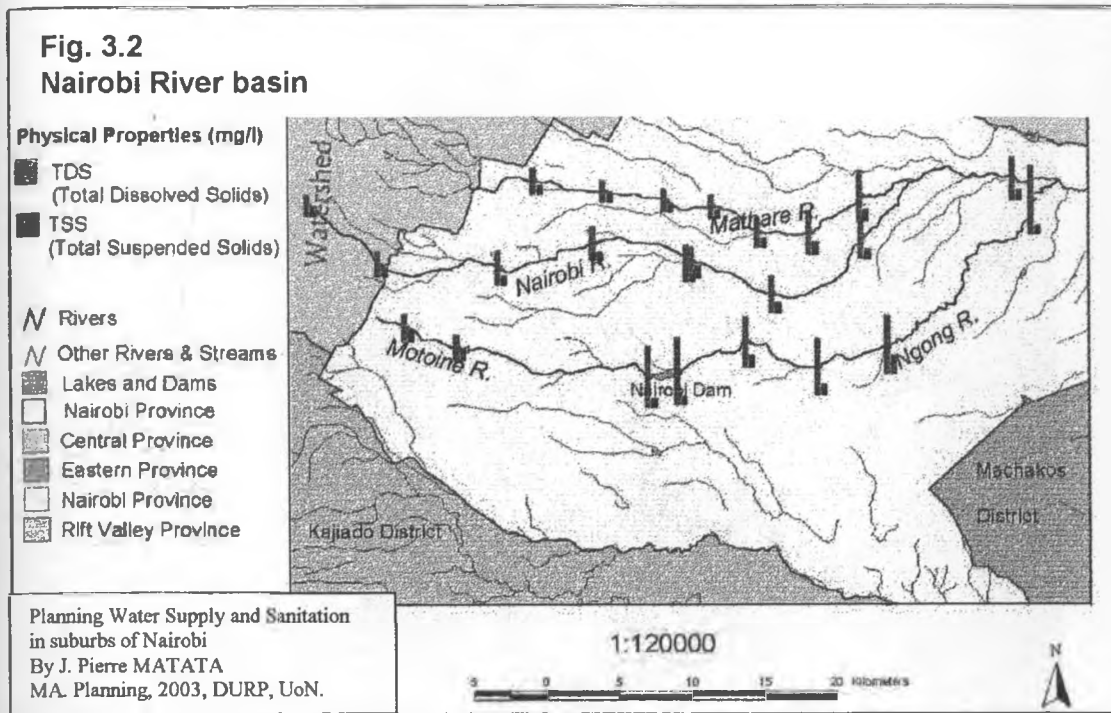
3.3. Climate of Nairobi area

The city is situated roughly 1° 20' south of the Equator; the area would have an equatorial type of climate. The climate has been modified by the altitude. The hottest month has a daily mean max temperature of 28° at midday, and after midnight mean minimum temperature of 14°. The coldest month has a daily mean max temperature of 23° at midday, and mean min temperature of 12° after midnight.

In Nairobi there are two rainy seasons coinciding with these intermediate periods from March to May and from October to December. Long rain season is from March to May where the rainfall is more intense. While short rain season is from mid-October to mid-December where the intensity of rains is shorter and light compared to the long rain season. This is due to the direction of the atmospheric winds.

In trying to relate this to the study, when rainfall is intense, people harvest or store rainwater for their different uses. During heavy rainfall, there is lot of water in the sewerage system and both sewage and runoff are diverted directly to natural drainage without any damage. During the dry season, river flow seems to be like sewage: oil or other pollutants from various activities directly flow to the river course. In this case,

such river water should be diverted into the truck sewer to be treated together with the sewage.



Source: Nairobi River Project, 2000

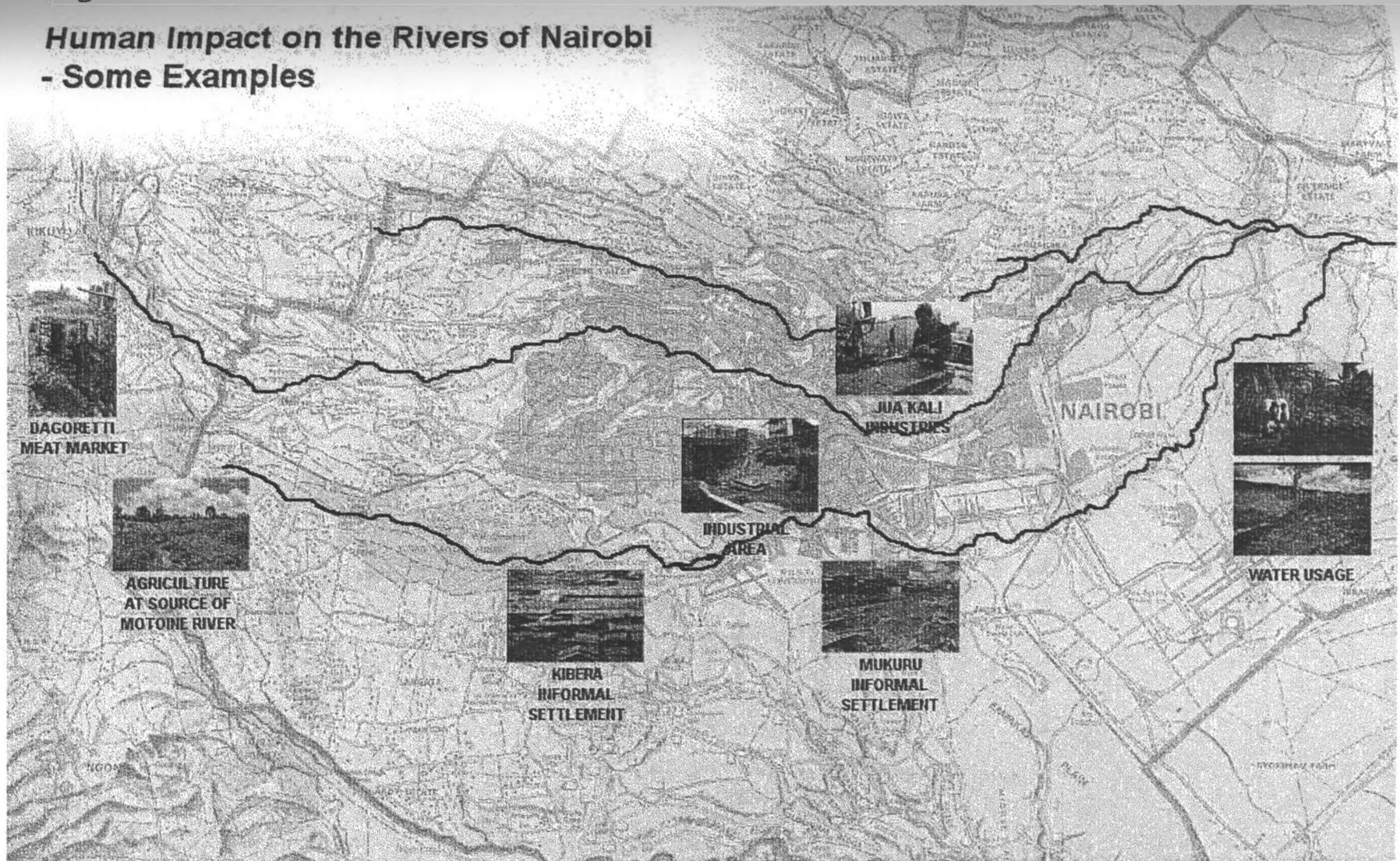
Nairobi is crossed by three main rivers such as Mathare River that flows to the north-side, Ngong river to the south side and Nairobi River, which divides Nairobi Province into two parts, to the centre. All these three rivers are highly polluted and they cannot be used as sources of domestic water as it was in the past. This pollution is due to the high pressure of population up stream. Garbage, human waste, sludge and other pollutants from agricultural practice and wastewater from Dagoretti meat market, car washes and informal settlements pollute rivers without any control or management.

The political boundaries of the city of Nairobi were defined in 1963. But at this time, it is difficult to define the limit since the city has, by its own natural set up, expanded its boundaries/influences to the surrounding towns and areas.

Nairobi houses many industries within industrial area that have strong influence on the sanitation of the town in general.

Fig. 3.3

Human Impact on the Rivers of Nairobi - Some Examples



Source: Nairobi River Project, 2000

Because of the expanding urban population of Nairobi, slums and squatter settlements have tended to develop in the former satellite towns and villages (permanent settlements especially laid out during the land consolidation process). It was in Dagoretti where satellite settlements were surveyed for cheap residences to house some of Nairobi's urban workers.

3.4. Dagoretti Division

Dagoretti, Kangemi, Riruta and Kawangware were designated areas for satellite settlements. These areas have been annexed to the city during the 1963 boundary extension.

Dagoretti Division is subdivided into seven locations: Kawangware, Woodley, Riruta, Waithaka, Uthiru, Ruthimitu and Mutuini. The division covers the area of 38.7 square kilometres. It is about 10 km from the town centre. It was annexed to the city of Nairobi in 1963 from Kiambu District. The division borders with other Divisions such as Kikuyu (Kiambu District) to the North and West, Westlands to the East and Kibera to the Southern side. The population in the division is about 240509 people and the number of households is 73670.

Table 3.2. Locations and Population of Dagoretti

Dagoretti Division			
Locations	Area (Km ²)	Population	Population Density
Waithaka	5.4	19937	3692
Kenyatta/Woodley & Golf Course	9.3	30253	3253
Riruta	7.3	65958	9035
Uthiru & Ruthimitu	7.9	23016	2913
Mutuini & Kirigu	4.8	14521	3025
Kawangware	4	86824	21706
Total	38.7	240509	6215

Compiled by author 2003, from Housing and Population Census, Kenya 1999

3.5. Kawangware Location

The area of study is Kawangware location that is situated in Dagoretti division, Nairobi district/province. Kawangware Location shares common borders with Riruta to the South, Kangemi to the north, and Maziwa and Muthangari (Westlands) to the east and northeast respectively. The location is subdivided into two sublocations namely Kawangware and Gatina. It is also subdivided into 10 villages in order to decentralize the authority. The location covers an area of 4 Km². The whole population is spread in 29918 households. This implies that 3 persons occupy one household. But from our study, the household occupancy has gone to 4 persons.

Table 3.3. Sub locations of Kawangware

Kawangware Location			
Sublocation	Area (Km ²)	Population	Density
Kawangware	2.6	52117	20045
Gatina	1.4	34707	24791
Total	4	86824	21706

Compiled by author 2003, from Housing and Population census, Kenya 1999)

3.6. Population profile

According to the 1999 population and Housing Census, Dagoretti division had a population of about 240509 people of which 115437 were female and 125072 were male. The population was distributed in 73670 households, with 4 persons in each household. Kawangware Location had a population of about 86824 people. From the 147 households interviewed, the total number of people was 540 among them 50.5 % were children. This showed the result of 3 children per household in average with the maximum of 7 children. Also 61 % of respondents were married. This implied that the dependency level is high for an average income of about Ksh 5000 per month.

Education level of the household head is such 50 % of respondents have reached at least the secondary level. And their occupations are mostly informal business at more than 80 % of residents.

Table 3.4. Resident's Income

HOUSEHOLD INCOME		
Income	Frequency	Percent
Below 4000	29	20
From 4001 - 6000	34	24
From 6001 - 8000	23	16
From 8001 - 10000	18	13
More than 10000	38	27
Total	142	100

Source, Fieldwork, 2003

3.7. Topography and drainage

The area is flat and slightly slopes in northwest to the east direction. The Nairobi River follows that direction. The natural drainage of the area is only the Nairobi River. Otherwise runoff will stagnate waiting to percolate into the soil when the time arrives due to the characteristic of the soil. The soil is almost black cotton soil with a smaller coefficient of permeability and higher porosity. It takes a long time for the rainwater to percolate due to those characteristics of the soil.

3.8. Land uses in Dagoretti

Dagoretti division has a character of rural setting. But subsistence-farming areas are giving way to housing pattern. Most of lands have been given to owners under the registered land act (cap 300), and people have acquired freehold interests on the land. Freehold implies absolute ownership. Such land becomes private land and this has facilitated landlords to construct houses of different forms in order to gain money through rents.

Dagoretti includes Villages and townships around which slums are developing more and more. The development of slums, and continuing rapid sub-divisions have been caused by economic factors brought about by the high demand for accommodation in Nairobi. Peripheral infrastructure developments have to be increased. Here we want to emphasize the accessibility between the area and the city, commuting, and subdivisions of some remaining large land to small land holdings.

The land use pattern in the area determined by economic forces is transitory. There is a need to plan for that area according to the urban developments. It is important to set up infrastructure services, land subdivision in small parcels in line with the city plan.

3.9. Road networks and social services

Roads and social services have important impact on water supply and sanitation. From the city centre to Dagoretti is the distance that can take about 2 hours on foot. Dagoretti Division is linked to the city by two main roads such as Ngong/Naivasha roads and Gitanga roads. These two roads are tarmacked roads. Gitanga road is in good condition though its width and poor open drainage alongside. Public transport is operated by Matatu and Buses n^o 46. Naivasha Road on the other hand is very poor: multitude of potholes, poor drainage, and lack of maintenance hinder the traffic and continual jams characterises that road. Buses and Matatu N^o 1, 2, 3, 4, 102, 103, and 135 operate there carrying people to and from the town centre. Also heavy trucks and lorries carrying goods have marked their presence especially when there is problem

on Waiyaki Highway that links the city to the Rift-valley, Central and Western provinces.

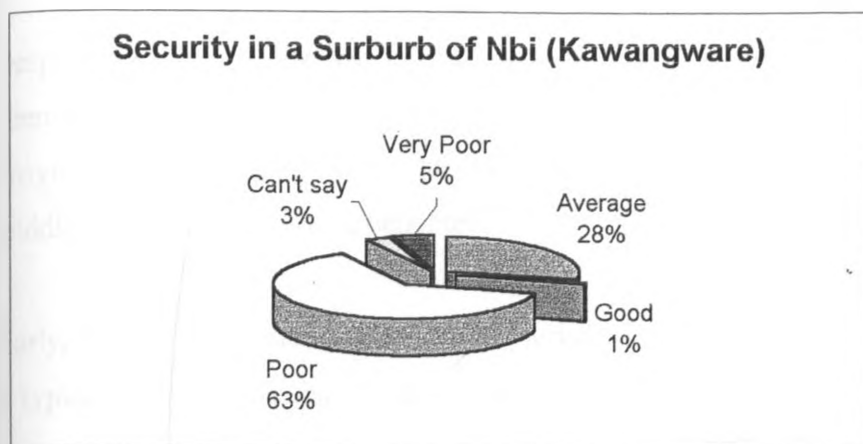
Therefore, emphasis must be put on Naivasha road because it is mostly used by cistern lorries that carry clean water to people, and it links the towns via Ngong road to the Waiyaki Highway in Udhiru. Also, many inner roads are earthy and need maintenance and enforcement because squatters invade road space and construct houses using non-permanent structures.

3.10. Social Services (Public and Private)

In order to support the life of the people, the provision of services is necessary. By social services other than Water and Sanitation, we mean: Administration, security, health, and education among other services. The functions include the provision of life-long and continuing formal, vocational and recreational education for both young and the old; provision of recreational and sporting services; provision of markets and other training facilities; the provision of family support for those with problems through a network of counselling and advisory services and the alleviation of poverty by bringing self-help groups together to undertake economically viable enterprises

Under Administration, the location is led by the Chief of Location for security and Councillor for service development. In order to reach ordinary people, the location is divided into 10 villages supervised by Chairmen. Chairmen and the police work together for the security of the people. This is on paper only because people complain that the police officers are number one to cause insecurity in the area. 63 % of the respondents said the security is poor. Thieves and police officers attack and harass people during day and night in order to steal their money and goods. About the councillor, during the last government, there was conflict of powers between Local and Central Governments. One can hope that the current Government will remove that equivocal situation that appeared between Central and Local Governments whereby Local Government and his agencies like Local authorities execute their attributions without any interference from the Central Government.

Figure 3.3. Security in Kawangware



Source: Fieldwork 2003

Education and Health facilities are closely affected by the water provision. Kawangware Location has one secondary private schools, three public primary schools and more than 15 private nursery schools. It also shares with Riruta location one public primary school. The location should have and according to Physical Planning Hand Book, 3 secondary schools, 13 primary schools (two streams) and at least 34 nursery schools. All such education institutions require adequate water supply for their effective operation

In terms of health facilities, there is no hospital facility in the location. The community use the nearest and cheaper health facilities that are located in Nairobi and Kiambu district such as Kenyatta National Hospital, Kikuyu, Kijabe, Pumwani, Mater, Coptic, and Nairobi Hospital among others. Kawangware has got four health centres in which one is a maternity or family planning centre. The maternity and one health centre are under the control of the Local Government through Nairobi City Council. Clinics are privately run. Most of them are dispensing chemists. This is not acceptable because nurses and pharmacists are different in term of their profession. In a Dispensing Chemist, people may be advised to take drugs not because they are efficient but because they are the only ones that are available in the stock. This endangers the life of the people and the economy of the country. Like education facilities, health facilities of necessity require adequate water supply for their efficient operation

3.11. Residential and Housing patterns

Despite the effort of the last Government in term of housing provision, nothing has been done for low-income residents. Sites and Schemes projects were not able to provide shelters to cater with the housing demand. So instead of profit the poor, middle and high classes have benefited.

Early, Dagoretti Division was under the jurisdiction of Kiambu county council. It was a typical rural area despite its proximity to the town. Most of lands were under the control of the county council. Because people, especially low income, found themselves unable to construct in the city, and they shifted to the area where there was cheap land to develop.

Workers and squatters who lived in the area were limited to renting houses because they could not afford land that was under absolute freehold ownership of Kikuyu people. The latter, took advantage and constructed for new arrivals and workers houses mostly in semi-permanent building material. From the field, 93 % of the households interviewed rent houses in which they live and they pay an average of Ksh 1650, 6 % are owners of the houses and 1 % of the respondents only has been protected by his employer. This means that majority of Kawangware residents do not own the land in which they live. Paradoxically, for them improving water services in the area does have an important issue since they are keen to pay for the service.

Table 3.5. Housing ownership in Kawangware

OWNERSHIP OF THE HOUSE		
Ownership status	Frequency	Percent
Owner Occupied	9	6.3
Private Rented	133	93.0
Employer Provided	1	0.7
Total	143	100

Source: Fieldwork, 2003

Plate 3.1. Dichotomy of housing Structures in Kawangware



Source: Fieldwork, 2003

Housing pattern can be used to determine the condition of living of people. Majority of the respondents are in tenancy with private landowners. The living space of the house ranks from 12 m² to 35 m² for more 81 %. 43 % of the households interviewed enjoy the space of 20 m². Imagine a space of 20 m² available for 4 persons in a household.

In terms of life conditions, the wall and floor are very important due to their protection against the bad weather: cold, wind and dampness that could be the cause of respiratory diseases and other viral ailments. Among 142 houses visited, 92 % of them have got cement screen in them. Others have the floor on PVC Tiles and others 6 % have nothing at all (Earth floors).

Table 3.6. Type of houses in the study area

TYPE OF THE MAIN HOUSE		
	Frequency	Percent
Permanent	44	31
Semi Permanent	73	51
Non Permanent	26	18
Total	143	100

Source: Fieldwork, 2003

A majority of the roofs in the area are made of corrugated iron sheets (96 % of houses surveyed). A very small number of houses have roofs in Clay tiles (2 %), concrete tiles, concrete slabs (2 % of visited houses). As far as type of the house is concerned, there are permanent houses whose walls are constructed in fired bricks or stones; and semi permanent or non-permanent houses, houses whose walls are made of either timber or galvanised iron sheets; and houses whose both the roof and walls are made of corrugated iron sheets. Among 138 households interviewed, 63 of them or 46 % are houses with both walls and roofs made of galvanized iron sheets. The material used for the roof is important in rainwater harvesting. When there is shortage of water, people can use rainwater collected from the roofs especially those made of corrugated iron sheets.

Table 3.7. Cross-tabulation wall/roof building material

BUILDING MATERIAL USED FOR WALL * BUILDING MATERIAL FOR ROOF						
(Cross tabulation)						
	BUILDING MATERIAL FOR ROOF					
	Materials	G. Iron Sheets	Clay Tiles	Concrete Tiles	Concrete Slab	Tot
BUILDING MATERIAL USED FOR THE WALL	Timber	21	1			22
	Mud Bricks	6				6
	Fired Bricks	3				3
	Concrete Block	14	1	1	1	17
	Iron Sheets	63				63
	Stones	31	1			32
Total		138	3	1	1	143

Source: Fieldwork, 2002

3.12. Hygiene, the availability of Toilet, Kitchen, Bathroom, and Telephone

Concerning hygiene around the house, only 5 % of the houses surveyed have a good clean environment around them while for others it is degrading. Hygiene includes both the condition of the house and the cleanliness of the surroundings.

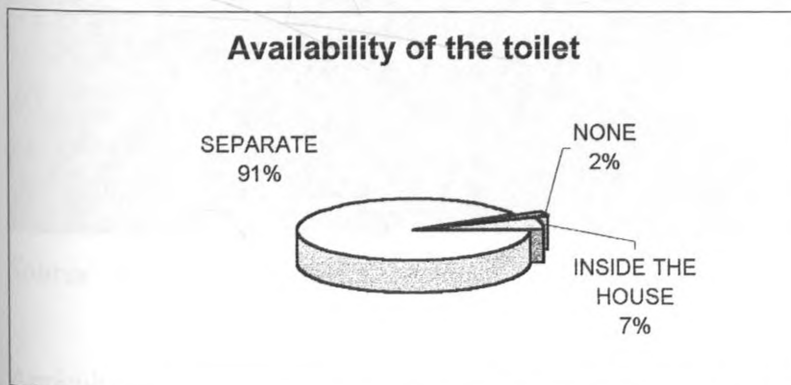
The condition of the houses has mostly been termed to be fair and good (Field survey). Only less than 1 % is in good conditions. Telephonic communication in houses is absent, and people have to go to the city centre for that facility. Or they can use public telephone that charges them 15 to 25 Ksh per minutes for local calls.

The availability of the kitchen and bathroom is quite rare where the space of the house is very small; 69 % said they did have neither kitchen nor bathroom. 28 % who said they had it inside meant that they made food inside the house but not in the kitchen room. People to take bath, 67 % of households availed a separate place for that purpose.

For the toilet facilities, 91 % contented themselves with pit latrines. But, what was pity was that 2 per cent of the respondents did not have toilets; they used “fly over” toilets that were very dangerous to the health of people. There were no public toilets available to them.

So, because Majority of people were in tenancy status, and dwelt temporary houses, public toilets were highly needed. Construction of those public toilets would offer a number of jobs for certain people, and the same toilets must be connected to sewer system. This would increase income for some and would improve the sanitation level of the area.

Figure 3.5. Availability of the toilet



Source: Fieldwork, 2002

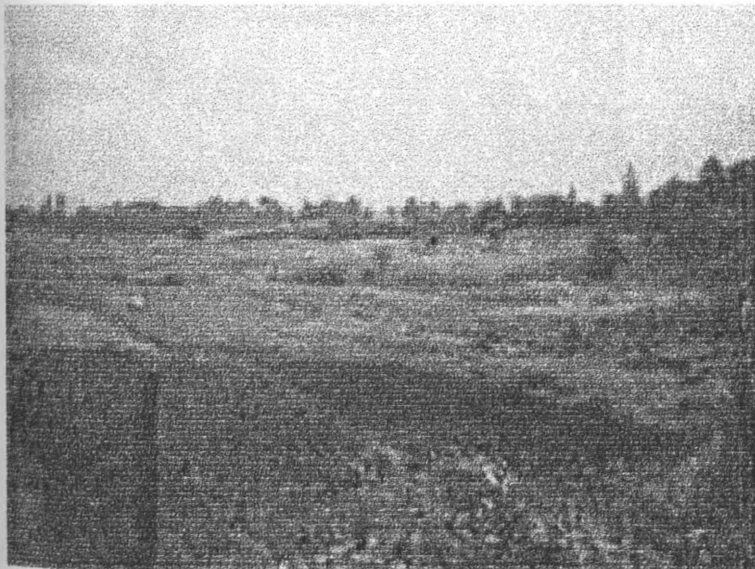
3.13. Economic Activities (*trading, housing, agriculture, etc.*)

Activities of the people determine the living standards. They affect services provided especially supplied water. Activities in Kawangware were mostly informal activities. They ranged from professional, labour, formal business, informal business, educational, farming, security, volunteer, hawking, driving, carpentry, medical care, masonry, bars, and cleaning, etc. Professionals were only 24 % of respondents. Most of them travelled on foot or by matatus to work in the city centre.

Examining the above, we saw how much poor the people of Kawangware were noting the low incomes they could get at the end of the month or when dusk falls.

Trading activities are run at home, at the market or along the roadside. This affects the environment since traders do not control garbage thrown about. With the coming of the current Government (NARC Government), councillors are prohibiting such kind of activities and advising people to go to designated trading places.

Plate 3.2. Agricultural activity along Nairobi River



Source: Fieldwork, 2002

Agricultural activity is mostly done in the valley along the river. Farmers grow maize, vegetable, beans both for sale and for consumption at their home. This activity was

very important in the location, as it was a typical rural location in Kiambu District. Besides farming activity, there was the active housing market through letting of dwelling houses. Letting of houses activity had great influence in the area and tended to eliminate other activities due to higher housing demand, as the area is a dormitory of some workers in the city of Nairobi.

Labourers and hawkers are very important in the Location. Constructing houses, digging and emptying pit latrines are their business. Also, they do transport water to consumers using carts or on the back. *At the time² when this report was written they were selling one jerrycan of 20 litres at 30 to 50 Ksh.*

Plate 3.3. Open drain worked out by Labourer



Source: Fieldwork, 2002

² Shortage of water in the entire Nairobi caused by heavy rain that has carried out pipes and destroyed Sasunua Dam.

3.14. Water supply Provision in Nairobi

From the early years of Nairobi's inception, demand for water has grown tremendously. Until the 1970s, Nairobi's principal source of water supply was the Kabete Treatment Scheme, which for many years had managed to keep pace with demand. But the city's rapidly growing population and high water losses severely strained the aging system's capacity. Throughout the 1970s and early 1980s water shortages were common.

The First and Second Nairobi Water Supply projects (WS I and WS II), approved in 1970 and 1978 respectively, sought to expand the supply of water (by developing the new Chania Scheme), improve and expand the distribution of treated water, and improve the availability and affordability of water.

Also, the latest water sector projects in 1984 and 1995 resulted in an increase in the total available supply to Nairobi from 130,000m³/day to 190,000m³/d and from 400,000m³/d with a potential for 519,000m³/d respectively. Although bulk water supply to the city is not currently in short supply, the reticulation system is in a poor state of repair and currently around 50% of the bulk water supplied to the city is lost through leakage and, illegal connections etc.

For these reasons, in 1989 the Nairobi City Council instituted a Leakage Control Programme, to reduce the level of water losses. Activities included (bulk metering, assessment of data from metering system, pilot investigations in leakage control methods and formulation of a leakage control policy) subsequently led to the setting up of a Leakage Control Section within the Water Department. Despite repeated interventions by external consultants and external support, the programme has never realised sustainable results as seen by an increase in leakage levels. There is an urgent need to improve the capacity of the unit and ensure it exerts a significant impact on the reticulation.

The Nairobi City Council has undertaken the Third Nairobi Water Supply project (WS III) to largely keep pace with the population growth, and the availability of water

has steadily increased as a result of the water supply projects which comprised new facilities for collecting and treating water from the Chania River as well as improvements to water distribution. Water distribution network is divided into 11 hydraulic zones to conform to the geography of the city and the accompanying pressure regimes. Because of the nature of the city of Nairobi, it is divided into 3-supply zones_ High, Middle, and Lower zone. Nairobi has a total of 265 kilometres of trunk mains in the distribution network (Aligula, 1999:146).

Nairobi gets water from four main sources: Chania River via Ngethu, Sasumua Dam (Kinangop), Ruiru Dam and Kikuyu springs. There are a number of reservoirs that form part of the water distribution network of Nairobi which have the capacity of 26 hours (See Map 3.6. Nairobi Water Reticulation Network).

Nairobi has installed water production capacity from its sources of 519000 m³ of water per day, estimated to meet the demand for the city up to the year 2007. Gross demand in 2000 was estimated at about 371000 m³ per day. The two largest sources for the city are the Ngethu and Sasumua dams that actually supply to the city the average of 310750 m³ of water per day.

Table 3.8. Capacity of existing water supply for Nairobi

Name of source	Capacity in m³ per day
Kikuyu spring	5000
Ruiru Dam	20000
Sasumua Dam (Kinangop)	57000
Chania I, & II (Ngethu)	136000
Chania III	250000

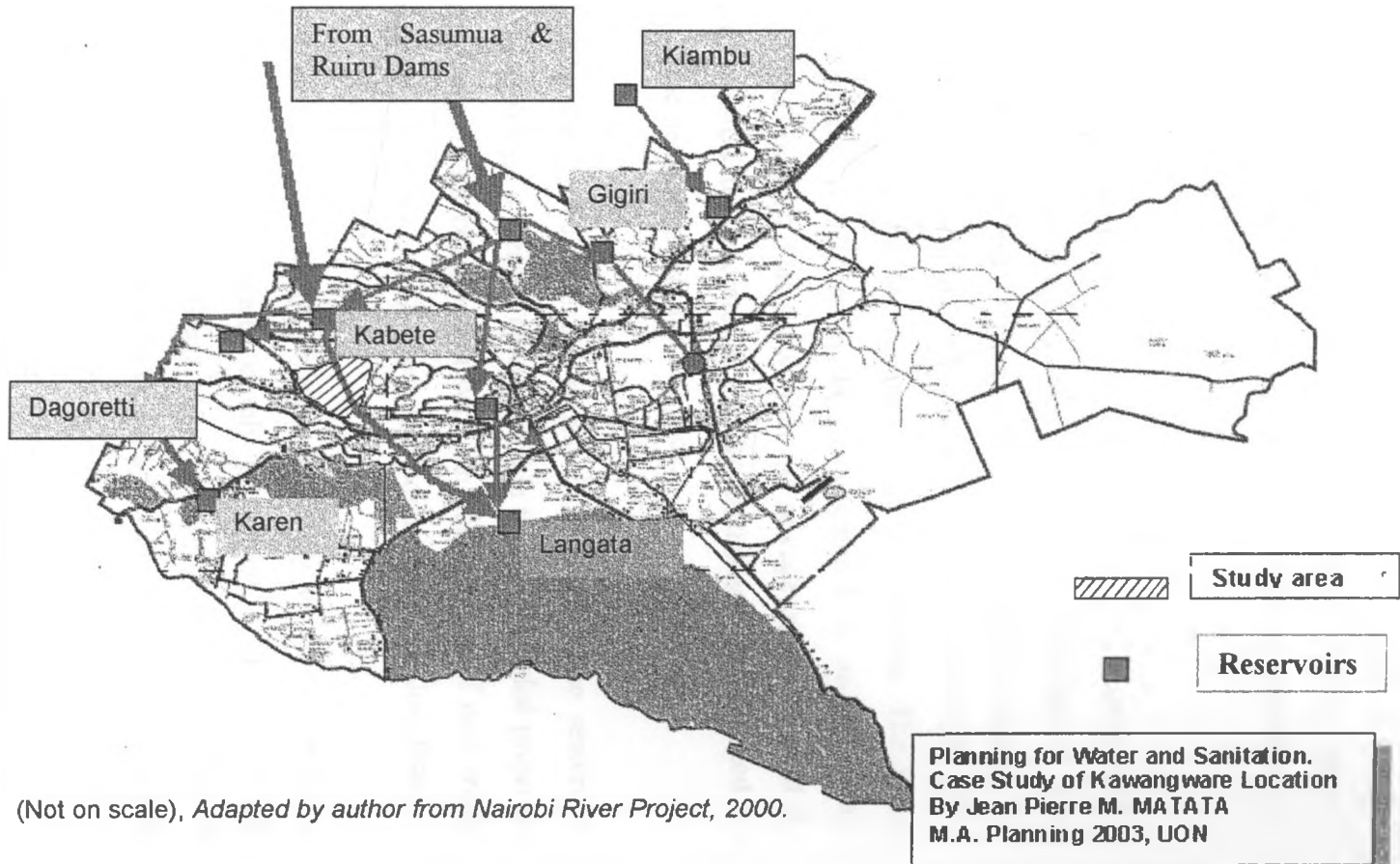
(Source: Fieldwork, 2003)

Water supply is about 100 percent provided by Nairobi City Council. Where water supplied does not reach, lorries, tankers, vendors take over by providing clean water at high cost. Sometime, those private suppliers draw water from the tap. They can take water from private borehole owners. But in case of shortage, they do not have choice and fetch water wherever. The latter could be polluted, but that did not bother

them. And the consumers on the other hand, though they do not trust the water quality, do not have a choice because what they need is water for their basic uses. During the study interview, some said they can expend up to Ksh 1800 per month. Twenty five percent of respondents pay Ksh 500 per month for water and they get it from the taps once or twice in week.

MAP 3.6

MAP OF NAIROBI AND WATER RETICULATION NETWORK



(Not on scale), Adapted by author from Nairobi River Project, 2000.

3.15. Sanitation in Nairobi

As stated earlier, sanitation includes both *public sewerage* system and the traditional system, that is, the use of *cesspools*, *septic tanks* and *streams*, and *pit latrines*. The latter may contaminate shallow ground aquifers from which some of the utilities draw their potable water supply. But it is wrong to imagine that simply through construction of latrines - that health conditions will improve. Sanitation is not more latrines. It is the introduction of a new way of life through education, behavioural change and personal hygiene practices.

In Nairobi, the sewer system has been designed to evacuate domestic, commercial, and industrial waste. Sewer development has been undertaken according to the Nairobi Master plan for Sewerage and Drainage of 1974. The sewer system is partially combined with a total sewer length of 600 km and covers an area of 240 km² where sewage flows under gravity to the treatment plant at Dandora. The total capacity of the sewage works is 120500 m³/day as compared to an estimated discharge in 2000 of 280200 m³/day. This shows that the sewage treatment plant is not enough to handle the wastewater generated in the city. In this case there is need to expand the plant because the demand grows at a fast pace.

About 65 percent of Nairobi's population has access to a water-borne sewerage system today. While the coverage increased chiefly outside the Bank-funded projects, Urban I project made a significant contribution with the construction of new trunk sewers and the initial phase of the new sewage treatment ponds at the Dandora Estate.

The field survey revealed that the sanitation issues in the study area have reached a critical level. As the improvement of water supply goes hand in hand with the improvement of sewerage system, insufficient water supply has in turn affected proper sewage flow. Pit latrines on the other hand, fill up easily due to high densities. It is thus common to find raw sewage that diverts into open drains in the settlements due to the sewer blockage - a feature which compromises the health status of people.

A paradox is also visible in the provision of these services by private groups. In the rainy season, sewage exhauster tractors and lorries are permanently in business. Come the dry season, water tankers take over. This is because rainwater enters in pit latrines and the latter are overflowed. And in sunny weather, water supply is in shortage.

To improve the living conditions of the people, under Lomé I (1976-1980) through Nairobi City Council, the European Economic Community financed the upgrading scheme in Kawamgware. That project had installed the main sewer system in a small area. The sewer pipe collects both sewage and runoff because of the flat relief form of the area. The bad operation and mismanagement of facilities, soil and garbage had obstructed the drainage. Runoff stagnates for a long time waiting to evaporate or percolate into the ground. The area that was not provided with the sewerage system faces great sanitation challenges: people use pit latrines. And when it is full, labourers unload it and expose the waste to the flies and other contaminating agents.

CHAPTER FOUR

WATER SUPPLY AND SANITATION SERVICES

4.1. Water Supply in Kawangware

4.1.1. Source of Water Supply

Water resources are under great stress as populous cities, states, and countries require and withdraw more water from rivers, lakes, and aquifers every year. A major threat to maintaining future water supplies is the continuing over-draft of surface and ground water resources.

Water source depends upon the rainfall and also the land it is drawn from. The topography of the soil plays an important role to get that precious resource. Following the topography of Kenya, there are four drainage basins such as Rift valley, Athi River, Tana River, and Lake Victoria¹. Nairobi is located within the Athi River drainage basin. (Map 4.2. Kenya basins)

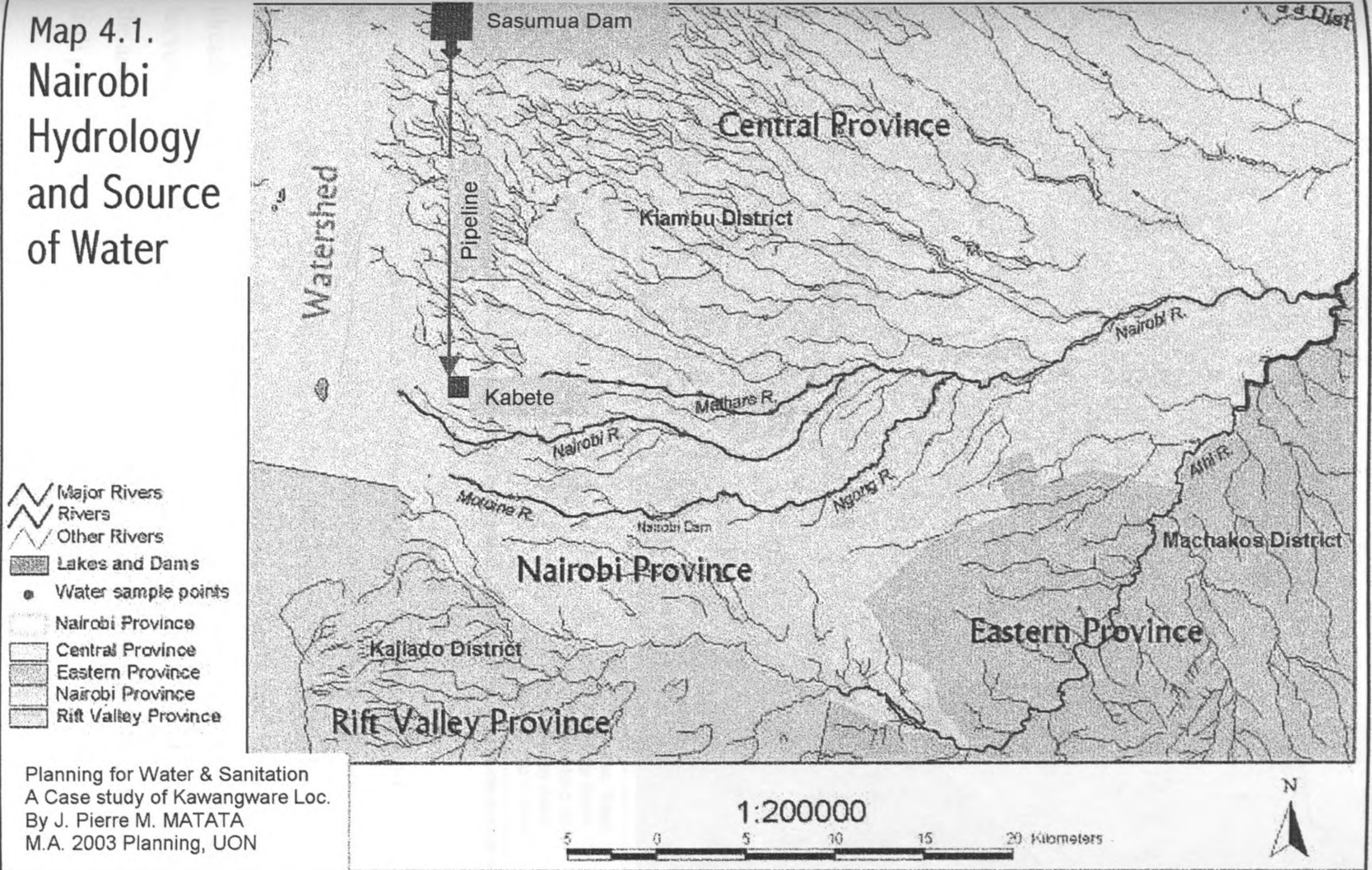
Although water supply capacity has kept pace with the growth of population, and also the availability of water has increased, there is need to improve water distribution because there are some areas especially low income residential areas that do not readily get water.

Nairobi residents get 20 % of water from the Chania River that is precisely in the Tana drainage basin, and the rainfall is higher in that area. The Aberdare Forest contributes a lot to water provided in town. It needs to be protected as well as the ground, dam, stream and river waters.

For the area of study, water intake is from the Sasumua Dam and after it is conveyed to the Kabete water treatment plant (Map 4.1.). And from there it is distributed to different areas of Nairobi. Kawangware area was neglected in terms of water distribution.

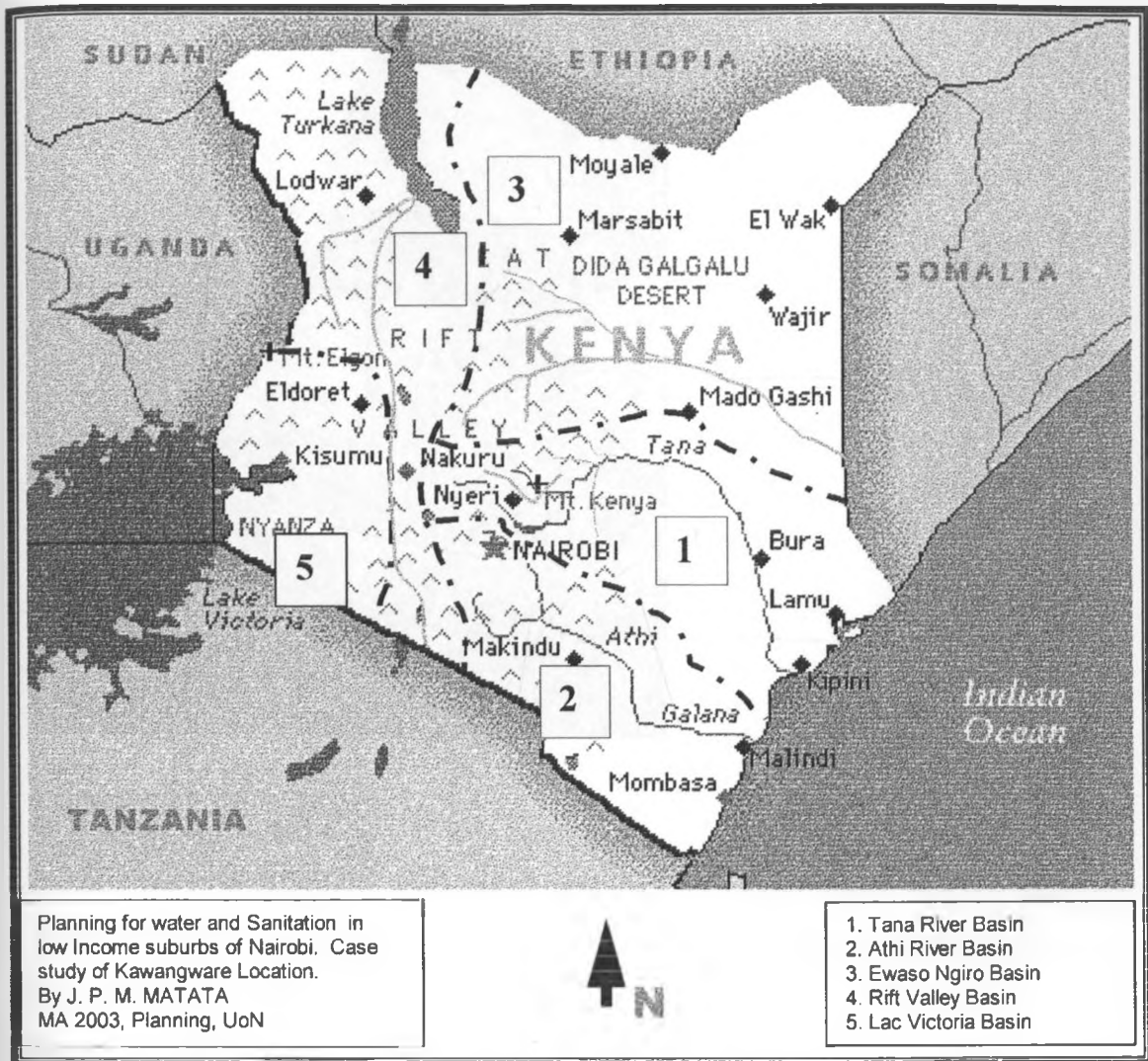
¹ See the map showing drainage basins of Kenya map. 4.2.

Map 4.1. Nairobi Hydrology and Source of Water



Source: Nairobi River Project, 2000

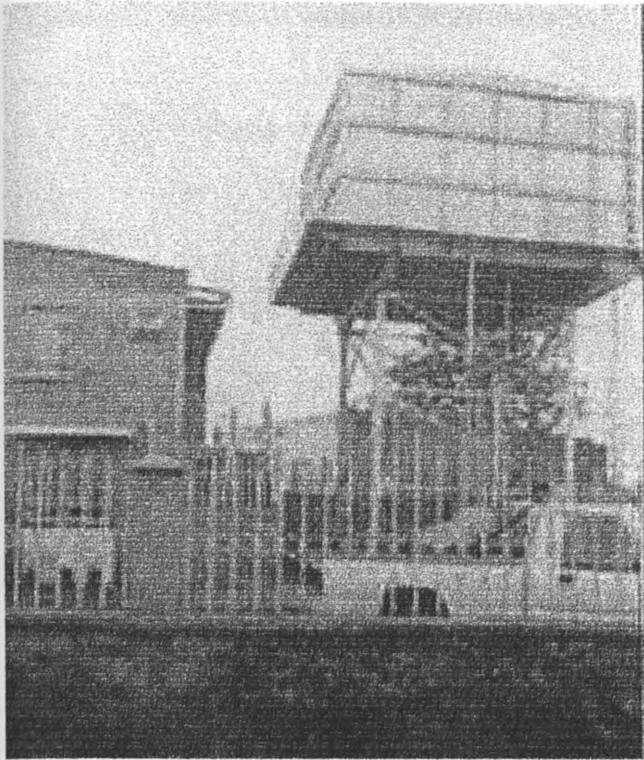
Map 4.2. Kenya Basins Drainage



Source: Fieldwork, 2002

Another water source is ground water. People dig shallow wells, and boreholes where they get water especially when water is in short supply. In Kawangware people had already two private water “stations”, as they called them, that supplied water to lorry tankers and vendors as well as to residents. About 45 wells and 10 boreholes had already been dug for the purpose of supplying water to residents. Rainwater is harvested during the rainy season and formed an alternative source of water supply in the area of study. Certain persons stored both rain and tapped water in tanks for sale at high price during shortage.

Plate 4.1. Filling Water Station



(Source, *Fieldwork*, 2003)

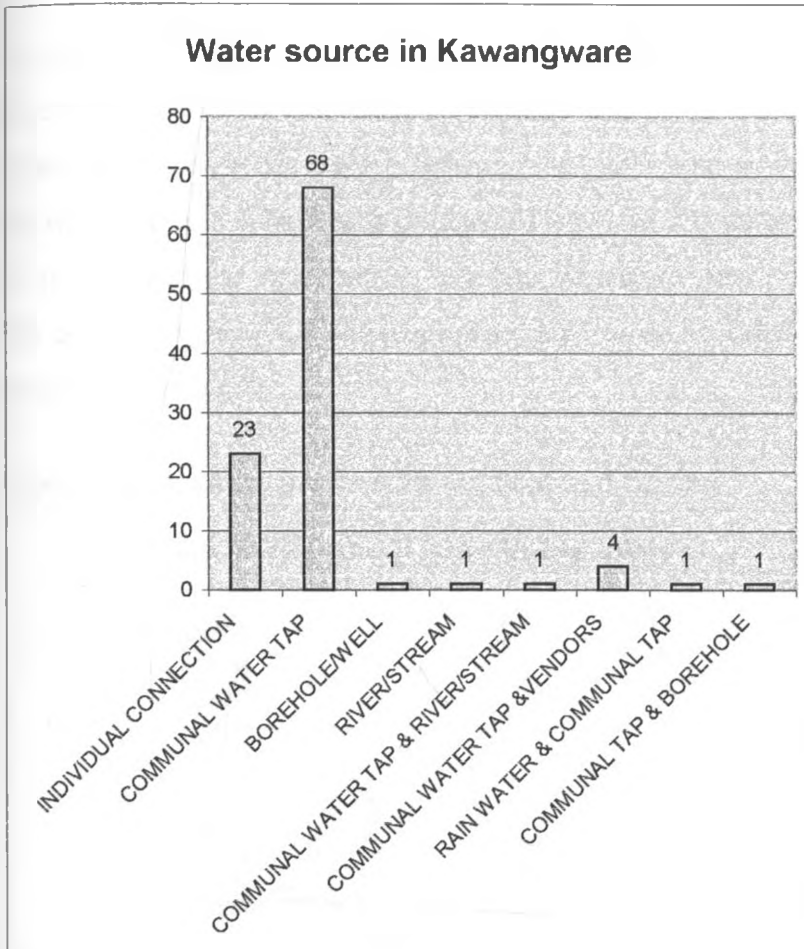
Surface water in Dagoretti was critical meaning that surface water was not abundant in the division. The only surface water was Nairobi River and its small perennial and non-perennial tributaries. In terms of quantity, the river flew during all seasons. Two percent of households² interviewed used the river as their water source for their domestic purposes.

As well as water quality is concerned; nobody could trust the quality of the river water from Nairobi River because of human activities up stream that highly polluted the river. Those activities among others included agricultural practices that used fertilizers in the valley, a multitude of car wash points that discharge oil and other pollutants, households' activities and finally the abattoir that generate great quantity of wastewater into the Nairobi River. Besides, another element was the habit of residents of throwing garbage directly into the water body. These considerably

² See Figure 4.1. Source of water in Kawangware.

polluted the river up to the level that no one could distinguish sewage and the water from the Nairobi River.

Figure 4.1. Source of water in Kawangware



(Source: Fieldwork, 2003)

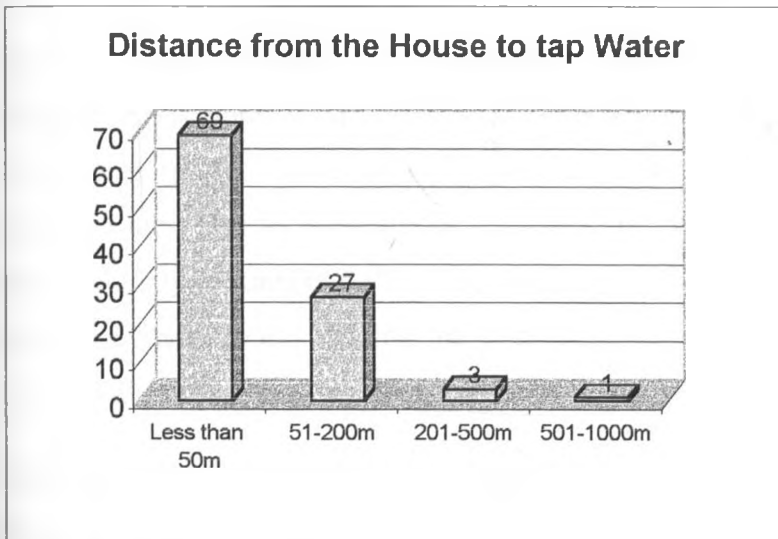
Tap Water (Individual and or Communal)

Tap Water is the most used water source in the area of study. From our analysis, more than 95 % of households in the division accessed water from water tap provided by NCC. In the chart above, one can see the combination of sources; that was because of the performance of water services. Water supply had got many difficulties in term of provision so that people sought other alternatives to provide themselves with water when there was shortage. That often occurred in the area. Those alternatives were as shown in the chart, 23 % of respondents had water in their houses (Individual connections), and 63 % enjoyed communal taps. The rest used a combination of

sources such as boreholes, wells, rainwater, rivers and vendors. The latter, drew water from a long distance and distributed it either by lorry tankers or carts at high prices as shown above.

In terms of distance from the homestead to water source, according to respondents' reports and observations, most households had easy access to water. This merely means that homesteads are located near the water source. 96 % of respondents said the water tap was located at a distance of less than 200 metres from their homesteads. 67 percent had the water tap at less than 50 metres. From a planning point of view, this is encouraging. The challenge was what to do to bring water up to the tap or outlet (consumer).

Figure 4.2. Distance between Homestead and the tap

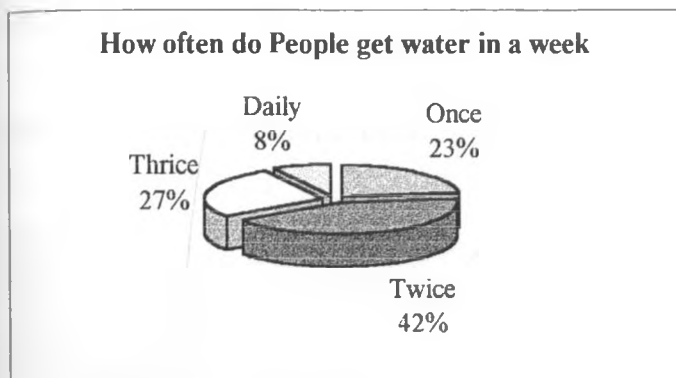


(Source: Fieldwork, 2003)

In terms of reliability of the source, although more than 90 % of residents had the tap at less than 100 metres from their doors, water was not enough. As shown in the chart below, 42 percent of households visited had water from the tap only twice in a week. 27 % got it three days in week, while 23 percent said water was provided once in a week. This implies how the conditions of supplying water were. The fact that people got water from taps at differing frequency was because of the topographic condition of the area. People, who were in the lower side, got plenty of water while those from the higher level, taps water got dry early. In addition to that, illegal connections and

sporadic development made water pressure in the pipes to be much lower so that it could not satisfactorily reach the consumers.

Figure 4.3. Water supply provision



(Source: Fieldwork, 2003)

4.1.2. Harvesting and Storage Methods

As shown in the table below, Water was perceived at 63 % of respondents as a scarce resource that requires careful utilisation, while 29 % said Water is an economic good to use for purposes that can benefit their family. Consequently, people really knew the value of water. Due to water source reliability, the population stored it in the fact that they could buy containers that cost up to Ksh 12000. This amount of money could be used for other purposes than buying containers that could store up to 10000 litres of water. Water was stored in jerricans, drums or buckets.

Table 4.1. People's perception on supplied water

PERCEPTION ON WATER	Percentages
Social good given, free to be used without caution	5
An economic good to use for purposes that can benefit my family	29
A scarce resource that requires careful utilisation	63
Water is life	2
Total	100

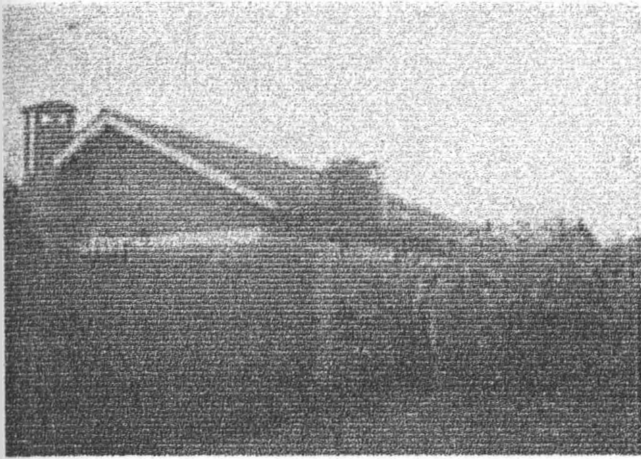
(Source: Fieldwork, 2003)

4.1.3. Water uses

Water uses depend upon the activities that are in the area. In the valley along the Nairobi River, irrigation was practiced using water from the river of course. For restaurants and bars, water is their most important resource they could not do without.

There were also some car wash business places along Gitanga road that used a lot of water especially the water provided by the Council. Apparently there were neither Public nor industrial water uses. Water in Kawangware was at 98 % used for Domestic purposes.

Plate 4.2. Water storage Tank

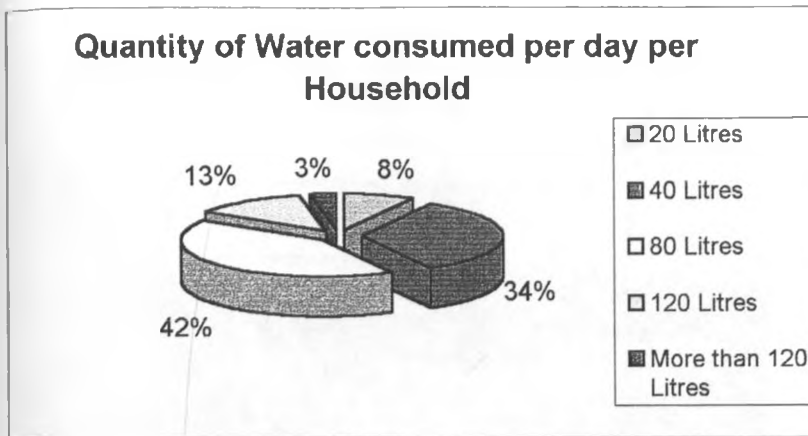


Source: Fieldwork, 2003- this tank stores water for domestic uses

The average water consumed per day depends on the use. In high-class residential urban areas the average can easily reach 200 litres. From planning point of view, in urban areas the average water consumed may be 135 litres per capita per day. Water consumed in such cases included all uses and in particular water used in flush toilets where they existed.

Water consumed per day per household was derived from the following Chart (Figure 4.4.). Majority of respondents (42 percent) consumed 80 litres in their homestead per day. The average quantity of water consumed was 60 litres per household per day. People consumed little water because they did not have plenty of water. If water supply was provided daily, the quantity of water consumed per day might significantly be increased.

Figure 4.4. Water consumed per day per household



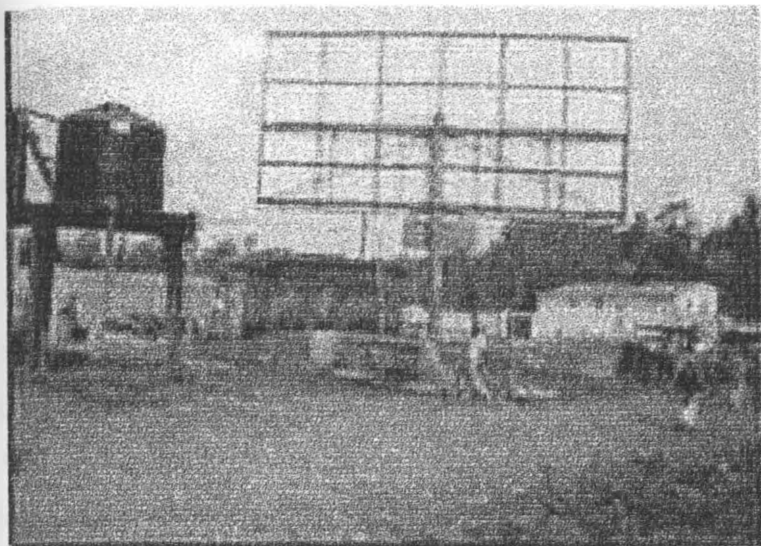
(Source: Fieldwork, 2002)

4.1.4. Water Quality

Water of good quality is one free from organisms that cause diseases (pathogens) and must not contain chemical substances at a concentration that they affect the human health. In addition, clean water is one free from taste, odour, colour and turbidity, not causing corrosion or encrustation of the water supply system not staining clothes washed in it. This interesting exercise of testing water quality was not done because water laboratory test was so expensive and due to lack of equipments and enough finance.

Ground water that is the second source of water in the area was certainly contaminated by the existence of pit latrine and garbage taking long to be collected. The water from water stations was not treated before it was distributed to people. It stains clothes. And it was not suitable for bathing. Middle class people used that water for their sanitation purposes such as flush toilet and car and washing houses', etc. Surface water, such as that of Nairobi River was polluted so that nobody could draw from it water for drinking. That kind of water needed further test in order to treat it accordingly.

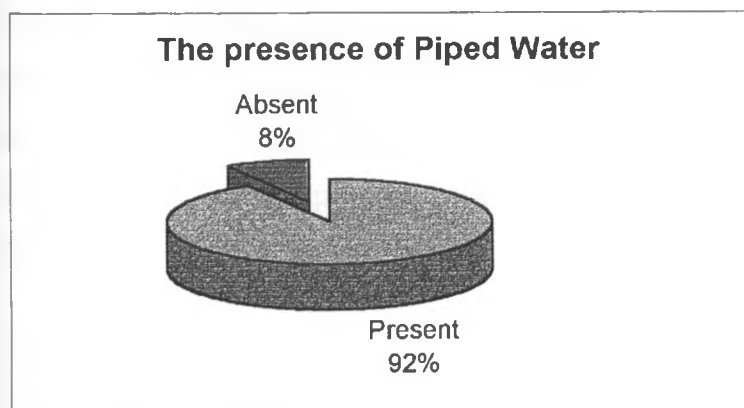
Plate 4.3. Deliverance Water Station



(Source: Fieldwork, 2002)

Tap Water was the only sources of drinking water one could trust. 92 percent of households visited relied on piped water. Some people mindlessly consumed water without any domestic treatment (1% of respondents). But all respondents revealed that they knew the water related diseases. They stated diseases like Typhoid, Cholera, Dysentery, Amoeba, Bilharzias, etc. And the method used by residents to prevent those diseases was to boil that water before drinking (99 %of respondents). In that case water should be boiled for 20 to 30 minutes, aerate it until it is cold to permit dissolution of oxygen so as to make it potable and suitable to drink.

Figure 4.5. Piped Water provided by NCC



Source: Fieldwork, 2002

4.1.5. Problems in Water provision

In the use and distribution of water, there was apparently no conflict apart from disputes among drawers due to long queue when water comes. Water comes twice or once in a week. Another challenge facing tenants was that in their contract with the landlord, they agreed that water is included in the rent; but landlords limited the quantity of water to fetch (not exceeding 40 litres per day). If a tenant wanted to take more water he paid for the surplus. If water had been stored, in subsequent days, every body would require paying at least 3 or 4 Ksh per 20 litres. From this analysis, people paid for water up to a maximum of Ksh 1800 per month or an average of Ksh 350 per month. To overcome such a challenge, water should be supplied more regularly or daily. And the Ministry of Housing, Ministry of Water and Nairobi City Council should set up maximum limits for rent and that of water charges and enforce this policy. As the current government has suggested taking over urban water services, which are under the City Council control through Water Boards, they have to consider how to protect low-income people from exploitation by the landlords.

4.1.6. Water provision and Providers

The provision of water in Kawangware depended on the water source. The water was unevenly distributed. Individual landlords provided water from their private boreholes and wells; also the same people supplied rainwater. Tap water, which was the main source of water, was under the control of Nairobi City Council.

There were only three Water kiosks installed for the whole location. They operated under NGO's and community groups and yet operators charged consumers higher rates of charges than that for house tap water connections. The beneficiary survey revealed that consumers perceived water quantity as not satisfactory and requested improvements in reliability and standards of supply

The private sector such as lorry-tankers, carts-vendors played a great role in water provision. They have made water prices to be higher than the one provided by NCC.

There were two private providers using two private water stations. They supplied water through vendors and tankers as above.

As far as provision of water was concerned, more than 66 per cent of respondents had attributed the responsibility of water problems to the mismanagement of public water services and recommended the proper management and implementation of new water projects to stop rationing system.

Even if the Central Government and its agencies (Ministry of Water, Ministry of Local Government and the Nairobi City Council) could not bear alone the responsibility of providing water services to urban population, there would still be need for a policy that controlled water charges in the city in the interest of the poor community residents.

4.1.7. Community Contribution in water supply and sanitation

Warner (1990) defines a community as a group of people that live in a defined area or people with common economic and political interests. The term community participation refers to community involvement in all stages of designing and implementing a project of which they are beneficiaries.

Furthermore, Community Participation means voluntary and democratic involvement of beneficiaries in contributing to the execution of the projects in sharing the benefits derived from that projects and in making decisions with respect to setting goals formulating the project and preparing and implementing the plan.

Warner (1990) also identified three components of community participation as follow:

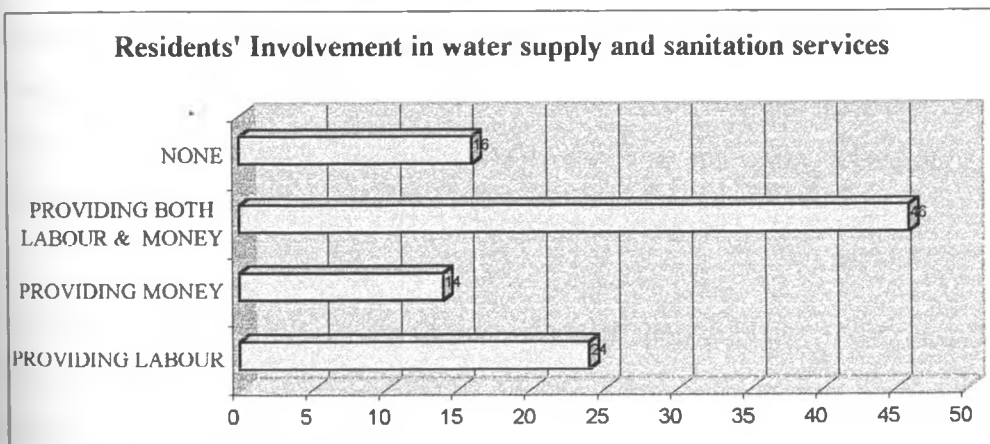
- **Authority**, the community has the right to make and take decisions on water supply and sanitation services.
- **Responsibility**, the ownership of the project is under the control of the local community.

- **Control**, the community must be empowered in making decisions to control the system.

The Sessional paper N° 1 of 1999 on water resource management and development stipulated that in order to ensure sustainability in water supply schemes there will be need to apply the participatory management option (GoK, 1999). The government's role will therefore be to facilitate and regulate the water services.

The community is the key beneficiary of the scheme. Thus, the community expressed their willingness to participate in the development affecting them. *Eighty four* percent of the respondents were ready to contribute towards the water and sanitation projects; forty-six percent were ready to provide labour and money, twenty-four percent labour only and fourteen percent were for money as depicted in the following chart. Sixteen percent declined any contribution.

Figure 4.6. People's willingness to be involved



(Source: Fieldwork, 2002)

4.1.8. Emerging Issues in Water Supply

The following were the main emerging issues associated with the supply of water in the study area:

- Destruction of catchment forests which may have changed weather patterns and led to acute runoffs with resultant siltation problems in dams and intakes;

- High levels of unaccounted water loss through leakage, illegal connection, etc.
- Inefficient and wasteful water use by consumers, even during a tight rationing schedule;
- Natural changes of climate (e.g. heavy rain that destroys dams and intakes and long periods of dry season). It resulted in the shortage of water due to the destruction of reservoirs and evaporation of water supply.
- Leakage, aging pipes that often burst and take long to be repaired;
- Rationing schedule itself is a challenge for resident 94 % of respondents.

4.2. Sanitation in the study area (Kawangware)

4.2.0. Sanitation is regarded as *systems* that “*dispose efficiently refuse in liquid or solid forms*”. Sanitation services include both liquid and solid waste management.

4.2.1. Solid waste services provision in Kawangware

Sanitary facilities are mainly concerned with the cleanliness of the areas. It is also concerned with the removal of waste and keeping places free from dirt or substances that may cause diseases. The process is divided into collection, conveyance, treatment or disposal of refuse.

Various methods in solid waste disposal depend upon the type of solid waste, whether biodegradable or non-biodegradable waste. They also depend on the quantity of waste, and local regulations that govern the environment. Solid wastes are disposed by the methods such as incineration, recycling/reuse, composting, animal use (e.g. food for pigs), sanitary landfill and rehabilitation of quarries for example, etc. And these methods must be done considering environmental impacts that can eventually occur.

In Nairobi, the elaborate procedure of waste disposal outlined above was not followed in practice. The only method in use was to collect garbage and dump it in a dumping site like Dandora and Riruta etc. The NCC-Department of Environment was supposed

to ensure that Nairobi residents enjoyed a clean, healthy environment through the provision of services such as cleansing and beautification of the city. Its practice was therefore far from satisfactory.

For the Department of Environment, to effectively collect, transport and dispose of garbage in the city, it would require an estimate of 180 vehicles. Only 20 vehicles were available but majority of these were not in a working condition.

The rate of refuse generation in the City was estimated at approximately 1600 tones per day. Of this amount only 40 % was collected leaving deficit of 60 % of uncollected garbage. Even the 40 % of garbage that was collected was never properly disposed off. What was done was only to burn the waste after it had been collected. That led to the production of smoke, which caused air pollution and was harmful to human health. The collection and disposal of waste have to be carried out in accordance with requirements of government Acts such as the Public health Act, the Local Government Act, the Water Act, the Factories Act and the Penal Code.

In terms of waste collection, Kawangware was neglected. The task was, where applicable, the arrangement of landlords and private societies to remove garbage from the plot. Sometimes the collectors (mostly street boys) threw the garbage just outside the gate. The objective for them seemed only getting rid of the waste from the compound.

Table 4.2. Storing of garbage

Garbage Storage	
Disposal Methods	Percent
In a plastic bucket	59
Big oil tin	2
Plastic paper bag	17
Galvanised iron bucket	1
Directly throwing in a ditch	18
None	2
Give pigs	1
Total	100

(Source: Fieldwork, 2002)

Table 4.3. Removal of refuse

Removal Of Human Wastes	
Agent	Percent
Myself	94
Sweepers (NCC)	1
Individual & street boys	1
Landlord (caretaker)	1
Private organisation	2
Total	100

(Source: Fieldwork, 2002)

In Kawangware, methods used to store the waste are presented in the table above. Answers given did not reflect the reality. People actually threw garbage in ditches or deposited it outside their premises waiting for runoff or City Council sweepers to be collected. The dumping place in the area was unoccupied plots or on the street where refuse took long time to be collected by NCC vehicles and conveyed to Dandora and/or Riruta dumping sites. In very few cases landlords had contracted a local private company to remove waste or refuse from their respective plot. In such cases, tenants put all refuse in one place in plastic bags.



Plate 4.4 Riruta Dumping Site, Nothing is done to dispose off refuse other than waste burning.



Source: Fieldwork, 2002

Garbage was collected once a week. After the waste had been deposited in the dumping site, it was simply burnt. The smoke and smell of the burning refuse would spread around the locality polluting the atmosphere

4.2.2. Sanitation services

Sanitation systems deal with the health conditions of people. In this case, sanitation referred to the *public sewerage system* that is the off-site disposal system including the collection, conveyance and disposal of liquid domestic waste such as sewage and sullage; and the *traditional system* that is the on-site disposal such as the use of cesspools, septic tanks, pit latrines and buckets etc.

The traditional or conservancy system is the system whereby the excretal wastes are collected and disposed on-site. This system is practicable in rural and small areas that are not densely populated. For example a Septic tank is recommended for an area of 30 persons per hectare.

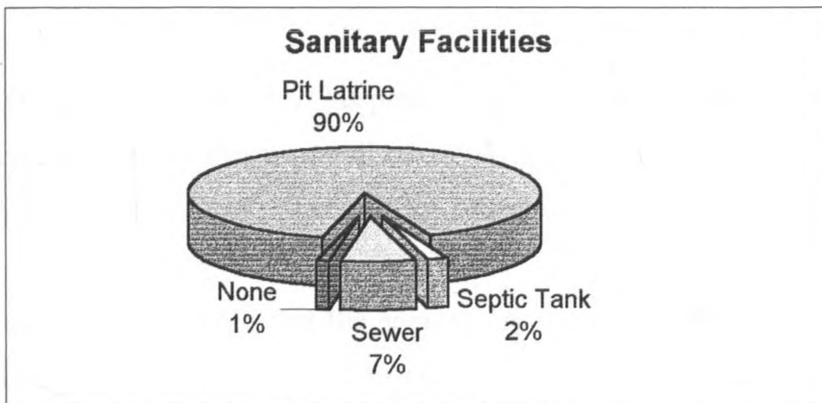
Septic tank is the improved sanitation system similar to the sewerage system. It is a water borne sanitary system and requires enough land for the drain field. That requirement was not fulfilled in Kawangware where the density was more than 20000 people per sq Km. and the land for drain field was not available. It was observed that where a septic tank was not appropriate, pit latrines were worse if found in that area. They got rapidly filled and the method used by labourer to empty the pit was not fair: human excreta was collected from the latrines and carried by labour in carts or trucks, etc. under the naked eyes of the people.

From the analysis, 7 % of the households surveyed had toilets connected to the sewer system, 2 % relied on Septic Tanks, and finally 90 percent of respondents used Pit Latrines. That was very dangerous for the life of the densely developed area in terms of population like Kawangware. Asked why they were not having a sewer system, 100 per cent of the respondents replied that it was due to the absence of the facility. The truth was that majority of houses were below acceptable housing standards. For

such temporary structure houses, the connection of their sanitary facility to sewer pipes was quite difficult. Where the sewer system had been installed, it benefited only 30 % of residents of Kawangware Location.

Furthermore, we noted earlier that in order to tackle the water-rationing problem, residents took up wells and boreholes as their alternative water source. In such cases, the sanitary facility _ the pit latrines mostly used were unsuitable as they polluted the ground water. That automatically implied that when there was no water in the taps, people had no potable or palatable water to drink. They relied mainly on the water from wells, which was not reliable.

Figure 4.7. Sanitary facilities



(Source: Fieldwork, 2002)

4.2.3. Open or surface drains

Surface drains are made along the streets; and run off and waste water from homes conveyed to them. Those water surface drains were given the longitudinal slope so that they carry wastewater under gravity flow and end up discharging the waste into the stream body or a sewer system.

In Kawangware, open drains were blocked: they were filled with soil or eroded by run off due to lack of maintenance. Because of the flat form of the terrain, wastewater flowed and discharged into the sewer system where it was present. Where there was no such facility water remained stagnating until it evaporated or percolated into the

ground. When asked how they dispose wastewater, 80 % of residents said that they used either open drain or a pit. Two percent only used the sewer system. But the truth was that people, who did not use sewer reticulation, poured their domestic wastewater in surface drains. The above has been depicted in the table below.

Table 4.4 Disposal of wastewater

Wastewater Disposal Methods		
Methods	Frequency	Percent
Use of Sewer system	2	1.4
Use of Open drain	57	40.4
Use a Pit	56	39.7
Can not say	26	18.4
Total	141	100

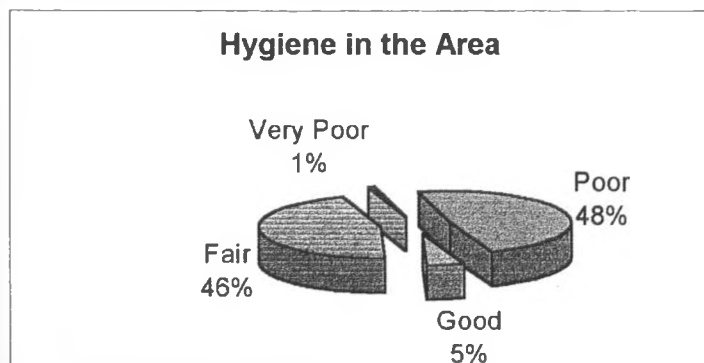
(Source: Fieldwork, 2002)

4.2.4. Hygienic conditions of the area

Hygiene is the practice of keeping oneself and one's living and working areas clean in order to prevent illness and diseases. Hygiene is one of the sanitation aspects that we have to look at. Hygienic conditions reflect cleanliness and aesthetics of the area.

The analysis revealed that the area was not at all in a hygienic state. Forty six percent of respondents said the condition was fair. And 48 % said the hygienic condition poor. That only implied that people preferred the area, but certainly the hygienic conditions are very bad. How could the area be fair in terms of hygiene, the area without proper open drains, sewerage system, adequate water supply and in additional without decent housing conditions?

Figure 4.8. Hygienic condition of the area



(Source: Fieldwork, 2002)

Regarding those issues, the author would recommend the immediate implementation of public toilets as well as a sewerage system in the whole area. These toilets would be provided with water supply and connected to the sewer reticulation. These sanitary facilities would be used and run by the residents for the system to be sustained. This was because most houses were built in non-permanent structures; and residents were mostly in rental status. The motivation for us to set up permanent sanitary facilities was minimal. And there was need to enforce development control in the area. That Development Control should evaluate and harmonize all developments that were taking place especially housing development. Otherwise the area would develop into a slum of houses with poor standards.

CHAPTER FIVE

THE ROLE OF WATER IN DEVELOPMENT AND POLICY IMPLICATIONS.

5.1. THE ROLE OF WATER IN DEVELOPMENT

5.1.1. Introduction

Water is the most important natural resource in the world since without it life cannot exist and it is difficult to imagine any programme for human development or improvement that does not presuppose or require readily available water.

Although human life can exist for many days without food, the provision of water is an essential prerequisite for the establishment of a stable community. In the absence of such a source nomadic lifestyles emerge, as communities have to move from one area to another in search of this precious commodity.

Water is a vital resource and a basic need for individuals and society, it can also be a deadly enemy due to mishandling of this invaluable commodity and instead of inspiring life, misuse of water can spread disease and cause death.

Urban development is all about improvement of the living conditions of urban people. It implies the creation of good working environmental conditions and the increase of income and services. Water supply is one of the basic resources for urban development.

UN General Assembly has stated in a resolution that "health is an integral part of development (UN, 1979); safe water supply being a major health component must hence form an integral part of every development programme.

The role of water is multiple and varied. Water can play biological and environmental roles. It is essential in the day-to-day business operations of our working life. Man uses water for various purposes, apart from the main biological

purpose of drinking, which maintains the normal 90% water ratio in the human body. These uses can be grouped, as far as environmental health is concerned, in three main categories, related to domestic uses, industrial uses, agricultural uses, water based recreation etc. Almost all these uses result consequently in the formation of used, or wastewater (80% of water supplied).

5.1.2. Water Biological or Biochemical Roles

The human body requires 2 to 3 litres of water per day. The role of water in the body is amongst others as follow:

Water facilitates the digestion process and, as catalyst and one of the elements, participates in the biochemical reactions.



Ions H^+ and OH^- react with other ions from minerals and matters to form glucose that would be converted into energy. As blood, water carries other nutrients during circulation. It regulates or stabilises body's temperature and assures the cleansing of the body through evacuations of human wreck in forms of sweat and urinal and other excreta.

5.1.3. Water Ecological Roles

Without water, there is no environment. The ecological balance would be disturbed. The cycle of water sustains the environmental stability as it makes the same water in a continuous existence. The sky of atmosphere is free from dust after the storm, the vegetation greens, and in open drains, the waste is cleared by the run-off etc. Water helps in maintaining the environment in good sanitary conditions if only the area has been provided with efficient drainage.

The role of water in development is derived from its day-to-day uses. Its role is noticed from the homestead to the working place.

The way in which water should be used for the development of the residential area like Kawangware includes: domestic, industrial, business, and public (civic) uses, recreational, agricultural and fishing purposes, etc. The agricultural use is based on the Nairobi River Plain and will clearly use water from the river if protected against pollutants. To streamline other water uses, there is a need to improve the distribution systems of water in the study area because they may use water distributed by Nairobi City Council and private bodies (e.g. handcarts, lorries, etc) using either water from City Council main water pipes or their own-drilled boreholes.

5.1.4. Domestic water uses

Domestic purposes consume only a small portion of the water available to man. It includes water requirements for drinking, cooking, bathing, washing, and household purposes. Nevertheless, this water use, which leads to the creation of domestic wastewater, poses the most dangerous hazard to man's health, due to the human waste component of the domestic wastewater, which contains huge amount of pathogenic organisms.

The solution to this basic environmental health problem is a proper wastewater treatment and disposal system. In a way, the development of such system is equally important as the development of the water supply itself. Water Supply and Wastewater disposal are two mutually related elements of development that are complementing each other and must be, therefore, designed, constructed, operated and maintained simultaneously as a single integrated part of the development programme.

Domestic water use remains the leading consumptive use of the area of study. Demand projections for domestic water use are relatively consistent with projections for population increase. Due to the trend of urbanisation in Kenya, urban areas particularly Nairobi, will experience a higher growth in demand for

water. There is need to promote the expansion of water supply sources in the area and attract the private investment in domestic supplies.

Kawangware location is a residential area. So for its development, the supply of water should be improved to cope with domestic and sanitary activities within and outside houses.

Nairobi City Council has adopted intermittent methods of water supply to reduce losses and in the effort for water to reach all consumers in the town. That is not fair since water can be easily polluted when stored in an unsuitable place. Water in Kawangware should be supplied continuously for the development of the area.

As discussed in Chapter 4 of this dissertation, water supplied in Kawangware area was hundred percent under Nairobi City Council responsibility. There was a spot of boreholes and shallow wells run by individual landlords. When water supply did not reach consumers, tankers and vendors took over water distribution.

This survey revealed the presence of tap water utmost at 100 metres of the homestead. The problem was the inefficiency in water provision. The quantity of water provided was not adequate due to, among others, the rationing system adopted by the provider. The situation worsened during shortage periods because some of water vendors drew sewage that leaked from the sewer pipes and distributed it as drinking water. This endangered the health conditions of residents. Based on that, the need for improving water supply service had highly been emphasized so that residents could daily get water. And such fact of drawing polluted water would never happen. Wholesome water supply should prove its reliability to consumers. Shortage of water had led to the development of unhygienic conditions.

Because water was supplied intermittently, the effective water supply would be possible with the construction of six surface water storage tanks. Tanks would store clean water provided at the time of supply hours. The stored clear water would be used at the time of non-supply hours.

In terms of materials of construction, the storage tanks may be designed and constructed in stone masonry or Reinforced concrete cement to reduce seepage. In terms of location, reservoirs should be situated at high natural spots¹, as water would flow under gravity for distribution. In this case, the following requirements should be complied with:

- The design should be such, as to provide for the drainage of the tank when necessary, and water should not be allowed to collect round the tank;
- Reservoirs should be perfectly water proof;
- The inner surface of the tank should be rendered smooth as far as possible
- The top of the tank should be so levelled as to prevent accumulation of water thereon.
- The tank should project at least 300 mm above the highest flood level.

As there was a sporadic development of high-rise buildings for residential, it was difficult to develop the pressure in the distribution mains that might make water to reach all levels of the building. In such cases, it have been advisable for every flat to have separate pumps to pump water from the ground storage to the overhead storage.

5.1.5. Business uses

At the same level with the domestic uses, businessmen required enough water supply of good quality in their operations. The primate business in the area was based on houses renting. The supply of adequate water would encourage investors to invest in the area and would improve the upgrading of the area in terms of housing structures. This would help residents to live in a decent shelter with good environment around. Hotels, laundries, restaurants, bars, bakeries and other trade purposes also needed plenty of water to operate. In such cases, the improvement of provision of water would increase the establishment of these business places and made possible the upgrading of the commercial centre in the area, which actually suffered from inadequacy of clean water supply for its economic and environmental development.

¹ See Map: 6.4 Proposed Water Storage Tanks

5.1.6. Housing development

Housing is more than shelter or physical structures. It encompasses all the auxiliary services, which are necessary to human well-being. Renting houses had predominantly increased in the study area. The issue of security of tenure was a big problem for its development. Most houses were built in non-permanent building materials. That was because the land was not yet subdivided and allocated to individual development. So improving water supply would encourage landlords upgrading or improving houses with all the necessities for domestic and sanitary uses. Sanitary facilities would be connected to main sewers to get rid of pit latrines.

5.1.7. Public (civic) uses

Public uses include fire fighting, road washing, recreation and ornamental purposes. Those services were projected and would be used in the long-term programmes. Roads were still in bad conditions and needed to be graded and reconstructed. Ornamental purposes would wait for demolition of the shanty structures and the development of new and modern decent houses. Public uses included also water uses in schools, health centres and administration offices.

5.1.8. Fishing, agricultural and recreational functions

Fishing and agricultural functions require abundant water of good quality. For both functions to be effectively served, all sources of pollution to the Nairobi River must be cleared. The watercourse should be controlled to prevent any harmful product to inter in.

Fishing ponds, in particular, need clear and aerated water for their efficient productivity. Agricultural activities on the other hand need huge space with good soil and water mainly used for irrigation purposes.

In order to increase food production, there has been need to develop the modern agricultural practices based on large-scale irrigation systems and the use of

fertilizers. But these have been followed by the curse of spreading, in the developed areas, numerous water borne diseases such as malaria, bilharzias (Schistosomiasis) and river blindness (Onchocerciasis), and the pollution of watercourse environmental aspects involved in irrigation development.

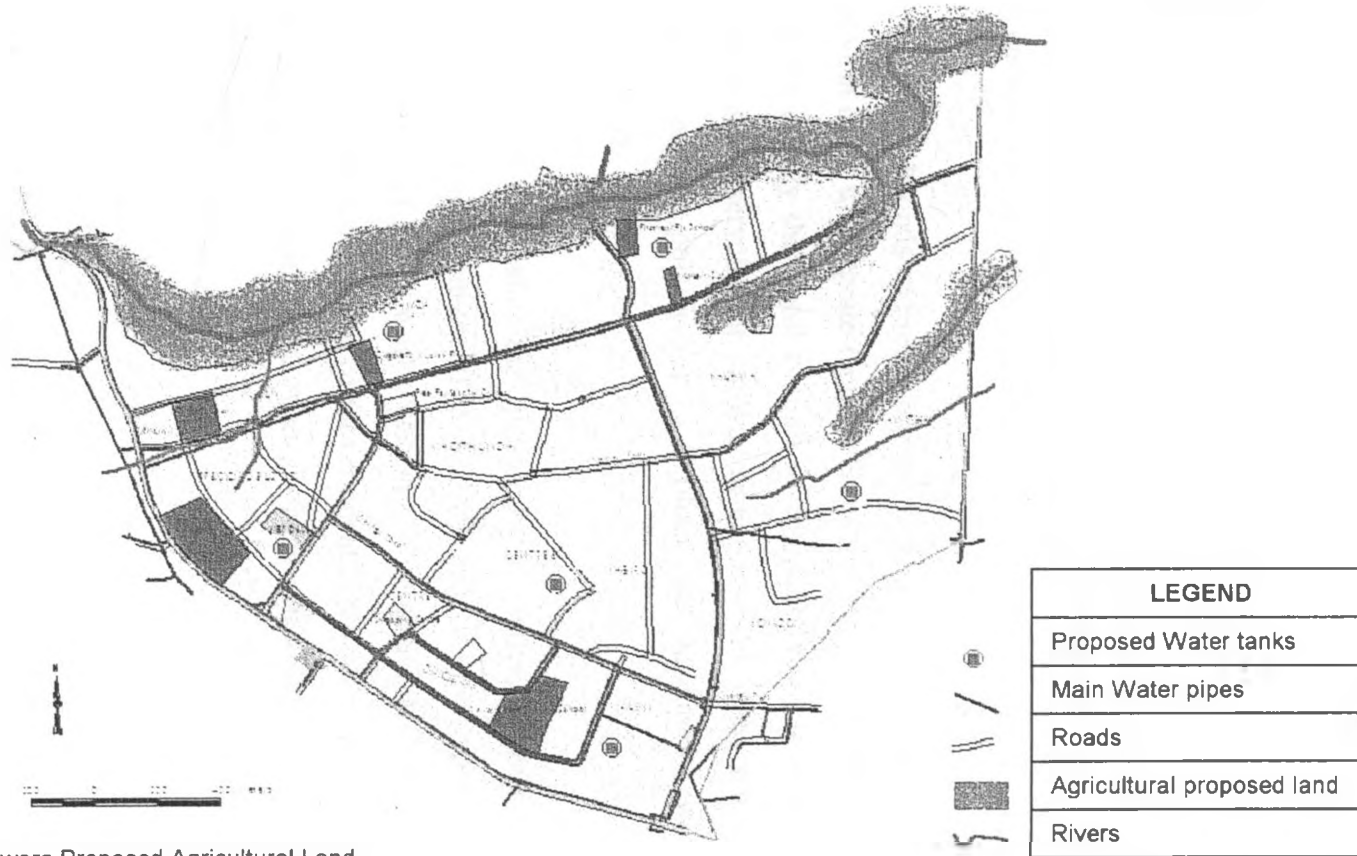
The major water borne diseases connected with irrigation systems are vector diseases that can be controlled by the elimination of the relevant disease vectors. This elimination can be successfully achieved by means of vector control practices. The most and effective vector control method is the environmental method that practices the modification of the environment to a point where it is no longer suitable for the breeding or development of the vector (WHO, 1972).

It is proposed that two fishing ponds be developed in the Valley of Nairobi River within the Kawangware Location. The remaining terrain will be recommended for agriculture and as long term possibility, these areas can also be used for recreational and leisure purposes.

According to the present study, the land for agricultural practice is proposed to be concentrated alongside the Nairobi River because other pieces of land have been occupied with residential houses. The soil along the watercourse is suitable for vegetable cultivation (e.g. Sukuma wiki, spinach, cabbage, leek, carrot, etc). The interested groups in such activities would easily find the market because the demand for those vegetable products is higher in urban areas.

The problem still remains the security of tenure. Because the government is the overall owner of all land in Kenya. The land held privately under English or customary law, the government exercise its power and compulsorily acquire it for development in the public interest (Land Acquisition Act, Cap 295 of Laws of Kenya). This is because the land will be acquired to promote the public benefit. In such a way, those agricultural operations will be allocated to cooperatives or associations of designated groups of residents (e.g. youth groups, women or men groups).

Map 5.1. Kawangware Proposed Agricultural Land



Kawangware Proposed Agricultural Land
By J.P. M. Matata, M.A. Planning, 2003

Source: Fieldwork, 2003

To control the flood and the flow of water, the borders of the watercourse require be walling with stones and paving with concrete slabs. And special dispositions should be made at certain points to facilitate the setting up of weirs to change its direction.

In addition, in West-lands areas of Nairobi, there is a strong public demand for recreational activities (leisure). Recreational opportunities, which can be offered using the Nairobi River, are as follows: fishing, swimming, diving, and rowing. Camping and other uses such as walking, riding etc will be suggested along the stream. For the establishment of swimming pools and sports facilities, one must consider hygienic condition of the water.

Location and position of fishponds and reservoirs for recreational interests will be carefully considered in order to integrate them as far as possible. Therefore it will be important to know exactly the possible limits of compatibility of recreational uses with other interests. Reservoirs for bathing, swimming and diving must be located up stream to prevent pollution from fertilizer, fish manure or waste harmful to the human body.

For these activities to be successful, the divisional Committee, Nairobi City Council, Ministry of agriculture, Ministry of Water, Ministry of Environment and Natural Resources, Ministry of Public works, Ministry of Land and Resettlements, etc should be involved. The participation of Government Agencies is essential in supporting and guiding that development. Also a strong sensitisation of people should be carried out.

5.1.9. Water Supply in Sanitation role

The city of Nairobi has got water carriage system of drainage. This system consumes more water for flushing sanitary units such as urinals and water closets (WC), etc. Kawangware area has been provided with sewer system in a small area while the rest relies on conservancy system using septic tanks and pit latrines.

Conservancy method is an old and outdated system of collection and disposal of the human waste.

Furthermore, this system is not recommended in urban areas whereby population is dense and the land is too small and limited. The area needs an intermediate solution of improving sanitary facilities and banning the use of pit latrines. Intermediate solution would be considered more appropriate because the area is still predominantly a squatter and slum settlements. It is very hard to prescribe final solutions due to lack of security of land tenure. The ultimate solution should be the connection of each homestead to the sewer system. Both intermediate and final solutions require water supplied continuously for wastewater to flow with sewage and sullage towards treatment plants that needs expansion and improvement.

5.1.10. Industrial Water uses

Industries use large quantities of water and in return generate huge industrial wastewater highly polluted comparing to that of domestic uses. Uncontrolled industrial wastewater in a river ends very often in the destruction of the river by robbing its dissolved oxygen and leading to septic conditions and mass killing of fish.

Every effort for planning for industrial development must incorporate means and measures of conducting adequate industrial wastewater pre-treatment (E.P.A 1979, Environment Protection Act). The pre-treatment is aimed at removing dangerous substances from wastewater, prior to its disposal, or connection to a central urban wastewater system.

As discussed in the previous chapters, it is not expected that any heavy industry development will be established in the area. But the development of Jua Kali activities (e.g. bicycle and car repairs, furniture workshops, woodworks, car washes etc) and the slaughterhouse at Dagoretti Market among others, are the main industrial pollution points.

There is need to control this situation by imposing stream pollution regulations, followed by the establishment of river authorities that will apply these regulations. In this context, measures of strict prohibition of discharging sewage or any other domestic/industrial wastewater in the river must be taken into consideration.

5.2. PLANNING FOR WATER AND SANITATION IN KAWANGWARE.

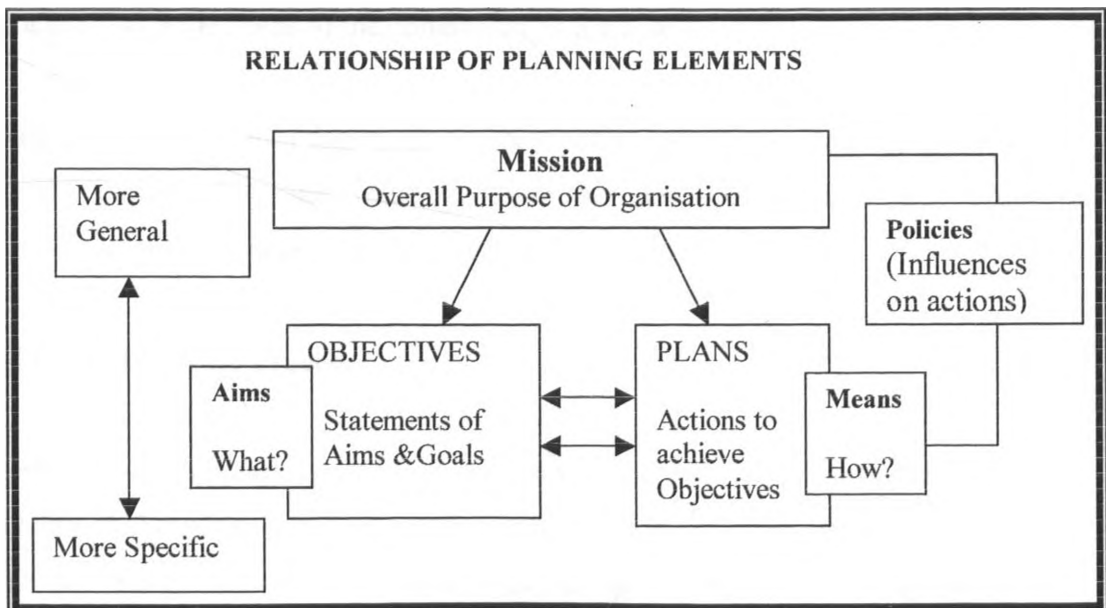
5.2.1. Introduction

A. Planning Definitions

Planning is a rational and deliberate activity in the making of an orderly sequence of action that will lead to the achievement of a stated objective. Planning is the managerial process of deciding in advance what is to be done and how it is to be done.

Rationality is a way of logically thinking about problems. The first stage in planning process is to identify the problem followed by the formulation of goals/aims. The primary purpose of Planning is to provide guidelines necessary for decision-making and resulting action, throughout the organisation.

Figure 5.1. : Relationship of Planning Elements



(Adapted by the Author from T. Lucey, *Management Information Systems*, 7th Edit. 1995, p.133)

The objectives of the organisation are normally of two levels. There are those that state the overall objective. They are in broad general terms intended to be permanent. And there are those objectives that are derived from the highest level and these are more specific enough so that it is possible to assess whether or not they have been achieved. In this case, they are likely to be tactical or operational level rather than true strategic ones.

The nature of the overall objective is influenced by many factors including; the political pressures which reflect different views of society, the type of the service, the attitudes of owners and so on. A more modern tendency is the application of stakeholder theory. When this view is adopted objectives are set not only for the good of the project but also for the other groups which are beneficiaries of the project, known as stakeholders. This may include, local authority, customers, suppliers, and the community at large.

With this context, one of the objectives of Sainsburys plc explains as follows; “ *To discharge the responsibility as leaders in our trade by acting with complete integrity, by carrying out our work to the highest standards and by contributing to the public good and to the quality of life in the community.*” This is the area of social responsibility which is taken seriously by many leading developments and associated with the needs of the community as a whole.

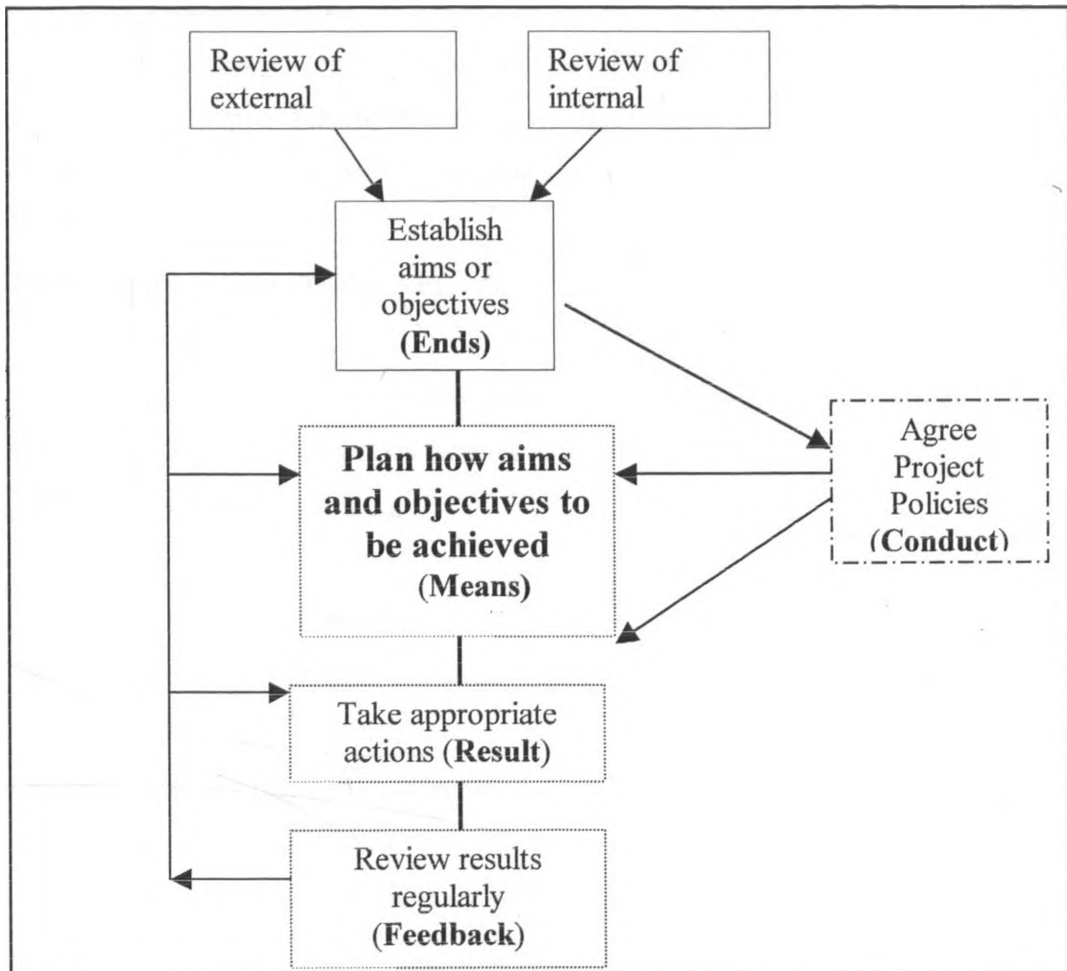
When the objectives of a project or an organisation have been established, policies provide guidance on the way they will be achieved. Policies are formal expressions of the organisation’s culture and belief systems.

B. Project Planning Process

Planning is a continuous process that is concerned with the identification of the problem, defining the ends, means and conduct at every level of the project life. After the problem has been identified, it begins by defining or redefining the aims and objectives of the project. Planning is also about taking steps to agree on the

means by which aims and objectives will be fulfilled. This is as much concerned with decision-making processes as with the provision of resources and the allocation of time schedules. This part of the planning process is concerned with the manner in which plans will be carried out or conducted. The conduct of the project is generally governed by such written documents as mission statements, policy statements and the like. It is also determined by the implicit standards that underpin organisational behaviour.

Figure 5.2. : A basic model of the Planning Process



Compiled by author, 2003, and adapted from G. A. COLE, Management _ Theory and Practice, 5th Edition, 1996, Shepherds Bush Green, London W12 82AW

As the diagram indicates, planning is a closed loop activity, in which the results of earlier decisions- the actions taken and their consequences –provide feedback to the other parts of the process. This reveals the information that can be taken into

account when assessing the earlier aims and objectives, the means used to achieve them, and the way in which these were implemented.

C. Planning Approaches

All the stages of the Planning Process are dependent on the availability of information. It is not possible to identify goals unless we know clearly about the existing values system in the community affected by that planning action.

The necessity of collection of information before planning has been recognised since Patrick Geddes in 1915 proposed that the process of planning should follow the cycle namely “survey, analysis and plan”. In Planning point of view, there are many planning theories but in this study we have taken the approaches such as Planning for Real (PR) and that of Community Action Plan (CAP).

D. Community Action Plan (CAP)

Community Action Plan serves a variety of purposes. It is a record of all community’s development priorities and potential, and is used as a basis for sustainable development planning.

The plan covers several issues

- Development priorities as agreed on by the community; _ *What is the problem?*
- Proposed actions and requirements; _ *What options and actions are most applicable and preferable?*
- Duties and responsibilities for individuals and groups; _ *Who does what?*
- Work schedules; _ *When and how to get it done?*
- And Identification of areas where the community needs external assistance.

In preparing and developing the CAP, the community regardless the gender, takes the lead. The local extension staff and professionals act as facilitators, and make technical information available to the community to help them come to rational

decisions. Technical staffs are from various departments such as water, sanitation, housing, health, sewage, planning, social and so on. There is need to involve NGO's and donor agencies in this task because they may be able to help during the implementation of the project in providing funds, technical support and training for the benefit of the same project.

E. Planning for Real

Planning for Real has been considered since the year 1970's to give *voice* to people and a clear idea of needs of local community to professionals in order to improve on their own community. This planning approach builds on the community, assembled model on which problems and improvements are identified through option and cards. The cards are means of exchanging views and information.

During this study priority has been given to residents through interview and conversation. Residents have specified out their problems and given out their views and options to apply in order to enhance water and sanitation services and therefore improve their living and environmental conditions. This tool is particularly effective in mobilizing community support and interest. Participants are chosen from the community, government officials, local authority officials, local leaders and relevant developers.

5.2.2. Planning For Water Supply

5.2.2.1. Introduction

Planning for water supply must start with the identification of uses and estimation of demand for these uses. The most commonly used technique estimates future water demand as the product of service, area, population and per capita water use. The per capita use coefficient may be assumed to be constant, or it may be projected to increase or decrease overtime. The method may be defined by using separate per capita coefficients for different use categories: residential,

commercial, public and industrial. A variation of the per capita approach is to use the number of customers of the system within the area of study.

The supply side of water supply requires knowledge of the source available to meet the projected demand and the amount that can be provided from these sources, as well as their costs and environmental effects.

For all practical purposes, water is available from ground water or surface water. The latter provides naturally abundant supplies where rivers have sufficient capacity to safely meet demands. Then, plans must be developed only for providing the necessary infrastructure for intake, treatment, storage and distribution of water. In many cases, however, reservoirs are needed to provide regulation of the distribution of surface water flow and volume.

5.2.2.2. Planning for Water Supply in Kawangware

From the Planning point of view, four aspects are considered.

- ✓ Environmental Aspect;
- ✓ Political Aspect;
- ✓ Economic aspect and
- ✓ Social Aspect.

From the above aspects, are derived some parameters and opportunities that will be useful in designing the plan for water services in Kawangware location.

a. Environmental opportunities

The existing treatment plant is located in Kabete at a high level comparing to the study area altitude. So the topography provides the opportunity for the operation of supply system because water can flow under gravity from the Kabete treatment plant to tanks that are proposed to serve the study area. Also, climate as God given, nobody can change it. Fortunately our catchment area has a rainfall of more than 1200 mm per year. This increases the availability of water from the source.

Taking advantage of the relief and the abundant water from the intake place five or six water storage tanks have been proposed. Four would be installed in Kawangware Sub-location, other in Gatina area. Water will be flowing during off-peak hours to the tanks. Water stored may be used during rationing schedules. Tanks should each have the capacity of storing water that can be consumed for 8 days. The tendency here was to provide people with water supply 24 hours every day.

The number of population in Kawangware of about 90000 people, and if we consider the consumption of 120 litres per capita per day, the actual water demand per day may be ($120 \text{ litres} * 90000 = 10800000 \text{ litres}$ or 10800 m^3). For one-week water demand may be ($10800000 \text{ litres} * 7 = 75600000$ or 75600 m^3). Tanks should have at least the capacity of 75600 m^3 of treated water. This means that each tank should have the estimated capacity of 12600 m^3 .

b. Supportive Political Good Will

Since the objective of this project matches with that of ending poverty by 2015, international and UN agencies may intervene in terms of providing funds for the implementation of the project. The Ministry of Water and Natural resources is examining how to set up a Water Board to take over Urban Water Supply Projects. The Minister in charge argued that water policy will be set up to encourage private sectors invest in urban water projects. For the Water Board to work efficiently, there is need to include all partners of water provision to get rid of the confusion that appears in the water policy and provision process.

In addition, the government of Kenya has the aim of creating Job opportunities up 500000 jobs per year. The project construction work would create number of occupations or job opportunities so as to alleviate poverty and improve the living conditions of low-income people in the study area.

c. Socio Economic Issues

The area is already overcrowded. Since the area is known as a dormitory for city workers the intervention in term of housing will tend to increase also the number of population. Really, people live in bad conditions; the planning exercise would recommend the set up of decent high-rise buildings for the accommodation of residents. We have seen that the minimum rental fee is Ksh 500 per month for single room. So, people can afford the rent if protected by the government social services' policies.

5.2.2.3. Technical Aspect and the Availability of Water Sources

From the technical point of view, water reticulation network is adequately distributed in the area. Though houses are shanty and in poor conditions, outlets (Water taps) are located at least 50 m from the house. Apart from some modifications, water supply network is all over the area and well distributed. The increase of pressure in pipes is required to push water to the level of about 15 m of height in order to fill tanks that are constructed with storied houses.

5.2.2.4. Improving Water Supply in Kawangware

For water Supply improvement in the area, the application of public-private partnership needs to be seriously observed. This partnership should be in the sense that private sectors be empowered without any barrier in the management and distribution of water resources because Nairobi City Council alone cannot fulfil the water demand in the City of Nairobi that tremendously increases in size and in number of population. There must be collaboration and cooperation between private and public sectors.

The issue of liberal privatisation in water services in Kenya is not yet applicable considering the poverty challenges that our country faces. People are poor and can not afford the water price set up by private bodies in a liberal economy whereby the price is automatically conditioned by the demand. The government must

intervene to protect people against the increased pricing by lucrative private sectors.

For effective and efficient water supply in suburbs of Nairobi, the following should be observed:

- ✓ The Conservation of Water Supply
- ✓ The protection and conservation of catchment area/forest
- ✓ The improvement of water sources
- ✓ The improvement of the distribution systems from the source to storage tanks and from tanks to consumers. Replacement and reparations of pipelines and the installation of meters at consumers level to reduce losses.
- ✓ The involvement of all stakeholders (Private, Public, NGOs and community) in decision making on water services.

1. Urban Water Supply Conservation

Public water conservation presented itself as a major factor in future public water supply. Conservation of public water supply can be attempted in maintaining and repairing of existing facilities. Old and deteriorated water supply systems are great wasters of water, yet with proper repair they can continue to provide sufficient quantities of water for domestic and commercial uses.

Domestic conservation methods can significantly contribute to overall water conservation. Certain economic measures, such as water pricing policies, can be utilised to reduce the demand for water. Related to this is the need for metering water use. Pressure reductions, improved plumbing equipment, public conservation education can all contribute to a reduction of water demand.

To protect and conserve the river, appropriate measures should be adopted for prohibiting any discharge of sewage or other domestic and industrial waste directly in the river body. Industrial wastewater needs to be pre-treated prior to its discharge into public sewage system.

2. The protection and conservation of catchment area/forest

The destruction of catchment area was caused by agriculture, housing, firewood cutting, etc. (In brief, human settlement activities to the detriment of forest area). Consequently, the above had favoured the erosion impact because the protection has been swept away.

To protect and conserve the catchment area we need the:

- Enforcement of policies that forbid people to settle in the reserve;
- Eviction and relocation of people that have settled in the reserve
- Penalty to people that cut and destroy the forest;
- Setting up disposition that retains runoff and allow water to penetrate into the ground to charge the aquifer;
- Sensitising people of rural surrounding the city of Nairobi to plant trees (at least four trees per head);
- Encouragement of continuing fencing the Aberdare forest; the fence would protect the forest against tree cutting and forest invasion.

3. The improvement of water sources

Water sources are inadequate due to inefficient and unprotected intakes. There is also erosion that deposits silt and dust in dams. To improve water sources, it is advised to:

- Construct more dams by public sectors or NGOs to increase water bulk in the future;
- Enable private sector to invest in that market;
- Utilise urban groundwater sources for particular uses (car washes, toilet, washing, etc) in order to reduce losses of water provided by the Council
- Increase the number of technicians and more labour to improve the intervention and repairs of burst pipes at the water source level.

4. The improvement of the distribution systems

Aging pipes, leakage, and illegal connections cause water distribution inadequacies. It results in big quantity of water losses. To improve the distribution systems from the source to storage tanks and from tanks to consumers, developers are advised to replace existing small pipes by big ones in size; and undertake repairing of aging pipelines to regenerate the distribution. This will reduce losses. And water will increase in terms of quantity because most of water gets lost due to the above problem. The case of illegal connections can be avoided by serious water control and if requested by registering all consumers so that they can easily pay for the service.

And the installation of meters to consumers level to reduce losses at local level and for people to pay for what they have consumed. To prevent water losses, residents should be educated and be made aware of water conservation and protection. Once the supply of water has increased and improved, Nairobi City Council should be enabled to provide water for 24 hours in the whole city of Nairobi. It is also advised to rehabilitate and increase the number of Kiosks by constructing more new ones in areas lacking them.

5. The involvement of all stakeholders (Private, Public, NGOs and community) in decision making on water services².

5.2.3. TOWARDS PROPER SANITATION SERVICES IN KAWANGWARE

A. Solid waste collection and disposal are not adequate. Besides, there is the issue of poverty at large. Lack of enough funds had made the Nairobi City Council Environment Department unable to adequately fulfil its duty. Staff and vehicles, according to them, were insufficient to handle all garbage generated in the city of Nairobi. And the old habit of residents of throwing refuse had worsened the ecological situation.

² N.B: This proposal has been elaborated in 5.3.

In order to streamline solid waste collection and disposal, it is advised that:

- Partnership between NCC Environment Departments and private sectors on garbage collection and disposal be improved;
- Waste reuse (e.g. manure and jua kali activities) be encouraged;
- Waste recycling be promoted;
- The Environmental Department be enforced in terms of staff and appropriate vehicles; as well as installation of dust bins in the area
- Further research on dry refuse disposal be promoted.

B. Sanitary facilities in Kawangware are mostly those that use reuse conservancy system of human waste disposal. Ninety per cent of residents rely on pit latrines, the system that is outdated and not advised in urban areas. As the area is likely to house dense population, it is recommended the method of waste disposal off site namely Refuse Water Carriage System commonly known as Sewer System. People willing to connect their sanitary facilities to sewer system, require adequate water supply. As Water supplied is not sufficient in quantity, residents preferred pit latrines. Pit latrines are not economically stable. When they fill owners have to empty them due to limited piece of land. Any way, Kawangware residents need to be encouraged to rely on sewer system even if the availability of water is critical. The sewer system is economically stable and not constrained or embarrassed.

To effectively provide proper sanitary facilities, first of all, water supply has to be made adequate. In such cases, residents would be encouraged and the sewage would flow in sewer pipes with no failure. There is urgent need to layout the sewerage system in the whole area of Kawangware Location. Also, it is necessary to replace sewer main and install big sewer pipes for the future extension of the system and the city in general increased urban population.

The area is still having slum and squatter settlements; the issue of demolishing will come in long term. But at this time, there is a need to upgrade the area. After sewer system had been laid out, it is essential to construct six public

toilets connected to the sewer system. Those public toilets should be constructed in sites like Muslim, Coast, Gatina, Kanuganga, Central (market) and Bus 46 Terminus. From those sites only three among them have the sewer system in their premises and therefore can directly be connected to sewer system.

- C. In Kawangware, landlords have for long built houses in non-permanent building material (wood and iron sheet). Those temporary structures were ready for subletting. Smaller and smaller, those shanties are giving way to high-rise and permanent houses. The challenge is that once landlords get leasehold title and funds, they come up by constructing flats or back-to-back residential houses without any planning consultation. This was due to inadequate development control and the spirit of corruption (KANU Government). To prevent that sporadic development, councillors and other local authority officials should have policy guidelines and strategies to guide the development that takes place in their areas of jurisdiction. Also, it is important for all developers and civil servants to collaborate and synchronize on any development in urban areas.

Furthermore, the following points should be emphasised for the land development in Kawangware:

- The setting up of guiding plans and strategies that will guide any development;
- The subdivision and allocation of lands as per standards of urban planning;
- The rehabilitation of roads as well as open drains along them so that runoff could safely flow. Open drains are often blocked due to misuse and domestic refuse waste thrown in them. Also the outcome of NCC workers was not efficient because they were not well organised. Garbage, after long time uncollected, forms soil that blocks the drain.
- In the long term, demolition of slum and construction of decent shelters by government, NGOs or/and private individual should be encouraged.

In general, Kawangware experiences poor public services delivery (e.g. Water Supply, Sanitation, Garbage collection, etc.). Noting the magnitude of those services in the living condition of people, those services are so hard to handle. Nairobi City Council workers need to be organized and if possible increased. Also, private bodies should be encouraged to massively invest in that market. Last but not least, increased public awareness on any development in general and water and sanitation project in particular, must strongly be focused on for those developments to succeed and be sustainable.

5.3. THE RESPONSIBILITY OF INSTITUTIONS INVOLVED IN PLANNING WATER SUPPLY AND SANITATION SERVICES IN KAWANGWARE

Through partnership different sectors (private, public, international and local community) gain access to each other's skills and resources, share risks and maximize returns on investment. It enables stakeholders fully participate in the development of the area in a democratic process. And it ensures the sustainability of basic services (e.g. WSS) when government or foreign aid/finances cease.

As stated in previous chapters, meagre public funds and increased population in urban areas are making governments unable to handle urban water and sanitation challenges. Therefore, public sectors seek support from other partners namely NGOs, CBOs, Private and to the extent local Community.

5.3.1. Roles of Government

In its responsibility, the government provides the right legal, fiscal and regulatory framework. It is the custodian of public interest and development. The government will train and provide the WSS staff, create enabling environment for partnership between Ngos/Private, Public and community sectors to thrive. The government will also provide the NCC with grants and partially finance WSS projects. It will enable NGOs and Private sectors actors to invest in WSS market to fill gaps left behind by public body. The government will then sensitise the

people on the magnitude of the project and finally promote further research on dry refuse disposal

5.3.2. Role of NCC and Councillors

Nairobi City Council together with councillors, after they have got grants from the government, should fund and control the implementation of public services in their respective wards. They should motivate, organise workers to perform their daily duty.

5.3.3. Role of NGOs and Private Sectors

Private sectors, NGOs, and CBOs play an important role in their development efforts. They should come up to fill the lack of services that are mostly needed. The diverse methods of private sector participation in WSS are full divestiture, build-operate-transfer/build-operate-own, concession, lease and management contract.

Private sectors participation is often associated with profit motive and therefore seen as unfair for the poor. The government or its agencies should control public services delivered by private bodies so they do not harm the health and economy of the people. Private must cooperate with NCC in WSS provision and it is required to define a clear partnership between all stakeholders to fix and determine an affordable commodities and services price.

In some areas, NGOs are the only institutions people trust because they are all close to people. Government and international community reach people through institutionalisation. They may finance, fund and invest in water and sanitation projects. International Community (World Bank, UNEP, UNCHS, UNDP), finance projects through NGOs, Government Agencies (NCC) and Community Based Organisations. They actually mobilize available resources, technologies and information to enhance the development of the area. They should effectively provide experts to guide the development in detailed way.

5.3.4. The Community Participation

The local community must cooperate with developers and donors in giving true information and explicating their felt need and problems priority. They need to be involved in all stages of development planning. They are required to actively participate in water and sanitation service design and provision. Also they require helping service providers to serve them (example: refuse waste should be disposed separately according to their nature before collection). Residents should connect their sanitary facilities to the sewer systems. They have to safely keep services provided because they are for their own benefit. Last but not least, residents, as they were willing, should provide workers either experts or non-experts and give out money as their contribution for water and sanitation delivery.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS.

Water is a precious commodity for any life; it is a vital resource and a basic need for animals, vegetation and human being as well as for society. It can also be a deadly enemy if this invaluable commodity is mishandled and instead of inspiring life, polluted water can spread disease and death. That was why the study had undertaken to study both water supply services and sanitation disposal.

Without water no good sanitary environment is expected. Also plenty of water can generate wastewater that may hamper the ecology unless well disposed off. Water supply and sanitation facilities ought to be observed hand in hand.

The purpose of this study was to examine the system of water supply and sanitation services and suggest solutions to improve those services in the attempt of upgrading the low-income residential suburbs of Nairobi and, broadly enhancing health conditions for the residents.

The study mainly focused on the existing situation of water and sanitation services in Kawangware location. This involved an analysis of the supply of water, sewage and sullage, solid and human waste disposal. It also included drainage and run-off conveyance.

The natural drainage is towards the Nairobi River valley. It is recommended to establish two fishponds and some recreational reservoirs in the valley. In the valley, there is a good soil suitable for vegetable cultivation. Agricultural practices have been proposed there. Also recreational activities such as swimming, diving, rowing, etc have been suggested in that area. These can be possible if a strict water quality control of the Nairobi River is enforced. Institutions involved here have largely been discussed in chapter five of this dissertation.

Due to the topographic layout of the area, surface run-off flows into open drains and is diverted in the sewer system where it is held stagnant because it cannot reach the

valley. The problem was that open drains were not maintained. And therefore, they were blocked and full of silt and garbage.

It was therefore recommended to rehabilitate and repair the existing roads. Roads to be rehabilitated were coloured in red (See Map 6.1. Roads Rehabilitation page 135). Those roads to rehabilitate should be resurfaced and tarmacked. In addition, to reduce the security problem that prevails in the area, road lighting highly needs to be revived and provided. It was also necessary to reorganise the Nairobi City Council workers and make them more effective in their work. Members of public should be sensitised and made aware of the environmental protection and conservation.

For the collection of domestic dry refuse, it was suggested to provide eight communal Dust Bins within the residential areas of Kawangware. Two bins were deposited in Gatina Sub-location. Two other in midway between Gatina and Kawangware sub-locations and the remaining bins should fully be located in Kawangware. Dustbins should be at three levels. At homestead level, residents will be using paper bags to collect garbage until they fill. From there paper bags can be brought to communal dustbins distributed in the area. Each dustbin serves people within the area of utmost 300 metres of radius. (See Proposed Map 6.2. Sites for Dust Bins page 136).

To avoid the issue of throwing garbage on the street, every one should be responsible for the area's hygienic conditions. Penalty will be charged against residents who don't follow that consideration.

From homesteads level to communal dustbins, landlords should be responsible of refuse collected from the plots they own. Carts could especially ensure the transport of garbage. Those communal dustbins are advised to be collected twice or thrice a week by either contracted private companies or the City Council to the designated dumping sites. Only two lorries are sufficient to effectively collect and transport dry refuse generated in Kawangware. At the dumping sites level, the government and other interested bodies should be encouraged in further research on dry refuse disposal.

As discussed in the previous chapters, most of the residents rely on pit latrines to dispose off their human waste. Sewer systems had been provided to a small area and still had the problem of overloading and inadequate water supply. Pit latrines are not effective in a densely population area such as the study area. The problem of insufficient quantity of water supply affected enormously the working of the sewer system. Once the above problem of water is tackled, it is recommended the immediate provision of sewerage reticulation in the whole area together with the construction of six public toilets. (See Map 6.3. Proposed sites for public toilets and Sewerage Reticulation page 137). Among those six Public toilets, two constructed in Coast and Bus terminus along Gitanga road would be directly connected to sewer system, while ones of Kanuganga, Gatina, Magithundia and Muslim will be connected to sewer after the sewerage reticulation has been implemented.

Over the long-term period, it is recommended to encourage residents to apply for connection of their sanitary facilities to the sewer system and get rid of pit latrines. This will be possible after carrying out a comprehensive land subdivision and allocation process based on and guided by a deliberate urban land use plan for the area.

As far as water supply is concerned, the study revealed that the area had been provided with water reticulation in the sense that each homestead is about hundred metres away from a tap. From a planning point of view, water supply is indeed, well distributed.

The problem experienced, was however, the inadequacy of water supply. Nairobi City Council adopted the rationing system of distribution. The system of distribution was not effective for the study area because the residents could get water only once in a week.

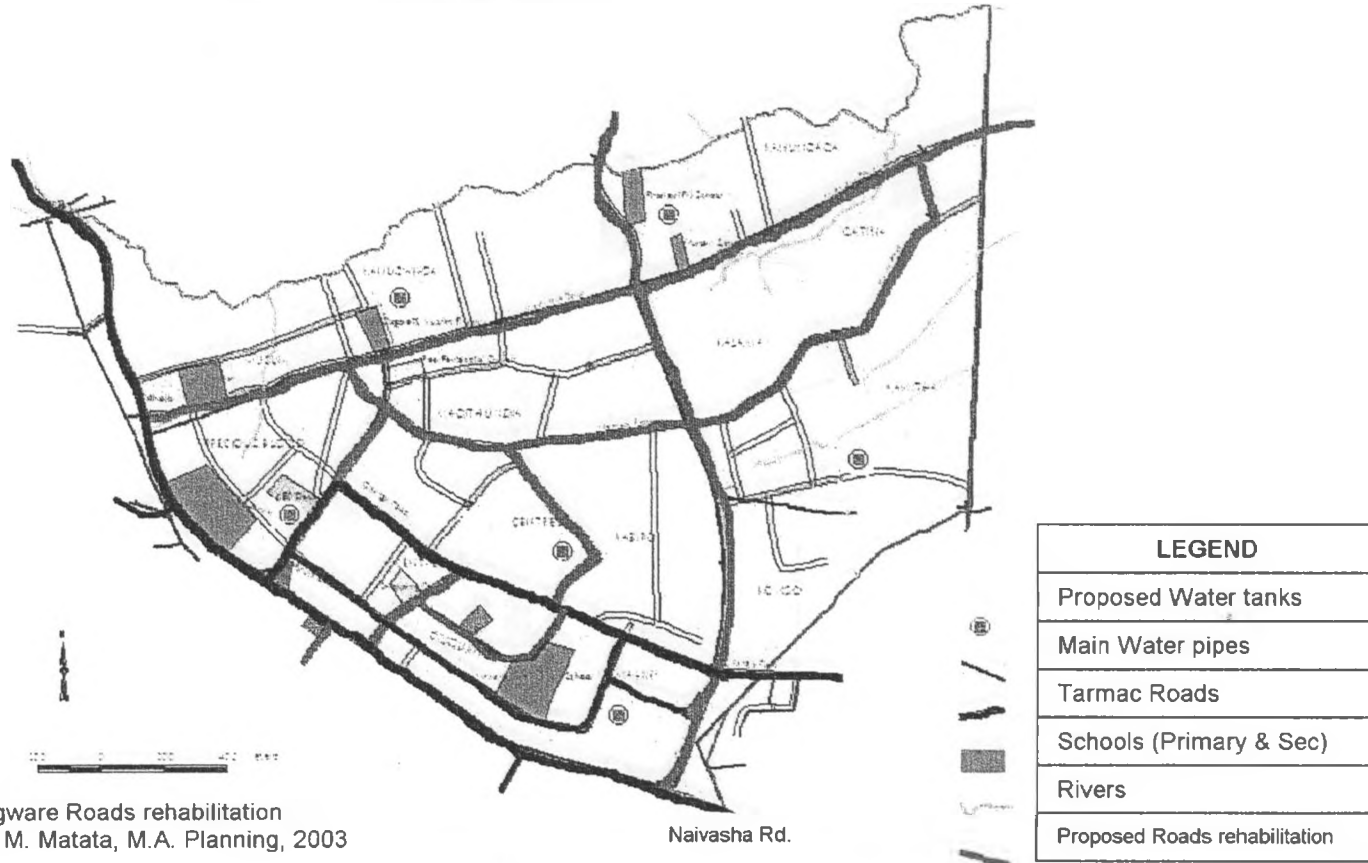
People need water regularly for their daily activities. They may use it for domestic, industrial, business, and public (civic) uses, recreational, agricultural and fishing purposes, etc.

Based on the fact that the bulk of water from intake is not currently in short (It has been projected up to 2007), there is urgent need to increase the quantity of water provided in Kawangware. That exercise could be satisfactory if six storage tanks are constructed in the area. Water would be expected to flow from the Kabete water treatment plants directly to those storage tanks by gravity. The location of water tanks has taken into account the altitude advantage and the number of population served by each water tank. Water tanks are located in areas such as KBS Garage, Muslim Primary School, Centre, Malini, Kanuganga and Gatina or Kamitha villages. In order to reach consumers, water kiosks have been suggested. Those Kiosks need to be more flexible and they have been distributed in terms of walking distance from the homesteads to public water taps (drawer has to walk a distance of 200 metres to water Kiosks). Also they can temporary be constructed when requested by residents. Water Kiosks will be maintained and managed by the community through their respective associations e.g. youth groups and women groups. Also licensed individuals can also run some of water kiosks them both under the supervision of NCC in terms of water pricing. Storage water would be used during rationing schedules. (See Map 6.4. Proposed Storage Water Tanks page 138).

Further Research

This study is not exhaustive. Therefore, the following areas have been identified for further research. A more detailed engineering study of the water supply (e.g. tanks, pipes, etc.) and sanitation (toilets, showers and sewer system) facilities should be done and on how those facilities can be designed and constructed in Kawangware. There is also need to carry out hydrological studies on underground water in the area to find out the quality and suitability of that underground water. This will help interested people to invest and drill boreholes and conveniently use the water. Also the Environmental Impact Assessment study needs to be done according to Physical Planning Act (PPA, 1996) and Environmental Management and Control Act (EMCA)

Map 6.1. Kawangware Proposed Roads Rehabilitation



Source: Fieldwork, 2003

Summary of Recommendations

Goal: To plan for Water Supply and Sanitation in low income suburb of Nairobi								
Sector	Problems	Causes	Objectives	Strategies	Programs	Resources	Indicators	Actors
Water Supply	Inadequate water supply	-Inadequate funds -Rationing schedule -Illegal Connection -Land tenure	To provide Water services at affordable price.	-Ensure each H/h having safe water every day. -Assure people to pay what they have consumed	-Monitoring & evaluation of existing water infrastructure services -Encouraging NGO, Rbos, Private providing adequate infrastructure -Construction of water tanks -Installation of Water Kiosks in the area	-Labour skilled and unskilled -Funds - Land - Building materials - Pumps -Electricity	-Water Tanks - Piped water -Water Kiosk -Sufficient Water	* Community * GoK * NGO's * CBO's, *Private Sectors *UN agencies * NCC
Sanitation	-Absence of sewer reticulation system	-Not provided -Political negligence -Land tenure -Lack finance	To set up and install sewer system	-Design and implement sewer system network. -Rise the awareness on how to keep clean the area	-Awareness campaign through radio, Television, Posters, Barazas, Workshops, Seminars, etc - Order of sewer pipes -Layout of sewerage system in the area	-Labour skilled and unskilled -Funds - Land -Building materials - Pumps -Electricity	-Cleanliness -Sewer system available.	* Community * GoK, NCC * NGO's * CBO's, *Private Sectors *UN agencies
	Lack of public toilets	-Political bottleneck -Not provided.	To provide affordable sanitary facilities.	-Design and construct public toilets. -Formulate suitable policy to encourage private sectors to invest in that market	• -Awareness campaign on the project • Public offer • Construction of toilets • Connection of toilets to sewer system	-Labour skilled and unskilled -Funds - Land - Building materials - Pumps -Electricity	Number of Public toilets constructed	* Community * GoK, NCC * NGO's * CBO's, *Private Sectors *UN agencies
	Poor Hygienic conditions	Poor waste collection Habits of residents Flat form of the area.	Create good environmental conditions	• Encourage private sectors (Refuse collection) • Enforce Public waste collection services • Install dust bins	• Public awareness on the waste disposal, • Encourage private bodies • Installation of dustbins in the area. • Promoting waste reuse and recycling	-Labour skilled and unskilled -Funds - Land - Building materials - Pumps -Electricity	-Clean environment -Number of Public dustbins	* Community * GoK, NCC * NGO's * CBO's, *Private Sectors *UN agencies
Transport	Inadequate Roads	Lack of maintenance	To rehabilitate existing roads	• Mobilise People • Mobilise funds	• -Awareness campaign on the project • Reparation of roads • Open drains rehabilitation • Road lightning set up	Machineries, Funds, Labour,	Repaired Roads Tarmacked Roads Open drainage Lightning	* -ditto-

Source: Fieldwork, 2003

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Appendix 1. Household Questionnaire

**UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING**

PLANNING FOR WATER SUPPLY AND SANITATION IN LOW-INCOME SUBURBS OF NAIROBI

Declaration : The Data collected will be confidential and used for the academic purpose only.

District : Nairobi
 Division : Dagoretti
 Location : Kawangware
 Sub-location :
 Village :
 Questionnaire No. :.....
 Date :...../.../2002
 Name of interviewer :.....
 Name of interviewee :

A. INFORMATION OF THE HOUSEHOLD HEAD

- a. Name :.....
- b. Age :.....
- c. Sex [] : 1. Male 2. Female
- d. Marital status : []
 1. Married 2. Single 3. Widowed 4. Separated/ Divorced
- e. Education level (Tick)[]
 1. None 2. Up to Primary 3. Secondary 4. Tertiary 5. University 6. Other
- f. Household sizeAdults Children
- g. For how long have you been staying in this area? []
 1. Less than 5 years 2. Between 5 and 10 years 3. More than ten years
- h. Where were you staying before you came to this area? []
 1. Another suburban within Nairobi 2. Different town 3. Rural areas
- i. Reason for your coming in town (Nairobi)[]
 1. To work 2. Having relatives here 3. Following spouse
 4. Shortage of land in area of origin
 5. Shortage of certain opportunities in area of origin 7. Other (Specify).....

- j. Reason for your coming in this area [] 1. Low rent 2. Big space of land 3. Noise in the C.B.D 4. Other.....

(Information on other household members)

Member	Rel. to Head	Age	Sex	Educ. level	Occup.	Income
1.						
2.						
3.						
4.						

B. WELFARE INDICES

- a. Nature and place of your occupation?.....
- b. If employed, state the term of employment []
 - 1. Permanent 2. Temporary 3. Not applicable
- c. Do you have any other source of income?[] 1. Yes 2. No
- d. If yes, what is that source and how much do you receive per month?

Source	Amount (Ksh)
Pension	
Sponsorship	
Working family member	
Other (Specify)	

- e. What is your average monthly income in Ksh? []
 - 1. Below 4000 2. 4,000 - 6,000 3. 6,000 - 8,000
 - 4. 8,000 - 10,000 5. More than 10,000
- f. How much do you spend per month on the following in Ksh?
 - 1. Housing improvement 2. Education
 - 3. Food 4. Health
 - 5. Water 6. Electricity
 - 7. Transport 8. Other (specify)

- g. Do you own any piece of land?[] 1. Yes (Where) 2. No
- h. What is the size of your farm / Plot? acres.

- i. How have you acquired it? []
 - 1. Bought 2. Inherited 3. Rented 4. Squatted
 If bought, How much did you spend to your land? Ksh.
- j. Do you keep any livestock? [] 1. Yes 2. No
- k. If Yes, state the number of each.
 - 1. Cattle: 2. Goat 3. Sheep: 4. Chicken:
 - 5. Pig :..... 6. Other (Specify).....

- l. Do you have the following infrastructure facilities: 1. Yes 2. No
 - 1. Piped water 2. Sewerage 3. Electricity 4. Telephone

C. HOUSING CONDITIONS

- m. Ownership of the house you stay in:[]
 - 1. Owner occupied 2. Private rented 3. Employer provided 4. Other (.....)
- m₁. If rental, how much is the rent per month?Ksh
- m₂. If owner occupier, state the status of tenure []
 - 1. Freehold 2. Leasehold 3. Gift 4. Inheritance
 - 5. Squatter 6. Other (Specify).....
- n. Total floor space of the main house m².
- o. Type of the main house; []
 - 1. Permanent 2. Semi Permanent 3. Non-permanent
- p. Building Materials used for the floor : []
 - 1. Earth 2. Cement 3. Concrete slab
 - 4. PVC Tiles 5. Brick Polished 6. Other

- q. Building Materials used for Wall: []
1. Timber
 2. Mud Bricks
 3. Fired Bricks
 4. Concrete Blocks
 5. Iron sheets
 6. Other (Specify)
- r. Building Materials for the roof (tick if any)[]
1. Grass or Thatch
 2. Galvanized iron Sheets
 3. Clay Tiles
 4. Cement
 5. Concrete Tiles
 6. Other (Specify)
- s. Condition of the main House []
1. Very Good
 2. Good
 3. Bad
 4. Very Bad.
- t. Availability of the Kitchen, Pit Latrine, Bathroom; (tick \checkmark if any)

Component	1. None	2. Inside the main house	3. Separate
Kitchen			
Toilet			
Bathroom			

- u. How much did you spend on the dwelling house? Ksh (Owner)
- v. What was the source of the housing finance? []
1. Own Savings
 2. Community based self-help groups
 3. Loan
 4. Inherited
 5. Other (Specify)
- w. What can you say about security in this area?
1. Good
 2. Average
 3. Poor
 4. Can't say

D. WATER SUPPLY

- a. Source of water supply. []
1. Individual connection
 2. Communal water taps (Yard tap and Kiosks)
 3. Borehole/Well
 4. Water vendors
 5. River/Stream
 6. Rain Water Harvesting
 6. Other combination of water source (Specify).
- b. Distance from Homestead to Water Source [].
1. Less than 50m
 2. 50 - 200m
 3. 201 – 500m
 4. 501 - 1000m
 5. 1001- 3000m
 6. More than 3000m
- c. If rainwater is harvested, what are your harvesting methods? (Tick)
- [] 1. Buckets/Drums
- [] 2. Galvanized iron sheet tanks
- [] 3. Masonry/Concrete tanks.
- [] 4. Other (Specify)
- d. What is the capacity of your home containers : Litres.
- e. What is the purchasing cost of your containers : Ksh.
- f. What is the main use of the fetched water? []
1. Domestic
 2. Irrigation
 3. Both Domestic and Irrigation
 4. Industrial
 5. Other (Specify)
- g. How many days you get water in a week? []
1. Once
 2. Twice
 3. Three times
 4. Daily
- h. Where do you store water? []
1. Bucket
 2. Tank/drum
 3. Jerrican
 4. Other (Specify).....
- i. Do you pay for water supplied? []
1. Yes
 2. No
- j. If Yes, How much?Ksh.
- k. If No, Give reason.

- l. What is the average quantity of water consumed per day? [.]
 1. 20 litres 2. 40 litres 3. 80 litres 4. 120 litres 5. More than 120 litres

- m. Who is responsible of the following
 1. Distribution:.....
 2. Monitoring:.....
 3. Enforcement:.....
 n. Who assumes the Maintenance/Operation of the pipes?

C. SANITATION

- a. What sanitary facilities do you have?
 1. None 2. Pit latrine 3. Septic tank
 4. Sewerage 5. Other (Specify)
- b. How do you dispose the wastewater?
 1. Use of sewerage 2. Pour it in a drainage 3. In a pit 4. Can't say
- c. If connected to sewerage reticulation, How much did you pay for the service?...Ksh
- d. How often is the sewerage blocked?
 1. Rarely 2. Many times 3. Other answer (Specify).....
- e. If not connected to sewerage reticulation, what are causes?
 1. High cost 2. Not present 3. No need 4. Complication from NCC.
- f. Where do you store your garbage? []
 1. In a plastic bucket 2. Big oil tin 3. Paper of plastic bag.
 4. Galvanized iron bucket 5. Other (specify)
- g. How long do you think garbage from your house can take to fill?
 1. One day 2. Three days 3. Five days 4. Seven days
 5. More than seven days.
- h. Who removes the refuse from your house for disposal?
 1. Yourself 2. Sweepers (NCC) 3. Other (Specify).....
- i. The level of Hygiene around your house is
 1. Good 2. Fair 3. Poor
- j. If you are asked to assist in maintaining high profile of hygiene in this area will you agree? 1. Yes 2. No
- k. If Yes, how would you like to be involved
 1. Providing labour 2. Providing money 3. Both 1 and 2
 4. Other (Specify)

D. PERCEPTIONS ON WATER USE AND MANAGEMENT

- l. What is your perception on water? (Tick)
 1. Social Good-God given, Free to be used without caution.
 2. An Economic good to use for purposes that can benefit my family.
 3. A Scarce resource that requires careful utilization.
 4. Other (Specify).
 m. What is your personal opinion in regard to water use and distribution in this place?

- n. What in your opinion are the causes (if any) of water problem in this place?
.....
.....
.....
- o. Has anyone sensitised you on water management? 1. Yes 2. No
If Yes, What did you learn and how have you implemented it?
.....
.....
.....
- p. Are you aware of disease water related? 1. Yes 2. No
- q. If Yes, state some of them.
.....
.....
- r. What do you think are the causes of those water diseases?
.....
- s. What disposition do you take to prevent those diseases?
.....

E. CONFLICTS RESOLUTION

- a. Are there any conflicts in water use? 1. Yes 2. No
How are those conflicts resolved?
.....
.....
- b. Who is the arbitrator?
- c. Are there any (existing) institutions helped resolve the demands of water?
1. Yes 2. No
- d. If yes, state them and tell us how they are involved.
.....
.....
- e. What can be your contribution on water problem resolution?
1. Labour force 2. Money (How much.Ksh at least) 3. Both 1& 2
- f. How do you think water problems can be resolved?
.....
.....
.....
- g. What do you expect from the Government?
.....
.....
- h. What are the main problems facing your Water supply system?
.....
.....
- i. Suggest please solution to the problems:
.....
.....
.....

Thanks!!!

Appendix 2. Community project questionnaire

**UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING**

**DEVELOPMENT ACTIVITIES AND THEIR EFFECT ON
WATER SUPPLY AND SANITATION IN LOW-INCOME
SUBURBS OF NAIROBI**

The person responsible in the project organization will provide information.

Declaration : The Data collected will be confidential and used for the Academic purpose only

Date of interview :/2002
Name of the Project :
Name of Respondent :
Position in the Project :

I. GENERAL INFORMATION.

1. Location.

- * District : Nairobi
- * Division : Dagoretti
- * Location : Kawangware
- * Sub-Location:.....
- * Village :.....

2. Number of Household covered by the Project :H/Hs

3. Average cattle per Household. :

4. What were your objectives of setting up this project?

- a.
- b.
- c.
- d.

5. How far have you achieved the set objectives (one by one)

- a.

6. What constraints have you faced to implement this Water Project?

.....

7. What conservation measure have you taken to ensure Water Supply?

.....

.....

8. Do you have a Water Permit? [] 1. Yes 2. No.

9. If Yes, Purpose of Permit (Tick)

- 1. Domestic 2. Livestock 3. Irrigation
- 2. Other (Specify)

10. If No, Give reason.

.....

11. How far away is the nearest Borehole? (Assume the distance between two Borehole).....Metres.

12. Who control the amount of Water used?

13. What payments are made for Water used?

14. Do you collaborate with any Agency/ NGO's

Agencies/NGO's	Collaboration

15. STRUCTURE

Constructed Pipelines

	Diameter	Length
PVC.		
GI		
CONCRETE		

16. Number of Tanks Total Volume (in m³)

17. Participation

a. How do you rate the members in relation to the following (Tick)

Participation	Low	Medium	High
Attendance in the Meetings			
Participation in Maintenance			
Participation in Election			
Financial Contribution			

18. Perceptions

a. How does the Project perceive Water?

.....
.....
.....

b. Water is becoming very scarce and there has been increasing degradation. Consequently costs of Water development has escalated. What is your opinion of the user pays approach?

.....
.....
.....

19. What are the main problems facing your Water Project?

.....
.....
.....
.....
.....

20. Suggest please solution:

.....
.....
.....
.....

Thanks!!!