DEVELOPMENT OF WATER AND SANITATION INFRASTRUCTURE IN UNPLANNED LOW-INCOME URBAN SETTLEMENTS OF KITUI, KANUKU AND KINYAGO, NAIROBI

BY

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"A THESIS SUBMITTED IN "PART" FULFILMENT FOR THE DEGREE OF MASTER OF ARTS (PLANNING) IN THE UNIVERSITY OF NAIROBI

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JUNE 1988

DECLARATION

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

Signed _____

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Candidate

This thesis has been submitted for examination with my approval as a University Supervisor

Signed _____

MR. SAMUEL O. AKATCH
Supervisor

JUNE 1988

DEDICATION

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DEDICATION

TO

OUR FAMILY

ACKNOWLEDGEMENTS

Work of a magnitude presented herein is certainly possible only with the support of many people. In this respect it is not possible to thank them all by name. Special thanks go to all those whose works are cited in the thesis, and to those in the study area, I owe special gratitude.

I owe special gratitude to my elder brother Charles and the entire family for providing a conducive environment during my course of study. Those in the Department of Urban and Regional Planning, University of Nairobi, have greatly proven a valuable asset at all times. In this respect special thanks go to the Department Chairman; and to my supervisor, Mr. S.O. Akatch, it is a job well guided.

Finally, the typed work presented in here is as a result of the articulate hands of Mrs. Sarah K. Lugusa and Mrs. Mary M. Muthigo. For them, it is a difficult job well done.

ABSTRACT

An adequate water supply and sanitation service constitute basic human needs so that a human settlement with inadequate development of the same can best be regarded as unplanned. In this respect Kitui, Kanuku and Kinyago villages of Nairobi can be described as unplanned. The study area is one of the low-income urban settlements that are often referred to as either squatter settlements, uncontrolled settlements, or occassionally as temporary settlements.

The objectives of this thesis is to assess the influence of those factors that explain the development of water supply and sanitation services in unplanned settlements and therefore to determine how best to develop these services. Findings from the study area show that the development of these services is largely in the hands of the residents. Unfortunately, indications are that their efforts have not been effective. A comparative assessment shows that sanitation is worst hit. Ironically the development of an increased water supply now poses a more serious sanitation problem arising from inadequate provision to handle the waste water generated thereof. Poor site conditions, socio-economic factors, institutional constraints, and lack of support services all act

simultaneously to inhibit an effective development of the infrastructural services. It is also true to state that the development of water supply and sanitation infrastructure goes beyond just the mere provision of facilities; it calls for a properly designed and managed system otherwise the same facilities turn out to pose worse environmental problems to the same beneficiaries. Housing development faces major investment decisions that revolve around making decisions in a field full of competing and conflicting interests. In this respect Maslow's principle of 'hierarchy of needs' appears to prevail. So that households first invest in the house structure unit before investing in services like sanitation. Unfortunately, the result is that this is only at the expense of the degradation of environmental conditions that threaten the survival of not only the residents, but also the larger urban community.

Among the major recommendations that have been put forward in this thesis is the need to prioritise investment resources so as to reflect the real aspirations of man, not just in the study area but also in the larger urban environment. In this respect sanitation infrastructure is accorded priority.

Nevertheless, water and sanitation services together with other support services need to be developed as a package-whole. Any upgrading and improved development of unplanned settlements must however be perceived within a wider perspective of the total urban system. Therefore Nairobi City Commission has an obligation to ensure the attainment of an improved living environment within the urban area. The sooner the environment is saved from further degeneration the better.

This thesis has put forward some policies and engineering model designs that call upon committed efforts by a wider body of planners and the society at large. Further research on appropriate sanitation technologies are proposed to ensure a balanced natural environment. The benefits to be derived thereof are immense but only after concerted efforts, the cost to society notwithstanding.

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INTRODUCTION

Preamble

An adequate water supply and sanitation service infrastructure constitute a basic human need because of the direct effect on the health of man - for improved health is the ultimate aspiration of any human community. Adopting the United Nations definition, health is not just the absence of disease and infirmity, but is a state of complete well-being - physically, mentally and socially. It is a fundamental human right and the attainment of the highest possible level of health being a most sought world-wide societal goal (WHO,ETS/ 83.7, p.3). It is on the strength of this premise, that the research author suggests that any human settlement should incorporate water and sanitation services as part and parcel of the total environment.

As a human settlement therefore, the scope of housing definition incorporates not just the provision of the 'shell' - the house unit - but that infrastructural services like water and sanitation form an integral component of the development package whole (Republic of Kenya, 1987, p.1). Unfortunately, housing surveys world-over would suggest otherwise (Ibid, pp.4 - 10;

Kalbermatten et al., 1982, p.3). In fact, recent surveys by the United Nations housing agency - Habitat (Ramachandran, 1987) - and the World Bank (Kalbermatten et al, 1982, p.3) indicate that despite recorded impressive levels of economic growth in the developing nations, the water supply and sanitation service in infrastructure development was bad, if not worsening (Subrahmanyan and Cvjetanovic, 1986, pp. 83 - 4). The problem is particularly acute among the unplanned low -income urban settlements not only because it inhibits the path towards the community's improved health but that the consequences of the decay of the general environment are a major concern to the larger society.

The focus of the research work is on the development of water supply and sanitation service infrastructure in the unplanned low-income urban settlement of Kitui, Kanuku and Kinyago villages in Nairobi. This settlement is three kilometres away from the city centre, downstream along the banks of Nairobi river. With a total population of over 3,000 people in Kanuku and Kinyago, for example, there is no one form of acceptable sanitary facility available. This does not however mean that efforts are not being made to develop these important infrastructural services within the study area Residents in the settlement have made concerted attempts to this end but with recorded success in one area of

services development and failure in others. A comparative analysis shows that the sanitation service is worse hit.

Research findings indicate that there are a number of underlying factor forces that could be advanced to explain the condition of water supply and sanitation service infrastructure development in the study area. Besides the poor site conditions that make the overall development of services expensive, the immediate socio-economic needs favour the investment of resources in other areas of housing but only at the expense of the deteriorating development of infrastructural services. It seems that in a situation where people are striving to obtain the bare minimum to survive for the day, the concern for the future irrespective of the consequences, makes no sense - at least to the individual households in the study area. Besides the poor site conditions and the socio-economic constraints, institutional variables and the inadequate development of other supportive services come in strongly.

As the problem of water supply and sanitation service infrastructure development manifests itself as a product of the interplay of the above factors working together, it would only be logical to propose that a solution would constitute a 'minimum package'

of inputs, in the sense that each input is addressed to the causal factor problem. In what can be best described as a viscious chain-reaction cycle, for example, the provision of a good water supply which does not incorporate the development of a sanitation service as part of the 'package-whole' can at best be described as a 'half-dosage'. And as the argument goes : a half-dosage is no dosage at all; infact, it may be worse than no dosage at all (Pickford, 1986). In the same manner unless functional management is taken as part of the total development of the infrastructural services, the mere provision of these facilities can be worse than having none in the first instance; for example, a poorly managed toilet facility is worse than having none at all (World Health Organization, 1964).

A critical synthesis of facts reveal that the prevailing conditions of infrastructural services in Kitui, Kanuku and Kinyago villages is as a result of circumstances that reflect the activities of the total urban society, not necessarily limited to the local communities in such settlements: For one, the settlement must be seen as part and parcel of the total societal environment in the city. In this respect the development of an improved infrastructural service of water and sanitation calls for joint efforts from the residents in the settlement and the larger agencies

like the Nairobi City Commission. The support from Nairobi City Commission is important because infrastructural services like water supply and sanitation service are best developed as public services in urban areas (Dubos, 1974).

In conclusion it must be recognised that the central question in the development of housing is the cost, not only to the consumer population, but also to the total society. It is well known that the housing problem in urban areas is partly attributed to the high cost which puts the majority of the urban poor out of reach of such housing and so forcing them to seek residence in the unplanned low-income settlements like Kitui, Kanuku and Kinyango. Unfortunately, the development of infrastructural services like water supply and sanitation service is very costly and so it makes housing infrastructure services out of reach by the urban low-income (Breese, 1966). The above constraint notwithstanding however, because water supply and sanitation service are basic human needs, ways must be sought to deliver these services to all people in society. It is for this reason that model proposals have been made as a contribution to that goal. Even more important is the support required from the professional planners - in the wider sense of the term - and the societal political will. If only the proposed

model designs in this research could trigger off more critical analyses, disposition and exposition from relevant professionals and the general public, the purpose of this research work would have more than accomplished - to say the least.

Statement of the Problem

The recognition of water supply and sanitation service infrastructure as a fundamental human right has prompted many urban authorities and the society at large to seek for ways and means through which water supply and sanitation service could best be extended to unplanned low-income settlements. One major characteristic of development of the unplanned low-income urban settlements is the inadequate or complete absence of infrastructural services like water supply and sanitation, among others. If experience is anything to go by, the task of extending such services to the unplanned settlements has not been easy. Evaluation reports on the United Nations 1981/90 Water and Sanitation Decade only show decimal progress, if not a deteriorating trend in other areas like sanitation because "the percentage of people having access to adequate excreta disposal has actually decreased in some countries, since the Decade began" (Subrahmanyan and Cvjetanonic, 1986).

Among the traditional problems and constraints that come to bear on the development of infrastructural services in unplanned low-income urban settlements are: the poor site conditions; unfavourable socio-economic environment; institutional factors and the ineffective development of support services. To what extent can the condition of water supply and sanitation service infrastructure development in Kitui, Kanuku and Kinyago be explained by : the site conditions; socio-economic factors; institutional variables; and the development of support services? This is the thesis problem before the research work. In order to address itself fully to the above task, the following are important facets to the problem:-

- What efforts have or are being made to develop these services; and what constraints and potentialities exist, if any?; and

- therefore, what improvements could be made towards a more effective development of these services?

Research Objectives

The research objectives derive directly from the research problem statement. In response to the two-facet dimension of the problem, the objectives are:-

- to make an assessment of the influence of: site conditions; socio-economic factors ; institutional variables; and the development of other support services - on the development of water supply and sanitation service infrastructure in Kitui, Kanuku and Kinyago; and

- to make recommendations on an improved development of the same services in low-income urban settlements.

Study Assumptions:

The main assumptions in this research are:-

- a higher proportion of the urban population will continue to seek for housing within low-income settlements as the level of urbanization rises;

- the ultimate goal in the improvement of societal well-being shall include the protection and/or conservation of the total environment;

- water supply and sanitation service constitute basic human needs which can best be developed as public services; and

- the strategy of the Kenyan government policy on housing shall be directed towards improvement and upgrading of low-income urban settlements (Republic of Kenya, 1987, p.28

Justification of the Research:

Research on water supply and sanitation service infrastructure development in unplanned low-income urban settlements in Kenya is justified on a three tiered perspective, namely: the importance of water supply and sanitation service as a basic human need; the seriousness of deteriorating environment; and the identifiable gap in the body of appropriate solution in existing technologies.

Further analysis gives the following exposition:-

- Water supply and sanitation directly affects the societal ultimate goal of improved health; over 50 infections are traceable to poor water supply and sanitation service (Mara, 1982; Kalbermatten et al., 1982).

- About 80 per cent of Kenya's urban population has no effective demand for the conventional housing and so seek residence in low-income settlements, many of which are unplanned

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- About 80 per cent of Kenya's urban population has no effective demand for the conventional housing and so seek residence in low-income settlements, many of which are unplanned

(Syagga, 1987; Kenya Development Plan, 1984/88). Moreover, research findings indicate that even a higher proportion of the urban population will continue to seek residence in the low-income settlements (Wakely et al., 1976).

- Within unplanned low-income urban settlements, the state of sanitation development is worsening to the extent that the problem of environmental decay is today receiving priority attention in all countries of the world. Deriving from recommendations by Habitat (1976) and the Water Conference at Mar del Plata (1977), 1981 - 1990 has been declared the Water and Sanitation Decade by the United Nations (WHO, ETS/83.7). The commitment to the above resolution is reflected in the increasing number of countries giving priority to the development of water supply and sanitation service, besides the increasing level of budgetary allocation in the sector (The Courier, 1986).

A survey through the existing literature reveals that a solution to the inadequate water supply and sanitation service is yet to be found. If anything, there is apparent bias favouring the development of the housing structure unit but only at the expense of

deteriorating development of infrastructural services which reflects on the decaying living environment (Dwyer, 1975). It is no secret however that the cost of this decaying environment is a threat to the very survival of man. It is only logical therefore to concentrate the planner's attention on this important area that seems to be receiving little attention from the general public but whose cost of neglect will have to be paid ultimately by the same society. Planners must therefore stand out to give guidance to the rest of the society, as a matter of obligation; if they do not, who else will?

The selection of the settlement of Kitui, Kanuku, and Kinyago villages in Nairobi is justified on the basis of:-

- continuing attempts by residents to develop a water supply and sanitation service that seem to give 'semi-solutions' that are no solutions; and

- the development conditions in the areas depict typical problem situations that affect the development of infrastructural services in unplanned low-income urban settlements.

Finally, it is important to mention that solutions to housing problems are never of general application, just as in many other areas of human development - solutions need to be tailored, at least, to local conditions. The use of case studies can therefore only be justified by the fact that approaches and experiences in other areas are occassionally valuable in solving similar problems elsewhere. In particular, it is recognised that water and sanitation practices are pertinent to local communities. Although sanitary measures are effective in improving general health, results from different studies "cannot be generalised as they depend on behavioural factors and environmental and social conditions" (Subrahmanyan and Cvjetanovic, 1986)

Scope of the Research:

The research presented herein is focused on the development of water supply and sanitation service infrastructure in the unplanned, urban low-income settlement of Kitui, Kanuku and Kinyago villages in Nairobi. Reference is also made to other infrastructural services as and when there is some bearing on the development of water supply and sanitation service in the study area.

First of all, the research addresses itself to the conceptual background of housing development with

particular reference to unplanned low-income settlements. This is then developed towards the analysis of the development of water supply and sanitation service infrastructure in the study area. It is this conceptual background that aids the detailed analysis of the factors that influence the development of water supply and sanitation service in the case study area. Before presenting the factor analysis, the prevailing state of service level development in the study area is analysed. Due to the limited resources available for the research, detailed analysis is concentrated on the villages of Kinyago and Kanuku, with only a general survey of Kitui Village.

The factors that explain the state and process of water supply and sanitation service in the study area have been divided into four categories, namely:- the site conditions; socio-economic factors; institutional variables; and the input of support services. A synthesis of these factors, together with the conceptual background influencing the development of infrastructural service in unplanned settlement, leads to the articulation of recommendations and design models aimed at an improved level of water supply and sanitation service development. The recommendations and designs are presented in the form of models rather than as a development plan for the study area. In the same context, the model

proposals are two-tiered in the sense that there are those of direct application to the case study area and that others are of general application in the development of services in unplanned low-income settlements elsewhere.

The recommendations are in the form of policy models and technical design models. Much as it is true to state that the technical design models call for the input of the engineering rigour, the presentation is however made in a simplified format so as to form easy grasp by a larger planning audience. Unfortunately, this simplification entails inherent loss of accuracy in the actual design model but not at all for the general policy level articulation. All the same, the level of design presented constitutes a sufficiently detailed base for further engineering detailing and research work.

Organisation of the Thesis:

This section of the Chapter summarises the format of presentation of the research work as is contained herein, and the organisation of each of the Chapters. Chapter One introduces the research work and gives an exposition of the research problem, the objectives, the research assumptions, the scope of the work and the research methodology.

Chapter Two gives the conceptual background to the research problem. The chapter starts off by giving a picture of the development of unplanned low-income urban settlements anywhere in the world. A number of aspects relating to the development of infrastructural services are discussed giving the position of various scholars and authorities on the subject matter. Towards the end of the Chapter, the discussion is narrowed down to give a detailed perception of the development of water supply and sanitation service in urban areas. The Chapter concludes by giving the background to the case study area of Kitui, Kanuku and Kinyago villages of Nairobi.

Chapter Three presents an analysis of the state of service level development in the study area. The presentation is tailored towards giving a comparative analysis of the demand versus the supply of water and sanitation services. The analysis is first focused on the development of water supply in the sampled villages of Kanuku and Kinyago. The analysis identifies potentialities and constraints to the development of the water supply service. The same analysis format is adopted for the development of the sanitation service.

Based on the problems identified in Chapter Three, and the potentialities and constraints to the development

of water supply and sanitation service infrastructure in the study area, Chapter Four sets out to analyse those factors that come to bear on the development of these services within the study area. These factors include:- site conditions, socio-economic factors, institutional variables and support services. In order to make recommendations and proposals, Chapter Five first of all gives a synthetic run-through of the first four Chapters of the thesis. The recommendation proposals are principally policy and technical design models. Chapter six is essentially the overall conclusion of the research work presented in this thesis. Constraints to the present research work, and areas of future research are also suggested in this concluding Chapter.

Finally, in order to guide the overall development of the whole thesis, each of the four main chapters that constitute the body of the research work are first introduced and then a conclusion given at the end of each Chapter. These Chapters are Two through Five. It is the hope of the author that the presentation format given will aid easier and efficient reading of the whole work.

Research Methodology

Survey Organisation:-

Actual physical survey was undertaken within the settlement of Kitui, Kanuku and Kinyago villages. These three villages constitute the case study area for this research work. The settlement is located on the immediate valley slopes and floodplain along Nairobi river, on a site lying between the river and the low-income residential estates of Pumwani, Gorofani and Biafra. This site overlooks the residential estates of Shauri Moyo on the other side of the river valley - Figure 1.2 .

After a reconnaisance survey of the settlement, it was decided to adopt two approaches to the detailed survey of the area. Due to the unavailability of any map or aerial photograph showing the pattern and nature of the housing layout, it was deemed feasible to apply sampling technique to only Kanuku and Kinyago villages where household questionnaire was administered. This is because the two villages present a layout pattern that is easier to identify and pick out individual house units for purposes of sampling. The techniques of key informants and indirect participant observation were however adopted to cover all the three villages.

The survey was wholly conducted by the author because it was felt that the information required could best be elucidated by the researcher. This was deemed necessary because the pertinent problems of water supply and sanitation service appear to hinge on personal perception of human behaviour. The survey was also not restricted to day-time hours but covered even the late hours of the evenings when the problem of water supply and sanitation is even more serious and therefore presents itself more critically.

Sample Design

Sampling for the purposes of administering the household questionnaire was limited to Kanuku and Kinyago villages for reasons given above. Kanuku has a total of 157 house units and Kinyago has 301 units. Due to the proximity of the villages to each other and the absence of any discernible physical and socio-economic disparities, it was decided to sample the two villages as one whole. Dictated by the time and resources available for the research, it was decided to cover 10 per cent of the house units. This means that a sample of 45 house units was taken.

Selecting the Sample

With the assistance of the layout map (figure 1.1 - but on an enlarged scale) of the houses, 45 house units were randomly selected for household questionnaire interview. From each of these 45 units, a single household was selected randomly for interviewing. This was because within a house unit, there is occassionally more than one household.

Data Collection Methods and Sources of data

Data was obtained from two main sources, namely the primary and secondary sources:-

- primary data was obtained from the household questionnaire administered in Kanuku and Kinyago villages. The questionnaire was designed in such a way as to provide community input at the recommendation and design stage. The essential point in the primary data sources was to elucidate the community perception of the problem of water supply and sanitation service development. The household questionnaire was supplemented by direct and indirect observations and the use of key-informants picked from within the study area.

A separate technical questionnaire was administered to officers of Undugu Society in the site office

and the Nairobi City Commission departments of Architecture and Planning, Water and Sewerage, Medical Officer of Health Department, and City Engineer Department. Consultations with practicing engineers formed a useful input in the design of technical models. A physical survey of the settlement was also undertaken and photographs constitute a useful back-up of the field survey.

- Secondary data was obtained from both published and unpublished literature. Design manuals constitute useful input in design detailing.

Analysis Techniques:-

Case study approach to research emphasises on examining a small number of units across a large number of variables and conditions (Isaac and Michael, 1971, p.20). This is depicted in the problem statement given earlier, where the research is set to examine a number of factors that explain the development of water supply and sanitation service infrastructure in Kitui, Kanuku, and Kinyago villages in Nairobi. The variables to be examined include site conditions, socio-economic factors, institutional variables and support services.

The data collected on theabove factors is analysed to show the distributive spread of a variable over the

study area. The normal percentile distribution is used and is presented in tables. Figures, maps and plates are also used in the presentation of data.

Introduction to the Study Area

Kitui, Kanuku and Kinyago are three unplanned low income villages that have sprung up together and appear to share a common background. Presented below is a brief introduction to the area where the research is based.

Location:

Kitui, Kanuku and Kinyago villages are located about 3 kilometres from the Nairobi Central Business District, downstream along Nairobi river (figure 1-1). Figure 1-1 also gives the spatial distribution of other similar and unplanned low-income settlements in Nairobi. The study area is surrounded by other low-income settlements of Pumwani, Eastleigh, Biafra on the one side of the river, and by Shauri Moyo estate on the other side of the river bank. The villages of Kitui, Kanuku and Kinyago actually span along the immediate valley slopes draining into the river (Figure 1-2).

Topography:-

As mentioned above, the study area is located on the immediate slopes overlooking Nairobi river. From figure 1-2, the ground rises from 5340 feet-contour along the river to over 5365 feet at Biafra estate. Part of this settlement actually falls within the river floodplain, although the larger part of the settlement is sited on the steep part of the river valley with a ground slope of 1 in 9.5 (Figure 1-3).

Geology and Soils

The geology of Nairobi indicates that the study area is underlain by Kerichwa Valley tuffs derived from Nairobi Trachyte (Republic of Kenya, 1971). Although it is apparent from figure 1-1 that the study area lies in a zone of black cotton soil, actual site investigations show that the study area has pockets of murram soil which may be an extension of the narrow strip of murram zone indicated in figure 1-1. In particular, the black cotton soil that is predominant in Kitui village thins off to form a murram soil with a shallow clay cover in Kanuku and Kinyago villages. The soil along the river floodplain is mainly swampy alluvial (Ibid.)

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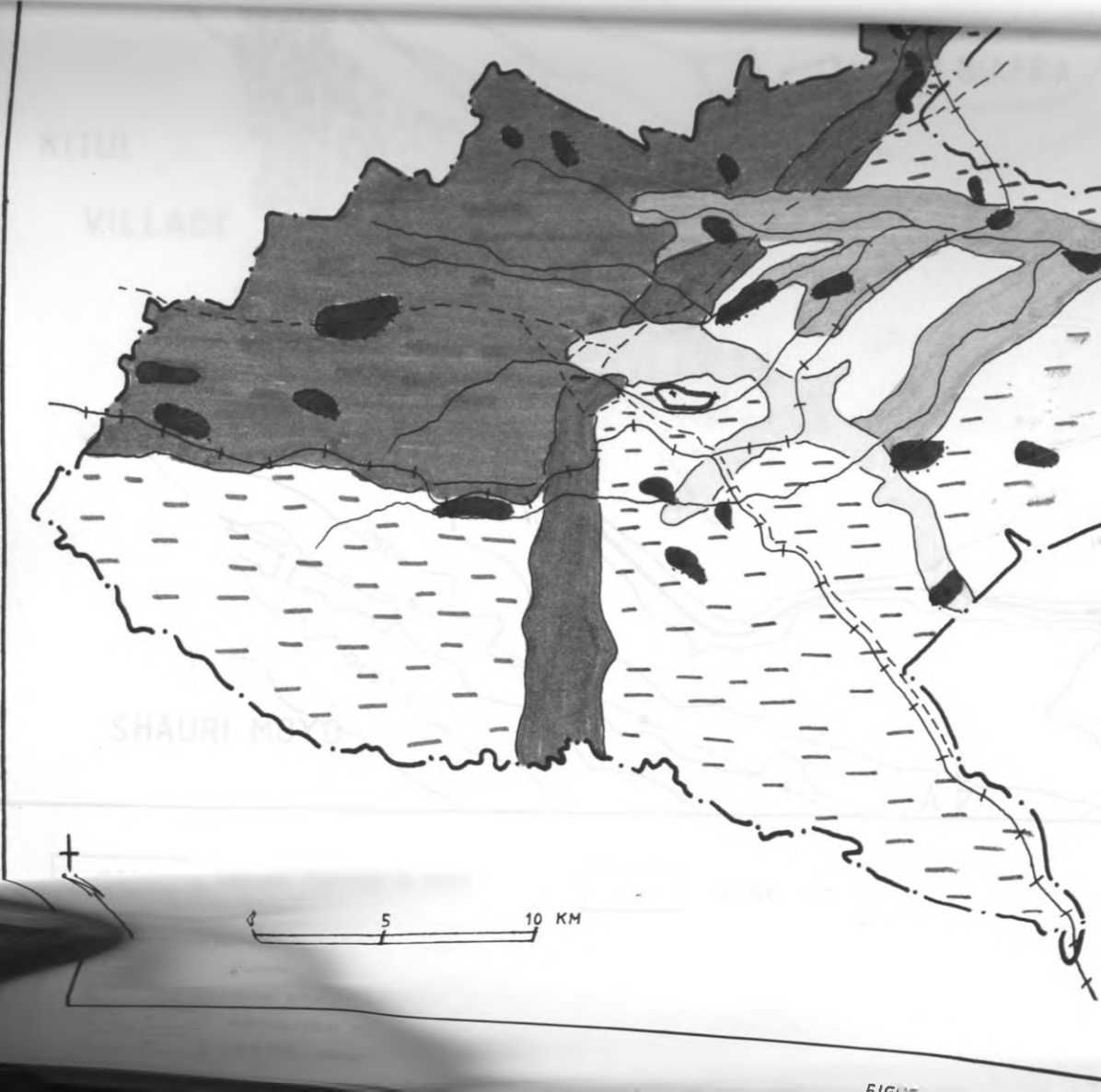
5
10 KM


NAIROBI CITY BOUNDARY
RAILWAY LINE
MAJOR ROADS
RIVER
RED COFFEE SOIL
RED FRIABLE CLAY SOIL
MURRAM SOIL
BLACK COTTON SOIL
ALLUVIAL SOIL
SHALLOW CLAY
UNPLANNED SETTLEMENTS
STUDY AREA

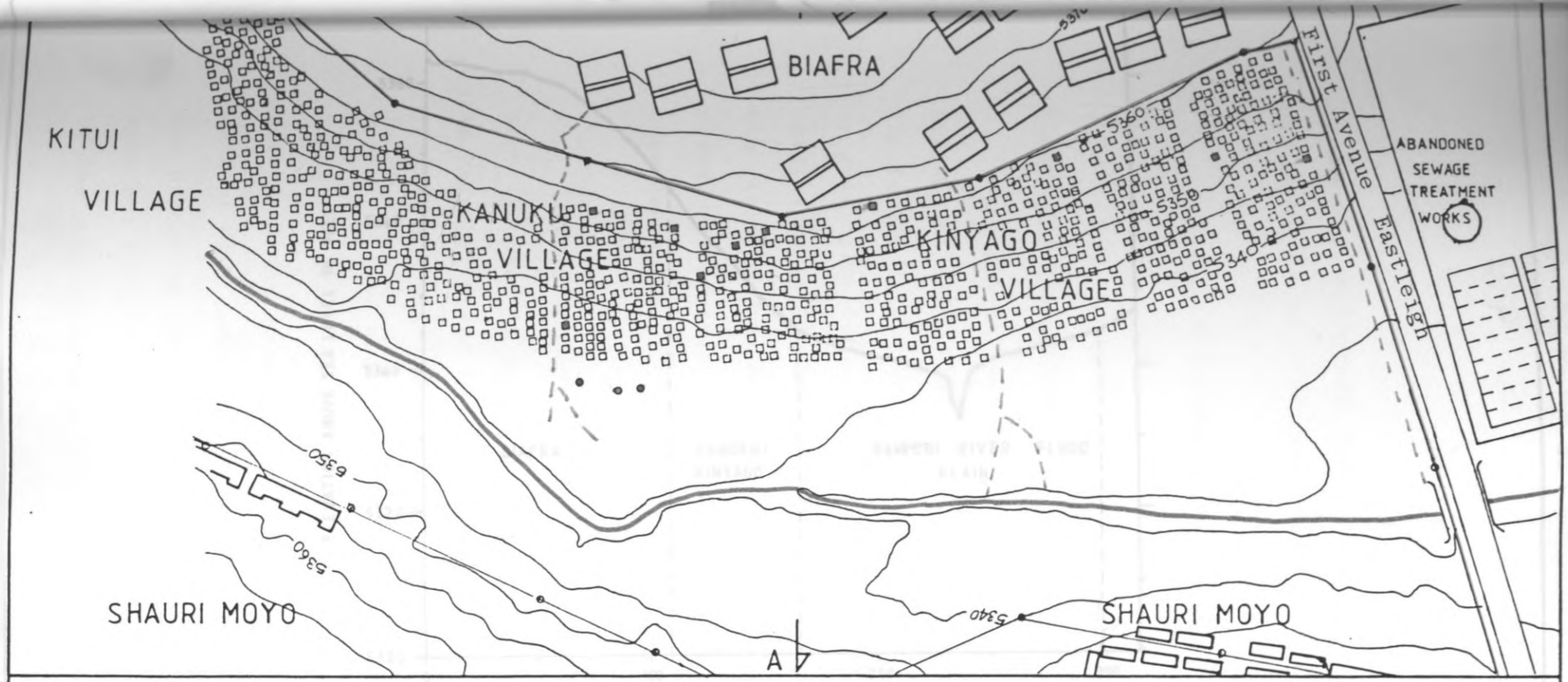

FIGURE 1–2
TOPOGRAPHICAL MAP OF STUDY AREA

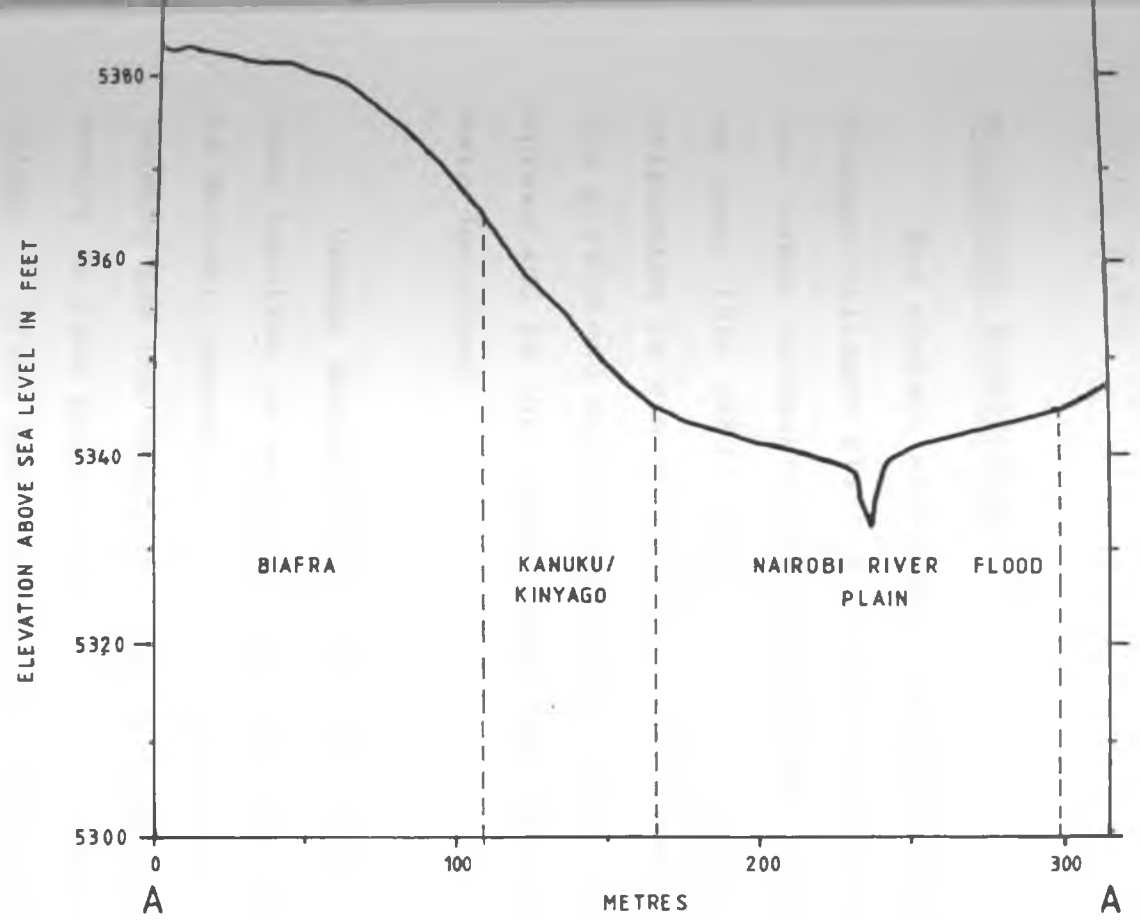

FIGURE 1-3
VERTICAL SECTION OF STUDY AREA

33 degrees centigrade, while the lowest temperature can be as low as 4 degrees centigrade.

The wind direction is mainly North-easterly (Ibid, p.43).

Historical Perspective

The present settlement form of Kitui, Kanuku and Kinyago villages started in 1983 after a fire destroyed the former cardboard and plastic huts in Kitui village on June, 12th 1983. This fire is believed to have originated in one of the huts, where one arsonist found his girlfriend with another man. This fire quickly spread and in that night alone over 130 shelter units were destroyed.

Undugu Society, which has for some time now been involved in assisting the poor and the destitute in Nairobi, moved in. In consultation with the local leaders and the residents, the victims declared their desire to have houses that were less vulnerable to fire (SINA). After some considerable hesitation, it was agreed by the local provincial administration and the Nairobi City Commission that the victims could build new houses on the site so long as their structures were not built of permanent material. The construction of the houses was also limited to the public land outside

the Military air base land at Eastleigh.

Undugu Society set out to seek for financial assistance to buy the building material. Undugu society has continued to insist on the full participation of the residents in any project. Together with the village committee, Undugu social workers team organised the purchase and transport of the building timber poles from Karura Forest. The village committee measured out the plots and divided the people into working groups of 10 - 15 people. Undugu hired a building supervisor to assist the residents in drawing out simple layout plans and also to assist in the actual construction work. By the end of 1983, over 500 mud-and-wattle house units, mostly one roomed, had been completed. Undugu supplied the roofing corrugated iron sheets. In addition, the community built a community hall and a nursery school.

In 1984 Undugu Society embarked on a second shelter upgrading project in Kanuku. This time the project was prompted by floods of Nairobi river, to which residents in plastic house units often fell victims. The local Eastleigh Chief approached Undugu for assistance. Having gained some experience from Kitui village, a more elaborate plan was drawn for Kanuku that allowed for more spacious two-roomed mud- and-wattle houses, and a wide and clearer spacing between the house units.

Allowance was also made for the development of pit-latrines, footpaths and a road. A total of 157 house units were in Kanuku at the time of conducting the field survey for this research.

Kinyago village was started in 1984/85 period. The residents of Kinyago were originally located in paper-like house structures near the old Eastleigh Sewage treatment works. They were evicted by the owner of the land to make way for the construction of new buildings. Negotiations between the provincial administration and the City Commission resulted in the granting of the present four acre plot to the evicted, next to Kanuku village. The local chief, the village committee and Undugu Society worked together in resettling the people in the present site. Together, a layout plan of the entire village was drawn, together with simple house design drawings. A community hall was also built. The villagers contributed labour and locally available building materials while Undugu contributed roofing iron sheets, poles, beams, tools, and a construction supervisor. At the time of conducting the field survey, in August/September 1987, a total of 301 mud-and-wattle house units were in Kinyago. The total cost of one house in Kinyago amounted to over Kshs. 4,510; Undugu Society contributed Kshs. 3,130, while each house unit owner met the difference,

including labour. The task of raising the contribution from the households presented a very difficult problem because of the prevalent poverty.

Socio-economic background

The land on which the study area is located is public land and the residents have no legal entitlement to the land. It is however recognised that insecurity of land tenure notwithstanding, the participation of the local provincial administration in the settlement upgrading has enhanced the assurance that the residents would not be evicted without being offered an alternative site. Therefore, the anticipation that the residents may not be willing to upgrade their housing may not arise, as an evaluation report by Undugu society shows (SINA). This is confirmed by the number of households who have actually undertaken housing improvements; in Kanuku 23 household have applied cement mortar to their house units and also lined the stormwater drains. In addition 19 rain water storage tanks have been constructed.

The average household size in Kanuku and Kinyago villages is estimated to be 4.3 persons. There are 711 households in Kanuku and Kinyago villages, which gives a total population of 3,057 people in the two villages.

On an area of 4.2 hectares, the population density is about 728 persons to the hectare.

Kanuku and Kinyago have a house layout pattern shown in figure 1.2. There are a total of 157 house units in Kanuku and 301 units in Kinyago. These units are not arranged in any specific pattern in relation to one another. Although Undugu had produced a simple lay-out plan to guide the pattern of settlement, the actual implementation was completely different, a fact confirmed by the Undugu site office located within the study area in Kanuku. So many residents units were added to the initial plan prepared by Undugu. Undugu Society site office staff explained that although a site had been prepared, the actual implementation was in the hands of the village committee and the local Chief.

The house units in Kanuku and Kinyago are of a typical size 4 metres wide by 5 metres long and are two roomed. Although each house unit was designed to house one household, there is a high degree of subletting the other one room. The average monthly rent in Kanuku and Kinyago is about Kshs. 250.

There are 6 small retail shops within Kanuku and Kinyago, selling simple consumer goods. Each of the villages has a community hall. During the morning

hours, the hall is used as a nursery school; in the afternoons it is taken up by adult education classes; in the evenings, it is used as a reading place by the older primary and secondary students. Worship services are also conducted in the halls over the weekend. Biafra clinic handles only the mother-and-child counselling cases but offer no curative treatment. A private Crescent Medical Centre is also located in the neighbouring estate of Biafra. The officers running the Biafra Clinic indicate that diarrhoea, eye and skin diseases, and malnutrition are top among the reported cases.

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CHAPTER TWO

THE CONCEPTUAL BACKGROUND

Introduction

The human right to decent housing has continued to be recognised since the Universal Declaration of Human Rights in 1948 (United Nations, 1976, p. 4). Decent housing is recognised as contributing directly to improved health of the people, where health is defined as, not just the absence of disease and infirmity, but is a state of complete physical, mental, and social well-being (WHO, ETS/83.7, p. 3).

A survey through many nations of the world will however reveal that the supply of housing is far below the demand. Focusing attention on the urban scene the United Nations (1965) report on housing notes that the rate of urbanization is far in excess of the supply of housing, thus leading to a housing shortage. In the words of the Executive Director of the United Nations Centre for Human Settlements (HABITAT), Ramachandran summarises the overall global shelter situation as "pretty bad and getting worse" (Daily Nation). In its last global conference held in 1987, Habitat estimates that well over 1 billion people out of 4.8 billion world population have no adequate housing and that a figure close to 15 million people die annually as a result of poor housing (Ibid).

A close analysis of the statistics would reveal that the situation is worse in the developing countries and that the situation favours the high-income groups in comparison with the low-income people. Infact the distribution is disproportionately bad for the low-income people because they constitute the majority number in urban areas and yet the supply of housing is lowest for this target population. While making reference to the situation in Kenya Syagga (1987, p. 11) notes that about 80 per cent of the urban population is out of reach of the conventional housing by virtue of the low levels of income. Even the few house units that are produced only cater for the middle-income and upper-income groups.

Unfortunately, well over 70 per cent of the demand for urban housing is by the lowest income groups in Kenya. Therefore this, Syagga (1987) explains, leaves the majority of urban population without housing with the result that, as their number increases, so is the proliferation of unplanned urban settlements; settlements constructed of any form of materials and lacking in essential services. This outline by Syagga (1987) appears to set the outline of the research work presented herein. This is the study of the development of water supply and sanitation service in the unplanned low-income urban settlement of Kitui, Kanuku, and Kinyago villages in Nairobi.

This chapter gives the conceptual background to the development of unplanned low-income urban settlements with focused attention on the development of water supply and sanitation service infrastructure. The presentation approach that has been adopted looks at the review of a number of broad issues related to the research problem and gives a literature review of the same. The chapter is divided into four main sections: the first section looks at the background to the development of unplanned settlements and in relation to water supply and sanitation service; the second section addresses itself to the response to the problem; and the third section looks at the policy towards the development of unplanned settlements and their service infrastructure. The chapter closes by addressing itself to the wider environmental balance equation.

Background to unplanned settlements

From the immediate discussion above, it is explicit that the unplanned urban settlements are largely catering for the urban low-income. What are unplanned urban low-income settlements? The central term that is of concern to the research problem is 'unplanned' settlement. It would be recalled from Chapter One that an adequate water supply and sanitation services are basic human needs and therefore constitute and integral

part of any human settlement (WHO, ETS/83.7, p. 3). Unfortunately, a look at the urban scene reveals that there are low-income settlements that either lack completely these services, or where they are offered, these services are inadequately developed. These settlements are often referred to as uncontrolled, spontaneous, illegal, squatter, and temporary, among other terms. This research thesis has therefore adopted the term 'unplanned settlements' to refer to these settlements because if an adequate supply of water and sanitation service are recognised as basic human rights then 'a consciously conceived - planned' human settlement would incorporate adequate development of the fore-mentioned services as part of the total development of the settlement environment.

Development of Unplanned Settlements:

As Syagga (1987) has pointed out above, the supply of urban housing is far less than the demand. So that as the rate of urbanization increases so is the proliferation of unplanned settlements. In Kenya, for example, a survey carried out in 1983 indicates that only 40000 dwelling units were produced compared to the total housing needs of 60000 units in urban areas (Republic of Kenya, 1987, p. 3). A critical analysis of the figures does present some pertinent characteristics.

Wakely (1976, p. 5) argues that there actually exists a 'lower threshold' cost below which not even the modest acceptable housing can be provided on an economic basis. Since any household has a limited proportion of income devoted to housing, those whose income corresponds to a proportion below the 'threshold cost' of housing can not enter in a recognised housing market. Certainly, Wakely (1976) has the urban low-income in mind. He is however quick to point out the consequences: "of course this does not mean that such a large number of households are homeless and without shelter" (p. 7). What it means is that their contribution to the housing stock is not recognised officially because their dwellings are below the defined standard of construction, servicing or accommodation. In Nairobi, Syagga (1987, p. 19) points; out, these unplanned settlement accommodate about 30 per cent of the population. Figure 1.1 indicates the spatial distribution of such settlements in Nairobi.

What makes conventional housing out of reach by the urban low-income? As Wakely (1976) has pointed out above, there is a limited proportion of household income that can be spent on housing. Therefore, a look at the distribution of resources among the urban residents indicates that besides the unprecedented rate of urban growth, there is a widening disparity in incomes, disfavouring the majority low-income. In Kenya, for

example, 80 per cent of the urban population has no effective demand for any form of conventional housing (Syagga, 1987, p. 11). Therefore income determines the ability to pay for housing and there is a 'threshold income' below which a household cannot afford any form of conventional housing.

Unrealistic housing standards have also been blamed for the high cost of housing in urban areas. The standards are unrealistic and arbitrary, if only because they are inattainable with the available resources and inappropriate to local conditions. The professionals have also a share of the blame, for they often assume irresponsive character to urban problems. On this latter issue Wakely (1976) attacks the attitude of the professionals where it is assumed that urban problems are the same over time. He disowns such a proposition: although urban administrators concede that their problems have grown bigger over time there is little indication that the administrators "understand that the problems they face are not just bigger but in their change of scale have become fundamentally different" (p. 7). He argues that although the provision of 1000 houses units per year may be viewed as principally the task of construction, the household needs of 20000 units per year would certainly present problems that cannot be solved by the mere construction industry. A city growing at

0.5 per cent per annum may solve its water supply problem by just good maintenance and occassional capital investment in civil engineering. For a city that is doubling in population size every decade will need more than routine public and civil works. Wakely (1976) continues even further to put up a case against the irresponsiveness of the professionals; they continue receiving the same kind of training that was relevant over decades ago and which may be appropriate in only developed countries but not in the developing countries of today.

A rather interesting perspective to the urban housing problem is put forward by Odongo (in Murison and Lea, 1979, p.31, eds.). He views the problem of housing shortage as having raised alarm, particularly from urban administrators and policy decision makers, to the extent that the true perspective of the problem of housing has lost track. The picture that has been presented on the magnitude of the housing shortage has largely been impressionistic and has subsequently led to its intrinsic attributes escaping evaluation. Quoting Turner (1971), Odongo "argues that the world housing deficit is a problem which is a measure of the official misconception of what housing should be rather than what it does and that the supply of housing stock is determined by unrealistic standards which are

founded on middle-class or western values" (Murison and Lea, 1979, eds). This view is shared by Angel et. al. (1977) who views the problem as a myth that derives from the orthodox use of questionable arithematical computations of the gap between the housing need and the expected supply. In addressing himself to the basic question: 'to what extent is the housing deficit in cities of the Third World fact or fiction?', Odongo looks at theories built around two conventional indicators of housing shortage - overcrowding and slum housing system. He notes that many of the theories focused on overcrowding - namely a health hazard and deleterious social behaviour appear to be unfounded because over-crowding "may aggravate or accelerate not cause or motivate any tendency to disorganisation in a personality or group" (op. cit. p. 31). On the other hand Mitchell (1971; quoted in Murison and Lea, 1979, eds.) finds little evidence to support the assumption that overcrowding is the causative of some forms of pathological problems. The point being put forward here is that there are a number of variables which either reinforce or ameliorate the impact of overcrowding. The overcrowding concept is often seen as the 'outsiders' own-value perception that is at disparity with the housing users - the 'insiders'. Making specific reference to slums, Clinard (1966) and Marris (1961) (in Murison and Lea, 1979, eds) reckon that the poor health of slum dwellers cannot be exclusively due to poor housing conditions,

but could also be traceable to poor nutrition, inadequate medical attention and wilful disregard of personal hygiene.

Response to the Problem

The author considers it important to assess and review the responses towards solving the problem of unplanned urban settlements. It would be recalled that the deteriorating sanitary conditions in the earliest urban settlements of the industrialized world were responsible for the establishment of urban development and control agencies as we know them today (Insel and Moos, 1974, eds). Therefore the first attempt towards solving the problem of unplanned urban settlements was directed towards demolishing these squalor settlements. But for a long time this strategy proved ineffective or for it, at best, worsened the housing situation. It shall be taken for the time being that the action was taken because the authorities then did not appreciate the role of these unplanned low-income urban settlements (Syagga, 1987, p. 12). Due to experiences learnt earlier and as a result of careful socio-economic and political considerations, the trend changed so that today these planned settlements are partially recognised (Ibid). This is seen in the changing housing policies that consider it viable to upgrade the settlements and

allowing greater individual initiatives towards alleviating the housing problem.

The task to improve the deteriorating housing situation in many parts of the world has been recognised as an uphill task which is, for all practical purposes, beyond the available resources. As the 1987 Habitat Conference in Nairobi noted, the task will not be easy (Daily Nation). A United Nations (1976) report on human settlement in Africa notes that even if 40 per cent of the population were to be provided with housing of minimum modest standards, the corresponding total investment need will be over 60 - 80 per cent of the annual income of the whole population in the region. Unfortunately, there are other needs considered more urgent so that even 5 per cent of the regional income invested in housing may entail considerable effort. Therefore, a solution to the housing problem presents tremendous dimensions which constitute an enormous challenge to any political system. In the same context, a research report makes it clear that the housing problem is complex and with many facets so that:

> It will only be fair to state that effective solutions will be many - sided. In the same token, it would be intellectually dishonest to propose any single solution any ideal. The best we can do is only to propose what is the least unsatisfactory in a particular context (Department of Housing and Planning Research, p.2).

The above position is also held by Smith (1977, ed) when she cautions planners against the past tendency by planners to look for a 'key' solution to problems. The "society is too complex and changes occur too rapidly to have a simple one-off solution. The character of social, economic and environmental problems have to be constantly redefined (Ibid). The conclusion by Smith (1977) is that "problems are not 'solved': they are merely changed" (Ibid).

Water and Sanitation Service Infrastructure:

What has been the trend in solving the infrastructural services of water and sanitation in unplanned urban settlements? From the previous discussion on the general question on housing, indications have been that the task of solving the problem is immense. Does this still hold for the integral component of housing - water and sanitation services?

The 1981/90 United Nations Water and Sanitation Decade target performance indicates that nearly half of the world population of 4 billion people have to be provided with water and sanitation services in order to meet the Decade's targets; that roughly worked out to be half a million people per day for the next twelve years (Kalbermatten et. al. 1982, p. 3). A major and

fundamental issue in the provision of housing and the infrastructural services is the fact that the housing and the associated services should be affordable by the low-income target population if the housing problem is to be solved at all. But one major constraint in the provision of services is reflected both in the sheer number of people to be served and also the mere costs involved in providing the services. Estimates indicate that over 800 billion U.S. dollars will be needed to meet the Decade's needs. At the current per capita investment levels in sewerage at 150 to 650 U.S. dollars, this is well beyond the incomes of the target popualtion, half of whom have a per capita income of less than 200 U.S. dollars per year (Ibid).

A mid - Decade evaluation report on the progress of the 1981/90 Water and Sanitation Decade indicates that the targets set may have been too ambitious. The report concludes that those who thought mankind's worst water and sanitation problems would be solved by 1990 will be disappointed. On a brighter note however the report concludes that perhaps the real aim of the Decade was "to make people and their governments aware of the situation and to get everyone doing something about it. This it has not yet failed to do" (Courier, p. 66). The above statement may however appear to justify the failure to solve the water and sanitation

problem but then the point is clear. It is in this context that the other objective of the Decade to create awareness seems to have faired quite well because a large number of countries in the world have responded to the call, though many traditional problems and constraints are yet to be resolved. Infact progress has barely kept pace with the rate of population growth so that "the percentage of people having access to adequate excreta disposal has actually decreased in some countries, since the Decade began (Subrahmanyan and Cvjetanovic, 1986, pp. 64-66).

In real terms, there are still over 1200 million people without easy access to drinking water and over 1.9 billion people without adequate sanitation (Courier, p. 65). As has been mentioned above, one of the major constraints to the actual implementation of the programmes is that investment in socio-economic infrastructure is very expensive. The situation is such that capital must be available in large blocks in order to ensure an adequate design and development of the services. Unfortunately, "the financial resources of most urban areas in newly developing countries appear to be hopelessly inadequate (Breese, 1966, p. 123). Infact Breese (1966) continues to explain that the situation is made even worse because of the low capacity of the ordinary beneficiaries to be taxed for funds to meet

the costs of the public services and utilities. A larger proportion of the urban residents are not even able to purchase housing, let alone to be taxed heavily enough to generate sufficient revenue for the installation of conveniences and services like water and sanitation. Making further reference to the inability of urban societies to obtain infrastructural services, Breese (1966) notes "that the amenities so fondly imagined as associated with urbanism as a way of life are likely to become propressively more inaccessible ... (Ibid, p.143). He therefore projects a situation of subsistence urbanisation where the urban societies will have to accept to live without these assumed right to urban amenities. Does this mean that the unplanned low-income urban settlements will have to accept the assumed inadequacy of the development of water supply and sanitation services? Loehr (1977, p. viii, ed) has a suggestion.

Loehr (1977) points out that the enormous problem of sanitation should not deter efforts of engineers and planners as a whole to look for a solution but rather these problems should serve to increase the challenge to look for better alternative solutions. In the same context, a UNESCO report makes reference to the endless enlarging gap between the needs for infrastructural services and the capacity of the

urban residents to pay for them. In a rather wider perspective, the position put forward by this UNESCO report is to the effect that "development without urbanization is an undesirable phenomenon, but there is no worse combination than urbanization without development (in respect to the development of infrastructural services, among other essentials of development)" (UNESCO, quoted in Breese, 1966, p. 143). In other words, what the report is saying is that urbanisation shall continue as an integral phenomenon of the development process. Therefore, having established this position, there could not be a worse position as urbanisation without corresponding development of infrastructural services like water and sanitation because then the total phenomenon of development ceases to make sense. It is essentially for this reason that this research thesis proposes an adequate development of water and sanitation services in the unplanned low-income settlements.

The last position suggestion presented above is put forward by the author. The author puts forward this suggestion, not because it needs necessarily support the research problem, but that in the light of the potentialities and constraints discussed above and the expositions therein, a decision has to be made as to the development priorities in urban settlements. In housing development of unplanned low-income settlements

the position of the UNESCO report given above stands and therefore the proposition that water and sanitation services deserve priority, if not because of their influence on the quality of the environment that must be protected if man has to survive.

Policy on Development of Services

This section of the chapter looks at the policies on the development of unplanned settlements before focusing attention on the policies governing the development of infrastructural services in unplanned settlements - the research problem area.

Policy on the General Development of Unplanned Settlement:

The immediate response to the blight caused by unplanned urban low-income settlements was initially the demolition of the same. Due to various socio-economic and political pressures however, and the realisation of the reality, this policy has now shifted to partial acceptance of these settlements (Syagga, 1987, p. 12). This policy shift may be explained by the realisation that there could not be a worse situation than a slum shortage caused by slum demolition - at least that is the view of Abrams (1966, p. 128). He reckons that worse than a slum is a slum shortage

that provides no shelter, good or bad. Wholesale demolition of unplanned settlements produces such a slum shortage and compounds the slums evils by forcing the poor and the evicted to crowd into what remains.

As a result, new strategies have been developed towards solving the problem of inadequate urban housing. One such strategy is the upgrading programme of the unplanned settlements. As Syagga (1987) points out, one central concept in this programme is the provision of infrastructural services of water and sanitation, among others. In giving key attention to the development of infrastructural services of water and sanitation in unplanned settlements, the conceptual basis is partially contained in the analysis of the development of these settlements as put forward by Huyck and Herbert (1968, p. 66). Based on the concept of a 'housing threshold', a term tht has already been addressed to by Wakely (1976, p. 5), Huyck and Herbert (1968) explain why a threshold exist.

> The mass of low-income people to be served, the costs of housing in any form, the administrative mechanism required, and the shortage of permanent building materials combine to establish the lower limit below which standard housing cannot be made available to the people on a widespread basis (p. 66).

Recognising the concept of a housing threshold, Huyck and Herbert suggest that investment should therefore be concentrated on "environmental improvement programs for the lowest - income groups and establishing the mechanisms ... at reasonable costs (to assist households) to cross the housing threshold". (Ibid). In their view, the concept of a 'threshold' is aimed at bridging the gap between the economic realities and the social aspiration of the people. In this respect the environmental improvement deserves top priority and so the rationale for concentrated efforts on water and sanitation services.

The policy position being put forward by Vagnby (1975) is worth considering in the light of the threshold concept. First of all, what contribution, as policy-makers, are planners making towards the development of unplanned settlements? Vagnby (1975) is very clear to attribute part of the problem facing the development of unplanned settlements to policy-makers. He points out to the fact that the problems facing the residents in unplanned settlements are due to the policy-maker (as a professional planner or politician) having failed to provide the 'urban settler' with enough incentive to maintain and improve his housing. The planner does not provide those in unplanned settlements the security of tenure or ownership; the settlers might be allowed to construct a house only on condition that

it is considered temporary because the planner retains the right to demolish it one day when the political climate is opportune (Ibid, p. 5). What is the basis of assuming that those in unplanned settlements have no right to stay where they are and deserve no compensation when "we are willing to pay compensation to settlers (colonial white settlers) who came and occupied land which cannot be said to belong more to them than to the indigeneous population ... Do we not reject these people their common rights to assume that what is considered adequate by themselves should also satisfy our requirements?" (Ibid).

The challenge facing planners today is therefore one of getting decision-makers to understand and accept that some of the standards governing housing in urban areas are too high. There is enough evidence to prove that it is impossible to provide the low-income population with housing at the present standards assuming that these people can spend 20 - 25 per cent of their income on housing as rent and that the total capital cost of the housing should not exceed 2.5 times their annual income. In this respect Vagnby (1975, pp. 6-7) calls for acceptance by policy-makers for necessary modification, particularly in the provision of sanitation infrastructure and also calls upon the residents in these settlements to accept that a minimum

spacing and order is needed if their problems are to be solved.

Studies carried out by Newmark (1978, p. 102) indicate that the quality of the house does not facilitate or inhibit upward mobility and does not induce improvement or deterioration in the life of the house dwellers; "... housing per se cannot and does not alter life sytle, behaviour patterns, and the values of people" (Ibid). Therefore Newmark (1978) argues that technological and material solutions like new and rehabilitated housing, which are not sensitve to life sytle differentials, alienation in modern societies and the breakdown of social controls cannot possibly be expected to provide incentive for upward mobility or even retard a process of rapid deterioration of the living environment resulting from neglect, vandalism, lack of pride or a combination of them all. Therefore policies that are primarily aimed at changing the physical environment have little impact on the behaviour patterns and values of society (Ibid, p. 105). Perhaps this indicates that the adoption of conventional sanitation options like sewerage would not automatically result in an improved sanitary environment. Planning which seeks to improve the living environment in unplanned settlements must address itself to the significant causal elements of these conditions -

namely economic, social, and political. In this respect Newmark (1978) is very clear to make a sharp distinction between 'slum dwellings' that are harmful to the residents and the society at large and 'low-rent dwellin that are not harmful and are accepted by the residents because of their low cost compared to other possible residential sites (Ibid, p. 106).

Finally, the continuing existence of unplanned low-income settlements may reflect the dilemna of whether the quality of housing provided presents an optimal use of resources or not. In his paper 'Urban Renewal Programs', Rothenberg articulates the future of unplanned settlements;" the benefits inhering in the goal of eliminating blight and slums are not self-evident, because it is not at once obvious that what is gained exceeds what is lost" (quoted in Page and Seyfried, 1970, eds.).

Policy on the Development of Services:

The foregoing section of this chapter has argued that unplanned settlements may no longer be regarded as either temporary or subject to demolition. Therefore any proposed improvement programmes must take place within an existing settlement that presents its inherent constraints and potentials. One such

improvement programme to be introduced in unplanned settlements is the development of infrastructural services of water supply and sanitation. A United Nations (1976) report states that an environment developed by squatting proves less economic in the long run than a planned one because the make shift construction of dwellings raises the cost of installing the utilities thereafter to excessive levels. It proves more economical to develop the housing and utilities from the start (Ibid, p. 34). This view is also held by Abrams (1966) who points out that the environment cannot be easily altered, and, in the long or short run, enormous public investments are required to reorder and rationalise an established pattern (Ibid, p. 112). Unfortunately, the real life situation in unplanned low-income urban settlements is such that infrastructural services have to be introduced in an already established settlement whose pattern of development presents a myriad of complex constraints. So that a report on an upgrading scheme of Kapwepwe Compound/George - an unplanned low-income urban settlement in Lusaka - makes it clear that any improvement of the unplanned settlement must take place within the framework of continued existence of these settlements for along time to come (Lundgren et. al. 1969). The report points out that in making any improvement it is necessary to recognise two aspects of the settlements:-

- there are those settlements located in area not suitable for residential settlement within the available resources and technology; and

- there are those settlements located in areas suitable for residential settlements. These type of settlements suggest a higher level of planning and resource commitment to the general improvement of the area. The best methodology here is the incremental strategy of improvement. Lundgren et. al. (1969) views the development of sanitation infrastructure as central to the total protection and preservation of the living environment.

There is no question that an urban crisis is looming in many urban settlements of the third countries. The rate of urbanization is growing at an ever faster rate and the time to find solutions is gradually running out. Dwyer (1975, p. 230) notes that in Kenya, for example, if the current, low environmental standards are not to deteriorate still further, the elements of urban infrastructure in housing will need to be raised by the same proportion of urban growth.

The conventional response to such environmental problems in urban areas has been the adoption of standard solutions developed in industrialised nations. For example, waterborne sewerage systems are seen as the answer to problems of human waste disposal; and the provision of individual piped water connections as a solution to the inadequate water supply in unplanned urban settlements. Whether one considers the popularised

low-cost option of site and service schemes on new sites as a realistic and indeed inevitable strategy towards solving the otherwise intractable problem of water and sanitation in low-income urban settlements, the fact is that as yet no developing nation has made a serious attack on, let alone solve, the water and sanitation problem. Abrams (1966) points out, site and service schemes, as a form of self-help programme, have their own problems to content with. Abrams (1966) argues that the more self-help required of the household occupant, the greater the need for inducement, supervision, and administrative costs. Unfortunately administrative, supervisory and technical skills, and their inherent financial requirements pose a great challenge to many developing nations because of the dire scarcity. In fact the most unfortunate thing is that even the popularised, low-cost site and service schemes, have been concentrated on new housing projects for the urban low-income settlements and relatively little attention has been given to similar schemes for improving unplanned settlements in situ (Dwyer, 1975, p. 232). This point is important because it appears the strategy requires that infrastructural services be developed within these unplanned low-income settlements as they are. These are the hard options that presently planners have to address themselves to. The most unfortunate observation made by Winland (1972, p. 9) is that despite the environmental

consequences that result from inadequate development of infrastructural services in urban settlements, much of the research effort is currently directed towards the house unit structure and that very little capital is set aside for the development of such services. For example, whereas investment requirement in infrastructure development stands at over 150 U.S. dollars per capita, only 8 U.S. dollars per person is available for these services in urban areas (Kalbermatten et. al. 1982, p. 3; Dwyer, 1975, p. 235). In fact Winblad (1972, p. 3) makes it clear that using the current conventional sanitation options from the industrialised countries, no one country in Africa could provide the urban population with these services, at the required standard, even using all the nation's total net savings (quoted in Dwyer, 1975; p. 233).

The search is therefore for appropriate technologies for water supply and sanitation services in unplanned low-income urban settlements. As a contribution to this call, the World Bank proposes a strategy of incremental programmes where, for example, a community initially installs a pit latrine which can gradually be upgraded to a pour-flush toilet, then small-bore sewered pour Flush toilets and eventually to a conventional sewer system. This approach is based on the view that technology selection should reflect the future need for

incremental improvement as the consumer's aspiration and socio-economic status rise (Kalbermatten et. al. 1982, p. 52). So that as levels of income rise and people can afford a higher level of water service, the potential incremental sanitation sequence can follows the pattern given in figure 2.1 below (Ibid. p. 53). Kalbermatten et. al. (1982 p. 57) is however prompt to point out a few important aspects. First, none of the upgrading schemes shown in figure 2.1, leads to the conventional sewer system. Secondly, though conventional sewerage is an excellent form of sanitation, it is not necessary in attaining the primary goal of improved health. The conventional sewer system only means increased water consumption level that leads to ever increasing costs of sewage treatment. From a technical point of view, it is important to realise that sewerage network are essentially designed for the disposal of sullage and not excreta. Therefore, a lot more could be saved if non-essential water consumption could be eliminated or reduced - thus giving savings in both economic and environmental cost consequences. Sullage greatly increases the costs of sewage treatment. If a technology could be found to adequately dispose the sullage on - site or reduce its production in the first place, enormous sewage cost savings could be made.

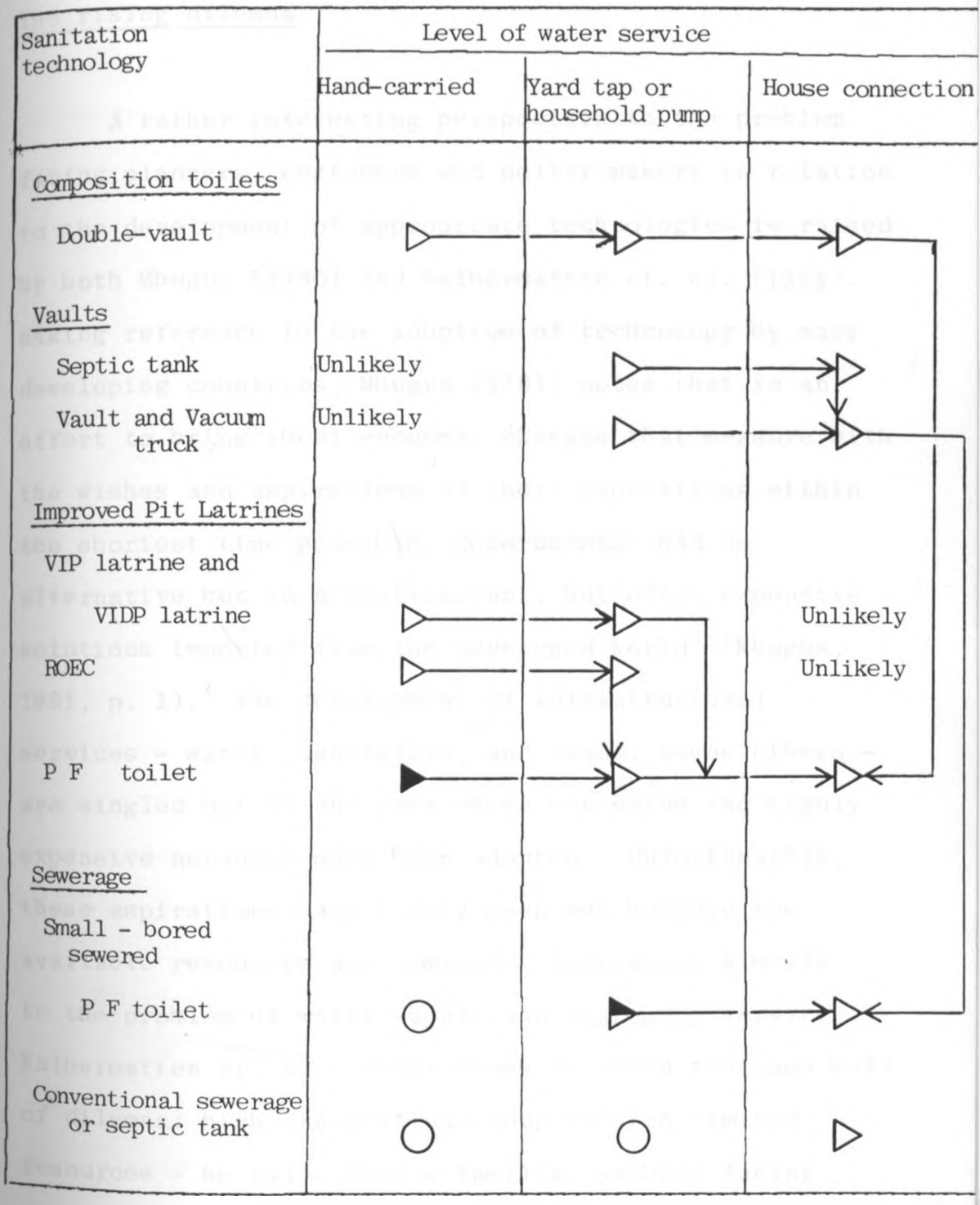

Figure 2 - 1

Incremental Sanitation Sequence

▷ Technically feasible
▶ Feasible if sufficient pour-flush water will be hand carried
○ Technically infeasible
▶ Feasible if total wastewater flow exceeds 50 litres per capita daily.

The rising dilemna:

A rather interesting perspective to the problem facing planners, engineers and policy-makers in relation to the development of appropriate technologies is raised by both Mbugua (1980) and Kalbermatten et. al. (1982). Making reference to the adoption of technology by many developing countries, Mbugua (1981) notes that in an effort to bring about economic changes that measure with the wishes and aspirations of their populations within the shortest time possible, governments" had no alternative but to accept instant, but often expensive solutions imported from the developed world" (Mbugua, 1981, p. 1). The development of infrastructural services - water, sanitation, and roads, among others - are singled out as one area where extensive and highly expensive networks have been adopted. Unfortunately, these aspirations have barely been met because the available resources are limited. Addressing himself to the problem of water supply and sanitation service, Kalbermatten et. al. (1982) seems to sound the same bell of dilemna: high expectations coupled with limited resources - he calls this a familiar problem facing developing countries. Policy-makers in developing countries are being asked to achieve standards of sanitation convenience, like the water-borne sewerage system, that are practiced in the developed countries.

but because of the high cost of development of sewerage systems, this objective cannot be attained because resources are limited. In fact, as Kalbermatten (1982) argues further, this failure to satisfy people demands and aspirations has resulted in many governments failing to make steps towards improving sanitation; the very magnitude of the problem has inherently discouraged action. Just as Batten (1957, pp. 219-20) argues in his thesis on human behaviour, setting up of unattainable goals only results in a state of hopelessness and despondency. As Pickford (in the Courier, March/ April 1986, p. 78) puts it, even a simple pit latrine that is well built and well-maintained can achieve better results than the more sophisticated systems that do not operate any way. And the reason why such inappropriate options are still to be found in the developing world is because of the false aspirations of the people. On the local scene therefore the policy being pursued by the Kenyan government on the development of infrastructural services in urban areas states, in part, that the "strategy for water is to work towards the provision of individual connections to all properties and to develop adequate water-borne sewerage disposal facilities" (Kenya, Development Plan 1984/88, p. 161). It is however not clear whether this policy caters for the unplanned low-income urban settlements because the level of service and the technology option suggested

is well beyond the means of the population in the unplanned settlements. The 1974 Nairobi City Master Plan for Sewerage and drainage assumed at the time then that the future population (which is today's population) would be able and willing to pay for water and other sanitation services proposed therein (City Council of Nairobi, 1974, p. 5). The Master Plan was prepared over 14 years ago and it would be interesting to make an evaluation of the validity of the assumptions contained therein; obviously the state of development of infrastructure services in the unplanned low-income settlements of Nairobi today is at disagreement with the assumptions. Either the assumptions were invalid or the plan was not meant to cater for the unplanned low-income settlements.

In an effort to correct the above dilemna of high expectations in an environment of limited resources, it is observable that the high expectations are misplaced because they are at disparity with the primary objective of improved health. This primary objective of improved health can be attained fully by sanitation technologies much less costly than sewerage. These other more expense sanitation technologies like sewerage are only aimed at consumer convenience and are supported by a high investment of resources. Certainly, consumer conveniency may not be the primary goal for many nations

in the third world at the moment. As Elizondo (1980) points out, technology in poor countries should be seen as the only way for survival while technology in wealthy nations is aimed at increased consumption and convenience. This dilemna is also addressed to by Roberts (1980) and Mazrui (1985); in his thesis, Roberts (1981) attributes the problem partly to the aid programmes where donors are concerned with financing straight forward technology transfer to the third world; while Mazrui (1985) attributes the problem to the people themselves in the third world who view development as nothing but the attainment of western cultures and living sytles.

In what appears to be a more awkward position of the solution to the problem is the fact that any hopes for prospects in reversing the current situation are being nubbed in the bud. The engineers, as planners, often find themselves in a dilemna. Most of the time they will be using standards and conventions developed in the developed world. This practice may not only be viewed as making the provision of infrastructural services out of reach by the target consumer but it discourages hope for local initiative and improvision of technology. So that engineers continue to use these practices which they are aware are not appropriate because they fear that the use of unorthodox solutions would entail

undue burden of responsibility in case of failure than if they followed the 'correct' design conventions, become in the latter case failure would not be blamed on them. Kaden (1981) shares these same sentiments, for example, when referring to a situation where an engineer has to choose between labour and equipment in the execution of a project.

> A civil engineer will consider as most appropriate a technique which assures him that the end product will be of good quality, executed within the scheduled time at least cost, preferably with a minimum risk ... He will properly respond to the criteria by which his department's performance will be judged (Kaden, 1981, p. 3).

In the development of infrastructure Kaden (1981) argues that the engineer is bound to pick the equipment for reasons given above because the engineer does not presumably benefit from making a proposal that implies delayed implementation of project or slower progress. It is difficult for the engineer to be expected to explore alternative techniques that result in increased initial cost and risk - characteristics of labour intensive programmes (Roberts, 1981). Moreover the fact that the engineer will ultimately be responsible for the success or failure in the application of a proposed technology and the fact that conventional wisdom has it that labour-based methods are inferior technically, makes the engineer oppose labour intensive method. This

professional dilemna is also shared by Wakely (1976), Eze-Uzomaka (1981) and Edmonds (1981).

In what appears to be an effort to correct the above dilemna position, Edmonds (1981) of the International Labour Organisation (ILO) however views appropriate technology as a term which has become much abused lately. Appropriate technology is not an alternative, it is purely and simply the technology that the developing world can afford to use at their level of development, resource endowment, and presumably, their commitment to attaining a new social order that benefits all members of society. Edmonds (1981) continues to argue that appropriate technology has been miscontrued as being some kind of alternative, labour intensive technology which can be used as a stop-gap to cure the more blatant inequalities in developing countries and to be discarded when these countries become capable of mastering the technology used in industrialised countries - for, as everyone knows, that is what these developing countries are aiming for.

Public Services and Their Management:

An important aspect in the development of infrastructural services like water supply and sanitation service is that they are regarded as public goods and

services. As Smith (1975, pp. 304 - 5) points out "there are several things people want that cannot feasibly be provided through the marketplace .... It is feasible but inefficient for people in a community to obtain water or dispose of wastes by unco-ordinated efforts". This calls for joint community effort and therefore government intervention. The point that Smith (1975) is raising leads to a very pertinent aspect of management of these public services. It is often a common observation that public facilities and services are not managed adequately in comparison to privately run services.

In addressing himself to the problem of poor management of slum properties, Sternlieb (1970) notes that the single most important variable that accounts for variations in the maintenance of facilities in slums is the factor of ownership. He continues to note that there is no question of the importance of local landlord residence, particularly single parcel landlords, in ensuring improved management of slum tenements. In a settlement where the tenant turnover is high, the management of individual and communal water and sanitation facilities becomes unfavourable. The provision of communal water and sanitation services should therefore be designed in such a way as not to hamper management.

The concept of public participation has also been recognised as an important aspect in the design, operation, and management of water supply and sanitation service infrastructure. The problem of poor sanitation,for example, is a direct consequence of community activities. The waste generated by individuals eventually has effect on the total community. What role can public participation play in the development of water supply and sanitation services in unplanned urban settlements? The community will only participate in solving community problems if the individuals in that community recognise the need and have the ability to do so. The degree of response to community problems will therefore depend on how widespread the recognition of a particular problem is and the subsequent felt need and ability to solve it. Experience from the Barrios of South America point to the fact that very few activity will be of universal appeal as to be termed 'community activity'. Nevertheless, while analysing social structure and social action in the Barrios,Peattie (1968, p. 66) notes that "the community does not need to act as a whole to initiate procedures for solving some general problems". It is also important to appreciate that being aware of the dangers of poor sanitation alone by the community does not mean that the community is willing and able to solve the problem. For example, Insel and Moos (1974, p. 448, eds) point out that a

smoker is well aware of the risks of smoking but this does not deter him from continuing to smoke. The fact that people in unplanned settlements know that defecation in the open ground poses a risk to health does not deter them from continuing to do so. It is important to appreciate the fact that individuals are least bothered about the waste they produce; there is little feeling of personal responsibility for the waste produced by an individual, for the individual believes that somebody else will find a painless and effortless solution to the problem. This is one reason that calls for central agency intervention in the development of sanitation infrastructure and therefore its being regarded as a public service.

The suggestion that local communities should participate more in the development of and management of their infrastructural services stems from the recognition that the burden to provide these services by the government alone is too difficult a task and there is need for cost-sharing (Pacione, 1981). A world Bank report entitled 'Accelerated Development in Sub-Saharan Africa: An Agenda for Action' considers the cost-sharing concept between the government and the consumer community as deriving "from considerations of efficiency, which suggest that governments can more effectively achieve their social and development goals by

reducing the widespread administrative overcommitment of the public sector and developing and relying more on the management capacities of private individuals (who) can respond to local needs and conditions (in the provision of services)" (Ndegwa et. al. 1985, p. 23). Of course the above suggest should not be taken to mean that infrastructural services like water supply and sanitation will cease to be managed as public services as advocated by Smith (1975) above. For example, in the much publicised cost-sharing strategy of site-and-service schemes, Abrams (1966) warns that the more self-help that is involved in a project, the more inducement, administrative and technical supervision that would be required but unfortunately these are the attributes that are not readily available amongst the local low-income communities. As a strategy toward self-reliance in the management and administration of infrastructural services, and in support of the cost-sharing concept, the words of Ndegwa et. al. (1985, p. 241) may suffice to explain the position of the realities: "these are harsh priorities. They involve cuts of parts to save the whole - like a surgical amputation. Precisely for that reason professionals have a duty to explain why such measures are necessary ... in terms which both decision-takers and communicators can understand."

The Environmental Equation

It has previously been mentioned that the poor state of sanitation in unplanned low-income urban settlements was causing a lot of concern because of the negative impacts on the environment. The problem of sanitation is perceived within the context that waste disposal is essentially concerned with the relocation of waste from the point of generation to a more suitable and non-detrimental site (Loehr, 1977, ed.).

In discussing the problem of environmental pollution caused by poor sanitation in unplanned settlements Bach (1972) wishes to draw the dichotomy between economic and environmental human aspirations. He attributes the problem of environmental pollution to man's desire to achieve higher economic returns at the expense of the quality of the environment (Bach, 1972, p. 1). In this respect reference can be made to the overcrowding of house units in urban settlements where there is a tendency to cover as much space as possible with undue regard to proper provision of infrastructural services and the general quality of the environment. The main reason being that there are higher and direct gains from the house unit compared to the maintenance of a quality environment - at least that is man's perception (McAllister, 1980,

p. 12). In the same manner, man has been tuned to follow the philosophy that natural resources should be exploited as fast as possible and rapidly distributed to individual consumers who are only convinced that they need these goods but yet not told about the wastes these goods produce. In this respect, reference is made to the increased level of water consumption in urban settlements that is not accompanied by adequate development of sanitary facilities to handle the waste water generated (Bach, 1972, p. 1; Huyck and Herbert, 1968). In the same economic philosophy context, Bach (1972) argues that man has managed to create unbearable living conditions right in the middle of his most desirable habitant - the urban settlement because he thinks" the price for progress and urbanization is (pollution), or It is necessary to put up with a certain amount of (pollution) in order to maintain the present standard of living. These statements indicate that man's mind has been polluted at least as much as the (environment)" (p. 2). But let man be warned because this attitude has no future and immediate redress is called for as "man can no longer afford to support his own apathy. He must begin now to restructure his economic and social philosophies and to redirect his technological efforts towards the conservation and preservation of the (environment)" (Ibid). It interesting to appreciate the paradox brought forth by Fitch (1970). Fitch (1970) argues that the deteriorating environment is coming at

a time when the society is growing towards affluence - a state of rising human aspirations and standard of living.

Human Values:

An interesting element that is worth investigating into in the light of the immediate issues discussed above is to pose the question: What governs the human behaviour in respect to the sanitation and disposal of waste discussed above? McAllister (1980, p. 12) considers human values as central in governing human action. He argues that people think and act on the basis of their view of the environment which is determined by their human values, knowledge of facts, and their beliefs. Human values serve as guides for personal decision making, directing preferance to things that are desirable or good. In unplanned urban settlements individual households have often to make a decision as to whether to cover completely the little space available with the house structure or to spare some space for infrastructural services - paths for movement; toilet facility; or open space for general ventilation and social functions. A general survey through these urban settlements will reveal that the little space available is not even enough to accommodate a house unit that will provide the desired indoor space. It therefore

means that a household has to make a decision as how to apportion the available limiting space to provide the desired needs. The decision taken by the household as to the use and apportionment of the space will certainly influence the resultant environment in the settlement.

To arrive at a decision, a household would seldom consider only a single human value, for the household requires both the indoor space provided by the house structure and the outdoor space that will accommodate space for movement, sanitary facilities, and the general open space for ventilation and social functions. A household in the unplanned settlement will often hold all the above value attributes so that his decision making will require selecting and weighting several values simultaneously. McAllister (1980) continues to state that although value system development tends to follow impulses for compatibility and harmony "conflict among values are virtually inevitable in any personal decision involving limited time, energy, or resources; even the most harmonious values can come into competition with each other when time or resources are allocated (Ibid, p. 13). Extending the household decision-making problem further in the light of McAllister's arguement above, it is indeed true to state that the housing value attributes of the house structure; outdoor space to

accommodate movement, sanitary facilities, air circulation and social functions all constitute a harmonious value system; but considering the limited resources of land and income, for example, at the disposal of the low-income household in the unplanned settlement, conflict and competition among the housing attributes results in congestion and degeneration of the environment.

In order to understand the situation prevailing in unplanned low-income urban settlements, it would be necessary to appreciate the source of human values. McAllister (1980) points out that human values arise from the interaction of man and his environment. What makes the household in low-income urban settlements show a tendency to cover all the available space with the house structure with undue regard to the provision of infrastructural services like sanitation? Is it because the household is ignorant of the environmental consequences, or is it sheet negligence? McAllister (1980) states that the biological and psychological nature of man generates motivating behaviour towards certain ends. Like other animals man acts in order to survive, so that there are certain basic needs that man seeks to meet. In what is cited as Abraham Maslow's 'hierarchy of needs', there are five basic needs, that operate in all people and cultures and arranged in a

hierarchy with physiological and self-actualization at the bottom and top of the hierarchy respectively: physiological need; safety; belongingness; esteem; and self-actualization. The theory explains that the hierarchical principle is such that the lower category of needs must be fulfilled first before a certain higher category need can play an important role in personal behaviour so that unless physiological needs are met, safety will not be a strong motivating factor. Physiological needs cover the most basic life-supporting elements like homeostasis, warmth, food, and water. Another school of thought explains that ends have value only insofar as there are means to reach them. Values governing behaviour are said not to be focused on ideals but on 'ends-in-view'.

Looking at the situation in unplanned low-income urban settlements, it is now clear why the house structure is accorded priority in the development of housing in the unplanned settlements as it constitutes a physiological need. On the other hand, infrastructure service like paths and sanitation fall in a secondary need to the first need. The absence or inadequate development of infrastructural services in unplanned settlements may not be surprising because the households are just being human. In the same context, because the house structure may be constructed of any material

available, it is an 'end-in-view' while the acquisition of water supply and sanitation services in the urban environment may be 'ends' without means to reach them. The prevailing level of development of the house structure and infrastructural services may be explained by the fact that values governing behaviour are not focused on 'ideals' but on 'ends-in-view'.

Another interesting aspect that requires consideration is the conflict between personal and social values. This is particularly true when considering the disposal of waste generated in the congested urban settlements. This is because waste is generated by individuals but when it is carelessly disposed of, its impact affect all households in the settlement. How many people care about the waste they produce? Miller (1979) argues that the general behaviour is that no one cares about waste once it is removed from his immediate environs - out of sight, out of mind is the general rule rather than the exception. On his part, Wayne (1970) describes the attitude of people as one where they confidently believe that by some miracle the garbage thrown anywhere would be collected and disappear. This miracle is unlikely considering the congested environment in the unplanned low-income urban settlements. McAllister (1980) concludes that "the tension between personal and social values, of course gives rise to many of the social,

economic, political, and public policy issues. The conflict between the interests of the individual and interests of society are constantly challenging us and, no doubt, always will" (p. 14).

Summary

Public policy has enormous influence on the development of unplanned urban settlements. Indeed, the development of unplanned settlements is a manifestation of the failure of the policies. In the analysis of the body of public policy, it is conceivable that restrictive devices are acceptable everywhere. But then, it is important to note that these policies have limitations when applied to housing.

Every restriction increases the cost of housing and, if too stringent, can curtail or stop housing development and supply. The restrictions cannot prevent the emergence of unplanned settlements in the face of mass urbanization. These restrictive policies only serve to raise the cost of housing and so remove a considerable sector of the urban population - the low - income - from the benefits of the private and self-help housing product that is prevalent in unplanned low-income urban settlement.

and the high levels of water consumption can only be explained by the uncalled for anxiety for the future and the unfounded notion that improved health could not possibly be attained by other water and sanitation technology options. The resultant costs on society may be traced in the worlds of Dubos (1974, p. 450) where he states that "one of the alarming aspects of environment pollution is that despite all the new powers of science, or rather because of them, man is rapidly losing control over his environment. He introduces new forces at such a rapid rate, and on such a wide scale, that the effects are upon him before he has chance to evaluate their consequences". This statement is made in reference to the adoption of technologies in sanitation like sewerage that consumer alot of water, and yet give rise to high generation of waste water, a problem that is more difficult to handle when it was not necessary to generate that quantity of waste in the first instance. As Kalbermatten (1982) argues, improved health can be attained without resorting to technologies that consumer alot of water and end up causing more dangerous environmental problems that could have been avoided in the first place.

A look at housing development policies in many developing countries of the world indicates that they are at variance with local needs. Dwyer (1975) argues

that due to out moded training and orientation, majority of town planners simply draw up plans and designs as perceived in developed countries without either discrimination or adaption to local conditions in developing countries. Most town plans fail to give due weight to the growing significance of unplanned settlements within these urban areas. This is clearly manifest in Nairobi City Council's Master Plan (1974) for sewerage and drainage. Besides failing to incorporate unplanned settlements "where they do, they tend to look forward to a millinium where all squatter huts will be eliminated and replaced by regularly laid out housing in the image of the Western city, without specifying the immediate rungs on this particular ladder to urban heaven" (Dwyer, 1975, pp. 94-5).

To make criticism on the professionals does not imply total responsibility for lack of a solution to the housing problem. There is undue patronage relationship of planning and politics, especially because it affects the use of land, a very sensitive national and political issue. Which politician, for example, would boost about the low-income settlement options being suggested today where it may imply the acceptance of a mud-and-wattle house with a pit-latrine? It is always a 'show-piece model' of the latest design that appeals to the politician of today. Commenting on the

predominant school of thought that perceives i
in which it can never be acceptable to build b
existing standard because" deliberate substand
housing will defeat the very purpose of housin
as it will lead towards the creation of future
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follow.

predominant school of thought that perceives idealism, in which it can never be acceptable to build below the existing standard because" deliberate substandard housing will defeat the very purpose of housing as it will lead towards the creation of future slums. The basic standards must be adhered to at all costs" - Dwyer (1975, p. 102) views such ideals as not only far from being constructive but reflect a blind unwillingness to face the housing reality.

It would be interesting to analyse the problem of water supply and sanitation service development in the unplanned settlemement of Kitui, Kanuku, and Kinyago villages in the light of what is presented in this chapter. What aspects come into play, from within and without, that explain the development of water supply and sanitation service in the study area? This constitutes the body of the rest of the chapters that follow.

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CHAPTER THREE

SERVICE INFRASTRUCTURE DEVELOPMENT TRENDS

Introduction

The Central theme running through the last two Chapters is that water and sanitation service constitute basic human needs. It is only logical therefore that this chapter looks at the actual state of development of these basic human services within the study area. There are many ways that this assessment could be done; for this research an analysis of the level of supply of these services is made in relation to the demand.

The first part of this Chapter looks at the development of water supply service in Kanuku and Kinyago villages. This is then followed by the analysis of the state of development of sanitation service. Figure 3 - 1 shows the distribution location of infrastructural services within Kanuku and Kinyago. Based on the assessment of the demand versus the supply, a comparative analysis shows that the state of sanitation development is poorer than that of water supply development. With a population of 3,057 people (in 1987), Kanuku and Kinyago villages have only three unserviceable pit latrines. This gives a hypothetical service level of about one pit latrine for every 1,000 residents. The term 'hypothetical' is used in the

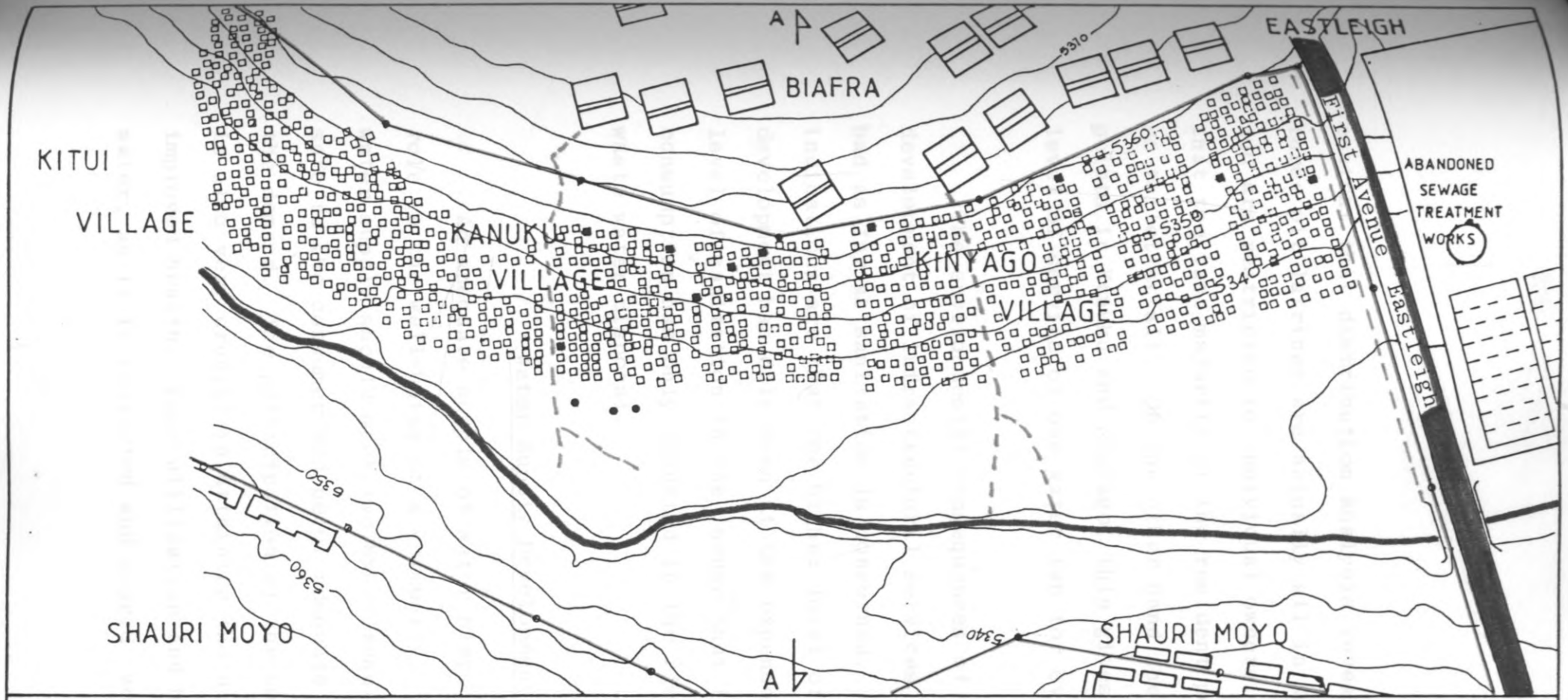


FIGURE 3-1

DISTRIBUTION OF SERVICES IN KANUKU AND KINYAGO

context that distribution analysis reveals that these three pit latrines are actually all in Kanuku village and are restricted to individual owners; this means that the vast majority of the resident population have no toilet at all. On the other hand there are 10 water points in Kanuku and Kinyago; this gives an estimated level of service of one water tap for every 300 people.

The environmental consequences of inadequate development of infrastructural services is particularly bad as far as sanitation is concerned. Moreover, indications are that the higher level of water supply development has only been at the expense of deteriorating level of sanitation in the sense that increased water consumption has only resulted in the rising problem of waste water disposal.

Water Supply Development

An adequate supply of water plays an important role in the well-being of a community. An adequate water supply should meet two basic requirements of being safe to the consumer and be of adequate quantity to meet the demand. The participation of the consumer community is also very crucial in attaining the ultimate goal of improved health. Poor utilization and handling of water, as it is collected and stored would certainly

render unclean an otherwise safe water supply by the time it is actually consumed.

This section of the Chapter is addressed to the level of water supply development in Kanuku and Kinyago. The analysis assesses the water demand; the supply development; the actual consumption; and problems associated with the water supply service.

Water Demand

The total water demand in the study area will depend on the consumer population characteristics and activities. For all practical purposes, the water requirements in the settlement are for domestic consumption. For planning and design purposes the water demand is assessed on the basis of the total human population count and the per capita water consumption rate. Irrespective of the composition characteristics of the population, an average per capita consumption rate is adopted. The per capita consumption rate is influenced by the service level of the water supply - that is, whether a consumer is served by an individual house connection, a yard tap, or a communal water point. The per capita consumption rate is also infuenced by the standard of living of the consumer, so that as the level of income or

standard of housing increases, the rate also rises - all other things being held constant. It is on this basis that this research work adopts a water demand rate of 20 litres per capita per day for the study area (Republic of Kenya, 1986, p. 27; Kalbermatten, et al. 1982, p. 39).

With an estimated population of 3,057 people, the total domestic water demand in the study area is 61 metres cubed per day. It would be important at this stage to note that since water is regarded as a basic human need, the terms 'water demand' and 'water need' are usually used interchangeably. For all practical purposes of water supply planning, it is therefore taken that 'effective demand' and 'demand' are the same thing.

Water Supply

The appraisal of level of service of the water supply in the settlement is aimed at assessing the supply of water in relation to the water demand. In assessing the level of service, important variables that are analysed include:- the sources of water; its quality; distance to source; and the provision of washing facilities.

Sources of Water:-

For domestic purposes, the main sources of water for use in the study area were the communal water points and water kiosks that are located either within the study area or in adjacent estates of Majengo, Pumwani, Shauri Moyo, Bahati and Gorofani. Within Kanuku and Kinyago villages, there are 7 water kiosks in Kinyago and 3 water kiosks in Kanuku. All these water kiosks are supplied from the City of Nairobi's Water supply distribution line running through Biafra estate. The location of these water kiosks is shown in figure 3.1. Out of the 7 water kiosks in Kinyago, 3 of them are owned by women groups while the other 4 are owned by individual households. For Kanuku, 2 of the water kiosks are owned by women groups and the third one is privately owned. All these water kiosks sell water to the residents at a rate lying between 30 and 50 cents for 20 litres of water. Eighty-nine per cent of the sampled households had either plastic buckets or jerry cans of 20 litre capacity that were used to collect and store water.

The communal water points in Majengo, Bahati and Shauri Moyo are owned and run by Nairobi City Commission. These water points supplied water to the general public free of charge. 37 per cent of those sampled

households however complained of occassional harassment by residents of these neighbouring estates when collecting water, or when using the communal ablution blocks especially during peak demand periods at the water points.

During the rainy season 76 per cent of the sampled households indicated obtaining some rainwater through the roof-catchment system. There are presently 19 water storage tanks that have been constructed to store rain water. These are also located in Kanuku village. Each of these ferro-cement ground tanks have a capacity of about 1.0 metres cubed.

Although the revelation was not made during the formal questionnaire interviews, indirect participant observation and informal discussions made by the author did indicate that some water was obtained from the open sewer running down along First Avenue Eastleigh next to Kinyago. This sewer has an appreciable continuous flow. On two occassions, young women with children were seen washing their clothes using water from this open sewer. During the informal discussions with residents in the settlement, it was also revealed that water for making the mud during house construction was also obtained from the open sewer and the numerous open sewer drains carrying sullage in the settlement. The

waters of Nairobi river are occasionally used to make mud for house building but the river water was regarded by the residents as heavily polluted.

Choice of Source:

The choice of the source of water by consumers within the settlement is influenced by the distance, time of day, the cost, day of the week, the weather, the use to which the water is to be put, and the age and sex of the person available to collect water. These factors act in a mutually inclusive manner rather than in an exclusive way. This means that the point from which a household finally decides to obtain its water is subject to decision on all the above influences.

Within Kanuku and Kinyago, all the sampled households were within a 70 metre locus of a water kiosk. Assuming that all other factors were held constant, a household would buy water from the nearest water point. During the day 68 per cent of the sampled households seemed to disregard distance as a factor dictating the point of the water source. These households travel over 500 metres to collect water from neighbouring estates of Majengo, Gorofani, Bahati and Shauri Moyo. This was particularly common with households

with either resident mothers or young children who could be sent to collect water from distant points. The greatest influence in this case, however, appears to be the fee charged at the water points. A longer distance to be covered to a water point appears not to be a hinderance if it only means obtaining water free of charge. The rest of the sampled households - that is 32 per cent - obtained water from the nearest water point irrespective of the fees charged. These households have either a household size less than four or have single men only.

During the weekends when a lot of family washing is done, 74 per cent of the sample households travelled to distant water points in the adjacent estates where water is obtained free of charge at the public water points. The main reason for this is the large quantity of water needed to wash clothes and other household items. If a household decides to do the washing at home, it would be forced to collect water from the water points several times, a factor that was not favoured by the households. Washing at home is also not popular with the households because of the limited water storage capacity as well as the absence of washing space and facilities.

During the rainy season a higher proportion of 82 per cent of the sampled households indicated obtain water from the water kiosks within the village compared to an earlier figure of 68 per cent during the dry season. The main reason given for this variation was the diffcult and dangerous narrow paths that are slippery during the rainy season.

Actual Water Consumption

In order to make an appreciable assessment of the water demand and the supply in the study area, it becomes imperative to analyse the actual water consumption characteristics.

Water is usually collected in plastic buckets and cans from the water points indicated above. The same containers are again used for water storage in the house. The stored water is used for food preparation, drinking and for limited washing and bathing. During the formal questionnaire administration and through indirect participant observation, it was clear that water is stored in containers with little regard for cover against contamination with dust. Table 3-1 below shows the pattern of distribution of the quantity of water stored and consumed by the sample households.

Table 3-1

DISTRIBUTION OF THE QUANTITY OF WATER STORED AND CONSUMED BY A HOUSEHOLD IN A DAY

Quantity stored and consumed by a household per day in litres	Percentage of sampled households
1 - 5	7
6 - 10	22
11 - 15	10
16 - 20	37
Over 20	24

"Source: Field Data

On the basis of the above water consumption pattern, the per capita water consumption is computed. From the above Table 3-1, the daily household water consumption is 16 litres. This gives a per capita water consumption of 4 litres per day, based on a household size of 4.3 persons. The actual water consumption is therefore one fifth of the recommended requirement of at least 20 litres per capita per day (Design Manual for Water Supply in Kenya, 1986, p.27). The health implication of this low water consumption is discussed in Chapter Two. The sampled households did indicate however that the amount of water consumed was not enough to meet their requirements. Notice that the above computation excludes water used for bathing and washing clothes, for these activities are mostly done either at the water points in the neighbouring estates or require no water storage in the house.

responded to their need to develop and improve the water supply system. It has been pointed out above that the initial main source of water, the Nairobi river, has been rendered useless. As has been previously mentioned, the residents in the study area have since then continued to rely on the communal water points located in the neighbouring estates and connected to the general Nairobi City's water distribution system. Lately, the trend is towards developing and extending a water supply system in the study area. No major work was done in this programme by the residents themselves until Undugu Society moved in and started a form of housing upgrading programme as described in Chapter Two. It must be pointed out at the very outset that the upgrading programme was initially concentrated in the development of the house structure units so that although Kanuku and Kinyago had improved house units completed in 1985, a programme to extend and develop a water supply system in the study area did not start until mid 1986. What kind of water supplies have been developed? Two water supply systems have been developed in the study area:-

- the extension of the piped water supply into the study area from Nairobi City Water supply; and
- rainwater harvesting.

Piped Water Supply

It has previously been mentioned that there are 10 communal water kiosks located within Kanuku and Kinyago villages (Figure 3 - 1). All these water points are connected to the Nairobi City water supply lines in Biafra estate. For those water points owned and run by women groups in the village, Undugu Society assisted in the development of the supply together with UNICEF's Child Survival Programme. The assistance was in the form of cost-sharing between the women groups and the support agencies given. Below is presented the cost of development of six such water project extensions (Tables 3 - 2, 3 - 3, 3-4 and 3-5).

Table 3-2

LABOUR COSTS FOR SIX WATER KIOSKS

Item	Total cost (Kenya Shillings)
Laying of the pipe	1782
Excavation @ Kshs. 35/ metre	9170
Plumbing on the pipe lines	7920
Construction labour (Kiosk)	3300
Application of the mud to walls of kiosk	3600

Source: Undugu Society site office.

The above cost schedule was distributed as follows:-

- Unicef met the cost of laying the pipes, plumbing and construction labour of the kiosk. This adds to a total sum of Kshs. 13,000.

- Excavation and application of the mud to the walls of the kiosk was met by the women groups. This amounts to Kshs. 12,770.

Table 3-3

MATERIAL COSTS FOR SIX WATER KIOSKS

Item	Quantity	Total Cost (Kenya Shillings
.Poles @ Kshs. 15.00	72	1,080.00
.Rafters @ Kshs. 12.00	48	576.00
.Purlins @ Kshs. 12.00	36	432.00
.Votoes @ Kshs. 1.50	1,380	2,070.00
.Nails @ Kshs. 10.00 per Kilogram	30	300.00
.GCS Sheets @ Kshs. 77.00	108	8,316.00
.Roofing nails @ 18.50 per Kilogram	18	333.00
.Door and window @ Kshs.250.00	6	1,500.00
.Ringings @ Kshs.20.00	24	480.00
.Door and window fittings @ Kshs. 50.00	6	300.00

Unicef met the full cost expenses for the kiosk materials amounting to Kshs. 15,387.00. Table 3-4 gives the material cost for extending the water pipe line into the village.

Table 3-4

MATERIAL COSTS FOR SIX WATER CONNECTIONS

Item	Quantity	Total cost (Kenya Shillings
Connection fees @ Kshs. 1,200.00	4	4,800.00
GI pipes @ Kshs.250.00	60	15,000.00
GI elbow (1in.) KShs 40.00	3	120.00
Re-Budh @ Kshs.60.00	14	840.00
GI elbow ($\frac{3}{4}$ in.) @ Kshs. Kshs. 40.00	24	960.00
Nipples ($\frac{3}{4}$ in) @ Kshs.35.00	14	490.00
Water taps @ Kshs.70.00	6	420.00

The total material cost for the six water connections amounts to Kshs. 22,630.00. This cost was met by Unicef. Other miscellaneous costs were:-

- Water deposit at City Hall @ Kshs. 600.00 per kiosk that totals Kshs 3,600.00;

- One padlock for each kiosk @ Kshs. 40.00 amounts to Kshs. 240.00; and

- stationery for book-keeping @ Kshs. 100.00 per women group amounts to Kshs. 600.00.

The water deposit and stationery cost was paid for by Unicef. The women groups bought the padlocks. Undugu Society provided the technical assistance on-site at a rate of Kshs. 5,000.00.

From the above analysis, Unicef (through the Child Survival Development Programme) met a total development cost of Kshs. 55,219.00; women groups contributed Kshs. 13,010.00; and Undugu Society contributed Kshs. 5,000.00. There were no charges for the land among the cost schedule.

The above cost analysis has been geared towards giving an economic cost appraisal for developing the piped water supply in the study area. Table 3-5 presents the actual financial cost schedule for the construction of an individual water kiosk, while excluding the costs of extending the water pipeline into the study area. This cost was directly paid by each of the women groups owning a water kiosk. As the total cost of Kshs. 4,292.50 could not be raised by the women groups, Undugu Society offered to advance a loan to each of the women groups in Kanuku and Kinyago to meet the cost of a water kiosk. This loan had to be repaid

back in 30 months at an interest rate of 10 per cent per annum. The repayment was to be made from the water sales made at the water kiosks.

Table 3-5

COST SCHEDULE FOR ONE WATER KIOSK

Item	Cost in Kenya Shillings
. 12 poles @ Kshs. 15.00	180.00
. 8 Rafters @ Kshs. 12.00	96.00
. 6 Parlins @ Kshs. 12.00	72.00
.230 Vitoes @ Kshs. 1.50	345.00
. 5 Kilograms of Nails @ Kshs. 10.00	50.00
. 18 GCS sheets @ Kshs. 77.00	1,364.00
. 3 kilograms Roofing Nails @ Kshs. 18.50	55.50
. Construction labour	550.00
. Mud-plastering labour	600.00
. 1 window and door	250.00
. 4 Ringings @ Kshs. 20.00	80.00
. Door and window fittings	50.00
	3,692.50
. Meter Deposit at City Hall	600.00
Total cost	4,292.50

The water sales bring income to the women groups. From this income, the women groups are able to repay back the loan, pay the water bill charges at City Hall, and pay the person(s) who actually do sell the water at the Kiosk. At the given terms on the loan, it means that each water kiosk is required to repay monthly rates on the loan at Kshs. 143.00 on the principal sum and Kshs. 23.00 on interest.

From the consumption pattern presented earlier, a per capita water consumption rate of 4 litres per day is conservatively adopted. The total water consumed in Kanuku and Kinyago in a month is therefore 36,684 litres or 3668.4 litres per water kiosk (currently there are 10 water kiosks in the study area of Kanuku and Kinyago). Taking the lower price limit of the price range of 30 - 50 cents for 20 litres of water, each water kiosks collects Kshs. 550.00 per month from the sales. From this revenue, the loan repayment of Kshs. 166.00 (Kshs. 143.00 + 23.00) is paid, and Kshs. 250 is paid to the person(s) on attendance at the kiosk. From the tariff schedule (Table 3-6), each water kiosk pays a water bill of about Kshs. 16.00 per month. Therefore at the end of the day each water kiosks expects to make a net sale profit of around Kshs. 118.00 per month. This money constitutes earnings to each owner women group.

Table 3-6 -

WATER TARIFF SCHEDULE (1987/88)

Water Consumption per month (in litres)	Charges
0 - 9000	Kshs. 4.00 per 1,000 litres of part thereof
Above 9000 - 18,000	Kshs. 6.00 per 1,000 litres or part thereof
Above 18,000 - 30,000	Kshs. 8.00 per 1,000 litres or part thereof
Above 30,000	Kshs. 10.00 per 1,000 litres or part thereof

A simple analysis of the price schedule will reveal that water consumers in the study area pay excessive charges for water compared to the rest of the city water consumers who pay their water bills direct to City Hall. A brief calculation will suffice to make the point clear:-

- A consumer in the study area who is charged 30 - 50 cents for 20 litres of water pays at Kshs. 15 - 25.00 for 1,000 litres; while

- a consumer who pays the water bill to City Hall direct will only be charged Kshs. 4.00 for the same 1,000 litres. It is therefore obvious that the water consumer in the study area is paying 4 - 6 times as much for water service

than the rest of the city consumers who are even enjoying a higher level of service.

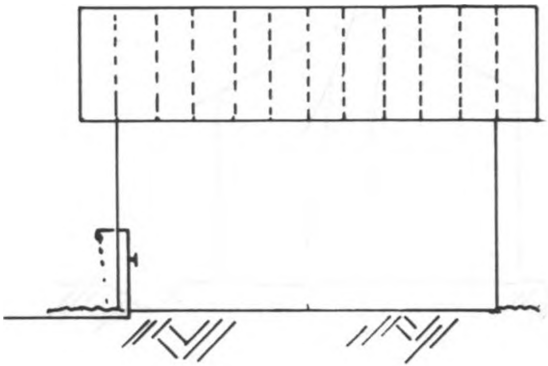
Further analysis of the above anomaly is revealed in the water billing system. Whereas the rest of the residents in the city receive refuse collection and dust-bin provision service, this latter service fee is also reflected in the water bill of the consumers in Kanuku and Kinyago who do not receive such a service at all.

Besides the women groups, private individuals have also extended piped water supply and operate similar water kiosks in the village. It was difficult to determine how much it costed the private water kiosk developers to extend water supply service to the village. This difficulty of obtaining information arose from the reluctance on the part of private developers to discuss any matter on the topic with the author. There was also expressed reluctance of even having the water kiosk identified to outsiders. It is also not clear whether these private water kiosks were actually metered and therefore paid any water bills to City Hall. The City Commission officials in the Department of Water and Sewerage were also not able to establish facts about these private water kiosks since the meter connection number was unknown to both the author and the City Hall officers.

Figure 3-2 shows a sketch of the two types of water kiosks in the study area. Whereas a water kiosk owned by the women groups constitutes a separate unit from the residential house unit, the kiosk operated by private individuals was simply a water tap outside the owner's residential unit. Whereas the tap is outside the house unit, the control value is located within the house.

Rainwater Harvesting. In an effort towards improved water supply in the settlement, Undugu Society has initiated a programme to tap the rainwater from the corrugated iron sheet clad roofs of the residential house units. This programme was initiated in 1987 and by March 1988 a total of 19 ferro-cement ground water storage tanks had been constructed in Kanuku village alone.

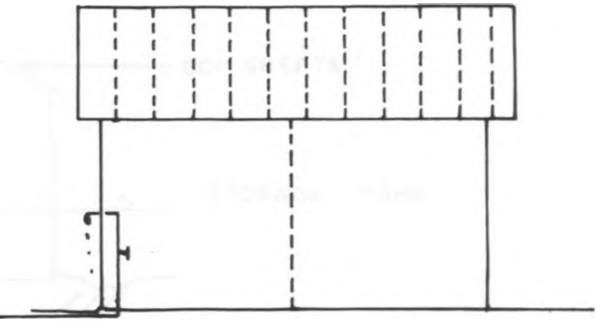
The mode of construction of the water tanks involves having a bag filled with woodshavings onto which is fitted a chicken-wire mesh. Once this formwork has been built, cement mortar is applied and allowed to set. The chicken-wire mesh acts as reinforcement material. The construction and technical work is supervised by a technician from Undugu Society site office. Figure 3-3 shows the orientation of a water storage tank in relation to the housing units. An average water tank is of 1 metre diameter and 1.5 metre high.



(a) WOMEN GROUP WATER KIOSK

FIGURE 3-2

PIPED WATER SUPPLY POINTS IN KANUKU AND



(b) PRIVATE WATER KIOSK

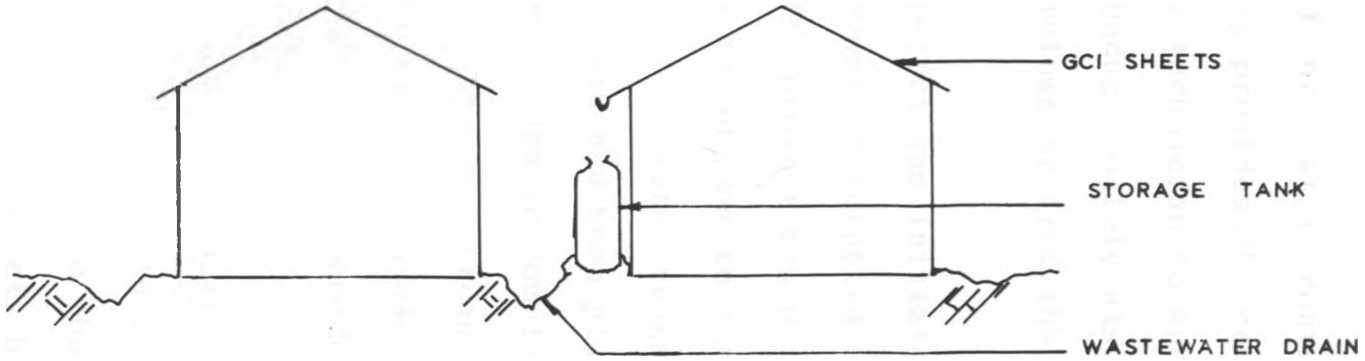


FIGURE 3.3

A WATER STORAGE TANK IN RELATION TO THE HOUSE UNIT

The household is required to buy the bags and collect the woodshavings. Each of these storage tanks costs Kshs. 960, out of which a household owner pays Kshs. 300 and the rest is contributed by Undugu Society. Undugu Society provides the cement, sand, chicken-wire mesh, and the technician to supervise the construction. In addition Undugu Society also supplies the gutters to collect the rainwater from the roof.

This project was initiated by Undugu Society in July 1987 and was anticipated to serve 40 house units in Kanuku. The project was planned to last 3 months and each tank is intended to serve 2 - 3 house units. With a target of 20 water tanks, the project has taken a longer time than had been planned for. So that it took upto March, 1988 to complete the construction of 19 water tanks. The main reason put forward to explain the delayed implementation was the limited funds on the part of the consumer households.

Development of the Water Service An important ingredient in the attempt to develop a water supply system in the study area is shown by Undugu Society. As an aid agency, Undugu Society has always insisted on the consumer population participation in the development of a water supply in the village. For example, in extending the piped water supply into the village, the

resident households are required to form registered women groups. These are the groups that Undugu society works with as a team to identify and implement plans for developing a water supply in the study area as presented in the previous sections of this research. This strategy is reflected in the cost-sharing approach, for Undugu Society believes in assisting households that show initiative to help themselves.

As part of the overall strategy of developing self-responsibility among the resident households, Undugu Society has encouraged the various women groups who own water kiosks to operate and maintain them all by themselves with limited external assistance. In order to achieve this objective, Undugu has introduced a business programme that educates these women groups on how to keep records on water sales. So far the performance of these women groups in running the water kiosks has been good. The water kiosks have been able to generate enough revenue to repay the loan advanced by Undugu Society; the water bills are paid at City Hall; the water kiosk attendant is paid; and the individual women group members earn some income from the water sales.

Water Supply Problems

The problem of water supply within the study area is perceived by the households to fall into two categories:-

- the high cost of the water; and
- absence of facilities where washing and bathing could be done.

Water Charges:- From the survey interview and informal discussion with the households, there is a general feeling that the charges at the water kiosks were too high. The price charged at the water kiosks is at a rate of 30 - 50 cents for 20 litres of water. 78 per cent of the sampled households felt that water is a public good that ought to be supplied free of charge just like in the neighbouring estates of Majengo, Gorofani and Shauri Moyo. When asked about the need for an improved water supply, 94 per cent of the sample households felt that this was necessary but that the cost of development should be borne by the landlords and the City Commission. The provision of more communal water-points, well distributed within the village, is a preferred strategy among the residents rather than individual connections; the reason given for this preference was the high cost of developing an individual water connection.

Absence of Facilities:- All the households that were interviewed expressed the hardship they face as a result of inadequate or absence of water facilities in the village. Throughout the entire settlement of Kanuku and Kinyago there was no facility provided for the family washing and bathing. As a result adults are forced to travel far into the neighbouring estates to obtain these services. 63 per cent of the sample households indicated that adults are forced to take a bath either within the house or just outside the house late at night. Three heads of households lamented that they prefer taking a bath at their places of work in town. As a response to this problem of absence of facilities, 7 households out of the sampled group have actually made makeshift bathing space along the narrow paths running next to their houses. This bathing space is secured by blocking the once-throughway passage.

During the discussions with the residents in the village it became apparent that lack of these facilities has limited the degree to which personal body hygiene could be kept; the number of days that a bath is taken is often limited to the weekends. For those people working in distant places like Industrial area and in town, it becomes difficult to use bathing facilities in the neighbouring estates at night after duty. This is because of the risk of being attacked by thugs, either

on the way or within the precincts of the ablution block. The risk of attack is made worse because of inadequate lighting. The utility of these facilities in the neighbouring estates is also reported by the residents to be poor because they are poorly used and managed. The poor usage and management of these facilities may also explain the high incidence of people preferring to do their washing and bathing within the house even if no facilities were available either.

Sanitation Service Development

By definition waste is that which is perceived to be of no use to the producer, presently or in the future. The first reaction of man towards any waste is therefore the disposal of the waste - out of reach by senses of feeling, sight and smell, if not out of mind. The presence of waste within the immediate environment within which man lives can therefore be best described as unacceptable to his ultimate aspiration. It is no wonder then that residents find life within unplanned urban low-income settlements totally unacceptable as far as sanitation is concerned. As one elderly man lamented in Kinyago village, "there is not even a right to free air".

This section on sanitation looks at the types of

waste produced in the villages of Kitui, Kanuku and Kinyago; this constitutes an appreciation of the demand for sanitation service. This is then followed by an assessment of the supply of these sanitation services to meet the demand; in this respect an analysis of the methods of handling the waste and the development of sanitation programmes is made. Finally, presented is an appreciation of problems experienced due to inadequate development of sanitation infrastructure.

The Demand for Sanitary Services:-

The demand for sanitation service infrastructure is reflected in the amount and types of waste produced in the study area. An analysis of the waste produced will therefore serve to present a case for sanitation service demand.

Human waste :- A survey through the villages of Kitui, Kanuku and Kinyago reveals that the disposal of human waste presents a most difficult situation among the residents. With a population of 3,057 people in Kanuku and Kinyago village, there is no formal toilet facility in the settlement except three unserviceable pit latrines in Kanuku and none at all for the larger village of Kinyago (Figure 3-1). As a result there is widespread defecation all over the

settlement on the open ground. The presence of human waste all over the place poses a lot of strain on the residents. Besides health and environmental hazards, the mere presence of human waste around the homestead makes the household feel socially dejected. The feeling of social dejection is reflected in the manner the residents received outsiders and their reluctance to discuss issues concerned with human waste disposal.

During the questionnaire interview one head of the household in Kinyago village pointed out the fact that a home was not complete without a toilet facility; while another lamented that they were not even accessible to 'God-given' free air because of the persistent pungent smell in the air. It is no surprise therefore to note that over 83 per cent of the sample households indicated the provision of toilets to be a top priority - Table 3-7.

Table 3-7

Distribution of a Priority Service Among Sample Households in Kanuku and Kinyago

Priority Service	Percentage of sample households
Toilet facilities	83
Water supply	17
Roads	0
Electricity	0

Indirect participant observation showed that during the day defecation is restricted to the open space along the Nairobi river (Figure 3-1). For the children, any open space within the village is readily available especially at the sites where the rest of the refuse is dumped. The open stormwater drains are also target spots for defecation.

As for the adults the situation is more agonizing and the problem takes different facets depending on the time of day. During the daylight hours adults have to travel deep into the vegetative growth along Nairobi river to relieve themselves; others have to travel over 500 metres to reach toilet facilities in Majengo and Shauri Moyo. Due to lack of privacy, one elderly

man confessed that he has been forced to keep a tin in the house for use during the day as he cannot travel far to reach the toilets in the neighbouring estates. The contents of the tin are latter emptied outside at an opportune time. This disposal strategy is preferred to being seen in the actual act of relieving oneself in the open. The important thing to appreciate here is how human psychology is being applied to beat the problem of lack of privacy during the day.

During the night the problem of lack of toilets takes a different dimension related to safety. For one there is the danger of being attacked by thugs if one tried to use the toilet facilities in the neigbouring estates. There is also the risk of inflicting self-injury if one tried to move along the dark and narrow paths between the congested house units. Besides the danger posed by the low-lying roofs, the paths often constitute open gulleys along which wastewater and refuse collects. There is therefore a high incidence of defecation on the open ground around the houses at night; the defecation is organised in such a manner that the human stool is deposited as nearer as possible to the neighbour's doorstep but then as far as possible from ones own doorstep.

Wastewater generation:- It should not be difficult to appreciate the fact that much of the water that is consumed by a household ends up as wastewater. Sullage is that waste water generated from domestic activwties and excludes the human body waste of faecal and urinal origin. Sullage is also known by the term 'grey' water. This means that sullage is generated from food preparation, washing of household items and general washing activities. Wastewater is a combined mix of sullage and human body faecal and urinal matter produced by a household.

The field survey indicates that most of the washing is done within and around the house precincts. From the sampled households in Kanuku and Kinyago, 89 percent of the households attested to the above fact. It may suffice to mention here that the proportion of the water consumed by a household that ends up as wastewater could not be ascertained with any degree of accuracy in this present research work. But it would be sufficient to appreciate the fact that for a water supply connection having a water closet within the house, 80 per cent of the water consumed ends up as wastewater (Design Manual For Water Supply in Kenya, 1986, p.86). It therefore follows that the proportion of the water that ends up as wastewater in the study area, where the

level of water service is low and with an earth floor - is less than 80 per cent. Since there is no provision made to handle wastewater produced within the study area, all the wastewater is emptied onto the open ground and drains around the houses. It would however be appreciated that since no organised system of disposing the wastewater exists in the study area, a lot of this wastewater collects and accumulates in the open drains in the settlement (Plate 3-1).

Solidwaste:- The quantity of solid waste produced in the study area was difficult to determine during the short field survey time. Even for the City of Nairobi, no report gives an accurate figure for the quantity of solidwaste produced in the City; if anything, the figures given merely indicate the quantity of solidwaste collected by the City Cleansing Section, a figure which is certainly not the same as the quantity of solidwaste actually generated. For example, a paper by Mwaniki estimate that low-income urban settlements in Nairobi produce 0.89 Kg. of solidwaste per capita per day; a solid waste project undertaken by the Ministry of Local Government gives an average per capita solidwaste production in Nairobi at 0.375 kilograms per day as at 1988 (Kenya Waste Project, p.175). At the same time, a study carried out by the United Nations Development Programme estimates

PLATE 3-1

ACCUMULATION OF SULLAGE IN THE OPEN DRAINS

the production rate in Nairobi to be 1.36 kilograms per capta per day as per 1988 (Nairobi City Commission, 1984).

The above shortcomings notwithstanding however, this research work needs to point out that the field survey reveals that much of the solidwaste produced in the study area is dumped in the wastewater drains and at the large dumping sites located along the periphery of the settlement (Figure 3-1). The composition of the solidwaste produced indicates dominance of ordinary paper, polythene paper, cooking oil tins, human faeces, and meat bone. There is very little food left-overs. The solidwaste is often wet as a result of mixing with wastewater. Table 3-8 gives the composition of domestic solidwaste collected from a similar unplanned low-income urban settlement in Nairobi. From Table 3-8, it is obvious that a high proportion of the solid waste is made of biodegradable matter, with vegetative matter standing at over 76 per cent.

Table 3-8

COMPOSITION OF DOMESTIC SOLIDWASTE COLLECTED IN MATHARE

Component	Percentage Composition
Perishable vegetable matter	76.50
Paper and Cellulose material	10.65
Plastic and Rubber	5.32
Non-classible fine material	3.55
Aggregate material (glass, stone, etc.)	2.39
Metallic Material	1.33
Toxic Material	0.26

Source: Kenya Waste Project, p.46.

26 per cent of the sample households indicated that they occassionally burnt their solidwaste. A physical survey of the settlement actually indicate that burning of the solidwaste is not widespread, and dumping of the waste on the open ground and drains is the general trend. Plate 3-2 shows one such dumping spot located next to the houses in Kanuku Village.

An interesting aspect related to solidwaste management did reveal itself during the field survey in Kanuku and Kinyago. Some of the open space that

PLATE 3-2

A SOLID WASTE DUMPING SITE

constitute a frontage to the residential houses is exceptionally clean; when further inquiries were made by the author, the responsible households pointed out that they worked as a group to maintain this frontage space clean. No one who shared this common frontage space was allowed to dump waste on it.

Development of Sanitation Services:-

So far an assessment has been made of the demand sanitation service in the study area. To complete the picture, it now becomes necessary to look at the supply side. A general statement that can be made from the analysis so far given is that the supply of sanitation service is inadequate to meet the demand. Does this mean that no efforts have been made to this end? This is the central area of investigation in this section of the research.

Location and Construction of toilets:- At the time of conducting the field survey there was no servicible pit-latrine in Kanuku and Kinyago villages, except 3 abandoned pit latrines next to Kanuku village (Figure 3-1). From the household interviews, it was revealed that a number of pit-latrines had initially been built by individual households in the open space along Nairobi river. The first pit-latrine that was

constructed - with the assistance of Undugu Society - had its pit walls cave in overnight after the completion of the superstructure. The main reason that was given by the residents was that the soil structure was weak and this was made worse by a high water table that was within 0.5 metres depth. Therefore, the pits were rarely more than 1.5 metres deep. Besides the unstable soil conditions, the residents also complained that many pit-latrines had been washed away by the flood waters of Nairobi river.

In what appears to be the exercising of socio-economic forces discussed in Chapter Two, the residents of Kinyago complain that the open space along Nairobi river that had been set aside for the construction of pit-latrines has now been taken over by more powerful people from within and without and converted to the cultivation of vegetables and a tree nursery. Efforts to lodge complaints to the village committee and the local administration chief have been fruitless. Throughout the entire settlement of Kitui, Kanuku and Kinyago, although some land had been set aside for the construction of toilets, this land has eventually been taken over by residential house units. This has either been through the demolition of existing toilets or taking over land set aside for toilets. When this phenomenon

was investigated further, the general impression was that the provision of residential house units was a priority over toilets.

Types of toilet in the study area:- Besides the common pit latrine, a rather 'interesting toilet is found in Kitui village. There is an open sewer discharging a lot of waste water from the direction of Pumwani Maternity Hospital into Nairobi river and passing through Kitui village. Near its outfall, the sewer has developed into a deep and unlined gulley above which incredibly genius households have constructed 'suspended' latrines. Figure 3-4 shows a sketch of the types of toilets in the study area. The 'attractive' aspect of the whole idea about these suspended toilets is that the human waste is carried away by the waste-water below and discharged into Nairobi river. Bathing is also carried out within these 'suspended' latrines. The Plates 3-3, 3-4, and 3-5 show the sewer and the toilets described. Notice the proximity of the sewer and the toilets to the residential house units and the structural safety to potential users like children. By and large, the faecal matter in the two types of toilets in the study area are exposed as shown in figure 3-4.

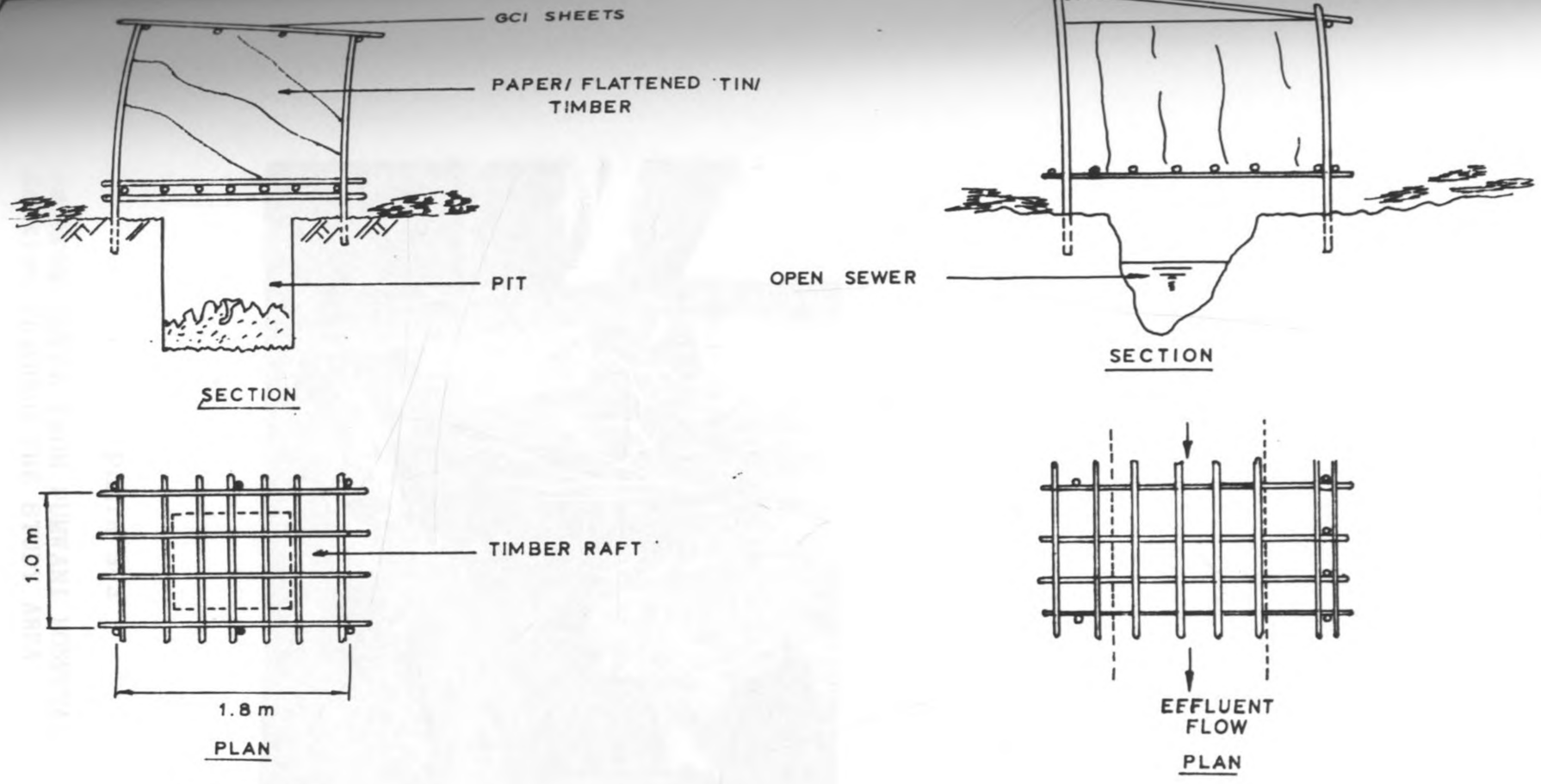


FIGURE 3.4

TYPES OF LATRINES IN THE STUDY AREA

PLATE 3-3

AN OPEN SEWER FROM PUMWANI HOSPITAL
RUNNING THROUGH THE STUDY AREA

PLATE 3-4

SUSPENDED BRIDGE TOILETS OVER AN OPEN SEWER

PLATE 3-5

A LINE OF SUSPENDED BRIDGE TOILETS NEXT TO RESIDENTIAL HOUSES

Trends in the development of toilets:- Undugu Society has continued to play a central role in the development of toilet facilities in the study area, especially in Kanuku and Kinyago villages. Just as Undugu society has assisted in extending a water supply to the study area, the same can be said of toilet development. As part of the overall upgrading programme presented earlier, Undugu planned and set aside some open space for the construction of toilets. This open space was along Nairobi river. But as a result of frustrations enumerated above, Undugu did identify a suitable open space along the trunk sewer line next to Mathare estate. Unfortunately once again, the field survey indicates that much of this space has been taken and given way to the development of more residential house units; infact, high-rise flats have been built on this space as part of the expansion pressure from Mathare estate. From the other side of Kanuku and Kinyago, residents are putting up new house units and kiosks in the open space along the sewer line. Undugu society field office points out that since the actual power to implement any development in the settlement is vested mainly in the village committees together with the local administration chief, the implementors found it a priority to satisfy the demand for house units over the provision of toilets.

The cost of development of toilets in the study area is shared between Undugu Society and the resident toilet owners. Any resident who wishes to construct a toilet in the study area usually seeks for financial and technical aid from Undugu Society. Besides providing the basic building material, Undugu also has a technician in the site office to assist in toilet construction. Below is a breakdown of the costs of developing a single pit latrine in the study area (Table 3-9).

Table 3-9

COST OF PIT-LATRINE CONSTRUCTION

Item	Contribution in Kenya Shillings	
	Undugu	Resident Owner
2 beams @ Kshs. 50.00	100.00	
6 sub-beams @ Kshs.20.00	120.00	
14 poles @ Kshs.15.00	210.00	
2 drum sheets @ Kshs. 75.00	150.00	
3 GCI sheets @ Kshs.85.00	255.00	
(Supervision staff)	*	
	835.00	
4 sideboards @ KSh.75.00		300.00
1 door @ Kshs.200.00		200.00
10 foot pit @ Kshs.30.00 per foot		300.00
labour (unskilled)		180.00
		980.00
Total	1815	

Undugu Society site office points that the development of pit latrines along the flood plain of Nairobi river is being made as a temporary measure because now the ultimate plan is to develop 10 sewered toilet blocks along the trunk sewer line next to Biafra estate. The proposed toilet blocks would each have twin 12-toilet units combined with a bathing space. Although approval for the project indicates positive response from City Hall, the cost of the project is estimated to be well above Kshs. 900,000 although it would just involve making a connection to the sewer line. Raising of this amount of money is the problem facing Undugu Society and the residents; City Hall will not contribute a cent though it may allow the connection to the sewer line.

Sanitation Development Problems

The development of sanitation services in the study area may be said to be entirely in the hands of the residents with a little assistance from outside in the form of financial and technical aid from an organisation like Undugu Society. This aspect of cost sharing has been addressed to earlier in the Chapter. From the analysis of the demand for and the supply of sanitation services, it is clear that the development of this important service has had to face a number of problems. In this respect the development of sanitation

infrastructure may be viewed as facing the following problems:- the rising accumulation of waste; poor site conditions; low priority rating; high cost of development; and poor design and utilization of facilities.

Accumulation of Waste:- It has been noted earlier in the Chapter that the level of water supply service in the study area has risen over the years. It is no surprise therefore to appreciate the fact that increased level of water consumption only means increased level of wastewater production. In engineering design work it is often estimated that a house conncection with a water closet would generate 80 per cent of the water consumed as wastewater. As a result of poor provisions in terms of disposal of wastewater and drainage, there is widespread accumulation of wastewater in the open drains within the settlement. The situation is made even worse by the dumping of solidwaste and human waste in the drains. The accumulated waste-mix creates an eyesore besides the environmental health hazard it poses.

The sample households indicated that because of the environmental health hazard that the accumulated waste poses, efforts are often made to keep the drains well maintained. Two of the sampled households in Kinyago village were actually found by the author trying

to clean the drains. When asked about the problem of waste accumulation, all respondents concurred that it is difficult to achieve a solution unless all households co-operate in the maintenance of a sound environment. A survey through the village shows that those households located on the lower ground along the Nairobi river flood plain are worst hit because they are virtually engulfed in the wastewater that has collected from the rest of the houses on the higher ground.

The accumulated waste acts as a popular site for children to play. The waste also emits foul smell and forms a breeding ground for water and excreta pathogens like the poliovirus, salmonella typhi, E.coli (Kalbermatten, 1980, pp. 7 - 19) and vermin habitation. The problem of poor water and sanitation in the study area was confirmed by the health officers in charge of the nearby Biafra City Council health clinic that attends to mother-and-child health care. The problem of accumulated waste is made worse considering the fact that this waste is right at the doorstep as plates 3-1 and 3-2 indicate.

Poor site conditions:- The development of toilet facilities along the floodplain of Nairobi river has been hampered by the poor site conditions attributed

to unstable soil structure, high water table and occassional floods. The steep ground has also given rise to the formation of deep gulleys that, not only threaten the structural foundation of the residential house units, but pose a risk to people moving along the paths that also form the storm and wastewater drainage channels. The shallow soil cover (Figure 2-1) is easily eroded by the gushing stormwater generated by the overcrowded house units (Figure 2-2). For those households located on the floodplain, the flat terrain inhibits effective surface drainage.

Low-priority rating:- The development of sanitation services has also been curtailed by the low priority given to the development of toilets compared to the developmet of the residential house units. A number of toilets have been demolished and land set aside for the development of toilets has now given way to the development of residential house units.

High Cost of development:- To build a simple pit latrine costs about Kshs. 1,815, of which Kshs. 980 is contributed by a household owner of the toilet. Considering the fact that the household income is estimated at Kshs. 600 - 800 per month, the down-payment of Kshs. 980 required from the household before it can be

assisted by Undugu Society must certainly be too much for the poor households. This amount of money is certainly well above 2 per cent of the household income that could be spent on sanitation infrastructure (Nielsen and Clauson-Kaos, 1980, pp.23-4) as discussed in Chapter Two. Even where it only requires a connection to the existing sewer, a resident population of over 3,000 people in the study area is unable to raise a cost figure of about Kshs. 900,000 for the development of sewered toilet blocks. For a population of 711 households in Kanuku and Kinyago, this gives a cost rate of Kshs. 1,266 per household for the development of the proposed sewered toilet block.

Poor design and utility of facilities:- A reflection on the design of toilets in the study area (Figure 3-4) will indicate these facilities by themselves pose a health hazard to the users. For one, the faecal matter in the toilets is, for all practical purposes, exposed, Considering the proximity of this poorly designed toilets to the residential houses (Plates 3-4 and 3-5), these toilets become a real environmental health hazard to the resident population. At the same time the structural design of the toilets with an open floor makes them unsafe for the children.

In fact there is expressed reluctance on the part of the elderly to allow children to use the pit latrines that are situated within the study area. Like the abandoned pit latrines along the river flood-plain, they are considered unsafe for children because they could easily fall into the pit. The pit latrines are also considered unsafe for children use because they are poorly maintained and used. Ironically, much as there is expressed desire for more toilets, the usage of these facilities by children, who may not be accompanied by an elderly person, is discouraged by parents for reasons given above. It was also implicit from the discussions with the elderly people that the poor usage of toilets is as a result of allowing children free access to the toilets. The implication of this may be obvious considering that 36 per cent of the resident population is below 15 years and that these children spend much of their time at home.

The utilization of communal toilet facilities in the neighbouring estates of Majengo, Shauri Moyo and Bahati is also rendered ineffective by virtue of poor maintenance, poor usage and the long distance to reach them. This makes these communal facilities out of reach by children and the aged. At the same

time, it becomes risky to travel and use these facilities at night because of possible injury along the poor paths and attack by thugs. Unfortunately, the demand for toilet facilities rises during the night hours because all the residents are at home and that the most common diarrheal disease tends to rise at night after meals.

Improvement Aspirations

All the sampled households indicated that there is need to provide more toilets within the study area. 57 per cent of the sample households did however express doubt over the possibility of having toilets within the crowded built-up area. There is a difference of opinion between landlords and tenants as to who has the responsibility of providing toilet facilities. The tenants feel that responsibility is with the landlords and the Nairobi City Commission. The tenants did point out however that landlords were unwilling to provide toilet facilities.

A distribution of preferances indicates that 69 per cent of the sample households preferred to have flush toilets just like all other people in the city. 82 per cent of the sampled households opted for individual toilet facilities on the basis of improved

maintenance and usage. The remaining proportion of the sampled households indicated preference for communal toilets like those found in Majengo and Shauri Moyo on the grounds that they could not afford individual toilets because of the high cost and scarcity of building space. 76 per cent of the sampled households however said that on the basis of the high cost of development and limited space, a communal facility would be acceptable if only it is properly managed. On the other hand 31 per cent of the sample households preferred a pit latrine so long as it would be well maintained.

Summary

This Chapter started off with a premise that water and sanitation infrastructure service constitute one of the basic human needs. The assessment of the demand versus the supply of these basic human needs shows that there is inadequate development of the services to meet the demand. As a basic human need, one would have expected that the development of water and sanitation service to be as a public service. The research findings however indicate that within the study area, these services have been developed largely by individual households acting either as a group or separate entities, with financial and

technical assistance from Undugu Society and with little assistance from Nairobi City Commission, if any.

It is therefore important to appreciate the fact that the low-income residents in the unplanned settlement of Kitui, Kanuku and Kinyago have taken up the initiative to develop these important basic human services. Their efforts cannot be said to be fruitless; they have managed to extend 10 water points into Kanuku and Kinyago. Unfortunately the development of these services has faced a number of problems and constraints. The poor site conditions and the high cost of development have hampered, to a large extent, the development of sanitation infrastructure; socio-economic forces seem to have given rise to the problem of developing residential house units at the expense of the infrastructural services; and worse still is the fact that the increased water service level is in itself giving rise to the ever worsening position of wastewater disposal. These factors - namely the site conditions and socio-economic forces seem to explain the state of development of water and sanitation services in the unplanned settlement. Factors influencing the development of these services is the core subject of Chapter Four.

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CHAPTER FOUR

FACTOR ANALYSIS IN SERVICES DEVELOPMENT

Introduction:

Great effort has been made by the residents of Kitui, Kanuku, and Kinyago to develop an improved water supply and sanitation service infrastructure. Great success has been recorded in the development of an improved water supply service, which today stands at 10 water supply points connected to the City water supply system, and 19 water storage tanks harvesting rainwater. Similar efforts can be registered in the pursuit to improve the sanitation service. Unfortunately, the success story in the area of sanitation has not been impressive. Attempts to construct pit latrines along the Nairobi river flood plain can be said to be thwarted; while a few toilets have been demolished to give way to the development of residential house units. At the same time, increased water level service has given rise to the ever rising problem of wastewater disposal.

What factors influence the development of water supply and sanitation service infrastructure in the study area? Four broad categories of factors may be discerned to explain the state of development of water supply and sanitation service infrastructure in Kitui, Kanuku, and

Kinyago. These are site conditions; socio-economic factors; institutional factors; and support infrastructural services. How do these factors explain the state of/ and how have they influenced the development process of water supply and sanitation service in the study area? These leading questions constitute the theme of this chapter.

Site Conditions

Either through discriminatory zoning regulations or the influence of market forces of demand for the scarce urban space or as a phenomenon of pure chance, low-income urban settlements are to be found located on sites that would otherwise be described as 'difficult' for housing development. The terrain is either rugged and steep or it is too flat and swampy for effective drainage; the soils depict poor engineering performance; and the climatic conditions could be unfavourable. Since the development of services is taking place within an already existing settlement, the settlement pattern also presents its own constraints that are to be contented with.

Terrain:

The settlement of Kitui, Kanuku, and Kinyago is located along the banks of Nairobi river. Part of this settlement is sited on the steep slopes of the rising ground while some houses have actually developed on the flood plain of Nairobi river (Figures 1-2 and 1-3).

For those houses located on the floodplain, the major problem facing them is the frequent floods during the heavy rains. These floods destroy both houses and toilets constructed on the floodplain. The houses on the floodplain also face the problem of poor drainage resulting from the accumulationg of stormwater and wastewater. For those residential units on the steep slopes, the problem is rather opposite to that facing households located on the floodplain. From Figure 1-3, the ground slope is about 1 in 9.5. This steep slope makes housing construction difficult; the problem of gulley formation is aggravated and threatens the foundations of the houses and water storage tanks (Figure 3-3). Because of inadequate stormwater drainage, water often bursts into the houses.

The seriousness of the problem of gulley formation on the steep slopes could best be appreciated from plate 4-1. The gulleys are about 1.5 metres deep

PLATE 4-1

GULLEY FORMATION ON THE STEEP GROUND

and because they are located right at the doorstep of many houses, households have been forced to construct make-shift bridges across these gulleys so as to reach their doors. The deepening gulleys threaten both the structural foundation of the houses and the safety of the residents, for the paths along which residents move coincide with the stormwater drains.

The above terrain conditions pose a lot of problems as far as the development of infrastructure services is concerned. The flat terrain along the flood plain presents a drainage problem of stormwater and wastewater besides the flood menace. On the other, hand the steep slopes makes the development of stormwater drains, latrines, and water storage tanks difficult by virtue of the ground slope and the problem of gulley formation.

Groundwater and Surface Runoff:

The problem of groundwater and surface runoff was first manifested when residents started to build pit-latrines. The location of the settlement along Nairobi river floodplain suffers from the problem of a high water-table that is within 0.5 metres. The high water-table results in having pit-latrines filled with water; it also limits the construction work as the

pits are barely more than 1.5 metres deep. The high water-table also reduces the stability of the soil. Certainly the high water-table limits the development of infrastructure services like sewers, septic tanks, and roads, besides the limitation on the development of residential house units and stormwater drains (Kalbermatten et. al., 1982, p. 42).

The problem of surface runoff in the study area presents itself in two forms. First, as a result of accumulated debris and vegetative growth along the river channel, Nairobi river often bursts its banks and destroy houses and pit-latrines along the floodplain (City Council of Nairobi, 1974, pp. 23-25). The problem of flooding is also attributed to the reduced capacity of the river channel at the downstream bridge on First Avenue Eastleigh (op. cit., p. 41).

Secondly, reference has already been made to the problem of surface runoff down the steep slopes on which part of the settlement is sited. The quantity of stormwater discharged is aggravated by the fact that the housing density is so high that alot of roof water is generated but with little open space to accommodate the high discharge of the stormwater. This explain further the formation of gulleys in the settlement.

Soil Characteristics:

The siting of the settlement along Nairobi river presents soil characteristics that are not conducive to housing development (Figure 1-1). The alluvial soil depicts poor structural characteristics with low values of the angle of friction and compressive strength; the high water-table also presents increased pore water pressure that reduces the effective shear strength of the soil. Any structural development on this kind of soil would require high investment input to stabilise and improve the engineering performance of the soil so as to avoid abnormally high differential settlement of and stress forces on the superstructure.

The instability of the soil is confirmed by the high incidence of collapse of the walls of the pit-latrines. It has also become an agonising experience to note that for a long time household effort to construct pit-latrines in these unstable soil conditions has all been thwarted because of the collapse of the walls of the pit. This is one reason that has made households lose hope of ever having a pit-latrine. Undugu Society confirmed that the first pit-latrine that was constructed on the floodplain collapsed overnight after the completion of the superstructure. The development of a sewerage system, septic tanks, and other

infrastructural development would certainly face similar soil problems.

The geology and soil survey of Nairobi indicates that the villages of Kutui, Kanuku, and Kinyago lies in a zone where the soils are black to dark grey clays forming what is commonly known as black cotton soil with calcareous and non-calcareous variants. These soils present poor engineering performance characteristics depicted in the low compressive strength, high contraction and swelling pressures, and low permeability (City Council of Nairobi, 1974, pp. 23-25). However, the upper parts of the valley slopes presents a narrow strip of murram soil that often gives way to shallow clay (Figure 1.1). The low permeability performance inhibits the infiltration of surface runoff and sullage absorption and thus giving rise to the problem of high discharge of stormwater which leads to gulley formation, and the accumulation of waste water in open drains.

Climate:

The local climatic conditions in Nairobi, and therefore in the study area, have an influence on the state of development of water supply and sanitation service infrastructure. For example, the frequency and intensity of rainfall have an influence on the development

of stormwater drainage and the subsequent formation of gulleys and the flood problem. Recent heavy rains in Nairobi indicate that over one tenth of the annual average rainfall was recorded in a single day (The Daily Nation, p. 3). Considering that Nairobi can receive 91.7 millimetres of rain over a period of 24 hours out of 900 millimetres of annual average rainfall, this high intensity of rainfall poses problems of stormwater disposal. This high intensity rainfall results in gulley formation and flooding in the study area (The Standard, p. 11). These rains certainly destroy the residential houses units and other infrastructural developments (Plates 4-2 and 4-3).

Rainfall characteristics also affect the utilization of the rainwater as a source of domestic water supply. It was mentioned in Chapter Three that residents of Kanuku have embarked on a project to tap the rainwater by the roof-catchment method. So far 19 water storage tanks have been built for the purpose. But with only 900 millimetres of rainfall per year, and with much of this rain concentrated in the months of March to May, the length of time that the water storage tanks are actually in use is very limited. Considering that the capacity of these tanks is about 1.2 cubic metres, a single household of 4.3 persons will take about 14 days to empty the tank, at a rate of 20

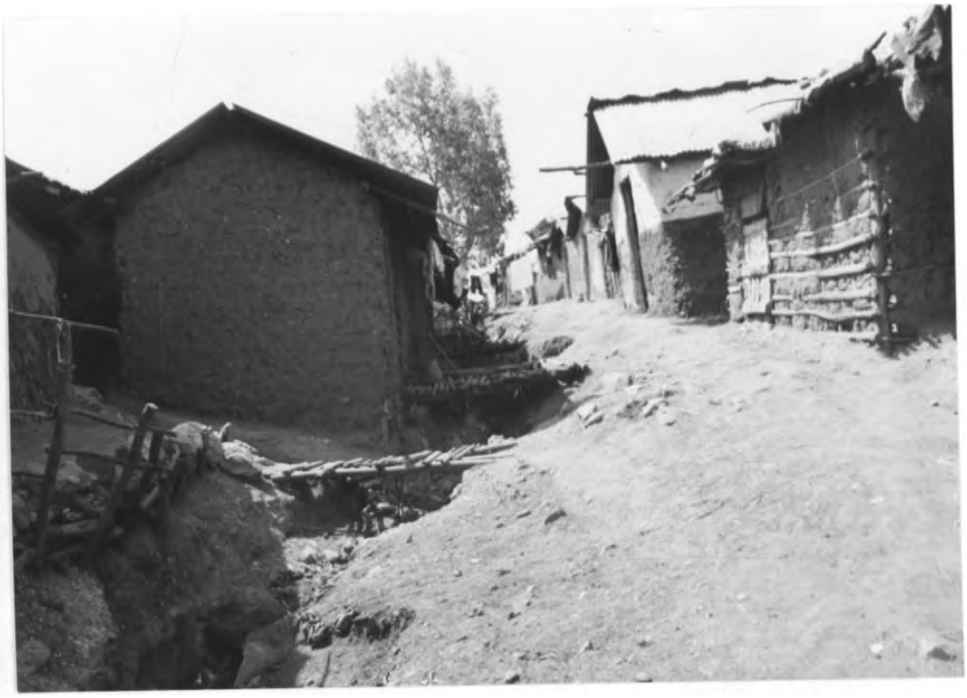

PLATE 4-2

INADEQUATE STORMWATER DRAINAGE ON THE STEEP SLOPES COULD LEAD TO GULLEY FORMATION.

PLATE 4-3

ABANDONED HOUSES ALONG THE FLOODPLAIN TOGETHER WITH A PIT-LATRINE. THE VEGETATIVE GROWTH PROVIDES PRIVACY FOR DEFECATION.

litres per capita per day. In the study area, each water tank is actually shared by 2 to 3 households, which means that the water tank would be emptied in 5 to 7 days. Because the rainfall is not well distributed throughout the year, this only means that the storage tanks are virtually out of use for most of the year. This was confirmed by 4 households sampled in Kanuku.

The local temperature conditions have also got o an influence on the state of sanitation in the settlement. With an average warm temperature of 17 - 20^{o} centigrade in Nairobi, the bacterial activity is enhanced and this is reflected in the high rate of waste putrefaction of either the undrained wastewater or the human waste scattered around the settlement. The resultant pungent smell in the air may attest to the above phenomenon.

The Pattern of Settlement:

Any development of infrastructual services in the study area will certainly be constrained by the already built-up pattern of settlement. From the layout plan, given in figure 4.1, the haphazard and congested pattern of settlement leaves very little space along which water supply and sanitation service infrastructure could be developed, leave alone other supportive services like paths along which people move.

There is barely any open space left between the houses. This factor of limited space for the development of infrastructural services was alluded to the Chapter Three during the formal discussions with the households in the area. As a consequence of the congested and haphazard pattern of settlement, there is very little space left to drain away the excessive runoff that drains off the corrugated iron roof cladding and this results in the problem of undrained runoff and wastewater. The unplanned nature of settlement also results in the formation of gulleys that often burst and lead stormwater into the residential house units. Plate 4-4 shows typical problems that arise as a result of congested pattern of settlement.

The congested and haphazard pattern of settlement presents a real problem in the disposal of waste. It is along the inaccessible and narrow passways that waste is dumped. Whereas the resident community has managed to extend the water supply lines into the study area, it has proved impossible to do the same with sanitation facilities like toilets. The alignment of the house units in relaton to the ground slope is such that stormwater is allowed to run directly down the slope (Figure 4-1). This alignment increases the velocity of the stormwater discharge to excessive levels and thus giving excessive energy to the runoff to erode the soil and form gulleys.

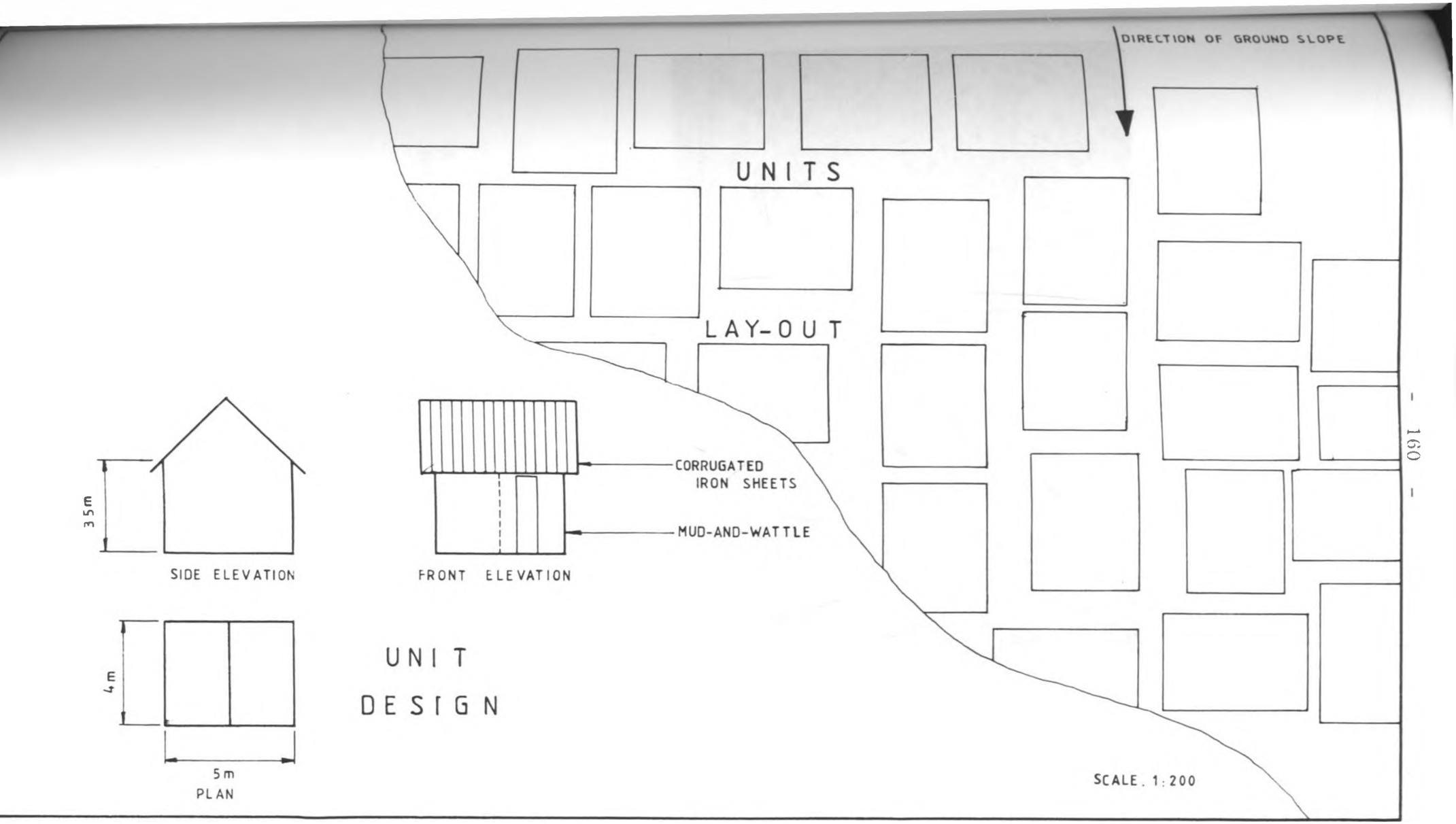

FIGURE 4-1

A TYPICAL PATTERN OF HOUSE UNITS ALIGNMENT

PLATE 4-4

A TYPICAL NAPROW PATH IN THE VILLAGE WITH OVERHANGING ROOFS AND ACCUMULATED WASTEWATER IN THE GULLEYS.

Socio-economic Factors

It was argued in Chapter Two that the way of life and the state of development of a community is more of a reflection of the underlying socio-economic forces that model peoples destiny. It is on this premise that this section of the thesis wishes to assess the influence of socio-economic factors on the development of water supply and sanitation service infrastructure in the unplanned settlement. The socio-economic factors that are analysed include:- population parameters; levels of education; household income; housing tenement system; and investment and management parameters.

Population Parameters:

The sampled villages of Kanuku and Kinyago have an estimated 711 households made up of 299 resident landlords and 412 tenants. Table 4.1 gives the household size distribution of the sampled households.

Table 4-1

HOUSEHOLD SIZE DISTRIBUTION OF THE SAMPLE HOUSEHOLDS

Household size	Percentage of sample Households
1 - 3	37
4 - 6	42
Above 6	21

The above household size distribution gives an average household size of 4.3 persons. With an estimated household number of 711, the total human population in the sampled villages of Kanuku and Kinyago is about 3057 persons as per 1987. The sample households had an age distributin given in Table 4-2.

Table 4-2

AGE DISTRIBUTION OF THE SAMPLE HOUSEHOLDS

Age in years	Percentage
Upto 15	36
16 - 30	36
31 - 45	21
Above 45	7

From the above analysis, it is clear that a good portion of the sampled households had a resident population below 30 years of age, with half that sample having children below 15 years. The analysis in Chapter Three reveals that the demand for water supply and sanitation services have alot of bearing on this young population. With inadequate supply of sanitation services for example, this young children have resorted to open ground defecation - a situation which endangers most - the health of the same young children. These children find the undrained wastewater and the dumped solid waste an ideal site to play. The same young and majority of the population is not allowed to use the few toilet facilities that are available in the study area and is accused of poor usage or misuse of facilities.

With a service of 1 toilet for over 1000 people the stress over the use of these facilities is certainly very high. This high demand has resulted in the resident population giving top priority to the development of toilets; whether their efforts have paid dividends or not is not a matter of concern at this stage. At the same time, the amount of water consumed by a resident population of 3057 people has resulted in the ever rising problem of wastewater disposal.

All the sampled households were of a christian faith, with literacy levels rarely exceeding primary level of education (Table 4-3); 82 per cent of the households had less than 9 years of schooling. From Table 4-3, it is clear that with such a high portion of the population having less than 9 years in school, the level of understanding environmental issues must be very limited. A proper usage of a water supply and sanitation facilities actually requires an educational input in order to achieve the ultimate goal of improved health. Indirect participant observation in the study area shows, for example, that clean water is often collected and stored in open containers.

Table 4-3

DISTRIBUTION OF LEVELS OF EDUCATION

Year in School	Percentage of the sample population
0 - 4	44
5 - 9	38
10 - 14	18

Incomes:

The determination of the household income in the study is not an easy thing. This is because of the nature of employment activities that the resident community is engaged in. 86 per cent of the members of the households sampled indicates being engaged in either self-employment informal activities within the settlement and in the neighbouring estates or are engaged as casual workers in industrial area, the city centre, and Gikomba area. The determination of household income based on the above employment pattern must indeed be difficult (Jørgensen, 1977, p. 22). Another problem that arises is that which is of direct relevance to the research work: what proportion of the household income is the household willing and able to pay for housing, let alone that portion spent on water and sanitation services.

38 per cent of the sample households that were able to determine their incomes give a monthly income level of Kshs. 600 - 800, as an average for a household. Levels of income of the households act as a good indicator of the effective demand for water supply and sanitation service infrastructure. One major constraint to the development of infrastructual services is the high cost of development and operation (Kalbermatten et. al. 1982, p. 43; Subrahmanyan and Cvjetanovic, 1986, pp. 83-84;

Breese, 1966, p. 123, p. 143). In Chapter Two it was argued that the urban low-income could only afford to spend 15 per cent of their income on housing, out of which 2 per cent of the income will constitute expenditure on sanitation infrastructure (Nielsen and Clauson-Kaas, 1980). With the prevailing rents in the settlement going for anything between Ksh. 200 and Ksh. 250 per month, the household income spent on housing (housing without infrastructural services of any form) is well over 15 per cent of the household income; the household income spent on housing without services in the study area is therefore above 30 per cent. Presently, a household spends over 4 per cent of its income on water alone when the computation is based on a per capita water consumption of 10 litres per day at a price of 30-50 cents for 20 litres of water. It is therefore not surprising to appreciate the complaint by the residents over the high cost of water; those whose income is limiting, travel to neighbouring estates to obtain free water at the communal water points.

In developing and extending the water supply service into the settlement, the low-levels of income have inhibited rapid development of the service. To this effect Undugu Society has stepped in to assist the households with financial aid. Under the cost-sharing strategy, Undugu Society reports great difficulties on the part of the

households to meet their obligations. On the same token, the inability of the households in Kanuku and Kinyago to raise enough money has stalled the development of a sewered ablution block.

Tenement System:-

The housing tenement pattern has a bearing on the development process of water supply and sanitation service in the study area. With a tenant occupation rate of 58 per cent of the households sampled, this factor majors strongly in decisions on the development of services. Although there is total agreement by all households that infrastructure services in the settlement need to be improved, the tenants feel that the development responsibility lies on the landlords and the Nairobi City Commission. Unfortunately, neither the landlord nor the City Commission is ready to undertake such a project; for the landlord the low income returns and lack of land tenure security make such an investment unattractive; on its part, City Hall regards the entire settlement as contrary to its housing programmes and therefore has no responsibility to develop it.

Investment and Management Parameters:

An important question that was posed to the residents by the author relates to the development of water supply and sanitation service infrastructure, as a central ingredient in housing development. It is clearly mentioned in Chapter One that one aspect which makes the study area be termed on 'unplanned settlement' is the absence or inadequate development of infrastructural services like water and sanitation.

The high prevalence of poverty within the settlement naturally dictates that only very basic needs will attract the attention of the residents. The very basic needs of man include food, shelter, and clothing; water being regarded as a category under food (McAllister, 1980, p. 17). When the question was put to the residents as to why no space had been set aside for the development of water and sanitation service infrastructure, the general reply was that the house structure unit - where one sleeps - is a top priority (Page and Seyfried, 1970, p. 2; WHO, 1964, p. 1). The indications by the households is that the house could easily be let out to augement family income. This phenomenon is confirmed by the high incidence of sub-letting in the settlement, even though a residential house unit is barely enough

for a single room. In such circumstances, the setting aside of space for services is rather secondary. This fact was confirmed by the village committee and Undugu Society as outlined in Chapter Three. Any land that might have been set aside for services development has over time, given way to the development of more residential house units.

It is also a general feeling among the residents that after all the responsibility of developing services is in the hands of the local authority at City Hall. As a public good or service the households do not feel fully responsible for the development of services. It is however important that, the above notwithstanding, the residents have tried what they can to develop a water supply and sanitation service, though with limited success.

The manner in which water supply and sanitation service facilities are managed has got a definite influence on the state of water and sanitation development in the study area. The poor usage and maintenance of toilets and the open stormwater drains has inhibited subsequent efficient usage by children and the rest of the people. Even the toilet facilities in the neighbouring estates of Majengo, Bahati and Shauri Moyo

may not attract as many users because of poor maintenance. These toilet facilities, that are often used by residents of Kitui, Kanuku, and Kinyago, are poor managed so that they pose a worse health hazard than having no facility at all (World Health Organisation, 1964, p. 111). Lack of security at these common toilets, especially at night, presents a difficult management problem.

When a comparative survey was made to assess the management of the communal waterpoints in the neighbouring estates and those water points within the settlement - the privately - owned and operated water kiosks in the study area, it becomes apparent that the privately owned water points are well managed and do not waste excessive water by leaving the tap running or through indiscriminate excessive water use.

A rather interesting phenomenon is revealed in Kanuku and Kinyago villages. Residents who share a common open space frontage have taken to closing the throughway paths so as to limit access to a well defined frontage. The main reasons given for this action is to improve security and proper sanitary maintenance of the common frontage space. Those sharing this defined frontage space have organised themselves to ensure proper sanitary maintenance of the space.

Support Infrastructural Services

Working within the concept of a 'minimum infrastructural service package' in housing, it would be recognised that an efficient water supply and sanitation service needs to be supported by other infrastructural services like roads, lighting, drainage, community education, community participation, and security. When the respondents were asked to prioritise the development of infrastructural services in terms of acuteness of the problem, disposal of human waste stands out as an area requiring emergency attention (Table 3-7). This does not however mean that the other infrastructural services like water, roads, and electricity are not necessary; in fact, effective utilization of water supply and sanitation service need the support of other infrastructural services.

Roads:

For purposes of this research work, a 'road' is used to refer to any passway providing access within the unplanned settlement. It has already been pointed out earlier in the chapter that housing development in the study area is largely haphazard and overcrowded with hardly any space left for movement through the village. Many of the paths in Kitui, Kanuku and Kinyago are barely 2 metres wide between adjacent walls of the house units.

The same narrow paths are overhang with low-lying roofs which forced people to move carefully along the paths (Plate 4-5). The hardship encountered while moving through these narrow paths often forces the residents to dispose of their waste every close to the houses thus creating a poor sanitary environment.

Movement along paths like those shown in Plates 4-1, 4-2, 4-4, and 4-5 can actually be an agonising experience; the roofs are very low and overhanging; the paths coincide with the formation of deep gulleys which also act as a collection point of undrained solidwaste and wastewater; and the paths run directly up steep ground slope. Movement along these paths can actually be difficult during the wet season and at night. Accessibility to water supply points and sanitation facilities is largely inhibited.

From the sampled households 57 per cent of the respondents felt that the existing roads running through the neighbouring estates are not too far away for purposes of obtaining transport service to the rest of the city. The rest of the sampled households consider it important to provide roads within the settlement just like other residential areas in Nairobi. The main reasons advanced by those who consider the development of vehicle-carrying roads in the study area as not of major

PLATE 4-5

WALKING THROUGH THE NARROW PATHS CAN BE AGONISING

priority include scarcity of land, safety of children, and the fact that they don't find walking to distant points to be a problem as such.

Lighting:

Closely related to the road problem is the aspect of adequate lighting at night. From both formal and informal discussions with the residents in the study area, it became apparent that poor lighting was more of a problem inhibiting movement through the village rather than lighting within the house. With the kind of road system described above, movement through the village at night is an ordeal in the absence of adequate lighting. Besides injuring oneself, movement through these narrow paths at night poses a risk of being attacked by thugs.

The absence of lighting provision at night means that accessibility to water and sanitation facilities is curtailed. The absence of electric lighting in the communal ablution blocks in the neighbouring estates is identified by the residents in the study area as one factor that inhibits proper use at night. Besides the risk of being attacked in the dark toilets, the absence of adequate lighting results in poor usage by those who manage to reach the toilets; in this

case users relieve themselves on the toilet floor which is as close as possible to the toilet exist - just in case of any possible attack. The paradox of the matter is that once a toilet facility is put to poor use by the first user, subsequent users are forced to be less civil in the use of the same facility.

Public Health Education:

Maintenance of a sound environment depends, to a large extent, on public health education. Public health education will determine the standard of personal hygiene, maintenance of a sanitary premises, and practices in the disposal of waste. For example, clean piped water that is collected from the communal water-points in the study area is often collected and stored in open containers. Chances are that this clean water is actually contaminated by the time it is actually consumed. Therefore the mere provision of a clean water supply may not be able to achieve the ultimate goal of improved health unless the supply incorporates a programme of health education.

A proper sanitary practice of disposing of human faecal matter plays an important role in combating and controlling the spread of pathogens responsible for many water and sanitation related diseases (Kalbermatten et.al.,

1980, pp. 7-19). The achievement of a proper sanitary environment requires a community well versed in public health education. It is important to note that it is not merely the knowledge that is crucial but the putting of the knowledge into practice. The practices of faecal matter disposal, the design and maintenance of the sanitation facilities, and use of the same facilities by the residents would suggest otherwise. The discouraging of children to use toilets simply because the children misuse the toilets may of course not be the best option available because the same children end up defecating all over the place and thus causing another equally dangerous health hazard.

To the extent that two resident landlords were eager and proud to show the author the efficient 'suspended toilets' built on the open sewer raises a fundamental question of public awareness of environmental implication of discharging raw sewage into the open sewers and the subsequent discharge into Nairobi river. When pressed further, the above landlords indicated that Nairobi river is already polluted from upstream in the City Centre and therefore their act is of no consequence.

Institutional Influence and Community Participation

The World Health Organisation recognises the improvement of human health as the societal ultimate goal and that an improved water supply and sanitation service play a central role towards attaining that goal (WHO, 1964, p. 31; WHO, ETS/83.7, p. 3). At the same time community participation has been identified as a valuable force in the improvement of housing conditions and the general environmental health.

The villages of Kanuku and Kinyago have each a village committee that oversees the development of water supply and sanitation service in the village. In organising the community to extend a piped water supply into the village, in the construction of water storage tanks and the pit-latrines. Undugu Society has always insisted on working with community groups through the village committees. Six out of the ten water kiosks in Kanuku and Kinyago are owned and run by registered women groups. As organised community groups, the residents in the study area have been able to obtain assistance from Undugu Society, UNICEF, and even some form of recognition by the local provincial administration and the Nairobi City Commission. This recognition of community groups by donor agencies and the local administration has enabled the community to get financial and technical assistance, besides an improved

form of security of tenure. For example, the community has been assured by the local provincial administration that they will not be evicted unless alternative site is provided. It has therefore become clear from the field survey that, as individuals, households in the village can not afford to effectively develop water supply and sanitation infrastructure. As individual households in the unplanned settlement, it is difficult to get connection access to public utilities like the City Water Supply System and the sewer lines. But as an organised community groups, the residents have been able to reach government and non-governmental aid agencies.

In Kanuku and Kinyago where stronger community group organisations exist compared to Kitui, it is possible to discern differences in the level of housing conditions. For one, the standard of sanitation and the development of water supply is higher in Kanuku and Kinyago compared to Kitui. In Kanuku and Kinyago, households have identified themselves with defined frontage space around their residential units and efforts are made by the same households to keep the surroundings clean. Three of the sampled households were actually found clearly the blocked stormwater drains and disposing of the solidwaste at the dumping sites. Therefore for these organised households, the problem of

solid waste was manifested at the dumping site where it was never collected - and not at the household production point. As two heads of household revealed during the field survey, maintenance of wastewater drains is a difficult job unless the whole community acts as a group rather than as individuals.

What has the participation of the local provincial administration had on the development of water supply and sanitation service? For one, the local administration has made the community in the study area more committed to investing in improving housing conditions. Because of the assurance from the local provincial administration that they will not be evicted without alternative site being given, the residents have started to invest in water storage tanks and the participation in the proposed sewered ablution blocks. At the same time, the local administration has helped the residents be more accessible to City Hall so as to connect to the City Water and Sewer Lines in the neighbourhood. The Nairobi City Commission, on the other hand, appears to agree to an improved development of services in the study area but only at the expense and initiative of the local community. This must be much of a dissappointment to the residents who feel that the development of water supply and sanitation service is a public responsibility.

Summary

A synthesis-run through this chapter reveals some important elements. First, the development of water supply and sanitation service in the unplanned settlement is a phenomenon that is no domain of any one single factor. The resultant state of service development in the study area is a product of an interplay of forces - site conditions, socio-economic factors, support infrastructural services, and institutional and public participation variables. An effective development of water supply and sanitation service infrastructure requires input from the various factors analysed above and the same factor inputs working together as a package.

The development of one service infrastructure with undue disregard to other housing demand variables will only result in the deterioration of the general environment, the result of which is a self-destructive chain reaction of events. For example, the development of an improved water supply service that is not accompanied by effective sanitation and public health education programmes could in itself create a worse problem than that which was initially intended to solve. The same can be said of inadequate and poorly designed sanitation practices.

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CHAPTER FIVE

RESEARCH SYNTHESIS AND RECOMMENDATIONS

Introduction:

The stage is now set to review the research content of the whole work in the light of the research problem and objectives so as to 'stitch together', as it were, ideas contained in the first four chapters. This will constitute a synthesized frame of thought from which recommendations and models are to be derived in line with answering the second research objective. The last point of argument presented in Chapter Four is that the development of water supply and sanitation infrastructure services in the study area is an interplay of a number of factor inputs. It is the suggestion of the author that this synthesis and proposal chapter be tackled along the same line of thought, for it is uncommon to have a single answer to a multi-faceted problem.

For purposes of logical synthesis, this chapter has been divided into a number of sections, each of which tries to address itself to the factor inputs that influence the development of water supply and sanitation service infrastructure in the unplanned settlement of Kitui, Kanuku, and Kinyago. The synthesis section is then followed by recommendations and design models.

In making recommendations and design models, the divide is two tiered - those of specific application to the study area, and those of general application elsewhere.

Planning Implications

This section of the thesis looks at the research findings as contained in the previous chapters and then discusses planning implications of these findings. These planning implications constitute the input in the subsequent recommendations made in the thesis towards an improved approach of developing infrastructural services of water supply and sanitation in the study area and also in other similar settlements elsewhere. For a more effective and easier run-through of the work, the section has been divided into a number of topical areas that derive from the pertinent findings that bear on the research problem. These topical areas include:- investment decisions; design and management of services; level of service development; institutional variables; site conditions; and the role of support agencies.

Investment Decisions:

Housing development can generally be viewed as an investment in the broad sense of the word. As a shell, it protects the occupant from the harsh and

adverse elements of the environment; its possesion accords the owner a sense of value and social dignity; and in a more familiar manner housing can provide an income to the owner when it is rented out. It has been revealed from the research findings, for example, that although the house space is hardly enough for a single household, subletting is highly prevalent. So that, the real and immediate aspiration of a household in the study area may not be lack of space for family occupation but lack of space to provide accommodation to potential tenants. Low levels of income in the study area may therefore explain the state of housing development in the settlement.

First, in unplanned low-income urban settlement of Kitui, Kanuku, and Kinyago villages, the development of housing is predominantly in the hands of individual households who have to rely on their own personal savings in order to build a house. Based on the 'hierarchy of needs' - and therefore priorities - a household contemplating on housing investment has to make a choice as how best to meet its needs within the available and limited resources at hand. These resources include the household income and the scarce land on which development shall take place. It has come out from the research findings that first priority is given to the development of the house structure

unit. This is because the house structure - the shell - provides the very most basic life-supporting physiological need. Besides the provision of the shell, it is also evident that the development of infrastructural services is required to 'service'' the human settlement, as it were. From the analysis presented however a case has been put forward to suggest that the development of these services of water and sanitation are of a secondary order in relation to the house structure. Considering that the development of housing in an unplanned settlement of Kitui, Kanuku, and Kinyago villages is spontaneous and in the hands of individual households - operating as individual entities within their assumed plots - the absence or inadequate supply of infrastructural services like water and sanitation may not be surprising because the households are just but being human. The priority accorded to the development of the house structure may also be explained in terms of human behaviour that is governed by the 'ends-in-view' rather than ideals. In this respect the benefits that a typical household in the study area derives from the shell are of direct and immediate consumption compared to the benefits derived from infrastructural services. The planning implication of this is that the time horizon and aspirations of residents in the study area are for the immediate concern and not the long term. This may explain why infrastructural services need to be

provided as public goods and services.

Considering the 'limitedness' of resources at the disposal of a household in the study area - a mere household income of Ksh. 600 to 800 per month, and a plot size of 4 metres long by 4 metres wide which is barely enough for one room - the household tries to maximise on those areas of higher priority benefit. Following the arguments presented previously, the household will therefore cover as much as possible of the available plot to provide maximum indoor space. This is depicted in the congested and overcrowded pattern of settlement in the study area (Figure 4-1 and Plate 4-4). When the ability of individual households to acquire water supply and sanitation service is assessed (Chapters Three and Four), it is clear that the cost is much higher than that needed in the house structure construction. The household therefore concentrates its resources on what it can achieve - 'ends-in-view' concept - rather than on the 'ideals' that may be derived from infrastructural services. In this respect, a household could easily construct a house using any available material like paper and timber that are relatively easily available and the actual construction needs the unskilled labour that is abundant. On the other hand, the construction and acquisition of water supply and sanitation services

within an urban environment requires financial and technical skills that are beyond the means of resident population in the unplanned low-income settlement. For example, efforts to construct simple pit-latrines in the study area and the efforts to connect to an existing sewer in the study area have also yielded little success because of limited financial resources and technical skills among the households.

In what may be viewed as socio-economic forces, it is revealed in Chapter Three that toilets have been demolished and space set aside for the development of the same services has been taken over in order to develop more house units. It therefore follows that, in economic terms, the demand for and supply of infrastructural services like sanitation are diametrically opposed to the development of the house units. As the demand for more houses increases, more house units are built but at the expense of decreasing supply of sanitation service level. During the early stages of the settlement development in Kitui, Kanuku, and Kinyago the supply of available space for the development of sanitation services was higher than is the case today.

The initial decision to give priority to the development of the house units notwithstanding, there is now a very high demand for sanitation services by the

same households. These households now find a house without sanitation provisions totally unacceptable - it is no home, for there is not even access to 'god-given air'. Attempts to develop sanitation facilities now is proving very difficult considering the high density development of the residential house units. The present state of inadequate services in the study area confirms one of the concepts in the development of infrastructural services - that is, the subsequent development is dependent on decisions taken earlier so that improper decisions taken make the subsequent development of infrastructural services more costly as is observed by a World Bank report given in Chapter Two. It can therefore be discerned that the initial decision to give priority to the house unit, at the expense of sanitation service, in the long run makes the total aspect of housing development unacceptable and costly. The house unit and the associated infrastructural services need to be developed together as a package.

A comparative assessment of the priority service in the study area reveals that 83 per cent of the households sampled recognise the development of sanitation service as a top priority. This is largely explained by the fact that households in the study area find the absence of such important facilities like toilets totally unacceptable. From table 3-7, it is

clear that the next priority service requiring improved development is the supply of water. None of the sampled households gave top priority to the development of either roads or electricity, although all the sampled households indicated the need to have all these services, "just like everybody else in the city". What the above synthesis is indicating is that there is need to order the development of infrastructure service so as to reflect the community aspirations. Top priority needs to be given to the development of the sanitation service, not just because it is a basic human need, but that inadequate development of this service poses a serious threat to the environment and the survival of man (Chapter Two on the environmental equation). Ironically, the present development of housing in unplanned low-income settlements would suggest a misplaced perception.

Finally, an important aspect that reveals itself through the chapters is that investment in infrastructural services of water and sanitation require both financial and technical assistance because these important attributes are in short supply within the unplanned settlements. In the study area this assistance has mainly been coming from Undugu Society. Because of the nature of infrastructure investment, a large amount of capital outlay and skill is required to start off

the services. It will be appreciated that although a sewer line is passing through the study area, the mere cost of making the connection requires a downpayment of over Ksh. 900,000, a figure that can not be raised by the resident community. In all areas of service development, a large sum of initial capital is required; for a single water kiosk, without the water supply material like the pipes, it requires over Ksh. 4,000; a pit-latrines requires over Ksh. 1,800. This large sum of initial capital outlay has greatly inhibited the development of services. Where financial assistance has been given, either as grants or loans, some marked progress has been recorded. On the other hand, the supply of unskilled labour is abundant in the unplanned settlement as is depicted in the high rate of unemployment. So that once technical assistance is provided by Undugu Society, the community itself has contributed labour towards meeting the cost of construction labour. Undugu Society confirms a high degree of enthusiasm on the part of the direct household beneficiary in contributing labour towards a worthwhile cause like the construction of the water supply and the pit-latrines.

A large portion of the tenants in the study area complained of the high rent charges. The basis of the argument was that a monthly rent of over Ksh. 250 for a single room was excessive since no infrastructural

services like water supply and sanitation were provided. Going by the previous findings, because the cost of these services has proved very high to the residents, it means that very high rents would be charged if these services were to be provided. The only logical conclusion here is that means be found to lower the costs of developing these services in the study area since they constitute basic human rights which the settlement cannot do without.

Design and Management of Services:

Irrespective of the type of service technology adopted, the final utility of the facilities depends on how the facility is managed. Reference is first made to the design of water and sanitation facilities used by residents in the study area. The 10 water-point kiosks operated by women groups and individual households in Kanuku and Kinyago villages are, by all standards, simple and modest designs consisting of just a stand-pipe tap. For a period of over 3 years, these taps have shown no operational problems because of the close attention given by the owners, while at the same time operating as community facilities. There is no water running to waste from these taps. In constrast, the communal public water-points in the neighbouring estates, that are often used by the residents of the

study area, show a major element of neglect. All these communal water-points in the neighbouring estates have broken taps that result in excessive water running to waste and causing a problem of undrained wastewater. The City Commission Department of Water and Sewerage confirmed the problem of maintaining these communal water-points and the ablution blocks in the neighbouring estates of Pumwani, and Shauri Moyo. A comparative assessment will show that despite the heavy investment that has been made in constructing water-taps embedded in massive concrete, the problem of careless usage and vandalism persists at these communal service-points. Therefore, a simple water-tap design, when operated as a private source, can supply the study area well compared to a communally operated tap having no person taking charge.

A look at the toilet designs used by the residents of Kitui, Kanuku, and Kinyago villages (Figure 3-4) shows that the feacal matter waste is, for all practical purposes, exposed and so it poses a direct health and environmental hazard to the residents. The exposed waste may be causing a more serious health hazard than the toilets were initially set out to solve. The poor maintenance of the communal ablution blocks in Pumwani, and Shauri Moyo, that are often used by the residents of Kitui, Kanuku, and Kinyago villages, also pose a serious

health hazard to the potential users, who many at time avoid using them because of the poor maintenance. Therefore, whichever the sanitation technology option adopted, poor maintenance of the same will give rise to more serious envionmental problems. From Chapters Three and Four, the element of attack by thugs at the communal ablution points has featured prominently as inhibiting a more effective usage of the facilities, especially at night.

Another important aspect relating to the development of services is now to manage the elements of cost-recovery in the provision of services. The policy of the Kenyan government shows that it is no longer feasible to provide free services. For the development and management of essential services like water and sanitation, the strategy is cost-sharing. As the central government agencies like the Nairobi City Commission have shown ineffectiveness to manage water supply and sanitation service at the local community level, the potential shown by the local community towards the management of the services should be given a chance. At least this management problem is also depicted in the planned residential housing areas that are served by the Nairobi City Commission. This does not however mean that the Nairobi City Commission will reliquish its obligation of ensuring a comprehensive

development of infrastructural services in the entire area under its jurisdiction. It is the Nairobi City Commission that has been entrusted with the overall responsibility of overseeing the development of services in the City of Nairobi; the delegation of part of this responsibility to the local community does not repeal this responsibility.

Level of Service Development:

It has been pointed out from above that priority be accorded to the development of sanitation service in the study area. But from Chapter Four, it is apparent that the ultimate success of water supply and sanitation service development in the study area requires the support of other services. For one, the inadequate provision of paths hinders the accessibility of water supply and sanitation service; inadequate lighting at night presents its own problems relating to safety, on the part of the users.

From Chapter Three, it becomes necessary to order priorities, not only among the different infrastructural services that need to be developed in the unplanned settlement, but also in the level of service within each particular sector service. Paying particular attention to the pattern of demand on water and

sanitation facilities, it is observed from Chapter Three that residents in the study area travel over longer distances to obtain water in the neighbouring estates - and are willing to do so - if only it means making a saving on some cost like paying a fee for the water at the water kiosks within the study area. This behaviour is largely explained by the fact that water can be collected during the day and be stored in the house for later use. This means that the utility of the water points is largely limited to day time hours and so people are able to travel far for the service. When the usage of toilet facilities is assessed, the residents complain of the ineffective usage of distant facilities irrespective of the time of day - daytime and night-time. The position here is that the demand on the usage of toilet facilities is high irrespective of the hour of the day. Because a potential toilet user can not possibly postpone the 'call of nature' when it is due, the location of toilet facilities at distant locations presents enormous strain. It is therefore the conviction of the author to suggest that, beyond a certain level of service, the utility of a toilet facility is inhibited and that a toilet facility requires a higher level of service compared to the supply of water.

A rather cynical phenomenon arises from the increased level of water supply service in the study area. As a result of increased water consumption, the settlement now faces the problem of handling the waste water generated. Much as the level of water supply service has increased to 10 water-points in Kanuku and Kinyago, no appropriate measures have to be taken to handle the waste water generated. This means that the development of an increased level of water supply service has only managed to improve the consumer convenience but at the expense of a deteriorating sanitation environment. This only points to what this research work wishes to term 'half-dosage' solution that are often worse than no dosage at all. A similar assessment can also be made on the development of rainwater storage tanks in the study area. For one, the tanks are idle for most part of the year due to the rainfall characteristics in Nairobi and so these storage tanks present a case of unsound investment decision for a community that is povery striken. Similarly, from the environmental health view point, it is the conviction of the author that the rainwater which collects in the tanks is not safe at all due to the problem of dusty roofs. The consumption of this water by the unsuspecting residents is certain to cause a health problem, although not as bad as if the Nairobi river waters were used.

Institutional Variables:

As an unplanned settlement that is not officially recognised by the Nairobi City Commission, direct involvement by the local authority in developing water supply and sanitation service in the study area is limited. Whereas these services are available in the neighbouring estates of Biafra, the City Commission is reluctant to extend the same services to the study area. The main reason for this is mainly socio-political implications. The information obtained from the field indicates that although the resident community has been allowed to make a connection to the city water supply and sewerage lines, the cost of development must be borne by the beneficiaries.

In order to pool resources together to meet the high cost of extending water supply lines into the study area, the community has formed community women groups. As registered women groups, these has enabled them to attract assistance from Undugu Society and the local provincial administration who together have approached the Nairobi City Commission to have water supply and sanitation service extended to the study area. Out of the 10 water-points in Kanuku and Kinyago, 6 of them are owned and operated by the women groups. Acting through the village committee, the residents of Kanuku and Kinyago, together with Undugu Society and the local

provincial administration, have managed to forward a proposal to the City Commission to have a toilet block project connected to the sewer line through Biafra. This proposal has been accepted and the actual implementation is delayed by limited financial resources of the community.

The important point here is that while acting as a recognised group, the residents in the study area have been able to win recognition from the City Commission, the administration, and non-governmental agencies like Undugu Society and the Child Survival Programme of UNICEF. This recognition has been forthcoming in terms of financial and technical aid, besides improved security of tenure. The presence of a village committee in each of the villages offers some form of local level community administration because these committees work closely with the local Chief. These committees are also used in organising the residents in the overall development of the village.

An important question that was posed to the residents in the village and the village committee was: how much were they committed to investing in infrastructural services, particularly in the disposal of human waste? As indicated earlier, this service sector on sanitation is a top priority. The Chairman of Kanuku Village

Committee indicated to the author that the residents had agreed to meet the cost of developing sanitation facilities like toilets and maintaining them. This is indeed a positive indication considering that maintenance of such public facilities is a major problem facing the Nairobi City Commission.

A rather interesting aspect that has come up in the research survey is that in some parts of Kanuku and Kinyago villages, residents who share a common frontage space have taken it upon themselves to ensure that no waste is carelessly dumped in the open space. In order to enhance this community aspiration these grouped households sharing a common frontage space have sealed the through-access paths that are depicted in the open pattern of settlement around the residential house units (Figure 4-1). This has led to a form of settlement pattern that identifies a particular group of households with a defined frontage space. The new development is also aimed at limiting interference by people just passing-by and who often turn-up to be thiefs. As pointed out in Chapters Three and four - solid waste section - this means that for this particular grouped households, the problem of solidwaste disposal is depicted at the dumping sites rather than at the household space level. When this issue was investigated further by the author, it became clear that the residents were concerned about

the cleanliness of the common frontage space where the washing and social gathering is done. This is indeed an important community - action aspect. The same can be said of the isolated cases in the settlement where some households interviewed were actually found cleaning the blocked wastewater drains.

When the above factor of community-action is combined with the earlier finding where priority of an internal road system is given a low rating by the residents, and considering the fact that the amount of solid waste production per capita is low (Chapter Three), the need to develop roads of a standard to cater for the heavy solid-waste vehicles does not arise.

Site Conditions:

A survey through the City of Nairobi will reveal that a number of the unplanned settlements are sited along the tributaries of Nairobi river (Figure 1.1). Just like Kitui, Kanuku, and Kinyago villages, these settlements face difficult site conditions outlined in Chapter Four.

Considering these poor site conditions, the research has established that the development of sanitation services and water supply is inhibited. A

comparative analysis shows that the construction of the residential house units is not inhibited to the same extent. From a technical point of view, the provision of infrastructural services like water and sanitation present a most difficult problem compared to that of house unit construction.

Information gathered from the study area shows that the initial location of this settlement along the banks of Nairobi river was as a result of the residents viewing the river as a source of water then. But with time, now the river has been polluted so much that the same river is now seen as an open sewer where they empty their waste. The waste from the study area is freely led into the river (Chapter Four). A critical analysis of the problem shows that the pollution problem of Nairobi river does not emanate in the study area but is a result of waste being dumped in the river by residential and commercial activities in the City Centre upstream. Because the initial source of water for the study area residents has been rendered useless by forces outside the area, it is only logical that the cost of developing an alternative water source be met by the total urban society that has contributed to the pollution problem. In this connection, the author views the problems in the study area as not just emanating in the settlement but is a result of

forces within the total urban environment. Therefore the suggestion is that a solution to the same problems can only be found by considering the same urban forces that cause the problems in the first place. Therefore a solution to inadequate water supply and sanitation service development in the unplanned settlement cannot be viewed within the sectoral context of services alone per se but must be seen in its wider dimension of housing development.

The Role of Agencies in Community Development:

So far the research findings point to the inability of the resident community in the study area to effectively solve the problem of inadequate development of infrastructural services of water and sanitation. The implication is therefore that, for effective development of these services, assistance must be received from outside. This assistance is in terms of financial and technical support, besides the need to develop the community self-help support.

Undugu Society and the local provincial administration have all played a central role in assisting the development of water supply and sanitation service in the study area. In participation of the Nairobi City Commission has only been limited to

allowing the connection of services to be made. Much as these developments have good intentions, the author feels that these developments have resulted in more problems because the process of change has not been fully addressed to. It is important to note that any change introduced in a community gives rise to its own problems. The increased level of water supply has given rise to a problem of waste water disposal; a pit latrine that is not well designed and maintained turns out to cause a more serious health hazard. Therefore the argument that the author wishes to put forward is that the resident community in the study area has been made to accept change to the supply of water and sanitation service but without accepting further changes that must accompany the development of the water supply and sanitation service. In this connection, what can be said of the Nairobi City Commission that has allowed the extension of a piped water supply into the study area without due regard to the subsequent question of the waste water generated? The suggestion is therefore that, in introducing changes in the water supply and sanitation service, the community must be assisted to accept the costs that are certain to arise.

Policy Approach

What does the above synthesis suggest about an improved development of infrastructural services of water supply and sanitation in the study area and similar settlements elsewhere? An overall view would suggest that a solution to the problem of inadequate development of infrastructural services in the study area must incorporate the total urban environment. In this respect any upgrading and improved development of the study area must be perceived within the concept of integration with the rest of the urban environment; it is not conceivable to achieve any effective development in the study area in isolation and devoid of urban forces influence. To the extent that the development problems in the study area are not limited to the present settlement alone, the suggestion is that an institutionalised agency be established within the ranks of City Hall to undertake an overall development of such settlements in Nairobi. In the same tone, challenge is posed to the Central Government to establish similar programmes throughout the country since the problem is not limited to Nairobi. The implication of the above argument is that the recommendations herein are not just specific to the study area but are of general application to similar settlements elsewhere.

It is therefore the suggestion of this thesis that the present policy on the development of unplanned low-income urban settlements depicts shortcomings. To the extent that:-

- policy gives priority attention to the development and research investment to the house structure at the expense of deteriorating environment caused by inadequate services;

- increased water consumption and provision is not accompanied by corresponding development of sanitation services;

- water supply and sanitation facilities are provided without the development of support services and subsequent poor maintenance and safety to potential users;

- unplanned settlements are developed in isolation and devoid of the urban forces influence;

- technology selection is based on mere aspiration to be like others and not because of the ultimate goal of improved health; and

- urban land zoning policies lead to the development of unplanned settlements in poor site conditions, and on which site the residents are only allowed to have temporary developments;

the present housing policies and practices can only but be summed as inadequate if not misguided and leading to worse environmental conditions.

It is the suggestion of this thesis that any improved development or upgrading of the study area shall adopt a policy whereby this settlement is incorporated in the total development of the urban environment . In addition to developing water supply and sanitation services together with support infrastructural services as a package, the problem of inadequate services must be seen in its wider dimension of the housing problem that is affected by employment opportunities, low-incomes and scarcity of urban land. In this context a solution to the problem of inadequate services must be found within the present area of settlement and site because there is no room for relocation to 'better sites', as it were. This calls for a reorganised pattern of settlement so that housing is arranged in such a manner as to maximise the utilization of the limited space while at the same time

allowing for an improved development and utilization of water supply and sanitation services. For example, certain housing layouts can identify a certain group of households with a particular service facility which enhances the maintenance and safety of these facilities. This factor is particularly important in water supply and sanitation facilities are concerned and as revealed in the study area. In the same manner, the research has revealed that this strategy also enhances community participation in the maintenance of water supply and sanitation facilities than when the same facilities are left unattended or assumed to be mainteained by the Nairobi City Commission. In suggesting that the residents should be encouraged to run and maintain facilities like water-points, the rationale is based on the study finding that the privately-run water-points in the study area are better managed than the communally, free for all, water points. The high charges on water at the water kiosks may be justified, if only because a better service is given compared to charges levied on water by the City Commission for services not rendered. In fact, even the complaint by the residents in the study area on the water charges is not genuinely attributed to cost as such but based on the fact that other people in the neighbouring estates receive these services free of charge.

In suggesting that the policy approach should look for solutions to the problem of inadequate water supply and sanitation serveces within the present location of the study area, the implication is that a search for appropriate technologies is required. First, priority attention needs to be paid to the development of appropriate sanitation technology because of the seriousness of the decaying environment that is caused by inappropriate technologies. It is important to appreciate that inadequate services does not imply the need to provide more of the same. It is indeed necessary to note that the mere provision and increased level of water service and consumption in the study area is now causing a more serious sanitation problem of wastewater disposal. At the same time, the mere provision of waterborne sanitation facilities and poorly designed toilets in the study area and in the neighbouring estates, now exposes the potential users to more serious health hazards because of the poor maintenance and design. Worse still is the fact that because of poor maintenance and design, toilet facilities fail to attract the consumer or target popultion because the same user doubts the sanitary safety of the toilets. This can only be viewed as wasted investment for a consumer community that can ill-afford it in the study area. The primary societal objective is improved health; increased water consumption or use of waterborne

sanitation does not imply improved health. Therefore the present policy approach that views increased water supply level and consumption or waterborne sanitation as necessary is misguided. A simple yard tap and a pit latrine can achieve the same levels of improved health but now at a much lower cost to the consumer and the overal urban environment.

Besides the wasted resources depicted in the rainwater storage tanks that are virtually idle for a long time in the year and the health hazard they may cause to the consumer in the study area, the vast amount of land along the Nairobi river floodplain can also be seen as a scarce and valuable resource which is underutilized if not abused. The scarcity of land in the study area is evident from congested pattern of settlement. The challenge is therefore that this scarcity of land is depicted in the presence of underutilized vast land along the river. This means that there is need to look at the possibilities of utilizing this value resource for the benefit of all, if not for the benefit of those in the study area. This calls for further research on how best to put this land into use. Presently, the findings of the research indicate that it is used as a waste disposal site, especially human waste. Could the open ground defecation and construction of collapsable pit-latrines be the best use?

What grounds are there to suggest that unplanned low-income settlement of Kitui, Kanuku, and Kinyago villages deserve no water supply and sanitation services or at least deserve no assistance to develop these basic human services? Who is responsible for the predicament facing households in the study area? Is the study area the cause or worst source of environmental pollution in Nairobi? As basic human needs, the study area requires improved development of services just as it is aright to the rest of the urban population. Due to planning policies themselves on land-use zoning, the low-income study area finds itself in poor site conditions; and the study area is neither the cause nor the worst source of environmental pollution. For example, the Nairobi river, which formerly was a useful source of water for the residents in the study area, has now been rendered useless by other urban and commercial activities upstream of the study area, including the sewage from a hospital in Pumwani. Why should the residents in the study area be condemned and made to pay the full cost of the problems caused by other urban activities in Nairobi? Some of the commercial activities in the City Centre are even better placed to pay for the cost of the problem of Nairobi river pollution. These facts point towards the need for intervention by Nairobi City Commission, if not the Central Government.

Finally, the problem of inadequate water supply and sanitation services in the study area cannot be said to be unique to the study area alone. It is true to suggest that similar settlements face the same problem both in Nairobi and elsewhere in Kenya or other regions of the world. To the extent that the above statement be true, the research findings are somehow applicable to similar settlements elsewhere. But it is important to appreciate the fact that every solution is unique in one way or other depending on the local conditions. In the same content the recommendations made in this thesis are sure to form substansive application to other similar settlements. For the planners, there is no room to assume that a problem does not exist. Concerted efforts need to be made in research on the problem and the sooner this is done the better. Planners have an obligation to guide society, for if they don't, who else will do it? It is not necessary to wait until the problem occurs so as to act. The planner will certainly require the support of the larger society, together with its political leadership.

The above planning suggestions constitute the input to the recommendations that follow.

Recommendations

It is the general suggestion of the author that a solution to the problem of inadequate development of water supply and sanitation in the study area can only be found within the total environmental equation of urban forces rather than the present sectoral approach that is limited to the provision of a water supply or a sanitation service *per se*.

The recommendations presented herein are divided into two main parts:-

1. The first set of recommendations consists of aspects related to investment decisions and policy; and

2. the second set of recommendations is mainly in the form of technical design models.

It will be noticed that the second set of model recommendations act as the operational translation of the first set of investment and policy suggestions.

Investment Proposals:

Improvement of housing in the unplanned settlement should give top priority to the problem of inadequate

sanitation, especially the disposal of human waste. This is because of the serious environmental consequences that threaten the basic survival of the resident community, if not the rest of the urban community. The present trend in housing in the settlement gives priority to the development of the house structure at the expense of the increasing demand for sanitation services. Unfortunately, a house unit without adequate sanitation fails to offer the very benefits it was initially intended to give. The development of housing should incorporate a house unit and sanitation services as a package.

In the same token therefore, there is need to order priorities accorded to various infrastructural services requiring improved development in the unplanned settlement. In the selection of various sanitation technologies, the problem may not be the inadequate provision of facilities but their maintenance.

In providing water and sanitation facilities the user community should share in meeting the cost - either by being charged for their use or being made responsible to run and maintain them. An increased level of water consumption in the settlement should be checked because beyond a certain level, excessive water may not necessarily mean an improved level of health but

will result in excessive waste water production which causes a worse problem. It is therefore being suggested that it is better to limit the water consumption than to wait and handle the waste water generated. This strategy will be enforced through charging a fee for the water, instead of providing it as a public service at public points. As a follow-up of the research finding that Nairobi river has a bearing on the initial location decision of the study areas and also considering that the same river has an influence on the development of water supply and sanitation service, the author proposes to incorporate the development of the river as part of the model for an improved service development in the study area.

Policy:

Considering the fact that adequate water supply and sanitation service are basic needs, must it be left upon the individual communities in these unplanned settlements to develop these services? It is clear from the synthesis of the findings that much as it has tried, the community in Kitui, Kanuku and Kinyago is unable to effectively develop these infrastructural services. The environmental degeneration that results is not only a threat to the residents, but a threat to the total urban community and beyond. In such a situation, what should be the role

In discussing the relocation option, the findings so for have established that the site conditions in the study area present a difficult situation for the development of infrastructural services, leave alone the development of housing as a whole. The site is relatively steep; the soils are difficult to allow for effective service development; the site suffers from the problem of a high water table; and the frequent Nairobi river floods. In such a situation there is often the choice of relocation. But unfortunately this option appears not to be feasible because the contemporary assessment practice acknowledges that the present state of urban forces system does not have much room for ' 'somewhere else' choice - an option that has in the past provided a way out. Therefore the proposal being put forward in this research is that, with the 'elsewheres' gradually being scarce, the alternative must be sought in new knowledge and technology rather than in new places (Holling, 1978). Therefore the challenge being put forward to planners is to be ready to make trials, for technology advancement is learnt and developed from errors that may be made in the process - the fear of cost to society and the profession notwithstanding.

Model Proposals:

The following are model designs that are aimed at operationalising the recommendations on investment and policy issues presented above. The models presented include:-

- The Minimum Package Model;
- The Housing Layout Model; and
- The Nairobi River Development Model.

The minimum package model:

From the research synthesis presented, it should be clear that a solution to a more effective development of water supply and sanitation service in the unplanned settlement must incorporate the following as a'minimum package':

- an increased water supply must be accompanied by a sanitation programme to handle the waste water generated;

- the consumer community must be fully integrated in the development and operation of the water supply and sanitation service;

- the user-community must be educated on the proper use of the service, i.e., public education must form part of the overall development of services;

- regular maintenance of the facilities;

- the development of water supply and sanitation service must have the support of other services like paths and security at service points.

Housing layout model:

It has been pointed out that the development of the house units in the study area has been in unfair competition with the development of infrastructural services for the limited land space. It has been recommended that the development of the house units and infrastructural services must be developed together as a package. In order to enhance the accessibility to toilet facilities and improve on the safety and management of these facilities, it has become necessary to propose a housing layout model that identifies with a particular resident group. A typical layout model is presented in figure 5-1. The component details are given below:-

1. Residential units.

Each of the Housing Court units will have 12 residential units arranged in the pattern shown in relation to other component facilities. Access into the inner open space around which the various components are arranged is highly restricted to the rest of the people who do not reside in the court unit. Therefore, access into this space is only through each of the residential units. This means that it is only the resident occupants of the court that can get into this open space. This will ensure a higher degree of maintenance of this space and the component water and sanitation facilities.

2. Water service:

One yard tap shall be provided for each court. This tap is suggested to be operated by one of the resident occupants, from whom the rest of the occupants will be buying the water. Modalities of to the actual pattern of purchase is not important at this stage. The water point should be metered and connected to the rest of the urban water supply system. The local authority, in this case the Nairobi City Commission should only handle the one resident operating the water point.

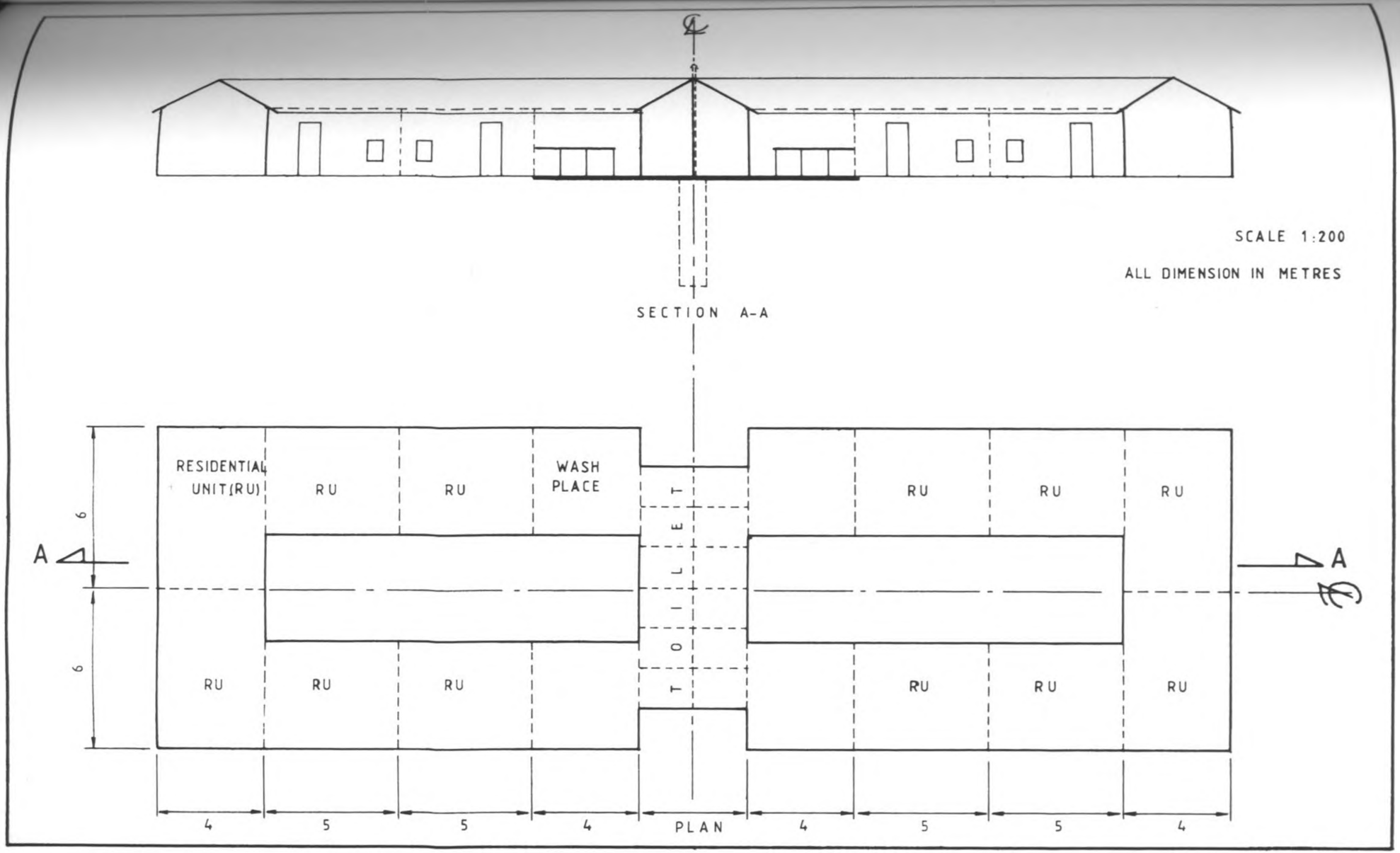


FIGURE 5-1
HOUSING COURT UNIT

At this level of water supply service, the per capita water consumption is estimated to be between 20 and 25 litres per day. Taking an average household size to be about 5 persons, the maximum water consumption per court will be (25x5x6 = 750) litres day. Taking a waste water generation coefficient of 0.8, the sullage water production in each court will be (750x0.8 = 600) litres per day.

3. Waste disposal.

All the human waste and waste water produced shall be led into the combined VIP toilet block unit.

a) Design Computations.

- the pit design is subjected to the constraint of a high water table and unstable soils. For this reason, the depth of the pit is limited to within 4 metres. In this respect, the capacity (V) of the pit is given by:

$$V = 1.33\ C\ P\ N$$

Where

C = pit design capacity, in cubic metres per capital per year.

P = number of people to be served; and

N = number of years the pit is in use before emptying

The capacity of the pit shall be increased by 50 per cent to allow for the usage of anal cleansing material like leaves and paper that are not readily decomposed. A capacity value of 0.04 is adopted since the pit is wet. For a household size of 5 person (P = 5), taking C = $0.04 m^3$/person/year and N = 5 years,

. The pit capacity, V = $(1.33 \times 0.04 \times 5 \times) \times 1.5\ m^3$

$= 1.995\ m^3$

. Assuming a cross-section plan of 1 metre by 1.5 metres, the depth of the pit will be:-

$$\text{depth of pit} = \frac{1.995\ m^3}{1 \times 1.5\ m^2} = 1.330 \text{ metres}$$

Since each toilet is paired by another one in the adjoining residential court unit (figure 5-1), the depth of the pit shall be doubled. The design depth of the pit is thus (2x1.33 m = 2.66 m).

For design purposes a depth of 2.66 metres is acceptable under the prevailing site conditions. The above computations are based on the design manual prepared by the World Bank (Kalbermatten et. al., 1982).

The design details of the toilet structure units and the pit are given in figure 5-2 and 5-3. The walls of the pit are lined with bricks that support the weak pit wals and allow for percolation.

Each toilet unit is 1.5 m wide and 2 m long. This size adequate to provide space for a combine toilet and bath space. The height of the superstructure is about 2.0 m.

The squat-hole is 30 cm. by 20 cm. in order to avoid soiling and is narrow enough to allow usage by children. The opening is sealed by a stiffened rubber sheet that is flexible enough to open when a little weight is deposited on it and yet stiff enough to close when the faecal waste enters and drops into the pit. The stiffened rubber sheet can be cut from used vehicle tyres. The rubber sheet is embedded in the body of the concrete slab. This squat hole is placed at least 100 mm. off the back wall.

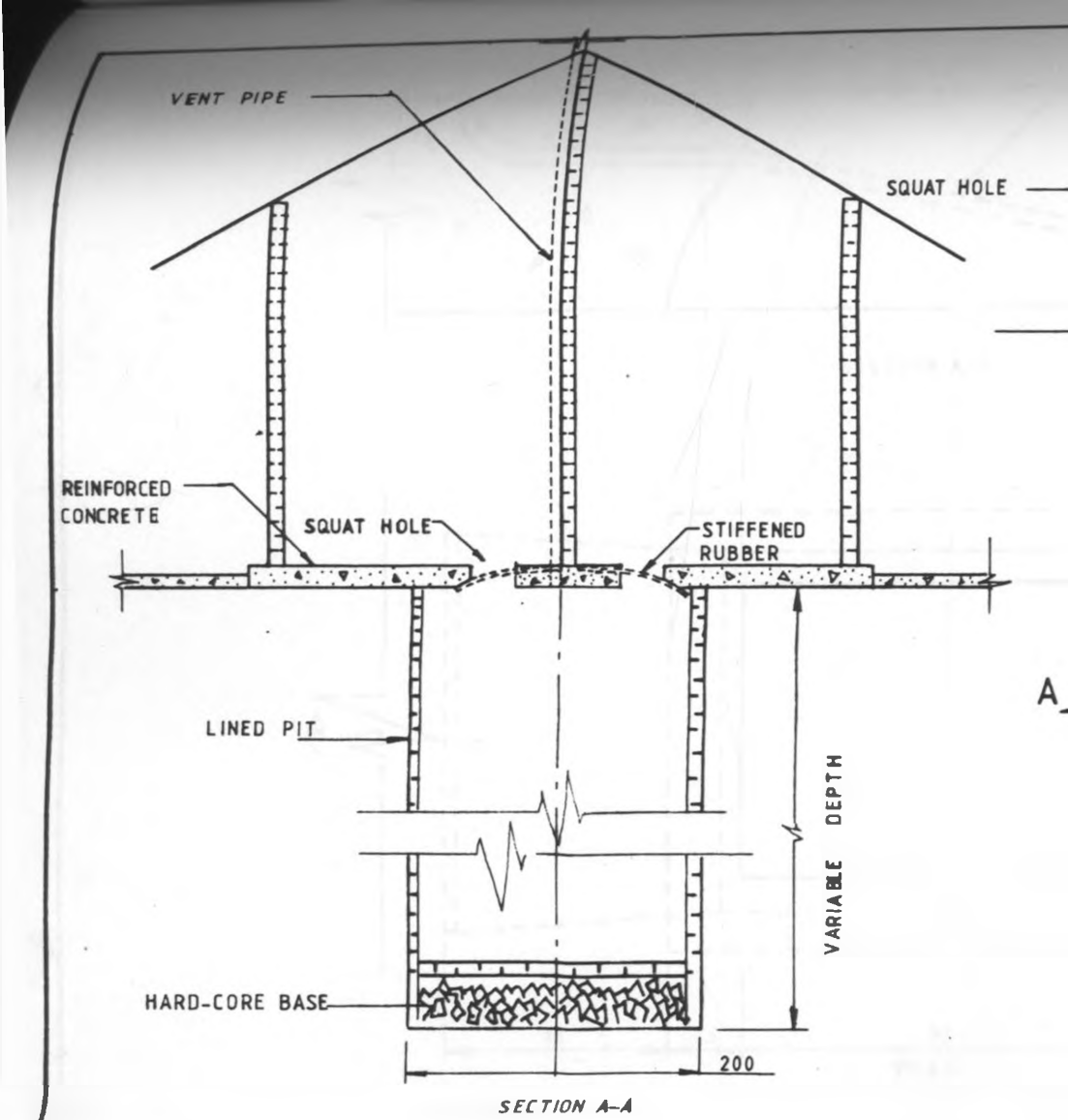
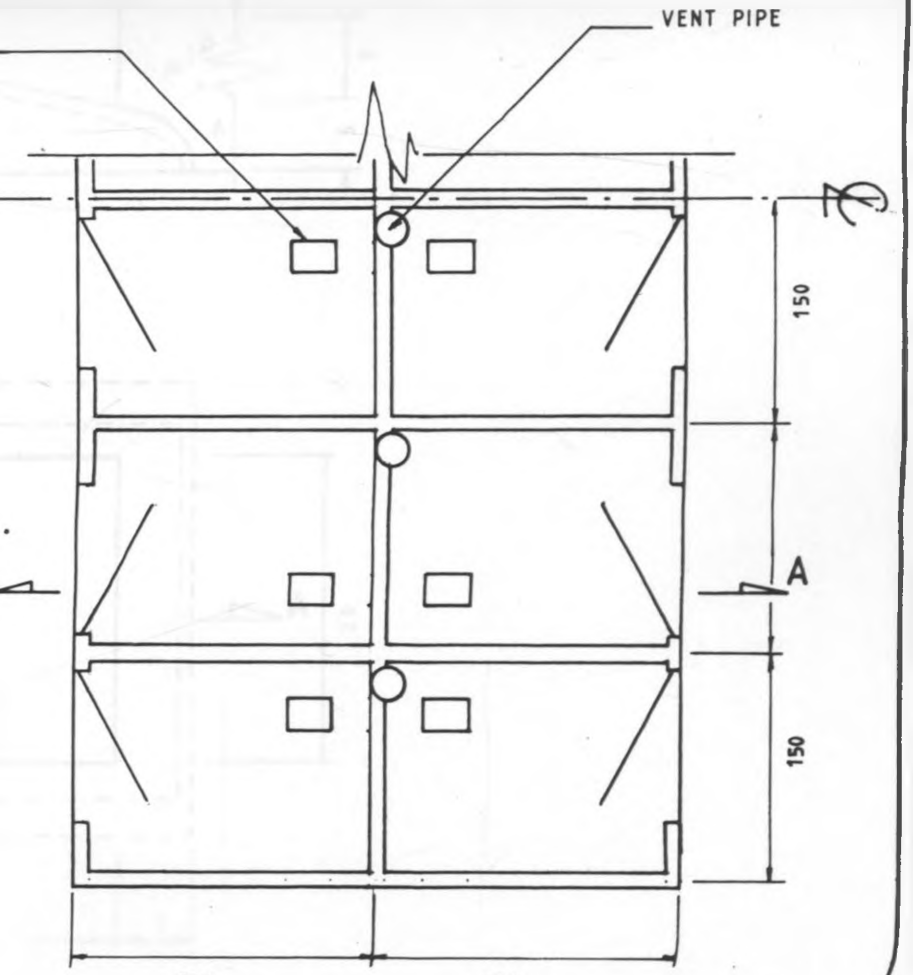


FIGURE 5-2

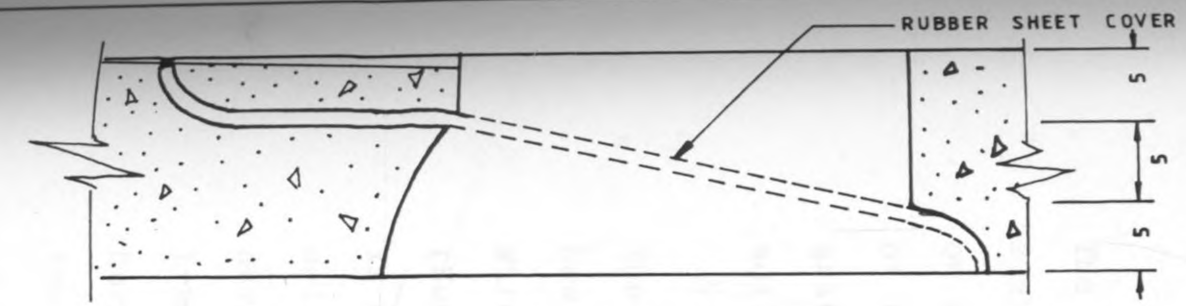
TOILET DESIGN



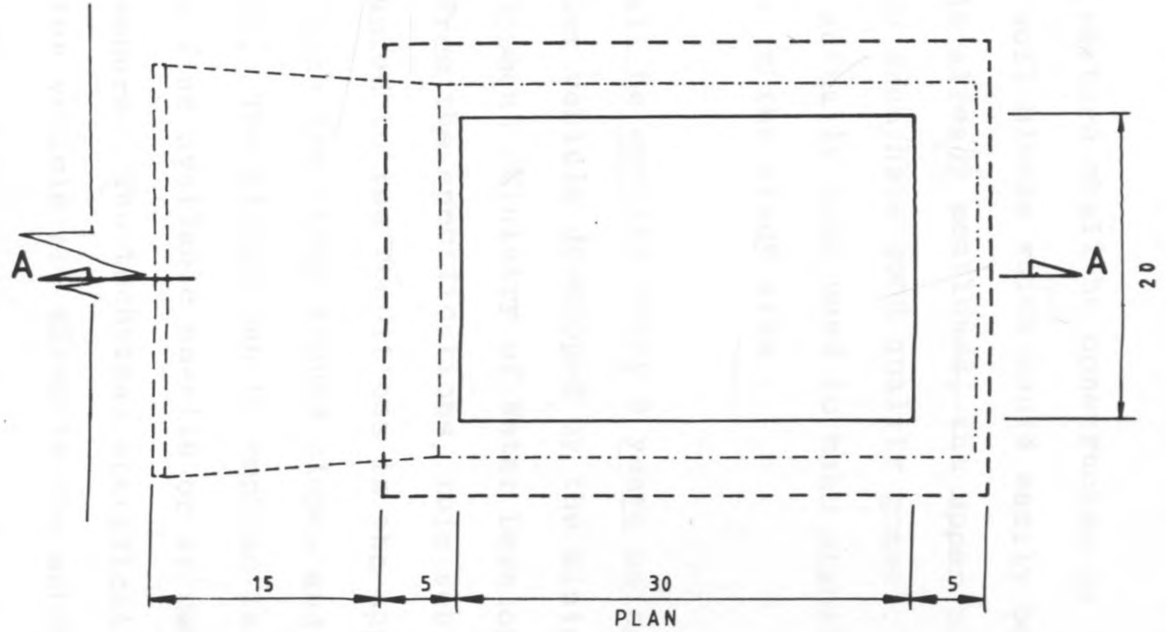
PLAN

SCALE. 1:50

ALL DIMENSIONS IN CENTIMETRES



SECTION A-A



PLAN

SCALE. 1:5

ALL DIMENSIONS IN CENTIMETRES

FIGURE 5-3

SQUAT HOLE DESIGN

- The floor slab is designed to drain into the this squat-hole. Since bathing is done in the toilet, cleaning of rubber sheet will be enhanced.

- Each resident unit will be entitled to one toilet facility in order to enhance local level, self-help maintenance.

- The superstructure shall be constructed of stabilised soil blocks which could easily be made on site. As already mentioned, the upper parts of the study area have good quality gravel. This gravel has actually been used to make stabilised soil blocks in the study area.

- The pit shall be emptied every 5 years using the New Exhauster vehicle developed by the Ministry of Water Development (Ministry of Water Development, (Kenya). From the specifications, this vehicle is well adapted to the conditions in the unplanned settlement like the steep ground slopes and the narrow paths. The sludge can be emptied into the trunk sewer line available on-site or it can be buried elsewhere. The technical specifications of the exhauster vehicle are given in the schedule B of appendices.

Housing Infrastructure Model

Figures 5-4 and 5-5 show a proposed model of the housing infrastructure. Figure 5-4 show the arrangement of the residential units, in relation to infrastructural services of water supply, sanitation, and roads or paths. The following are the major components:-

1. Small-bored sewer system.

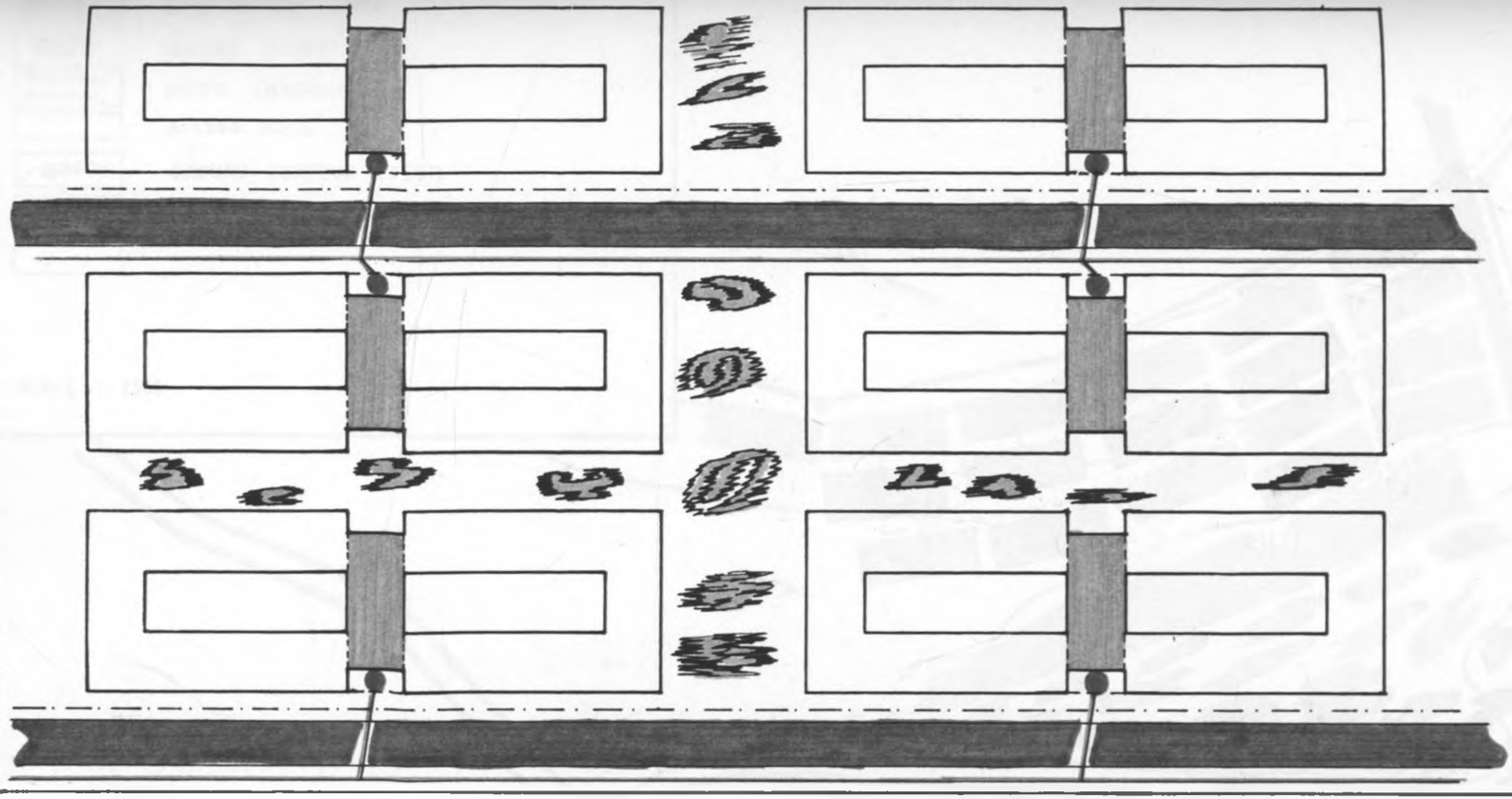
Due to the unpredictable quantity of sullage that may be generated, and because of the unpredictable fluctuation in the groundwater table, it becomes important to provide a mechanism of disposing of the excess waste water from the VIP pit. This provision is made through a mechanism of an overflow pipe that discharges into the small-bored sewer lines. It is noted that the problem of waste water disposal is of major concern in the study area. In order to address this research to the problem of waste water disposal, a small-borne sewer system is proposed. This method of disposal is preferred because it is relatively cheap and easy to manage since it is handling waste-water free from solids except the tiny suspended particles. The waste water is discharged into a system of sand-filter trench field, the details of which constitute the next model of development along Nairobi river.

2. A road network along which the exhauster vehicles will operate. The standard of the road need not be of a bitumen finish.

3. Water distribution line. This forms an extension of the Nairobi City water supply system.

4. Power line supply (optional)

Since the overflow drain pipe from the pit will be carrying only the tiny suspended solids, the pipe size can be anything between 100 mm. and 150 mm. for a fall of 1 in 150 to 300. From the ground slope in the study area, the slope is more than adequate, being around 1 to 10. It would also not be necessary to maintain a self-cleansing velocity of 1.0 metres per second for the small-bored sewers because even velocities as low as 0.3 metres per second are acceptable (Kalbermatten, et. al., 1982, p. 105). From Figure 5-5 it would be appreciated that the residential units have been fitted into the natural ground contour flow so as to minimise design and construction costs, while at the same time ensuring maximum utilization the natural ground slope to give the flow discharge head along the wastewater flow system.



WATER DISTRIBUTION LINE

SMALL-BORE SEWER

TOILET BLOCK

INSPECTION CHAMBER

ACCESS ROAD

SCALE. 1 :500

FIGURE 5-4

ON-SITE INFRASTRUCTURE MODEL

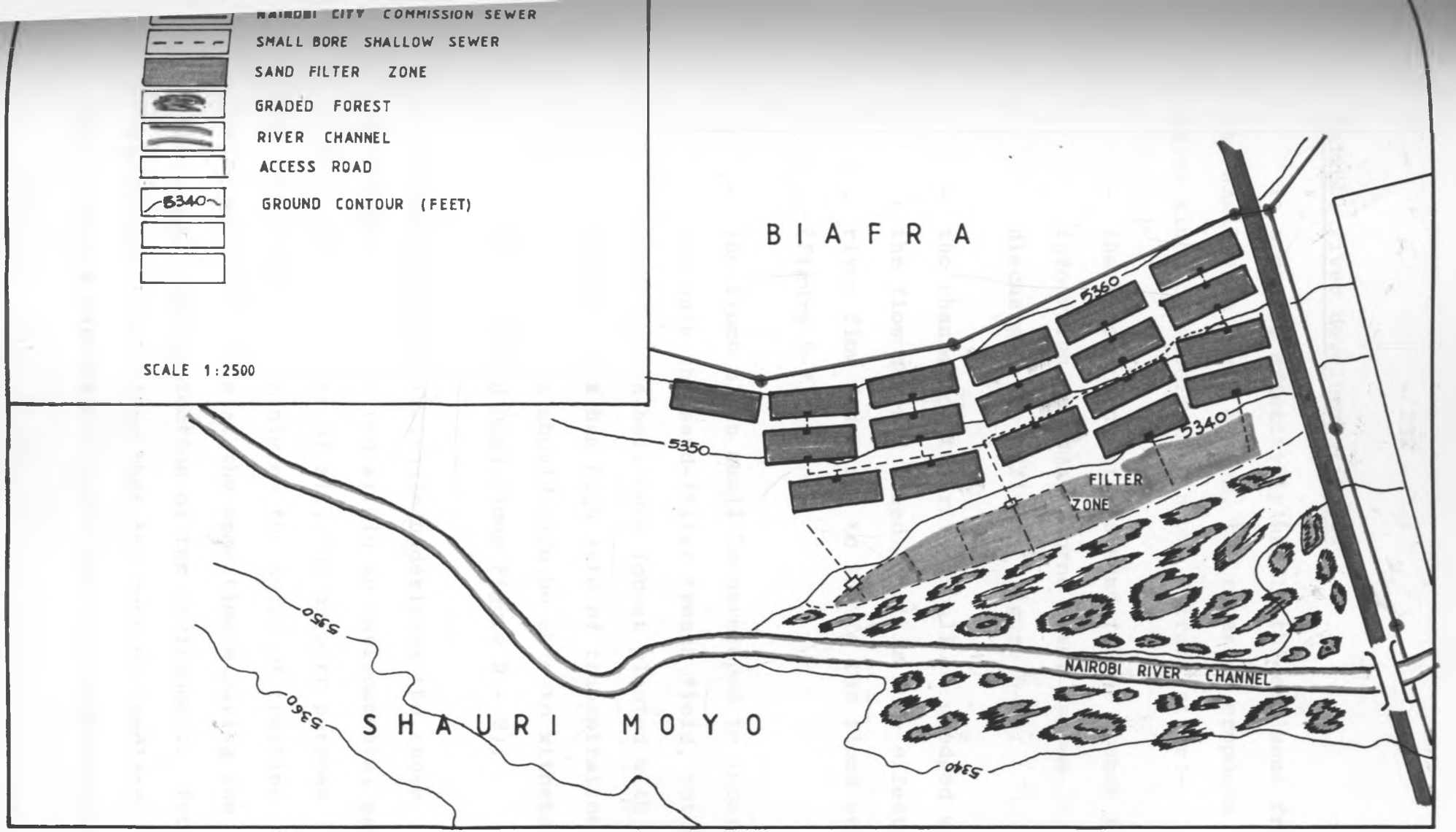


FIGURE 5-5

HOUSING INFRASTRUCTURE MODEL

Nairobi river development model.

In order to effectively handle the effluent from the small-bore sewer system, the research proposes three kinds of development along Nairobi river:-

- the development of the sand-filter trench field into which the small-borne sewer system discharges its effluent (Figure 5-6);

- the channel of the river shall be dredged and the flow channel lined to allow more effective river flow discharge to tackle the flood problem. (Figure 5-7); and

- the flood plain small be developed to incorporate, not only the sand-filter trench field, but also a graded green-belt open forest planted with a tree species that has high rate of transpiration. The tree species should also be able to withstand water-logged conditions Figure 5 - 8).

The technical rationale underlying the above development is conceived within an environmental package consideration. First of all, the primary purpose of the model is to minimise the costs of treating waste effluent while at the same time ensuring the enhancement and protection of the environment. From Chapter Two it is clear that the cost of handling and treating wastewater by the existing technologies is

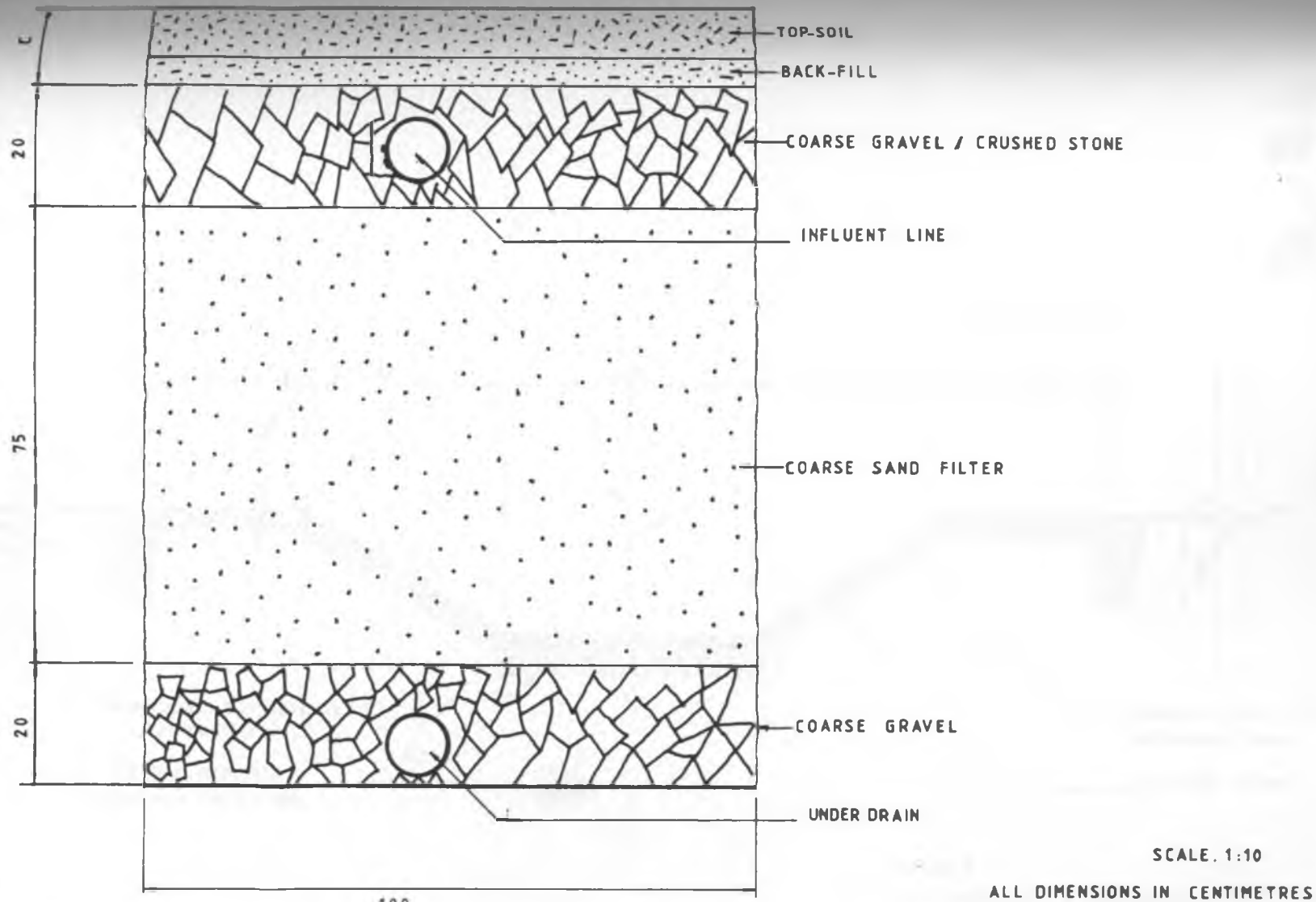


FIGURE 5-6

A SECTION THROUGH SAND-FILTER TRENCH

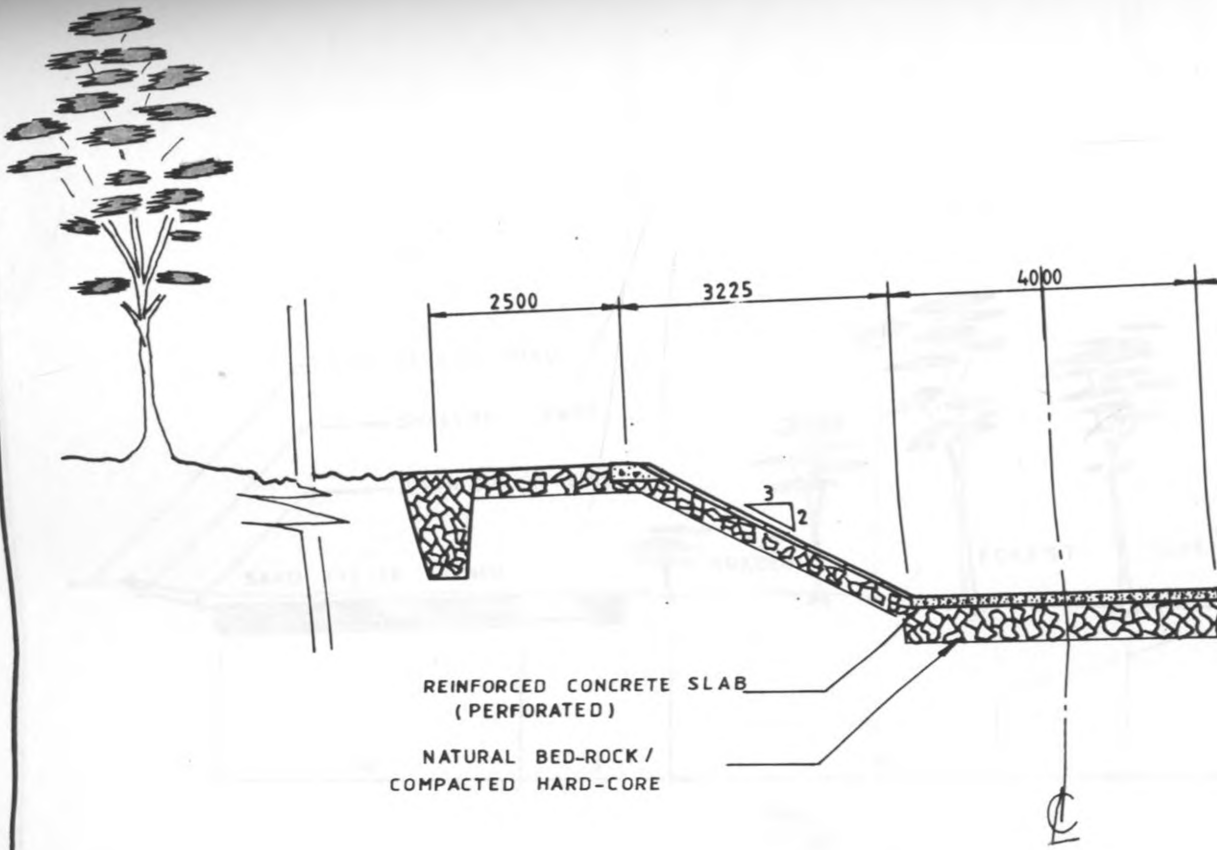
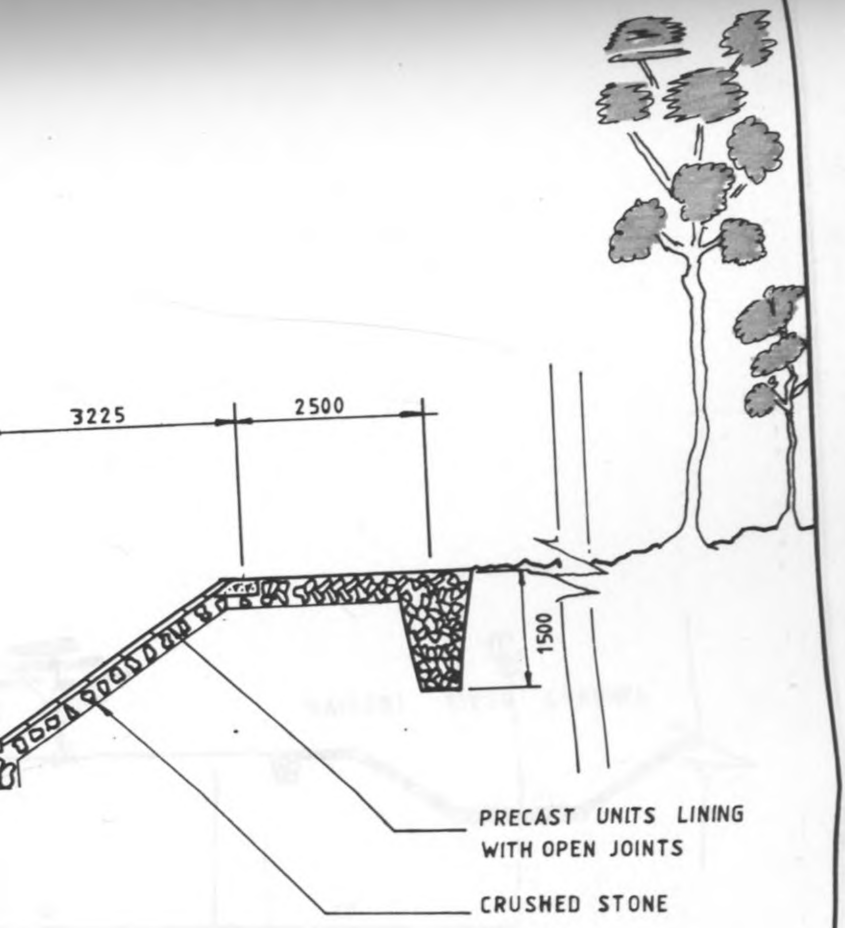


FIGURE 5-7

PROPOSED RIVER CHANNEL



SCALE 1:10

ALL DIMENSION IN MILLIMETRES

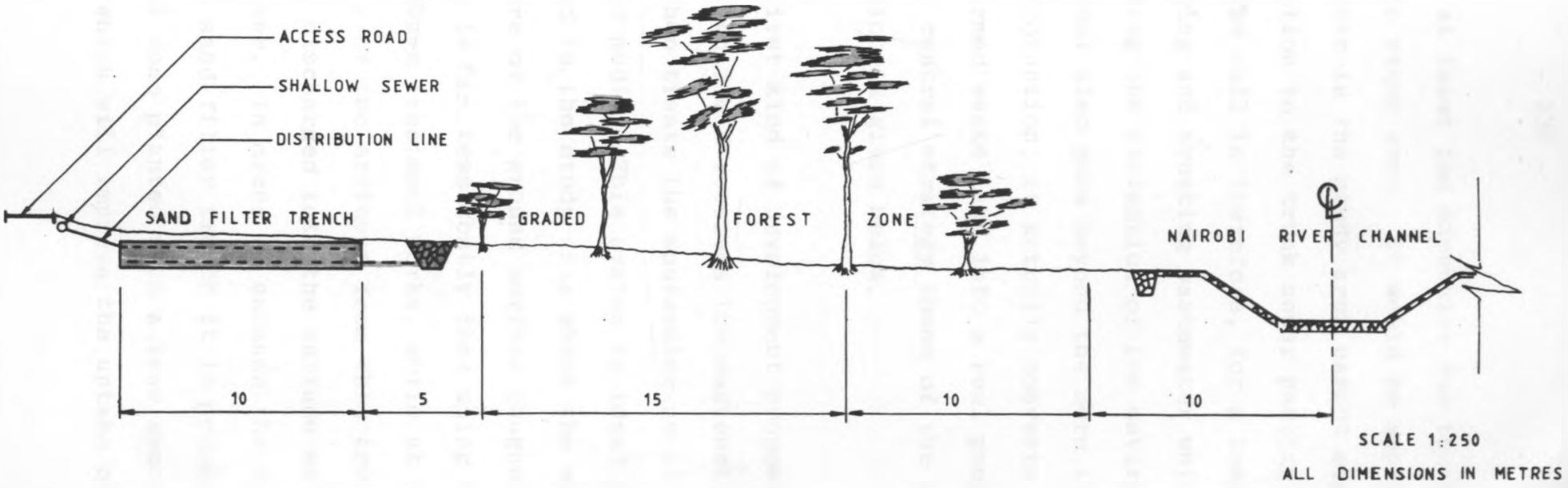


FIGURE 5 - 8
PROPOSED WASTEWATER DISPOSAL SYSTEM AND RIVER DEVELOPMENT

very expense - at least too expensive for the low-income residents in the study area. It would be appreciated that the residents in the study area cannot even afford making a connection to the trunk sewer passing through the village. The call is therefore, for a less costly method of handling and treating wastewater while at the same time ensuring the protection of the environment. The proposed model also goes beyond the mere issues of environmental protection; it actually converts what may otherwise be termed waste land into a real productive use - this is a central strategy theme of the model. Further exposition is given below.

For the first kind of development proposed, the sand-filter trench field receives the wastewater discharge and then treats the wastewater as it percolates through the sand media. This system is ideal for the site conditions found in the study area where the water-table is within 1 metre of the ground surface (Wagner, 1958). This technology is far less costly than using the conventional sewage treatment works, while at the same time the quality of the effluent from this trench is very high to be discharged into the surface water sources like Nairobi river. In order to enhance the loading capacity of the sand-filter trench it is proposed to develop a forest zone planted with a tree species like the eucalyptus which will improve the uptake of water

from the likely waterlogged soils along the river flood plain. The trees will also improve the non-capillary porosity of the clayey soils found along the floodplain and consequently the infiltration of water from the sand-filter field (Hillis and Brown, 1984). The quality of the effluent that may eventually percolate through the filter zone and the forest zone is indeed of a very high quality by the time it gets into Nairobi river.

The second development proposal entails the development of a graded open forest zone. It is the suggestion that this forest zone, developed with the eucalyptus, will have a number of benefits to the total enhancement of the urban environment. The open green belt will certainly improve the quality of the neglected urban land along the river. The wood can be harvested for use elsewhere. It is also the suggestion that the eucalyptus tree will grow faster due to the nutrients contained in the wastewater effluent (Hills and Brown, 1984).

The third aspect of the river development is the channel lining of the Nairobi river. This will ensure an improved system of discharging the river water that occassionally causes floods because of the undredged and overgrowth of vegetation along the present river channel.

The greatest challenge facing urban sanitation is the disposal of sullage - liquid waste component (Pickford, 1986). The above model proposal that constitutes the sand-filter trench field and a eucalyptus green zone is not only adaptable to isolated settlements that may as well be the low-income unplanned settlements shown in figure 1.1 but the model can be appropriate in areas where moisture limits the vegetative growth; the wastewater effluent could be utilised to support growth. It is further suggested that, not only do the eucalyptus do well under such regimes but that the model is likely to be less costly and environmentally sound than alternative conventional waste disposal systems (Hills and Brown, 1984).

The proposed development along Nairobi river should also serve as an alternative site for burying the sludge from the VIP toilets proposed above. The development along Nairobi river should also create a lot of job opportunities if it is undertaken as an overall development programme along the entire river course. This project should be seen as giving rise to considerable technical and research benefits. Another supplementary project that could be started as part of the long term programme to solving the housing problem is the use of the harvested wood as fuel in making bricks

from the soils that are presently lying idea along this low-income settlements in Nairobi. Already the Clay Works Company is exploiting this soil resource in making similar building materials. In this way the programme suggested will be trying to address itself to the root cause of the housing problem of offering labour-intensive job opportunities, building material for housing as timber and bricks, and at the same time making use of resources along the rivers that are presently idle, if not abused.

Rationale to Technology Selection:

It is important to outline the rationale behind the technology contained in the proposed models:

- The water supply at the residential court unit level is limited to a single stand-pipe tap operated by one of the residential occupants, from whom the rest of the household buy the water. This strategy is aimed at limiting excessive water consumption that leads to the problem of excessive waste water production. At the same time the management of the facility will be enhanced and relieve the Nairobi City Commission of the direct responsibility of managing such services at the household level.

- The VIP toilet is adopted considering its low cost of construction and operation. Each of this is used as a toilet and bathing place and is used by individual households that will ensure a high level of self-management and operation. The VIP toilet has also got high qualities of ensuring that odour and fly-menace is minimised. The use of the rubber sheet ensures all-round sealing of the squat-hole. This toilet design ensure a high degree functional flexibility that is important in the proper management of such facilities; there is very little room for interruption of use. On this basis the design is superior to even the water-borne systems of waste disposal (Sharkass, 1979).

- The housing layout model is aimed at enhancing management of the quality of the sanitation environment and facilities enclosed within a defined core unit. The proposed design will ensure all-round utilization of the toilet facilities because of self-security offerred by the unit components layout and enhanced social interaction within a given core unit (Kloss et. al., 1976).

- The small-bore sewer system is relative cheaper to construct as it does not need a high level of professional input. This means that much of the work of construction can be undertaken by the community itself, with minimal assistance from the professional

staff. For example, these sewers need not be laid at one specific invert level because the invert level can rise or fall along the discharge line. No manholes, as such,are needed along the line and the sewers can be laid at shallow depths and bent easily around corners (Otis and Mara, 1985).

- The waste water disposal system and the accompanying river development ensures an enhanced urban environment that is superior to even the conventional wastewater treatment systems.

Execution of the Suggested Proposals:

It is obvious that the proposed development models entail a reorganisation of the unplanned low-income settlement, if not the entire pattern of development along the Nairobi river. It is also inevitable to appreciate the central place of the Nairobi City Commission in initiating and developing a programme of the proposed models and ensuring a comprehensive development of infrastructure services. Much as it is important to incorporate the local community in the reorganising the new pattern of housing layout at the housing court unit, the technical design of the water supply and sanitation service infrastructure and the river development calls for direct involvement of the City Council.

Given below is, therefore, an outline of the modus operandi that will be called for:-

- Organisation of the project.

It is the suggestion of the author that there is need to look at the possibility of setting up a special project unit to undertake the upgrading and development programme proposed. In setting up this special unit within the Nairobi City Commission, the modalities of how this programme fits or will eventually be incorporated in the total urban enviornment and administration will need to be considered both at the planning and implementing stages.

- Land Acquisition.

Land will always be a crucial element in the development of any project of the kind suggested Since this programme is concentrated in unplanned settlements, with no formal legislation, this question may need special legislation. Furthermore, since the problem is not limited to Nairobi alone, a nationwide programme will require the Central Government attention.

- Project Finance.

The implementation of any project will obviously call for financial outlay of one kind or other. In assessing the financial implications of the programme, the overall environmental costs and benefits need special attention so that this programme should not be seen as chargeable to the residents of the unplanned settlement. The enhanced urban environment is a benefit which all will enjoy.

- Community Participation.

The overall performance of an improved water supply and sanitation service development depends on community participation. The upgrading strategy adopted in the models calls upon the direct participation of the community in the unplanned settlements and the other urban land-users who also contribute to the problem under study.

Summary

The major findings in this research include the fact that investment in housing revolves around making decisions in a field full of competiting and conflicting interests. In this respect Maslow's principle of 'hierarchy of needs' appears to prevail. So that households first invest in the house structure unit before investing in infrastructural services like sanitation. Unfortunately, in so doing, it appears that this is only at the expense of the degeneration of the environmental conditions.

Housing development in the unplanned settlement is largely in the hands of the local community. The resident community in Kitui, Kanuku, and Kinyago has tried its level best to improve water supply and sanitation services. Unfortunately, indications are that their efforts have not been effective. A comparative evaluation shows that the situation is worse in the development of sanitation service. In fact the development of an increased water supply has only given rise to a more serious problem of waste water disposal. Site conditions, socio-economic factors, institutional constraints, and lack of support services have all acted simultaneously to inhibit an effective development of the infrastructural services. It is also true to state that the development of water supply and sanitation services goes beyond just the mere provision

of facilities; it calls for a properly designed and managed system otherwise the same facilities could turn out to cause worse conditions.

Among the major recommendations that have been made in respect to the findings include the need to prioritise investment decisions so as to reflect the real aspirations of man, not just in the study area but in the total urban environment. In this respect investment in sanitation infrastructure has been accorded priority but not at all at the expense of other services and human needs that need to be developed as a package whole. Sanitation has been accorded priority because of the seriousness of the repurcussions on the environment. The local community and the support agencies like Undugu Society and the Nairobi City Commission must work as a team towards the societal ultimate goal of improved health. It is also apparent that future development and upgrading of unplanned settlements must take place within the existing environs, although distruptions to the existing pattern of settlement cannot be ruled out. Four models have been proposed in response to the problem of inadequate water supply and sanitation services in unplanned settlements. These models are both specific to the study area and also of general application to other areas of similar problems.

Any upgrading and improved development of unplanned settlements must be seen within a wider and comprehensive development of the total urban environment. Therefore Nairobi City Commission has an obligation to ensure the achievement of this goal. In this respect a special programme needs to be established within the ranks of City Hall to handle this major environmental problem of inadequate water supply and sanitation services. The sooner the environment is saved from further deterioration the better for all.

Finally, some of the policies and engineering design models proposed require a pragmatic approach and call for concerted efforts to begin further research on the same. This is particularly true for the waste water disposal model and Nairobi river development model, for the environmental potentials look immense. In this respect the support of all - the engineers, environmentalists, and the wider body of planners is needed. The support of the politician and the general society at large has a key role in the pursuit of this worthy cause.

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CHAPTER SIX

CONCLUSION

The programmes adopted in the development of water supply and sanitation infrastructure in unplanned low-income urban settlements have so far not been effective in solving the problem of inadequate services. The programmes have been ineffective because of the high cost that puts them out of reach by the target low-income population; they have failed to foster community involvement; and the technologies have themselves been inappropriate due to poor design and operation which leads to the community being exposed to more environmental and health risks. So that the development of water supply and sanitation infrastructure goes beyond the mere provision of facilities and calls upon a more effective strategy as contained in the 'minimum package' model.

While not presuming that one can get 'blood from a stone', the residents in the unplanned settlement of Kitui, Kanuku and Kinyago have played their role in developing some form of water supply and sanitation infrastructure. The research findings have established that their efforts have been hindered by factor forces beyond their means, not to mention the strong urban system forces that depict environmental degeneration. While appreciating the

'basic nature' of water and sanitation services in any human settlement, the major question that is asked is : What is the role, and what should be the role of the community in these settlements vis-a-vis the local planning agency like the Nairobi City Commission, in the development of these infrastructural services? As the overall planning authority within Nairobi City, the Nairobi City Commission has an obligation to oversee the development of an effective and comprehensive infrastructure services in the City, the study area being no exemption. Failure to do this will only lead to a serious environmental degeneration that threatens the survival of all, within and without the unplanned settlement. For one, what moral obligation, in real terms, do individuals show towards waste and therefore sanitation, and its subsequent investment requirement? Very little, if any, in practice. It is important to appreciate the fact that the poor sanitation problem is not confined to the low-income settlements alone. Even in the highly developed countries, with enlightened societies, individual behaviour points to very little concern for waste (McAllister, 1980, p.12; Bach, 1972, p.1; Fitch, 1970; Miller, 1979). So, what can one expect of the low-income society living in what may be considered unhabitable environment - a society that can best be said to be socially, economically, educationally

and technically deprived? How much do you expect them to invest in the development of sanitation infrastructure if at all there is any investment they might have, when they cannot meet their very basic and immediate needs? (McAllister, 1980, in reference to Maslow's hierarchy of needs). In the same line of argument planners need not behave as if no solution is possible to the problem of inadequate development of water supply and sanitation services in unplanned settlements. Planners have a role to guide society to solving its problems even much earlier before the problems are actually experienced. For when a solution has to be sought then, the cost to society is much heavier. In this connection, the adoption of inappropriate technologies that only end up in causing more environmental problems should be avoided and planners need to be more innovative to outgrow traditions of 'conventionalism'.

Finally, as has been mentioned earlier, the method of water supply and sanitation services developed so far have failed to address themselves fully to problems that face the urban low-income population. Therefore, the models proposed herein in the development of water supply and sanitation infrastructure in the study area have attempted to broaden the approach, from the present narrow and sectoral approach on the development of services alone, to include an environmental approach that

addresses itself to the total environmental problems in the low-income area. Furthermore the proposed models attempt to convert what can otherwise be described as idle and misused resources, into environmentally beneficial use. In this connection, particular reference is made to the physical site conditions along Nairobi river that presently pose as constraints to the development of sanitation infrastructure but which, in the proposed model, are put into beneficial use.

It is no secret that the proposals made in this thesis face an enormous task. In proposing to use land as a waste management alternative, the largest problem to be faced is the institutional acceptance of such system for water pollution control (Freshman, 1977) As far as the economic and environmental soundness of the method is concerned, it equally competes with the conventional treatment systems presently in use, if not better. All that is needed is for sanitation engineers and environmentalists to be more bold and outgrow the the methods of sanitation they have always been used to. It has been expressed that many professionals fear taking initiatives because of the uncertainties over the outcome, but it must be remembered that even the present practices which they are now used to and termed

'conventional' did not just come about, they were developed. As was noted in a recent sanitation engineers conference, environmental pollution resulting from waste water that has passed through the soil is far purer than any waste treatment process short of distillation. The challenge that is now put forward is that, being used to the conventional sanitation technologies should not and cannot mean an irrevocable commitment to these technologies. It is for this reason that land sanitary technology is proposed. Land waste treatment technique can be an end process for the disposal of waste; it can be a beginning of reclamation programme to enhance the environment; and land treatment returns nutrients to their natural cycles, and the waste is disposed of in such a manner that long-term adverse impacts can be monitored, controlled and effectively corrected (Ibid; Reid and Coffey, 1978, p.49).

In making the model proposals, the author feels that they should be given a chance to prove their case, for failure to do so will only constitute the perpetuation of the past trends where the professional has no room for local initiative and development of technology, the risks on investment notwithstanding,

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APPENDIXES

A. RESEARCH QUESTIONNAIRE

B. TECHNICAL SPECIFICATION ON EXHAUSTER VEHICLE

APPENDIX A

RESEARCH QUESTIONNAIRE

INTERVIEWER DETAILS - A

1. Name of Interviewer ----------

2. Time of each interview ----------

   Starting ---------- Ending ----------

3. Household Number ----------

Respondent - B

4. Relation to head of household ----------

5. Age ---------- Years

6. Sex : Male/Female

Household Details - C

7. Size of household ----------

8. Household details, including the respondent:

Sex M/F	Age (Yrs)	Religion	Original Home	Length of stay - Kitui	Years in School	Place of Work	Income KSh/month

The House Building Unit - D

9. Number of rooms used by the household ----------
10. Total room area in m^2----------
11. Building material - mud-and-wattle/masonry/timber/ paper/others ----------
12. Building cost of the house Kshs. ----------
13. Who owns the house unit? Self/landlord/private company
14. Rent paid for the accommodation per month Kshs ----------

Water Utility - E

Objective : ascertain respondent's ability, willingness and understanding of the problem so as to contribute to the improvement.

15. Which are the sources of your water?

Source	Location	Distance (m)	Cost (Kshs.)	Private
Individual tap				
Communal tap/				
Kiosk				
Nairobi river				
Rain water				

16. Does the source of water vary depending on the: user/use of water/time of day/payment/congestion/ rain season?

17. Who delivers the water from the source to the house? women/men/anybody/private sellers/others specify

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18. How many times is water collected in a day? ------

---------- quantity ----------

19. Do you store any water in the house? Yes/No, Container/capacity.
20. Do you find storing water a problem? Yes/No
21. What kind of storage problem? Small quantity/ no space in house/pollution.
22. What is the stored water used for? Drinking/Washing/ Cooking/others
23. When is the stored water used? Night/day/any time.
24. For which purposes do you use Nairobi river water? Cooking/Drinking/Bathing/Washing/House Cleaning/ House Building
25. Do you use Nairobi river because of congestion/ payment at the water kiosk? Yes/No
26. What danger does Nairobi river pose? Disease/Flooding
27. What problem do you have with water? High payment/ too far/dirty/congestion at source
28. How can the problem of water be solved?
29. Are you willing to pay more for an improved water service? Yes/No
30. What type of improvement? Individual tap/more communal taps/reduced payment.

31. Where do you pour the waste water? The floor/ outside drain.
32. What problem does the undrained water around the house cause? Disease/unsightly/mosquitoes.
33. Where is the washing and bathing done?
34. Which system is used in the disposal of human waste? Pit latrine/bucket night-soil/ on open ground/Nairobi river/others
35. Which system do you prefer?
36. Do you have a private or a communal toilet?
37. Where is the toilet located? Distance from house/inside/outside?
38. What problem do you encounter with the toilets? Too few/congestion/Dirty/nots safe/others (specify)
39. Do you prefer communal or private toilets?
40. Are you charged for the use of the toilet? Yes/No
41. Which type of toilet do you prefer?
42. Can you prefer a pit latrine if it can be maintained properly? Yes/No
43. What problems is encountered in using the toilet at night?
44. Do children find it easy to use the present toilets? Yes/No
45. Who built the toilets?
46. Why do you think toilets are dug a long Nairobi river?
47. How deep are they toilets?
48. For how long are these toilets used before they fill up?

49. How can the provision of electricity improve the usage of water and toilet facilities?
50. How do you dispose of your solid waste?
51. Do you have a problem with dogs/rats/mosquitoes/ other vermin?
52. Do you participate in communal activities?
53. Would you prefer to join others in improving health conditions in the village or should everyone work as an individual to improve the poor environment?
54. Do health and education officers work within this village? Yes/No
55. Which mass media are you accessible to? Radio/TV/Cinema/Newspaper.

Technical Information - H

(a) Local authorities

1. What is the legal standing on unplanned squatter settlements like Kitui, Kanuku and Kinyago villages in Nairobi?

   On land ----------

   On the house building ----------

   On the residents ----------

2. What makes these settlements illegal? Land ownership/ residential land zoning/poor site conditions/unplanned development

3. Do you recognise ownership of land/house building by the residents? Yes/No

4. Do you provide infrastructure services to these unplanned settlements? Yes/No. Water/human waste/solid water/roads

5. Can an individual or group apply to obtain these services? Yes/No

6. Who finances investment in on-site/trunk services?

   On-site - NCC, NHC, Central Government;

   Trunk services ----------

7. What are the development costs of water supply?------ sewerage ------ pit latrines; septic tanks --------- night-soil -----; roads -------- water---------- communal points ------; individual connection ------

8. Which types of sanitation services do you offer?
   Sewerage/septic tanks/cesspools/pit latrines/night-soil (buckets)/soakways/others.

9. What determines the type of service offered?
   Residential area/income/existing services around/density of development.

10. Is the cost recovery based on market rates/subsidy?

11. What are the charges on these services of water and sanitation?
    Water: Communal -----; Individual connection;
    Sanitation: Sewerage Communal ----; Private ------
    Septic tank ----------; Cess pools ----------;
    Pit latrine ----------; Night soil ----------;
    Soakways ----------; Others ----------;
    Solid waste ----------

12. What is the revenue collected from these services used for?
    Maintenance of facilities/service staff salaries/Service expansion/City Treasury.

13. How is the revenue for these services collected?
    With water bill/separately for each service as is done/flat rates.

14. Is any problem encountered in revenue collection?
    Defaulting/Staff/High operational costs/Vehicles/Identifying users.

15. Who maintains the plot connections/communal facilities?

16. Who pays for the maintenance? NCC/Individual users.
17. What maintenance is done? Cleaning/blockage/ exhauster emptying/breakdown repairs/
    What are the charges?
18. Which are the common maintenance problems?
    Poor usage/storage of Personnel and Vehicles/ equipment and material.
19. Do you have specific staff for maintenance of these services alone?
20. What are their salary rates per month?
21. What is the capital maintenance cost of exhauster vehicle?
    Capital ----------
    Maintenance per month -------
22. What is the size of the exhauster vehicle?
    ----------m^3/litres
23. What problems does unplanned settlement pose to exhauster vehicle?
24. How are the various cases of maintenance reported and executed?
25. Do you have staff assigned to a particular estate to look after infrastructural services?
    Yes/No
26. What time is the cleaning or emptying of toilets done? Morning/Night.
27. What problem does communal water points/toilets pose?
    Poor usage/wastage/no revenue.

28. Which infrastructure service do you provide as a priority to low-income housing area? Water/ Sanitation (human, solid)/roads.

    (b) Health and others (e.g. NGOs)

29. Name of Organisation ----------

30. What aspect of community life do you address yourselves to? Child care/General health Nutrition/ Family Life/House building/Community activities/ others/employment.

31. Which section of the community do you deal with? Women/Children/Youth/Men/All /Community groups/ disabled.

32. Which is the forum for meeting your target group? Public meetings/chief's baraza/group meetings/ individual family/others.

33. Which aspect of community life is your staff trained in? Health/Child care/nutrition/environment/Social/ administration/general education.

34. Is the public response good/bad?

35. What problems do you encounter in giving your services? Administrative/unwillingness by the people/high expenses/shortage of personnel and vehicles/equipment and material.

36. In what form do you disseminate information to the community? Orally during meetings/Media/ Literature.

37. Do you undertake surveys to evaluate the success of your programmes? Yes/No

38. What aspects of community life inhibits the success of your programmes? Illiteracy/Poverty/Security of land tenure/Other family engagements/Scarcity of land/Water/Unwillingness.

39. Which infrastructure service do you consider to be of priority? Water/Sanitation/Roads/electricity.

40. What role does public participation/Education play in the success of your programme?

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41. Which are the most common water-borne and poor hygiene diseases? ----------

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42. Are most diseases in the community caused by : Water/poor sanitation/Diet/Hygiene/Ignorance/ Overcrowding in the house/Vermin?

APPENDIX B

TECHNICAL SPECIFICATION ON EXHAUSTER VEHICLE

T: The basic model is expected to cost less shs 200,000. This is only about 30-40% of osts of a conventional exhauster. It. should be affordable to most local authorities while a entional machine is not.

ROW WIDTH. Only 155 cm wide to le it to travel into areas where other cles cannot reach.

NOUVERABILITY. Only 395 cms long with independant rear wheel brakes so one wheel can be locked to "skid" the auster around in a turning circle of only O metres.

F ROAD PERFORMANCE. With tractor p rear tyres and most of the weight on se driving wheels the exhauster can travel o areas which are normally inaccessible to icks. Its ground clearance of 24.5 cm ows it to clear obstructions.

NK CAPACITY. A 1,500 litre sludge pacity is adequate for most pits.

RESH WATER CAPACITY. A 200 litre esh water tank and high pressure 150 p.s.i.) wash down pump enables dense udges to be injected with water to make iem liquid enough for pumping and the xhauster and surrounding areas can be ashed down after pumping.

OW TANK HEIGHT. The liquid level in the ank is only 180 cm above the ground ompared with 3.0 metres or more for onventional exhausters. this allows the exhauster to suck from deeper tanks or pits.

CREW CAPACITY. Safe seating for two crew and the driver.

SUCTION CAPACITY. A high performance, forced air cooled vacuum pump sucks 9,000 litres of air per minute and can reach vacuums as high as 0.8 bar.

allow most wastes to be discharged easily. The high pressure wash down pump can be used to "jet" water through the discharge valve. For extreme conditions, the 80cm diameter rear door can be opened and the tank tipped hydraulically to an angle of 50 degrees.

LISTER ENGINE. The three cylinder, 30 hp Lister engine runs at only 2,200 rpm to give a long life with the minimum of maintennance.

FOUR SPEED GEAR BOX. The wide ratio, four speed gearbox gives a crawling speed of only 4.2 kph for climbimg steep hills when towing a trailer. The high top gear gives a maximum speed of 31 kph which is adequate for city conditions and short haul distances.

CYCLONIC GRIT TRAP. Centrifugal force removes any dirt from the air stream with a fine meshed filter to give full protection to the pump and prevent pollution of the atmosphere.

LARGE DIAMETER SUCTION HOSES. 4"Dia. suction hoses will not block if there are bottles or other such debris in the pits.

TYRES. Rear. 7.50 x 16 - 8pr tyres with tractor or "Translug" grip give good traction and 6.00 x 16 -6pr , tractor front ribbed tyres give easy steering.

SIMPLE MAINTENNANCE AND SPARE PARTS AVAILABILITY. The exhauster is designed to use as many parts as possible which are already readily available in Kenya.

TRAILER. The exhauster can tow a trailer behind it with a further.. capacity of 1,500 litres of sludge. The trailer is fitted with automatic over run brakes for use on steep hills.

PUMPING ATTACHMENT. A simple attachment allows the exhauster to be used for pumping liquids or sludges by alternatively