SUSTAINABLE URBAN DESIGN IN NAIROBI'S EASTLANDS: THE CASE OF KALOLENI ESTATE

(RESEARCH-PROJECT REPORT)

MASTER OF ARCHITECTURE

UNIVERSITY OF NAIROBI

COLLEGE OF ARCHITECTURE & ENGINEERING

DEPARTMENT OF ARCHITECTURE

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MAY, 2016

DECLARATION

I declare that this is my original work. I also affirm to the best of my knowledge that this thesis has not been presented in this or any other university for examination or any other purpose.

This work forms part fulfilment of the requirement for the award of the degree of Master of Architecture.

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DEDICATION

This work is dedicated to my Sister Leah Gesare Arwari for giving me passion to work hard and live a life well lived. To my Father Jackson Nyanumba Arwari and Mother Callen Moraa Arwari for according me the gift of Education.

ACKNOWLEDGEMENTS

I am sincerely indebted to God for the strength and people he has graciously blessed me with. The success of this research project report is attributed to the following; who contributed directly or otherwise towards the undertaking of this study. However, as the author, I accept full responsibility for any inaccuracies of this work.

My profound thanks go to my supervisors Prof. T.J.C Anyamba and Dr. Laban Shihembetsa whose guidance, intellectual input and encouragement greatly assisted in the production of this work. I thank the Post graduate staff at the Department of Architecture, University of Nairobi, for affording me the opportunity to fulfill my dreams and support to complete this study.

I wish to express my heartfelt gratitude to my mom and dad, for their undying support and relentless encouragement especially during my weakest moments. Many thanks to Fiona Latabo for your priceless company and encouragement that made campus life memorable. . Lastly, to the Rogenas, for showing me the essence of education Thank you for the moral support and humor through tough times.

ACRONYMS

CBD	Central Business District
CHP	Combined Heat and Power
EPA	Environmental Planning Agency
JICA	Japan International Cooperation Agency
KERA	Kaloleni Estate Residents Association
LEED	Leadership in Energy and Environmental Design
LEH	Low Energy House
MUD	Mixed Use Development
MVRDV	Rotterdam based Architecture and Urban Design practice. The name is an acronym for the founding members: Winy Maas, Jacob Van Rijs and Nathalie de Vries.
NCC	Nairobi City County
NEMA	National Environmental Management Authority
NUC	Neighbourhood Unit Concept
PPP	Public Private Partnership
TOD	Transit Oriented Development
UK	United Kingdom
USGBC	United States Green Building Council
VMT	Vehicle Miles of Travel

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ABSTRACT

This study examines how sustainable urban design principles can be used to ensure a sustainable Kaloleni Estate. Kaloleni Estate is a case study in Nairobi's Eastlands and shares similar chacteristics to other neighbourhoods within this part of the City. The paper examines the quality of built and open spaces in Kaloleni Estate. It also studies how the land in Kaloleni Estate has been utilized in relation to its proximity to Nairobi CBD.

This study revealed that sustainable urban design principles entail components such as density, sustainable corridors, biophilia and high performance buildings and infrastructure. These components are tailored depending on the context in which they are applied. This study examines these sustainable urban design components in Nairobi's Eastland, the case of Kaloleni Estate.

In order to explore sustainable urban design in Nairobi's Eastlands with the aim of ensuring a sustainable Kaloleni Estate, use of a local study was employed. This contextualized the sustainable urban design components and lessons were derived. Best practices from an international case study were used as a benchmark for the study.

The study concluded that sustainable urban design for Nairobi's Eastlands is an important factor in ensuring a holistic city for all classes of people. Compactness and Biophilia are the hallmarks of sustainable urban design in Kaloleni Estate and this can be applied to other neighbourhoods in Kenya. Considerations should be given to density and integration of landuses to ensure job creation is achieved. This should go hand in hand with achieving Biophilia (connecting human beings to nature) in Nairobi's Eastlands.

This study recommends the need to compact Kaloleni Estate and Nairobi's Eastlands as a whole. This is with a view of optimally utilizing the land in Kaloleni Estate. The density in this area should be within a sustainable range depending on the proximity to Nairobi CBD. The government and Nairobi City County should take a leading role in ensuring sustainable neighbourhoods are achieved in Nairobi's Eastlands.

1.0 INTRODUCTION

This chapter introduces the research project report and it is broken down into ten sub-sections as follows:

1.1 Background

Urban design is defined as an interface between Architecture, Planning and Landscape Architecture in the urban areas. This is with a view of making cities efficient, live-able, equitable and sustainable. Sustainable urban design draws attention to the enormous opportunity to design the built environment in a manner that supports a higher quality of life and promotes a healthy and sustainable lifestyle (Farr: 2008)

The current popular definition of sustainable urbanism is also imagined as a grand unification of architecture, city planning, and environmental design for a better way of life. According to Adhya et al: 2010 this is problematic as it situates the domain of sustainable urbanism in the context of contradictory and conflicting design bias of architecture, urban planning, landscape architecture and civil engineering. This also underscores a lack of clear definition and understanding of sustainability and sustainable urbanism (Newman: 2005).

Sustainable urbanism has also been defined as walkable and transit served urbanism integrated with high performance buildings and high-performance infrastructure (Farr, 2008). Compactness (density) and biophilia which is connecting humans to nature are considered as the core values of sustainable urbanism.

The meaning of sustainable urban design is explained from a relatively new model of sustainability-the ecological model (Williams: 2007). This model argues sustainable urban design as a system of dynamic connective processes of biological interchanges, efficient use and storage of energy and effective management of natural resources as opposed to sustainable urban design as a definite product (Adhya et al: 2010).

The ecological model has three important implications: firstly spatial interdependence and connectivity becomes critical to sustainable design. Secondly, the ecological systems approach brings a process oriented notion of sustainability. Lastly, it allows connections of the environmental systems to the social and economic systems towards generating an interconnected network of interrelations.

This study focuses on the sustainable urban design model by Douglas Farr with a view of investigating it in Nairobi's Eastlands, Kenya. According to Angels: 2012 cities across the

world face similar challenges. However, urban design solutions have to be specific to developing countries due to the uniqueness of these cities.

The path to sustainable urban design builds on the principles of smart growth, new urbanism and green buildings. If successful it will not only vastly reduce environmental harm but also offer stunning enhancement to the current quality of life. Sustainable urbanism helps in the creation and support of communities that are so well designed for high quality of life. The people in these communities meet their daily needs on foot and also transit.

Farr: 2008 argues that it is no longer acceptable to build a high performance building in a greenfield, automobile dependent context and have it certified as green. It is no longer good enough to develop in a responsible location and build an admirable, walkable, mixed use neighbourhood while ignoring the level of resources required to build and maintain the buildings there.

The most appealing aspect of sustainable urban design is the sustainable neighbourhood. Sustainable neighbourhood should be compact and pedestrian friendly but typically have a single use for example campus, industrial park or college. Sustainable urban design emphasizes that personal appeal and societal benefits of neighbourhood living.

Kaloleni Estate is a good example of neighbourhood living in the Nairobi, Kenya. It has been described as a 'model neighbourhood unit' (Hake: 1977). Kaloleni was constructed between 1945 and 1948 (Ogilvie: 1946, Hake: 1977, Nevanlinna: 1996 and Anderson: 2002) through colonial grants. It was developed to house the native Kenyans following the recommendations of Mortimer who chaired the African Housing Committee (Mortimer: 1946, Ogilvie: 1946) that was tasked to address African urban housing needs.

Kaloleni Estate is located on the Eastern part of Nairobi, about two kilometres from the CBD. Bordering the estate to the west is the City Stadium; to the east, Makongeni estate; to the north, Jogoo Road; and to the south is the Industrial Area, a manufacturing district. Kaloleni Estate sits on prime land due to its proximity to the CBD and the land value is estimated as Kenya Shillings 400 million per acre.

Kaloleni Estate was designed based on Ebenezer Howard's Garden City principles. It had wide access roads planted with trees to the sides, generous open spaces, plenty of greenery and housing units to accommodate the rising population. (Hake: 1977 p. 56).

Today this garden city like neighbourhood has deteriorated with most of the open spaces having been converted into platforms for informal activities (Makachia: 2010). The housing units are in disrepair due to lack of maintenance by the Nairobi City County. The spaces in Kaloleni estate are no longer sustainable, live-able, equitable and thus not of good quality.

According to Hake: 1977 p. 55 in the year 1946 the native Kenyan population in Nairobi was 67, 000 but there was barely adequate housing for 50, 000 native Kenyans. Kaloleni Estate was designed to cater for population of 3,000 thousand bachelors. The Kenya population census of 2009 depicts the population at 7, 761 people. The population is projected to reach 8, 126 people by the year 2015. This shows that the population has more than tripled and the same spaces and infrastructure designed in 1945 serve this population.

This study seeks to study Kaloleni estate with a critical evaluation of the spaces. This is with a view of finding out whether these spaces are livable and sustainable. Sustainable urban design principles will be used as the benchmark of studying Kaloleni Estate with the aim ensuring Kaloleni Esate is a sustainable neighbourhood.

1.2 Problem Statement

Kaloleni Estate is located approximately two kilometres from Nairobi CBD. Due to this fact, the land is valued at Kenya Shillings 200 million per acre due to the proximity to Nairobi CBD. Kaloleni Estate covers 92.4 acres of land and the population is projected to reach 8,126 people by the year 2015. There exists single dwelling duplexes in form of bungalows with informal extensions to accommodate this population. The land in Kaloleni estate is underutilized bearing in mind the estates proximity to Nairobi CBD and also the density evident.

In addition, the housing units in Kaloleni Estate are in disrepair due to lack of maintenance by the Nairobi City County. There exists informal housing extensions to accommodate the population growth. Most of the open spaces have been converted into platforms for informal activities such as informal commercial activities, garbage disposal. The roads have not been paved since 1948 and the estate lacks running water despite having the water piping in place. This study seeks to establish the quality of spaces in Kaloleni Estate and how the land can be optimally utilized using sustainable urban design principles.

1.3 Aims and objectives of study

i. To assess the condition of built and open spaces in Kaloleni Estate.
ii. To investigate sustainable urban design principles with regard to Kaloleni Estate.

iii. To explore how sustainable urban design guidelines can be used to optimally utilize the land in Kaloleni Estate.

1.4 Study Assumptions

i. It is assumed that Kaloleni Estate faces similar challenges to the larger Nairobi's Eastlands. This is due to the fact that Eastlands is comprised of colonial estates and estates constructed after Independence by the Nairobi City County and private developers.
ii. Sustainability can be articulated from different schools of thought. It is assumed that this research will lay emphasis on the spatial element of sustainability.

1.5 Research Questions

i. What the quality is of built and open spaces in Kaloleni Estate? Are they efficient, live-able, equitable and sustainable?
ii. How are the spaces in Kaloleni Estate utilized in the relation to its proximity to the Nairobi CBD?
iii. How can sustainable urban design principles be used to ensure Kaloleni Estate is a sustainable neighbourhood?

1.6 Significance of study

One of the fundamental pillars of Vision 2030 is the Social and Political Pillar. This focuses on the following sectors; Education, Health, water & Sanitation, Environment, Gender-culture-Sports-Social Services, Youth, Housing & Urbanisation and Political Governance. This Study will contribute to the Housing and Urbanisation Sector of Vision 2030.

The Housing and Urbanisation Sector aims at Production of 200,000 housing units under various initiatives (urban renewal and re-development programme, PPP urban housing infrastructure programme and the employer incentivized public and private housing schemes. Nairobi's Eastlands renewal is one of the Nairobi City County Vision 2030 Flagship project. This research report will contribute in ensuring that the Nairobi City County achieves its aspirations of renewing the entire Nairobi Eastlands. This research can be used as a model of designing sustainable neighbourhoods in Nairobi and across the country.

1.7 Study Scope

This study entails a theoretical scope and a geographical scope so as to ensure it is Specific.

1.7.1 Theoretical Scope

The main focus of this study is to study sustainable urban design in Nairobi's Eastlands. This study will explore the ecological model by Williams: 2007 and the theory by Farr: 2008 on Sustainable Urban Design. The Ecological Model argues sustainable urban design as a process entailing system of dynamic connective processes of biological interchanges, efficient use and storage of energy and effective management of natural resources. Farr: 2008 argues Sustainable Urban Design as a product defined by compactness and biophilia. This study will be limited to the theory by Farr: 2008 explaining Sustainable Urban Design as a product of Compactness and biophilia. This is because this study seeks to explore how the prime land in Kaloleni Estate can be optimally utilised using the sustainable urban design principles.

1.7.2 Geographical Scope

This study will be carried out in the County of Nairobi focusing on the Kaloleni area. This is because Kaloleni Estate was considered a model neighbourhood but its current state leaves a lot to be desired. The housing units in Kaloleni Estate are in disrepair, most of the open spaces have been converted into platforms for informal activities and infrastructure is in a poor state. Kaloleni is also part of Nairobi Eastlands which faces urban design challenges such as compactness and poor quality of spaces.

Fig 1.7: Map of Kenya showing location of Nairobi City. Source: Survey of Kenya, 2005

1.8 Study limitations

The study will limited to Kaloleni Estate in Nairobi's Eastlands in Nairobi County. This is due to the Estate being a good representation of the city neighbourhoods. In addition limited resources such as time and funds available for the research confined the study to Kaloleni Estate.

1.9 Research Design

This is a research that aims at investigating sustainable urban design with regard to Kaloleni Estate. The study aims at using already available data on Kaloleni Estate to assess the quality of spaces. This will take a keen look at a historical study of Kaloleni Estate and how the estate has transformed to the current state.

This study will be Qualitative and Quantitative in nature owing to the theoretical scope which argues Sustainable Urban Design based on Compactness and biophilia. This study will explore the density in Kaloleni Estate with a view of establishing whether it is compact and thus quantitative. The study will also establish how Kaloleni Estate is connected to Nature through open space design, stormwater management, waste management, public lighting, and food production. This focuses on the quality of spaces and spatial usage and thus qualitative in nature. The table below explains what the research intends to find out, the sources of information to be utilized to achieve the different facets of Sustainable Urban Design in Kaloleni Estate.

Table 1.9: Research Design. Source: Author

No.	Research Question	Data Source	Remarks
1.	What is the quality of spaces in Kaloleni Estate? Are they efficient, livable, equitable and sustainable?	Primary data	Sustainability through connection to nature
2.	How are the spaces in Kaloleni Estate utilized in the relation to its proximity to the Nairobi CBD?	Primary data	Compactness-optimal utilization of space based on its land value
3.	How can sustainable urbanism be used to ensure Kaloleni Estate is a sustainable neighbourhood?	Secondary data	Kaloleni Estate as a sustainable neighbourhood

1.10 Operational definition of terms

This sub-section is further divided into eleven categories as follows:

Compactness: Density that efficiently supports public transit and ensures walkable destinations within the neighbourhood. This is an average density more than seven or eight dwelling units per acre.

Biophilia: Connecting human beings to nature based on the intrinsic interdependence between humans and other biological systems.

Equitable: spaces that are accessible to all for living, playing and working. These spaces can be accessed by people of all ages, gender and the physically challenged.

Livable: Spaces that support human life with natural ventilation, daylighting, ample space for work, play and residence.

Efficient: The ability of spaces to meet the maximum need of the users with minimum wasted effort or expense.

Quality spaces: Spaces that are comfortable to live, work and play in. These spaces with densities not too low or to high should be able to support public transit, entail walkable destinations and are in tandem with nature.

Optimal utilization: maximum exploitation of space by ensuring the space is compact and in touch with nature.

Sustainable: Spaces that seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future.

Smart growth: concerns with taking advantages of compact building design. The location within a region is important so natural areas can be preserved.

New urbanism: main focus is on creating walkable, mixed-use neighbourhoods with distinct urban design form in terms of architecture.

Green buildings: concern with urban heat islands, storm water filtration, local content, and buildings' life cycle cost

1.11 Research Project Report Structure

The project report will be organized in seven chapters as follows:

Chapter One features the introduction, problem statement, research questions, aim and objectives, study assumptions, significance of study, study scope, study limitation, research design, operational definition of terms and report structure.

Chapter two focuses on a review of literature related to the research topic. It will look at the description of urban design and form, the concept of sustainable urbanism in developing countries, the concept of sustainable neighbourhoods, and conceptual framework of this study. This chapter will also look at case studies of how sustainable urbanism has been applied in Nairobi, Kenya and also the best practises with regard to Sustainable Urban Design in Developed countries.

Chapter three discusses the methodological approach used for the study. This entails how the research is designed, research procedure to be applied and the research methods to be utilized in data collection.

Chapter Four focuses on a historical study of Kaloleni Estate, current state of Kaloleni Estate in terms of the quality of spaces and density. Finally, the study will look at how sustainable urban design principles can be used to create livable, efficient, equitable and sustainable Kaloleni Estate.

Chapter Five will discuss study findings and analysis

Chapter Six will depict the results and discussions of findings and give conclusion, recommended actions and area of further research.

2.0 LITERATURE REVIEW

This chapter provides a discussion on the theories and concepts of sustainable urban design in Nairobi's Eastland's, Kenya. It further discusses principles of sustainable neighbourhoods and how sustainable neighbourhoods ensure the urban areas are sustainable. These two issues are concerned with urban form which is the core of urban design. This study begins with defining urban design and current urban context before delving deeper to the theories of sustainable urban design. This research will look at the ecological theory and the Grand unification theory by Farr: 2008 and delve deeper into the application of the Grand unification theory to Nairobi's Eastland's.

2.1 Urban design and current urban context

Urban design is the interface between town planning and architecture, this is the design and layout of urban spaces (Ratcliff et al; 2009). According to the American planning Association (2006) urban design gives a three dimensional physical form to policies enshrined in the comprehensive plan. The key elements of an urban design scheme entail a plan, perception of design guidelines for buildings and the open spaces.

At the beginning of the third millennium of the 21st century, the world is denser than before. It entails more people who consume more and who produce more and more pollutants through their lifestyle. This demands more space, more energy, more resources, while demanding more safety and buffers in the event of increasing possibilities of disasters (Adhya et al; 2010).

According to Ayres; 1999 there exists four revolutionary changes sweeping the world and transforming our lives: firstly the increasing population, secondly is the increasing consumption, in addition increasing waste (CO2) production plays a key role, and lastly it is the increasing extinction of flora and fauna. Combination of these factors has resulted in a complex global context that is characterized by a downturn in the global economy, deterioration of global environment, and breakdown of global relationships in terms of human conflicts (MVRDV; 2007).

In his book planet of cities, Angels; 2012 argues that urban expansion is a universal phenomenon, it is however characterized by a powerful contradiction. The urban contradiction reveals that the growth is not uniform in many urban situations. In the situation of shrinking cities, the growth is occurring in the certain pockets of the metropolis.

So, though there is huge metropolitan growth, there is simultaneous displacement, deterioration, and devaluation of the inner core cities. Such a metropolitan context presents a scenario with new challenges and opportunities. Evolution of Sustainable urban design as a new discourse within the disciplines of architecture, city planning, and urban design is one of such new opportunities.

2.2. Sustainable urban Design Theories

Sustainable urban design has recently been defined using the ecological model of sustainability (Williams; 2007). According to Bregon et al; 2006 Ecology is the scientific study of the distribution and abundance of life and the interactions between organisms and their natural environment.

Within this framework, the focus shifts from understanding sustainability as a definite product to valuing sustainability as a system of dynamic connective processes, biological interchanges, efficient use and storage of energy, and effective management of natural resources (Adhya et al: 2010).

The ecological model of sustainable urban design steps from classical works such as Fundamentals of Ecology (Odums: 1953) and Design with Nature (McHarg: 1992). It explains sustainability as a process of relationships among the natural systems (such as soil, climate, hydrology) and between the natural systems, relationship to the human systems (social ethics and values), and the economic systems (allocation, distribution, and management of resources).

The ecological model has three important implications: firstly, spatial interdependence and connectivity becomes critical to sustainable urban design. Secondly, the ecological systems approach brings a process oriented notion of sustainability. Finally, and it also allows connections of the environmental systems to the social and economic systems towards generating an interconnected network of interrelations.

Sustainable urban design has recently also been defined as “walkable and transit-served urbanism integrated with high performance buildings and high-performance infrastructure” (Farr; 2008). Compactness (density) and biophilia (human access to nature) are considered as the core values of sustainable urbanism.

These associated values of sustainable urban design focuses on the form-based bias of the current architectural theories and practices for understanding sustainability. It focuses on the

definite product of urban design as opposed to the ecological model. The ecological model by (Williams: 2007) values sustainable urban design as a system of dynamic connective processes, biological interchanges, efficient use and storage of energy, and effective management of natural resources.

2.2.1 Convergent points of Sustainable Urban Design Theory/Model

The theory by Farr; 2008 and the model by Williams: 2007 on sustainable urban design have points of convergence in as much as they are different. The two paradigms of sustainable urban design emphasise on the need to create connections of the environmental systems to the social and economic systems towards sustainable urbanism. Secondly, they both subscribe to the idea that sustainable urban design is holistic combines economic, social and environmental aspects.

In addition, the relationships between natural systems is an important aspect in both the two explanation of sustainable urban design. Farr; 2008 argues that connecting humans to nature is a core component of sustainable urban design. Williams: 2007, second this argument by explaining sustainable urban design system of dynamic connective processes, biological interchanges, efficient use and storage of energy, and effective management of natural resources.

Farr: 2008 and Williams: 2007 share the same views regarding sustainable urban design in the sense of spatial interdependence. They argue that spaces in sustainable urban design should be integrated and connected. Farr: 2008, explain that integrating transport with land uses and technology is key in achieving sustainable urban design. Williams: 2007, alludes to this by emphasising that spatial interdependence and connectivity becomes critical to sustainable urban design.

2.2.2 Divergent points of Sustainable Urban Design Theory/Model

The main divergent point is that the approach by Williams: 2007 process oriented while the approach by Farr: 2008 is a product oriented. Williams: 2007, emphasises on the need for ecological systems which is basically geared towards biological interchanges. Farr: 2008, argues sustainable urban design as a product of compactness and biophilia. This theory is keen on ensuring that neighbourhood are sustainable.

The model by Williams: 2007, argue that connections of the environmental systems to the social and economic systems towards sustainable urbanism. Environmental systems are the

primary concern of the ecological model of sustainable urban design. The social and economic systems are secondary to the ecological systems. The theory by Farr: 2008, share an interest in comprehensive economic, social and environmental reform. It a grand unification of social, economic and environmental sustainability.

Farr: 2008's theory emphasises on the need for compactness and biophilia in achieving sustainable urban design. This are the building blocks of a sustainable neighbourhood. The ecological model is interested in a balance in the natural systems with built environment. Density is not a primary concern in this model of sustainable urban design. This model actually advocates for low densities as opposed to sustainable densities by Farr: 2008.

2.2.3 Unification Theory

This study is focused on the theory by Farr: 2008 and thus the need to delve deeper on the building blocks of this theory. Farr: 2008 claims that sustainable urban design grows from three late 20th century movements. The "smart growth", "new urbanism" and "green buildings movement" with its standards for green building - Leadership in Energy and Environmental Design (LEED). While all three share an interest in comprehensive economic, social and environmental reform, they differ in their history, constituencies, approach and focus.

First and foremost the smart growth movement concerns with taking advantages of compact building design. This movement emphasizes on the location of the urban design scheme within a region is so that natural areas can be preserved. Secondly New urbanism's main focus is on creating walkable and mixed-use neighbourhoods. Lastly the green building concern with urban heat islands, storm water filtration, local content, and buildings' life cycle cost (Farr: 2008).

Individual implementation of these movements has resulted in myopia when it comes to searching for long term solutions. This is due to self-validation owing to an unwillingness to engage a larger, comprehensive agenda. For example, a walkable neighbourhood is hard to sustain when its houses are inefficient. Another epitome is, a certified green building is not in tandem with the environment when it is surrounded by a massive parking lot.

In order to understand the grand unification theory by Farr: 2008, it is important to understand smart growth, New urbanism and green building movements. These are the building blocks of this theory creating a unification.

2.2.3.1 Smart Growth Theory

Smart growth is founded in the environmental movement of the 1970s which was strengthened by President Richard Nixon's environmentally focused legislative agenda. The smart growth movement embraced a broader agenda in 1996 with the development of ten principles of smart growth.

The ten principles of smart growth are as follows: to create a range of housing opportunities and choices, to create walkable neighbourhoods, to encourage community and stakeholder collaboration, to foster distinctive attractive places with a strong sense of place. In addition, the other principles are: make development decisions predictable, fair and cost effective, mix land uses, preservation of open space, farmland, natural beauty and critical environmental areas (Farr: 2008).

Lastly, provision of a variety of transportation choices, strengthen and direct development toward existing communities and taking advantage of compact building design. At the time, many environmentalists were anti-growth and viewed all development as hostile to the environment. The principles united a decentralized grassroots movement of local and regional activists.

2.2.3.2 New Urbanism Theory

The congress for new urbanism was founded in the early 1990's by six architects: Peter Calthorpe, Andres Duany, Elizabeth Moule, Elizabeth Plater-Zyberk, Stephanos Polyzoides and Daniel Solomon. They had earlier collaborated in the design of a Playa vista, a large mixed use development in Carlifonia. In the year 1991, they had also participated in the writing of the Ahwahnee Principles for Resource-Efficient Communities. Their common goal was to provide an antidote to conventional sprawl by promoting traditional urbanism (Farr: 2008).

The stature of new urbanism is reinforced by the coffee table book The New Urbanism: 1994. This book features expensive, surburban greenfield and resort development and was further promoted by Disney's decision to develop the town of Celebration, Florida using new urbanism principles.

These new urbanism principles are clearly spelt out in New Urbanism: 1996) as follows: First and foremost the metropolitan region is a fundamental economic unit of the contemporary world. Governmental cooperation, public policy, physical planning, and economic strategies

must reflect this new reality (Calthorpe: 1996). Secondly, Metropolitan regions are finite places made of multiple centres that are cities, towns, and villages, each with its own identifiable centre and edges (Yaro: 1996).

In addition, the metropolis has a necessary and fragile relationship to its agrarian hinterland and natural landscapes. The relationship is environmental, economic, and cultural. Farmland and nature are as important to the metropolis as the garden is to the house. (Arendt: 1996). Another principle is that Development patterns should not blur or eradicate the edges of the metropolis. Infill development within existing areas conserves environmental resources, economic investment, and social fabric, while reclaiming marginal and abandoned areas (Grimshaw: 1996).

Morris: 1996, explain the fifth principle as where appropriate, new development contiguous to urban boundaries should be organized as neighbourhoods and districts, and be integrated with the existing urban pattern. Moreover, the development and redevelopment of towns and cities should respect historical patterns, precedents, and boundaries (Bothwell, 1996, p. 49).

Richmond: 1996 adds that, Cities and towns should bring into proximity a broad spectrum of public and private uses to support a regional economy that benefits people of all incomes. Affordable housing should be distributed throughout the region to match job opportunities and to avoid concentrations of poverty.

In relation as explained by Arrington: 1996 the physical organization of the region should be supported by a framework of transportation alternatives. Transit, pedestrian, and bicycle systems should maximize access and mobility throughout the region while reducing dependence on the automobile.

The congress for new urbanism also stipulated that revenues and resources can be shared more cooperatively among the municipalities and centres within regions to avoid destructive competition for tax base and to promote rational coordination of transportation, recreation, public services, housing, and community institutions. (Orfield: 1996).

In the fourth congress of new urbanism Barnett: 1996 explains that the neighbourhood, the district, and the corridor are the essential elements of development and redevelopment in the metropolis. They form identifiable areas that encourage citizens to take responsibility for their maintenance and evolution.

It is important to note that Neighbourhoods should be compact, pedestrian-friendly, and mixed-use. Districts generally emphasize a special single use, and should follow the principles of neighbourhood design when possible. Corridors are regional connectors of neighbourhoods and districts; they range from boulevards and rail lines to rivers and parkways (Plater-Zyberk: 1996)

According to Kulash: 1996, Many activities of daily living should occur within walking distance, allowing independence to those who do not drive, especially the elderly and the young. Interconnected networks of streets should be designed to encourage walking, reduce the number and length of automobile trips, and conserve energy.

In addition, there should be a broad range of housing types and price levels can bring people of diverse ages, races, and incomes into daily interaction, strengthening the personal and civic bonds essential to an authentic community (Weiss: 1996). Transit corridors, when properly planned and coordinated, can help organize metropolitan structure and revitalize urban centres. In contrast, highway corridors should not displace investment from existing centres.

According to Lieberman: 1996, There is a need for appropriate building densities and land uses should be within walking distance of transit stops, permitting public transit to become a viable alternative to the automobile. This is an important new urbanism principle explained in the Charter for New Urbanism.

Moule: 1996 goes on to argue that concentrations of civic, institutional, and commercial activity should be embedded in neighbourhoods and districts, not isolated in remote, single-use complexes. Schools should be sized and located to enable children to walk or bicycle to them.

The economic health and harmonious evolution of neighbourhoods, districts, and corridors can be improved through graphic urban design codes that serve as predictable guides for change. This is a new urbanism principle explained in the essay by Lennertz: 1996 in the book New Urbanism.

According to the essay by Comitta: 1996 it is clear that a range of parks, from tot lots and village greens to ballfields and community gardens, should be distributed within neighbourhoods. Conservation areas and open lands should be used to define and connect different neighbourhoods and districts.

New urbanism other principle is that the primary task of all urban architecture and landscape design is the physical definition of streets and public spaces as places of shared use. This is elaborated by Solomon (1996) in his essay in the fourth congress for new urbanism.

Polyzoides: 1996argues that Individual architectural projects should be seamlessly linked to their surroundings. This issue transcends style and one of the core principles of new urbanism according to the fourth congress. In addition, the revitalization of urban places depends on safety and security. The design of 133 streets and buildings should reinforce safe environments, but not at the expense of accessibility and openness (Gindroz: 1996)

The other principle explained in the essay by Farr: 1996 is that in the contemporary metropolis, development must adequately accommodate automobiles. It should do so in ways that respect the pedestrian and the form of public space. Dover: 1996 adds that streets and squares should be safe, comfortable, and interesting to the pedestrian. They should be properly configured to encourage walking and enable neighbours to know each other and protect their communities. This is similar to the “Nyumba Kumi” initiative by President Uhuru Kenyatta (Kenya).

The essay by Kelbaugh: 1996in the fourth congress for new urbanism explains another principle. This is that architecture and landscape design should grow from local climate, topography, history, and building practice. It is key to point out that Civic buildings and public gathering places require important sites to reinforce community identity and the culture of democracy (Duany: 1996)

Lastly all buildings should provide their inhabitants with a clear sense of location, weather, and time. Natural methods of heating and cooling can be more resource-efficient than mechanical systems (Schimmenti: 1996). Greenberg: 1996 explains that preservation and renewal of historic buildings, districts, and landscapes affirm the continuity and evolution of urban society.

In conclusion, new urbanism promotes the creation and restoration of diverse, walkable, compact, vibrant, mixed-use communities composed of the same components as conventional development, but assembled in a more integrated fashion, in the form of complete communities. These contain housing, work places, shops, entertainment, schools, parks, and civic facilities essential to the daily lives of the residents, all within easy walking distance of each other (Farr: 2008).

2.2.3.3 Green Building/High Perfomance Building Movement.

This was the third reform of sustainable urbanism founded in Washington D.C., in 1993 by three development industry professionals: David Gottfried, Richard Fedrizzi and Michael Italiano. They were inspired by the Rio Earth Summit and were largely concerned with the same intellectual ground explored in the Environmental Resource Guide.

The American Institute of Architects committee on the environment: 1993 published The Environmental Resource Guide. This entailed the theory, practice and technology of environmental buildings and accelerated the adoption of green building practices. United States Green Building Council: 1995 pioneered standards for green building. This led to the adoption of Leadership in Energy and Environmental Design (LEED) in 1996.

The LEED standard combines prerequisites with optional credits that earn points toward an overall score. As a project's point score goes up it earns LEED certification at increasing levels of performance from certified on the low end to Platinum on the high end. This allows a project to incorporate only well-suited green building strategies (Farr: 2008).

According to the United States Environmental Protection Agency: 2014, Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or high performance building.

The table below explain the factors to be considered when designing a high performance/green building and the effects of not designing an environmentally friendly building. Table 2.2.3.3: High Performance/Green Buildings.

Source: www.epa.gov/greenbuilding/pubs/about.htm

Aspects of Built Environment:	**Consumption:**	**Environmental Effects:**	**Ultimate Effects :**
Siting Design Construction Operation Maintenance Renovation Deconstruction	Energy Water Materials Natural Resources	Waste Air pollution Water pollution Indoor pollution Heat islands Storm water runoff Noise	Harm to Human Health Environment Degradation Loss of Resources

2.3. The unification model

This model of sustainable urban design builds on the principles of smart growth, new urbanism and green buildings. The models aims at reducing environmental harm and also enhance the quality of life by creating quality spaces to live, play and work in (Farr: 2008). According to LEED and USGBC, the work and principles of the aforementioned movements i.e. smart growth, new urbanism and green buildings are heartening developments.

This model emphasizes on the need of fusing the initiatives of the various movements in to a cooperative whole to truly achieve a sustainable urban design. It is no longer acceptable to build a high performance building in a greenfield, automobile dependent context and have it certified as green. it is no longer good enough to develop in a responsible location and build an admirable, walkable, mixed use neighbourhood while ignoring the level of resources required to build and maintain the buildings there (Farr: 2008).

2.3.1 Core Components of Sustainable Urban design

Kazimee: 2002 in the publication Sustainable urban design paradigm argues there are twenty five simple things to do to achieve sustainable urban design. The design guidelines for sustainable and affordable urban design discussed below are organized under five primary variables: human ecology, energy conservation, land & resource conservation, water quality and air quality.

Human ecology is a fundamental principle with regard to sustainable urban design. It is the way people interrelate & use the environment. Regional design strategies: It is necessary to provide an opportunity to balance the critical and selected human-environmental interchanges in the region by providing and enhancing greenbelt and water impoundment systems to improve and balance air exchanges (O=CO2); water cycles (precipitation + H2O use); land and it's food/fiber processes (gardens, urban forests and reducing/reusing/recycling of resources) and energy use (conservation and use of renewable resources).

Kazimee: 2002 explains 25 principles that define Sustainable Urban Design. The principles are broken down into 5 parts as depicted in the table below:

Table 2.3.1: Sustainable Urban Design Principles

Source: kazimee 2002

NO.	SUSTAINABLE URBAN DESIGN PRINCIPLE
1.	Use greenbelt to moderate climate extremes, increases recreational opportunities and bio-diversity by using indigenous landscaping to conserve water and reduce maintenance

2.	Harvesting stormwater in balancing lakes to supplement dry seasons, reduces spring flooding, filters eroded soils, improves water quality, fishing and recreation potential.
3.	Emphasis on the use of regional hydroelectric power, solar and photovoltaics and wind farms in the greenbelt.
4.	The city centre and its historic character should be reanimated to facilitate an ideal, centralized geographic position. The clustered restructuring of central city will foster incentives for economic growth and establishes a dynamic central focus for the city.
5.	Emphasis on pedestrian and public transit systems
6.	Resource management (traditionally waste disposal) should become self-sufficient by adopting priorities to first reduce, then reuse and recycle. This model fosters community enterprises based on sustainable resource use, reuse and recycling.
7.	Enhance a sense of community by preserving and restoring site characteristics and qualities (natural, cultural, historical, etc.) this is by enhancing pedestrian access to neighbourhood schools, Greenways, wetlands and wildlife habitat, parks, views and Activity centres (indoor and outdoor)
8.	Provide for pedestrian priority connections (between residential developments and neighbourhood amenities and services). Bike and walkways are critical to enhancing a more personal/pedestrian sense of community.
9.	Design for effective land use and density by clustering and not sprawling. Provision of moderate densities at least 12-16 dwelling units per acre encourages pedestrian focus and safety.
10.	Develop defined residential clusters. 25-35 dwellings with similar cultural character and life styles, shared social amenities and open spaces, form a cohesive cluster.
11.	Carefully define land territoriality - public to private areas. Define for user control and responsibility at least 60-70% of the property in the cluster.
12.	Minimize front setbacks by Providing outdoor porches, gardens, etc. to enhance human scale, social activities, surveillance and safety.
13.	Minimize the impact of parking by distributing parking behind housing or in small, landscaped lots (8-12 cars).
14.	Think small and smart, not big and dumb by designing Small, Efficient homes. Townhouses are an excellent housing prototype for effective quality living.

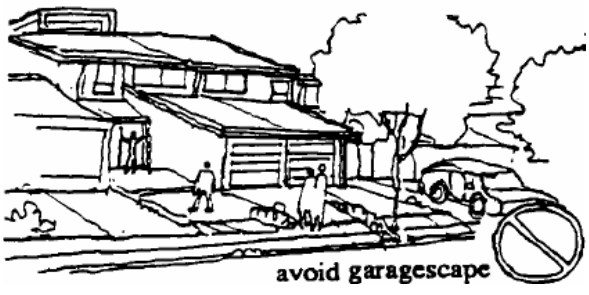


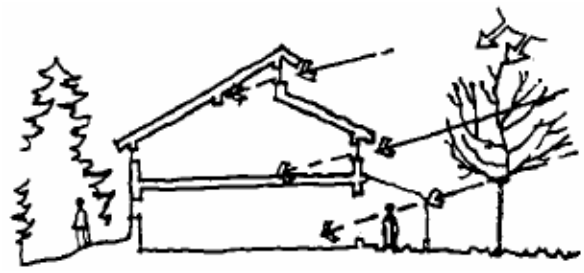
Plate 1: Garagescape

Source. Kazimee: 2002

Plate 2: clustered housing

Source. Kazimee: 2002

Secondly, energy conservation is a major long-term cost to people and environment. Energy conservation can be achieved by ensuring the following:



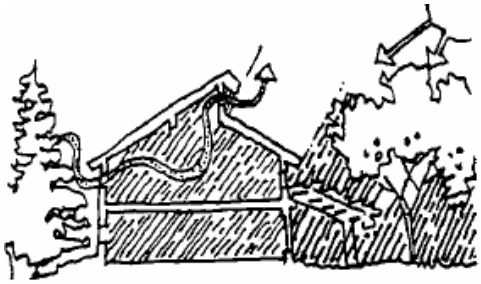


Plate 3: Design with climate

Source: kazimee 2002

plate 4: Design for natural ventilation.

source: kazimee 2002

II. Energy conservation	
15.	Carefully orient each dwelling unit to sun and site.
16.	Increase use of renewable energies and passive and active solar strategies.
17.	Select energy and resource conserving materials and construction methods.
18.	Conservation through daylighting
III. Land & resource conservation	
19.	Practice the 3 R's – Reduce, Reuse and Recycle.
20.	Design with permaculture for landscaping various open spaces and community areas.
21.	Localize the economy. Encourage programs for neighbourhood and community-wide sharing or exchanges of resources and talents.
IV. Water conservation: A fundamental need for human health	
22.	Retain all water on the site as long as possible. This allows water to percolate into the ground, water landscaping, reduce downstream flooding, and increase water quality and bio-diversity.
23.	Use water conservation appliances such as: low flush toilets, low flow faucets, water and energy efficient appliances, drip irrigation, and Harvest the rain and gray water
V. Air quality: A Critical variable for human & environmental health	
24.	Develop greenways and greenbelts to carbon to oxygen cycle
25.	Build with green materials. Indoor air quality and human health are greatly improved by the use of green (non-toxic) materials.

This research report delves deeper into the theory by Farr: 2008 explaining sustainable urban design as a grand unification of Smart growth, new urbanism, and the high performance building and infrastructure movements. According to Farr: 2008, sustainable urban design can be achieved and increased through density, sustainable corridors, mixed landuses,

biophilia, high performance buildings and designing sustainable neighbourhoods. This are the core components of sustainable urban design in detail as follows.

2.3.2. Density

The radical, deliberatist urbanism of the 1960s and 1970s saw cities extending into the formerly agricultural land which surrounded them. The new towns and districts which sprang up as a result met immediate needs, but failed to take into consideration the long-term effects on the population and the environment.

Sustainable development rejects such expansion, in favour of the reclamation of urban identity and culture through redevelopment of the existing city: renovation of older districts, regeneration of former industrial and military zones or docklands. A basic principle of sustainability as applied to urban development is increased density. A first step towards this is a move away from the detached house, set in its own plot of land at the edge of the city. Property prices, particularly in densely-populated areas, are a major influence on this.

In a compact city, the proximity to each other of housing, jobs, services and amenities can make for optimum use of space, with economical use of natural areas and efficient public transport. The challenge is to ensure a sufficiently attractive, vibrant environment relative to the rival attractions of a house and garden in the suburbs, and thus prevent families from moving out of the inner city as soon as they are able. Sustainable urban planning also allows synergy to be developed between, for example, businesses, research facilities and higher education establishments on a single site.

2.3.2.1 Increasing sustainability through Density

Density is a critical typology in determining sustainable urban forms. It is the ratio of people or dwelling units to land area. The relationship between density and urban character is also based on the concept of viable thresholds: at certain densities (thresholds), the number of people within a given area becomes sufficient to generate the interactions needed to make urban functions or activities viable (Jabareen: 2006).

Density is a double sided coin of sustainable urban design providing across the board reductions in per capita resource use. These reductions occur in proportion to increasingly development density which provides local, regional and global benefits. Reducing per capita production of greenhouse gases becomes an essential strategy so much so that increasing local density has global benefit (Farr: 2008).

Newman and Kenworthy: 1989 argue that some policies can save significant amounts of energy, mainly by “increasing the urban density; strengthening the city centre; extending the proportion of a city that has inner-area land use; providing a good transit option; and restraining the provision of automobile infrastructure.” They advocate a policy of new mass rail transit systems for the “inefficient” cities.

On the other hand Farr: 2008, tends to incite local hostility to new developments in direct proportion to their density. Neighbours come out to oppose dense development, perceiving it as a threat to their quality of life. However tempers flare more often due to traffic and parking and occasionally blocked sun than over population density itself. Dense mixed us neighbourhoods generate few per capita trips than auto dependent places. On the contrary project opponents experience per capita traffic increases and not per capita traffic reductions.

According to Angel: 2012, there exists a reluctance to come to terms with urban expansion and accommodate the urban expansion through densification of the city. The established residents of cities, municipal officials, homeowners, and environmentalists are the people against densification of the city. They see newcomers as nuisances rather than as assets—more mouths to feed, more children to educate, threats to jobs, and more congestion on the roads.

Sustainable urban design needs to strike the right balance between local impacts and global benefits. The development density should right enough to support both human and natural systems (Farr: 2008). Densities should be neither too high nor too low but “just right,” that is, within a tolerable sustainable range. City densities must remain within a sustainable range and if density is too low, it must be allowed to increase, and if it is too high, it must be allowed to decline (Angel: 2012).

Farr: 2008, argues that a density of two dwelling units per acre is too low and hence not within a sustainable range. He goes further to allude to the fact that sustainable urban design is not achievable below an average of seven or eight dwelling units per acre. One of the best Sustainable Urban Design project is Kronsberg, Hannover (Germany). It entails a density of 47 dwelling units per net acre. This density is able to support a tram line and is deemed to be sustainable.

According to Christopher Leinberger in his publication walkable urbanism, he echoes that the percentage of land covered by the equivalent of one story building between 0.05 and 0.30 do

not support transit and is not sustainable. Sustainable neighbourhoods should be walkable on a day to day basis and this is achieved through a density of above 8 dwelling units per acre.

In addition, Shelley Poticha, an expert on transit oriented development argues that fifteen and twenty dwelling units per acre is necessary to support streetcar service. This is therefore the minimum sustainable density required to ensure a sustainable urban design. Shelley Poticha also alludes to the fact that a minimum corridor development density of seven dwelling units per net acre is necessary to support a bus service and thus could ensure a sustainable neighbourhood.

In a wider sense, sustainable cities are a matter of density (Carl: 2000)[1]. Density and dwelling type affect sustainability through differences in the consumption of energy; materials; and land for housing, transportation, and urban infrastructure (Walker and Rees: 1997). High density and integrated land use not only conserve resources but provide for compactness that encourages social interaction.

Density is the single most important factor associated with transit use (Transportation Research Board of the National Academy USA: 1996). As density increases, automobile ownership declines, and automobile travel—as measured by gasoline consumption or per capita vehicle miles of travel (VMT) — also decreases. Similarly, transit use increases with density. In a sample of eleven large metropolitan areas, the density of nearby housing strongly influenced commuter mode choices.

Holding constant the mix of land uses, residents of higher density areas were more likely to commute by transit, walking, bicycling, or combinations thereof, and less likely to drive, than people who live in lower-density areas (Transportation Research Board of the National Academy USA: 1996). There is an inherent conflict between lower densities and a good transport system, where lower densities encourage car use. Freeman (1984) blames planners, architects, and local governments for reducing high urban density as well as for the low densities of suburbs (Jabareen: 2006).

According to Farr: 2008, it is easy to attract and retain public transport in densely developed corridors. This can be achieved by putting a concentrated population working or living adjacent to a transit stop. This creates a reliable market of people within easy walking

[1] Cited in Jabareen: 2006

distance of the transit service. Research done by Jeffrey Zupan and Boris Pushkarev in 1970 for the New York metropolitan region still resonate today. The chart below links transit modes to minimum residential density necessary to support it.

Table 2.3.2.1. Transit Modes Related to Residential density

Source: Jeffrey Zupan and Boris Pushkarev, 1970.

Table 5-3 Transit Modes Related to Residential Density (Boris Pushkarev and Jeffrey M. Zupan)

Mode	Service	Minimum Necessary Residential Density (dwelling units per acre)	Remarks
Dial-a-bus	Many origins to many destinations	6	Only if labor costs are not more than twice those of taxis
Dial-a-bus	Fixed destination or subscription service	3.5 to 5	Lower figure if labor costs twice those of taxis; higher if thrice those of taxis
Local bus	"Minimum," 1/2 mile route spacing, 20 buses per day	4	Average, varies as a function of downtown size and distance from residential area to downtown
Local bus	"Intermediate," 1/2 mile route spacing, 40 buses per day	7	
Local bus	"Frequent," 1/2 mile route spacing, 120 buses per day	15	
Express bus—reached on foot	Five buses during two-hour peak period	15 Average density over 2-square-mile tributary	From 10 to 15 miles away to largest downtowns only
Express bus—reached by auto	Five to ten buses during two-hour period	3 Average density over 20 square mile tributary area	From 10 to 20 miles away to downtowns larger than 20 million square feet of nonresidential floorspace
Light rail	Five-minute headways or better during peak hour	9 Average density for a corridor of 25 to 100 square miles	To downtowns of 20 to 50 million square feet of residential floorspace
Rapid transit	Five-minute headways or better during peak hour	12 Average density for a corridor of 100 to 150 square miles	To downtowns larger than 50 million square feet of nonresidential floorspace
Commuter rail	Twenty trains per day	1 to 2	Only to largest downtowns, if rail line exists

In conclusion, Sustainable Urban Design requires that the density is more than eight dwelling units per acre. The density should be in such a way that the percentage of land covered by the equivalent of one story building should be above 30%. Sustainable Urban Design only gives the minimum sustainable density and not the maximum. The argument is that the density should be within a sustainable density. If the density is too low it should be allowed to increase and if it is too high it should be allowed to decrease.

Sustainable Urban design calls for a density that can support transit and ensure the neighbourhoods are walkable. The maximum density is therefore dependent on location of the project in relation to the city's central business District. This is to ensure that the land is optimally utilized. A sustainable density should therefore be able to ensure transit and walkable neighbourhoods but also ensure the land is optimally utilized.

Kronsberg in Germany depicts a density of 47 dwelling units per acre and it is deemed to be sustainable. It is 8 kilometres from the City of Hannover and thus its density is within a sustainable range. The Nyayo Estate NSSF Housing Scheme Embakasi (Nairobi) depicts a density 48 dwelling units per acre and this is within the sustainable range. This is because it is located 15Km from Nairobi CBD and the stated density optimally utilizes the land based on the land value. The debate on what exactly is a sustainable density is dependent on the location of the project but the constant fact is that the density should not be less than 8 dwelling units per acre.

The sustainable density of Kaloleni Estate ought to be much more than 48 dwelling units per acre. This is because it is located 2Km from Nairobi CBD and thus sits on prime land. Secondly, the Estate was meant to house low income earners whose spatial requirements are low. This means that the number of dwelling units per acre will be higher but should be within a sustainable range to ensure the built and open spaces are quality spaces.

2.3.2.2 Water and Density

Protecting water resources with higher density developments is a fundamental goal of sustainable urban design. There are a lot of components to watershed protection such as appropriately siting development in the watershed, preserving adequate open space and protecting critical environmental features. Most of our regions, cities, towns and neighbourhoods are undergoing urban expansion both in space and population (Farr: 2008).

This has seen the mushrooming of new buildings across the country but communities are grappling with related challenges like the impacts on water resources. In order to protect those resources the authorities are embracing some land use strategies such as low density development. Research by Lynn Richards: 2006 explains that this strategy is misguided and low density approaches does not really protect our water resources.

According to the U.S Department of Agriculture's National Resources Inventory, the amount of developed land has quadrupled between 1954 and 1997. This is due to population growth

by 15 percent leading to land development growth by 34 percent. Most of this growth is taking place at the edge of developed areas on greenfields which includes forests, meadows, pasture and rangeland. The median lot size of these building developments is just under half an acre to help protect water quality due to research indicating that impervious cover can degrade water quality (Farr: 2008).

According to water and the density debate, June 2006 by Lynn Richards many communities have adopted low density zoning and limit on site level imperviousness by giving regulations on the maximum percentages to be covered by impervious surfaces such as buildings and driveways. This is informed by the fact that higher density produces more impervious cover. On the contrary. Douglas Farr in his book Sustainable Urbanism (2007), goes on to explain that a density of below eight dwelling units per acre does not really protect our water resources based on the following argument.

On the onset Farr: 2008, argues that total imperviousness and runoff should be minimized within a region or watershed as opposed to particular site. A planning department typically analyses the projected stormwater runoff impacts of a development proposal based on the acreage involved not the number of housing units being built. Using a one acre model, communities may conclude that lower density development minimizes runoff because from one house on one acre equals roughly half the runoff from eight houses on that same acre.

One should also consider where the other seven houses and their occupants would be located. They are usually located within the same region or even same watershed and hence have storm water impact. The impacts of original and displaced houses need to be considered so as to accommodate whatever growth expected in the region (Richards: 2007). According to the scenarios modelled by the United States Environmental Protection Agency (2007), it was established that higher density scenarios generated less stormwater runoff per house at all scales and time periods.

The EPA modelled scenarios at three scales; one acre, development site and watershed and at three different time periods of build out to examine the premise that lower density development better protects water quality. They found out that: with more dense development of eight houses per acre, runoff rates per house decrease by about 74 percent from one house per acre. Secondly for the same number of houses, denser development produces less runoff

and less impervious cover than low density development. Finally, for a given amount of growth, lower density development covers more of the watershed.

Table 2.3.2.2. EPA modelled Scenarios.

Source: U.S. EPA

Scenario	Number of Acres Developed	Impervious Cover (%)	Total Runoff (ft^3/yr)	Runoff Per Unit (ft^3/yr)	Savings Over One house/ acre runoff per unit (%)
One-Acre Level: Different densities developed on one acre					
A: One house/acre	1	20	18,700	18,700	0
B: Four houses/acre	1	38	24,800	6,200	67
C: Eight houses/acre	1	65	39,600	4,950	74

According to these findings, it is evident that lower density development is often not the best way of minimizing stormwater runoff. In addition, higher density development utilize less land at the same time accommodate the same number of houses at lower density developments. This goes a long way in protecting the water quality and ensuring a sustainable density within a neighbourhood (Farr: 2008).

Richards: 2007 of the U.S. EPA argues that higher densities can also increase water quality problems in nearby water bodies due to the site level impervious cover created. This can be addressed by incorporating low impact techniques such as rain gardens, bio retention area, bioswales, reducing parking spaces, narrowing streets and eliminating cul-de-sacs. This will prevent, treat and even store runoff and associated pollutants. In general, to fully protect water resources, communities must build in a range of development densities, incorporate open space, preserve critical ecological and buffer zones and minimize land disturbances (EPA: 2006).

According to Farr: 2008 some site specific strategies can also enhance a neighbourhood's sense of place, increase community character and save taxpayers money. These strategies meet multiple community objectives and work best in dense urban areas. This is because they use existing elements of the neighbourhood such as roads, roofs, abandoned shopping malls, courtyards and add some engineering to landscaping elements to retain, detain and treat stormwater on site. These approaches to address stormwater issues can add value to the community and hence make the neighbourhood a more desirable place to live.

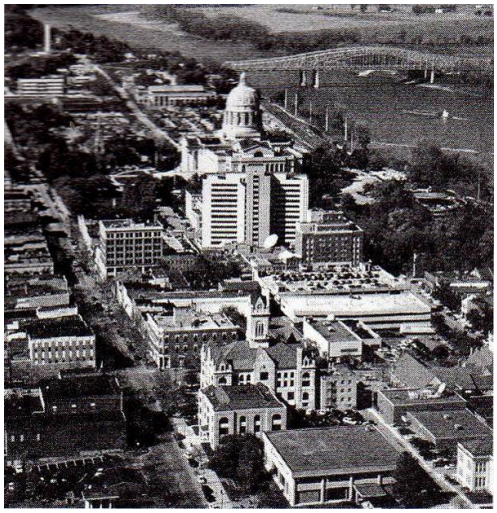


Plate 5: Compact urbanism is the best tool for Protecting water quality. U.S. EPA, 2008

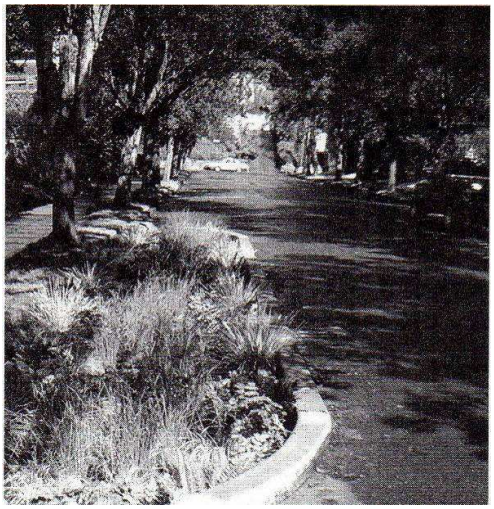


Plate 6: Street scale bioswale. Source: U.S. EPA, 2008

2.3.3 Sustainable corridor

Sustainable corridors are similar to a wildlife corridor in that they connect one area to another efficiently, cheaply, and safely. They allow people to pass from their immediate proximity to another without relying on cars or other wasteful and inefficient products. It also relies on accessibility to all people in the community so that the mode of transportation is the most convenient and easiest to use for everyone. Sustainable Corridors include the integration of transportation, land use, technology and biodiversity corridors to allow animals to move around communities so that they may still live in and around cities

2.3.3.1 Mixed land uses: the integration of Transportation, Land Use and technology

Mixed-use allows compatible land uses to locate in close proximity to one another and thereby decrease the travel distances between activities (Parker; 1994). Mixed land use determines the diversity of functional land uses such as residential, commercial, industrial, institutional, and those related to transportation. This plays a fundamental role in reducing the need for travel and hence achieving sustainable urban design (Jabareen: 2006).

According to Alberti et al: 2000 mixed land use reduces the probability of using a car for commuting, shopping, and leisure trips, since jobs, shops, and leisure facilities are located nearby. Moreover, mixing uses ensures that many services are within a reasonable distance, thus encouraging cycling or walking (Thorne and Filmer-Sankey: 2003). Lastly, mixed land use can renew life in many parts of the city and thus enhance security in public spaces (Elkin, McLaren, and Hillman 1991, 22).

Crane: 1996 argues that there exists causal links between urban design and travel behaviour. The aim of creating the casual links between urban design and travel behaviour is to reduce air pollution and traffic congestion and ensure a social environment for the residents. This can be achieved by increasing pedestrian traffic and generally improving neighbourhood quality of living by creating quality spaces. Numerous studies report that higher densities, mixed land uses, more open circulation patterns, and pedestrian-"friendly" environments are all associated with less car travel (Jabareen: 2006).

The Institute of Transportation Engineers 1989; Ewing, Haliyur, and Page: 1994 found that transportation-related benefits of mixed land use include a decrease in vehicle trip generation rates and the number of vehicle hours travelled and higher levels of pedestrian travel. However, some urge caution because the issue is complex. Frank: 2000 argues that empirical research regarding the relationship between mixed land uses and travel behaviour has been limited by the relative complexity of measurement, requirements for parcel or area-level data, and the difficulty in accurately translating findings into public policy.

Transport is arguably the single biggest issue for environmental debates relating to urban design Jenks, Burton, and Williams: 1996. Sustainable urban design is defined as diminishing both mobility and the negative of traffic. According to Elkin, McLaren, and Hillman: 1991 sustainable urban design must provide for walking, cycling, and efficient public transport. It must also be compact so as to encourage social interaction among the dwellers and users of the spaces (Jabareen: 2006).

Sustainable transportation is defined as transportation services that reflect the full social and environmental costs of their provision. The social and environmental costs should respect carrying capacity and that balance the needs for mobility and safety with the needs for access, environmental quality, and neighbourhood livability" (Jordan and Horan: 1997).

According to Duncan and Hartman: 1996, a sustainable urban transportation system limits emissions and waste to within the area's ability to absorb. It is powered by renewable energy sources, recycles its components, and minimizes the use of land, provides equitable access for people and their goods and helps achieve a healthy and desirable quality of life in each generation and is financially affordable, operates at maximum efficiency, and supports a vibrant economy.

These advantages have led to the growth in public transportation use and construction. This is due to the expensive cost of mobile transportation and also the increasing traffic congestion in cities across the globe. This has motivated infill development and transit investment. This desire for improved accessibility and greater choice in housing and transportation has resulted in Transit Oriented Development (TOD). Tod fosters greater use of transit system by creating neighbourhoods within walking distance of transit stations that offer compact development, a diversity of land uses and pedestrian oriented design (Farr: 2008)

According to Poticha: 2008 in the publication "The integration of transportation, land use and technology, Transit oriented development is more than simply a project next to a transit station. It includes the neighbourhood surrounding the station, comprising multiple development projects, a mix of uses, a walkable network of streets and design that supports living and transportation choice. TOD focuses on improving the convenience of transit for residents.

Farr: 2008 argues that TOD cannot be defined by a prescribed set of densities of mix of uses. This is epitomised by those who live in neighbourhoods near downtown using transit more and drive less than those in suburbs even though they may live close to a transit station. The reason is many in neighbourhoods combine density with walkable street patterns, access to transit, neighbourhood amenities and an adequate mix nearby retail and jobs. TOD ought to create places that integrate transit into neighbourhoods and help support lively and vital communities in urban and suburban neighbourhoods.

2.3.3.2 Environmental Corridors

Kihslinger et al: 2007, argues that land use decisions made at local levels play a significant role in conservation of biodiversity. Conservation biologists have made considerable progress over the past twenty years in determining how the size, shape and connectedness of habitat affect the sustainability and persistence of species and natural processes.

According to studies compiled by the United States Environmental Law Institute there are general threshold recommendations for habitat patch area, buffer size, patch connectivity and percent of suitable habitat in a landscape to support land use, open space and smart growth planning that will sustain species, community and ecosystem diversity. The types, extent and arrangement of land uses within the landscape will influence the viability of habitat patches,

the amount of suitable habitat, the severity of edge effects and the utility of buffers and corridors.

Conservation minded landscapes include; large, high quality and well-connected habitat patches capable of supporting sustainable populations of native and rare species. Secondly, well designed habitat corridors to connect otherwise isolated larger remnant habitat patches. In addition, the landscapes should limit developments in sensitive ecosystems such as wetlands, riparian corridors and critical habitats. Lastly, wide and vegetated buffers to minimize edge effects on habitats and protect water quality and stream habitat (Kihslinger et al: 2007).

Farr: 2008 explains the guidelines that can influence local land use, open space and smart growth planning and policies as follows: first and foremost, determine the locally important and rare species and habitats in need of protection. This information can be obtained from wildlife action plans, heritage programs, consulting local biologists and consulting land management agencies with the view of identifying rare species and landscapes in need of protection.

Secondly, utilization of local biological information and knowledge on landscape context to determine the amount and location of land to conserve. The amount of suitable land to conserve will vary depending on the local species and habitats to be protected. In addition, there is a need to preserve large connected habitat patches. Land use plans should maximize patch size, minimize isolation among existing habitat patches and optimize the natural connectivity of the landscape using habitat corridors.

According to studies compiled by the United States Environmental Law Institute, use of local biological information and knowledge on landscape context to determine buffer size and structure is key. The area within a buffer should not be included in the patch size measure, and roads and rails and other development should not occur in the buffer. Native and diverse vegetation is the back bone of riparian buffers and should be continuous along the maximum extent of the river.

Lastly, the regional context of the planning efforts should be considered. Landscape scale planning can help promote the proactive conservation of large, connected, high quality habitat patches while addressing the regional impacts of local land use decisions.

2.3.4 Biophilia

'Biophilia' is a concept that has been explored by researchers for several decades, beginning with the German psychoanalyst Eric Fromm in the 1960s, and popularised by Edward O. Wilson in 1984, in his book Biophilia. In this, Wilson suggested that humans have 'an urge to affiliate with other forms of life' (Wilson: 1984) that can be explained through evolutionary processes of survival and natural selection.

Biophilia refers to the innate connection between humans and nature. It describes this connection as a need for humans to be surrounded by nature in order to feel complete in their own natural state of being. More recently, biophilia has been used to describe the design elements of cities that carve out several areas for plants, living walls, gardens, waterfalls, and other natural aspects (Powerhouse Growers: 2013).

According to Farr: 2008, Biophilia is the name given to the human love of nature based on this intrinsic interdependence between humans and other living systems. The earth provides free services with the view of sustaining life. The earth receives sunlight, fresh air, makes oxygen and grows plants that feed humans and animals. Humans love for nature creates an interdependence between the earth and human beings.

Cities around the world are growing rapidly in size and number, as they provide unprecedented economic and social opportunities. The importance of both the scale and density of cities in creating these opportunities is now well understood (Glaeser, 2011; Newman and Kenworthy, 1999). However, in achieving such scale and density, urban areas are becoming increasingly abstracted from nature, and urban residents are more disengaged from the natural world (Reeve et al: 2011).

Biophilia has been recently defined as an emerging design principle for buildings and urban areas, featuring a suite of natural design elements that address multiple pressures related to climate change, increasing urban populations, finite resources and our inherent need for contact with nature. The principle directs the creation of urban environments that are conducive to life, delivering a range of benefits to stakeholders including building owners, occupiers and the surrounding community (SBEnrc: 2012).

Biophilia has been shown to: reduce energy demand for heating and cooling; manage stormwater runoff; improve air quality; reduce congestion by encouraging walking and cycling; increase property values and stimulate the economic development and rejuvenation

of urban areas; sequester carbon and reduce carbon emissions; enable urban food production and enhance food security; and increase urban biodiversity (Reeve et al: 2011).

According to Farr (2008) biophilia can be achieved through provision open space, public lighting, stormwater systems, and food production, outdoor and indoor waste water treatment. Reeve et al: 2011 argues that Biophilia can be considered on multiple scales: at the building, neighbourhood and city level, with natural design features, or 'biophilic elements' integrated into the urban environment across all three.

2.3.4.1 Open Space connecting humans to nature

According to Farr: 2007, walk to neighbourhood parks and plazas are neglected spaces in the urban realm. Parks and plazas enhance the quality of neighbourhood due to their prime location- a short walking distance from a large population. Walks to parks outfitted with benches, playground equipment allow casual social environment hence building social capital. Biophilia is supported by parks and plazas with a high degree of landscaping, a naturalized stormwater feature or even a view of the night sky. Parks also increase the property value of the area around and buyers are willing to pay to live close to these areas.

Biophilia can be considered on multiple scales: at the building, neighbourhood and city level, with natural design features, or 'biophilic elements' integrated into the urban environment across all three (Reeve et al: 2012). It is relatively easy to plan and build new smaller parks within master planned development due to the fact that it is phased in with the surrounding development. Small parks are difficult to develop in existing cities due to the high land values and also publicly land owned land is rarely located where parks are needed (Farr: 2007).

According to Patchett and Price: 2008 one of the important aims of sustainable urban design is filtering storm water even in high density urban spaces. Storm water management practices can be designed in at the site, block and neighbourhood scales. In existing built out areas storm water parks are utilized for storm water filtration in the public streets.

In order to ensure parks achieve sustainable urban design through biophilia, the following standards needs to be considered; firstly, parks or high quality open spaces should be within a three minute walk of every dwelling. Secondly the minimum park are should be 1/6 acre and the minimum average size of all neighbourhood parks should be ½ acre. In addition, all parks should be bounded on at least two sides by public rights of way. Lastly, parks may be fenced and blocked at night for security reasons.

Farr: 2008, defines various aspects of open space within the neighbourhood as follows; sports field which is an open area specifically designed for large scale recreation. Secondly, green – a medium sized public space consisting of lawn areas and trees for unstructured recreation, circumscribed by building facades. The other open space within a neighbourhood is the square. A square is a public space, seldom larger than a block at the intersection of important streets. Its streetscape consist of paved walks, lawns, trees and civic buildings.

In addition, a plaza is another aspect of open space within the neighbourhood. A plaza is a public space at the intersection of important streets set aside for civic purposes and commercial activities. It is circumscribed by frontages; its landscape consist of durable pavement for parking and trees requiring little maintenance. The last aspect of open space within a neighbourhood is the community garden. This is a grouping of garden plots available for small scale cultivation, generally to residents of apartments and other dwelling types without private gardens (Plater-Zyberk: 1999).

2.3.4.2 Public Lighting

In the publication "public lighting-cities shaped by light" 2014 in the urban design magazine, Daniel Boscari explains that public lighting has been structuring urban landscapes since 1900s though we are not always aware of its use in shaping the face of the city. He goes on to argue that, in a city there is a clear lighting topography. Each different zone (city centre, residential areas, industrial and arteries) require a specific level of lighting based on how it is used. It involves combining utility with aesthetics.

Public lighting was primarily used as a way of providing public safety and to encourage night-time activities and commerce along rights of way. However conventional designs have often led to extensive over lighted area leading to wasted light. Exterior lighting also has a harmful effect on flora and fauna and can cause disturbances of human circadian rhythms leading to insomnia and sleep disorders (Farr, 2008).

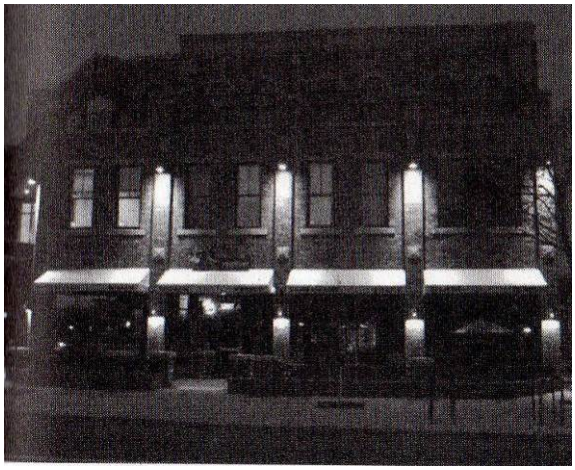


Plate7: Pedestrian lighting

Source: Clanton Associates

Plate 8: Automobile Lighting

Source: Clanton lighting Associates

Nancy Clanton and Todd Givler of Clanton Associates argue that a better approach to lighting design in a neighbourhood uses light where most needed. Light is most useful at potential vehicle/pedestrian conflict zones, to accentuate building facades and for way finding. According to Nancy Clanton, lighting can be designed to eliminate glare, over lighting and light trespass by regulating the level of brightness based on the type of place lit.

The table below explains different lighting zones based on the ambient light level, population density, frequency of use and lighting expectations:

Table 2.3.4.2. Lighting zones. Source: Farr, 2008

	LZ0	LZ1	LZ2	LZ3	LZ4
Transect Zone	Rural and Reserve	Reserve and Suburban	General Neighborhood	Urban Center	Urban Core
Allowed Initial Lamp Lumens/SF	1.25-1.6*	2.5-3.2	3.3-4.2	7.6-9.7	10.9-13.9
Base Allowance (lumens)	0	17,000	24,000	44,000	60,000
Lighting Design Criteria	No ambient light	Very low ambient light	Low ambient light	Medium ambient light	High ambient light

2.3.4.3 Storm water Management

Patchett; 2007 publication in the Conservation Design Forum explain that most contemporary urban land use practices generate substantial amount of storm water. This storm water is associated with increased erosion, sedimentation and flooding, water quality degradation, loss of biodiversity, aquifer depletion and climate change. Certain types of urbanization and the addition of hardscape prevent the infiltration of rainwater into the soil and increase surface runoff (Omlid, 2009).

Urban areas are challenged by extensive impervious surfaces, damaged soils, and little room for greenspace or for stormwater management facilities. Distributed stormwater management techniques, such as bioswales, are used to retain stormwater at many sites throughout the urban landscape as opposed to collecting runoff at a more centralized facility, such as a detention pond, or relying on a storm sewer system. But some sites do not have sufficient open ground to handle water collected from surrounding impervious surfaces in a dispersed fashion (Day et al; 2008).

According to Farr; 2008, traditional storm water engineering practices are designed to direct water away from where it falls. On the contrary, sustainable approaches strive to treat water as a resource not a waste product. This entails the restoration of stable groundwater hydrology on a site by site basis through the incorporation of techniques that cleanse, diffuse and absorb water where it falls. This recharges the ground water and ensures the water quality is maintained.

Day et al: 2008 argues Stormwater management in urbanized settings faces special challenges: paved surfaces and buildings generate high amounts of runoff while at the same time leaving little space for constructed stormwater management facilities or for the soil and vegetation combination that could reduce the need for these facilities. On the contrary, Olmid:2009, explains that storm water can be effectively managed in the urban setting through storm water systems such as vegetated swales, bio retention planters, Permeable paving, rain gardens, cisterns and rain barrels, downspout disconnection and expanding the urban forest.

Farr: 2008, argues that there are many practical, cost effective design and development innovations that are directed at stormwater management. These innovations effectively capture, cleanse, recycle and infiltrate water on site. Building and site design techniques such as greenroofs, porous paving systems, bioswales and other bio retention measures, rainfall collection and storage cisterns and incorporation of deep rooted high absorbent native landscape systems are some of the cost effective strategies that maybe applied.

Bioretention Planter-Source: A. Omlid.

Plate 7: Bioswale
Source: A. Omlid.

Plate 8: bioretention planter
Source: A. Omlid

Bio retention systems are designed to reduce flow energy and cleanse, convey and infiltrate water generated from nearby impervious surfaces. Bio retention systems suited for urban contexts includes rain gardens, bioswales, dry wells, naturalized detention or retention and other bio retention structures such as specially designed tree wells, planter boxes and median strips.

Plate 9: Permeable paving
Source: A. Omlid.

Plate 10: rain garden
Source: A. Omlid

The Conservation design Forum emphasizes the need to include porous materials such as sand or gravel under 18 to 24 inches of amended topsoil to facilitate temporary storage. The resultant reduction in stormwater runoff volume promotes the protection and enhancement of area wide aquatic systems.

According to Patchett and Price: 2008, the stated measures are important for groundwater recharge, flood reduction, site and regional water quality enhancement and the restoration of terrestrial and aquatic ecosystem viability. These tools and threshold meet traditional water quality and standards as well as well as planning, urban design and landscaping objectives. Sustainable water management elements can be integrated into roofs, parking lots, streets, driveways, alleys, sidewalks, lawns and landscaped areas, parks and other open spaces.

2.3.4.4 Waste water management

Wastewater management (both indoor and outdoor) is not intended to be comprehensive but give the professional enough information to work towards a sustainable design. This design should integrate the reuse of wastes and water in a way beneficial to humankind without harming the environment. Wastewater management is a broad field that design professionals and even consulting firms focus on certain niches of the market (Ennis: 2007).

According to (Farr: 2008), there are many alternatives for outdoor waste treatment for a wastewater planner. He goes on to argue that a sustainable project needs a balance of science, site, economics and regulations. The key consideration in waste water treatment system is to do no harm to the receiving waters. There is therefore a need to obtain a letter from a local environmental group such as NEMA stating that it has no objections to the project.

In addition, it is important to reuse 75 percent of nutrient energy in the outdoor waste treatment into beneficial uses and this should be calculated annually. It is imperative also to ensure the energy consumption of the operation and maintenance including sludge hauling and disposal does exceed not 80 kilowatt hours per capita. Lastly, 75 percent of water in the outdoor waste treatment should be reused for beneficial use and calculated on annual basis.

The essay “Ecological Design’ by John Todd asserts that indoor waste treatment is important with regard to achieving sustainable urban design. Indoor waste treatment can be achieved by use of eco machines which are ecologically based waste water treatment facilities. Eco machines create clean and reusable water from local waste water hence saving on the cost of other sources of water. What would otherwise be a monetary and environmental expense for the community can be turned into a resource and asset.

The eco machine technologies offers the opportunity for the neighbourhood to use its on waste water for maintaining green spaces, growing plants and ecologies that sequester carbon and to produce clean, chemical free water for reuse. This can be done in a green house

facility requiring a small above ground footprint with sub surface constructed wetlands both as a park and orchard (Farr: 2008).

According to Todd: 2008, Eco machines systems built for urban neighbourhood wastewater incorporates the following elements: A collection and distribution point which entail a small diameter collection systems with interceptor tanks at each input location. Secondly, pre-treatment and equalization is another element which entails underground tanks with bio filters to reduce organic loading. This to ensure that subsequent treatment elements are not overloaded with suspended solids.

In addition, constructed wetlands which are passive, two foot deep gravel recirculating beds planted with aesthetical flora used for bio filtration. Lastly Eco machine Aquatic cells treats the secondary effluent from the constructed wetlands. These aquatic cells are open aerobic tank based systems often housed in a green house. Each tank is designed to accommodate a variety of organisms which play a unique role in the ecological cycle e.g. microscopic algae, fungi, bacteria, protozoa, snails, clams, fishes and phyto and zooplankton. Higher plants grow on suspended racks within each tank (Farr: 2008)

The tertiary quality water from the eco machine can be reused for irrigation of the landscape and crops, for water features and even flushing toilets. Eco machines offer opportunities to use waste water within the neighbourhood while creating local value.

2.3.4.5 Urban Agriculture

Peemoeller et al: 2008 explains that food production is no longer sustainable due to industrialization and globalization of food production. Urban expansion has led to conversion of farms into businesses, sprawl and agricultural monoculture in order to feed the expanding communities. The farm as corporation economic model has become the epitome of modern food production concentrating on volume and efficiency. This has led to low cost food which is of questionable quality, taste and safety. This is due to the toxic pesticides used and hence creating a myriad of health problems such as cancer, diabetes, hypertension and obesity.

Sustainable solution such as organic food production and increased food access integrated within neighbourhoods are some of the ways urbanists can ensure a sustainable community. This can be achieved by food production and food access through proper zoning allowing communities to produce their own food. This community based food systems create jobs and self-sustaining markets. This also comes with environmental benefits such as less energy use,

cleaner air and water and remediated soil. The community benefits through food security, neighbourhood aesthetics and connections between man and nature (Farr: 2008).

In order to ensure this increased food production and access, the following should be considered. Firstly, use of clean soil to grow food to ensure safe high quality produce. Secondly, access to water, sunlight and good drainage is important for food production in urban environment. Urban agriculture can be undertaken individually or can be neighbourhood based both in public and private land (Peemoeller et al: 2008).

The table below highlights how food can be produced in the urban spaces individually or in a neighbourhood set up.

Table 2.3.4.5. Food production in neighbourhoods. Source: Farr: 2008

NO	INDIVIDUAL	NEIGHBOURHOOD BASED
1.	Rooftop gardens	Community garden
2.	Household gardens	Community Orchard
3.	Household greenhouse	Community greenhouse
4.	Indoor gardens	Urban aquaculture
5.	Kitchen gardens	Edible landscapes
6.	Edible landscaping	Community farms

2.3.5 High Performance/Green Infrastructure and Buildings

Sustainable urban design incorporates high performance infrastructure and also buildings. This is with a view of optimizing performance, minimizing environmental impact, using materials efficiently and extending the lifecycle. High performance infrastructure refers to the core best management practices applicable to the section public of way encompassing street and sidewalk, underground utilities, storm water infrastructure, landscapes and streetscape elements. This can be achieved through component optimization, multifunction optimization and integrated design (Brown: 2008).

2.3.5.1 Single optimization

Infrastructure Performance can be enhanced by optimizing a single component in such as standard details can be improved. This can be achieved through the following: use of reclaimed supplementary cementitious materials to increase pavement strength. Secondly, designing drought tolerant and water efficient landscapes to reduce the landscape maintenance. Finally, use of light emitting diodes for street lighting to increase efficiency and reduce energy consumption (Farr: 2008)

2.3.5.2 Multi Optimization

In addition undertaking multifunctional optimization can ensure long term cost savings, improved performance, reduced environmental impact and increased municipal returns. Multifunctional optimization is necessary due to the mutual impact of adjacent systems arising from unanticipated damage. This can achieved through using structural soils in tree planters to provide load bearing capacity for walkways while offering a better medium for trees for rooting (Newman; 2008).

Moreover incorporation of pervious pavement material can be used to reduce stormwater runoff while providing adequate driving surface for vehicle. Lastly, utilizing trenchless technologies to repair water main infrastructure to minimize trench cutting and subsequent pavement degradation (Brown; 2008).

2.3.5.3 Integral Approach design

This aims at improving the entire roadway system performance requiring cross disciplinary teamwork at the planning, scoping, design and construction stages. This is with the aim of promoting comprehensive performance improvements, compounds environmental benefits and cost savings. Some of the examples of integrated design include: designing a right way with reduced impervious pavement area and maximum shading by trees to reduce the urban heat island build up, improve air quality, increase pavement durability and calm traffic (Far; 2008).

Furthermore, designing an accessible utility corridor for subsurface utilities within the roadway to allow easy maintenance, extended pavement lifecycle and reduced environmental impact. Integrated design can also be achieved by designing a roadway with diversely planted centre median that functions as both a traffic calming device and storm water bio retention area to improve pedestrian safety, minimize storm water runoff and improve air quality.

2.3.5.4 High performance buildings

High performance buildings are buildings that are energy efficient both through cooling or heating to keep the interior at a reasonable temperature for human comfort. This can be ensured through building energy simulation programs designed to model building energy usage.

This can simulate the energy a building will use before it had been built. The energy use profile of housing is characterized by internal loads such as lighting, equipment, people, and ventilation system inside the building. It is also entails external loads, which is the skin load

influenced by the building massing and building envelope. This is basically how the walls, roofs and windows are constructed (Farr: 2008).

According to Chailfoux: 2008, the energy use in buildings is different due to the diversity of buildings. Different buildings use energy differently resulting in distinct energy use profiles. Houses where few people are characterized by low internal loads as opposed to an auditorium in a public building. Therefore the external loads drive the energy use profile of housing units. The building envelope has a major impact on the energy use profile of housing units. Decisions regarding these buildings elements are typically made by design architects. However, most of the design opportunities to reduce building energy use i.e. building orientation and massing are controlled by the site planner.

Voitiuc et al: 1999, argues that Taking advantage of the physical features of the building site and microclimate will reduce heating and cooling loads, thereby lowering overall energy consumption. This can be achieved by orienting the building to maximize solar opportunities. Secondly, the building should be oriented to minimize thermal loss due to infiltration from prevailing winds while taking advantage of natural ventilation. In addition, careful consideration of the placement of existing and proposed deciduous and evergreen trees on site. Lastly, Utilize or modify existing topography to optimize thermal mass and/or insulation. Consider earth forms, berming, and other manipulations of the site section.

Building orientation and massing which is the work of a community planner have significant influence on the energy used by the unit. It is argued that reducing the surface to volume ratio of buildings minimizes energy loss in buildings. This should be addressed on a case by case basis taking into account the other issues affecting neighbourhood planning such as desired mix of detached houses versus town houses. Lastly the south facing glass that receives direct sunlight should be reduced. In addition, designers should incorporate roof overhangs, external shades and trees as a means of reducing direct sun (Farr: 2008).

According to Voitiuc et al: 1999, controlled daylighting should be incorporated into the building as the preferred mode of interior illumination and to reduce lighting load and operating costs. Daylighting can be achieved by Specify glazing with high visible transmittance and integrate placement in building envelope to control glare. Use of glass with higher daylight transmittance and lower shading coefficients on north walls where glare is much less of a problem should be considered.

In addition, the use of roof monitors and high clerestory windows in addition to or in place of skylights should be considered. If using skylights, consider models that respond to differences in seasonal sun altitudes. It is important also to specify and coordinate placement of photocell-dimming sensors that adjust electric lighting in response to the amount of available natural light.

Use of interior and/or exterior light shelves on south-, east and west-facing facades to reflect natural light deeper into interior spaces. It is ideal to provide shading devices, such as overhangs or vertical fins, to let in quality natural light but exclude undesired glare while controlling contrast ratios. Lastly, courtyard, atrium, or other daylight-enhancing techniques should be incorporated to bring light into the interior (Voitiuc et al: 1999).

High performance building in the African context have been explained by Kimeu: 2014 during the African regional workshop. Kimeu: 2014, opines that there is a need to design climate responsive building to ensure the buildings are high performance. This can be achieved by the guidelines in the table below:

Table 2.3.5.4. High performance buildings in tropical regions. Source: Kimeu: 2014

NO.	DESCRIPTION OF HIGH PERFOMANCE BUILDING IN AFRICA
1.	Designing the buildings such that the long axis is along the East-West axis in the tropics.
2.	Design building that are narrow in plan to achieve maximum natural lighting penetration into the buildings and good cross - ventilation.
3.	Place window openings on the North and South facing walls
4.	Locate building services (like lifts, lobbies, toilets, stores, ducts etc.) on the East and West facing facades.
5.	Sun-shade all glazed areas. This should be realised by use of vertical and horizontal sun-shading elements, deep roof overhangs and balconies etc.
6.	Have minimal window openings. It is recommended that all buildings located within the tropics, Kenya included should have minimal window openings.
7.	Use high thermal mass on walls (thick walls). All external walls should be at least 200mm thick.
8.	Use external finishes that are smooth and light coloured to reduce solar heat absorption e.g. having whitewashed external walls, roof cover consisting of brilliant white g.c.i. or aluminum-zinc sheets etc.

9.	Use natural ventilation to provide cooling: This should be elaborately done throughout the building e.g. using operable windows, thermal chimneys, metal/timber louvred fenestrations, perforated timber (mashrubiya) screens on openings etc. This can be achieved through wind driven ventilation (Bernoulli's principle) and Stack driven ventilation (buoyancy ventilation).

2.3.6 Sustainable Neighbourhood

A sustainable neighbourhood is one that has value as a place to live over many generations (Falk and Carley; 2012). They argue that a sustainable neighbourhood entails four key areas: safer streets and living place, a greater choice of homes, environmental features that add value to living in a new neighbourhood and healthier and stronger communities. To count as a sustainable urban neighbourhood (Rudlin and Falk: 2009) a new settlement will have five basic ingredients.

First and foremost a sustainable neighbourhood has a wide choice of housing and facilities to ensure long-term value and to create a balanced community over time. A neighbourhood with some common facilities requires a minimum of between 500 and 1,000 units, with homes catering for a range of incomes and ages. Secondly, is well connected to jobs and services by foot and bike as well as by other modes of transport in order to cut travel time and costs. Creating connectivity (so that people do not have to depend on their cars and can be economically active) requires a location on a transport corridor or close to a town or city centre

In addition it has places of different character that appeal to different markets. Creating character or a sense of place requires a minimum net density of 30 units to the hectare, as in the garden cities and some of the new towns (Alexander: 2009). Higher densities can support better infrastructure but call for higher quality design (Bretherton and Pleace: 2008). Moreover it is designed to save resources and ensure that neighbourhoods are well looked after, and do not 'cost the earth'. Climate-proofing a development will include provision of green infrastructure to promote biodiversity and reduce environmental impact, as well as measures to save energy.

Lastly, it entails benefits from hands-on management and long-term stewardship by responsible local organisations, such as housing associations, development trusts or parish councils, both during development and after residents have moved in.

Research by Churchill and Baetz: 1999 explain that sustainable neighbourhood design involves the development of communities with consideration to environmental, social, and economic goals in a balanced perspective. Specific objectives include minimizing external resource inputs and residual exports to and from the neighbourhood system, maintaining a non-toxic environment, sustaining a high quality of life, and financing infrastructure in an equitable and efficient manner (Heaney et al. 1999; Hellström et al: 2000).

Farr in his book sustainable urbanism: 2008 explains that the most appealing aspect of sustainable urban design is the sustainable neighbourhood. It is therefore important to define the sustainable neighbourhood to enable its understanding and design and to support the establishment of performance expectations. Sustainable urbanism emphasizes that the personal appeal and societal benefits of neighbourhood living is meeting daily needs on foot.

According to canons of sustainable architecture and urbanism: 2008 the balance of jobs, shopping, schools, recreation, civic uses, institutions, housing, areas of food production and natural places shall occur at the neighbourhood scale. Wherever possible, new development shall be sited on underutilized, poorly designed or already developed land. In addition, Neighbourhoods should be as compact as possible, with a range of densities that are compatible with existing places and cultures while promoting lively mixed urban places.

The charter for new urbanism emphasises that Renewable energy shall be produced at the scale of neighbourhood and town as well as at the scale of the individual building in order to decentralize and reduce energy infrastructure. Wetlands, other bodies of water and their natural watersheds shall be protected wherever possible, and the natural systems which promote recharge of aquifers and prevent flooding should be restored wherever possible.

Natural places of all kinds shall be within easy walking distance and Public parklands and reserves shall be protected and the creation of new ones promoted. There is also a need to create a broad range of housing types, sizes and price levels for a population of diverse ages, cultures and incomes can provide for self-sufficiency and social sustainability, while promoting compact cities and regions.

Elizabeth Moule, Hank Dittmar, Stefanos Polyzoides in the publication canons of sustainable architecture and urbanism explains that a steady source of water and the production of a wide

range of locally raised foods within an easily accessed distance establish the self-sufficiency and overall size of neighbourhoods and/or small towns.

Lastly the Charter of New Urbanism proposes that the design of neighbourhoods and towns shall use natural topography and shall balance cut and fill in order to minimize site disturbance and avoid the import and export of fill. There is also a need for Projects to be designed to reduce light pollution while maintaining safe pedestrian environments. Noise pollution should also be minimized. To add to these principles defining a sustainable neighbourhood Farr: 2008 explains five attributes of a sustainable neighbourhood as follows: definition, compactness, completeness, connectedness and biophilia.

2.3.6.1 Neighbourhood Definition

The perfect epitome of neighbourhood definition is in the Clarence Perry's neighbourhood developed in 1924. Clarence Perry neighbourhood explained that the radius of the neighbourhood should be a maximum of one quarter mile thus precluding a walk of more than that distance for any elementary school child. Lastly, shopping districts should be sited at the edge of neighbourhoods preferably at major street intersections (Institute of Town Planners, India Journal 8 - 3, July - September 2011, 81 – 87). Victor Dover proposes a minimum neighbourhood size of forty acres and a maximum of two hundred acres with a neighbourhood centre comprising between six and ten percent of the total land

Victor Dover goes on to assert that the centre and the edge of a neighbourhood should be identifiable. The neighbourhood should have places where the public feels welcome and encouraged to congregate. A proper centre has at least one outdoor public environment designed with pedestrians in mind e.g. a square or plaza.

The potential for high density mixed use at a pedestrian level is key at the centre of the neighbourhood. Paul Murrain argues that the neighbourhood dwellers cherish a well-defined centre other than a well-defined edge because centres affect the quality of life by being the place for meeting daily needs and connecting socially. The edge brings about psychological comfort other than meeting physical needs and that's why the edge are often subtle.

2.3.6.2 Neighbourhood Completeness

According to Falk and Carley: 2012 completeness entails a wide choice of housing and facilities to ensure long-term value and create a balanced community over time. A neighbourhood with some common facilities requires a minimum of between 500 and 1,000

units, with homes catering for a range of incomes and ages. In addition completeness also refers to the diversity of dwelling types needed to accommodate the varied needs for housing over a lifetime. A neighbourhood that provides a full range of housing types allows people and families to remain in the neighbourhood even as their housing needs change (Farr: 2012).

2.3.6.3 Neighbourhood Connectedness

In order to achieve internal connectedness within the sustainable neighbourhood, the entire neighbourhood needs sidewalks on both sides of the street and the distance between intersections needs to be relatively short i.e. not more than 90-120metres. Most people, when walking as a mode of transportation, will not walk farther then ¼ mile or five to ten minutes from their origination location, when walking for transportation the route from the origination location to the destination should be as direct as possible (Yan-et-al: 2005).

According to Rohe:2009 neighbourhood connectedness incorporates the following elements: A street system that uses a grid or undulating design to maximize connectivity, a mix of compatible land uses that includes housing, retail, and public facilities, single family homes set close to the street, with front porches, and garages set to the rear and pedestrian amenities and public open spaces.

2.3.6.4 Neighbourhood Compactness

Sustainable urban designed can be increased through density in the neighbourhoods. However, sustainable urban design is not achievable at low densities, below an average of seven or eight dwellings per acre. This density threshold is achievable in neighbourhood scale projects by offering a spectrum of housing types. This is from multifamily dwelling to large detached single family homes in the same neighbourhood. The only way this can be achieved is by concentrating the density in the neighbourhood centre with the upper floor dwellings and lower floor businesses adding vitality and pedestrian buying power (Farr: 2008).

2.3.6.5 Connecting humans to nature

The table below summarizes how humans can be connected to nature in the setting and also at a neighbourhood scale. It clearly highlights the benefits of connecting humans to nature with regard to ensuring sustainable neighbourhoods.

Table 2.3.6.5. Biophilia in Sustainable neighbourhoods. Source: Reeve et al, 2012

Element		Forms	Specific Benefits	Common Benefits
Building	Indoor Plants	-Pot plants in buildings -Indoor living walls, including pots within a frame (also see Green Walls) -Indoor planted vegetation, such as atriums and large planted installations	-Reduces illness -Increases productivity -Improves air quality	Revitalises urban environments
	Green Roofs	-'Intensive': Soil deeper than 200mm and vegetation up to the size of trees -'Extensive': Soil up to 200mm with ground cover vegetation	-Improves building energy efficiency -Water management -Space efficiency -Food production -Sound insulation -Increases roof/wall lifespan -Vertical urban Farming	-Reduces urban heat island effect -Improves air quality -Improves microclimate -Sequesters carbon/ reduces greenhouse gas emissions
	Green Walls	-Internal and external green walls -Include: vegetation directly attached to infrastructure (such as ivy), panel Systems with substrate (such as preplanted panels with soil), and container or trellis systems.		
Neighbourhood	Green Verges	-Street trees and canopies -Shade planting for buildings -Green streets and alleys that create cool pervious greenways -Rain gardens and bio-swales integrated into stormwater management plan and consisting of pervious channels -Green permeable sidewalks	-Encourages walking, and cycling -Reduces building cooling/ heating energy use -Water management -Food production	-Increases biodiversity Improves water cycle management Provides amenity -Enhances well-being/ reduces stress -Recreation Reconnects with nature -Revitalises cities -Increases property value -Enhances tourism
	Green Islands	-Urban parks and gardens placed close to transportation routes -Community farms close to homes -Residential backyards -Lawns and gardens (public and private)	-Encourages walking and cycling -Food production -Increases community Cohesion	
City	Green Corridors	-Green corridors (biodiversity corridors) reaching outside the urban area	-Links biophilic elements -Encourages walking	

		-Highway crossings and migratory routes -Backyard commons -Vegetated buffer zones along coastal areas	and cycling	
	Urban Farming	-Large scale community gardens and urban farms -Urban and peri-urban agriculture	-Food production -Employment and education	
	Waterways, and water sensitive urban design features	-Wetlands (natural and constructed) -Ponds and lakes -Rivers and streams -Vegetated swales, drainage corridors, infiltration basins, etc.	-Water management, treatment and storage -Protects downstream water bodies	

2.4 Sustainable Urban Design in Nairobi's Eastlands

Nairobi as whole faces unique urban design challenges ranging from population growth, urban sprawl, transportation problems, housing deficit, storm water management just to mention a few. Over the years Nairobi's has experienced urban expansion both in population and spatially. The same facilities designed and constructed during the pre-colonial colonial era and post-colonial era are evident and in disrepair. There has however been new developments coming up to respond to the urban expansion. In as much as Nairobi's Eastlands urban design challenges are specific, universal solutions can be applied to mitigate these problems. Sustainable urban design can be applied with a view of accommodating urban expansion and other urban challenges. This has to however be tailored to suit Nairobi Eastlands. The theory and model of sustainable urban design explained in this chapter are applicable. The theory by Farr: 2008 which is defined by compactness and Biophilia is best suited for the study area.

This is due to the fact that it is product based and aims at accommodating urban growth while striking a balance with the natural systems. This can give a guideline on how the study area can optimally utilized the prime land and ensure quality spaces. For this to be effective, first of all it has to be tropicalized and also be cognisant of the challenges in Nairobi's Eastlands. These challenges are economic, social and environmental in nature and have to be addressed holistically. In order to tailor this sustainable urban design theory by Farr: 2008, it is imperative to look at its core components in context. This is by using Kaloleni Estate as a case study to represent Nairobis's Eastlands. The application of the components of sustainable urban design by Farr: 2008.

2.5. Case studies of Sustainable Neighbourhoods

This part of the research report provides a study of two neighbourhoods incorporating sustainable urban design ideas. These neighbourhoods aspire to integrate walkable and transit served with high performance buildings in order to ensure there sustainability. Each project offers different lessons in design, technology, system integration and leadership. This study looks at Nyayo Estate NSSF Housing Scheme Embakasi (Nairobi) and best Sustainable Urban Design practices in Kronsberg Hannover (Germany).

2.5.1 Nyayo Estate NSSF Housing Scheme Embakasi (Nairobi)

Nyayo estate is a residential neighbourhood located approximately 15km from the Nairobi CBD. The site is bound by industrial developments and informal settlements near phase III, the presence of airport police residence is conspicuous.

2.5.1.1 Project Details

Developer: National Social Security Fund

Master planner & Architect: Symbion International

Dwelling units: First phase: 992 Apartments, 156 Maisonettes and 8 Shops. The second phase included 1,774 Apartments, 288 Maisonettes and 5 shops. Lastly the third phase entailed 1320 Apartments, 255 Maisonettes and 6 shops. This estate was home to between 23, 925 people and 33, 495 people.

Other Facilities: Shopping centre, Health centre and public hall, Sports facility, Market, Nursery school, Primary school, Refuse collection centre, Secondary school, Nursery school 2, Children's play area, Nursery schools 3,4,5, Triple stream primary school, Church and Petrol station

Land area: Total development 25 Ha.

2.5.1.2 Background

There is no determinate history of the development apart from pure capitalistic real-estate speculation. The initial idea of the scheme is still intact since only phase I has been done.

The site is bound by industrial developments and informal settlements near phase III, the presence of airport police residence is conspicuous.

2.5.1.3 Site Location

The development is located in Embakasi approximately 15km from the CBD. In the west, Embakasi is served by two main links to the city centre. Mombasa road: this is the main link, being a highway, it provides the quickest link to the city centre. Secondly, Embakasi is served by Jogoo road through outer-ring road: it is a busier route linking most of the eastern estates especially to phase III. The figure below clearly points out the location of the site in relation to the existing neighbourhood.

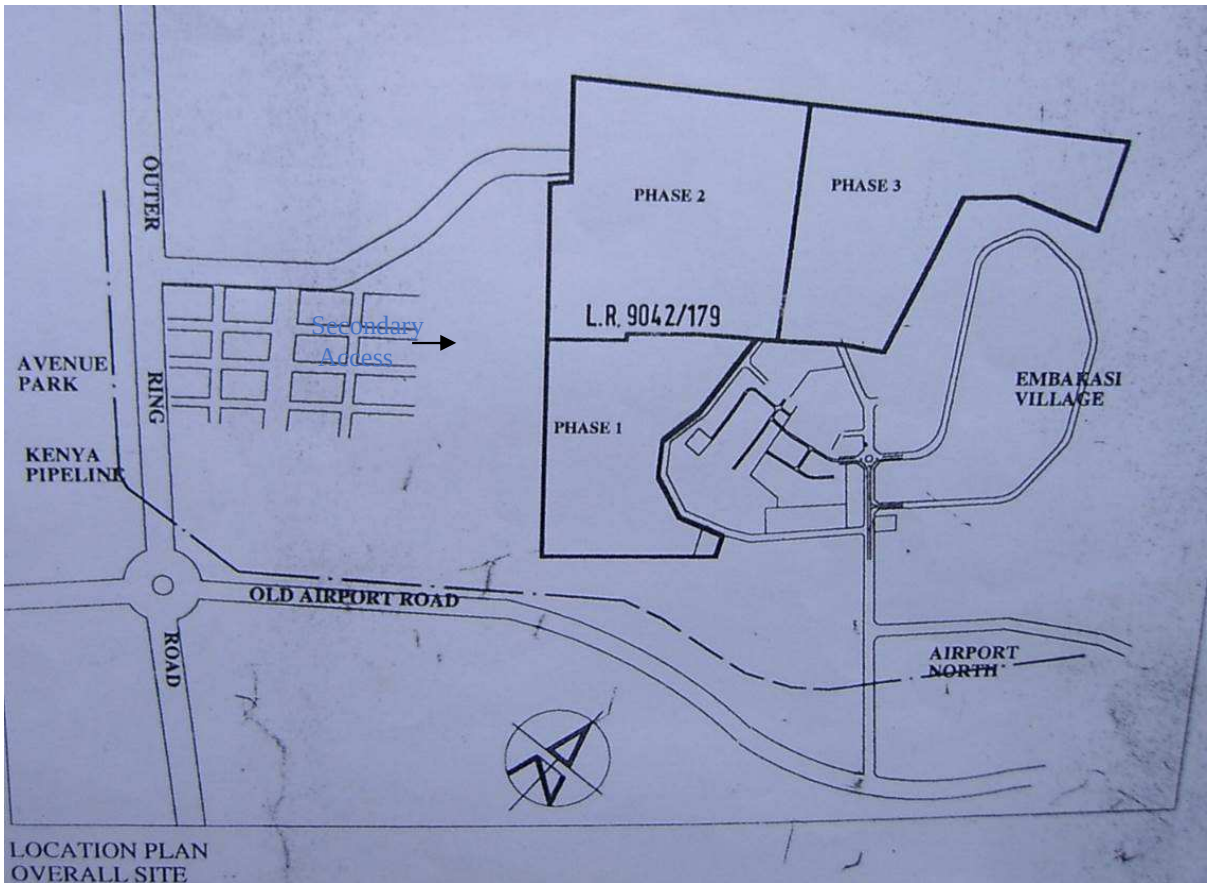


Fig 2.5.1.3. Phasing, Source: Symbion International

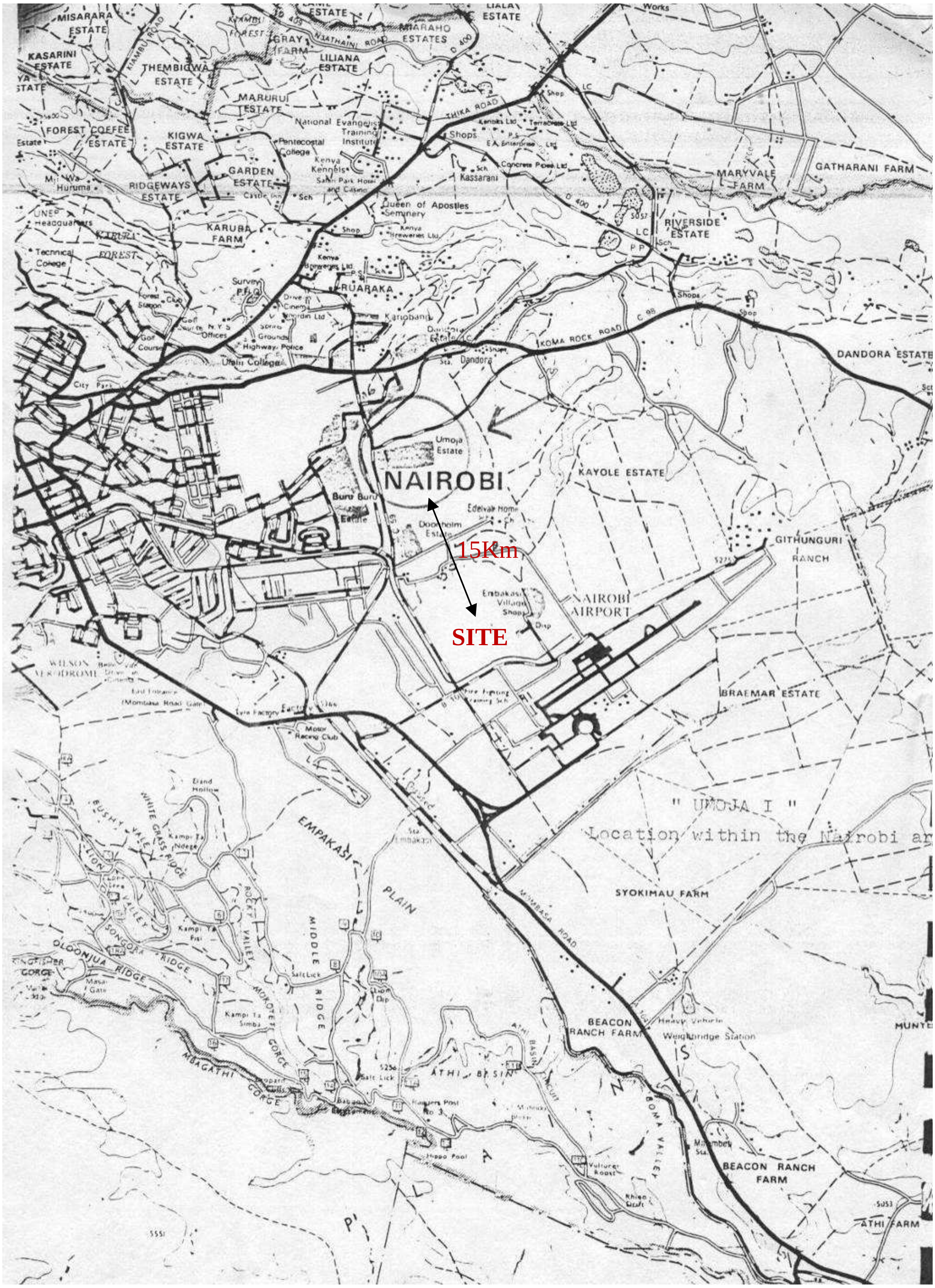


Fig 2.5.1.3. Embakasi in Nairobi.

Source: Symbion International

2.5.1.4 Nyayo Estate Embakasi Planning

The scheme was conceived based on two concurrent principles:

Linear layout. Based on the circulation spine acting as the main arterial with subsidiary access roads supplying the various clusters with basic facilities. All the maisonettes are organized along the road network in the estate

Grid planning

The grid layout has been used to organize the built form. A basic grid of 55x43m has been employed. The planning principles in Nyayo Estate Embakasi are depicted in the overall master plan

Fig.2.5.1.4: Nyayo Estate Embakasi Master Plan.Source: Symbion International

2.5.1.5 Sustainable Urban Design Components

Nyayo Estate was planned and design to exhibit some sustainable urban design principles. Some of the designed landuses and amenities were however not implemented. The following sustainable urban design components explain Nyayo Embakasi Estate as an attempt to achieve a sustainable neighbourhood.

2.5.1.5.1 Density

Nyayo Estate, Embakasi covers 25Ha and was designed to accommodate 4, 774 units. The development is planned into three phases as follows:

Table 2.6.1.5.1: Nyayo Estate, Embakasi density

Planning	**Apartments**	**Maisonettes**	**Dukas (Shops)**	**Total (Units)**
Phase I	124x8=992	156	8	1, 156
Phase II	218x8=1, 744	288	5	2, 037
Phase III	165x8=1, 320	255	6	1, 581
Total	4, 056	699	19	4, 774

The family structure is composed of 5-7 members making the target population to be between 23,794 people and 33,323 people. The average density (persons per acre) of the development is therefore 238 persons per acre. In terms is dwelling units per acre the density is 48 dwelling units per acre. According to Farr; 2008, this density is within the sustainable range. This is due to the fact that densities above 8 dwelling units per acre is within the sustainable range.

2.5.1.5.2 Integration of Transport, Land uses and Technology

The different land uses have been tied together with transport. The main circulation spine acts as the main artery with subsidiary access roads supplying the landuses. All the maisonettes are organized along the road network in the estate. The streets in this development are walkable due to the provision of walkways.

Plate 13: Walkable streets in Nyayo Estate
Source: Peter Oluoch

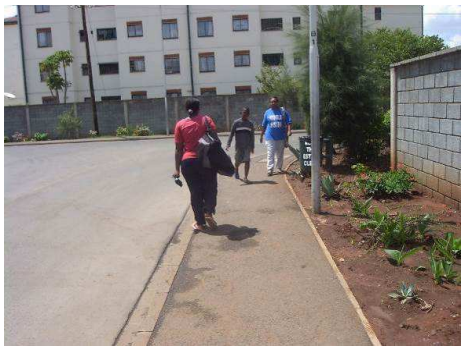


Plate 14: Adequate Walkway in Nyayo Estate
Source: Peter Oluoch

Car usage has also been provided for because the development allots 1.5 cars per unit through communal parking for apartments and individual parking for maisonettes. The drawing below illustrates building clusters with communal parking.

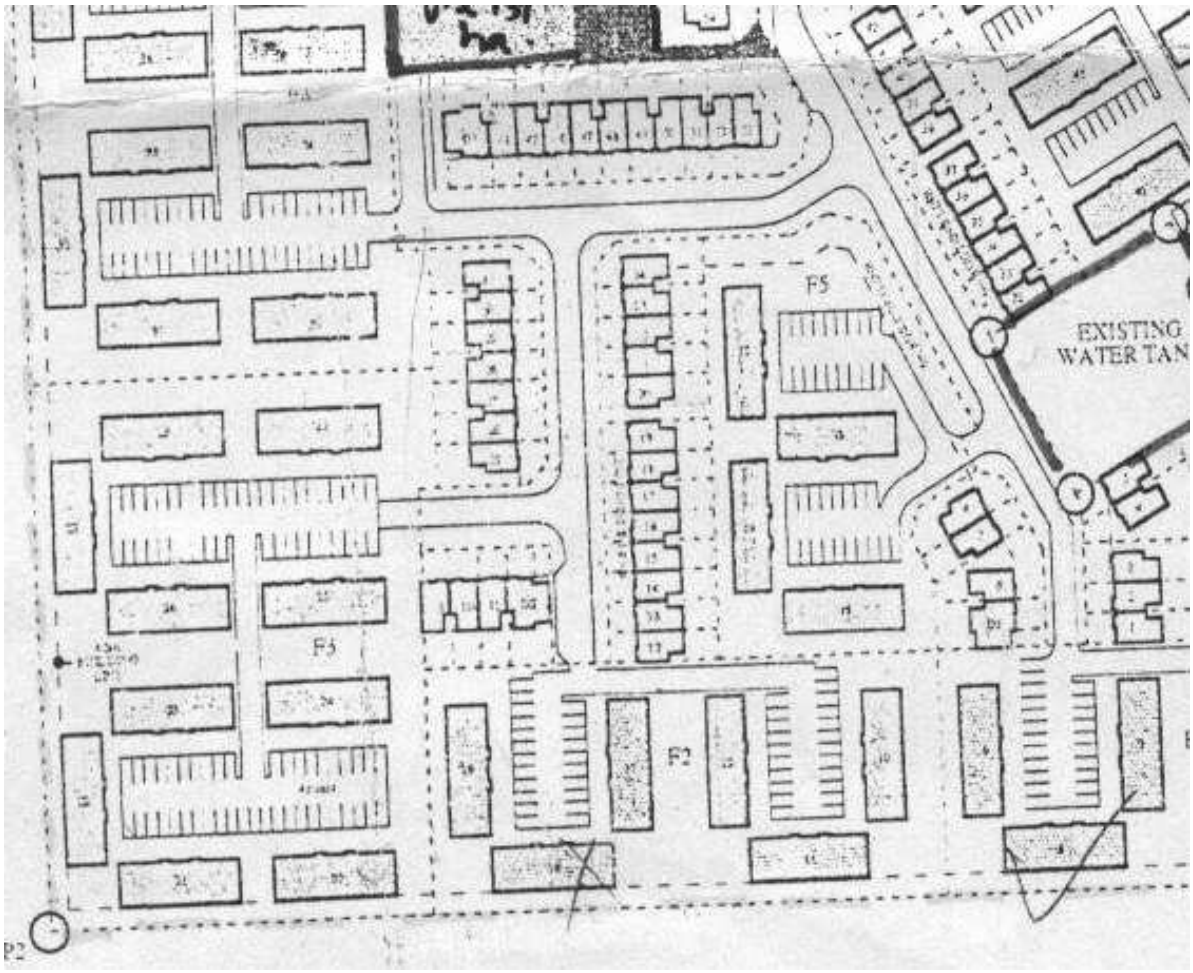


Fig.2.5.1.5.2: Illustrating building clusters with parking. Source: Symbion International.

The communal parking is not only used for parking vehicles but also as a play area for the estate children. It was however not designed for multiple use but children have adapted it for recreation. Technology has also been integrated to transport and the landuses at Nyayo Estate Embakasi. Services such as water, power, telephone and internet has been integrated with transport as depicted below.

Plate 15: Underground telephone line
Source: Peter Oluoch

Plate 16: Telephone booth
Source: Peter Oluoch

2.5.1.5.3 Open spaces

The development was planned to accommodate a variety of open spaces to connect humans to nature. Some of the open spaces are: children play area (Phase II), Sports fields, individual and communal gardens. There was an attempt to construct this open spaces but they were poorly articulated. The images below depict some of the open spaces at the Estate.

Plate 17: Redundant spaces no street furniture
Source: Peter Oluoch

Plate 18: Redundant spaces not appropriate
Source: Peter Oluoch

2.5.1.5.4 Stormwater Management

The main storm water drains in the development runs behind the housing blocks and is channeled to the main public roads. There is also presence of subsurface stormwater drainage on the access roads to dispose the rain water. There are primarily two types of stormwater drainage in Nyayo Estate Embakasi: on surface and subsurface drainage.

Plate 19: On surface stormwater drainage
Source: Peter Oluoch

Plate 20: Subsurface stormwater drainage
Source: Peter Oluoch

Stormwater in Nyayo Estate is basically collected and disposed to the main public roads. There is no attempt to achieve biophilia through stormwater drainage. This is due to lack of an attempt to harvest, treat and reuse the stormwater. Secondly, stormwater is not allowed to percolate into the ground to recharge the aquifers. Lastly the approach taken in stormwater management is collection of all stormwater and channelling it to drains. There is no attempt to reduce stormwater runoff by provision of bioswale, bioretention ponds, rain gardens etc.

The drawing below elaborates how storm water drainage has been articulated using manholes and on surface drainage

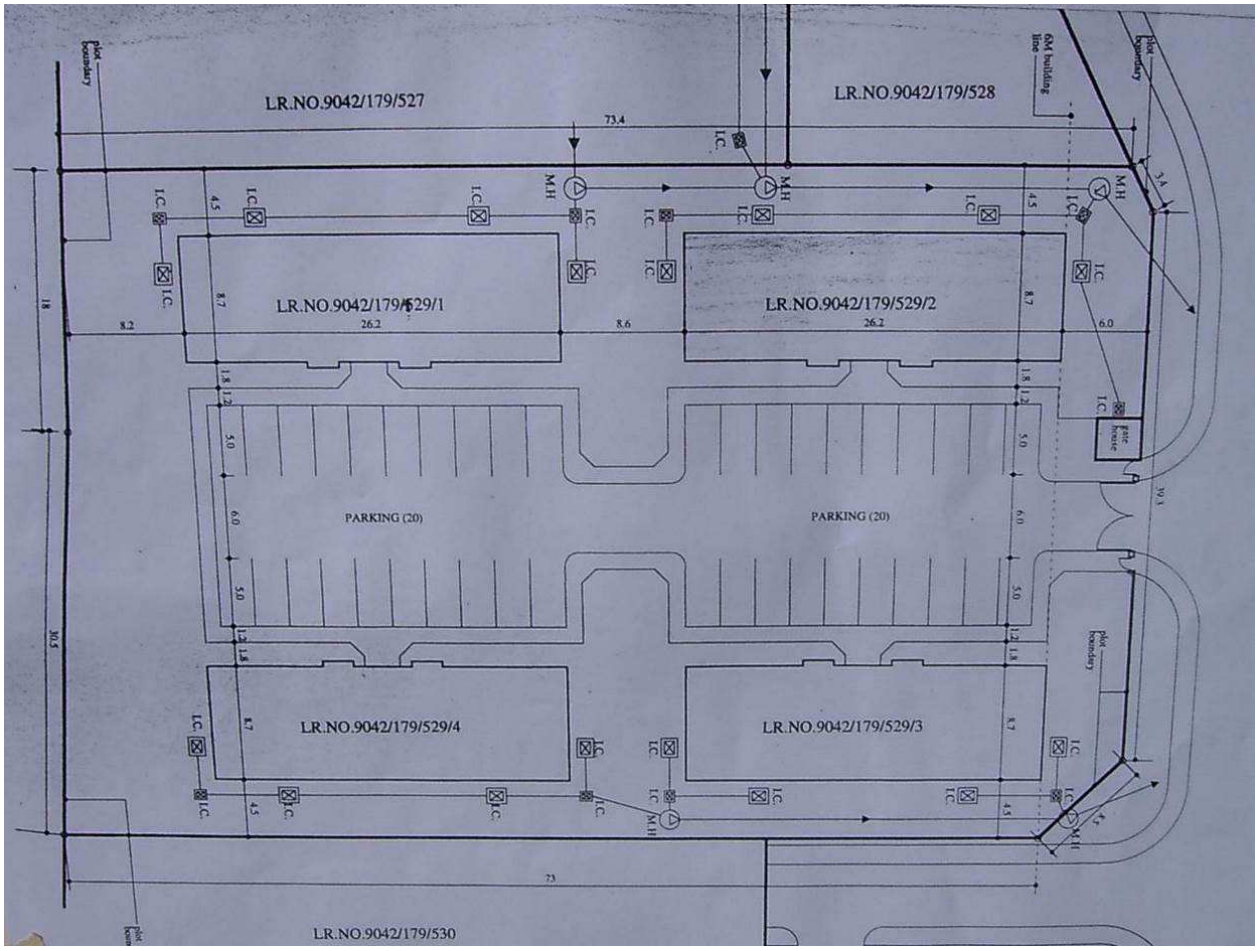


Fig.2.5.1.5.4. Stormwater drainage in Nyayo Estate Embakasi. Source: Symbion International

2.5.1.5.5 Waste management

All the flats in Nyayo Estate Embakasi are connected to inspection chambers which drain black and grey water into manholes which link various clusters. Drainage channels in the blocks are in backside to enable linkage of two clusters. The black water is eventually emptied into the main sewer line.

Plate 21: Sewage system at the backside

Source: Peter Oluoch

Plate 22: Sewer network

Source: Peter Oluoch

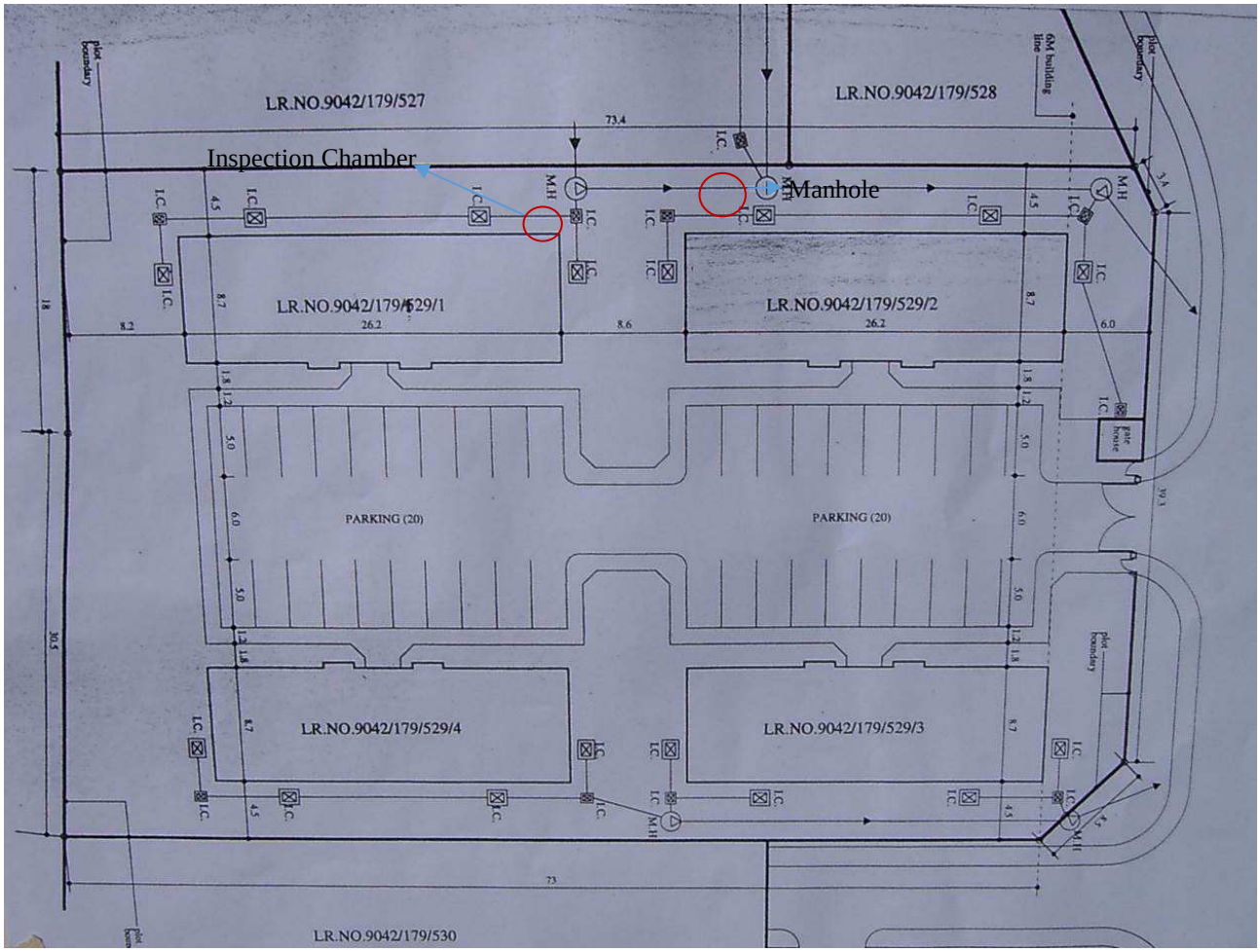


Fig. 2.5.1.5.5: Sewage network at Nyayo Estate Embakasi

Source: Symbion International

The sewage in Nyayo Estate Embakasi is basically collected and disposed into the main sewer line. There is no attempt to incorporate ecological sustainable principles to recycle and reuse the black and grey water for landscape irrigation or even flushing toilets. The population in the estate is high enough to harness biogass which can be reused for cooking or even street lighting.

Refuse collection in the estate was subcontracted to a private firm. The same firm is also in charge of cleaning streets, outdoor spaces and maintaining the gardens. All the refuse be it electronics, degradable waste and non-degradable waste is collected at the refuse chutes and transported to dump sites. There is no attempt to separate the refuse, reduce the waste or even recycle the waste within the estate.

2.5.1.5.7 Public Lighting

The key function of public lighting in Nyayo Estate Embakasi is to ensure security. This is ensured by presence of a subcontracted to a private security firm (securicor). The firm is in charge of all the gates to various courts and security check. The import of public lighting is to

allow night time activites such as commerce and outdoor recreation. This is not reflected in Nyayo estate Embakasi. The street lighting evident is only for security purposes and not connecting human beings to nature.

Plate 23: Street Lighting along circulation spine

Source: Peter Oluoch

Plate 24: Street lighting for security

Source: Peter Oluoch

2.5.1.5.8 Food Production

The master plan did not include spaces for food production either at the individual building block level or communal gardens. The residents of the estate has however incorporated food production at an individual level in private gardens. This is an attempt to achieve urban agriculture at a neighbourhood scale.

Plate 25: Urban Agriculture

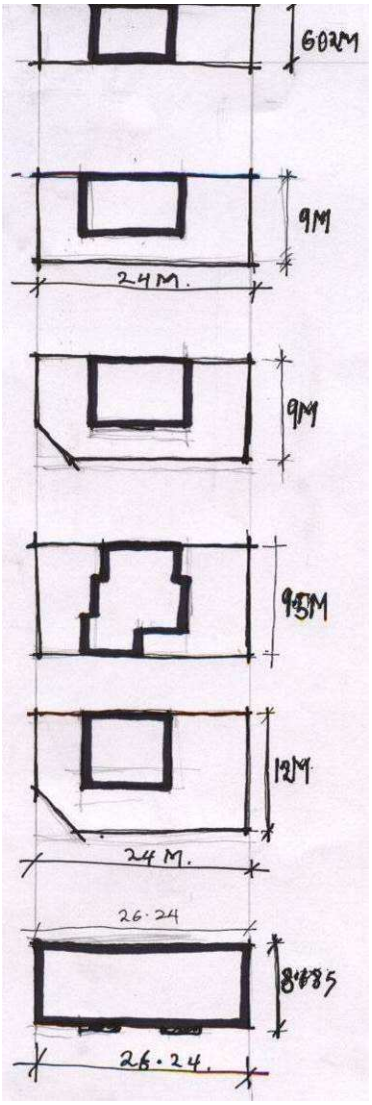
Source: Peter Oluoch

Plate 26: Subsistent Poultry farming

Source: Peter Oluoch

2.5.1.5.9 Building Performance in Nyayo Estate Embakasi

There are two main house typologies in the development; Flats and Maisonettes. There are six basic typologies in the whole scheme. The maisonettes are varied to the following:



- 24M by 6.02M Plot
- 24M by 9M Plot
- 12m wide plot with 6m truncation
- 9.5m wide plot for duka with 3BR maisonette
- 12m wide plot with 4.5m truncation
- Block of 8 NO. 3BR Apartments

Fig. 2.5.1.5.8. Maisonette typologies. Source: Author.

Flats

The form planning tool was symmetry and the basic shape was a rectangle. The flats were organized to form courtyards. The flat was composed of two units per floor making eight units per block.

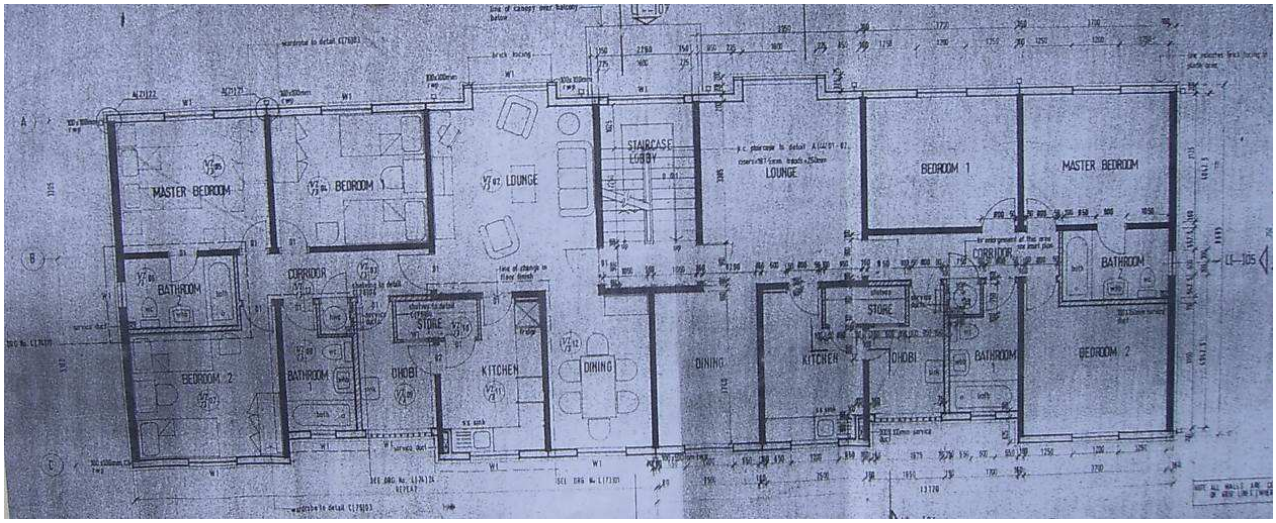


Fig. 2.5.1.5.8b. Floor plans for typical Flats

Source: Symbion International

In order to determine whether the flat is a high perfomance it is imperative to study an individual unit. This is with a view of understanding whether the designed Flats entailled High perfomance strategies suitable for tropical regions. This was achieved by studying the the ventillation, daylighting, construction technology and materials.

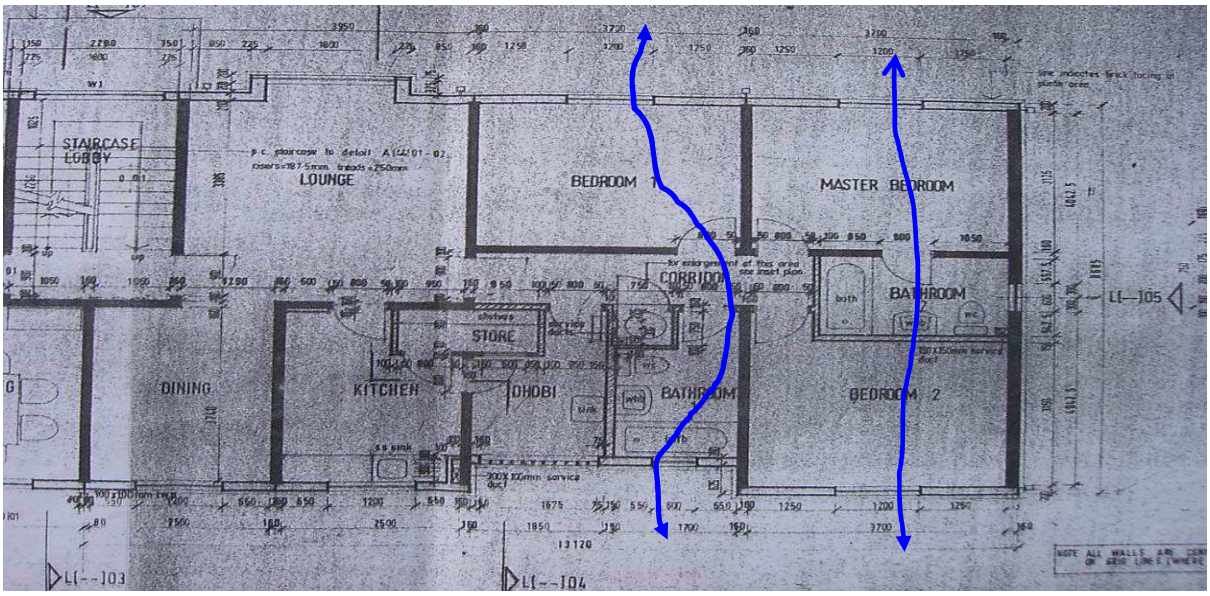


Fig. 2.5.1.5.8c: Ventilation and Daylighting Source: Symbion International

Lighting and Ventilation

Natural lighting in the house is adequate with provision through the corridor. The light colour of the walls and soft white ceiling enhances the propagation of natural light. There is adequate in internal ventilation except for the, master bedroom bathroom where the fowl air is trapped in the bedroom.

Maisonettes

Simple floor layout determined by the need for rationalization of the construction process. There is adequate ventilation due to the well-articulated cross ventilation. There is adequate daylighting due to enough windows though they are not sun shaded.

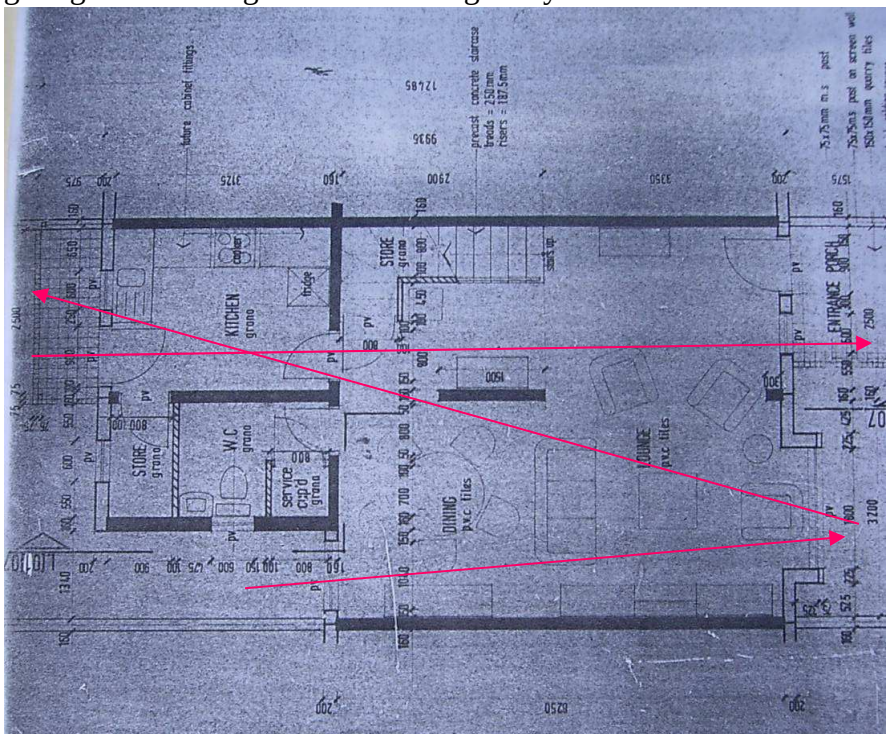


Fig. 2.5.1.5.8d. Maisonette Lighting and Ventilation

Source: Symbion International

Daylighting and Ventilation

Natural lighting in the house is adequate with provision through the corridor. The light colour of the walls and soft white ceiling enhances the propagation of natural light. There is adequate in internal ventilation except for the, master bedroom bathroom where the fowl air is trapped in the bedroom.

2.5.1.5.10 Lessons Learnt

The first lesson derived from this case study is increasing sustainability through density. This neighbourhood has an average density of 48 dwelling units per acre. This is within a sustainable range and can support transit. In addition, this density optimally utilizes the land at Nyayo Estate Embakasi. This is due to the fact that the development is 15Km from Nairobi CBD and hence the land value is high. It is therefore to design densities which are within sustainable ranges depending on the site location and the need to ensure walkability.

Secondly, the Master plan for Nyayo Estate Embakasi included different land uses, amenities and technology. Transport, technology has been integrated into the land uses, however, certain amenities and Landuses are conspicuously lacking. These are: shopping centre, Sports facilities, Children's play area, Market, Health centre and a public hall. This is major weakness in achieving sustainable urban design in this development. It is imperative to integrate transport with landuses and technology to ensure a sustainable neighbourhood.

This development attempted to connect humans to nature through open space provision. These spaces were however not constructed and the attempt to provide gardens failed. There were no meaningful and interactive open spaces, the street was not designed for user experience. The lesson derived then is that, it is important to provide and design diverse connected open spaces to connect humans to nature.

There are other attempts to achieve Biophilia (connecting human beings to nature) in Nyayo Estate Embakasi. This development collected the stormwater through on surface and subsurface drainage and directed it to the main public roads. There was no attempt to harvest and reuse this water through rain gardens, detention ponds etc. There was also no attempt to reduce stormwater by use of bioswlaes, bio retention pond, permeable paving etc.

It is imperative to first of all reduce stormwater by utilizing the stated methods. Secondly harvesting, treating and reusing stormwater ensures sustainability. This similarly applies to grey and black water at the development. Waste management goes a long way in achieving sustainable urban design. This is through the ecological ways of reducing, recycling and reusing the waste water.

There was public lighting integrated to transportation in Nyayo Estate Embakasi. This was primarily for security purposes and not to encourage night time activities such as commerce. In order to achieve a sustainable neighbourhood it is important to integrate public lighting with the other landuses. This is to connect humans nature by ensuring even the open spaces can be used at night and other landuses too.

Nyayo Estate Embakasi manifested some traces of Food production for the residents. This was through some Individual Dwelling Unit subsistent kitchen gardens and poultry keeping. The food produced in these gardens was so little that it could not sustain the population in the development. This could be averted by introducing communal food gardens, edible landscaping and increasing the individual kitchen gardens.

Lastly, the development attempted to achieve sustainable urban design through the buildings. The planning of these buildings entailed clusters forming a courtyard. There was a variety of building typologies to suit the different users' tastes. The building had fairly good ventilation and daylighting. This attempt to ensure high performance buildings was not successful and thus sustainable urban design was not entirely achieved.

In conclusion, this development depicted some sustainable urban design component but they were not articulated well. In order to achieve a sustainable urban design it is key to incorporate the core components illustrated by Farr: 2008 to the latter.

2.5.2 Kronsberg Hannover, Germany

Kronsberg is located 8 kilometres in the South- East of the city of Hannover and represented the last remaining area in Hannover suitable for urban development. It is a long low hill, two kilometres wide and about six kilometres from north to south. Its crest is 106 metres above sea level, about 30 metres higher than the surrounding area. Kronsberg's particular charm lies in the sweep of the open countryside and clear views to all points of the compass; the Hannover city skyline is particularly distinctive from here. Following the landscape plan, the crest of the hill was planted with trees before construction planning began to emphasise the elevation (Farr: 2008).

2.5.2.1 Project Details

Master plan and Developer: City of Kronsberg

Timeline: City Started buying land in 1970s; city council resolved to use sustainable guidelines in 1990; first phase built in 1998.

Dwelling units: First phase: 3, 000, including 300 private row houses; 2, 000 additional private houses upon completion and will be home to around 15000 people. Almost 3000 new jobs have been created and are located in the immediate vicinity.

Commercial square footage: Approximately 377, 000 square feet

Other Facilities: Three children's day centers, a primary school, a high school, a district arts and community center, a church center, a health center and shopping complex are in operation, all built to high ecological standards.

Land area: Total development 395 acres; first phase; 173 acres.

2.5.2.2 Background

The Kronsberg District is the city of Hannover's vision for sustainable development in Germany. It entails a development scheme dominated by ambitious energy reduction goals, transit oriented design and mixed income residential areas. Kronsberg's success by 2001, a 74 percent reduction in CO2 emissions compared to conventional developments. The design entails a clearly defined residential and mixed use section following the natural contour of a hill designed as a protected open space (Eckert et al: 2000).

2.5.2.3 Concept

Two competitions were the basis for a concept for the entire Kronsberg area, including the Expo grounds, the new city district and the countryside. The new district runs roughly north-south along the western slope of Kronsberg hill beside the new tramline, thus linking the older district of Bemerode with the World Exposition grounds. Its eastern boundary to the countryside is defined by a kilo meter-long avenue. The dispersed development in Bemerode to the west is contrasted with the rectilinear blocks of the Kronsberg development. The new district is laid out across the contour in neighbourhoods with their own distinct identity, each of them grouped around a neighborhood park and bordered by park corridors or green zones along the streets (Granvik et al: 2013)

The essential elements of realizing a vision of sustainable urban development are compact building forms and high density while promoting architectural diversity and high quality living accommodation. By establishing two legally binding local plans the municipality set the parameters of possible architectural forms; the principle planning aim was space-saving construction through high density. Defining the number of storeys, and compulsory building lines on the street frontage created a dense urban townscape (Eckert et al: 2000)

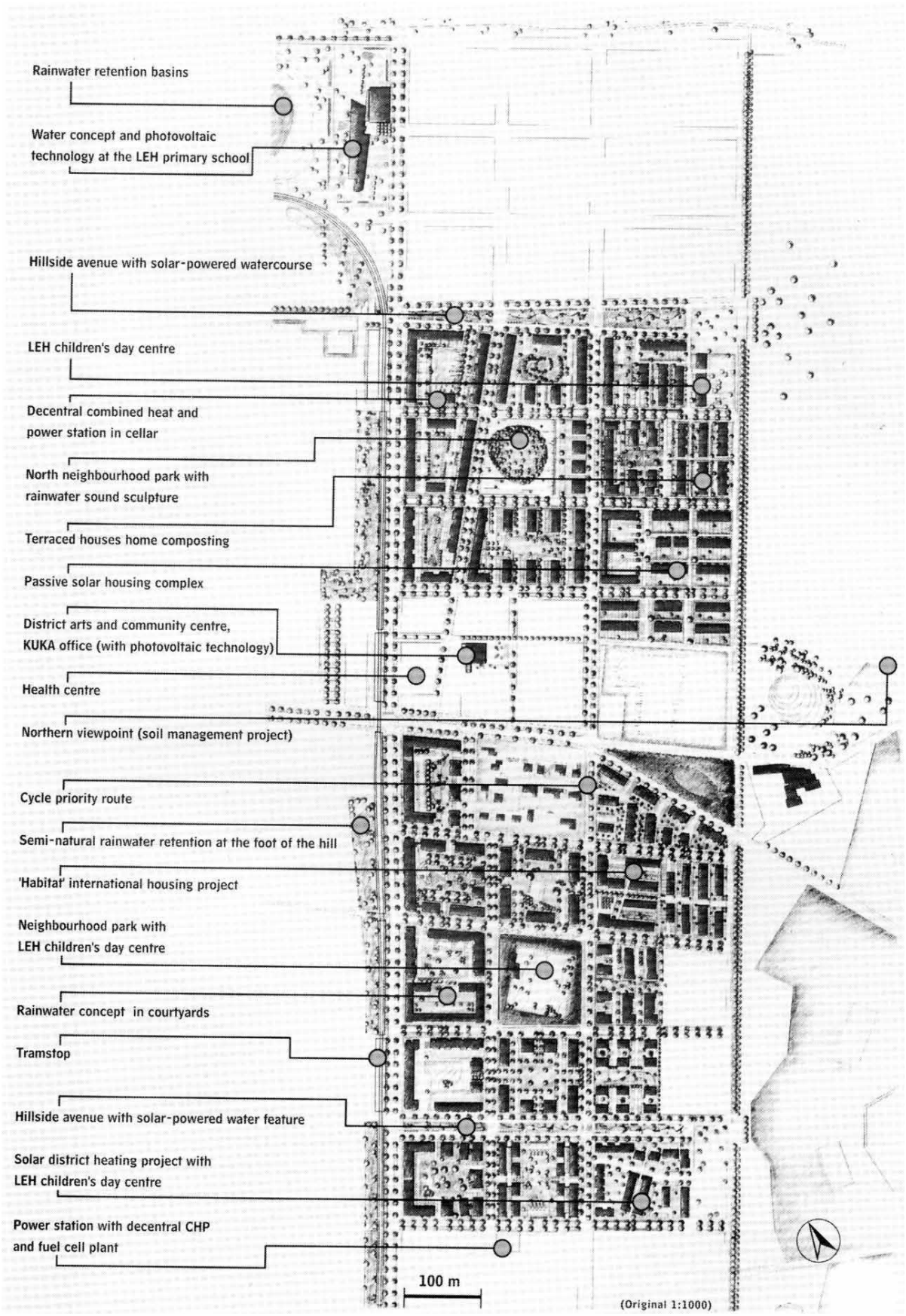


Plate 27: Kronsberg Neighbourhood Master Plan.

Source: Granvik et al: 2013

2.5.2.4 Neighbourhoods

The first development phase established 'Kronsberg-Nord' and 'Kronsberg-Mitte', two neighbourhoods with their own identity each focused around a neighbourhood park; communal inner courts encourage a neighbourhood atmosphere. The development plots on the uphill side are relatively large - 1.2 or 1.8 hectares; this made it possible to keep the proportion of public access areas fairly low at 19%. The grid-like block layout at the same time provides the basis of the intended urban appearance of the settlement with its clear contours and profile.

Plate 28: Grid like planning structure. Source: Eckert et al: 2000

2.5.2.5 Architectural Structure

Most buildings are aligned parallel to the contour, enabling them to make the best use of natural light through mainly west- and east-facing windows. While the multi-storey apartment buildings on the lower slopes are mainly block structures, there are rows and some pavilion layouts in the middle zone. Most buildings have a set-back top storey with shallow single-pitch or inverted pitch roofs, often combined with spacious roof terraces. In the spirit of planning for sustainability, close links between living and working in the vicinity was a priority. In the western section around the IBM site more than 2,000 jobs have created.

2.5.2.6 Open Space Design

The Kronsberg district has a great deal of open space and intensively designed greenspace. Each building plan was complemented with a qualified open space plan by a landscape architect who had to meet the high design and ecological standards set by the municipality. Streets lined with trees, front gardens, and the individually-designed neighbourhood parks underpin the overall town planning concept. Several large playgrounds are laid out close to the apartments (Rumming: 2013).

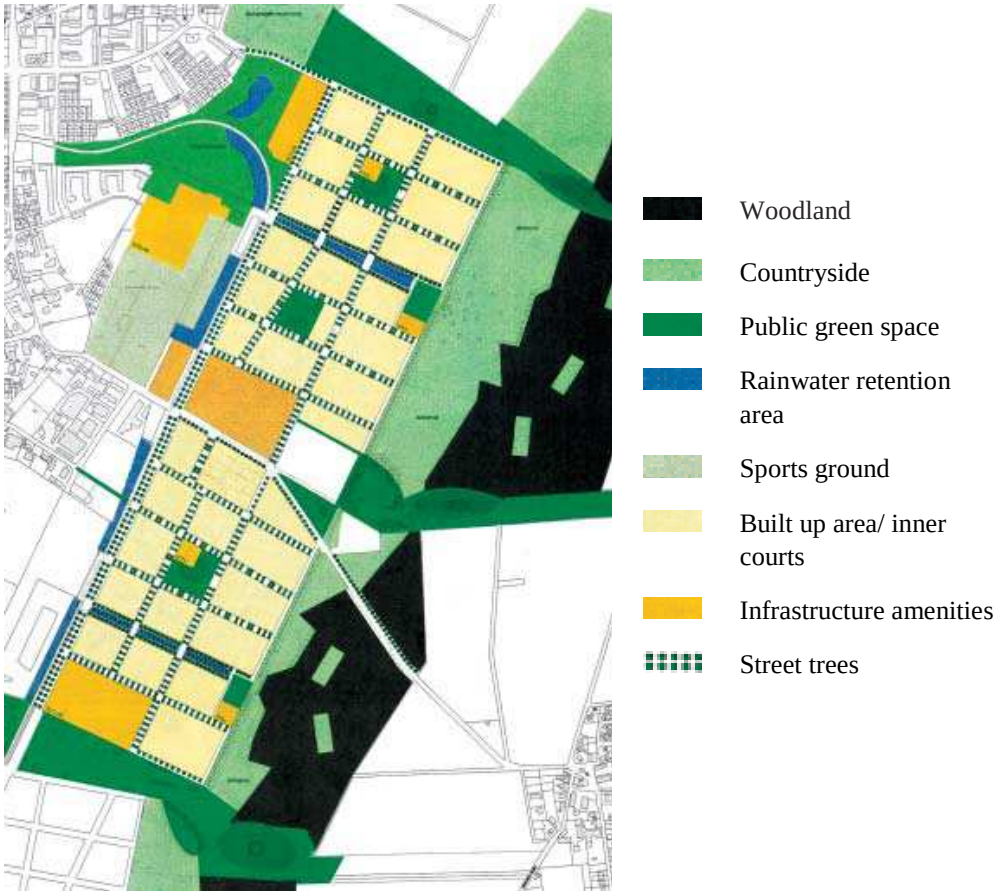


Plate 29. Open spaces in Kronsberg. Source: Eckert et al: 2000

2.5.2.7 Transport

At forty seven units per acre, the density of the settlement is able to support a new tram line with three stations in Kronsberg. These are situated so that no resident walk farther than one third of a mile to reach one. The main arterial road is also situated alongside the tram line on the western edge of the development eliminating traffic through- traffic in the neighbourhoods. Car usage is further discouraged because the development allots 0.8 cars per unit with the remaining fraction converted to additional public parking space (Eckert et al: 2000)

A designated bike street bisects the length of the site. A cluster of mixed use buildings such as a health centre, a church, a shopping centre, an arts and community centre near the tram stop provides residents with pedestrian friendly community hub. Kindergartens, a primary school and a high school are also situated within the development.

Plate 30: Shopping/service centre/transport
Source: Rumming: 2013

Plate 31: Tram Station
Source: Rumming: 2013

Motor traffic is channelled along the edge of the district parallel to the tram line to reduce nuisance; planning of the residential streets prevents through traffic. Traffic calming is effective, with 30 kph zones, right-before-left priority, and many constrictions of the road width and some bollard barriers. A special cycle road crosses the district from north to south for about 1.5 kilometres.

Overall, a third of the cars are parked underground, a third in sunken car parks, and a third at surface level. To restrict the number of parking spaces in the inner courts the City of Hannover passed a bylaw allowing only 0.8 of a parking space for each apartment, compensating with an extra 0.2 for on street parking. This uses the parking spaces better through the day, and the required total space is reduced (Rumming: 2013).

2.5.2.8 Infrastructure Amenities

The apartments in the first construction phase have the following amenities: a primary school with sports hall, three children's day centres, around 17 rooms for community use. The community use rooms are mostly located on the ground floor of apartment buildings; developers were obliged to provide these rooms, most of them originally conceived as apartments, in the main building work (Eckert et al: 2000).

At the centre of the district, right next to 'Kronsberg' tram stop, is the district square, on which are grouped: KroKuS arts and community centre, Protestant church centre, a health centre (under construction), a shopping centre, other shops, cafés, and restaurants (Rumming, 2013).

2.5.2.9 Energy Efficiency Optimisation

The central concern of energy efficiency optimisation at Kronsberg is to reduce CO2 emissions by at least 60 % compared to current standards for conventional residential buildings. Reduction of energy consumption is achieved through Low Energy House building

methods with the appropriate quality assurance measures, optimised energy provision by a differentiated district heating system fed by two decentral cogeneration plants, and specific saving measures on the consumer side. Further reductions in CO2 emissions are achieved by integrating wind- and solar power projects and the use of innovative technology (Eckert et al 2000).

Plate 32. Energy optimisation. Source: Eckert et al: 2000

2.5.2.10 Water Management

Although the construction projects cover large areas of ground the balance of natural water resources on Kronsberg could be largely maintained with a newly-devised method of rainwater management. All precipitation on built-up and paved areas is absorbed, collected and gradually released. There have been no adverse effects on groundwater regeneration in nearby woodland, and water levels in the existing ditch system have remained constant. On the public streets, rainwater is fed into the 'Mulden-Rigolen- System' soakaways.

On private open space, rainwater from roofs and paved areas is also collected and gradually released; in the residential areas it is often used as a design element to fill open ponds or watercourses. Rainwater management has had a shaping influence on the design of the district and helped to create good quality open space. Making the theme of water visible is intended to raise public awareness of the life-giving importance of this element. Equipping all apartments with water-saving taps helps reduce water consumption. Residents are also encouraged by exhibitions and information materials to economise on drinking water (Granvik et al: 2013).

Plate 33: Soak way trench system. Eckert et al

Source: Rumming: 2013

Plate 34: Pond in private inner court.

Source: Rumming: 2013

2.5.2.11 Waste Management

Consistent waste avoidance and recycling was practised from the beginning of the planning and construction phases. Recycling rates of around 80% were achieved (Eckert et al: 2000). The main component of the domestic and commercial waste concept is setting up innovative collection systems: attractively designed containers close to the houses and pre-sorting bins in the apartments promote comprehensive waste separation. A grants programme supports home composting in the gardens. Under the motto “mend it, don't dump it” there is a close network of repair- and alteration services at Kronsberg. (Rumming: 2013).

Plate 34: Pre-sorting bins.

Source: Rumming: 2013

Plate 35: Waste collection points

Source: Eckert et al: 2000

2.5.2.12 Low Energy Houses

All buildings in the Kronsberg district have been erected as Low Energy Houses (LEH). Every building must use less than 55 kWh per m2 and year for space heating, verified through a quality assurance programme. All developers and contractors are obliged through conditions in the land sale contracts to carry out building work to these standards.

To meet the Kronsberg Low Energy House Standard it is essential to consistently inhibit transmitted heat loss through external building components. These standards resulted in buildings that have substantially thicker insulation layers in their typical cross sections; buildings constructed according to the current energy efficiency regulations have 8-12 cm of cavity insulation, but on Kronsberg thicknesses of 14-28 cm were required. The dimensions of the other main building components had to be enlarged accordingly. The majority of buildings have been erected in masonry with external bonded insulation because such constructions are also economically viable with thick insulation layers (Eckert et al: 2000).

Plate 36. Wall insulation

Plate 37. Balcony insulation

2.5.2.13 Lessons learnt

This project Illustrates density due to the fact that the density was above eight units per acre. The neighbourhood entailed an average density forty seven units per acre, this was able to support a new tram line with three stations in Kronsberg. This density was ideal due to the proximity of Kronsberg to Hannover City which was 8Km away. The project was to accommodate 15, 000 people upon completion and covered 395 acres. This density was ideal due to the proximity of Kronsberg to Hannover City which was 8Km away. Location and the ability to support transit are factor to consider in determining a sustainable density.

Kronsberg also illustrated the integration of transportation, land use and technology. There exists tram line on the western edge and the main arterial road is also situated alongside the arm line. This is so as to eliminate traffic in the neighbourhoods. A designated bike street bisects the length of the site to ensure the development is walkable. A cluster of mixed use buildings are located near the tram stop provides residents with pedestrian friendly community hub. There is a need to ensure that developments entails mixed landuses to ensure sustainability

The development connected humans to nature through Open spaces design. Each building plan was complemented with an open space that met high design and ecological standards set by the municipality. Streets lined with trees, front gardens, and the individually-designed neighbourhood parks were evident in the development. Several large playgrounds are laid out close to the apartments for children recreation. There is therefore a need to incorporate open spaces in neighbourhoods to connect people to nature. This is by providing a variety of open spaces in relation to the buildings.

Storm water systems played a fundamental role is achieving a sustainable urban design for Kronsberg. All precipitation on built-up and paved areas is absorbed, collected and gradually released. On private open space, rainwater from roofs and paved areas is also collected and gradually released; in the residential areas it is often used as a design element to fill open ponds or watercourses. Due to the clear articulation of stormwater in Kronsberg, it is imperative to harvest rain water, design for percolation of stormwater to the ground and collect the stormwater in ponds.

This development also entailed walkable streets and networks defined. Car usage is further discouraged because the development allots 0.8 cars per unit with the remaining fraction converted to additional public parking space. There exists a designated bike street bisects the length of the site to ensure the development is walkable. The lesson derived from this design solution is the car is not the most important transport mode in a development. Developments should be entail mixed landuses integrated with transport to ensure walkability.

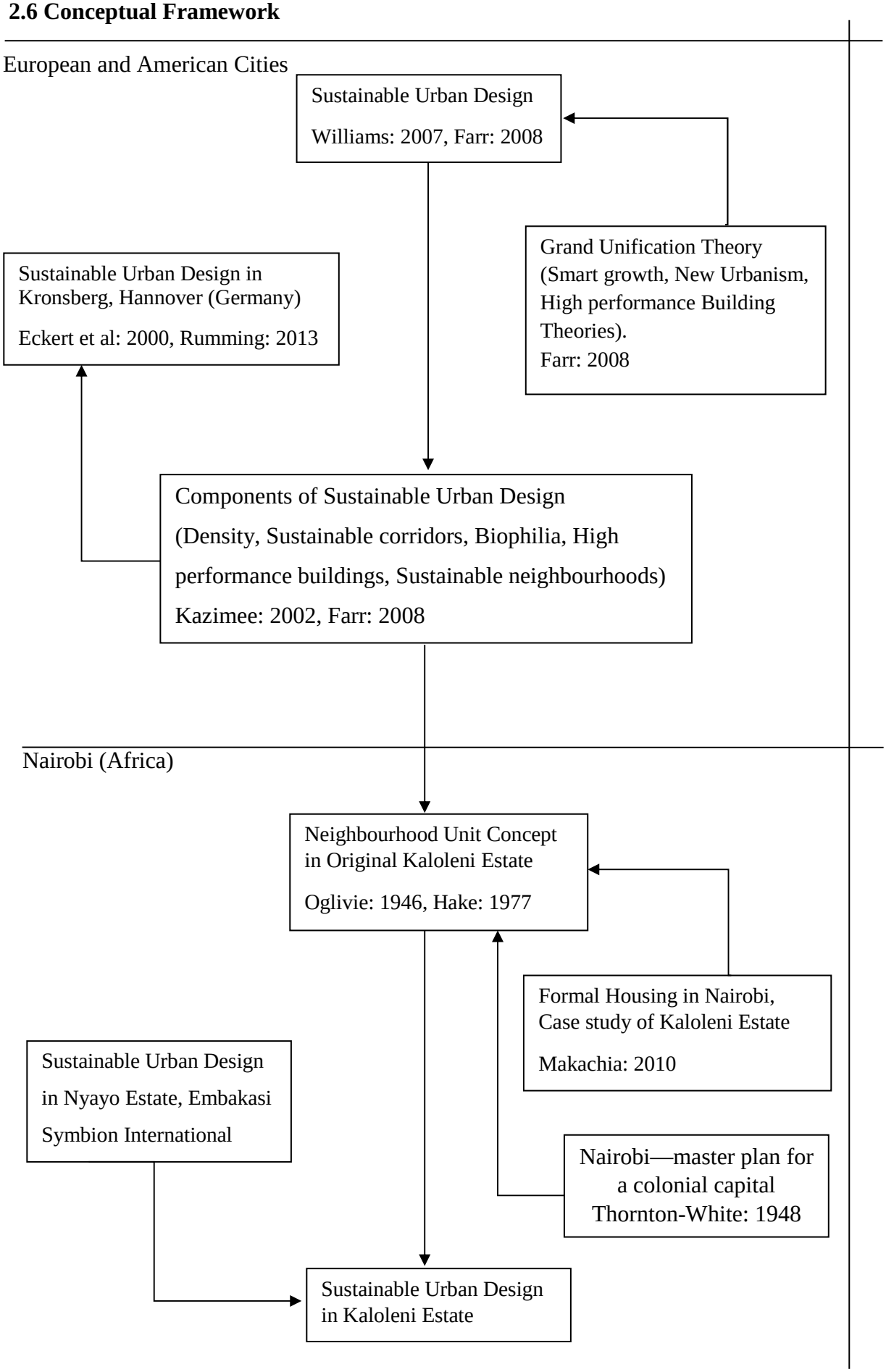
The Energy efficiency in Kronsberg was Optimisation through large district energy systems. Reduction of energy consumption is achieved through Low Energy House building methods. Energy was optimised by providing differentiated district heating system fed by two decentral cogeneration plants. There were also single gas central heating boilers for each dwelling to optimise energy efficiency. The lesson derived from Kronsberg energy optimisation is that there is a need to articulate energy issues in a development in a holistic manner. In the tropical regions energy issues such as low energy house building methods, central cooking gas provision etc.

Another fundamental lesson from Kronsberg is the impact of planning on building energy usage. This is essentially designing high performance buildings by ensuring ventilation,

natural lighting, and thermal control. This can be applied in tropical buildings by designing climate responsive buildings within the sustainable neighbourhood.

Lastly the economic aspect of sustainable urban design is key. Kronsberg created 3,000 jobs which sustained part of the population. It is important to consider the economic sustainability of the development by designing income generating activities. In conclusion, sustainable urban design should satisfy environmental, social and economic aspects. The lessons learnt should be applied on the basis of our tropical climate context and not in full.

2.6 Conceptual Framework



3.0 RESEARCH METHODOLOGY

3.1 Introduction

This chapter explains the process that was used to undertake the research. It spells out the instruments that were employed in selecting the study case and analysing its sustainable urban design principles and how conclusions were derived. The chapter also outlines how the research was approached, designed and how the overall study strategy was adopted. Research methodology consists of enunciation of a problem, formulating a hypothesis, data collection, data analysis and searching for a conclusion.[2]

Miller[3], defines research methodology as the body of knowledge that describes and analyses methods for collecting data. Different research instruments such as questionnaires, interview schedules, observational forms and standard tests are used to generate information under social science research.

3.2 Research Approach

The fundamental aim of this research is to find out how sustainable urban design principles can be used to ensure Kaloleni estate is a sustainable neighbourhood. The study employed several techniques and research operations in trying to achieve the set goals i. e. examination of the quality of spaces in Kaloleni estate, establish whether the land in Kaloleni estate is optimally utilized in a sustainable way and to establish how sustainable urbanism can be used to ensure a sustainable Kaloleni estate. Sustainable urban design is a facet that is concerned with the quality of space (Biophilia) and compactness. This research is therefore be qualitative and quantitative in nature.

3.3 Research Design

Research design guides the investigator in the process of collecting, analysing and interpreting observations (Yin; 2003). According to Philiber et al; 1980, research design deals with four key areas; what questions to study, what data are relevant, what data to collect and how to analyse the results. [4] This research employed a case study strategy in conducting the study. This is due to the fact that the study area was Nairobi's Eastlands which cover a large area. There was a need to delve deeper into a specific part of Nairobi's Eastlands which represented the problems in the study area.

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[2] Kothari, C. R. (1990). *Research Methodology.* New Delhi: New Age International Ltd.

[3] Miller, D. C. (1991). *Handbook of Research Design and Social Measurement.* California: Sage Publications.

[4] Cited from Yin; 2003

According to Yin; 2003, case study is defined as an empirical inquiry that seeks to understand a contemporary phenomenon in its real life context. This is important especially when the boundaries between phenomenon and context are not evidently clear and due to the fact that multiple sources of evidence are employed.

This study aimed to find out the answers to the research questions outlined in chapter one. First and foremost this study involved finding out how the land in Kaloleni Estate was utilized i.e. both the built and open space. This was with a view of exploring whether Kaloleni Estate is efficient, live-able, equitable and sustainable. It was imperative to study the quality of built and unbuilt spaces in Kaloleni Estate. This is by a critical analysis of the spaces depending on how the spaces are used and for what purpose. It was also imperative to study the infrastructure and how it was articulated and maintained i.e. sewer, water, power, storm water, access and circulation systems.

Secondly, this study sought to find out how the land in Kaloleni Estate has been utilized and how it can be optimally utilized. This was by mapping the context of Kaloleni Estate in relation to Nairobi CBD, its neighbourhood and studying the densities. The major themes in the study were: the physical setting, buildings, open spaces, integration of transport to landuses and the connection of humans to nature (Biophilia). This focus demanded a direct encounter between the researcher and residents and other users of Kaloleni Estate.

Lastly this research sought to explore how sustainable urban design principles can be used to ensure Kaloleni Estate is a sustainable neighbourhood. This needed an analysis of Kaloleni Estate as was designed and constructed in 1944/47. This is by studying the densities, land uses, corridors, buildings and biophilia evident in the initial design. This will be compared to the current situation at Kaloleni estate by analysis of site images and documentation of the changes that have taken place in Kaloleni estate. This study calls for qualitative and quantitative approaches in research.

The data on Kaloleni Estate as a sustainable neighbourhood was documented by undertaking reconnaissance surveys and archival analysis of the area. First and foremost, a pilot study was done to know the physical boundaries of Kaloleni estate and its neighbouring surroundings, actual field survey to document the condition of spaces to demystify the quality of spaces in terms of utilization, location, and the resulted state.

The neighbourhood sustainability analysis was undertaken by conducting a field study to determine the compactness of the area and biophilia. This was documented by production of a map of the area and an analysis of the key urban sustainability elements. Secondly, the residents were interviewed by use of questionnaires and focused group discussions. The KERA leaders were the point men on the ground.

This material was synthesized in a series of maps and reports so as to give an understanding of Kaloleni Estate from a sustainability point of view. This highlighted the general sustainable neighbourhood strengths and weaknesses, the critical elements of sustainable urban design in Kaloleni estate, the detailed qualities of Kaloleni estate, the quality of spaces in Kaloleni and the possibilities of ensuring their sustainability. The table below outlines the research questions, the data to be gathered and tools for gathering this data.

Table 3.3: Research design. Source: Author

No.	Research Question	Data Source	Data collection tools
1.	What is the quality of spaces in Kaloleni? Are they efficient, livable, equitable and sustainable?	Primary data	Questionnaire Focused group discussions Direct Observation Observation of physical traces
2.	How are the spaces in Kaloleni estate utilized in the relation to its proximity to the Nairobi CBD?	Primary data Secondary data	Questionnaire Focused group discussions Direct Observation Observation of physical traces Archives
3.	How can sustainable urbanism be used to ensure Kaloleni is a sustainable neighbourhood?	Secondary data	Archives Unpublished work

The data obtained from the field was synthesized into a form that could be interpreted and then coded using a system of numerical indices. Other data analysis techniques used were tabulation and a series of maps and reports. This was to give an understanding of Kaloleni estate from a sustainability point of view. Data analysis software such as Ms Excel was used to process the collected data.

3.4 Research strategy justification

Lerise; 1996 echoes the fact that a properly selected research strategy has real life practical value. This therefore means that the selection of a research strategy is key because it may affect the validity and reliability of data. The choice of research strategy is guided by a

number of factors including the purpose of study, the type of information required and the availability of resources to conduct the research.

This research entailed a case study strategy which was justified by the nature of the research problem, objectives and research questions. This study delved deeper into the sustainable urban design with a view of establishing a sustainable neighbourhood. It entailed sustainable optimal utilization of the land in Kaloleni Estate, quality of spaces, condition of spaces and sustainable urban design principles for Nairobi's Eastlands as a whole. The focus was on determining compactness and humans' connection to nature in Kaloleni Estate.

The research strategy for this study was based on two questions answered in this study; these were "what" and "how". The first question was "what is the quality of built and unbuilt spaces in Kaloleni"? Secondly, "what is sustainable urban design in Nairobi's Eastland"? This was answered by recording the quality of built and unbuilt spaces in this particular environment. In addition, sustainable urban design elements were recorded and analysed to determine the study area as a sustainable neighbourhood.

Another question was "how" with a view of determining the way to ensure the study area is a sustainable neighbourhood. For instance "how is the land in Kaloleni estate utilized in relation to its proximity to Nairobi CBD?" This was answered by recording the current state of the study area in terms of the built and unbuilt spaces by documenting the densities, spatial usage and type of spaces evident.

Some types of "what" questions are exploratory with a view of explaining a phenomenon. This explained this research as an explanatory kind of study due to it attempting to explore sustainable urban design in Nairobi's Eastlands. Yin; 2003, argues that the "how" and "why" questions are more explanatory and likely to lead to the use of case studies, histories and experiments as the preferred research strategies. This research therefore combines exploratory and explanatory accounts so as to explain Kaloleni Estate as a sustainable neighbourhood.

3.5 Qualitative versus Quantitative analyses

Qualitative research seeks to find out peoples, attitudes and opinions regarding what they feel or think about a particular phenomenon. It is therefore concerned with qualitative phenomenon (Kothari; 2004). This research on sustainable urban design was grounded on compactness and biophilia. Biophilia deals with how humans in the urban setting are

connected to nature. This is through use of open spaces, sustainable corridors and high performance buildings.

Quantitative research is generally concerned with measurements of phenomenon. It is characterized by structured and standardized data collection (Gilham; 2010). This research sought to establish sustainable urban design in Nairobi's Eastlands, the case of Kaloleni Estate. This entailed a keen study of the density of the study area and also the articulation of the land uses to ensure compactness. Following the explanations above, this study is both qualitative and quantitative. This is due to the fact it focused on how density can be used to ensure sustainability. Secondly, on how the integration of land uses with transport can ensure compactness. Lastly, this study explores how humans can be connected to nature.

3.6 Research Procedure

This study was undertaken in four parts due fact that case study research rely on many sources of data such as documentation, archival records, interviews, direct observation, participant observation and physical artefacts (Yin; 2003). There are however other sources of data used for example; films and photographs.

The first part of the study entailed acquiring a letter of introduction from the department of Architecture so that I could seek formal permission by the Nairobi City County to visit and conduct research in the study area. The Nairobi City County required a research permit from National Commission for Science, Technology and Innovation so that they could give me a letter permitting me to conduct studies in Kaloleni Estate. Secondly, secondary data regarding the research topic was collected from the library, internet and discussions with authorities in the field of study. This was with a view of reviewing this information so as to answer the research questions.

In addition, this study entailed visiting the Nairobi City County offices to seek archival material for the study. This material included the historical data of Kaloleni Estate and Nairobi's Eastlands, urban design strategies of the study area and the current/future plans with regard to the study area. Lastly, a field reconnaissance was conducted with a view of understanding the study area's physical setting. Observations and recording of activities and spaces was conducted during the site visit. Finally, detailed interviews and field trips by the Researcher and research assistants were conducted.

3.7 Sampling procedure

A sample design is a definitive plan for obtaining a sample from a given population. It may also be defined as the method by which information about an entire population is gotten by only examining a part of it (Kothari; 2004). Information regarding the sustainable urban context of Kaloleni Estate was gathered by using a sample size of forty five people representing the Kaloleni Estate population.

3.7.1 Target population

The target research population was the Kaloleni Estate residents which is projected to reach 8,126 people by the year 2015. According to (Mugenda Mugenda; 1999) any sample of above 30 respondents is adequate for descriptive studies. This study employed a sample size of forty six representing the entire Kaloleni Estate population.

The sample size was informed by the fact that Kaloleni Estate entailed 884 dwelling units in the ratio 1: 30: 15 (Three Roomed House: Two Roomed House: One Roomed House). Residents living in the one roomed houses, two roomed houses and the three roomed houses were selected in the above ratio for the study. In addition to the selected sample size, the following departments: Planning Department, Housing Department and Engineering Department in Nairobi City County were instrumental in providing information regarding the existing conditions in Kaloleni Estate and the future plans for Kaloleni Estate.

3.7.2 Sampling methods

This study employed two sampling methods as follows:

3.7.2.1 Systematic sampling

This is a sampling technique used to select a sample from a defined population. This sampling technique was used to select original Kaloleni Estate residents. The sample was selected systematically based on the building typologies evident in Kaloleni Estate. The Estate entails 884 formal dwelling units designed to include the following building typologies: one roomed house, two roomed house and the three roomed house.

The Kaloleni Estate Residents Association (KERA) opine that these dwelling units are organised in the ration 1: 30: 15 (Three Roomed House: Two Roomed House: One Roomed House). This ratio informed the sample size being a total of 46 people representing the different building typologies. Questionnaires were administered to this selected sample according to the ratio stated above.

3.7.2.2 Stratified random sampling

This sampling method is considered effective in the research as it will enable the breaking of the population into subgroups that would give a true reflection of the population composition. The criteria for breaking the sample were based residents in one roomed houses, two roomed houses and the three roomed houses. The reason for choosing these criteria is due to the fact that opinion about Kaloleni Estate Urban sustainability will vary according to the different users of the study area.

3.8 Data Collection

This research employed various data collection tools to gather specific data with regard to the research questions. They included the following;

3.8.1 Observation of physical traces

This entails systematically looking at the physical surroundings with a view of understanding previous activity that was not produced in order to be measured by researchers (Zeisel; 2006). These traces may have been left behind unconsciously for example paths across a field. Some of the traces evident in the study area were the Governor's House which is currently being used as a temporary shelter. Another example is the paths within the courtyards, traces of the central ablution block in some of the plots just to mention a few.

Observations of physical traces was undertaken by first of all coming up with a base map indicating all the existing physical features. This helped in physical identification of affected elements. This is with a view of determining the choice of appropriate routes, standards origins during the field trips.

The observations of physical traces gathered information regarding the initial design of Kaloleni Estate. Secondly, they also depicted the activities within these spaces indicating the quality of the built and unbuilt spaces. The quality of spaces depends on how it's being utilized.

3.8.2 Direct Observations

Direct observations was conducted during the field reconnaissance and the actual field trips. This was with a view of understanding the current physical condition and structure of the area. Yin; 2003, argues that making a site visit to the study area creates an opportunity for direct observations. This direct observations was undertaken by trained observers carefully selected by the interviewer. The observers included two research assistants and an original Kaloleni Estate resident who was the field study point man. The aim of the direct observation

was to establish the condition of built and unbuilt spaces. This was with a view of establishing the quality of spaces in Kaloleni Estate.

3.8.3 Archives

According to Zeisel; 2006, historical topics that cannot be studied through direct observations or interviews, can employ archives as the only source of data. Archival records usually take the form of computer files and records (Yin; 2003). This research is interested on studying Kaloleni Estate as a sustainable neighbourhood. This means that the historical context of Kaloleni estate is relevant in order to understand the past physical conditions of the study area.

This archival information on the past physical condition of Kaloleni Estate and the larger Nairobi's Eastlands was collected from the Nairobi City County. I was able to get a lot of data pertaining the historical context from literature by Hake; 1977, Nevanlinna; 1995, Oglivie; 1946 and Makachia; 2010. This information included description of the past physical condition of the case study area, photos, sketches and drawings of Kaloleni Estate.

3.8.4 Questionnaires

Questionnaires are used to establish regularities among groups of people by comparing answers to the same set of questions asked of a large number of people (Zeisel; 2006). In order to get views from stakeholders, questionnaires were devised. There were two types of questionnaires; one type for Nairobi City County departments of Engineering, Planning and Housing and the other type for the Kaloleni Estate Residents.

This was in order to achieve a holistic sustainable urban design strategy. In total 49 questionnaires were utilized as follows: 3 questionnaires to Nairobi City county and 46 questionnaires were administered to Kaloleni Estate Residents. The questionnaires to be administered to Kaloleni Residents were guided by building typology ratio of 1:30:15 (Three Roomed House: Two Roomed House: One Roomed House).

The first type of questionnaire was administered to the Nairobi City County: Planning department, Housing Department and Engineering Department. This questionnaire was tailored to suit each department due to fact that each department offered specific information. These questionnaires sought to establish if there were any policies regarding the development of Nairobi's Eastlands and Kaloleni Estate in specific. The level of enforcement of these policies and guidelines will be established through this questionnaires. Finally, to get to know the future plans for Kaloleni Estate by Nairobi City County.

The second type of questionnaires will be administered to the original Kaloleni Estate residents or the existing relatives of the original Kaloleni residents. This was aimed at collecting information regarding the current state of the estate, whether they felt it was sustainable using the sustainable neighbourhood parameters. This questionnaires also sought to establish the quality of the built and unbuilt spaces in the eyes of the residents. Lastly, this questionnaire sought to collect data regarding the utilization of the land in Kaloleni Estate.

3.8.5 Focused Group Discussions

A focused interview is where a residents is interviewed for a short period of time during which interviews may remain open-ended and assume a conversational manner (Zeisel; 2006). The group to be interviewed will be asked to show the most important features in the map of Kaloleni Estate, make a list of facilities that connect them to nature, what makes Kaloleni Estate sustainable, rate the corridors within Kaloleni estate i.e. biodiversity, integration of transport and land uses, public lighting and lastly rate the infrastructure and buildings and infrastructure. The focused group discussions were used to fill the gaps in the administered questionnaires.

The group was composed of a minimum of two and a maximum of five Kaloleni Estate residents. It was however hard getting willing residents to engage in the group discussions. This was due to the anxiety among the Kaloleni Estate residents regarding the Nairobi Eastland Renewal plans by Nairobi City County. The residents feared that they would be forcefully evicted and were therefore sceptical to engage in this group discussions.

3.9 Data analysis

The data obtained from the field was synthesized into a form that could be interpreted and then coded using a system of numerical indices. Other data analysis techniques used were tabulation and drawing of statistical inferences for easy computation. Data analysis software such as Ms Excel was used in this process. Data analysis sought to establish the quality of built and unbuilt spaces, the utilization of land in Kaloleni Estate and to explore how sustainable urban design principles can be applied in Kaloleni Estate. This was with a view of drawing conclusions and proposing recommendations for the study area.

3.9.1 Data valuation

This was done to ensure accuracy, quality, completeness, and relevance of the collected data. This was done in the field for cross checking and verification of any shortcomings. Any gaps detected was filled by deductions from memory or comparisons from other research methods.

The vulnerability of the Kaloleni Estate Residents posed some challenges with regard to the data collected.

This was due to the fact the residents were sceptical about the research due to the plans by Nairobi City County to renew the Estate. They felt that they would be forcefully evicted to pave way for the urban renewal. This was mitigated by having point men from KERA helping out with the field study.

3.9.2 Data editing

This was done to ensure that data was consistent with the facts gathered, uniformly entered, as complete as possible and were well arranged to facilitate coding and tabulation.

3.9.3 Data coding

The edited information was grouped and these groups were assigned specific numerical and alphabetical codes for ease in analysis. A code key was prepared to show and describe the coding scheme followed.

3.10 DATA PRESENTATION

In order to present the numerous data in an easily interpretable manner, several methods were used: three dimensional models, sketches, drawings, bar charts, graphs and tables. This was in order to effectively present the qualitative and quantitative information.

The analysed data on the quality of spaces was presented using sketches, drawings, tables and three dimensional models. This was with a view of explaining the potentials and weaknesses of the built and open space. This went a long way in understanding whether or not Kaloleni Estate is a sustainable neighbourhood from the basis of Biophilia.

This study also employed graphs, bar charts, tables to present the analysed data regarding the utilization of land in Kaloleni Estate. This was a more quantitative presentation emphasising mostly on the densities and the integration of land uses. This was with a view of establishing whether the density in Kaloleni Estate is within a sustainable range. This was clearly elaborated using the three dimensional models of the site.

Lastly, the analysed data on how sustainable urban design principles can be used to ensure Kaloleni Estate is a Sustainable neighbourhood was presented using three dimensional models, sketches and tables. This explained sustainable urban design in our local context with a view of responding to problems unique to Nairobi, Kenya.

4.0 STUDY AREA

This chapter offers a description of Nairobi's Eastlands with regard to sustainable urban design. This is with a view of understanding Kaloleni Estate as a sustainable neighbourhood. In order to understand Kaloleni estate it is important to study its history, current situation and the future plans according to Nairobi City County. This study highlights the urban context of Nairobi Eastlands and the similarities of the neighbourhoods within this part of the city.

4.1 Nairobi

Nairobi city is situated at 1°17′S 36°49′E and occupies 696 square kilometres[5]. It was founded in 1899 as a supply depot of the Uganda railway and soon became the railway's headquarters and hence a railway town. The choice of Nairobi for this town was based on its topographical surroundings.

The flat terrain was suitable for construction of shunting areas, depots, workshops and housing for European staff and commerce (Jameson; 1927). The choice of Nairobi's was informed by environmental and economic sustainability considerations and not social sustainability aspect of an urban area. This was due the segregation evident during that time.

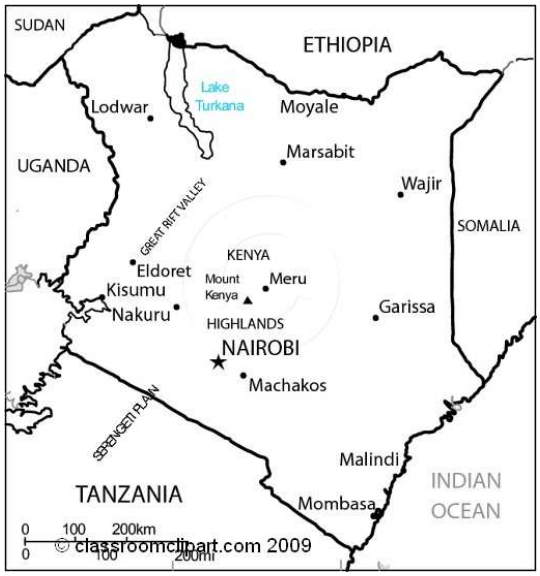


Fig. 4.1: Kenya showing Nairobi
Source: Classroom Clipart: 2009

Plate 39: Nairobi in 1900
Source: Nairobi City County

[5] Cited from (Obudho and Aduwo 1992)

4.1.1 Nairobi's Population Growth

According to Hake; 1977, the population of Nairobi was approaching 8,000 people by 1901. By 1930, the population had reached 49,000 of whom 28,000 were Africans. The 1948 full census revealed that the total population in the town was 118, 976 people of which 64, 397 were Africans. By 1962, the population had risen to 343,500 people an average growth of 9,000 people per year.

By 1969 the population was 509,286; in 1979 it was 827,775 and 1989 it reached 1, 342,435 people. In the year 1999 the population of Nairobi had risen to 2,137,000 people. According to the 2009 census, in the administrative area of Nairobi, inhabitants lived within 696 Km^2. According to Rakodi; 1997, Nairobi is projected to top 3.8 million by 2015. The table below depicts the population growth in Nairobi from 1962 to the last census.

Table 4.1.1. The population density in Nairobi showing an increasing trend. Source: GOK; 2002

Province	Urban Population						Growth rate		
	1962	1969	1979	1989	1999	2009	1979-1989	1989-1999	1999-2009
Nairobi	343,500	506,286	827,775	1,324,570	2,087,668	3,138,295	4.7	4.5	4.7

According to the Literature review in the earlier chapter, density is a fundamental component of Sustainable Urban design. The population in Nairobi has experienced tremendous growth over the years due to urban growth. There is a need to engage on how sustainability can be achieved through increasing densities to ensure a compact sustainable Nairobi City.

4.1.2 Nairobi's Spatial Growth

According to Jameson; 1927 the city boundary covered 18 Km^2 and was extended to 25 km^2 in 1920. The boundary of Nairobi was extended in 1927 to cover 30 square miles (77 km2) as a result mainly of the rapid growth of the urban centre both in terms of population and infrastructure. From 1928 to 1963, this boundary remained the same with only minor additions and excisions taking place. In 1963, the boundary of Nairobi was extended to cover an area of approximately 696 km2[6]. [7]The table below depicts how Nairobi has expanded spatially and also in population. This is essential in the study of sustainable urban design in

[6] Cited in Obudho and Aduwo 1992)

[7] Cited in Mitullah; 2002

Nairobi since compactness is one of the key elements of sustainable urban design. Population and Spatial growth of Nairobi between 1906 and 1999. Table 4.1.2. Population and Spatial growth of Nairobi. Source: Olima; 2001

YEAR	AREA (hectares)	POPULATION	%POPULATION INCREASE	DENSITY (Persons per Hectare)
1906	1,813	11,512		6
1928	2,537	29,864	159.4	12
1931	2,537	47,919	60.5	19
1936	2,537	49,600	3.5	20
1944	2,537	108,900	119.6	43
1948	8,315	118,976	9.3	14
1963	68,945	342,764	188.1	5
1969	68,945	509,286	48.6	7
1979	68,945	827,755	62.5	12
1989	68,945	1,324,570	60.0	19
1999	68,945	2,143,254	61.8	31

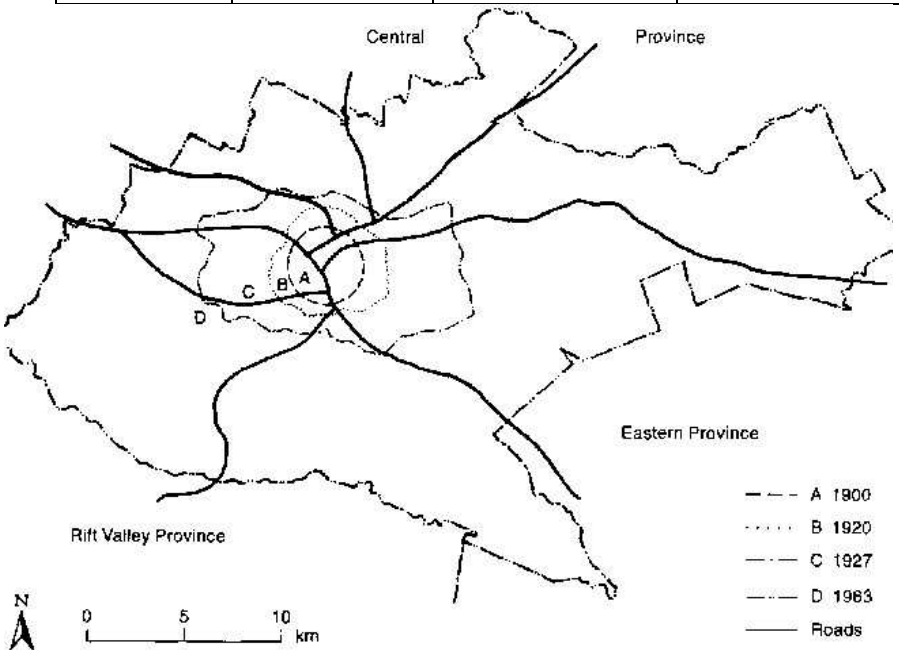
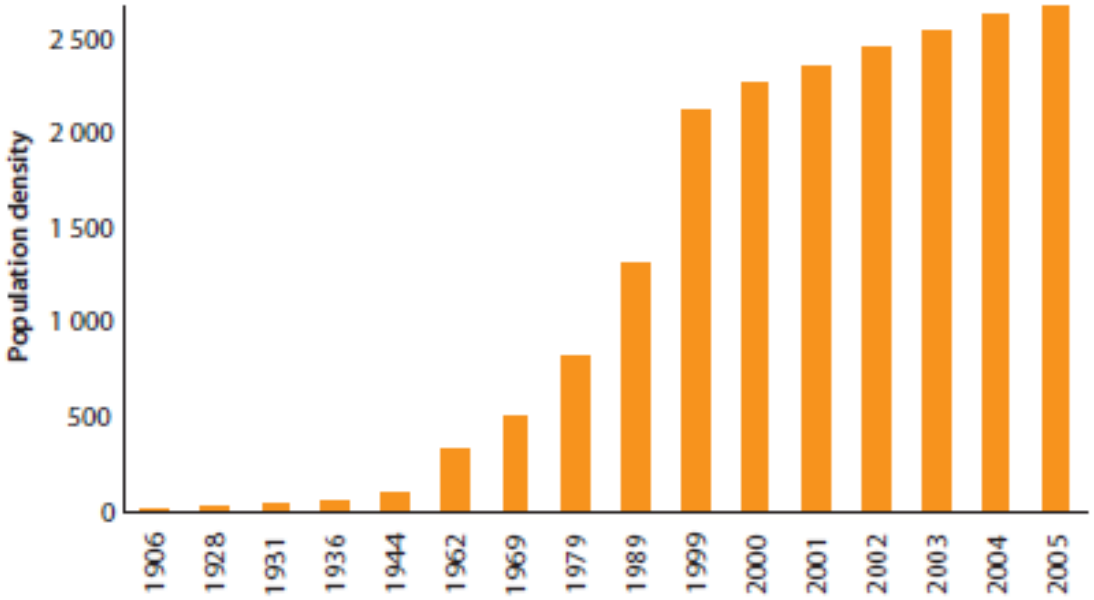


Fig. 4.1.2: Nairobi boundary changes. Source: Obudho and Aduwo 1992

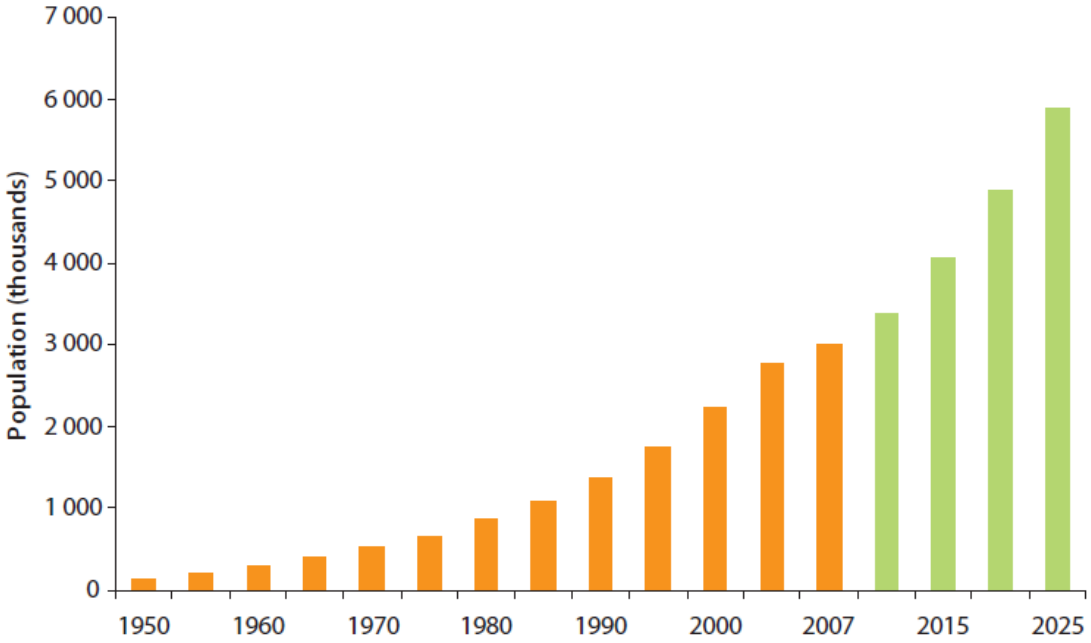
Nairobi's population density 1906-2005

The above data indicates that Nairobi has grown both spatial and in population due to economic opportunities in the city. Nairobi's spatial grown explain the urban sprawl evident in Nairobi city. According to Farr: 2008, compactness is one of the building blocks of sustainable urban design. It is therefore imperative to accommodate the rising population within the city to ensure a more compact city which can be sustainable if connected to nature through Biophilia.



Bar chart 1: Population density. Source: CBS; 2001[8]

Nairobi's historical and projected population 1950-2025



Bar chart 2. Projected population 1950-2025 Source: KNBS 2008.

[8] Cited from Tibaijuka; 2007

4.2 Nairobi's Eastlands

From its earliest times, Nairobi was characterized by segregation between the Commercial centre (CBD) the Europeans, Asian and African residential areas. There existed European quarters, Asian Quarters and African Quarters. The African Quarters is the current Nairobi's Eastlands as depicted in the map below[9]

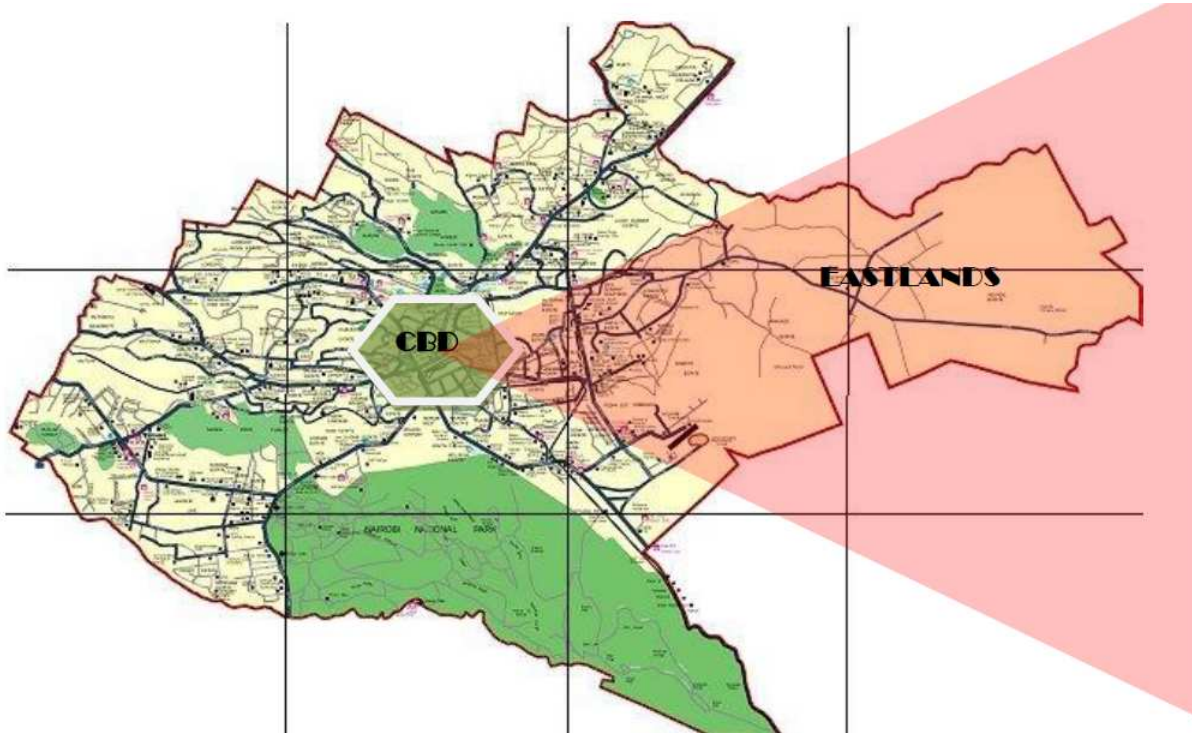


Fig. 4.2: Map of Nairobi. Source: Makachia; 2010

Nairobi's Eastlands is characterized by colonial estates such as Kariokor, Shauri Moyo just to mention a few. In addition, individuals built their own homes in places such as Makadara, Bahati, Ofafa, Maringo, Jerusalem and Jericho. Lastly, employer organizations like the Railway authorities that built in 1939 houses for junior employees. In this scheme at Muthurwa ('Landi Mawe), married workers were meant to be accommodated (Hake; 1977).

This estate was meant to accommodate married workers as opposed to the colonial estates meant for bachelors. On the contrary in reality, these units that had only one living space, a cooking area and common ablution blocks seemed hardly meant for a non-single household. Indeed, the demographic balance between the sexes in Nairobi remained unsatisfactory with a female to male ratio of one to eight reported (Hake; 1977). The Bachelors quarters during the colonial times were designed to be compact to serve the African workers who were connected

[9] Cited in Jameson; 1927).

to nature through walkable neighbourhoods. This meant that at the time, Nairobi depicted some traces of sustainable urban design.

The beginnings of African habitation of the city of Nairobi began when their labour was required in the emerging urban settlement. The African workers had to walk from their rural homes because of lack of housing for Africans in the city. Due to increased demand and long-time un-sustainability of the routine of daily footing from their distant homes, this was succeeded by the emergence of informal dwellings on the city's periphery (Hake; 1977).

According to Makachia; 2010 the informal settlements were hardly a strategy but only a corollary of the exclusionist policy, the creation of an African location at Pumwani, to the east of the city centre (CBD), was purposeful and perceived as a direction towards accommodation of the native's role in the imminent paradigm of urbanity. This notion of an African 'native location', mooted in 1907 by Bransby-Williams' report, was developed in 1921 (Hake 1977).

Pumwani was aimed at regulating African settlements within the boundaries of Nairobi by providing serviced plots and permitting the erection of their own house to replace the informal settlements on the city periphery (Hake: 1977). As Anderson; 2002 states, 'It represented the first attempt to regulate African settlements within Nairobi, replacing the informal villages of the early years.'

The plots were laid out with services, mainly piped water and water-borne sanitation, which was provided for communally. The other physical infrastructure was roads laid out to define lots referred to as 'stands' measuring about 1,500 square feet (50ft by 30ft). The services and infrastructure were efficient and high performance. This depicted some sustainable urban design strategies even at that time due to the fact that the services provided served the population then.

The first official housing 'estate' for the Africans was erected at 'Kariokor' in 1929 (formerly a military 'Carrier Corps' camp). The basic concept was shared occupancy of individuals and not households (the Bachelor's Quarters). This objectified the unsettled and transient African status within the urban areas. These were basic spaces in mainly dormitories that remained unpopular (Hake; 1977) and were later demolished.

In 1936, a different strategy in ‘Shauri Moyo’ (Hake; 1977), where complete houses were provided ostensibly to resettle dwellers from Pangani informal settlement. The houses were then demolished to pave way fornew Indian Quarters. The typology was a linearly organized unit where 3 to 6 habitable rooms were arranged around a corridor access. These units remained labour camps, providing only bed-spaces. This due to the fact that they were bachelors quarters to accommodate African workers in the city.

Kaloleni Estate development of 1944-45 was the first neighbourhood planned residential area for the African workers in the city. It entailed the Neighbourhood Unit Concept (NUC) envisaging a community of 3, 000 people united by neighbourhood facilities like a school, shopping and public function buildings. They were communities defined by transport networks or open spaces on the periphery. Within they were highly pedestrianized with facilities within walking distance (Hake; 1977), (Oglivie; 1946). This was a form of a sustainable neighbourhood then embracing sustainable urban design strategies.

The Nairobi Master plan; 1948 proposed residential buildings, a surrounding green area with social amenities, churches, nursery schools, shops and a community centre (White et al; 1948). The Master Plan enumerates desiderata where each inhabitant would access social, environmental and other physical amenities. In NUC planning an economic rationality was computed comparing it to the garden city and speculative planning and it was found more economical (MP 148, 37). Thus, more people were possible within the NUC with the same services than any other then contemporary planning (Nevanlinna; 1995).

Nairobi’s Eastlands is defined by colonial estates, estates by organizations (Kenya Railway). This estates share certain characteristics from the dwelling types, the density they were designed for and the general urban design. The table below summarizes the estates in Nairobi’s Eastlands indicating the type of housing, the year it was built, the number of units and the sizes of the units with a view of explaining attempts to achieve sustainable urban design. Table 4.2: Nairobi’s Eastlands Estates. Source. Nairobi City County

Estate	**Year Built**	**No. of Units**	**Typology**	**Unit size**
Bondeni	1928	110	Row Housing	Single Rooms
Kaloleni	1928-46	648	Bungalows	1&2 Rooms
Gorofani	1928-50	896	Walk ups	1&2 Rooms
Landhies Road	1929	56	Row Housing	Single Rooms
Shauri Moyo	1939-46	1, 022	Row Housing	Single Rooms

Ziwani	1941	553	Row Housing	2 Rooms & Kitchen
Starehe	1942	318	Row Housing	2 Rooms & Kitchen
Jevanjee	1945	80	Row Housing	1&2 Rooms
Ngara	1945-58	214	Flats	1-2 Bedroom units
Mbotela	1950-52	939	Row Housing	Single Rooms
Bahati	1951	1, 965	Row Housing	Single Rooms
Ofafa-1	1953	1324	Row Housing	Single Rooms
Pangani	1955	48	Maisonettes	3 Bedroom Units
Meru Road	1956	6	Single Houses	1-3 Room Units
Maringo	1956	1, 400	1&2 Storey	2Rms, Kitchen, WC
Joseph Kangethe	1957	286	Bungalows	3-4 Bedrooms
Embakasi	1958	234	Row Housing	2Rms, Kitchen, WC
Dagoretti	1960	136	Single Units	2 Bedrooms
Kariobangi North	1960	408	Row Housing	2Rms, Kitchen, WC
Jerusalem	1960	633	1&2 Storey	1-2 Bedroom units
Caledonia Road	1960-61	2	Bungalows	4 bedroom + SQ
Jericho/Lumumba	1961	3, 004	1&2 Storey	1-2 Bedroom units
Mariakani	1963	240	Flats	3 Bedroom Units
Kariokor	1963	240	Flats	3 Bedroom Units
Uhuru	1967	1, 196	1&2 Storey	2-3 Bedroom Units
Jamhuri	1969	224	Flats	3 Bedroom Units
Makadara	1969	34	Row Housing	2 Bedroom Units
New Pumwani	1969	224	Flats	2-3 Bedrooms
Outer Ring Road	1970	360	Row Housing Maisonette	1&2 Bedroom Units
Juja Road	1970	11	Maisonette	3 Bedroom Units
Harambee	1971	96	Flats	2 Bedroom Units
Madaraka	1972	600	Flats	2-3 Bedrooms Units
Kariobangi Timber	1972	27	Maisonette	2 Bedroom Units
Huruma	1977	586	Maisonette Flats	2 Bedroom Units
Kariobangi South	1979	720	Maisonette Flats	2 Bedroom Units
Buru buru	1981	386	Maisonette Flats	2-3 Bedroom Units

In order to understand sustainable urban design in Nairobi's Eastlands it is imperative to study one of the estates. This research will study Kaloleni Estate as a neighbourhood unit with a view of evaluating it using sustainable urban design principles.

4.3 Kaloleni Estate

Kaloleni is located about 2 km from the CBD. Bordering the estate to the west is the City Stadium; to the east, Makongeni estate; to the north, Jogoo Highway; and to the south is the Industrial Area, a manufacturing district. Kaloleni estate depicts an attempt to achieve a Neighbourhood Unit Concept. Makachia; 2010 argues that lessons from the state offer a firm verdict to the strategy in the contribution to management of urban space. The Neighbourhood Unit Concept enshrined the sense of a community as the heart of model settlements in the 19th century.

4.3.1 Historical Perspective

In 1942 a committee was appointed to investigate the need for African housing. The chairman of the committee was C.E. Mortimer, commissioner for Local Government and son of the Councillor Joseph Mortimer who as Mayor in 1937-38 had backed the five year's programme committee. The committee reported that housing was needed for 24, 000 people and they aimed at providing for 10, 000. In 1944-45, Kaloleni Estate project was meant to house 3, 000 people was under construction. It was termed as the model neighbourhood unit due to some sustainable urban design principles evident. It was taken over from the government by the municipal council in 1945 (Hake; 1977).

Table 4.3.1. Kaloleni Estate. Source; Author

	Kaloleni Estate
Area	37 Ha
Population	3, 000
No. of Housing units	884
Type of Housing	Bungalow/walk-up flats
Target population	Low-income
Density	8

Kaloleni Estate was home to Historical figures such as Tom Mboya, former Ugandan President Milton Obote, Vice-President late Kijana Wamalwa's widow Yvonne, former Vice-President Moody Awori, Barrack Obama senior and Charles Rubia, the first African mayor of Nairobi. According to a resident, Moses Ouma, Tom Mboya lived in a two-roomed house in Kaloleni Z1 near the City Stadium. Former cabinet minister Fred Gumo and the late business tycoon and Member of Parliament Gerishon Kirima also make the list of well-known people who lived in the estate.

Residents recall various historical moments with a mixture of pride and nostalgia: Queen Elizabeth of England opened a clinic in Kaloleni Estate in 1952, and Senator Robert Kennedy gave a speech in the same estate in 1969. The community hall was originally used as a center of the independence movement, and later as Kenya's first parliament building. According to a resident, Moses Ouma, Tom Mboya lived in a two-roomed house in Kaloleni Z1 near the City Stadium.

4.3.2 Original Kaloleni Estate Urban Design Strategies

Kaloleni estate borrows heavily from the Neighbourhood Unit Concept (NUC) proposed in the 1948 Nairobi Master Plan (Thornton-White et al; 19480). The NUC entailed the 'garden city' principles by Ebenezer Howard such as self-sufficiency and environmental persuasions. Secondly, it enshrined the sense of a community as the heart of model settlements in the 19th century. This formed a basis for garden city developments such as Hampstead and Letchwood garden suburbs in the UK (G. Towers 2005). It envisaged communities of 6,000 to 10,000 united by neighbourhood facilities like a school, shopping and public function buildings.

They were communities defined by transport networks or open spaces on the periphery. Within they were highly pedestrianized with facilities within walking distance.

White et.al 1948, dismissed the gridiron planning used in historic cities as inappropriate for Nairobi because of its monotonous effect- "deadening effect". They lauded the "garden city" concept by Ebenezer Howard that replaced it as it achieved a desirable "rural atmosphere" within an urban area. This however fell short of deliberate encouragement of a social atmosphere hence the evolution of the NUC, which they proposed for Nairobi. [10]

4.3.2.1 Planning

Unlike the linear, street-based clusters depicted in the proposed NUC Model, the clusters in Kaloleni estate were arranged around vast courtyards. In addition, the residential blocks were aligned within open spaces in a linear way. The Kaloleni estate layout was also defined by a radial street network giving it character and identity. According to Oglivie; 1946, Kaloleni Estate's circulation paths were of two types: the concentric rings originating from the central

[10] Cited from Makachia; 2010

court and continuing up to the edges; and radial linkages between them focussing on the centre.

courts was 115 m, while the width varied from about 20–50 m; these distances could vary within one cluster. The ablution block was designed at the centre of the courtyard to foster a sense of community.

The central open space, was called ‘village green’ (Oglivie: 1946). It was surrounded by communal and civic buildings for social, commercial and administrative functions. This was the focal point of the Kaloleni estate layout. The social hall was the hallmark of the village green. It was used for recreational activities as well as social functions. The commercial facilities (‘African shops’) included a shopping centre that housed formal commercial activities, including grocery shops, bars, butcheries, carpentry shops, salons, and barber shops.

Other than the social hall at the village green, there were other recreational facilities. First and foremost, an open ground used as a handball pitch and the nearby city stadium. Secondly, ‘a small welfare clinic and a social centre, were used for reading, writing, recreation and games, feeding, and facilities for occasional cinema shows. Other recreational facilities included were children’s playgrounds and shelters, schools, playing fields, allotment gardens, and a bus shelter (Oglivie; 1946).

4.3.2.3 Buildings and Building Clusters

Kaloleni Estate covered nearly 37 Ha. composed of 26 courtyard clusters. Each cluster had 16–34 bungalow-type semi-detached units. The total number of units was 618 units in courtyards that varied in size. Due to varying size of courtyards the minimum number housed per plot was 65 persons and the maximum was 120 people. In addition there were apartment blocks composed of 224 DUs that were arranged in two linear clusters. These clusters were located adjacent to the railway and the city stadium. Courtyards within the building clusters varied in size with maximum lengths being 115 metres and the width varied from 20 to 50 metres (Oglivie: 1946).

The courtyards in the building clusters had an organic form. This therefore meant they did not have definite geometry. The courtyards were also porous on the edges to allow visual porosity and openness. This was however tied up by the centrally placed communal ablution block which ensured a sense of community ensuring a social environment. The ablution block was used for communal sanitary, bathing, clothes and pot washing facilities and as a central sanitary block. These communal ablution block was however demolished in the 1980’s and the wet core was incorporated in the individual units to make them self-contained. The vast majority of the houses in Kaloleni Estate were for low-income households. In addition, the typologies were often largely semi-detached bungalows with one or two rooms. There also existed apartment blocks located adjacent to the railway and city stadium.

4.3.2.4 Two Dwellings-One room semi detached

The typical two dwellings house comprised of a Kitchen, food store, Bicycle shelter and a verandah. The Dwelling was designed for 3-7 persons as a bachelors quarters. These Single units were in blocks of 2, 3 and 4 units. The two dwelling-one room house came in two designs as depicted in the following drawings.

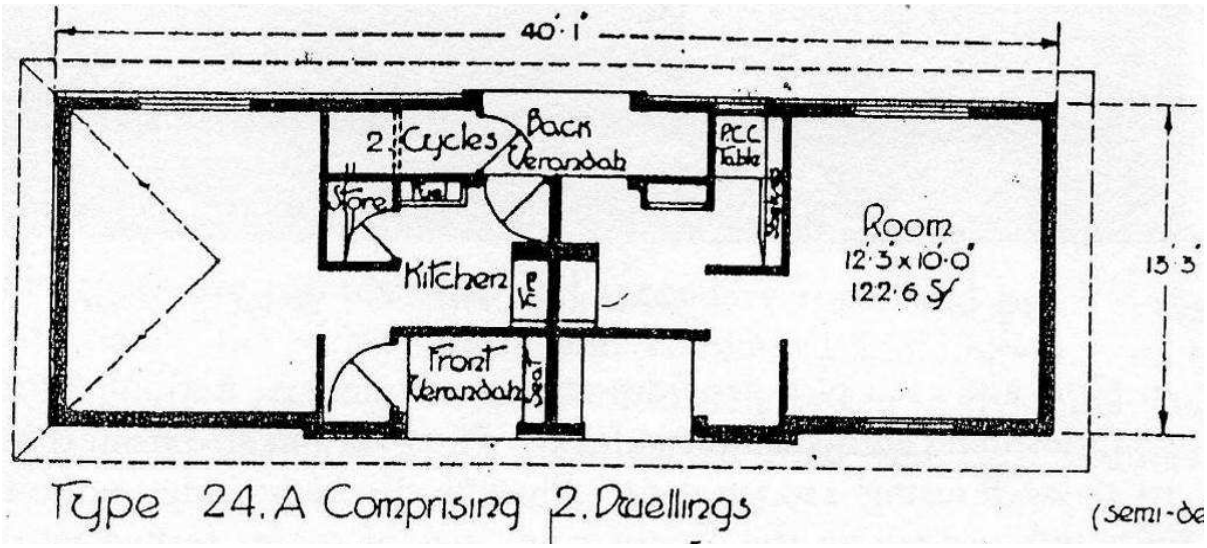


Plate 40: One Room House. Source: Oglivie: 1946

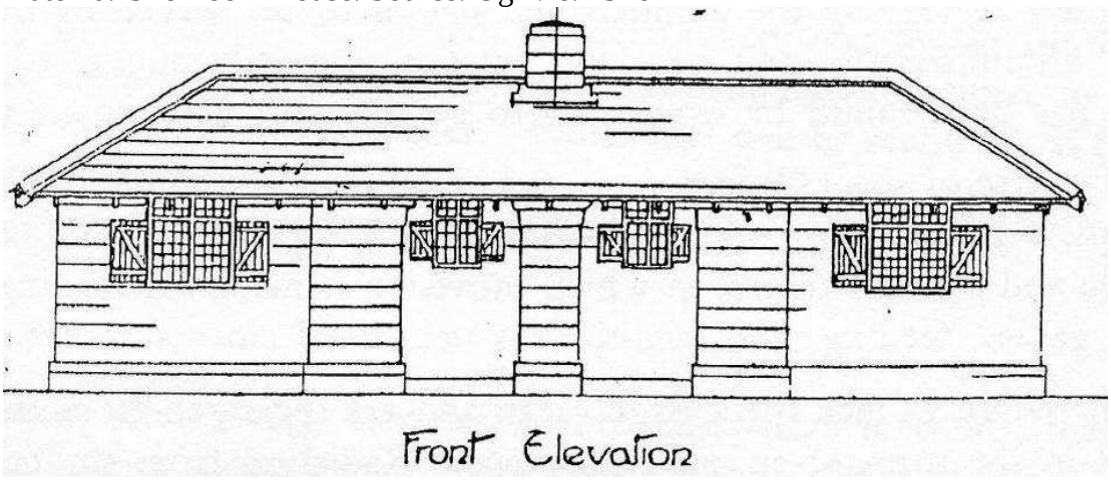


Plate 41: One Room House. Source: Oglivie: 1946

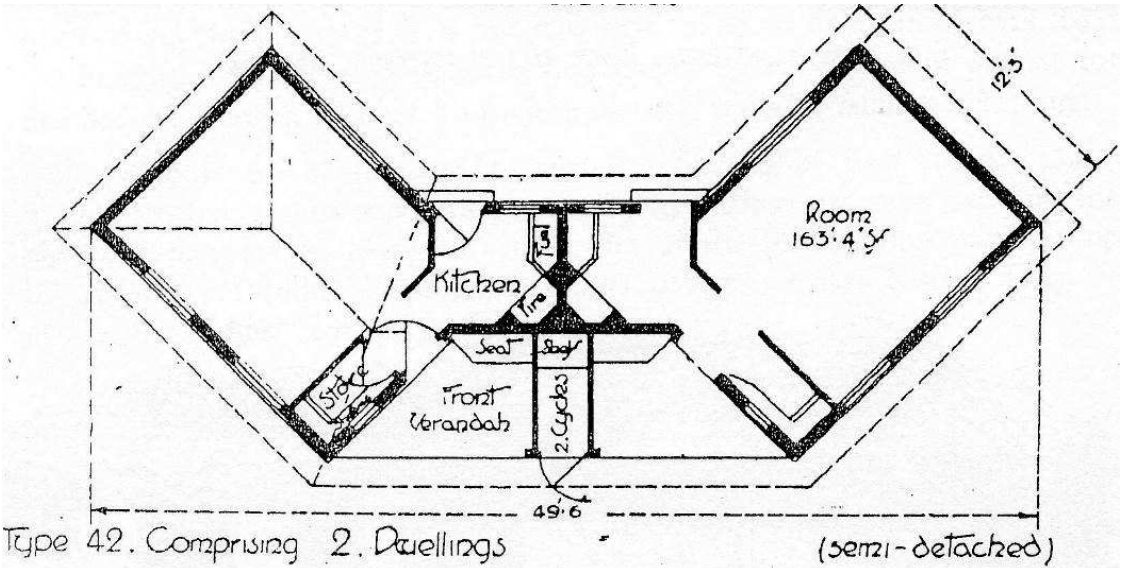


Plate 42: One Room House. Source: Oglivie: 1946

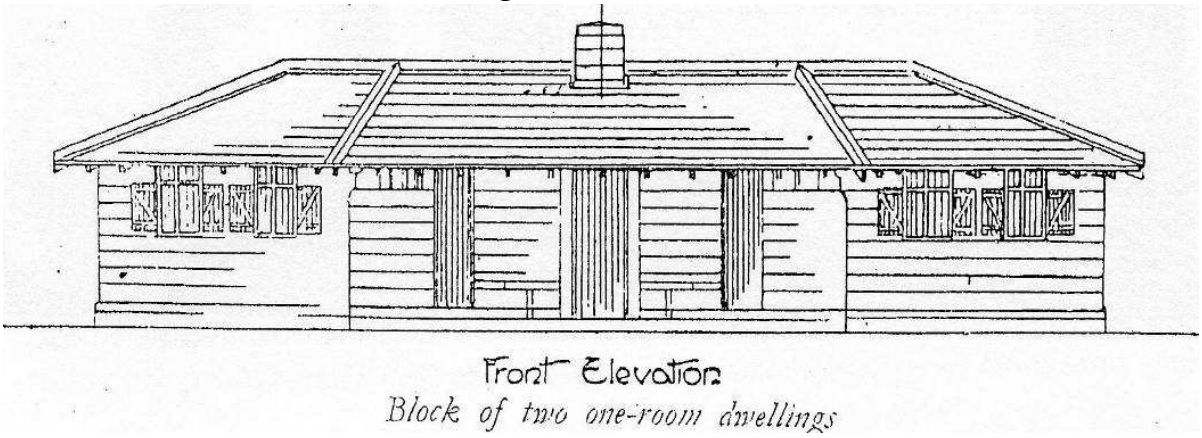


Plate 42: One Room House. Source: Oglivie: 1946

There also existed 2 roomed semi-detached houses in some of the courtyard clusters. They were designed as depicted below:

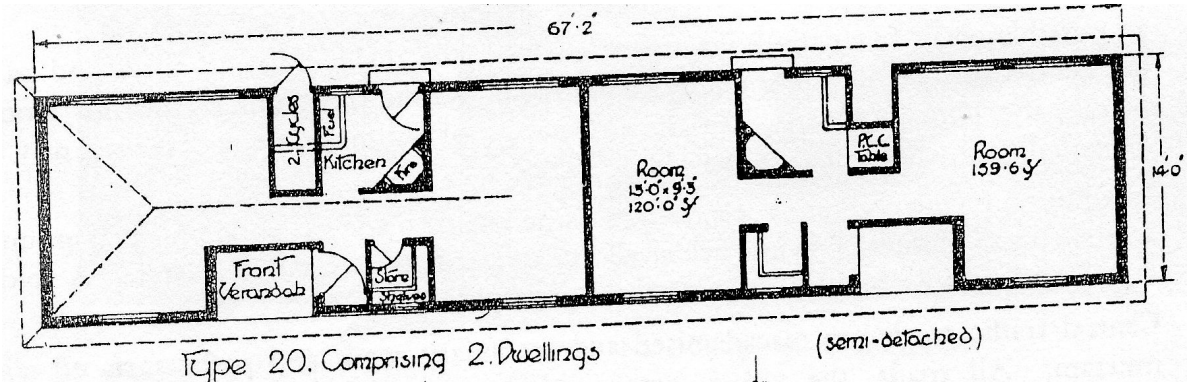


Plate 43: Two Room House. Source: Oglivie: 1946

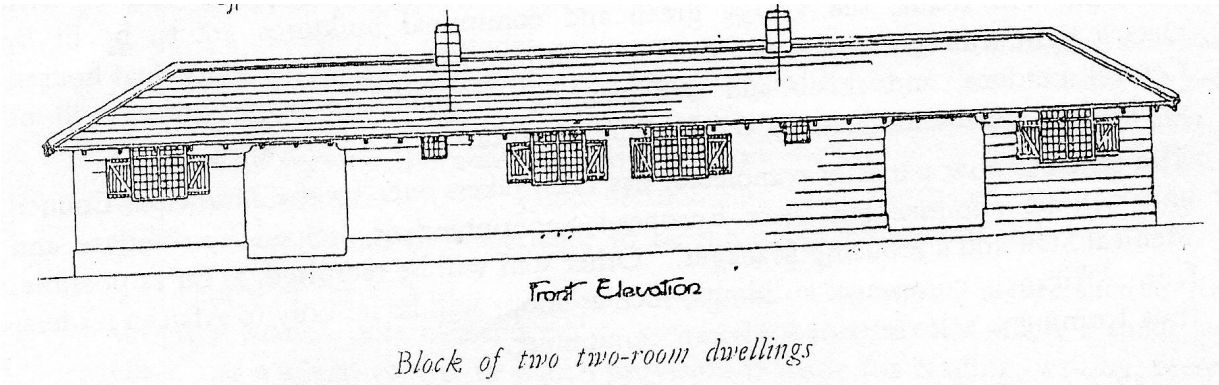


Plate 44: One Room House. Source: Oglivie: 1946

The dwelling units were designed to accommodate the population then (3,000 people). They entailed high quality construction materials, ventilation and day lighting. This was responsive to the tropical climate in Kenya and could be considered as an attempt to achieve a high performance tropical building.

4.3.2.5 Transport

According to the originally designed Kaloleni estate master plan, there existed an oval vehicular road which separated the communal and civic buildings for social, commercial and administrative functions from the dwelling units. Radial roads and paths connected the oval vehicular road to the entrances of the dwelling units. The central traffic roads were initially made of tarmac while the secondary roads and paths were made of murram.

Oglivie; 1946 report explains that the estate was interlinked by roads and footpaths. Concrete footbridges over the wide, 1–2 m wide, open storm water drains linked the clusters to these circulation networks. These wide drainage gullies were also useful as elements defining the edges of the clusters in some parts of the estate. Intra-estate circulation was mainly pedestrian, but many residents used other modes of transport for goods and water.

In the projections, the streets and communal buildings had street lighting provided. The dwelling units were later to have individual unit connections. Street and path borders, as well as courtyards, had landscaping with trees, shrubs and manicured grass, and a
Housing Authority was to maintain these features. [11]

[11] Cited from Makachia; 2010

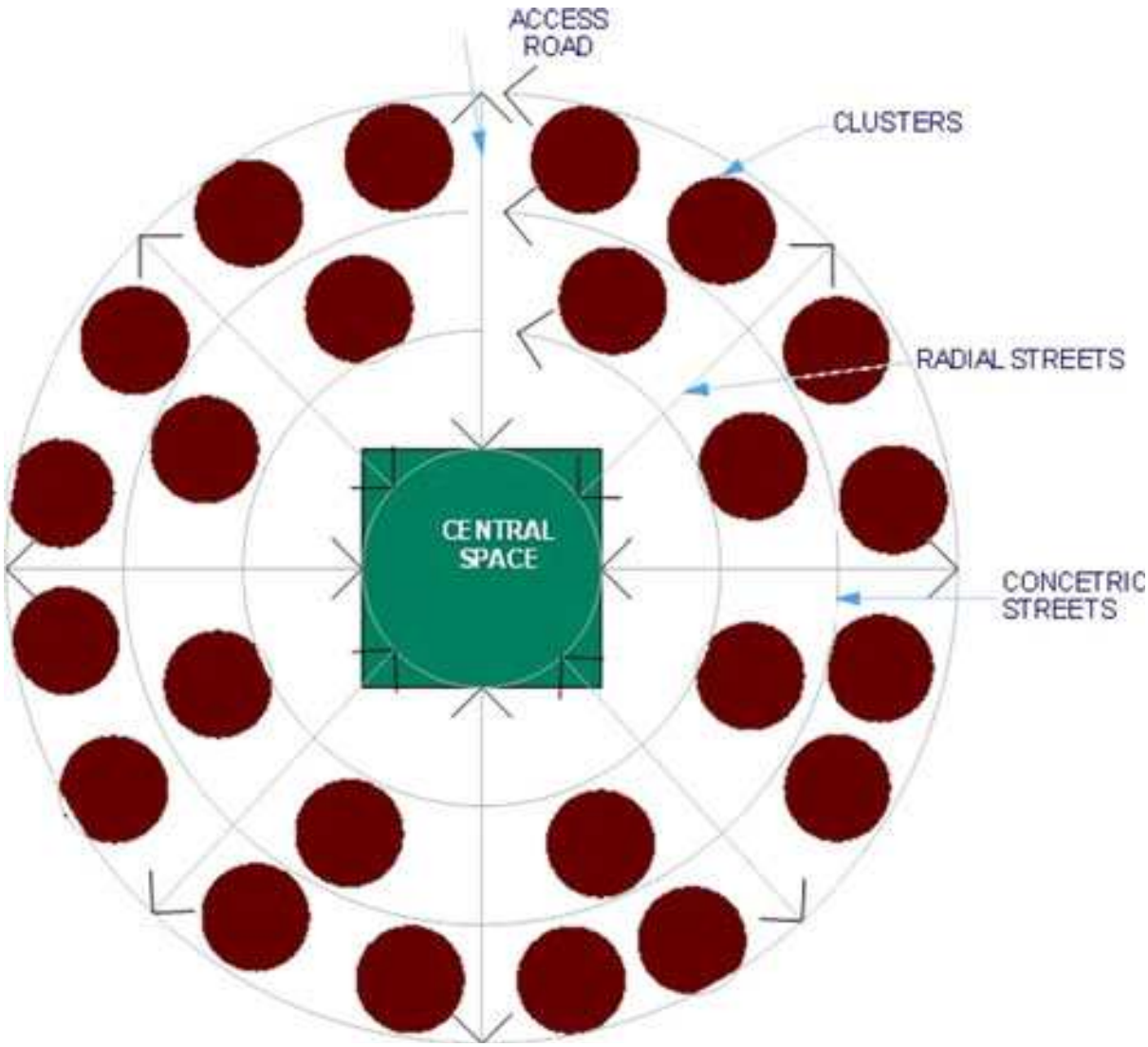


Fig. 4.3.2.5: Kaloleni schematic street layout Source: Makachia: 2010

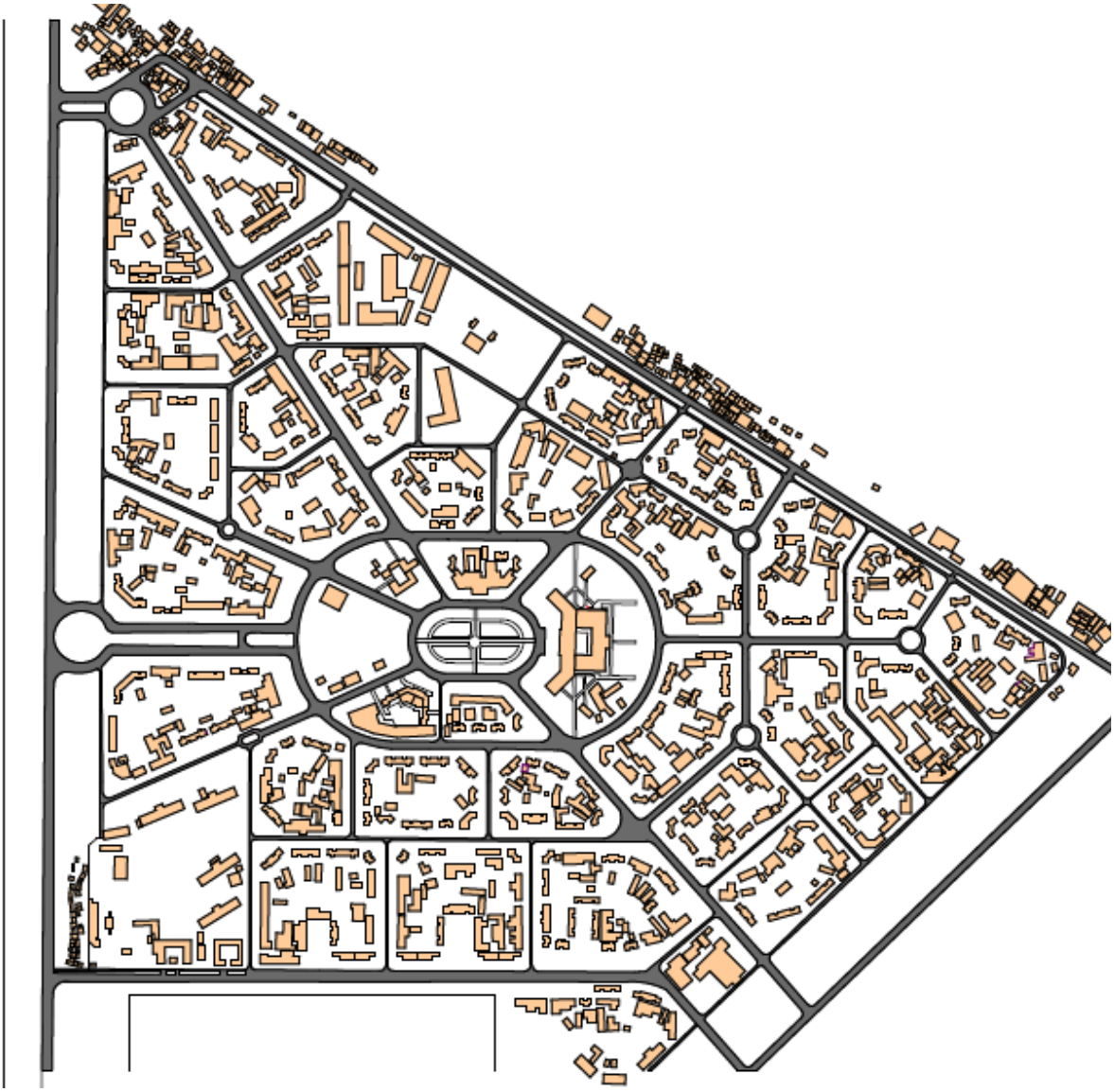
4.2.3 Kaloleni Estate in 2015

Kaloleni estate (garden city like neighbourhood) has deteriorated with most of the open spaces having been converted into platforms for informal activities. These informal activities include trading, waste disposal, religious activities just to mention but a few. They are carried out in temporary structures constructed by residents and other city residents.

The housing units are in disrepair due to lack of maintenance by the city council. Temporary house extensions are evident adjacent to the houses designed in the original Kaloleni estate master plan. In order to understand the current situation in Kaloleni, it is imperative to use the sustainable urban design core components to evaluate the study area. These include: density,

high performance buildings and infrastructure, sustainable corridors, biophilia and sustainable neighbourhood components.

Fig. 4.2.3: Existing situation at Kaloleni Estate. Source: Author



4.2.3.1 Kaloleni Estate's Density

Kaloleni Estate covers 91.4 acres composed of 26 courtyard clusters and was meant to house 3, 000 people. There were 618 units in plots that varied in size housing 65 to 120 people per plot. In addition there were apartment blocks composed of 224 DUs hence making a total of 842 units in the 91.4 acres. Kaloleni Estate was designed to accommodate a density of 9 units per acre or 33 people per acre.

The current development ordinances and zones in Nairobi City County indicate that Kaloleni Estate is ripe for high-rise high density redevelopment. There is no clear designated density for this estate rather than a mere indication of the density being high. According to Nairobi City County Planning, Housing and Engineering Department the density in the old city council housing is projected to be more than 70 dwellings per acre. There are plans to renew these City Council Housing Estates to accommodate the rising population in Nairobi County. There is though no clear development density as of yet.

Fig. 4.2.3.1: Kaloleni Estate Density as Designed. Source: Author.

The 1948 full census revealed that the total population in Nairobi was 118, 976 people and covered 77km2. The population of Nairobi is projected to reach 3.8 million by 2015 according to Rakodi; 1997. Olima; 2001 states that the boundary of Nairobi covers 696Km2 meaning that Nairobi has experienced nine times spatial growth since 1948. The population of Nairobi has grown 319 times.

According to the 2009 Census, the population of Kaloleni Estate is 7, 761 people up from 3,000 people when it was built in 1944-45. It is projected to reach 8, 126 people in the year

2015. KERA opines that the population of Kaloleni Estate is 17, 000 people as of 2014. In addition, according to GOK; 2002, the density of Kaloleni Estate is projected to top 125 people per acre in the year 2015. This means that it will have grown by 3.8 times compared to the density it was designed for. Apart from the 884 units originally designed in Kaloleni Estate, there exists temporary house extensions to accommodate the rising population.

Fig. 4.2.3: Kaloleni Estate Density in 2015. Source: Author.

4.2.3.2 Sustainable corridors in Kaloleni Estate

Sustainable Corridors include the integration of transportation, land use, technology and biodiversity corridors to allow animals and human beings to move around communities so that they may still live in and around cities. Kaloleni Estate was designed with the central court being the planning principle.

The central court was known as the Village green and was surrounded by commercial, social and administrative activities. There was an open space at the core of the central court designated for recreational activities. Roads radiated from this central core in a concentric manner leading to the residential units with central courtyards in form of open green spaces. The residential areas were integrated with transportation and open spaces as communal spaces and biodiversity corridors.

The original Kaloleni Estate was planned with the different landuses clearly zoned out. The commercial, social and recreational landuses were the designed at the core of the layout.

Residential spaces radiated from the village green and transport was integrated to the residential spaces. Educational landuses were designated at the periphery on the eastern side of the site. The following image depicts how the different landuses were organised in the original design of Kaloleni Estate.

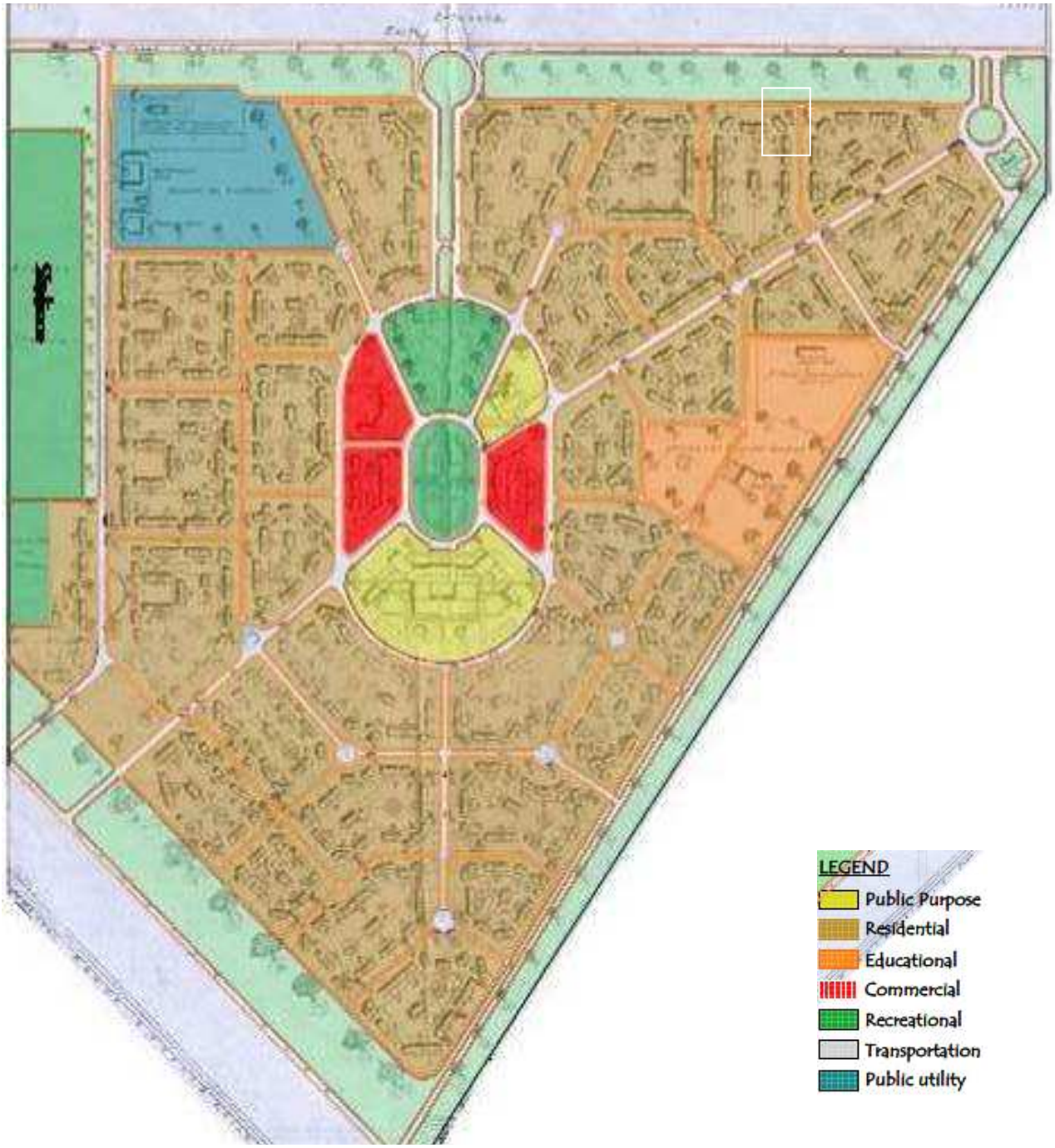


Fig. 4.2.3.2: Original Landuse planning. Source: Author

Kaloleni Estate has transformed from a clearly zoned landuse plan to a more mixed land use plan. This is however in an informal way with illegal house extensions and informal structures evident along the transport arteries and adjacent to the originally designed houses.

This is depicted in the map below.

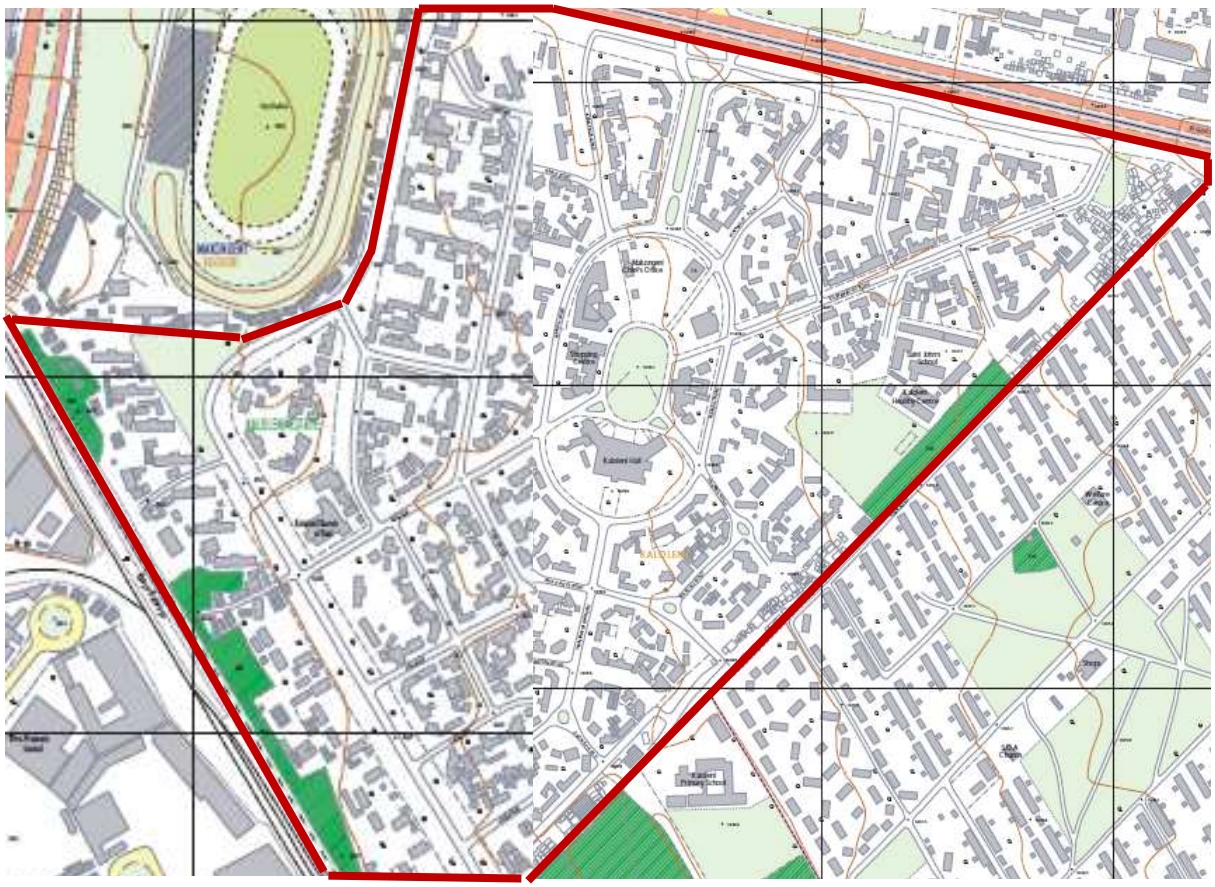


Fig. 4.2.3.2b: Jica Map showing existing condition in Kaloleni Estate. Source: Jica

The JICA map shows that open spaces have been converted into platforms for informal activities such as informal commercial activities, informal housing etc. Kaloleni Estate was designed using the garden city concept: with wide roads, open spaces and greenery. Uncontrolled and unplanned development has occurred in the designated open spaces and even adjacent to the originally designed dwelling units.

5.0 FINDINGS AND STUDY ANALYSIS

5.1 Introduction

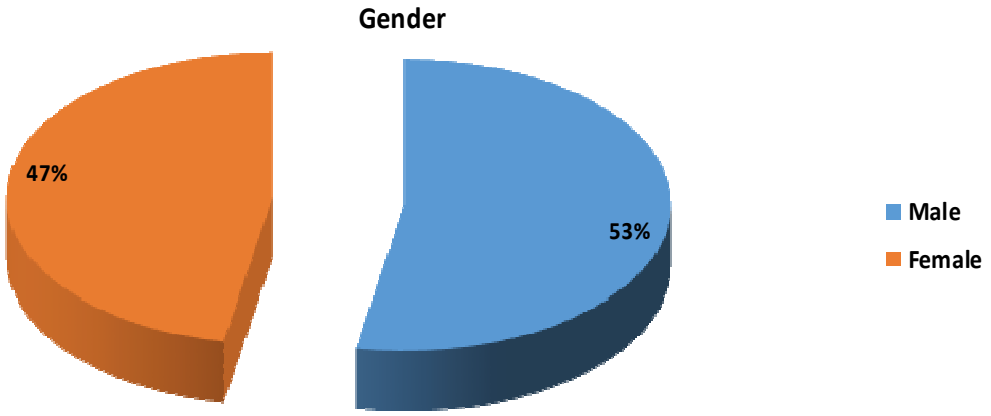
This chapter presents the findings and study analysis of the data collected from the field based on the research questions. It therefore examines the quality of built and open spaces in Kaloleni Estate, Utilization of space/land in Kaloleni Estate and how sustainable urban design principles can be used to ensure a sustainable Kaloleni Estate. The unification theory by Farr: 2012, was used as a guide to evaluate Kaloleni Estate. This combines the smart growth movement, New urbanism and the green building movement. This is with a view of evaluating Kaloleni Estate as a sustainable neighbourhood. The field study sought to establish how compactness and biophilia has been accommodated in the estate.

5.2 Characteristics of the Residents in Kaloleni Estate

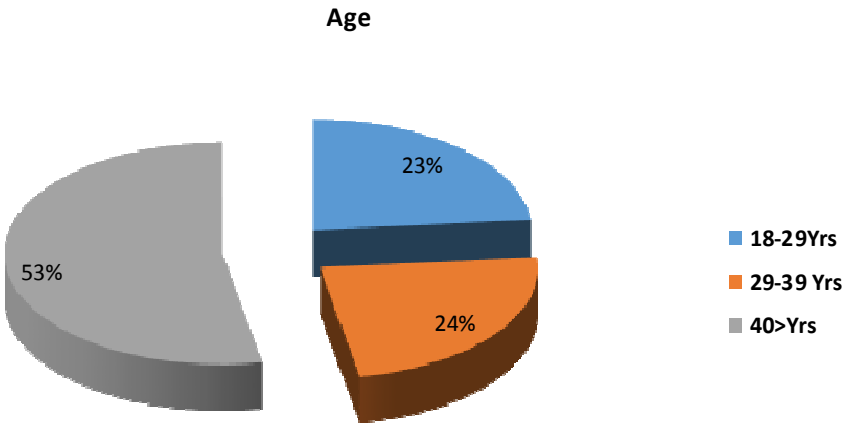
Two groups of people live in Kaloleni Estate: Original Kaloleni Estate residents and other city dwellers living in the informal house extensions. This study was limited to the original Kaloleni Estate residents so as to get a clear account of the Estate since they have seen its transformation.

5.2.1 Age-Gender Distribution

The results from the field survey show that original Residents in Kaloleni Estate are mainly men. 53% of the respondents were men while 47% of the respondents were women. This explains a lot regarding the tenancy of Kaloleni Estate dating back in the colonial times. Kaloleni Estate was designed for African workers who were men at the time. They were supposed to reside in Bachelors Quarters which were more of bed spaces. The Original Kaloleni residents were predominantly men and as years went by these houses were passed down to generations including men and women.



Pie chart 1: Gender Distribution (Original Kaloleni Estate Residents) (Source: Author Field Survey April, 2015)



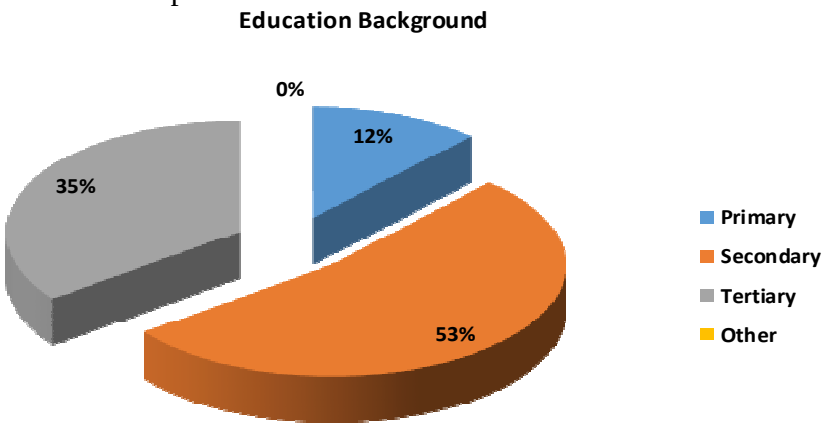
Pie chart 2: Age Distribution (Original Kaloleni Estate Residents)

(Source: Author Field Survey April, 2015)

Results from the field survey show that 53% of the respondents were above 40 years of age, 24% were between 29 years to 39 years and 23% were between 18 years to 29 years. This therefore means that the Original Kaloleni Estate residents evident in the Estate are majorly second generation owners. The third and fourth generation make up 47% of the original Kaloleni Estate residents. The dwelling units were passed down to them from their relatives. These findings also explain evidence of house extensions in Kaloleni Estate. This was to cater for their children's and grandchildren's privacy.

5.2.2 Education background and Occupation.

According to the findings from the field study, the education level of majority of the Original Kaloleni Estate Residents is secondary education. 39 % of the respondents' educational background was Secondary Education. 35% of the respondents attained Primary education or dropped out of Secondary School. The Original Kaloleni Estate Residents with Tertiary education were 26% of the respondents.



Pie chart 3: Educational Background (Original Kaloleni Estate Residents)
(Source: Author Field Survey April, 2015).

Majority of the respondents were self-employed undertaking business within the estate. 52% of the respondents were self-employed, 13% were house wives and the remaining 33% were employed in blue collar jobs while only 2% of the respondents were employed in white collar jobs. The following table below depicts the Occupation of the Respondents (Original Kaloleni Estate residents). Table 5.2.2: Original Kaloleni Estate Residents occupation
(Source: Author Field Survey April, 2015).

Occupation	**Number**	**Percentage**
Front Office	3	6.5%
Self Employed/Business	24	52%
Tour Consultant	1	2%
Lawyer	1	2%
Salesperson	3	6.5%
Technician	3	6.5%
Tailor	2	5%
Hair dresser	3	6.5%
House wife	6	13%
Total	**46**	**100%**

This can be summarized into three categories: self-employed, employed and unemployed as follows: Table 5.2.2: Occupation (Original Kaloleni Estate Residents) (Source: Author Field Survey April, 2015).

Description	**Number**	**Percentage**
Self employed	24	52%
Employed (White collar)	1	2%
Employed (Blue collar)	15	33%
Unemployed	6	13%
Total	**46**	**100%**

This findings therefore mean that the Kaloleni Estate Residents are low income earners with the majority owning businesses within the Estate. This is the reason there are so many informal commercial activities in form of house extensions. Kaloleni Estates' residents are majorly self-employed, in blue collar jobs and 13% are unemployed.

Plate 45. Self-employment/informal extensions
Source: Author Field Survey April, 2015

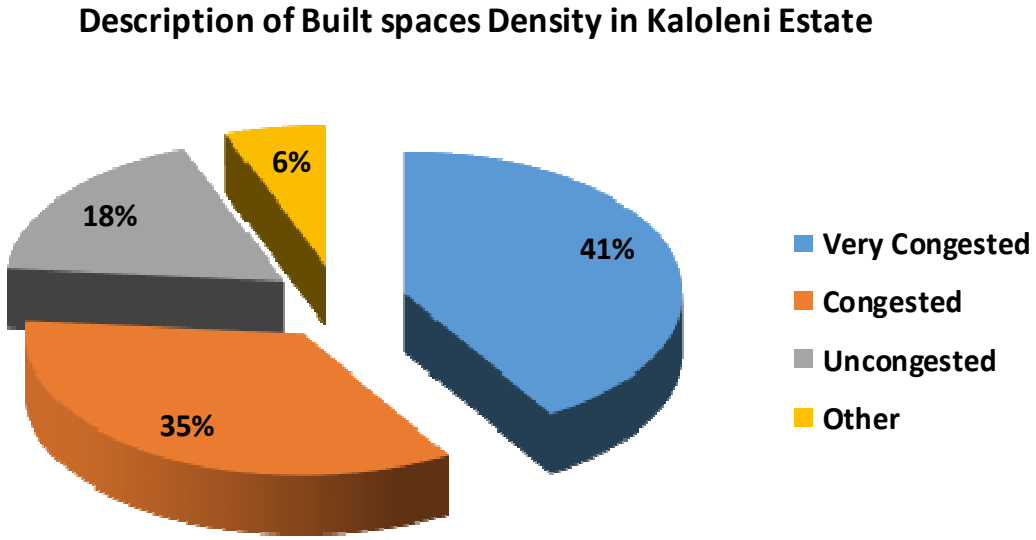
Plate 46. Mixed use landuse
Source: Author Field Survey April, 2015

5.3 The Quality of Built Spaces in Kaloleni Estate

The following qualities were studied: Density of built space in Kaloleni, built space needs, state of buildings and infrastructure and efficiency of built space.

5.3.1 Density of Built Spaces in Kaloleni Estate

From the Sample population 41 percent considered Kaloleni Estate to be very congested. This is due to the mushrooming of the informal house extensions for residential and commercial activities. 35 percent of the respondents found Kaloleni Estate congested but livable. There were some Kaloleni Estate Residents who felt that the estate was not congested but was just fine. This accounted for 18 percent of the respondents while 6 percent considered the estate to be not congested but the informal house extensions were growing at a high rate.



Pie chart 4: Built space Density (Original Kaloleni Estate Residents)
(Source: Author Field Survey April, 2015).

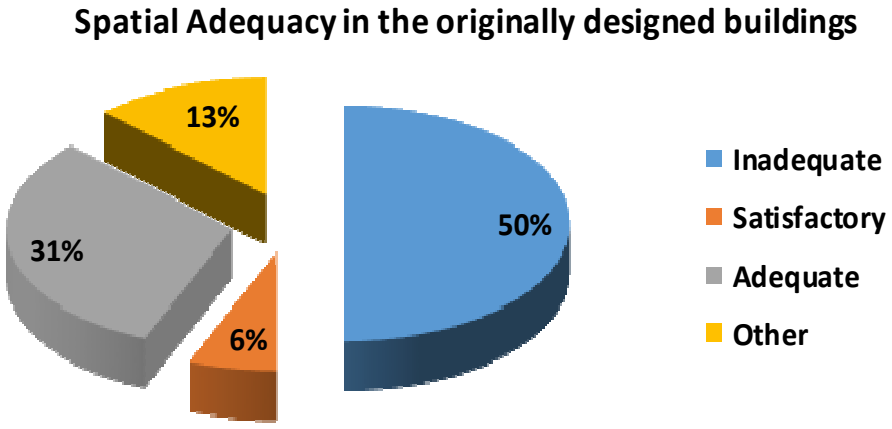
The results from the findings infer that Kaloleni Estate is congested. This is due to the high number of the informal house extensions and structures which are not planned. This tends to give an impression of congested space. All the respondents alluded to the fact that the originally designed dwelling units could not accommodate the population in Kaloleni Estate. This is because Kaloleni Estate was designed for 3,000 people in 1944/45 but currently accommodates a projected population of 8,126 people. KERA opines that the population in the Estate is 17,000 people according to their records.

Plate 47: Kaloleni Estate extensions, 2015.
Source: Author.

Plate 48: Kaloleni Estate extensions, 2015.
Source: Author.

5.3.2 Spatial Adequacy in Original Buildings in Kaloleni Estate

50 percent of the respondents considered the spaces in the originally designed buildings inadequate. This is due to the fact these dwelling units were designed as bachelor's quarters for the African male workers. However, 31 percent found the spaces adequate for their needs. This probably because these people lived in 2 roomed and 3 roomed houses. 6 percent of the respondents considered the spaces to be satisfactory. According to them the space was not luxurious but served them. Lastly, 13 percent considered the space in the originally built houses to be neither satisfactory nor inadequate.

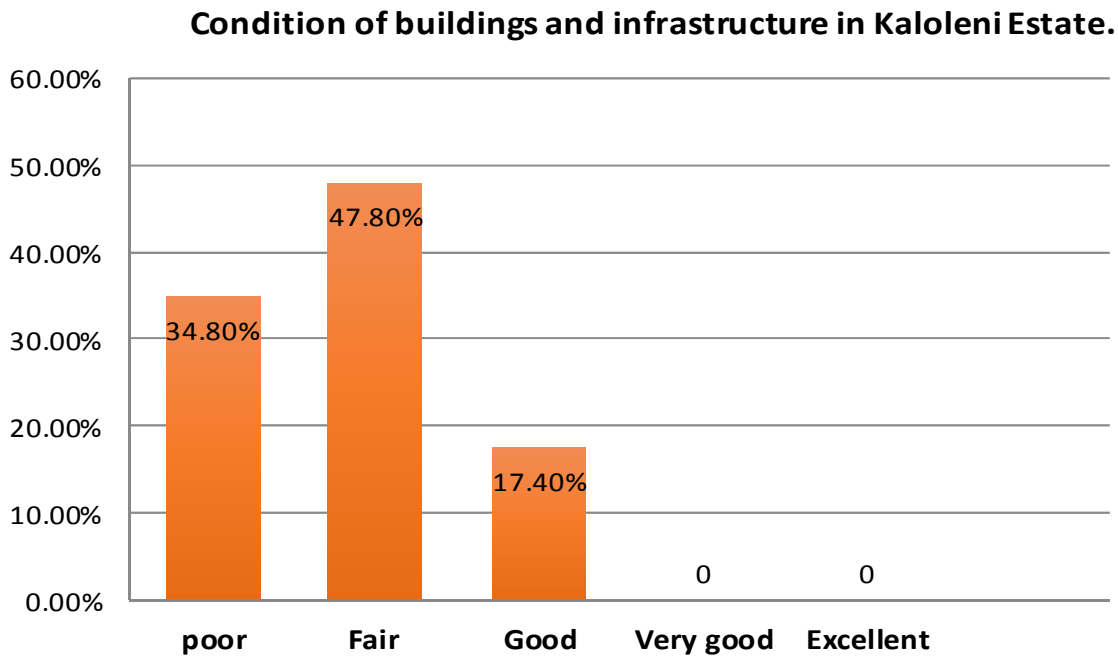


Pie chart 5: Spatial Adequacy in Built space (Original Kaloleni Estate Residents)
(Source: Author Field Survey April, 2015).

More than 50% of the respondents in Kaloleni Estate considered spaces in the originally built houses inadequate. It is therefore imperative to provide just the right amount of space in Kaloleni Estate and not to overprovide but meet the needs of the user. A three roomed house would be an ideal amount of space for Kaloleni Estate Residents. The residents needed three rooms for sleeping, a kitchen and a wet area.

5.3.3 Condition of Originally Built Infrastructure and Buildings in Kaloleni Estate

On condition of the originally built infrastructure and buildings, 38.8% of sample population considered the state of the originally built buildings and infrastructure to be in a poor state. However, 47.8% found the condition of the buildings and infrastructure to be in a fair state. Only 17.4% of the respondents considered the condition of buildings and infrastructure to be in a good state. The majority (86.6%) were therefore not satisfied with the condition of buildings and infrastructure.



Bar chart 3: Conditions of buildings and infrastructure

(Source: Author Field Survey April, 2015).

The state of the originally built buildings and infrastructure in Kaloleni Estate is in a bad state due to lack of maintenance by the Nairobi City County. The residents do their own renovations and maintenance. The following images depict the state of the buildings and infrastructure.

Plate 49. Poor state of buildings

Source: Author Field Survey April, 2015

Plate 50. Leaking roofs

Source: Author Field Survey April, 2015

Plate 51. Poor state of roads

Source: Author Field Survey, 2015

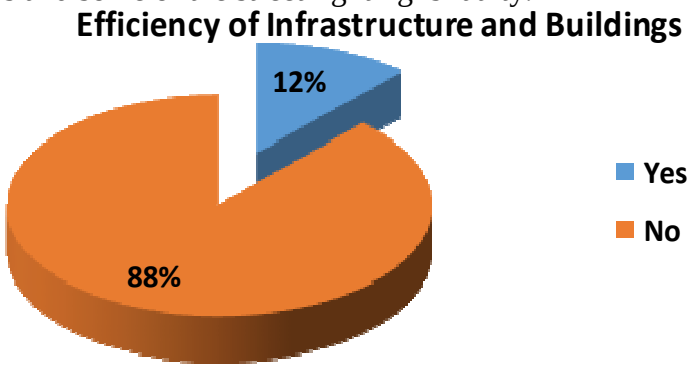
Plate 52. Lack of piped water

Source: Author Field Survey, 2015

5.3.3 Efficiency of Infrastructure and Buildings (Originally Built)

High performance buildings are buildings that are energy efficient through cooling or heating to keep the interior at a reasonable temperature for human comfort. High performance infrastructure refers to the core best management practices applicable to the section of public way. This is with a view of optimizing performance, minimizing environmental impact, using materials efficiently and extending the lifecycle.

According to 88% of respondents, the originally designed infrastructure and buildings are not efficient nor are they environmentally friendly. 12% of the respondents considered the buildings and infrastructure to be efficient. This is due to lack of maintenance by Nairobi City County. The buildings are in disrepair, the drainage is clogged, the sewage is tampered with by informal extensions and some of the street lighting is faulty.



Pie chart 6: Infrastructure and buildings efficiency. Source: Author Field Survey, 2015.

Plate 53. Clogged drainage
Source: Author Field Survey April, 2015

Plate 54. Buildings in disrepair
Source: Author Field Survey April, 2015

5.4 The Quality of Open Spaces in Kaloleni Estate

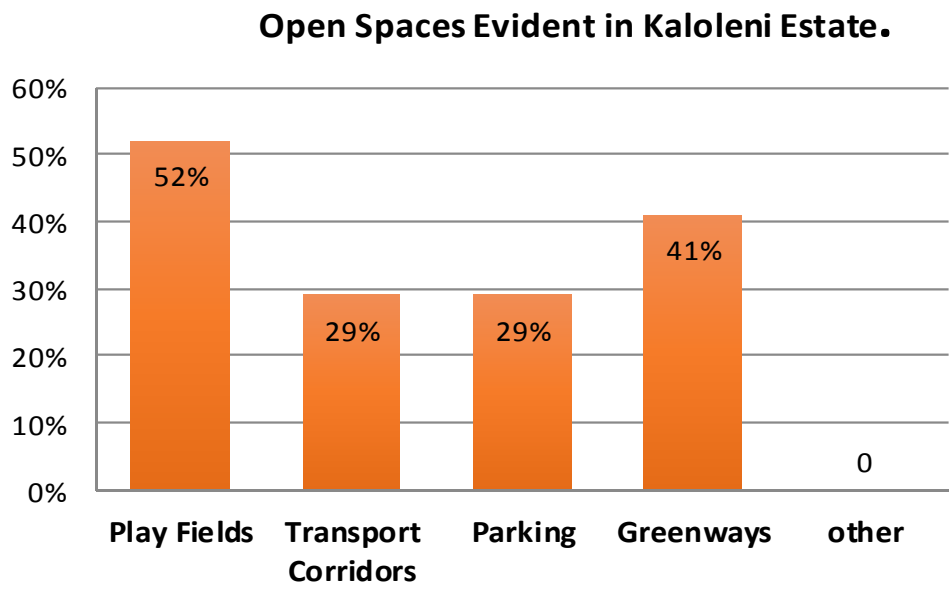
The following qualities were studied: type of open spaces, state of open spaces, storm water management, waste management and food production in Kaloleni Estate.

5.4.1 Open Spaces in Kaloleni Estate

Results from the sample population, 52% stated that play fields were the major open spaces in Kaloleni Estate. 41% of the respondents alluded to the fact that greenways were available in the Estate. 29% considered transport pathways as open spaces evident in the Estate and also 29% stipulated parking as open spaces.

According to the respondents, play fields, parking, transport corridor and greenways were the open spaces in Kaloleni Estate. From the group discussions, the play fields were shrinking due to land grabbing. The greenways were also decreasing due to the mushrooming of informal house extensions.

Plate 55. Play field at village green. Source: Author Field Survey April, 2015



Bar chart 4: Open spaces in Kaloleni Estate. (Source: Author Field Survey April, 2015).

Plate 56. Transport corridor

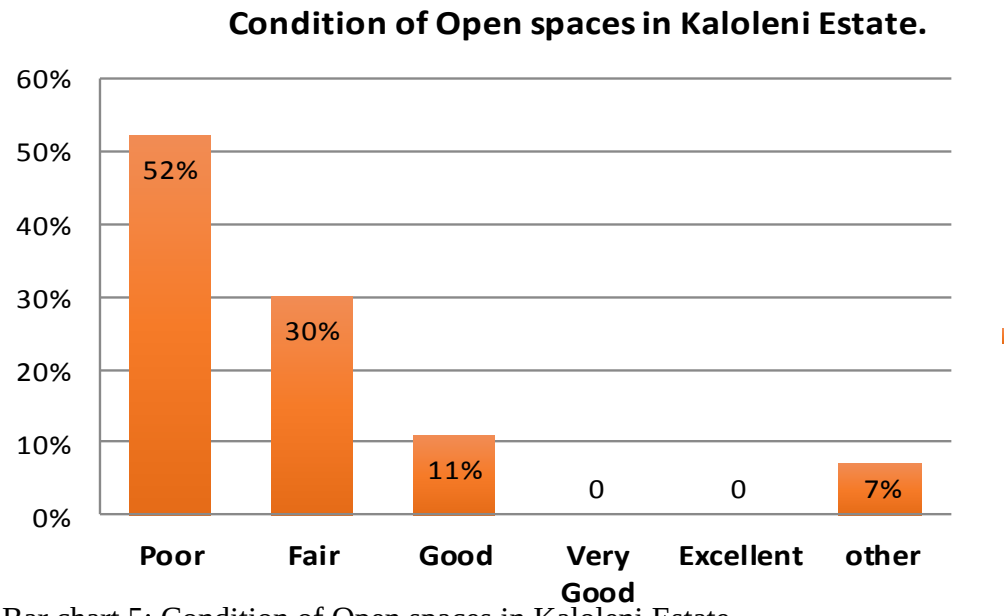
Source: Author Field Survey April, 2015

Plate 57. Informal parking spaces

Source: Author Field Survey April, 2015

5.4.2 Condition of Open Spaces in Kaloleni Estate

52% of the respondents considered the state of open spaces to be in poor condition. According to 30% of the sample population, the condition of open spaces is in fair condition. However, 11% of the respondents felt that the open spaces were in good condition and lastly 7% described the open spaces in Kaloleni Estate to be in very poor state.



Bar chart 5: Condition of Open spaces in Kaloleni Estate

(Source: Author Field Survey April, 2015).

Based on the results from the feedback from respondents it is evident that open spaces are in an in unacceptable condition. This due to lack maintenance by the Nairobi City County, illegal house extensions in open spaces, garbage damping and grabbing of the open spaces by private developers (Majimbo grounds).

Plate 58. Grabbed open space

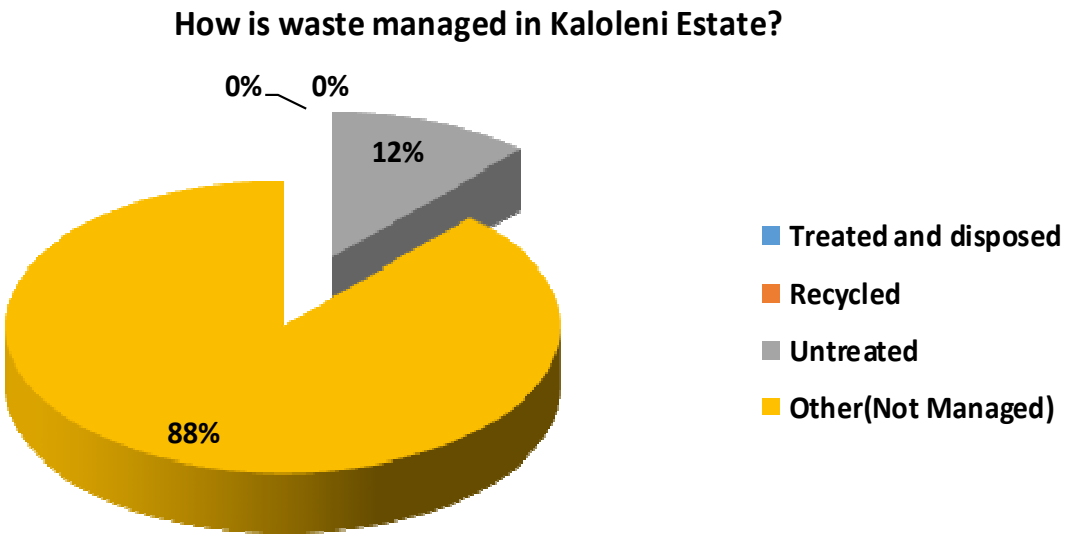
Source: Author Field Survey April, 2015

Plate 59. Garbage damping on open space

Source: Author Field Survey April, 2015

5.4.3 Waste management in Kaloleni Estate

The results from the field survey indicate that 88% of respondents said that the waste in Kaloleni Estate was not well managed. The individual resident was responsible for the waste he/she produced and managed it in any way he/she chose. 12% indicated that waste in the estate was not treated before disposal.



Pie chart 7: Waste management in Kaloleni Estate

(Source: Author Field Survey April, 2015).

There was no clear waste management system in the estate due to lack of designated spaces for waste disposal. This has led to littering in the estate in open area, along transport corridors and even close to the built spaces. This is depicted in the images below of certain spaces in the estate.

Plate 60. Garbage damped along roads

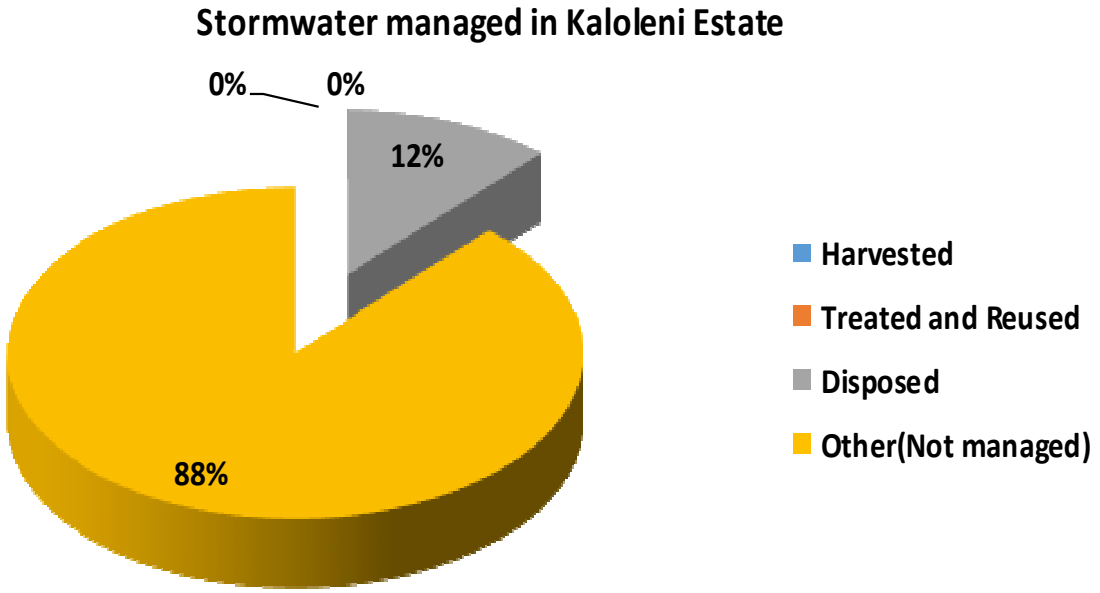
Source: Author Field Survey April, 2015

Plate 61. Garbage damped in open spaces

Source: Author Field Survey April, 2015

5.4.4 Stormwater management in Kaloleni Estate

According to 88% of the respondents, storm water is not well managed in Kaloleni Estate. It is neglected and left to dry up in the sun. There is no attempt by the Nairobi City County or residents to manage it. 12% of the sample population indicate that stormwater is disposed off in the originally designed drainage. This drainage is usually blocked and this stormwater stagnates and thus harbouring mosquitos.



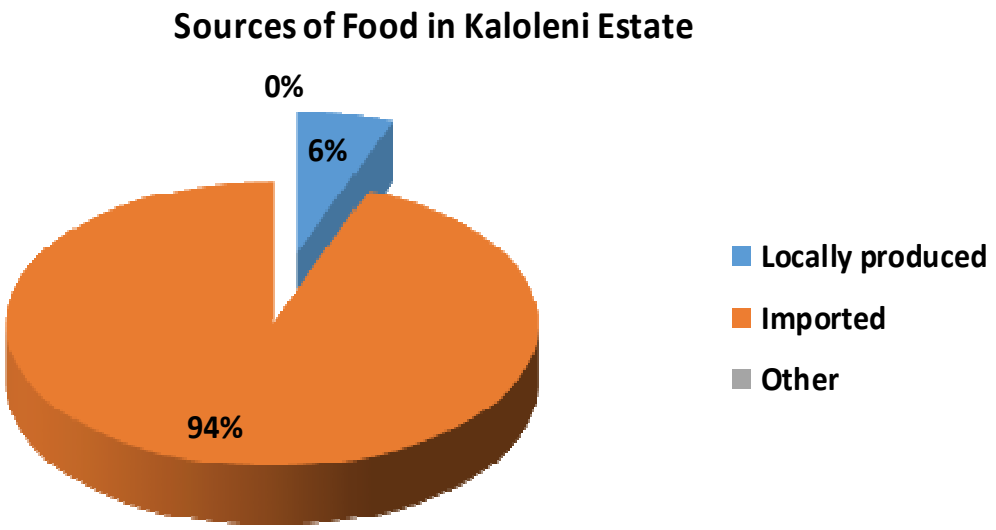
Pie chart 8: Stormwater management. Source: Author Field Survey April, 2015

Plate 62. Stormwater in clogged drainage
Source: Author Field Survey April, 2015

Plate 63. Unmanaged stormwater
Source: Author Field Survey April, 2015

5.4.4 Sources of Food in Kaloleni Estate

The findings regarding food production in Kaloleni Estate indicated that food is imported or purchased from surrounding markets. This is according to 94% of the respondents while 6% indicated that they produced food locally in Kaloleni Estate for subsistence.



Pie chart 9: Sources of food in Kaloleni Estate

(Source: Author Field Survey April, 2015).

The majority of residents in Kaloleni Estate imported food from outside the estate. There were few individual gardens for food production which supplemented some residents.

Plate 64. Food production in Kaloleni Estate

Source: Author Field Survey April, 2015

Plate 65. Imported food from markets

Source: Author Field Survey April, 2015

5.5 Use of Land in Kaloleni Estate

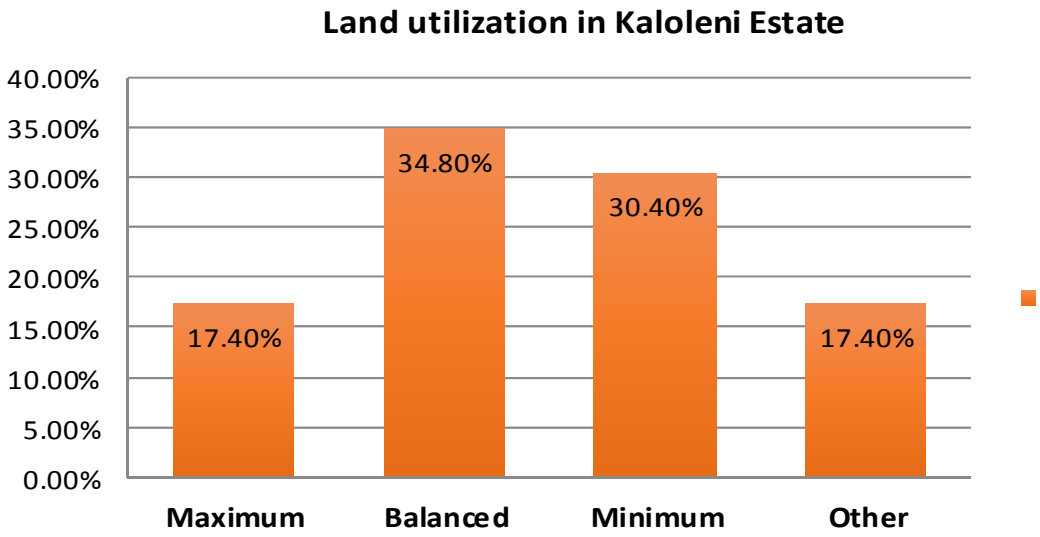
In order to understand how the land in Kaloleni Estate is used, the following aspects were studied: utilization of land, land use organization, integration of informal and designed land uses, state of land uses and the proportion of land uses in Kaloleni Estate.

5.5.1 Land Utilization in Kaloleni Estate

The findings indicated that 34.8% of the responded considered the land utilization to be balanced or medium. This is due to the well planned original buildings and open spaces which were not overcrowded and the house extensions evident. They were however cautious that the house extension would soon be uncontainable. 30.4% of the respondents indicated

that the land utilization in the estate was at a minimum scale. The land could be utilized further to its potential due to proximity to town.

According to 17.4% of the sample population, Kaloleni Estate is optimally utilized. During the group discussions, it was clear that this maximum utilization was informal and there was a need for formal comprehensive utilization. 17.4% also were in between indicating that it the land in Kaloleni Estate was underutilized especially in the formally planned units but over utilized with regard to house extensions.



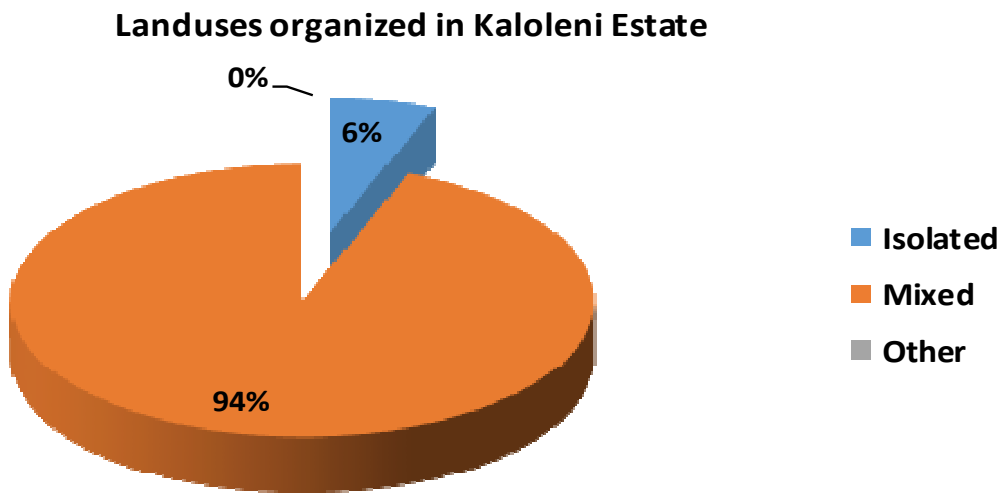
Bar chart 6: Land utilization in Kaloleni Estate

(Source: Author Field Survey April, 2015).

82.6% of the Original Kaloleni residents agreed that the land in Kaloleni especially the formally designed spaces were underutilized and there was a need densifiy it further. In addition according to the majority, the informal extensions over utilized the land in the estate and there needed to be a middle ground to ensure the Kaloleni Estate original environment is maintained but optimal utilization of the land is achieved.

5.5.2 Land use organization in Kaloleni Estate

The findings indicated that 94% of the respondents considered the Land uses in Kaloleni Estate to be mixed. 6% considered the land uses to be isolated and specific areas had different land uses. Kaloleni Estate was designed to be residential with a central shopping area. This has changed overtime due to market forces and according to the residents informal commercial uses are located within the residential areas and along transport corridors. There is a need to work and live in the same place.

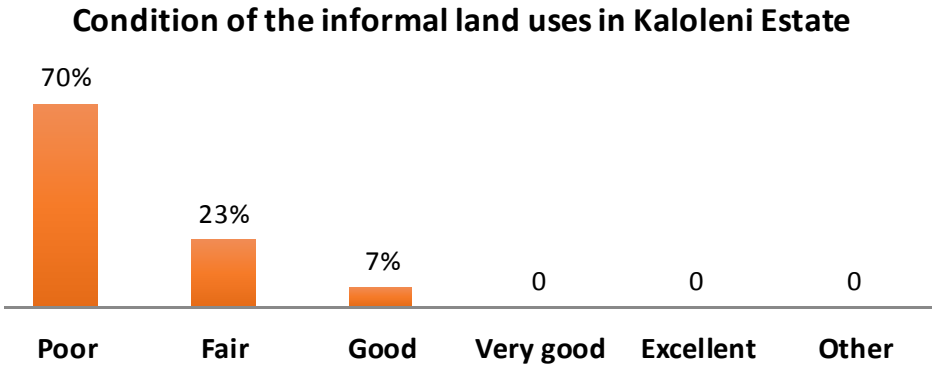


Pie chart 10: organization of landuses in Kaloleni Estate

(Source: Author Field Survey April, 2015).

5.5.3 Condition of Informal Land uses in Kaloleni Estate

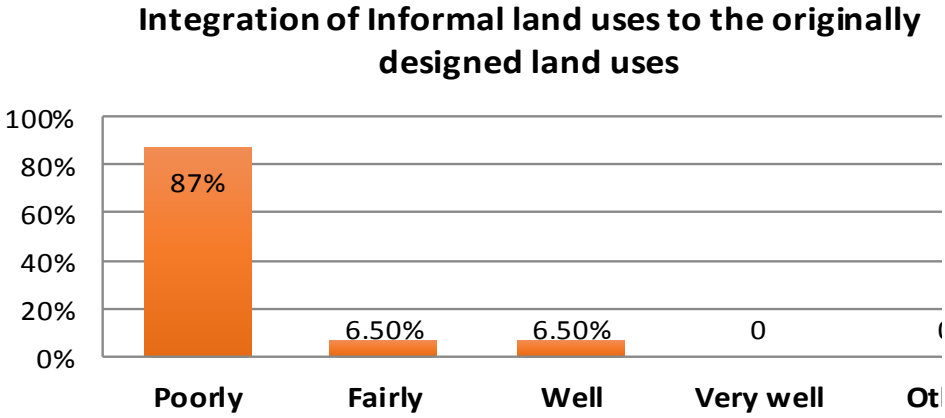
Majority of the residents, 70% indicated that the condition of the informal land uses was poor. This was defacing the originally designed land uses. Secondly, the construction material used made the informal structure inhabitable. 23% of the respondent indicated that the informal land uses were of fair conditions since the residents could live and work there though not comfortably. Only 7% of the sample population considered them to be good. This was probably because they owned them and did not want to lose them. The informal land uses were dweller initiated and therefore little or no technical planning was undertaken. Nairobi City County ought to have intervened to control and manage the development of Kaloleni Estate.



Bar chart 7: Condition of informal landuses in Kaloleni Estate

(Source: Author Field Survey April, 2015).

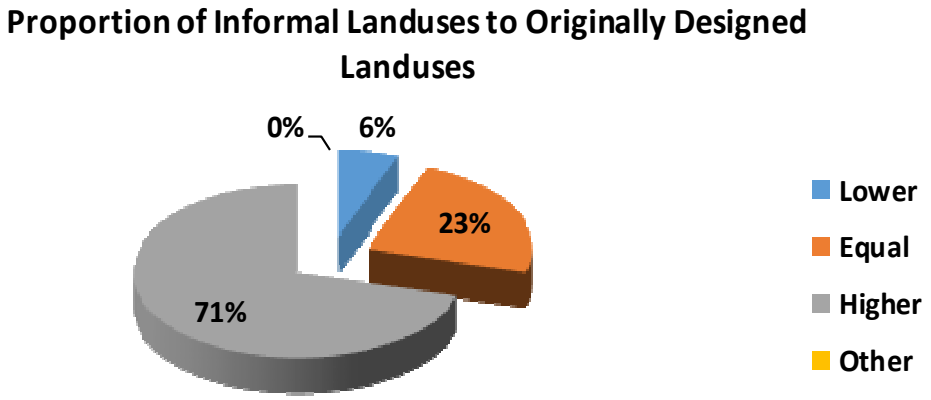
Majority of the residents (87%) indicated that the informal landuses were integrated poorly to the designed land uses. This is due to the fact that they were not planned and designed by experts but rather dweller initiated.



Bar chart 8: Integration of informal and formal land uses in Kaloleni Estate (Source: Author Field Survey April, 2015).

5.5.4 Proportion of Informal to originally designed Land uses in Kaloleni Estate

The findings indicated that 71% of the respondents considered the number of informal land uses (house extensions) to be higher than the originally designed land uses. The Nairobi City County had allowed the residents to build 2 room house extension adjacent to their houses in 1980s to accommodate the rising population then. Currently some residents have up to 15 room extensions and others have extension along the transport corridors. 23% of the respondents said that the proportion of informal to originally designed land uses was equal. A small percentage (6%) could not tell whether the informal land uses were more than the originally designed land uses and vice versa. The findings show that Kaloleni Estate is mainly made up of informal land uses and can even be considered to be a slum. This is due to lack of planning of the informal land uses.



Pie chart 11: Informal: originally designed land uses. Source: Author Field Survey, 2015.

Fig. 5.5.4. Originally designed Kaloleni Estate Land uses. Source: Author

Fig. shows the 1944/45 master plan indicating the different land uses planned around the village green. The estate was residential with a central core for commercial and recreation. The figure below shows the land uses in Kaloleni Estate in the year 2015.

Fig. 5.5.4. Current Kaloleni Estate. Source: Author

Fig show the current situation in Kaloleni Estate with regard to land use organization. The originally designed houses have been transformed to accommodate the rising population through house extension. The open spaces are platforms for informal activities such as commercial, residential and even waste management. The estate entails mixed informal land uses integrated to the formally planned land uses. From the fig it is evident that the informal land uses are more in number as compared to the formally planned land uses. This is an attempt to accommodate urban expansion through a dweller initiated programme. There is a need to densify the estate using sustainable urban design principles to ensure that the neighborhood is compact and the residents are connected to nature.

5.6 Future plans for Kaloleni Estate

The findings from the Nairobi City County Planning, Housing and Engineering Department indicated that:

i. The condition of built spaces in Kaloleni Estate is poor and the buildings are in disrepair.
ii. The infrastructure and buildings in Kaloleni Estate are not efficient nor are they environmentally friendly.
iii. The state of housing and related infrastructure is in a very poor state.
iv. The land in Kaloleni Estate is not optimally utilized in relation to the proximity of the Estate to Nairobi CBD
v. The current landuse in the Estate is mixed albeit informally and the Nairobi City County plans to maintain the Estate as residential with a commercial center.
vi. The Nairobi City County plans to facilitate trade at the commercial centre to create wealth for the residents. The commercial centre will be the only source of job creation in the Estate.
vii. The Nairobi City County plans to densify Nairobi's Eastlands and Kaloleni Estate is part of it. The aim is to provide housing to majority of low income population in Nairobi.
viii. The projected density for Kaloleni Estate is above 70 dwelling units per acre.
ix. Some of the Nairobi City County Vision 2030 flagship projects are: Re-development and urban renewal of Eastlands, Bus rapid transport systems and extension of the sewage disposal systems.
x. Nairobi City County has plans for Bus Rapid Transport with regard to general urban transport and the designs for the pilot projects have been prepared.

6.0: SUMMARY, CONCLUSIONS & RECOMMENDATIONS

6.1 Introduction

This chapter discusses summary of findings and conclusions derived from the study undertaken. The chapter then presents possible Sustainable Urban Design interventions towards a Sustainable neighbourhood in Nairobi's Eastlands.

6.2 Summary of Findings

From the field study, the following was established:

6.2.1 Mixed Landuses

For a neighbourhood in Nairobi's Eastlands to be Sustainable it should entail mixed landuses. This is due to the fact that the residents in Kaloleni are low income earners and 52% of them are self-employed while 13% are unemployed. It is imperative to design their neighbourhood to be place they can work and live in. This calls for a shop house typology which will ensure they can earn a living to be able to sustain themselves and even create more jobs for other Kaloleni Estate and even people from the larger Eastlands.

This is informed by the fact that most of the residents in Kaloleni Estate have Secondary education and below. This is depicted across Nairobi's Eastlands and there is therefore a need for job creation to be at the core of designing these neighbourhoods. For instance Kaloleni Estate has a population of approximately 10,000 people according to KERA. A sustainable urban design should aim to create at least 10,000 jobs in Kaloleni Estate.

6.2.2 Sustainable Density

Kaloleni Estate is congested due to the haphazard informal house extension which have encroached into the open spaces killing the serenity at Kaloleni Estate. This informal house extensions are unauthorised but it is upon the Nairobi City County to monitor the Estate and Nairobi's Eastlands. This will ensure they respond to urban growth and design to accommodate the rising population. This is with a view of attaining and controlling a density which is sustainable for the neighbourhood. The Estate was designed to accommodate a density of 9 dwelling units per acre in 1944/45.

Since then the population of the Estate has more tripled hence the need to design a sustainable density. Nyayo Estate Embakasi was designed to accommodate 48 units per acre and that is ideal considering the distance from Nairobi CBD (15Km). Kronsberg in Hannover is 8Km from Hannover CBD and exhibits a density of 47 dwelling units per acre. These are relevant case studies which could help in determining what could be the sustainable density

for Kaloleni Estate. NCC is projecting the densification plans for Kaloleni Estate will be more than 70 dwelling units per acre. Nairobi City County argues that the City Council housing Estate are ripe for high density housing. This is with a view of averting the housing shortage in the city. I propose a density of between 50 dwelling units to 70 units as a sustainable density range. This is based on the lessons learnt from the case studies in chapter two.

In addition, the estate is located in close proximity to Nairobi CBD (2.5KM) and land value is 400million per acre. There is therefore a need to optimally utilize the land in the estate. A density ranging 50 to 70 units per acre can work due to the low income target clientele. The low income clientele need less dwelling space since the units will not be designed for luxury living. An average of 50 square meters can accommodate a medium family size. Due to the small size of the dwelling units, many dwelling units can be accommodated hence the density range of 50 to 70 dwelling units per acre being within a sustainable range. The density should not exceed 70 dwellings units per acre so as not to compromise on the quality of built space in the estate as a whole.

6.2.3 High performance Buildings

The buildings in Kaloleni Estate are in a bad state, actually in disrepair. They are not efficient and neither are they environmentally friendly. The space in these buildings is inadequate for the current residents. The current residents have families and 1 roomed and 2 roomed houses do not accommodate them comfortably. The 3 roomed houses may be enough for some of the residents in Kaloleni Estate. There is a need to design buildings with sufficient spaces for the residents in the Estate and Nairobi's Eastland at large. The building ought to be designed to be green and respond to the tropical climate. This will ensure adequate daylighting, ventilation and of sustainable construction materials just to mention a few.

6.2.4 High performance Infrastructure

The infrastructure in Kaloleni Estate is not efficient and thus can't be categorised as high performance. There is an acute water shortage in the estate, roads are in poor condition, no designed parking, sewage system is compromised by informal extensions etc. There is a need to integrate the services along the transport corridors, design minimal individual parking spaces, the road should be efficient with sustainable street lighting (solar Powered).

6.2.5 Open Spaces

Open spaces connect the Estate to nature and thus achieving Biophilia. There are few open spaces in Kaloleni Estate and they keep reducing each passing day. This is due to the mushrooming of informal extensions constructed in the open spaces. There is a need to design a variety of open space in such a way they are meaningful and well-articulated. This is to attract residents to utilize them. Diverse open spaces are ideal for instance: parks, squares, sports fields, gardens, parking, open markets, green roofs, and recreational spaces. The open spaces should include the needed facilities such as furniture, lighting, water fountains. They should be designed to generate income for their maintenance.

6.2.6 Waste management

There was no clear waste management systems in Kaloleni Estate. Individual tenant chose how to dispose the waste i.e. burn it, dispose it on weekends when it is collected, dispose it in the estate etc. Waste management is a major problem in the Estate due to lack of waste receptacles to collect the waste, lack of enforcement of the policy by NCC on the same. Waste management strategies such separating recyclable waste and placing in different containers provided/approved by the Council should be enforced. This and the other strategies stipulated in the by-laws on waste management will play a major role ensuring sustainability in the estate.

The sewage in Kaloleni Estate is overloaded and tampered with by the informal house extensions. Some of extensions are built on top of the sewage network and thus in the long run it is compromised. I propose ecological strategies of waste water management to ensure the waste water is recycled and disposed into the sewer line or to be reused to maintain the greenery in the estate.

6.2.7 Stormwater management

According to 88% of the residents stormwater in Kaloleni Estate is not treated nor is it managed in any way but rather it is left to dry up. The originally designed drainage systems are blocked leading to stagnant stormwater which becomes a breeding area for mosquitos. Some of the resident harvest rain water and reuse the water in the dwelling units. I propose reducing stormwater in the estate by allowing it to percolate to the ground through rain gardens, bio swales, detention ponds etc. the stormwater can also be collected and bio filtered to be reused in the estate.

6.2.8 Food production

Kaloleni Estate get its food from the surrounding markets such as Burma market and Gikomba. Very few people practice urban agriculture and it is for their subsistence use. This both cultivation of vegetables and rearing of poultry. I propose provision of space in the estate for urban agriculture to meet the food needs of the residents. This is by designing individual food gardens, edible landscaping, communal farms, and kitchen gardens.

6.3 Study Summary

This study was focused towards renewing Nairobi's Eastlands specifically Kaloleni Estate. The aim was to explore how sustainable urban design principles could be used to ensure Kaloleni Estate is a sustainable neighbourhood. Various methods were used to achieve the set objectives. Kaloleni Estate was selected as a case study due to its suitability explained in chapter one. It involved interviewing original Kaloleni Estate Residents who live in the estate; using structured questionnaires, observation checklist as well as interviewing relevant officials of the Nairobi City Council.

The data collection tools were designed to investigate the density in Kaloleni Estate, the organization of Landuses in the estate, the presence and condition of open space, stormwater management, waste management, food production in the estate, public lighting and high performance buildings/infrastructure. The exercise involved rating the built spaces, open spaces and the land utilization in Kaloleni Estate.

6.4 Summary of Data Interpretation

i. 53% of the original Kaloleni Estate residents are men and this attributed to the fact that the estate was a bachelors quarters meant for African workers (men) in the colonial time.
ii. The high number of respondents (53%) being above forty years means that they were between the second and third generation original residents. This explains the evidence of extension which is meant to house their expanding families.
iii. 65% of the original Kaloleni Estate residents have an educational background of Secondary school and below. This indicates that the estate accommodates low income earners.
iv. According to 76% of the residents, the estate is congested. This is due to the informal house extensions mushrooming along the roads and adjacent to the originally designed buildings.

v. All residents considered the originally designed buildings inadequate to accommodate the population in the estate. This explains the high number of informal house extension.

vi. 31% of residents indicated that the space spaces in the originally designed houses was adequate. This were most likely residing in the two and three roomed houses.

vii. According to 82% of the residents, the condition of built spaces in the estate was below average. This is due to lack of maintenance by Nairobi City County which is mandated to maintain it.

viii. 88% of the residents felt that the infrastructure and buildings in Kaloleni Estate were not efficient.

ix. According to the focused group discussions the majority of residents indicated that the open spaces in Kaloleni Estate were shrinking. This was due the fact that they were being grabbed by private developers and illegal house extensions.

x. 82% of the respondents felt that the Nairobi City County was not doing much with regard to open spaces' maintenance

xi. The majority of respondents (88%) indicated that stormwater and waste was not being managed in the estate. This explains the pools of stormwater drains evident in the estate.

xii. 94% of the residents imported food from neighbouring market and few cultivated crops for food. This explains the few number of kitchen gardens evident and also the lack of communal gardens for food production.

xiii. According to 65% of the original Kaloleni Estate residents agreed that the land in the estate especially the formally designed spaces were underutilized. This explains the mushrooming house extensions to accommodate the rising population.

xiv. 94% of the respondents considered the land uses in Kaloleni Estate to be mixed. This was because of the illegal house extensions used for different land uses.

xv. According to 71% of respondents the informal land uses (house extensions) were much more than the originally designed land uses due to population growth over the years

6.5 Conclusion

i. One of the major component of Sustainable Urban design in Nairobi's Eastlands is job creation. The neighbourhood or urban area should be designed to ensure the residents can work and live in the neighbourhood.

ii. When undertaking Re-development or urban renewal in low income zones such as Nairobi's Eastlands, it is imperative to study the existing land uses and how they have been integrated before proposing any design. For instance Kaloleni Estate was designed to be purely residential with a central commercial centre. Currently the land uses are mixed though informally. It is therefore ideal to respond to the site problems by designing mixed land uses.

iii. Integration of transportation, land uses with technology is key in the design of sustainable urban areas/neighbourhoods in Nairobi's Eastlands and similar areas. This ensures that the residents can earn a living and afford living there.

iv. High performance infrastructure and buildings are the building blocks for sustainable urban areas in Nairobis's Eastlands. Provision of the right amount of space in buildings and not overprovision is important. The infrastructure should be integrated with transport to ensure efficiency.

v. Urban agriculture-food production goes a long way in achieving sustainability in Nairobi's Eastlands. This should be done communally and also individually in these neighbourhoods.

vi. Open spaces are important spaces in the neighbourhoods in Nairobi's Eastlands. They should however be designed to be meaningful and income generating to ensure they are sustainable.

vii. Stormwater should be designed and managed by Nairobi City County in this part of the city to ensure sanitation and possible treatment for reuse of the water to curb the water shortages. Percolation of stormwater should be encouraged to recharge the water table.

viii. The NCC should enforce the policy on solid waste management. This is by educating residents on reducing, recycling and reusing the waste. It should also provide/approve designed waste refuse points to collect the waste.

ix. Public lighting is an essential component of ensuring sustainable urban design in Nairobi's Eastlands. This promotes night commerce and thus a 24hr economy and also security is enhanced.

x. The buildings in the study area should be designed to be high performance green buildings responding to the tropical climate. They should also be environmentally friendly.

6.6 Recommendations

i. There is a need to densify Kaloleni Estate to optimally utilized the land and also accommodate urban growth in Nairobi's Eastlands. This can be achieved by ensuring the density is within a sustainable range. Due to the proximity of the estate to the CBD, density between 50-70 dwelling units per acre will optimally utilize the land in the estate. The transportation grid, village green and courtyard is maintained to ensure social-cultural sustainability due to the rich heritage in the Estate.

Plate 66. Highest Density along Jogoo Rd. due to high land value

Source: Author.

The open space along Jogoo road entails the highest density to serve as mixed use development. This is due to the high land value and proximity to the busy road. The M.U.Ds will also accommodate parking spaces for the estate. The high density along the road will also buffer the remaining major part of the estate. In order to achieve a compact Kaloleni Estate with a sustainable density range of between 50-70 dwellings per acre, high density residential blocks should be placed in the courtyards. In addition, a compact Kaloleni Estate should entail mixed landuses and hence the densification of the existing buildings from bungalows to two levels. This is to accommodate commercial activities on ground floor and residential activities on the upper floor.

The courtyard to accommodate a high density residential block surrounded by green space.

Plate 68. High Density block in the courtyard.

This should be done especially along the major streets in the estate by designing shop-house typologies. The following can be mixed using scenario which could work in Kaloleni Estate.

Plate 69. Mixed land uses along major transport arteries (Shop-House Typology)

Source: Author.

ii. The policies specifying that all government and Nairobi City County buildings should be environmentally friendly should be enforced and encouraged. This can be done through incentives to development partners. Incentives such as tax relief, provision of roads and infrastructure, provision of land for development partners developing

environmentally friendly buildings and infrastructure. The buildings should be high performance buildings responsive to the tropical climate in Nairobi's Eastlands.

iii. A mix of greenways and functional open spaces should be incorporated in Kaloleni Estate. Spaces such as parking, sports field, parks etc. should be designed to be income generating to ensure they are maintained and sustainable.

Plate 70. Open Space designed at the core of the Estate. Source: Author

iv. The study findings can be used for policy formulation to ensure sustainable neighbourhoods and a sustainable City.

v. The by-laws against construction of house extension especially in the open spaces should be enforced. This can be enforced through regular inspections in Kaloleni Estate.

vi. Stormwater should managed by NCC by providing stormwater drainage. The design should provide for percolation to recharge the water table. Stormwater can be collected in retention ponds and bio filtered for reuse in the estate. The main idea is to reduce stormwater runoff by incorporation of rain gardens and bioswales.

vii. Strict policies on disposing waste in undesignated place should be imposed by the City County. The NCC should have waste management models embracing reducing, reusing and recycling waste in designated places in the Estate.

viii. The Estate and entire Nairobi Eastlands should be designed to accommodate urban agriculture. This is through designated individual and communal spaces for food production.

ix. A 24Hr economy should be encouraged in Nairobi Eastlands through public lighting. The lighting fixture should be environmentally sustainable i.e. use of solar powered street lighting.

6.7 Project Implementation

Kaloleni Estate covers approximately 91.4 Acres (37Ha), assuming the development density is 70 dwellings per unit then there will be 8226 dwelling units. A typical dwelling in Kaloleni Estate will be 50 Meters Squared. This is because the Estate is inhabited by low income earners who can comfortably live in that space. The total developed area for housing will be 411,300 Meters Squared. The table below indicates the cost estimates for renewing Kaloleni Estate to be Sustainable Neighbourhood.

Description	**Units**	**Quantity**	**Rate**	**Cost (Kshs)**
Buildings (Mixed Use)	M2	411,300	45,000	18,508,500,000
Roads & Walkways	KM	10	20,000,000	200,000,000
Open Spaces (Parks, Streets, Greenways)	M2	120,000	2,000	240,000,000
Stormwater management Wastewater Management Gas	SUM			600,000,000
Street Lighting CCTV ICT	SUM			900,000,000
Preliminaries				50,000,000
Project Cost				**20,498,500,000**

This project can be implemented through PPP whereby Nairobi City County can contribute land (valued at 200 million per acre) and build the infrastructure while private developers can do the housing. The private developers can build and sale or operate the housing until they recoup their investment and then handover to the City County. The current Kaloleni Estate entails low income earners and thus the need to provide social housing. This is to accommodate the original residents who may not afford the rent determined by market forces.

The sustainable urban design guidelines emphasizing compactness and Biophilia in Kaloleni Estate are replicable in the rest of Nairobi's Eastlands. However, the guidelines should be applied in context. This is because different neighborhoods have specific challenges other than the general urban issues in the larger Nairobi's Eastlands.

6.8 Areas of Further Research

i. Ecological model of sustainable urban design in African cities

ii. Safety and security measures for urban space development

iii. Development of design typology for High performance buildings in Africa.

iv. Holistic re-examination of Stormwater management in Nairobi's Eastlands

v. Sustainable Infrastructure density for urban Areas in Africa

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Appendix I

UNIVERSITY OF NAIROBI

School of the Built Environment

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Our Ref: UON/CAE/ABS/ST **DATE:** 5th **March**, 2015

TO WHOM IT MAY CONCERN

RE: ARWARI SAMUEL KERONGO - B52/67057/2013

This is to confirm that the above named is a Student at the University of Nairobi, Department of Architecture & Building Science, pursuing **Masters of Architecture**. As part of the continuous assessment culture in the Master of Architecture programme our students are encouraged to conduct research for their portfolio project.

We wish to request you to give him some of your valuable time by responding positively to his inquiries, and provision of drawings/plans/photographs, etc. This is for academic purposes only.

Any assistance accorded to him will be highly appreciated by this office.

DEPARTMENT OF ARCHITECTURE & BUILDING SCIENCE UNIVERSITY OF NAIROBI

Arch. Erastus Abonyo
AG. CHAIRMAN,
DEPT. OF ARCHITECTURE & BUILDING SCIENCE

/mao.

COLLEGE OF ARCHITECTURE & ENGINEERING

DEPARTMENT OF ARCHITECTURE

MASTER OF ARCHITECTURE

Topic: Sustainable Urban Design in Nairobi's Eastlands: The Case of Kaloleni Estate

DECLARATION: The information obtained from this Questionnaire is confidential and is for academic purpose(s) only.

Respondents: Nairobi City: Planning Department, Housing Department, Engineering Department

Instructions: Please respond to as many questions as possible

Tick where appropriate

QUESTIONNAIRE

SECTION A: RESPONDENTS BIO DATA

1. Name..... Judy Gitau .....
2. Organization/Department..... NCC - Urban Planning .....
3. Sex. Male [ ] Female [✓]
4. Occupation [Job Title]..... Urban Planner .....
5. Education background

   Primary [ ] Secondary [ ] Tertiary [✓] Other [specify].....

SECTION B: THE STATE OF SPACES IN KALOLENI ESTATE

1. How would you describe the density in Kaloleni Estate?

   Low [ ] Medium [ ] High [✓] Very High [ ] Other.....

2. Do the originally designed built spaces accommodate the population in Kaloleni Estate?

   Yes [ ] No [✓]

3. What is the proportion of the informal house extensions to the originally designed built spaces? Lower [ ] Equal [ ] Higher [ ] Other [specify].....

4. What is the condition of the built spaces in Kaloleni Estate?

   Poor [✓] Fair [ ] Good [ ] Very good [ ] Excellent [ ]

5. Is the infrastructure and buildings in Kaloleni Estate efficient and environmentally friendly? Yes [ ] No [✓]

6. How are the users of the spaces in Kaloleni Estate connected to nature?

   Open spaces [ ] Public lighting [ ] Stormwater management [ ] Waste management [ ]

   Urban Agriculture [ ] Other [specify].....

7. Which are some of the open spaces evident in Kaloleni Estate?

   Play fields [ ] Transport corridors [ ] Parking [ ] Greenways [ ] Other

   [specify].....

8. What is the condition of the open spaces in Kaloleni Estate?

   Poor [ ] Fair [ ] Good [ ] Very good [ ] Excellent [ ] Other

   [specify].....

SECTION C: UTILIZATION OF SPACE IN KALOLENI ESTATE

9. What are some of the land uses evident in Kaloleni Estate?

   Residential [✓] Commercial [✓] Public purpose [✓] Transport [ ] Other

   [specify].....

10. How would you describe the planning of the land uses in Kaloleni Estate?

    Mixed [ ] Zoned [ ] Other [specify]...The current land use is mixed albeit informally / unauthorized.....

11. What is the take of Nairobi City County with regard to mixed landuses in Kaloleni Estate?...The NCC is aware that the original planned area of Kaloleni has completely changed without the necessary guidance of the Planning Dept

12. What Nairobi City County doing regarding job creation in Kaloleni Estate?...NCC planned Kaloleni with a well designated commercial centre to facilitate trade & thereby create wealth for the residents.

13. What is the proportion of the informal land uses to formal land uses in Kaloleni Estate?

Lower [ ] Equal [ ] Higher [ ] Other [specify].....

14. Based on the proximity of Kaloleni Estate to the CBD, is the land in Kaloleni Estate optimally utilized? Yes [ ] No [✓]

15. Is Kaloleni Estate liveable and sustainable? Yes [ ] No [✓].

Why? The state of the housing and related infrastructure is very poor state.

16. What is the density (Dwelling units per acre) projections for Kaloleni Estate?

<10 [ ] 10-30 [ ] 30-50 [ ] 50-70 [ ] >70 [✓] Other.....

17. What is the future plans for Kaloleni Estate?

The plan is to densify the Eastern part of the City of which Kaloleni is part. ... to facilitate to provide housing to the majority of the low income population in Nairobi

18. What are some of the Nairobi city County Vision 2030 flagship projects and what is the progress so far? Re-development & urban renewal of Eastlands, Mass Rpid Transport systems, extension of the sewerage disposal systems etc.

19. What is the plan of Nairobi City County concerning the general urban transport in Nairobi? What is the progress so far?

Light rail [ ] Bus Rapid transport [✓] Water transport [ ] Other [specify]..... The designs for the pilot project have been prepared.

THANK YOU

Appendix III

1 Roomed House.

UNIVERSITY OF NAIROBI

COLLEGE OF ARCHITECTURE & ENGINEERING

DEPARTMENT OF ARCHITECTURE

MASTER OF ARCHITECTURE

Topic: Sustainable Urban Design in Nairobi's Eastlands: The Case of Kaloleni Estate

DECLARATION: The information obtained from this Questionnaire is confidential and is for academic purpose(s) only.

Respondents: Kaloleni Estate Residents.

Instructions: Please respond to as many questions as possible

Tick where appropriate

QUESTIONNAIRE

SECTION A: RESPONDENTS BIO DATA

1. Name..... Mr. Peter Kibue Mwenga .....
2. Sex. Male [✓] Female [ ]
3. Age. 18-29Yrs [ ] 29-39Yrs [ ] 40>Yrs. [✓]
4. Education background

   Primary [ ] Secondary [✓] Tertiary [ ] Other [specify].....
5. Occupation [Job Title]..Business Man.....

SECTION B: THE QUALITY OF SPACES IN KALOLENI ESTATE

1. How would you describe the built spaces in Kaloleni Estate?

   Very congested [ ] Congested [✓] Uncongested [ ] Other.....
2. Are the originally designed built spaces sufficient for the current population in Kaloleni Estate? Yes [ ] No [✓]
3. How would you describe the spaces in the originally designed buildings in Kaloleni Estate? Inadequate [ ] Satisfactory [ ] Adequate [ ] Other: For a bachelor it is satisfactory (1 Room). For a family at least 3 room will suffice (NOT satisfactory for a family.

4. What is the condition of the buildings and infrastructure in Kaloleni Estate?

   Poor [ ] Fair [✓] Good [ ] Very good [ ] Excellent [ ]

5. Is the infrastructure and buildings in Kaloleni Estate efficient and environmentally friendly? Yes [ ] No [ ].

6. Which are some of the open spaces evident in Kaloleni Estate?

   Play fields [✓] Transport corridors [✓] Parking [ ] Greenways [✓] Other .....

7. What is the condition of the open spaces in Kaloleni Estate?

   Poor [ ] Fair [✓] Good [ ] Very good [ ] Excellent [ ] Other.....

8. How is waste managed in Kaloleni Estate?

   Treated and disposed [ ] Recycled [ ] Untreated [ ] Other.....

9. How is rain water/storm water managed in Kaloleni Estate?

   Harvested [ ] Treated and Reused [ ] Disposed [ ] Other.....

10. Where does the food in Kaloleni Estate come from?

    Locally produced [ ] Imported [✓] Other.....

SECTION C: USE OF SPACE IN KALOLENI ESTATE

11. How is the land in Kaloleni estate utilized?

    Maximum [ ] Balanced [ ] Minimum [✓] Other [specify].....

12. How are the land uses organized in Kaloleni Estate?

    Isolated [ ] Mixed [✓] Other [specify].....

13. How is the informal land uses integrated to the originally designed land uses?

    Poorly [✓] Fairly [ ] Well [ ] Very well [ ] Other.....

14. What is the condition of the informal land uses in Kaloleni Estate?

    Poor [✓] Fair [ ] Good [ ] Very good [ ] Excellent [ ] Other.....

15. What is the proportion of the informal land uses to the originally designed land uses?

    Lower [ ] Equal [✓] Higher [ ] Other [specify].....