

I

AN ASSESSMENT OF THE ENVIRONMENTAL IMPACT
OF WASTE DISPOSAL
IN
RESIDENTIAL AREAS

A Case Study of Dandora Residential Area
in
Nairobi

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FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF
THE BACHELOR OF ARTS DEGREE IN BUILDING ECONOMICS

UNIVERSITY OF NAIROBI

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II

DECLARATION

**THIS THESIS IS MY ORIGINAL WORK AND HAS NOT BEEN
PRESENTED FOR A DEGREE IN ANY OTHER UNIVERSITY.**

Signed: 

LUCY W. CHEGE

**THIS THESIS HAS BEEN SUBMITTED FOR EXAMINATION WITH
MY APPROVAL AS A UNIVERSITY SUPERVISOR; AND IS TO THE
BEST OF MY KNOWLEDGE, AN ORIGINAL ACCOUNT OF HER
FIELD RESEARCH AND INVESTIGATION.**

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IV
III

ACKNOWLEDGEMENTS

DEDICATION

**To God and my beloved parents for all the
inspiration and support they gave me.**

IV

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A great many people helped me develop this project paper most of whom I cannot mention here.

I am indebted to them all but in particular to my Supervisor, Mr. John Mbaya of the University of Nairobi for his constructive criticism, comments and directions throughout the course of writing the project.

I wish to thank Mr. J. Mbindyo of City Bins Limited, for his tremendous assistance. I also wish to thank Mr. Gathua, the Assistant Cleansing Superintendent of the Nairobi City Council who kindly agreed to be interviewed by me. Also, Mr. Wanjau, the Assistant Technical Director of Planning at the Dandora Housing Office of the Nairobi City Council.

Thanks also to the residents of Dandora for their co-operation during my field work.

Lastly but definitely not least, special thanks to my sister, Judy Chege, for her moral support and constant encouragement.

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ABSTRACT

This work sets out to study the environmental impact of waste disposal in Dandora residential area.

In order to examine this impact, four environmental attributes are analyzed - air, land, people and buildings. The study examines these environmental attributes in each of the five areas in Dandora; in order to see the extent of environmental damage in each area and examine the relationship of this with their location relative to the position of the waste disposal site or tipping site.

The findings of the study reveal that the cause of these environmental problems is the lack of proper controlled tipping practices. This study finally gives recommendations as to how this environmental degradation can be minimized.

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VII
CHAPTER ONE
LIST OF MAPS

CONTENTS

The maps in this chapter are being prepared for the Government of Kenya and are intended primarily to assist in the planning, development, and management of processing resources through co-operations.

1. **MAP OF NAIROBI SHOWING THE DANDORA AREA Page 7(a)**

However, the scientific, technological and social progress, the continuous development of the standard of living and knowledge in manufacturing have just demonstrated its great economic quality. One development in the process in the

2. **DANDORA AREA Page 7(b)**

It was found that applying this was essentially three of reduction of reliance from the point of operations for a more suitable and less developed area.

From having a primary need without loss of planning relief overall. The development of quality and increasing concern about environmental matters will allow the development of open dumping area plus controlled burning, etc.

Controlled burning is a natural response of open dumping. It was developed as a means for waste disposal in England and Germany during the first World War.

Controlled burning of industrial property is actually, a very good method of waste disposal. Of the three methods for the efficient disposal of waste - incineration, pyrolysis and land filling, incineration is the most appropriate method for which the use of an appropriate incinerator, waste water and emissions of toxic environmental impact.

CHAPTER ONE

1.0 INTRODUCTION

The age in which we are living is earmarked by intensive scientific and technological progress which enables cosmic flights, utilization of atomic energy and management of production processes through cybernetics.

However, this scientific, technological and social progress, the continuous improvement of the standard of living and intensive industrialization have their disadvantages on environmental quality. One disadvantage is the increase in the quantity and volume of solid, liquid and gaseous wastes.

Waste disposal approaches are essentially those of relocation of residues from the point of generation to a more suitable and non detrimental site.

Open dumping is probably man's oldest form of planning refuse disposal. The urbanization of society and increasing concern about environmental matters made obvious the unacceptability of open dumping and thus controlled tipping was developed.

Controlled tipping is a natural extension of open dumping. It was developed as a method for waste disposal in England and Germany during the first World War.

Controlled tipping if practised properly is actually, a very good method of waste disposal. Of the three locations for the ultimate disposal of wastes - surface waters, atmosphere and land - the land represents not only an appropriate location for wastes but also an opportunity to manage wastes with minimum adverse environmental impacts.

1.1 PROBLEM STATEMENT

Maintenance of adequate primary health care is a prerequisite for every community, whether in the cities, slums or in the rural areas. Every person in the world has a right to a clean and healthy environment.

In Kenya, however, the unprecedented rate of urbanization has led to a situation whereby basic infrastructural services have been stressed beyond their capacities. This has in turn led to several problems, and one of these is the problem of environmentally sound methods of waste disposal.

As a result of this problem, mounds and mounds of filthy and smelly garbage dot many of the City's once beautiful and hygienic low and middle income residential area. Garbage in most parts of the city estates is disposed by the residents in open dumps. An example of this was cited in one of the local dailies, "The Standard" by a correspondent in an article entitled "*The Garbage Watchtower*". In this article the writer stated that at one corner of Nairobi's Umoja Estate is a man-made mountain. Years of open dumping has resulted to a peaked mountain with a huge crater on top. The ugly white and black-peaked mountain which gradually grew to overtake the fences and houses, is now threatening to bury the families bordering it. This in addition to its offensive stench. One kiosk operator interviewed said, "When people organise to burn the rubbish, the dark smoke is quite disturbing".

An example was cited by a reporter in "The Kenya Times"². He found that the Kawangware suburb of Nairobi is filled with the smell of rotting heaps of garbage lying at the main entrance of the Market Centre. He said that the people complained that they are exposed to the danger of communicable diseases like diarrhoea and should there be any outbreak of an epidemic like cholera, the spread would be rapid.

A third example was in "The Daily Nation" in an article in which it was reported that "Kiosk owners at Nairobi West complained that the Council has been leaving garbage to rot at various points rendering the estate environmentally unsafe"³.

Mbugua (1979-80)⁴ in his study found that refuse disposal is inefficient. He went on to say that this refuse is likely to become injurious to health, create public health problems, as well as spoil the environment.

Wachira (1979-80)⁵ found that there are evident problems in extensive dumping and illegal dumping.

Muthaura (1990)⁶ found that in Meru Town, estate children can normally be found playing on garbage heaps, and the stench from the decomposing garbage chokes them.

Dandora is one of the low cost residential areas of Nairobi. In Dandora, the problem of refuse disposal is very major indeed. The researchers observed that in most parts of the estate refuse is just disposed off carelessly. See Plate No.1 and Plate No.2

Plate No.1



Refuse dumped carelessly in the area between the houses.

This is a problem not only because of the foul odour produced but also because such rubbish can breed disease vectors such as flies, rats, cockroaches and mosquitoes.

Plate No.2



This is part of Dandora Area 3. Rubbish dumped even along the road.

This indiscriminate dumping of refuse shown in Plate No.1 and Plate No.2 creates several nuisances to the residents such as foul odour and is a health hazard to the residents.

At Dandora in Area 2 is the location of the Nairobi City Council's landfill. The presence of this landfill has brought several problems to the residents of the area. They have complained of air pollution due to the stench from rotting garbage and also due to the burning of wastes, they have also complained of invasion of their houses by flies, rats and mosquitoes,, increased crime which they attribute to the presence of scavengers, health problems such as malaria and pollution of the Nairobi river.

These problems have been highlighted by the local press. In one article about the Dandora tipping site in the Daily Nation, a reporter observed that: "Stifling black smoke spirals upward almost concealing the approaching vultures. The stench - a mixture of every foul odour conceivable - is overwhelming Walking through it is like a trek through a never ending trash bin Some young boys are intoxicated by foreign substances that litter the area, and they dig through the filth for anything that can be sold. Medical wastes are dumped at the site and these include expired medicines, syringes, used swabs, satchets of blood, human placenta and even aborted fetuses Of concern is the communicable diseases those in contact with the waste have been exposed to. These include hepatitis 'B', HIV and meningitis viruses."

Plate No.3



This plate shows some of the features of the tipping site that were found. "Walking through this is like a trek through a never ending trash bin".

The aim of this study is to assess the effects of this refuse disposal to the residents of Dandora.

1.2 OBJECTIVES

1. To examine the method of waste disposal at Dandora.
2. To establish the pollutants from this waste disposal.
3. To assess the effect of these pollutants on the environment.
4. To give recommendations as to how environmental degradation arising from this method of waste disposal can be minimized.

1.3 HYPOTHESIS

The null hypothesis of the study H_0 is:

Dumping of wastes at Dandora has no effects on the

- property values
- health of the people
- building structures
- quality of life of the people.

The alternative hypothesis H_1 is:

Dumping of wastes at Dandora has caused:

- (i) Property values to decline.
- (ii) Health problems to the residents
- (iii) Deterioration of building structures.
- (iv) Quality of life of the people to go down.

1.4 SCOPE AND LOCATION OF THE STUDY

Although the study is on the environmental impact of waste disposal in residential areas, only Dandora residential area will be studied. The reasons for this are due to the limited amount of time available to the researcher, and due to limited finance available for travelling to several areas.

The study is on environmental impact; however, not all variables that define the environment will be studied. The variables that will be studied are air, land, people and buildings.

The Dandora residential area was selected by the researcher because it is the location of the Nairobi City Council's tipping site.

The results found at Dandora will generalize the environmental effects of waste disposal in any residential area.

Dandora residential area is located 11 km. North-East of the Nairobi City Centre (See Map No.1).

The area straddled a ridge which is bounded on the North and East sides by the Nairobi River, flowing in an easterly direction within a deep natural valley. Located within this valley are several quarries, one of which was supposed to be the location of the dumping ground (see Map. No.2). Unfortunately, the dumping area has spread up to John Osogo Road due to lack of proper supervision and enforcement by the Nairobi City Council.

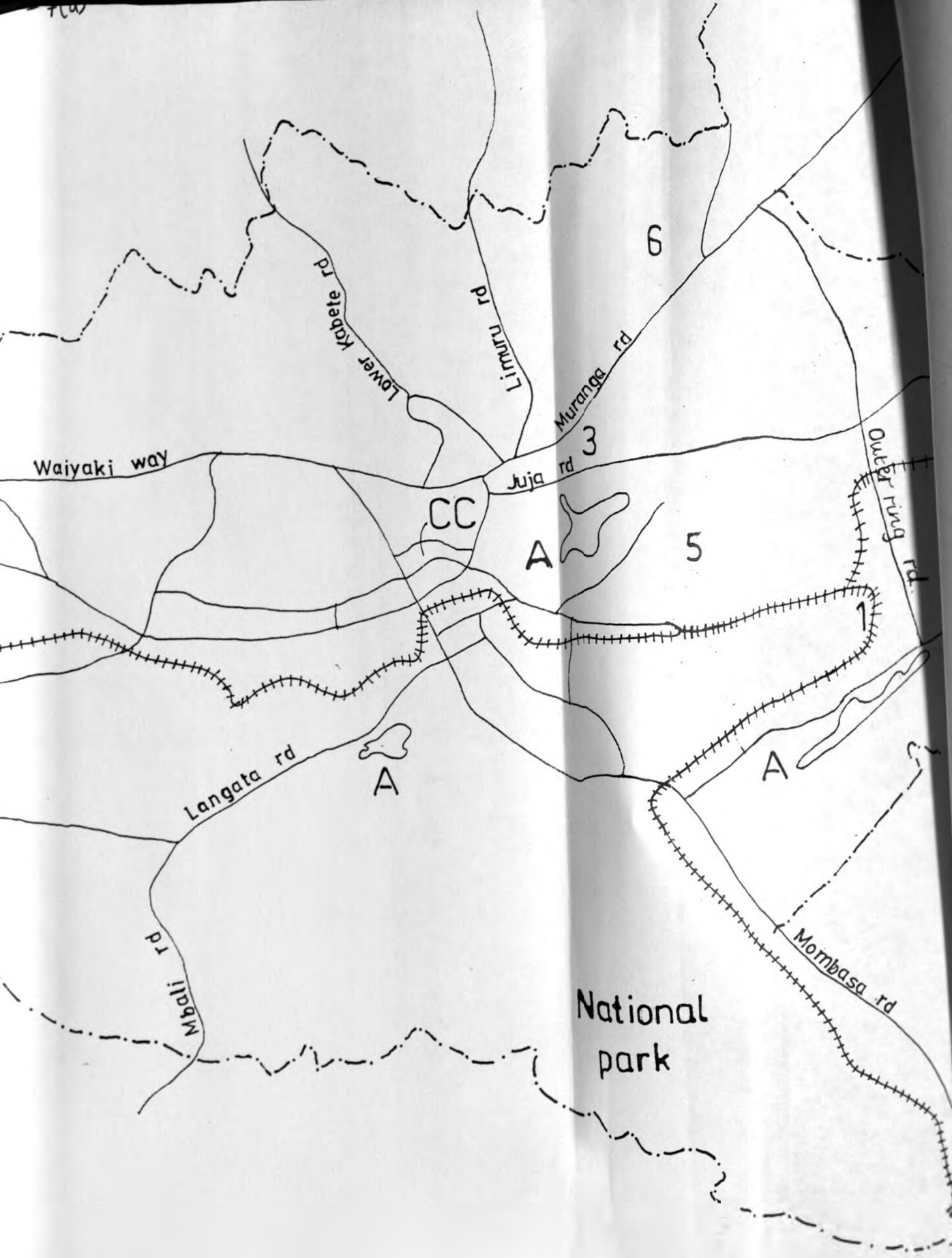
Along the Southern boundary of the site extends a seasonally dry watercourse located in a shallow wide profiled valley. This stream joins with the Nairobi River in the eastern corner of the area. (See Map No.2).

The soil on the site is predominantly black cotton.

The Dandora residential area is divided into 2 Phases, that is Phase 1 and Phase 2. According to the way residential development in the area was carried out, Phase 1 is also called Area 1, and Phase 2 is divided into Area 2, Area 3, Area 4, Area 5 and Area 6. These areas are shown clearly in Map No.2.

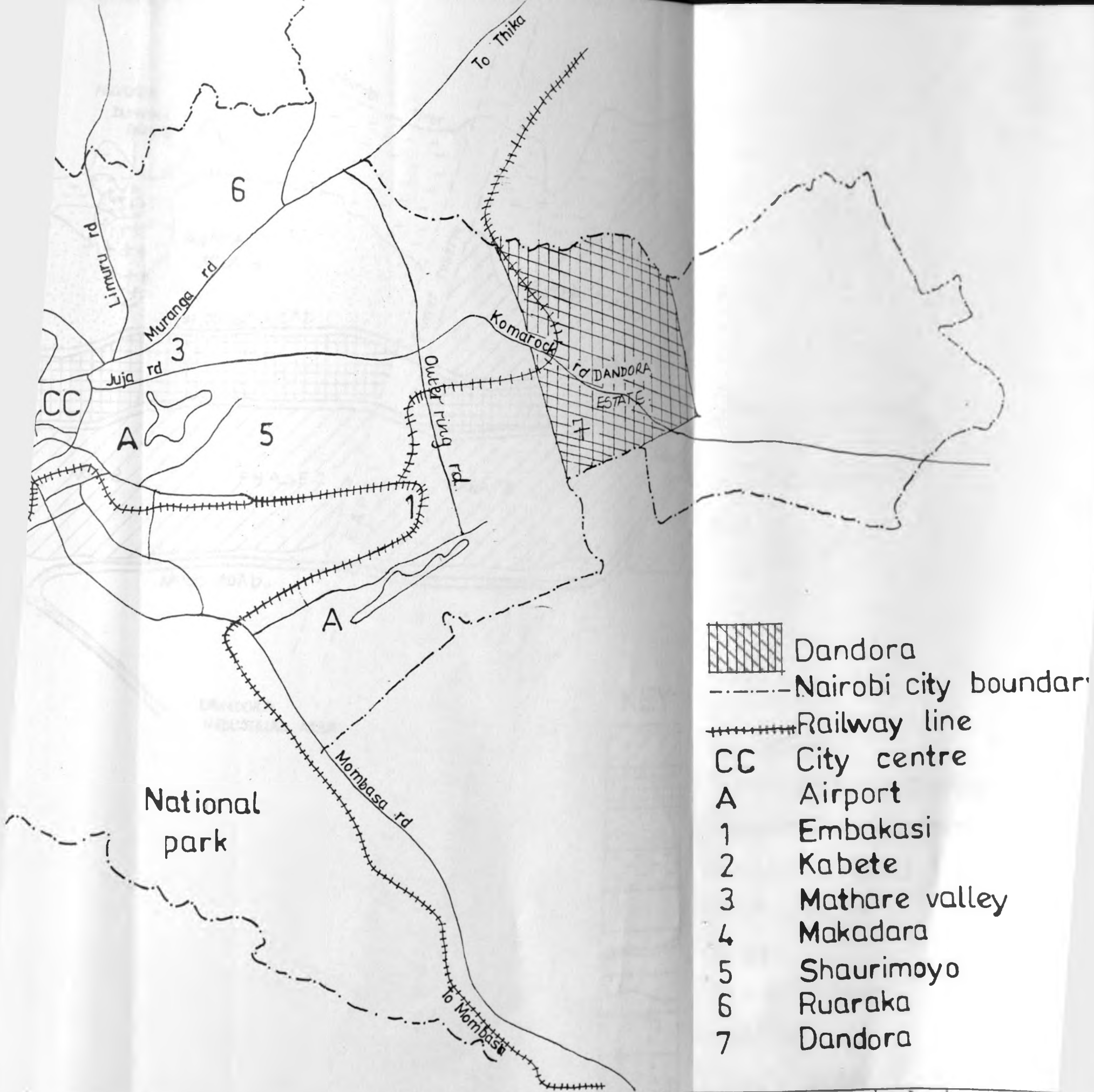
For purposes of division of the area of study, the researcher used these areas as the divisions.




As can be seen from Map No.2, Area 2 is closed to the tipping site. Area 6 is also close to the tipping site; however, residential development has never began in Area 6.

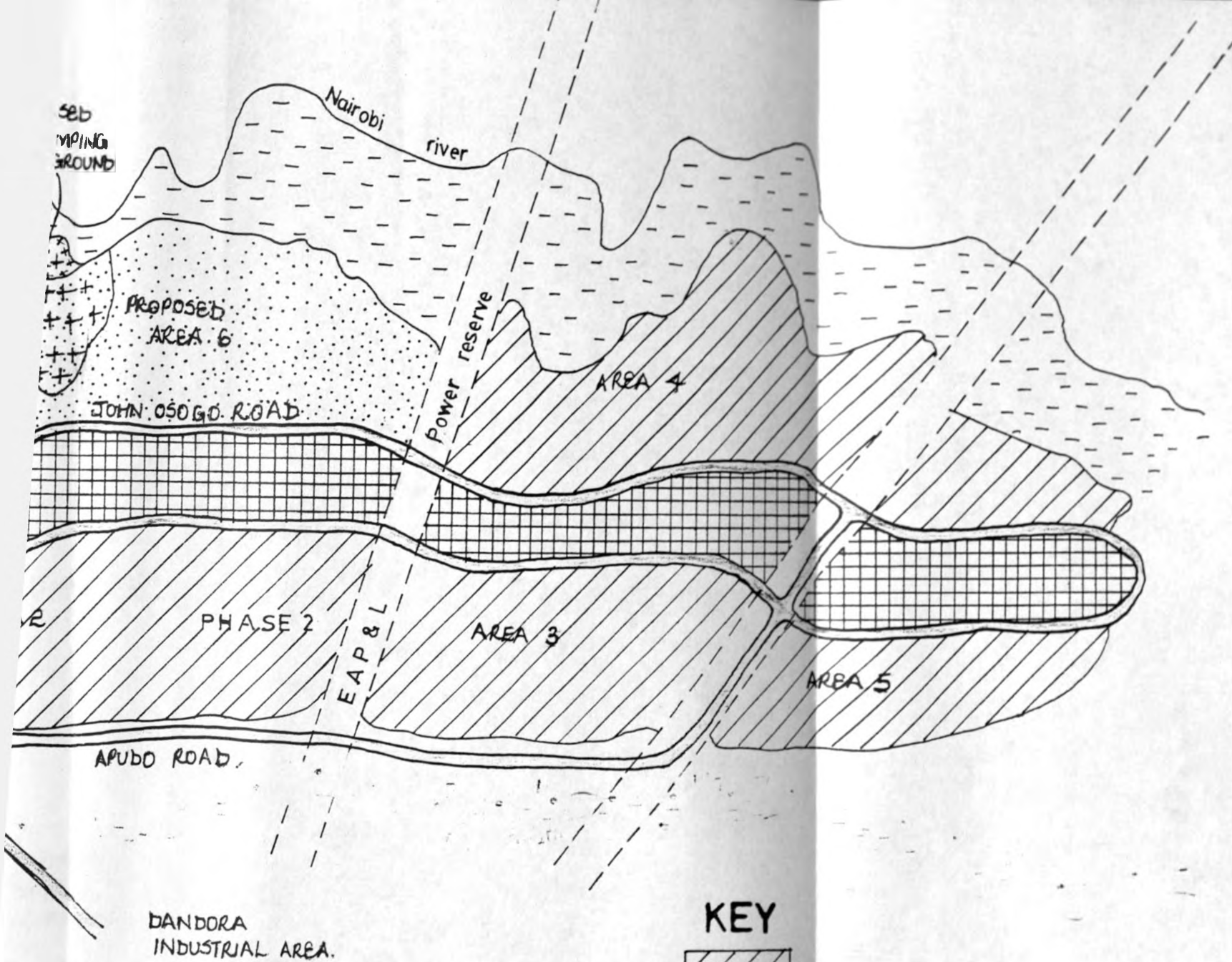


OF NAIROBI SHOWING THE

ANDORA AREA



- | | |
|---|-------------------------|
|  | Dandora |
|  | Nairobi city boundaries |
|  | Railway line |
| CC | City centre |
| A | Airport |
| 1 | Embakasi |
| 2 | Kabete |
| 3 | Mathare valley |
| 4 | Makadara |
| 5 | Shaurimoyo |
| 6 | Ruaraka |
| 7 | Dandora |



KEY

	Residential
	Community activities
	Future development
	Unusable land
	Open space
	Roads
	Trunk sewer
	Quarry
	Study area



1.5 RESEARCH METHODOLOGY

This study used both primary and secondary data.

1.5.0 Data Collection

Primary data was collected through personal observation, questionnaires, interviews and discussions.

(a) Personal Observation

Visual observations of the dumping ground and its environs were carried out. The condition of the buildings adjacent to the dumping ground was recorded in a checklist. The following elements of the structures were examined in each building.

- . roof
- . walls
- . floors

Photographs of these building structures and of the dumping ground were also taken.

(b) Questionnaires

Two sets of questionnaires were administered:

- (i) To the residents
- (ii) To Nairobi City Council Cleansing Officers.

In order to sample out the residents to whom questionnaires would be administered, stratified sampling was used. The residential area of Dandora is divided into five areas. Random samples of eight residents were taken from each area.

The questionnaires administered to these residents were self-administered questionnaires with structured questions. These questions were mainly closed questions with open-ended questions to cover any alternative not include in the alternatives presented.

A similar format was used in the questionnaires to the Nairobi City Council Officers but more open questions were included.

Interviews

Face to face oral interviews were conducted with eight schoolteachers and two doctors of Dandora.

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Interviews

Face to face oral interviews were conducted with eight schoolteachers and two doctors of Dandora.

They were asked to give the views as to the social and physiological impact of the dumping ground.

1.5.1 Secondary Data Collection

Secondary data relevant to the research topic was collected from libraries and institutions. Both published and unpublished literature proved useful. Collections or publications by University of Nairobi libraries, United Nations Environment Programme (U.N.E.P.) and Ministry of Environment and Natural Resources were very important in building a secondary data base.

1.6 Data Analysis

The data collected using these methods was presented in various ways, but descriptive statistics were most commonly used.

To test the hypothesis the following methods were used by the researcher:

- (i) Descriptive statistics in particular percentages were used along with tables in order to test all the four aspects of the hypothesis.
- (ii) To test the effect on the building structures, Chi Square (χ^2) test was used in addition to (i) above.

Qualitative analytical techniques were also used. These include photographs and descriptions in prose form.

1.7 SIGNIFICANCE OF THE STUDY

Many scholars have gathered information on the problem of garbage collection, storage and disposal but have not distinguished the environmental impact of these problems. They have mainly dealt with the management aspects of garbage collection, storage and disposal.

This study will, therefore, help get information which has been left out and will form a source of information on environmental impact of waste disposal in residential areas.

This research will also form a good base for data in the subject in future for reference by students as it will be placed in the library.

1.8 **Footnotes:**

1. James Waititu, 'The garbage watchtower', The Standard (Tuesday, November 1, 1994), p.15
2. Isaac Vuni, 'Garbage Litters Kawangware', Kenya Times. (Wednesday, October 12, 1994).
3. NATION Correspondent, 'Garbage mounds litter City estates', Daily Nation (Thursday, January 5, 1995).
4. Michael N. Mbugua, Refuse Collection & Disposal in City of Nairobi. Investigation Report. Thesis U.O.N. 1970-80.
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6. P.C.N. Muthaura, Refuse Storage, Collection and Disposal within Meru Municipality. An Investigation Report. Thesis U.O.N. 1990.
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CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

Many of the studies that have been done have been to try and establish ways of managing refuse collection and disposal and making it more efficient. There is, however, scarcity of literature on the impact this poor and inefficient refuse disposal has on the environmental quality.

Pollution is a phenomenon that has received public attention. Newspapers, magazines and television have brought the evidence sharply into focus. The dumping of wastes into the air, water or land in such quantities that the processes of nature can no longer handle them is a good initial definition of pollution.

Ronald Abler (1977) stated that:

"The community at large suffers when unnecessary congestion and pollution are concentrated at one point."¹

This argument reviews one of the problems of the study addresses itself to in Dandora that of the pollution and the effect it has on the society.

The American Institute of Real Estate Appraisers' "Real Estate Appraising" textbook makes the following points on the impact of such things as air pollution on a residential neighbourhood:

"A neighbourhood's exposure to odors, smoke, dust and noise from commercial or manufacturing enterprises limits its desirability. The physical presence of a nuisance depreciates the value of a home"

There are certain housing needs required by man. These needs include physical needs, that is, the need for shelter, physiological needs that include sanitary quality and the avoidance of unsanitary conditions in the vicinity of the dwelling, and psychological needs which include the provision of possible aesthetics in the home and its surroundings.

It is contended that the presence of a refuse disposal site adjacent to a residential area affects both the physiological needs and the psychological housing needs of man.

Nourse (1973)² notes that the amenities that make a house desirable are absence of noise and dirt

Fitzsimmons et al (1975)³ argue that many families are especially concerned that they are able to live in a clean, accessible and attractive area. They go on to say that pollution, in addition to legal and economic costs, has social costs.

U.N.E.P. (1979)⁴ states that there is an ongoing environmental degradation causing deterioration in the quality of life now and in the future.

The impact of waste disposal on the environment can also be seen as a form of degradation of natural resources.

Sewell (1975)⁵ states that wastes should be minimized by regarding all depletable resources as more valuable than the market price would indicate, and we should recycle wastes whenever the cost is reasonable.

Bidwell (1989)⁶ calls for a flexible system of control, environmental planning as a priority emphasis on waste management.

Sewell⁷ op.cit states that solid wastes that are mishandled or not handled .. can harbor disease - carrying agents, become air and water pollutants, and pose serious safety hazards both for the general public and for professionals engaged in waste collection and processing.

Food wastes offer an attractive food source for insects and rodents. The Public Health Service (U.S.A.) has identified 22 human diseases that can be associated with solid wastes. For example, typhoid fever, cholera, various diarrhoeas, dysentery, anthrax, trachoma, plague and trichinosis.

This was reinforced by the WHO Expert Committee 1971. They stated that: "Solid wastes management is an important facet of environmental hygiene and needs to be integrated with total environmental planning. Its storage, collection, treatment and disposal can lead to short-term risks; in the long term, there may be dangers arising particularly from the chemical pollution of water supplies."

This touches on part of the area of this study, that is the physiological problems and the pollution problems that have arisen due to the dumping of wastes at Dandora.

This study also addresses itself to the problem of dereliction of land.

According to Sewell⁸ *ibid.*, solid wastes from private individuals, municipalities and established industries are a visible and durable blight upon our landscape. He goes on to state that wastes are "out of place", a form of scenic pollution.

A report on the control of pollution entitled "Pollution : Nuisance or Nemesis"⁹ stated that local authority rubbish tips are a form of dereliction.⁹

Sewell¹⁰ *op.cit.* also stated that open dumps used by municipalities contrary to accepted rules of public health and aesthetics provide eyesores and odors for nearby citizens.

This literature review provides teachings from which the environmental impact of poor refuse disposal can be studied. From these lessons in this literature review, the environmental impact to be studied can be classified under the following headings:

1. Economic impact.
2. Physiological impact.
3. Sociological impact.
4. Technological impact.

2.1.0 ECONOMIC IMPACT

When assessing economic impact one should consider resources. According to Jain et al (1981)¹¹ natural resources include the land, air, water, vegetation, animal and mineral resources which constitute our natural environment, and provide the raw materials and spatial settings which are utilized in developing our familiar man-modified environment.

They go on further to state that aesthetics is an environmental attribute which may be thought of as a resource.

They also say that any activity that alters the quality or distinguishable characteristic of the perceived environment can be considered as having an effect on aesthetics.

In this case study of Dandora residential area, the dumping ground has altered the quality of the environment. In particular, visual perception and smell have been affected by the presence of the dumping ground in the area.

Air is one of the primary resources. When emissions and unfavourable climatic conditions interact to create undesirable air quality, the atmospheric environment may begin to exert adverse effects on man and his surroundings. Great care must be exercised when assessing and maintaining the quality of resources.

Therefore, dumping of wastes at Dandora leads to depletion of air which is an important natural resource.

According to Jain et al¹² *ibid.*, malodors frequently cause loss of personal and community pride, loss of social and economic status, discomfort, nausea, loss of appetite and insomnia.

They argue further that malodors can affect both health and welfare of a community. These effects, they say, result from the loss of personal and community pride, reducing appetite, producing nausea and vomiting, causing headache and disturbing sleep, breathing and olfactory sensation.

They state the secondary effects of malodors as lowering of socioeconomic status, damaging community reputation and discouraging capital investment in a community.

As can be seen, all these aspects affect the welfare of a community. The production of malodors from the wastes at Dandora thus affects the welfare of that community negatively.

Jain et al¹³ *ibid.* also point out that the value of structures is an indicator of change in the stock or quantity of resources such as buildings which are used in the conduct of man's social and economic activities.

From this point it can be inferred that the value of the buildings in Dandora is an important measure of the resources in the areas.

2.1.1. PHYSIOLOGICAL IMPACT

This deals with the impact on the health of the people. There are several health problems associated with refuse.

The main source of food for rats and other small rodents is refuse, and in rubbish dumps they quickly proliferate and spread to neighbouring houses. The diseases for which rats may be a reservoir make a horrifying list : 'plague, murine typhus, leptospirosis, histoplasmosis, rat-bite fever, salmonellosis, tularaemia, trichinosis and many other diseases' (WHO Expert Committee, 1971)

A survey in India (Central Public Health Engineering Institute, 1973) showed that at Bhopal, up to half the samples of refuse in the slum and poor quarters and at the disposal site contained roundworm ova. These roundworms are detrimental to peoples' health.

Flies which are disease carriers thrive on food wastes and in the U.S.A. 90% of the housefly population in cities breed in open garbage cans (Wilson, 1974).

According to Feachem et al (1978)¹⁴ refuse dumped on the ground results in infestation with fly eggs and larvae which have been found up to 50mm below the surface.

Mosquitoes, which spread malaria are also commonly found in dumping grounds. Feachem et al (1978)¹⁵ *ibid.* state that scrap tyres are a particular danger in the tropics as they can contain water which is a good breeding ground for mosquitoes; these mosquitoes can also find as good a place in empty tin cans or jam jars.

Table I. Examples of environmental health factors and related disease agents, exposure, and risk groups solid wastes improperly disposed.

Factors and their effects:

- (i) inert materials such as stone, glass and metal (injury hazard).
- (ii) toxic materials (human ingestion through water or food).
- (iii) organic fermentation products (favours growth of pathogens).
- (iv) food residues (increase population of disease animal vectors, for example flies, rats).

Exposure

- (i) contact with disease vectors.
- (ii) contact with toxic materials.
- (iii) consuming contaminated food or water.

Risk groups:

- (i) children playing on discharge sites.
- (ii) garbage collection workers.
- (iii) consumers of water from aquifers contaminated by leachate.
- (iv) people within dispersal range of vectors.

Source : Peter Wathern, Environmental Impact Assessment. (Unwin Hyman London, 1988), p.267.

2.1.2 SOCIAL IMPACT

When considering the environmental impact of waste disposal, a social assessment must also be considered.

Any assessment which purports to be "social" in its character must deal with man in social terms. A meaningful assessment must refer not only to economic indicators but also to questions of man's social relationships, personal life style, and the culture in which she/he lives.

An area of special concern that deals with social impacts has to do with attitudes held by individuals. Attitudes are complex and have various dimensions -- emotional, intellectual, ethical and so on. They vary markedly according to the groups to which one belongs, one's personal views about life, experiences and goals.

According to Fitzsimmons et al,¹⁶ they said that when considering social impact, one has to look at the social effects. One social effect is the effects on the general quality of the life of the people.

Quality of life refers to the overall nature of impacts on the individual and his/her family and to the effects which such changes, in turn, may have on the individual's perception of the opportunities for personal and family development.

A national study conducted by the Environmental Protection Agency in connection with work on the meaning of quality of life suggested that a variety of social goals exist for individuals and families which can be important in the quality of life. Among these are: good health, decent home and neighbourhood, peace of mind,

Johnston (1973)¹⁷ said that besides its practical use, housing also acts as a principal means of 'socio-economic status display'. He goes on further to say that in an anonymous urban society, where the individual's personal identity is unknown outside an immediate social circle, the dwelling place assumes immense significance as a public badge of worth, a means of status affirmation.

Cater and Jones (199)¹⁸ stated that the dwelling place is conceived to exert a profound influence on the well-being and life chances of its occupants. They go on to argue that a home in a deteriorating area is likely to inflict on its occupants a range of physical dangers, psychological stresses, health hazards and social disadvantages. In effect, it extorts a 'psychic' penalty, undermining self worth and heightening feelings of social rejection.

Herbert (1982)¹⁹ argued that crime concentrations are localized within neighbourhoods which give little material, financial or psychological satisfaction.

These arguments review one of the problems this study addresses itself to in Dandora, that of the presence of a dumping ground in the residential area and the social effects it has on the people due to the fact that its presence causes deterioration of the residential area.

2.1.3 TECHNOLOGICAL IMPACT

In this study the technological impact is geared to mean the impact on the building materials and structures.

It is known that air pollution has an effect on building structures. Otieno A.O. (1988)²⁰ in his study found that the poor state of building structures in Nang'eni and Sango in Webuye is a direct result of the air pollution activities of the Pan African Paper Mills.

Burning enormous amount of coal generates vast amounts of polluting gases. The polluting gases contribute towards the production of acid rain. Elsworth²¹ states that there are several different ways in which acid rain occurs, and diverse pathways through which it affects the environment. He went on further to say that acid rain corrodes stone and other materials

According to Petts and Eduljee (1994)²², air pollution can affect a range of materials and structures. Acid gases such as sulphur dioxide attack buildings and monuments, by converting the insoluble calcium carbonate to calcium sulphate causing crumbling of the structure. Materials can be damaged through physical and chemical attack. They go on further to say that electrochemical corrosion and both direct and indirect chemical attack can occur when the pollutant acts in combination with moisture.

1. To minimize the damage caused by acid rain, the following guidelines should apply:
- 1.1. Use of acid resistant materials for the construction of buildings and structures.
 - 1.2. Use of acid resistant materials for the construction of monuments and structures.
 - 1.3. Use of acid resistant materials for the construction of monuments and structures.
 - 1.4. Use of acid resistant materials for the construction of monuments and structures.
 - 1.5. Use of acid resistant materials for the construction of monuments and structures.
 - 1.6. Use of acid resistant materials for the construction of monuments and structures.
 - 1.7. Use of acid resistant materials for the construction of monuments and structures.
 - 1.8. Use of acid resistant materials for the construction of monuments and structures.
 - 1.9. Use of acid resistant materials for the construction of monuments and structures.
 - 1.10. Use of acid resistant materials for the construction of monuments and structures.

²¹ Elsworth, R. (1994) The Physical and Chemical Aspects of Acid Rain, Department of the Environment, London.

2.2. METHODS OF REFUSE DISPOSAL.

According to Skitt (1972)²³, there are two basic methods of disposal, incineration and controlled tipping.

2.2.0 CONTROLLED TIPPING

Controlled tipping is the term used for the disposal of refuse and other wastes on land, using certain recognized principles to prevent nuisances and achieve more even compaction than would be the case with uncontrolled dumping. Basically, it consists of tipping in shallow layers and covering with material suitable for producing an air seal, for example, soil.

A report of the Working Party on Refuse Disposal, Department of the Environment, H.M.S.O. 1971 stated inter alia that in general, tipping should not approach nearer than 183m from the curtilage of any residential development.

In terms of the tipping process alone, controlled tipping is acknowledged to be the cheapest method of refuse disposal. It is probably the oldest method of refuse disposal used by man and is still the one which is in most common use amongst local authorities in this country.

Site Selection and Preparation

In selection of an ideal site the following conditions should apply:

1. It should be so situated as to give the minimum length of haul for refuse collection vehicles.
2. It should be free from water, either static or running.
3. It should not be nearer than 183m to any dwellings.
4. It should have good access with good fast roads nearby.
5. It should have all the main services readily available.
6. Covering material should be available on the site or from nearby sources.
7. The prevailing wind should blow away from the nearest dwellings.
8. It should be large enough to provide a tipping life which would economically justify the provision of a weigh bridge and semi-permanent site buildings.
9. The tipping site(s) already in use and those in the pipeline should give tipping for at least 25 years.

In search for sites, an investigation of the whole area with the aid of the relevant planning officers must be undertaken.

2.2.1 SANITARY LANDFILL

In the U.S.A., the technique of refuse disposal known as sanitary landfill has been developed. This can take any of the following three forms:

- (a) the area method which is very similar to the method of controlled tipping in that refuse is tipped in layers, compacted and then covered,
- (b) the trench method which is to dig a trench, tip the refuse into it, spread it in thin layers and compact it with a bulldozer or similar equipment and cover it with the earth which is being excavated from a future trench.
- (c) the ramp or slope method, which is used on an existing slope and cover with earth which has been excavated from the ground ahead of the tip face.

In each of these methods all the compacting is done by the use of a bulldozer or some similar machine as the refuse is tipped ahead of the face and, after being placed in position, crushed by the compacting equipment.

Salvator (1972)²⁴ gives a summary of recommended operating practices for a sanitary landfill as follows:

1. The sanitary landfill should be planned as an engineering project, operated and maintained by qualified personnel under technical direction, without causing air or water pollution, health hazards or nuisance conditions.
2. The face of the working fill should be kept as narrow as is consistent with the proper operation of trucks and equipment in order that the area of exposed waste material be kept to a minimum.
3. All refuse should be spread as dumped and compacted into 30 to 45cm thick layers as it is hauled in.
4. All exposed refuse should be covered with 15cm earth at the end of each day's operation.
5. Control of dust, wind-blown paper and access roads should be maintained. Portable fencing and prompt policing of the area each day after refuse is dumped are necessary. Design the operation, if possible, so that it is not visible from nearby highways or residential areas.

6. Salvaging, if permitted by the operator of the refuse disposal area, should be conducted in such a manner as not to create a nuisance or interfere with operation. Salvaging is not recommend at the site.
7. Sufficient equipment and personnel should be provided for the digging, compacting and covering of refuse. Daily records should be kept, including type and amount of solid wastes received.
8. The breeding of rats, flies and other vermin; release of smoke and odors; pollution of surface waters and groundwaters; and causes of fire hazards are prevented by proper operation, through compaction of refuse in 30 to 45cm layers, daily covering with earth, proper surface water and ground water drainage and good supervision.

2.2.2 INCINERATION.

Incineration is a controlled combustion process for burning solid, liquid or gaseous combustible waste to gases and a residue containing little or no combustible material when properly carried out. It is a volume reduction process suitable for about 70% of the municipal solid waters.

A properly designed and controlled incinerator is satisfactory for burning combustible refuse provided air pollution standards can be met. Continuous operation six or seven days a week and a high controlled temperature are needed for efficiency, prevention of excessive air pollution and odor control.

An operating design temperature range of 1500 to 1800°F is generally recommended. Incinerators generally are not economically feasible for communities of less than 50,000 to 100,000 population. Supplemental air pollution control equipment is required on all incinerators. Additional fuel is needed when 30% or less of the refuse is rubbish or when the refuse contains more than 50% moisture.

Salvator *ibid.*²⁵ goes on to give certain guidelines as to site selection, plant layout and building design:

1. Public acceptance in relation to the surrounding land use and precautions to be taken in location and design to offset public objections should be considerations.
2. Site suitability in reference to foundation requirements, prevailing winds, topography, surface water and groundwater, floods, adjacent land uses and availability of utilities should be considered.

3. Plant layout should be arranged to facilitate tasks to be performed and provide for adequate space, one-way traffic, equipment maintenance and storage.
4. Building design should be attractive and provide adequate toilets, showers, control room laboratory, administrative offices, adequate lighting and good landscaping.
5. The proposed method and cost of handling bulky and nonincinerable wastes should be taken into consideration when incineration is proposed.

It is extremely important that a careful investigation be made of these social, physical and economic factors involved when incineration is proposed.

Despite these two methods discussed, Salvator goes ahead and mentions other methods of solid waste disposal. These methods are:

1. Open dump.
2. Hog feeding.
3. Grinding.
4. Disposal at sea.
5. Garbage reduction
6. Composting.
7. Pyrolization.

2.2.3 OPEN DUMP

The open dump is all too common and needs no explanation. It is never satisfactory, as usually unmaintained. Refuse is generally spread over a large area, providing a source of food and harborage for rats, flies and other vermin. It is unsightly, an odor and smoke nuisance, a fire hazard, and often a cause of water pollution. It should be eliminated or its operation changed to a sanitary landfill.

2.2.4 HOG FEEDING

This is where garbage is fed to hogs, and careful supervision is necessary. The spread of trichinosis to man, hog cholera, the virus of foot-and-mouth disease and vesicular exanthema in swine is encouraged when uncooked garbage is fed to hogs. In some instances, tuberculosis, swine erysipelas, and stomatitis many also be spread by raw garbage. The boiling for 30 mins. of all garbage fed to hogs will prevent transmission of trichinosis and economic loss to the swine industry due to hog illness and death. For hog feeding to be satisfactory (in addition to the cooking of garbage) it

is necessary to rat-proof concrete feeding platforms and structures; remove manure and left over waste daily; dispose of the waste by sanitary landfill or incinerate or compost the waste; clean the hog pens and flush the feeding platforms and troughs frequently. Wastewater should discharge to a disposal system that will not pollute receiving waters or become a nuisance. More often than not, these precautions are neglected, as a result fly and rat breeding is supported and bad odors are common.

2.2.5 GRINDING

The grinding of garbage is another method of garbage disposal. It is highly recommended from a convenience and public health standpoint, but the disposal of other refuse remains to be handled. The putrescible matter is promptly removed, thereby eliminating this as a source of odors and food for rats, flies and other vermin.

In one system, the home grinder is connected to the kitchen-sink drain. Garbage is shredded into small particles while being mixed with water and is discharged to the house sewer. In another system garbage is collected as before but dumped into large, centrally located garbage-grinding stations that discharge garbage to the municipal sewerage system. In small communities, the garbage-grinding station may be located at the sewage treatment plant. The strength of the sewage is increased and additional sludge digestion and drying facilities will be required when a large amount of garbage is handled.

2.2.6 DISPOSAL AT SEA

Where dumping at sea is practiced, all garbage and other refuse is dumped into large garbage scows or barges. The scows are towed by tugs and the garbage is taken out to sea and dumped a sufficient distance out to prevent the refuse being carried back to shore and causing a nuisance. Bad weather conditions hamper this operation and unless this method is kept under very careful surveillance, abuses and failures will result. Because of the cost of maintaining a small navy and difficulty in satisfactorily carrying out this operation, coastal cities have reverted to sanitary landfill and incineration.

Research is needed to determine stability of compacted refuse and effect on marine life.

2.2.7 GARBAGE REDUCTION

In the reduction method of garbage disposal, the garbage is cooked under pressure. Fats melt out and are separated from the remaining material. The fat is used in the manufacture of soaps or glycerines and the residue is dried, ground and sold for fertilizer or cattle feed.

Odor complaints are associated with this process and, where a solvent such as naphtha is used to increase the extraction of fat, a greater fire hazard exists. The use of synthetic detergents and chemical fertilizers and high operating costs have led to the abandonment of this process.

2.2.8 COMPOSTING

Composting is the controlled decay of organic matter in a warm, moist environment by the action of bacteria, fungi, molds and other organisms. This may be an aerobic and/or anaerobic operation. Moisture is maintained at 40 to 65%; 50 to 60% is best. Composition of the refuse, disposal of refuse not composted, demand for compost and salvaged material, odor production and control, public acceptance and total cost are factors to be carefully weighed. Compost is a good soil conditioner but a poor fertilizer.

The composting operation involves a combination of steps. These may include:

1. Weighing.
2. Separation of noncompostables and salvage by hand and by a magnetic separator.
3. Size reduction to 5cm or less by means of a shredder, grinder, chipper, rasp mill, hammer mill.
4. Ballistic and magnetic separation.
5. Biological digestion.
6. Screening and possible standardization of fertilizer value.
7. Disposal by bagging for sale or transporting to a sanitary landfill.

The Beccari method of garbage treatment has been used in Europe for many years. The garbage is placed in tightly sealed tanks and allowed to digest 10 days without air then 10 to 20 days in the presence of air. Drainage from the garbage is collected at the bottom of the tank and is re-circulated back over the garbage if necessary to keep it moist. The digested residue is relatively stable.

Naturizer composting uses sorting, grinding and mixing, primary and secondary composting including three grinding operations, aeration and screening. Digested sewage sludge, raw sewage sludge, water or segregated wet garbage is added at the first grinding for dust and moisture control. The total operation takes place in one building in about 6 days.

2.2.9 PYROLIZATION

Pyrolization as applied to solid wastes (metal and glass removed) is an experimental thermochemical process for conversion of complex organic solids, in the absence of added oxygen, to water, combustible gases, tarry liquids and a stable residue. Intermediate products may be collected or may be used to contribute heat to support the process.

The end products would be carbon, water and carbon dioxide if carried to completion. If the raw material contains sulphur and nitrogen, these oxides will be formed with resultant air pollution unless provision is made for their removal. Temperatures of 900° to 1700°F have been used. In a variation, some oxygen and a temperature of up to 2100°F is used.

It is a process of destructive distillation similar to that used for making charcoal and for the recovery of organic by-products such as turpentine, acetic acid and methanol from wood.

2.3 CLASSIFICATION OF REFUSE MATERIALS

The American Public Works Association (1966)²⁶ classified refuse materials as follows:

2.3.0 GARBAGE

Garbage is the animal and vegetable waste resulting from the handling, preparation, cooking and serving of foods. It is composed largely of putrescible organic matter and its natural moisture content. The term garbage does not include food-processing wastes from canneries, slaughterhouses, packing plants or similar industries; large quantities of condemned food products. Garbage originates primarily in home kitchens, stores, markets, restaurants, hotels and other places where food is stored, prepared or served.

Garbage decomposes rapidly, particularly in warm weather and may soon produce disagreeable odors.

2.3.1 MARKET REFUSE

Market refuse comes from wholesale and retail stores and markets as a result of the handling, storage and selling of foods. It originates principally in poultry, fish, meat, vegetable and fruit markets, and includes large quantities of putrescible garbage along with some rubbish such as wooden crates and cardboard boxes.

2.3.2 RUBBISH

Rubbish consists of a variety of both combustible and non-combustible solid waste materials from households, stores and institutions. This waste is defined more specifically as "combustible rubbish" and "non-combustible rubbish", but whenever the term "rubbish" is used alone, it means a combination of combustible and non-combustible rubbish. When other materials such as garbage or ashes are collected with rubbish, the mixture should then be designated as "combined" refuse.

2.3.3 ASHES

Ashes are the residue from the burning of wood, coal, coke and other combustible material in homes, stores, institutions and small industrial establishments for the purposes of heating, cooking and disposing of waste combustible material.

2.3.4 BULKY WASTES

Bulky wastes are large items of refuse such as appliances, furniture, large auto parts, trees and branches, stumps and so on. These may be generated in residential or commercial areas, on public property such as parks, streets, alleys and beaches, or they may be abandoned on vacant lots.

2.3.5 STREET REFUSE

Street refuse is material picked up by manual and mechanical sweeping of streets and sidewalks and litter from public litter. It includes dirt, leaves, paper and the like.

2.3.6 DEAD ANIMALS

As a class of urban refuse, dead animals are those that die naturally or from disease or are accidentally killed. Condemned animals or parts of animals from slaughterhouses or similar places are not included in this term, but are regarded as industrial refuse.

2.3.7 ABANDONED VEHICLES

This class of refuse includes passenger automobiles and trucks that are no longer useful as such and have been left on city streets and in other public places. Usually they are found stripped of tyres, wheels, lights and other easily salvaged parts.

2.3.8 CONSTRUCTION AND DEMOLITION WASTES

Construction and demolition wastes are the waste building materials and rubble resulting from construction, remodeling, repair and demolition operations on houses, commercial buildings, pavements and other structures. They comprise a great variety of rejected matter, such as excavated earth, stones, concrete, bricks, plaster, roofing and wastes from installation or demolition of plumbing, heating and electrical systems.

2.3.9 INDUSTRIAL REFUSE

Industrial refuse consists of the solid waste materials from factories, processing plants and other manufacturing enterprises. It is usually of a special character, peculiar to a specific industry, and its removal should be the responsibility of the industry. Refuse of this class may include putrescible garbage from food-processing plants and slaughterhouses; condemned foods; and miscellaneous manufacturing wastes.

Because putrescible industrial refuse may cause serious nuisances and even endanger public health, its storage, hauling and disposition should be subject to municipal control.

2.3.10 SPECIAL WASTES

Special wastes are defined as hazardous wastes by reason of their pathological, explosive, radioactive or toxic nature. They require very careful handling and disposal to render them innocuous or safe from human and animal contact for an adequate decay period. These are mainly solid wastes or liquids in containers, generally explosive or highly flammable in nature, which should be carefully segregated at the source or at the time of pickup. They present hazards to collectors and may cause dangerous explosions or flash fires at incinerators, grinding plants, sanitary landfills or refuse dumps.

2.3.11 ANIMAL AND AGRICULTURE WASTES

Agricultural wastes are principally the manures and crop residues from various agricultural pursuits, including dairying and the raising of livestock and poultry.

Animals wastes include, in addition to those mentioned above, wastes from stables, kennels, pet pens, chicken coops, veterinary establishments and the like. These wastes are often public health and nuisance problems.

2.3.12 SEWAGE TREATMENT RESIDUES

These wastes consist of coarse screenings, grit and dewatered or airdried sludge from sewage treatment plants, and dumpings of cesspool or septic tank sludges which require disposal with municipal solid wastes.

2.4 DEFINITION OF TERMS

1 Environmental Impact Assessment

This term is applied to the identification, description and assessment of the direct and indirect effects of a project on: human beings, fauna and flora; soil, water, air, climate and the landscape; the interaction of these factors; and on material assets, and the cultural heritage.

2 Waste

The word waste refers to the useless, unwanted or discarded materials resulting from normal community activities. Wastes include solids, liquids and gases.

3. Refuse

Solid wastes are classed as refuse. Refuse actually comprises all of the solid wastes of the community. It also includes semi-liquid or wet wastes with insufficient moisture and other liquid contents to be free-flowing.

4 Garbage

This is the animal and vegetable waste resulting from the handling, preparation, cooking and serving of foods.

5 Social Impacts

This is defined as those changes in social structures or behaviours which are forecasted to occur as a direct or indirect result of implementing a plan. Where social behaviour reflects to the individual's ability to mentally function in a normal manner on an interpersonal basis.

6 Physiological Impact

This refers to the effect on anything that is a part of a person's body or that plays a part in a bodily function. It includes both individual parts (organs) and systems, such as the transport, respiratory, circulatory, digestive, skeletal and excretory systems.

7 Psychological Impact

This refers to the impact on the needs of human beings that can be distinguished from the physiological needs, primarily those of emotional stability and security. It refers to the effect of changes in the degree of emotional stability and feelings of security within individuals.

8 Economic Impact

This refers to the effect on economic aspects such as property values and natural resources such as air, land, water and vegetation.

9 Aesthetic Impact

This refers to impacts on the environment which are apprehended through the senses - sight, taste, smell, hearing and touch.

10 Pollution

This is defined as an undesirable change in the physical, chemical or biological characteristics of air, land and water that may or will affect human life or that of other desirable species or industrial processes, living condition and cultural aspects, or that may or will waste, or deteriorate the quality of our resources.

11 Technological Impact

This is the impact on those aspects of technology, for example, building structures.

2.5 **SUMMARY**

It can be appreciated from this Chapter that assessment of environmental impact of waste disposal is complex. It requires a large and broad spectrum of knowledge ranging from economics, physiology, sociology and technical knowledge.

This Chapter has dealt in detail with various aspects of environmental impacts, methods of refuse disposal, classification of refuse materials and lastly, gives definitions of the terms used. The next two Chapters try to gauge the impacts of poor refuse disposal in the Dandora residential area. The method of refuse disposal practiced at the Dandora tipping site will be assessed to see whether it conforms to the professionally acceptable policies or controlled tipping or sanitary landfill as discussed in this Chapter. The resulting environmental impact will also be assessed.

2.6 **Footnotes:**

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CHAPTER THREE

DATA COLLECTION AND ANALYSIS

3.0 HISTORICAL BACKGROUND OF THE STUDY AREA

The history of the Dandora tipping site can be traced back to the year 1984. In this year, the Nairobi City Council Planning Department designated the quarry shown on Map No.2 as a tipping site.

In this year, however, there were several other tipping sites in the Industrial Area, Mathare North, Dagoretti and Langata.

However, by 1989, these tipping sites had ceased their operations. The Industrial Area, Mathare North and Dagoretti sites were all filled up. The Langata site was closed because it was too close to residential developments and, thus, was a nuisance to the public.

Since 1989 up to date, the Dandora tipping site is the only designated area for the whole of the City's solid waste disposal.

1.2 RESEARCH FINDINGS

The following were the objectives of the study :

1. To examine the method of waste disposal at the Dandora tip.
2. To establish the pollutants from this waste disposal.
3. To assess the effects of these pollutants on the environment.
4. To give recommendations as to how environmental degradation arising from this method of waste disposal can be minimized.

1.2.1 THE METHOD OF WASTE DISPOSAL

According to the Assistant Superintendent of the Cleansing Department in the Nairobi City Council, the method of waste disposal supposed to be carried out at Dandora is controlled tipping.

The researcher, however, made the following observations:

As soon as the dump trucks arrive, they are pursued by a herd of scavengers who fall head-on, upon the cascading filth, fighting for the privilege of being first amid the rubbish.

The waste is then tipped from these dump trucks on to the ground. After being tipped on to the ground, the scavengers rammage through it trying to separate the plastics, pieces of glass, bottle tops, steel wires and other items which could be of some considerable value.

The Nairobi City Council bulldozer then spreads the refuse and pushes it to the edge.

About once a month the refuse is set on fire in order to try and 'reduce' it. The refuse is also sprayed occasionally with insecticide.

After observations, the researcher found that this method of waste disposal falls short of the many requirements of controlled tipping. The problems observed were:

1. The tipping site is too close to some dwellings. For example, there are two schools just across the road from the tipping site (see Plate Nos. 10 and 11).
2. The refuse is not covered with an inert material at the end of each day's operation.

3. There is no control of dust and wind-blown paper.
4. There is no fencing round the tipping site. The Assistant Cleansing Superintendent said that there was a fence round the tip but all the fencing materials were vandalized.
5. Salvaging is done at the site, with proper controlled tipping, salvaging should be done away from the site.
6. The equipment is not sufficient for the digging, compacting and covering of refuse. At the moment, there is only ONE bulldozer working on the tip. When this bulldozer breaks down serious problems are experienced because large quantities of accumulated refuse may become nuisances and hazards to health.

The following plate shows the Nairobi City Council bulldozer working on the tipping site.

Plate No. 4



The only bulldozer that works on the tipping site. Air pollution being generated as the bulldozer works on the refuse.

According to the American Public Works Association (1966)¹ four major types of equipment are supposed to be used in operating sanitary landfills or in controlled tipping sites:

1. Track-type tractor that picks up and carries earth.
2. Track-type tractor with bulldozer
3. Dragline.
4. Wheeled-type tractor with bulldozer and scraper.

Therefore, the use of one bulldozer only is highly unsatisfactory.

The following types of waste were observed being disposed at the site:

- (a) **Industrial wastes.**
This is waste from enterprises and includes packaging materials, wool and textiles. Examples of industries that dispose of their waste at the site are Firestone and East Africa Industries.
- (b) **Household garbage.**
This forms the largest component of the waste and is derived from residential neighbourhoods.
It was noted to consist of a large number of elements such as food and garden waste, paper, plastic, cupboard, glass, newspapers and magazines.
- (c) **Institutional waste.**
This included waste from schools, colleges, religious institutions, government offices, universities and EVEN HOSPITALS.

The researcher was alarmed to see syringes mixed with the wastes. Institutional waste was, however, noted to contain large amounts of paper and other light material.

It is important to note, however, that hospital waste forms a threat for the health of the waste pickers and neighbourhood residents when mixed with other types of waste.

- (d) **Commercial Waste.**
This is waste which was seen to emanate from shops, restaurants, hotels, markets and offices.

(e) Street and alley cleanings.

These are also disposed of at the tipping site.

(f) Demolition and construction wastes.

Some sand was observed to have been dumped on the site. However, demolition and construction wastes are dumped very rarely at the site because of their value.

These wastes were observed as being dumped at the site all day long from morning up to evening.

According to the Assistant Cleansing Superintendent, approximately 400 tons of waste is disposed at the site per day.

When the Assistant Cleansing Superintendent was questioned as to why the method of waste disposal employed has fallen far below the required standards of controlled tipping, he said that the Council's most major problem was lack of finance in order to have proper mechanization. He went on further to say that in the 1970's up to early 1980's, there was proper controlled tipping. The City Council had a fleet of tippers, bulldozers and graders then, but they broke down and there was no finance to either repair them or purchase new ones.

When the Assistant Cleansing Superintendent was asked how the medical wastes find their way to the tipping site, he said that this was due to the fact that garbage is dumped by the Nairobi City Council, private collectors and even by individuals at the tipping site, thus the City Council has no way of controlling these wastes.

3.2.1 POLLUTANTS FROM THIS WASTE DISPOSAL

Due to the combine nature of the refuse, it was difficult to establish the polluting elements; however, the following were observed and noted down:

1. **Carbon dioxide.**
This is produced when the refuse is being burnt at the tipping site and when the scavengers burn tyres in order to keep themselves warm.
2. **Methane.**
This is produced from rotting refuse.
3. **Lead.**
This is from batteries and paints.
4. **Arsenic.**
This is from pesticides and some medicines. It is very toxic.
5. **Mercury.**
This is from fungicides and pharmaceuticals.
6. **Sulphide gas.**
This is from burnt garbage.

3.2.2 IMPACT ON THE ENVIRONMENT

During the data collection, forty residents were issued with self-administered questionnaires. In order to sample out the residents, stratified sampling was used. The residential area is divided into five areas. Random samples of eight residents were taken from each area.

The Nairobi City Council Officers were interviewed using questionnaires as well.

Eight schoolteachers and two doctors o Dandora were also interviewed, using face to face oral interviews

3.2.2.1 IMPACT ON AIR

The most obvious impact on air is pollution. The forty residents whom were issued with questionnaires were asked a question as to whether they experience any foul odour around their house. They were also asked to choose from a list of options what they attribute to be the cause of this foul odour (if any).

Table 2 : To show whether the residents experienced foul odour or not in the different areas.

AREA	FOUL ODOUR EXPERIENCED		NO FOUL ODOUR EXPERIENCED	
	NO.	%	NO.	%
1	1	12.5	7	87.5
2	2	75	6	25
3	0	NIL	8	100
4	0	NIL	8	100
5	0	NIL	8	100

Source : Field Survey, 1995.

(The locations of thee areas with respect to the dumping ground is seen in Map No.2)

Only one resident experienced a foul odour round his house in Area 1. He attributed this foul odour to industrial pollution from the nearby factory called EMCO.

In Area 2, 30 out of 40 residents, that is, 75% experienced a foul odour round their houses. They said they attributed this prevailing foul odour to two causes:

1. **Rotting garbage.**
This is illustrated in the Plate below.

Plate No.5.



Part of the tipping site. Heaps and heaps of garbage piled on the land. This garbage is supposed to be covered completely at the end of each day; however, it remains uncovered thereby producing an awful smell.

2. **Smoke from burning waste.** This is illustrated in Plate No.6 and Plate No.7.

Plate No.6.



Huge amounts of smoke polluting the air.

Plate No.7.



The amount of pollution can be seen at the tipping site. Scavengers at work in the background.

The residents were also asked a question as to when is the smell very prevalent. They gave the following answers:

- (i) During the rainy season because the garbage become putrid.
- (ii) When the garbage is being burnt to 'reduce' it.
- (iii) When the scavengers burn tyres to keep themselves warm.

The rest of the 25% of the residents in Area 2 who experience no foul odour live about 1km. away from the dumping ground.

In Areas 3, 4 and 5, the residents experienced no foul odour around their houses. This is attributed to the fact that they are not close to the dumping ground.

The locations of these five areas and their proximity to the dumping ground is clearly illustrated in Map No.2

As can be seen from Map No.2, the residents of Area 2 are closest to the dumping ground and this is why they experience the foul odour the most.

3.2.2.2 IMPACT ON LAND

Out of the forty residents interviewed, thirty-eight, that is, 95%, when asked whether the tipping site is a nuisance to them said Yes because they do not like the constant sight of mounds of garbage.

The following effects were observed:

1. Deterioration of local amenity
The mounds of garbage greatly reduce the aesthetic appeal of the area. The land is not attractive at all.

See Plate No.8 and Plate 9

Plate No. 8.



Unsightly refuse strewn all over the land.

Plate No.9.



The edge of the tipping site showing a large ugly mound of garbage.

2. Occupying valuable space.

The tipping site occupies a lot of valuable land which could otherwise have been used for another purpose like residential or commercial.

The tipping site occupies over 0.5km radius.

Unfortunately, due to lack of proper supervision, the tipping site has spread from its designated area to areas which were designated for residential development. See Map No.2.

The plot owners in Area 6 cannot even develop their plots now because they have been occupied by the tipping site.

3. The vegetation is affected.

One resident who stays about 10 metres away from the tipping site complained that he had tried growing maize on the land next to his house but that maize did not grow.

The researcher thought that this maize had stunted growth most probably due to the numerous gases produced at the tipping site.

	1991	1992
1.000	1.000	1.000
2.000	2.000	2.000
3.000	3.000	3.000
4.000	4.000	4.000
5.000	5.000	5.000
6.000	6.000	6.000
7.000	7.000	7.000
8.000	8.000	8.000
9.000	9.000	9.000
10.000	10.000	10.000

3.2.2.3 IMPACT ON PEOPLE

When considering the impact on people, two aspects were analyzed:

- (a) The effect on the health of the people.
- (b) The effect on the quality of life of the people.

(a) Effects on Health

The forty residents interviewed complained that they suffer regularly from the following ailments.

Table 3 : To show the ailments the residents complained about.

AILMENT	NO. and % of Residents that complained of the ailment	
	NO.	%
Malaria	38	95
Diarrhoea	37	92.5
Nausea	30	75
Coughs	28	70
Vomiting	20	50
Dysentery	5	12.5
Fever	1	2.5
Plague	0	NIL
Cholera	0	NIL

Source : Field Survey, 1995.

One doctor in Area 2 who was asked which is the most common ailment in the area said that a condition known as gastroenteritis was a very common health problem in the area.

He went on further to explain that the signs of this condition included diarrhoea and vomiting. The cause of this he said is contamination of food and water.

According to the second doctor who was approached by the researcher and asked what the common ailments are, said that malaria was a very common ailment. He also concurred with the first doctor's view that diarrhoea was very common and that it occurs due to contamination. This doctor said that malaria was very common most probably because the tipping site provides a very good breeding ground for them. The mosquitoes breed in old tins, tyres and in stagnant pools of water.

(b) Effect on quality of life of the people

In order to assess the social impact certain aspects were analyzed:

Security.

Stability.

Attitudes.

When asked a question as to whether the tipping site is a nuisance to them, out of the forty residents interviewed 38, that is 95%, expressed that the tipping site was a great nuisance to them. They also said that the tipping site should be removed from there and given a location elsewhere.

This shows that the residents have a bad attitude towards the dumping ground.

Eight schoolteachers were asked what social effect the tipping site has on the community and the neighbourhood. These schoolteachers interviewed were of the view that the tipping site has a negative effect on the school system. These were the problems given by these teachers.

1. Some of the schoolchildren abandon school, and go to the tipping site to become scavengers searching for anything valuable they can sell and make money out of.
2. On weekends, instead of concentrating on their homework, some of the schoolchildren spend all their time scavenging for items such as paper to sell.

This is a problem because it greatly limits the amount of time these children will spend on their homework and thus affects their academic performance negatively.

3. The schoolchildren pick up bad habits from some of the scavengers, for example, sniffing glue, using bad language and stealing.

4. One school called James Gichuru Primary School is separated from the tipping site only by a road. This can be seen in the plate shown below:

Plate No. 10.



James Gichuru Primary School. Very close to the garbage tipping site. Makes conditions at the school unbearable.

Another school called Wangu Primary School is also very close to the tipping Site.

Plate No. 11.



Refuse being burnt very close to Wangu Primary School (in the background).

These two schools are too close to the tipping site. They should not be that close to the tipping site.

The tipping site causes odour problems to the teachers and schoolchildren, is a health hazard to them, and it is very unsightly.

The residents also voiced their concern about insecurity in the area. The residents were asked a question as to whether they think Dandora Estate is safe, relatively unsafe, or very unsafe and why.

Out of the forty residents interviewed the following was recorded.

Table 4 : To show the residents' views on safety of the area.

	NO. that said YES.	% that said YES.
Safe	3	7.5
Relatively unsafe	25	62.5
Very unsafe	12	30
Totals	40	100

Source : Field Survey, 1995.

Thirty-three out of the thirty-seven residents who find the area unsafe, that is, 89.2% of the residents, attribute this insecurity especially in Area 2 to the '*chokoras*' or scavengers.

The other reasons give for insecurity were:

- (i) Lack of proper security measures by the residents.
- (ii) Laxity on the part of law enforcement officers like policemen.

These '*chokoras*' or scavengers roam around the estate, making the residents feel very insecure.

In Plate No. 12 the scavengers are seen sitting outside someone's house.

Plate No. 12



Scavengers sit outside somebody's residential home, next to the garbage tip. A source of harassment to children and women especially at night.

As can be seen from this data collected, the tipping site can be seen to have a negative effect on the security of the people, stability of institutions such as the schools and on the attitudes of the people, thus, lowering the quality of life of the people in Dandora residential area.

3.2.2.4 IMPACT ON BUILDINGS

In order to establish the impact on buildings.

- (i) Building structures within $\frac{1}{2}$ km of the site were examined and compared with those further than $\frac{1}{2}$ km and those in Areas 3, 4 and 5.
 - (ii) Property values and rental values were compared in the 5 areas.
- (i) After carrying out a preliminary survey of the buildings in the five areas, the researcher found that the buildings in Area 2 which were close to the dumping site had some serious defects, whereas those buildings in Areas 1, 3, 4, 5 and part of Area 2 were not damaged.

This is illustrated in the table below:

Table 5 : Damaged and undamaged houses in each area.

	AREA 1	AREA 2	AREA 3	AREA 4	AREA 5	TOTAL
<u>DAMAGED</u>	1	7	2	0	0	10
<u>NOT DAMAGED</u>	7	1	6	8	8	30
	8	8	8	8	8	40

Source : Field Survey, 1995

On collecting this data, the researcher went on to test the hypothesis.

The null hypothesis stated in part that the dumping of wastes has no effects on the building structures.

The alternative hypothesis stated in part that the dumping of wastes has caused deterioration of the building structures.

The Chi-Square test or 'goodness of fit' test was used to test this hypothesis. The first step is to find the expected frequencies.

These are found by making what is essentially the null hypothesis, that is, the quality of building structures are the same in each of the areas, that is, none is more damaged than the other. The expected frequency in each cell in the Table is found by apportioning the total of the houses in each area in the ratio of damaged; not damaged, that is, 10 : 30.

Thus the 8 houses in each area are split in the 10 : 30 proportion, that is 2 : 6 resulting in the following Table:

EXPECTED FREQUENCIES

	AREA 1	AREA 2	AREA 3	AREA 4	AREA 5	TOTAL
<u>DAMAGED</u>	2	2	2	2	2	10
<u>NOT DAMAGED</u>	6	6	6	6	6	30
	8	8	8	8	8	40

The x^2 calculation is then made.

OBSERVED FREQUENCIES (O)	EXPECTED FREQUENCIES (E)	(O-E)	(O-E) ²	(O-E) ² / E
1	2	-1	1	0.5
7	6	1	1	0.17
7	2	5	25	12.5
1	6	-5	25	4.17
2	2	0	0	0
6	6	0	0	0
0	2	-2	4	2
8	6	2	4	0.67
0	2	-2	4	2
8	6	2	4	0.67

$x^2 = 22.68$

$$\begin{aligned} \text{No. of degrees of freedom } v &= (\text{Rows} - 1)(\text{Columns} - 1) \\ &= (2-1)(5-1) \\ &= 4 \text{ degrees of freedom.} \end{aligned}$$

From the Table on Page 55(a), the cut-off point of χ^2 for 4 degrees of freedom is 9.488.

The calculated value (22.68) is greater than the table value, is the null hypothesis is rejected and accept the alternative hypothesis that there is deterioration of the building structures in Area 2 and this is due to the presence of the tipping site.

Eight building structures in Area 2 close to the tipping site were examined with respect to the condition of the :

- * roof
- * walls
- * floors.

1. Roof

Roof coverings form an important part of a building since it determines the extent to which the roof performs its function of protection from weather elements.

The survey identified that the roofs were of galvanized iron roofing sheets.

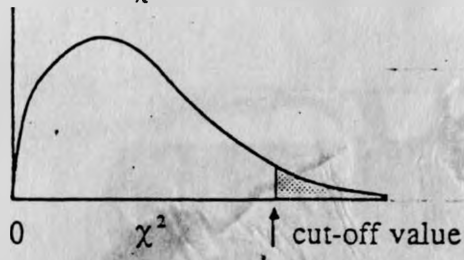
During the survey, it was noted that most of the roofing sheets were corroded.

Table 6 : To show the incidence of corrosion in roof covering materials.

	INCIDENCE	
	NO	%
Corroded Roofs	6	75
Roofs not Corroded	2	25
Total	8	100

Source : Field Survey, 1995

THE χ^2 DISTRIBUTION



Degrees of Freedom	LEVEL OF SIGNIFICANCE	
	5%	1%
$\nu = 1$	3.841	6.635
2	5.991	9.210
3	7.815	11.345
4	9.488	13.277
5	11,070	15.086
6	12.592	16.812
7	14,067	18.475
8	15,507	20.090
9	16.919	21.666
10	18.307	23.209
11	19,675	24.725
12	21.026	26.217
13	22,362	27.688
14	23,685	29.141
15	24,996	30,578
16	26.296	31,999
17	27,587	33.409
18	28,869	34,805
19	30,144	36,191
20	31,410	37,566
21	32.671	38,932
22	33.924	40,289
23	35.172	41,638
24	36.415	42,979
25	37.652	44.314

Plate No.13 and Plate No.14 show two houses which are very close to the tipping site.

Plate No. 13



A house very close to the tipping site. Built in 1980 but the galvanized iron sheets are already severely corroded. Deep stains on the walls are caused by smoke from the nearby garbage tipping site. The foreground court is littered with papers and other rubbish blown from the tipping site.

Plate No. 14.



A temporary structure constructed in 1985 has corrugated iron sheets severely corroded.

The corrosion seen in these two plates is attributed to the wastes which are burnt at the tipping site

(ii) Walls

A wall is the vertical element of a building which encloses and divides the space within the building.

The survey identified that the walls were of natural stone block walling.

During the survey the walls were noted as having the following problems:

Table 7 : Incidence of Wall Faults

Wall Faults	Incidence	
	NO.	%
Stained walls	7	87.5
Cracking	5	62.5

Source : Field Survey, 1995.

Plate No.13, Plate No.15 and Plate No.16 help to illustrate some of these wall faults observed.

Plate No.15.



Black stains on the wall are due to soot deposits emanating from the nearby tipping site.

Plate No. 16.



Cracked entrance wall to a residential home. Overgrown grass and untended surroundings attract garbage dumping.

(iii) Floors

A floor is the structural horizontal supporting element of a building structure. There are various floor coverings made from diverse materials which differ widely in appearance, performance and costs.

During the survey the floor finish which was identified by the researcher was cement screed.

It was noted by the researcher that most of this cement screed was cracked.

Table 8 : To show the incidence of cracking in cement screed floor covering.

	Incidence	
	NO.	%
Cracked cement screed floor	5	62.5
Cement screed floor not cracked.	3	37.5
	8	100

Source : Field Survey, 1995.

Plate No. 17 shows cracked cement screed in the floor of one of the houses.

Plate No. 17.



Stained cement screed floor seriously cracked. The stains are due to sulphide gases emanating from burnt garbage.

It was found that James Gichuru Primary School located next to the tipping site had been seriously vandalized. The garbage tip attracts scavengers, who also turn to vandalizing the school, especially at night.

At this school the teachers complained of rampant vandalism of the school. They said that the school was always being broken into. This vandalism was attributed to the fact that the school was just next to the tipping site so they think it is the scavengers or thieves who hide in the tipping site that break into the school at night and vandalize it.

The Plate on the next page shows some of the vandalism in the school.

Plate No. 18.



James Gichuru Primary School showing vandalized windows. Glass is replaced with wood panels.

Pictures of two buildings in Area 1 were also taken by the researcher for comparison purposes. Area 1 is the oldest residential development in Dandora, it was built in the 1970's.

Plate No. 19.



A decent wall looking clean and free from black stains and soot. The wall is located in Area 1 which is away from the garbage tipping site.

Plate No. 20.



A house in Area 1. The walls are not cracked or stained. The roof is also only slightly corroded. This house is located in the same Dandora residential area but away from the garbage tipping site.

Buildings in Area 2 have some serious defects which are attributable to the presence of the garbage tipping site.

- (ii) The second impact on buildings which was being analyzed was the effect on the property values.

As most of the tenants interviewed were renting the houses, the researcher used rental values in order to compare them.

The rental values in the same forty houses were analyzed as follows:

Table No. 9 : Average rental values in each of the five areas.

Area	No. of Houses	Average Rental Value in K.Shs.
1	8	1,000
2	8	900
3	8	1,100
4	8	1,200
5	8	1,100

Source : Field Survey, 1995.

The researcher observed that the houses were of similar construction form.

It was noted that the rental values in Area 2 were exceptionally low as compared with the other areas; in one house the rent was recorded as low as K.Shs.600/-.

CHAPTER FOUR

3.3 **Footnotes.**

American Public Works Association, Municipal Refuse Disposal (Interstate Printers and Publishers, Inc., 1966) pp. 89 - 139.

This study set out to measure the environmental impact of waste disposal by conventional means. The study was going to specifically measure how waste disposal has affected air, land, water and buildings.

It was revealed that the method of waste disposal being practiced is important to be considered first, but the requirements of controlled tipping would not in Chapter Four are not being followed at all, and in actual fact, the method being carried out is not better than uncontrolled burning or open dumping.

It was also revealed that Areas 2 of Districts residential areas in the zones selected by this study were disposed methods. In this Area 2, the conditions found were the

general nature of the houses are lower than in the other zones simple examples of structural elements which are associated with the waste disposal such as dustbins, vermin, rodents and insects building materials have diverse defects. These defects, however, are mainly confined to the roof structures and the walls of the buildings people complaints of various nuisances within the region. Security is one of the measures of quality of life of an individual. An individual who is insecure is likely to have a low quality of life because his well-being is threatened.

The study areas 1, 2, 4 and 5 do not have all these problems that are in Area 3. However, they get some problems common to all these areas that are ascribed to the urban life. These are:

The problem of distribution of land and use of gravity. All the residents agreed that the tapping system is very considerably unimproving and that it does not give the constant right of access of garbage and they are often out. If they were given a choice, the residents would prefer a different tapping system which does not rely on gravity. This was largely attributed to the managers of Unilever (UK) in the past given to the community.

CHAPTER FOUR

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

4.0 SUMMARY OF FINDINGS.

This study set out to examine the environmental impact of waste disposal in residential areas. The study was going to specifically examine how waste disposal has affected air, land, people and buildings.

It was revealed that the method of waste disposal being practiced is supposed to be controlled tipping but the requirements of controlled tipping as set out in Chapter Two are not being followed at all, and in actual fact, the method being carried out is now more like uncontrolled tipping or open dumping.

It was also revealed that Area 2 of Dandora residential area is the most affected by this poor waste disposal methods. In this Area 2, the problems found were that:

- rental values of the houses are lower than in the other areas.
- people complain of numerous ailments which are associated with the waste disposal such as diarrhoea, vomiting, coughs and malaria.
- building structures have adverse defects. These defects, however, are mainly centered on the roof structures and the walls of the buildings.
- people complain of rampant insecurity within the region.
Security is one of the measures of quality of life of an individual. An individual who is insecure is seen to have a low quality of life because his well-being is threatened.

The other Areas 1, 3, 4 and 5 do not have all these problems that are in Area 2. However, there are some problems common to all these areas that are attributed to the tipping site. These are:

- The problem of deterioration of land and loss of amenity. All the residents agreed that the tipping site is very unanesthetically unappealing and none of them like the constant sight of mounds of garbage that they so often see. If they were given a choice, the residents would prefer it if the tipping site was closed down.
- Insecurity in the area.
This was largely attributed to the scavengers or '*chokoras*' (this is the name given to the scavengers).

This insecurity interferes with the quality of life as described earlier.

- The other problem is that their children's school education is being interfered with because of them dropping out of school in order to go and scavenge for items. They also feared that their children were getting negative social values and picking up bad habits like sniffing glue from the scavengers.

Thus, the findings in this research confirm the alternative hypothesis earlier stated that dumping of wastes at Dandora has caused:

- (i) Property values to decline.
- (ii) Health problems to the residents.
- (iii) Deterioration of building structures.
- (iv) Quality of life of the people to go down

4.1 CONCLUSIONS.

Waste disposal at Dandora tipping site is causing severe environmental degradation in the residential area.

After careful analysis the main problem is seen to lie with the poor waste disposal methods practiced at the tipping site.

The Nairobi City Council's Cleansing Department should, therefore, take remedial measures in order to correct these practices and ensure that proper controlled tipping is carried out.

Although the problems faced by the Cleansing Department could be partly attributed to economic constraints, every City has financial constraints and it is upon the Management to distribute funds among the basic services it is required to render on the basis of priority services. Surely waste management should be one of the priority services if a clean environment is to be achieved.

To achieve proper solid waste disposal systems, there is a great need to co-ordinate solid waste disposal management through planning, infrastructure provision and development control.

Solid waste management policies also need to be revised both at national and local levels to make them more effective in meeting the needs of the society. Environmental assessments need to be integrated in these policy revisions because we have reached a stage where we are now irreversibly damaging and depleting the environment; we are living at the expense of our descendants for they will have nowhere else to go.

4.2 RECOMMENDATIONS

In order to help improve the municipal waste disposal system in an environmentally sustainable manner, the following suggestions are made:

1. Strict supervision by the Nairobi City Council should be done on tipping sites to ensure that controlled tipping is properly carried out. Each day's refuse should be adequately covered, levelled and compacted by mechanical plant.
2. The City Council, Central Government and other interested agencies should assist in order to mobilize funds for:
 - (i) The purchase of equipment necessary for controlled tipping such as graders, bulldozers and tippers.
 - (ii) The purchase of incinerators to install in public hospitals, clinics and dispensaries.

The Government can also purchase one incinerator and place it in a convenient place in the City Centre in order to cater for the doctors in small private practices. These private doctors can then be charged a fee for use of the incinerator.

Incinerators are very expensive equipment to install and maintain; however, if they are utilized they can ensure that hospital wastes are disposed of properly.

3. The Council should undertake a waste recycling venture. They should look into ways and means of recycling wastes. This would help reduce the amount of waste significantly.
4. The scavengers should be removed from the tipping site. This, however, does not mean getting rid of them totally; on the contrary, the Council should facilitate hand-picking (scavenging) by providing sanitary waste recovery stations.
5. Industries should be encouraged and supported to adopt low and non waste technology, and clean technologies such as those involving recycling or re-use of wastes where feasible.

6. The Government of Kenya should develop a competent and efficient institutional and legal framework to deal with all matters relating to environmental pollution.
 - (i) A body should be set up and given the task of pollution monitoring and surveillance.
 - (ii) The Government should also build institutional capabilities to enforce environmental protection.
7. The Nairobi City Council should make sure that there is compulsory environmental impact assessment of all tipping sites.
8. Solid waste disposal strategies should be discussed and assessed not only by Cleansing Officers but also by economists, sociologists, health officers and technology experts. This multi-disciplinary assessment is essential in order to develop strategies which have minimum environmental impacts.
9. Awareness campaigns.

These should be done frequently in order to sensitize the public on various waste disposal aspects such as the need to recycle wastes, the need to reduce wastes and the need to dispose wastes in the proper areas so as to minimize environmental hazards. An aware and concerned public is likely to be more responsive to any regulatory framework which is established to enhance environmental protection.

FURTHER RESEARCH AREAS

1. Ways of improving solid waste management in developing countries such as Kenya.
2. The effectiveness of salvage and reclamation as a method of refuse disposal.
3. The importance of Environmental Impact Assessment of all solid waste management projects.

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APPENDIX 1

QUESTIONNAIRE FOR DANDORA RESIDENTS

Please tick as appropriate where necessary.

Date Interviewed _____

Status of the respondent

Adult

Minor

1. Status of the occupant.
- Tenant.
- Owner Occupier.
- Company/Organization House
- Other. Please specify.
-
-

2. How long have you lived in this house?

3. What are the rental values of your house?

Shillings (Shs.)

4. Has the value (Rent Purchase Price) of this house changed significantly during your tenancy?

YES

NO

5. When did the value change? _____

From _____ K. Shs. To _____ K. Shs.

6. When did the last tenant/owner move out of the house? _____

7. Do you experience any odour around your house?

YES

NO.

8. When did you notice the smell? _____

9. At what time is this smell prevalent?

Morning

Afternoon

Evening

10. What do you think is the cause of this smell?

Motor vehicles exhaust fumes

Rotting garbage

Industrial pollution

Some from burning wastes

Other. (Please specify)

11. Is your house invaded often by any of the following?

Rats

Flies

Mosquitoes

Fleas

Cockroaches

Ticks

Other (Please specify)

12. Do you often experience any of the following ailments?

Fever

Nausea

Diarrhoea

Plague

Cholera

Dysentery

13. Would you say that this residential area is:

Safe

Relatively Unsafe

Very Unsafe

14. What sort of waste is disposed at the dump?

- Industrial waste
 - Household garbage
 - Demolition and construction debris.
 - Institutional refuse
 - Other (Please specify)
-

15. At what times is waste dumped?

- Morning
- Afternoon
- Evening

16. Is the presence of the dump a nuisance to you?

- YES NO.

17. What are your reasons for your answer in No. 14 above?

- Due to * prevalent smell of rotting garbage
 - * continuous invasion of your house by rats, flies, mosquitoes, fleas.
 - * the presence of scavengers
 - * the constant sight of mounds of garbage
 - * outbreaks of fire at the dumping site.
 - * Other (Please specify)
-

18. What steps do you think can be taken by the Nairobi City Council to improve this situation?

Thank you for your assistance.

APPENDIX 2

QUESTIONNAIRE FOR NAIROBI CITY COUNCIL OFFICERS

Please tick as appropriate where necessary.

Date Interviewed _____

Officer Interviewed : Rank/Position

1. What is the specific name of the dumping site for the City's garbage?

2. When did this tipping site come into existence?

3. What sort of waste is disposed at the site?

- | | |
|------------------------------------|--------------------------|
| Industrial waste | <input type="checkbox"/> |
| Household garbage | <input type="checkbox"/> |
| Demolition and construction wastes | <input type="checkbox"/> |
| Institutional refuse | <input type="checkbox"/> |
| Street and alley cleanings | <input type="checkbox"/> |
| Other (Please specify) | <input type="checkbox"/> |
- _____

4. Which method of waste disposal is used?

- | | |
|------------------------|--------------------------|
| Controlled tipping | <input type="checkbox"/> |
| Uncontrolled tipping | <input type="checkbox"/> |
| Sanitary Landfill | <input type="checkbox"/> |
| Open dump | <input type="checkbox"/> |
| Other (Please specify) | <input type="checkbox"/> |
- _____

5. Who dumps there?

- | | |
|----------------------------|--------------------------|
| Nairobi City Council | <input type="checkbox"/> |
| Private garbage collectors | <input type="checkbox"/> |
| Others (Please specify) | <input type="checkbox"/> |
- _____

6. What criteria is used in choosing dumping grounds?

7. Was this criterion used when choosing this dumping ground? YES NO
8. Is an Environmental Impact assessment (EIA) carried out on prospective dumping grounds? YES NO.
9. Was an EIA carried out when choosing this dumping ground?
YES NO.
10. Approximately how much waste is disposed at the site per day? _____
tonnes/lorries/bags
11. After dumping is any further work carried out on the landfill? YES NO.
12. What sort of operation is carried out thereafter?
Incineration
Recycling
Covering with compacted soil.
Other (Please specify)

13. What measures have been taken to prevent the spread of flies, rats, mosquitoes, fleas, cockroaches, from the dump to the adjacent houses?

14. Which measures have been taken towards environmental conservation in the area?

15. In your opinion is the method that is used a good method of waste disposal?
YES NO.
Why?

16. What steps do you think can be taken to improve the method of waste disposal that is used?

Thank you for your assistance.