

ENVIRONMENTAL IMPACT ASSESSMENT PROJECT REPORT FOR THE PROPOSED LABORATORY AT MACHAKOS DISTRICT HOSPITAL IN MACHAKOS TOWN



MISCELLANEOUS

NAME OF PROPONENT: Ministry of Public Health
ADDRESS: P O Box 19982-00202, Nairobi
NAME OF CONTACT PERSON: Dr. Willis Akwale, MBS
POSITION OF CONTACT PERSON: Project Manager
TELEPHONE NO: +254 20 2716934/5
LOCATION: Machakos District Hospital, Machakos town

SIGNED: _____ **DATE:** _____
(For Project Proponent)

Green Globe Foundation, a registered Environmental Impact Assessment Firm comprising of Lead and Associate Lead Experts compiled this Project Report for the proposed laboratory for Machakos District Hospital. The following are the names of the staff members involved in the actual environmental impact assessment.

- ❖ **Kyalo Patrick (Lead Expert NEMA Reg no. 1275)**
- ❖ **Shandrack Ngewa**
- ❖ **Judith Kanini (Community Mobilizer)**

Contact: 0721997876

The Environmental Impact Assessment was done in January 2012

SIGNED: _____ **DATE:** _____
Green Globe Foundation

ABSTRACT

This report addresses both environmental and socioeconomic issues related to the development, operation or decommissioning of the proposed laboratory. The proposed Machakos hospital laboratory is under the Ministry of Public Health and Sanitation which is financed by World Bank. It is located at Machakos district hospital. The proposed laboratory has been designed on the basis of the client brief and the additional information collected during the site visits. The site is partly covered with vegetation and the existing laboratory. The site has an efficient road network that connects to the main road. There is a sewer line that serves the hospital managed by the Machakos town council. Electricity and water is also available and also the facility will benefit from water desalination equipment.

The new laboratory will have two levels, ground and first floor plan and it is to be constructed to a standard laboratory as provided in the designs.

In the event of implementing the proposed project, some demolition as well as construction work will be undertaken. Throughout the world, construction activities impact the environment in one way or another, be it the social, economical, biological or physical environments. Such impacts should be checked to avoid or reduce any negative effects to the environment and public health.

As well, with improved infrastructure (health facilities) provision, there is bound to be a rise in business/economic opportunities leading to increased population within the development site and its surrounding. Increase of population; be it temporary (during construction as a result of labor import) or permanent is likely to stretch services and other facilities in and around the project area. Measures should be put in place to ameliorate against any negative impacts and maximize on any positive ones.

Referring to the environmental law of the country and in accordance with Section 58 of the Environmental Management and Coordination Act (1999) and Legal Notice No. 101 of 2003, a project of this magnitude is supposed to be subjected to an Environmental Impact Assessment (EIA). Procedural guidelines on the EIA are spelt out in Legal Notice No. 101

The objectives of the EIA were to consider all possible positive and adverse impacts to the environment, critical habitats, wildlife, aquatic ecosystems and the overall fauna and flora, determine socio-economic impacts of the project, assess environmental hazards and risks associated with the project, design and prepare mitigation measures and action plans to address all possible significant negative environmental impacts. The preliminary findings during public consultations with stakeholders indicated that the public support the project as long as it is

transparent, their livelihoods are taken care of, and they are fully sensitized on what the project involves.

Some of the issues that were raised during the consultation and public participation process included safety of the public during the construction period, occupational health and safety during the operation phase, concern of increased dust around the project site especially during the construction period, potential increased traffic jam around the area, especially during the construction period, what plans are in place to address both , biomedical/clinical, solid and liquid waste management in and around the project area and if the project is going to involve landscaping.

A number of project alternatives were considered in the assessment. These included the “no project” alternative. Although this would lead to preservation of the environmental conditions, this alternative was the least favorable because it would mean people will not benefit from the much needed casual jobs as well enhancing the health service provision in the area. Decommissioning phase impacts include loss of direct and indirect employment, large amounts of demolition waste, noise pollution, dust and exhaust emissions, likely occupational health and safety hazards.

The EMP that was developed for this EIA report outlines the actions that are required to address the identified negative impacts, responsibility, implementation stage, costs and relevant regulations/standards to guide monitoring and auditing of the effectiveness of the proposed mitigation measures.

The proposed project offers many significant positive impacts at the local, regional, national and even international levels. The anticipated positive impacts include: direct and indirect employment generation and improved provision of health services in and around Machakos.

On the other hand, potential significant negative project impacts may affect environmentally sensitive areas such as wetlands (rivers), groundwater, air quality and humans and their cultural properties. The main issues are geographically limited, well defined, and well understood in Kenya. Thus, the proponent’s major task in respect of the EMP is to properly manage the negative impacts while enhancing the positive ones to ensure a project that is economically, socially and environmentally sustainable. In so doing, the proposed project could be approved for implementation provided that the proponent shows capacity to implement the EMP.

Table of Contents

MISCELLANEOUS	1
ABSTRACT	2
1.0 INTRODUCTION	7
1.1 The Satellite Laboratory	7
1.2 Laboratory Design	7
1.3 Objectives of the EIA	9
1.4 Environment Impact Assessment Methodologies	10
1.5 Need for the Project	11
1.6 Private and Public hospitals in Kenya	11
2. ENVIRONMENTAL AND BASELINE INFOERMATION	12
2.1 Identification of the site	12
2.2 Machakos District Profile	16
<i>Table 1: Administrative divisions of Machakos District</i>	16
2.2.1 Demographic and Population Profile	17
<i>Table 2: Demographic and population profiles of Machakos District</i>	17
2.2.2 Welfare Indicators	18
a. Education	18
b. Labour Force	18
c. Poverty Analysis	18
2.2.3 Socio-Economic Indicators, 2002	19
<i>Table 3: Socio-economc indicators, 2002</i>	19
a. Health	19
2.2.4 Health Indicators 1999	19
Table 4: Health indicators, 1999	19
2.2.5 Population and Development	20
2.2.6 Main Issues/Problems	20
3. ENVIRONMENTAL LEGISLATION IN KENYA	21
3.1 Constitutional Provisions	21
3.2 Land Tenure and Land Use Legislation	21
3.3 Legislation Relevant to Water Resources	22
3.4 Environmental Health	22
3.4.1 Public Health	23
3.4.2 The Working Environment	24
3.4.3 Radiation Control	24
3.4.4 Management of Hazardous Waste	25
3.5 Legislation on specifically protected areas	25

3.6	The Environmental Management and Co-ordination Act (EMCA)	25
3.6.1	Protection and Conservation of the Environment	26
3.6.2	Environmental Impact Assessment	26
3.6.3	Environmental Audit and Monitoring.....	26
3.6.4	Waste Management Regulations, 2006	27
a.	Standards for Liquid Waste	27
3.7	The Occupational Safety and Health Act, 2007	28
3.8	The National Health Care Waste Management Plan 2008-2012	29
3.9	Kenya National Guidelines on Safe Disposal of Pharmaceutical Waste, 2001.....	29
3.9.1	National Policy on Injection Safety and Medical Waste Management.....	30
3.10	Radiation Protection Act, Cap 243.....	30
4.	CONSULTATIONS AND PUBLIC PARTICIPATION (C&PP)	31
4.1	Concerns raised by the participants	32
4.1.1	Creation of job opportunities	32
4.1.2	Improvement of infrastructure	32
4.1.3	Gains in the Local and National Economy	32
4.1.4	Environmental concerns raised by the respondents.....	32
4.0	PROJECT ALTERNATIVE.....	35
4.1	Introduction.....	35
4.2	No-action alternative	35
4.3	Renovation option	35
4.4	Relocation option.....	36
4.5	Waste Water Treatment Systems	36
4.5.1	Bio-digesters	36
4.5.2	Septic tank.....	37
4.5.3	Bio-box technology	37
4.5.4	Connection to a Sewer Line	37
5.0	ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES.....	38
5.1	Introduction.....	38
5.2	Construction phase- Potential Environmental and Social Impacts.....	38
5.3	Operational Phase- Potential Environmental and Social Impacts.....	39
5.3.1	The Scope of the EIA during the Operating Phase.....	39
5.3.2	Environmental Conservation Activities	39
5.3.3	Water Utilization and Conservation.....	40
5.3.4	Waste Disposal and Management	40
a.	Liquid Waste Management (Human Excrement)	40
b.	Liquid Bio-Medical Waste.....	40
i.	Challenge of Liquid Bio-Medical Waste	40

ii. Liquid bio-medical waste standards.....	40
5.3.5 Solid Waste Generation and Management	41
A. Potential Health impacts of health-care waste.....	42
a) Types of hazards.....	42
b) Persons at risk.....	42
c) Hazards from infectious waste and sharps.....	43
d) Hazards from chemical and pharmaceutical waste	43
e) Hazards from genotoxic waste	44
f) Public sensitivity.....	45
B. Potential Public health impact of health-care waste	45
5.3.6 Emergency response.....	46
5.3.7 Dealing with spillages.....	46
5.3.8 Reporting accidents and incidents.....	47
5.3.9 Other Health and Safety issues to be considered in the Health Care Facility	48
5.4 De-Commissioning Stage	48
5.4.1 Positive Decommissioning Impacts.....	48
5.5 Negative Decommissioning Impacts	48
6. ENVIRONMENTAL MANAGEMENT/MONITORING PLAN.....	50
6.1 Introduction.....	50
6.2 Management of Asbestos	50
6.2.1 Asbestos removal	51
6.3 Environmental Monitoring and Auditing Program	52
6.4 Environmental Management Plans (EMP)	53
6.5 Operational Phase EMP.....	61
6.6 Decommissioning Phase	64
7. AUXILLIARY INFORMATION	65
7.1 Budget	65
7.2 Monitoring Guidelines.....	65
7.3 Reporting.....	65
7.4 Conclusion and Recommendations	65
8. APPENDICES	66
9. REFERENCES.....	67

1.0 INTRODUCTION

The proposed East Africa Public Health Laboratory Networking (EAPHLN) Project is being undertaken in selected hospital facilities in Kenya, Uganda, Rwanda and Tanzania. The project is intended on establishing a network of efficient, high quality, accessible public health Laboratories for the diagnosis and surveillance of TB and other communicable disease. The beneficiary countries will also be able to share information about those diseases and mount on effective regional response.

1.1 The Satellite Laboratory

The client has selected 6 facilities to benefit from this scheme. These include:

- National Public Health Laboratory services (NPHLS) Building, Nairobi.
- Machakos District Hospital
- Kitale District Hospital
- Busia District Hospital
- Malindi District Hospital
- Wajir District Hospital

1.2 Laboratory Design

The proposed laboratory design is lean and optimized to address the movement related to patients, personnel and specimens. It clearly indicates how specimens move from the specimen accessioning area to the labs for test and dispatch of the results to the patients. The proposed laboratory for the Machakos District Hospital has been designed on the basis of the client brief and the additional information collected during the site visits. The new laboratory will entail a two level building, ground and first floor plan. It will include the following provisions:

a. Ground floor

The ground floor will accommodate a Waiting area, Specimen reception area, Reception area, Reports release desk, Cashier office, Records room, Patients WCS, Phlebotomy room, Donor room, washing area, Counseling room, Blood donor room, Rest room, Blood bank, Pathologists office, Server room, Staff Lounge, Office for in-charge, Office for County laboratory Technician, Utility Room, Cold Room, Training Room; video conferencing, Suppliers store and Staff WCs

b. First floor

The first floor will accommodate Blood transfusion laboratory, Serology laboratory, Chemistry laboratory, Hematology laboratory, Parasitology laboratory, Histology laboratory, Microscopy, Freezer room, Media prep room, Specimen Museum, Quality control laboratory, Molecular

laboratory, Virology laboratory, Microbiology laboratory, TB laboratory, Decontamination room, Glassware washing, Store and Staff WCS.

c. Other Laboratory Design Provision

i. Laboratory Worktops.

The worktops/workbenches will be constructed in 25mm thick solid panels which are acid, solvent, stain and scratch resistant made as TRESPA Toplab Plus or equal and approved with a marine edge top and applied backsplash to contain spillage.

ii. Lab Shelves

The laboratory will have shelving for reagent storage which will have lipped edges which makes sure the reagents do not fall off.

iii. Emergency shower and Eye wash.

The design will provide an emergency body shower, wall mounted with self-draining head. An emergency wash will also be provided and a stainless steel bowl to mechanical engineers specifications. The eyewash will be a fixed unit that is centrally located to ensure it is accessible by the staff within the first ten seconds.

iv. Floor finishes.

The laboratory floors will be finished in epoxy floor finish which can be laid in continuous form and is compatible with the base materials such as concrete. The office floor finishes will be non-slip granite tiles while the wet areas will have ceramic tiles to floor and wall up to 2100mm high.

v. Heating, Ventilation and Air-conditioning

In the laboratory, certain rooms will be air-conditioned to ensure safety of staff and comfort; such spaces include TB laboratory, Media prep, Microbiology laboratory, Virology suite and Training room.

vi. Coat Hooks

The design has provided for coat hooks next to the laboratory doors to ensure the laboratory staff can access laboratory coats easily when entering the laboratory.

vii. Hand washing Sinks

The hand washing sinks have been located near doors and the taps will be elbow operated. A shelf will be provided for the soap dispensers as well as a mirror near the wash hand basin.

viii. Water Supply

The domestic water branch piping serving the laboratory will be fitted with backflow preventers and an isolation valve if considered necessary for safety reasons.

ix. Laboratory waste water Handling

In order to ensure the laboratory waste water is sterilized before being released into the sewer system, the following measures may be desirable, especially in the TB Lab;

- Drainage traps to be provided up to the required deep seal depth.
- Autoclave condensate drains to have closed connections.

x. Gas Supply

The gas supply to the laboratory will be piped and the LPG cylinders located outside the labs for safety purposes.

xi. Emergency Lighting

The laboratory will be fitted with emergency lighting and signage. All the doors shall be fitted with LED type exit signs.

xii. Communication system

The laboratory will have communication system between the various sections and also LIMS for electronic transfer of information and data from the laboratory area to other sections or other satellite labs.

1.3 Objectives of the EIA

This is the report of an Environmental Impact Assessment for the proposed project in accordance with Section 58 of the Environmental Management and Coordination Act (1999) and Legal Notice No. 101 of 2003. The objectives of the study were:

- To assess the potential environmental and social impacts of the proposed project, whether positive or negative, and propose mitigation measures which will effectively address these impacts;
- To inform the proponent and contractor of the potential impact of different alternatives, and relevant mitigation measures and strategies;
- To inform stakeholders of the proposed project and to seek their views regarding its potential environmental and social impacts as well as measures to mitigate the negative impacts.

1.4 Environment Impact Assessment Methodologies

The scope of this assessment was guided by the requirements in the Environmental Management & Coordination Act No. 8 of 1999) and in particular by the Environmental (Impact Assessment and Audit) Regulations, 2003. Environmental Impact Assessment (EIA) is the systematic examination conducted to determine whether or not a program, activity or project will have any adverse effects on the environment. According to the Canadian Environmental Assessment Agency (2004), EIA provides benefits such as “an opportunity for public participation; increased protection of human health; the sustainable use of natural resources; reduced project costs and delays; minimized risks of environmental disasters; and increased government accountability”.

The objective of EIA is not to force decision makers to adopt the least environmentally damaging alternative because if this were the case, few developments would take place. However, EIA is just but one of the issues addressed by decision makers as they seek to balance the competing demands of development and environmental protection. The EIA will also assist the government through National Environmental Management Authority (NEMA) to advise the project proponent via licensing on whether the project should be implemented or not, and if it should proceed, then under what conditions. It also provides a monitoring guideline for the project management to act upon.

A wide range of methods were used in the various stages of the EIA. They included methods used by the various specialists for:

- Stakeholder analysis and consultation and public participation
- Scoping of key issues and carrying out the various baseline studies
- Impact analysis and
- The development of an Environmental Management Plan (EMP).

The range of interested and affected parties was identified through consultations with the project proponent, leaders as well as relevant Government Departments with knowledge of the area. The purpose of the scoping exercise was to capture issues that required investigation in the EIA process. The scoping was conducted in a number of consultative one-to-one meetings with individuals surrounding the project area.

Previous reports of the project area were key sources of secondary data to review habitat; demographic and settlement; the physical environment; historical, archeological monuments and cultural heritage. The review of literature included work done by government Lead Agencies and local and international Non-governmental Organizations (NGOs). These assessments have formed the background information for the present EIA.

Aspects of the physical and biological environment studied included physical features of the project area, agro-ecological zones, soils and their properties, potential ecological problems, siltation and accumulation of pollutants in the soil, air and water. Data was obtained from both secondary and primary sources.

1.5 Need for the Project

The project is intended on establishing a network of efficient, high quality, accessible public health Laboratory for the diagnosis and surveillance of TB and other communicable diseases. Other objectives of the project are to:

- Enhance access to diagnostic services for vulnerable groups.
- Improve capacity to provide specialized diagnostic services
- Conduct drug resistance monitoring.
- Strengthen laboratory based disease surveillance to provide early warning of public health events.
- Support training and capacity building for laboratory personnel.
- Increase pool of experts in the region.
- Improve the effectiveness of public health laboratories.
- Create a platform to share information regionally on operational research, impact of TB diagnostic technologies and enhance TB surveillance.

1.6 Private and Public hospitals in Kenya

We have both private and public hospitals in Kenya all serving similar or less purposes. Unlike the private hospitals, the public hospital are less expensive, and especially the National Public Hospitals which keeps all specialists at each related department and are quite useful to all and especially to the locals, but could be hard to deal with due to the high demand of patient and the crowd could cost one's time before one gets attended to and it is for this reason why it is important to consider that some diagnosis will require lab tests usually done in a laboratory. Moreso, efficient medical services provided usually constitute a combination of medical research, pharmaceutical manufactures and hospitals and others including training and laboratory services.

b. Reception area

The existing reception is small and crowded and has a fridge. There was need to provide a standard reception that can serve at least two patients at the same time and lockable shelves for specimen.

c. Bleeding area

The existing bleeding area is inadequate and is located along the entrance into the laboratory and should be converted into a standard bleeding area. It should include a door that opens outward at 180°.

d. Training room

This does not exist and the proposed design should incorporate one. It should have a conference facility and a library.

e. Staff-lounge

At the moment, the virology lab doubles up as the staff lounge and there is need to provide a proper staff lounge in the design.

f. LIMS office/sever room

This does not exist at the moment but is a requirement.

g. Pathologist's office

The current pathologist's office is too small and should be increased in size

h. Radiation room

This room is not existent and the client clarified it is not required.

i. Office for laboratory-in-charge

The existing office is inadequate and it should have a wall cabinet.

j. Waiting area (patients)

The waiting area needs to be expanded to accommodate an average of 100 patients since the current one can only accommodate 50 patients.

k. Reagent store

Currently, the laboratory hosts four different scattered reagent stores that are very small. The design should provide a common reagent store which is big enough.

l. Microbiology

The current microbiology laboratory operations are conducted on the last bench in the laboratory and the space is inadequate. The design should provide adequate space for microbiology laboratory incorporating screening and culture cabinet. The client is proposing that the microbiology laboratory be accommodated in the new facility.

m. TB Laboratory

The current TB laboratory is located in a small room of 2.6 x2.4m, near the media room, and is inadequate for carrying out proper TB tests safely. The design is to provide for new TB laboratory in the proposed facility with all the equipment and safety measures.

n. Decontamination / sterile washing

The current decontamination /sterile washing area is a small room of 2.6 x 2.4m which is inadequate and lacks the proper equipments. The proposed facility should incorporate the sterilization room and a sluice room.

o. Media Preparation

The existing media preparation room is located between the deacon and the TB laboratory. The new facility is to incorporate the media preparation next to the microbiology laboratory.

p. Specimen Museum

This does not exist currently and is to be provided.

q. Cold room

This is the machine room to have freezers and fridges. The space does not exist currently.

r. Histology laboratory

The histology laboratory does not exist and should be provided in the extension.

s. Parasitology Laboratory

The existing parasitology laboratory has a separate access from the main laboratory and the new facility should make it part of the other laboratories.

t. QC Room

This does not exist currently but should be provided to have office set-up, printing areas.

u. Blood Transfusion

The current blood transfusion laboratory also hosts the microbiology, serology & biochemical laboratories. Once the microbiology laboratory is moved, the existing spaces will be reorganized to have serology, biochemistry and BT laboratories with partitions.

v. Serology Laboratory

This will be covered as explained above.

w. Virology Laboratory

There's an existing virology laboratory, which is adequate in size however a bench should be provided across the room to decongest it.

x. Haematology Laboratory

This laboratory does not exist currently and the machines for the same are scattered in three different rooms. It should be provided as this is where point of care (POC) testing should be done.

y. Bio Chemistry / Clinical chemistry

This laboratory exists but should be expanded and renovated to have lockable cabinets and sliding doors made of glass.

z. Tea Room

The current tea room is small and should be increased to include fixed lockers / TV. The distiller in the tea room should be moved to the distilling unit.

aa. Duty Room

The design should incorporate a room with a lounge seat and desk for the on-call room.

bb. Staff changing rooms

Currently, the laboratory staff have converted one of the rooms into a changing room which is unisex. The design proposal should provide proper changing rooms for male and female.

cc. Other provisions

Water: The client requested that the facility be provided with water desalination equipment.

Special test room: The client pointed out that the design should consider providing a room for semen analysis.

It should also be noted that the reception area doubles as a patient receiving area and phlebotomy area, hence there's no privacy. There is need for a separate reception room and a phlebotomy area and that there is need to provide an office for the laboratory -in-charge which should be provided.

The existing laboratory is about 425m², while the site for the proposed facility is 180m². This means the total available space on the ground floor is 615m². Comparing this with the standard laboratory drawing the ground floor has 550m², which therefore means the common functions on the ground can fit at the Machakos laboratory. However, the extension is inadequate to accommodate the required 550m² of laboratory space as per the schedule of accommodation. This may require parts of the new laboratory to sit on top of the existing one laboratory which is not tenable due to the excessive levels of demolitions to be carried out and also that we do not have the structural strength / integrity of the building. In this regard, the best option was to provide a new laboratory for the facility and which is in line with the schedule of accommodation.

2.2 Machakos District Profile

Machakos District is one of the thirteen districts that form Easter Province. The district borders the city and Thika District to the northwest, Kitui ad Mwingi District to the east, Kajiado District to the west, Makueni District to the south, Maragwa District to the north and Mbeere District to the northeast. It stretches from latitudes 0° 45' south to 1° 31' south ad longitudes 36°45' east to 37°45' east. The district covers an area of 6,281.4kms most of which is semi-arid. High and medium potential areas where rain fed agriculture is carried out consist of 1,574km² or 26 percent of the total area. Administratively, the district is divided into twelve divisions, sixty-two locations ad two hundred and twenty, five sub locations as show in table1 below:

Table 1: Administrative divisions of Machakos District

DIVISION	AREA (KM)	DENSITY	LOCATION
Central	49.5	307	9
Kalama	330.2	130	4
Kangundo	178.2	539	5
Kathiani	205.8	486	4
Masinga	1,094.1	72	6
Matungulu	634.3	165	7
Athi River	957	54	3
Mwala	481.5	195	7
Ndithini	316.8	107	3
Yathui	533	129	6
Yatta	491	90	4
Katangi	568	164	4
Total	6,281.4	152	62

Machakos Municipal Council covers Central Division while Mavoko Municipal covers Athi River Division. Kagundo Town council covers Matugulu and Kagundo Division while Matuu town council covers Matuu and Kathiani locations The Masaku County Council covers all the others

areas of the District. Kagundo and Kathiani Divisions had the highest population densities of 512 ad 462 persons per km² respectively during the 1999 census ad 539 ad 486 persons per km² projected for 2002 as they have relatively high economic potential than the other divisions. These divisions though covering the least areas have fertile soils that support other cash and food crops ad receive moderate rainfall. Athi river Division which is among the biggest in the area, had the lowest density of 51 ad 54 persons per km² (1999 ad 2002) although over 50% of the population is concentrated Athi River Town. The densely populated divisions have a scattered type of settlement with small farms raging from 1 to 10 hectares while Athi River Division the majority of the people are food rural settlements.

2.2.1 Demographic and Population Profile

The average population density of the district was 126 persons per km² in 1989 while in 1999 it was 144 persons per km² representing an increase of 14.3 percent. This increase is attributed to overall population growth rate and migration of people to towns, especially along the major highways. Divisions with fertile soils ad high agricultural potential have higher population densities than the rest of the district. These include the hill masses of Central, Kagundo, Kathiani and Matungulu Divisions. This population has however put much pressure on the land and will continue to increase over the years. Marginal divisions have relatively low population densities. Athi River Division has the lowest density of 51 persons per km². Over 50percent of this population is, however, concentrated around Athi River town, where labour can seek employment in the industries. Over the years, the density is expected to increase up to 59 persons per km² at the end of the plan period.

Table 2: Demographic and population profiles of Machakos District

Population	954,082
Number of Males	466,064
Number of Females	488,018
Female/Male Sex Ratio	100:96
Number of Youthful Population (15 - 25) years	223,708
Primary school population (6 - 13) years	225,630
Secondary School Population (14 - 17) years	103,843
Labour Force (15 - 64) years	489,784
Dependency Ratio	100:94
Population Growth Rate	1.7%
Rural Population at start of Plan Period 2002	421,945
Urban Population at start of Plan Period 2002	532,137

The district's population stood at 906,644 according to the 1999 Population Census consisting of 442,891 males and 463,753 females representing 48.8% and 51.2% of the population respectively. Growing at rate of 1.7%, the population is expected to rise 954,082 and 1,056,535 in 2002 and 2008 respectively. The majority of the population of the district is young with 510,507 or 56.3% being below 20 years.

2.2.2 Welfare Indicators

a. Education

Machakos District has close to 850 primary schools. The primary school enrolment rate is 81% for both boys and girls. School dropout was reported to be 5.5%. The Primary school going population (6-13 years) makes up to 20.3% of the district total population and was estimated to be 237,338 in 1999. This age cohort is expected to increased to 276,576 in year 2008. Although the enrolment rate is high (81%), the district will need to invest in the provision of additional educational facilities. The district has 154 secondary schools and an enrolment rate of 32% for both boys and girls. The secondary school going age group comprises about 9% of the total population and was estimated to be 98,680 in 1999. It is projected to rise to 114,996 by year 2008. The secondary school dropout rate was estimated to be 4.7%. Many children drop out of primary and secondary school mainly due to in ability to afford cost of education and the limited number of schools.

b. Labour Force

The labour force in Machakos District is increasing rapidly. According to the 1999 Population and Housing Census the total population of this age group represented 47.6% (465,432) of the total population and comprised 221,403 males and 244,029 females. This number is projected to increase to 542,379 comprising of 258,006 males and 284,373 females by year 2008. The high increase in labour force has led to increase in unemployment and this could lead to escalation of crimes as a result of non-absorption of this active population in services of gainful employment.

c. Poverty Analysis

According to the welfare monitoring survey (WMS II) of 1994 ad WMS III of 1997, the district had 68.7 per cent had 63.3percet respectively of its population below the poverty line. During the poverty assessment exercise carryout in year 2000, the district was estimated to have 66.2 percent of the population as poor. From the surveys it may not be possible to set out a trend. However, it is worth noting that the surveys were carried out under different circumstances, which may have influenced the results. The 1994 survey was carried out when the district was experiencing very severe drought and as such most of the households could not afford basic essential needs. The 1997 survey was carried in March-May, a period when the district had just harvested the crops and as such most of the households were food secure while the 2000 poverty assessment was carried out against a background of severe drought when most of the households were dependent o relief food. From the three results, however, it can be deduced that over 63 per cent of the people in the district are poor. This compares well with poverty assessment, which put the figure at 63.3 percent. The results indicate also that the district contributed about 4.4per cent to the national poverty

2.2.3 Socio-Economic Indicators, 2002

Table 3: Socio-economic indicators, 2002

Total number of Households	186,297
Average Households size	4.9
Number of female headed households	Not available
Number of disabled groups	Not available
Children needing special protection	15,000
Absolute Poverty (Rural & Urban)	63%
Income from Agriculture	70%
Income from Rural Self employment	10%
Wage employment	11%
Number of unemployed	2%

a. Health

In the year 2001, Machakos had over 110 health facilities spread across the district. The doctor/population ratio is about 1:62,325 showing over-utilization of doctors. The average distance to a health facility is 5 Km. The most prevalent diseases are Malaria and Skin diseases while the childhood diseases include anaemia, marasmus, eye infection, pneumonia, malaria, Kwashiorkor etc. HIV/AIDs in Machakos is a major health problem with the prevalence averaging 15%. With regard to bed occupancy, about 50% of the hospital beds are occupied by patients with HIV/AIDs related diseases. HIV\AIDS in the district was diagnosed in June 1989 and 4 males and 5 females tested HIV positive. In December of the same year, 42 cases had been reported ad since then the numbers have continued to increase.

Majority of HIV\AIDS patients are found in Machakos Town and its environs and in all towns along the Mombasa highway. Cases are being reported in the small up-coming towns in the district like Wamuyu and, Matuu. HIV\AIDS incidences along the major highway and upcoming towns are attributed the long distance truck drivers\touts and, the commercial, sex workers. The biggest challenge facing the district is the increasing cases HIV\AIDS in spite of the awareness level of over 85 per cent. It also faces the challenges of providing medical care for the infected and support for the affected. Currently the district estimates that there are over 15,000 children who are in need of special care (CSP) ad this numbers is expected to rise due to the increasing number of HIV\AIDS orphans. The table below summarizes the health indicators of the district.

2.2.4 Health Indicators 1999

Table 4: Health indicators, 1999

Crude Birth Rate (CBR)	46/1000
Crude Death Rate (CDR)	9/1000
Infant Mortality Rate (IMR)	53/1000
Under 5 Mortality Rate	78/1000
Total Fertility Rate	3.5
HIV Prevalence Rate	15%
Doctor/POPULATION Ratio	1:62,325

2.2.5 Population and Development

The Population of Machakos District is estimated to be 954,082 (2002) with a growth rate of 1.7% per annum. By the year 2008 this population expected to increase to 1,056,535 assuming that the same growth rate persists. Clearly the high population growth rate has serious effect on social and economic development. This is manifested in increased unemployment, high dependency ratio, increased demand for health services, increased demand for agricultural land, more need for fuel and forest products, overcrowding in educational facilities, more demand for better housing, high levels in poverty indices. If viewed against the limited resources, clearly population growth is a major challenge of the district. Poor farming practices coupled with lack of concern about forest conservation in the district has resulted in soil erosion and environmental degradation.

2.2.6 Main Issues/Problems

Rapid population growth has resulted in high population especially that of youth. Land has been fragmented into uneconomic holdings leading to environmental degradation. Other problems related to increasing child labour and family breakdowns. All these developments have taken place in an environment of insufficient integration of population and environmental concerns in the development process. The issues/problems concerning population and development in the district are therefore:

Population and development: The issue here is weak integration of population concerns into development planning due to lacking of training and poorly equipped DIDCs. Population and environment: Environment issues have been a major problem facing Machakos District. The effects of population and environment in the district include pollution from the industries, destruction of forests leading soil erosion and desertification.

Youth and Children: High unemployment rate, high rate of school dropout, high rate of early marriages and pregnancies and high rate of HIV/AIDs prevalence are the major concerns affecting youth and children. Child labour, orphans and street children are on the increase.

Family: The following issues affect families in Machakos District; increased instability in marriages; increased numbers of female-headed families; and high rate of wife inheritance.

Elderly and People with Disabilities: Problems facing elderly people and people with disabilities include increased poverty, increased rates of abandonment of elderly persons and PWD's, inadequate shelter and health for the elderly and PWD's.

3. ENVIRONMENTAL LEGISLATION IN KENYA

Kenyan Acts of Parliament which mention the environment and/or natural resources are numerous. But some are more direct than others, and thus indicate certain critical areas of legal intervention in the management of natural resources and the environment. A prominent feature of Kenya's environmental legislation is its diffuse nature with provisions being contained in about 77 statutes. Most of the statutes are sectoral either by the natural resources such as fisheries, water, forestry and wildlife, or by the functional sectors such as public health, agriculture, factories, mining, shipping or chiefs' authority

For analytical purpose, this report will briefly review relevant Kenyan statutes as discussed in the following categories: (1) Statutes relating to land use; (2) Water resources legislation; (3) Statutes on Environmental health including public health, the working environment, radiation control and disposal of hazardous wastes (4) Fisheries legislation; (5) Statutes on specially protected areas, including forests, wildlife and marine parks; (6) Statutes applicable to the Marine Environment; (7) Legislation relating to tourism.

3.1 Constitutional Provisions

Before we review the statutes relevant to environmental protection in Kenya, it is important to ascertain any provision relating to environmental protection in the national constitution. Although the current Constitution of Kenya does not have direct environmental protection provisions, it has been argued that Section 71 of the Constitution which deals with the right to life encompasses the right to a clean and healthy environment, as this right can only be meaningful if enjoyed within a conducive environment.

3.2 Land Tenure and Land Use Legislation

The following statutes cover land use activities with direct impact on the environment: the Agriculture Act (Cap. 318 of the Laws of Kenya); the Land Control Act (Cap. 302); the Chief's Authority Act (Cap 128); the Mining Act (Cap 306); the Local Government Act (Cap 268) the Trust Lands Act (Cap 288) the Land Planning Act (Cap. 303); Governments Land Act (Cap 280); the Physical Planning Act of 1996, the Registered Land Act (Cap 300) the Irrigation Act (Cap 347); the Crop Production and Livestock Act (Cap 321).

The Agriculture Act is the principle land use statute covering, *inter alia*, soil conservation and agriculture land use in general. Two major parts of the Act deals with the central conservation issues: preservation of soil fertility and prevention or control of soil erosion.

Watercourse and land abutting on these are also protected under the Rules. Cultivation, destruction of soil, cutting down of vegetation, or de-pasturing land within two meters of a watercourse is permissible only if done with a written consent of an authorized officer.

The Mining Act of 1972 (revised in 1987) is primarily for the purpose of stipulating the terms of mining as a commercial operation. However, the Act prohibits any nuisances or disturbance of the rights of the owner or occupier of any adjoining land. It similarly prohibits damage to such land, trees, crops, buildings, stocks or works thereon. The holder of a mining license is required to mine only for the minerals specified in the lease for the specific location. The license holder may cut, take and use trees from the leased land that may be necessary for the mining operation, provided that he obtains consent of the landowner or occupier. However, he remains civilly liable for any fees or royalties which may be payable under the national law.

3.3 Legislation Relevant to Water Resources

Water resources are dealt with under several Sectoral Statutes and it is not practical to bring all those statutes under one heading. The Agricultural Act (Cap 318), for instance has several provisions on water resources especially in relation to catchment conservation, because agriculture depends on water supply and security. But the Agriculture Act provides that where any provision there is inconsistent with a provision of the Water Act, the provisions of the latter shall prevail.

This part is therefore restricted to an overview of the Water Act No. 8 of 2002. The additional instruments in Kenya's law are the National Water Conservation and Pipeline Corporation Order of 1988 issued as Legal Notice No. 270 in 1988. Other legislation that have a bearing on the management of water resources include; the Forests Act (Cap 385), the Irrigation Act (Cap 347), the Malaria Prevention Act (Cap 246), the Fisheries Act (Cap 378), the Lakes and Rivers Act (Cap 409), the River Basin Development Authorities Act (Cap 443), the Maritime Zone Act (Cap 371) and all the land tenure and land use legislations.

The purpose of the Water Act according to its title is to provide for the management, conservation, use and control of water resources and for the acquisition and regulation of rights to use water, to provide for the regulation and management of water supply and sewerage services. Except for waters that are wholly situated in a private landowner's domain, the Act vests the rights over all surface and ground water in the state. This is only subject to the rights which users may acquire under license from time to time.

3.4 Environmental Health

The health of the environment is a broad issue that should apply to any activity occasioning environmental degradation. However, what we have in Kenya is construed rather narrowly to

apply only to environmental problems which affect the human body, but not including diseases. For brief analytical purposes, it is handled in four subsections, namely:

- Public Health,
- The Working Environment,
- Radiation Control,
- The Management of Hazardous Wastes.

3.4.1 Public Health

Under this section the review is confined to the provision of the Public Health Act (Cap 242), the Traffic Act (Cap 403), the Local Government Act (Cap 265), the Penal Code (Cap 63) and the Factories Act (Cap. 514). Within the Public Health Act, the sections on housing and prevention of mosquitoes are directly pertinent.

On sanitation, the Act borrows from the common law doctrine of nuisance which makes it an offence for any landowner or occupier to allow nuisance or any other condition liable to be injurious or dangerous to health to prevail on his land. A medical health officer, once satisfied of the danger, may issue an order requiring the owner or occupier of the land to remove the nuisance.

Fighting malaria is also a critical environmental task dealt under the Act. Part XII makes it an offence to leave on one's land or premises, any collection of water, sewage, rubbish, well, pool, gutter, channel cesspit, latrine, urinal or dump pit where mosquitoes may breed. Such a situation constitutes a nuisance. Any person who fails to clear such a nuisance is guilty of an offence under the Act.

Environmental health requirements are also provided for under the general powers and duties of the local authorities in the Local Government Act (Cap 265). Municipal Councils are required to provide and maintain sanitary services, sewage and drainage facilities, take measures for the control, destruction of rats, vermin, insects and pests, control or prohibit industries, factories and businesses which emit smoke, fumes, chemicals, gases, dust, smell, noise vibrations, discomfort or annoyance to the neighborhood, and to prohibit or control work or trade of disinfection or fumigation by cyanide or other means.

The Penal Code (Cap 65) carries the offence of common nuisance identical to that in the Public Health Act. The offence under the Penal Code is a misdemeanor punishable by imprisonment for one year. This however is distinct from that in the Public Health Act which may require the offender to abate the offence.

Air pollution is dealt with by the Traffic Act (Cap 403) and the Factories (Amendment) Act of 1990. The Factories Act specifically prohibits factories from emitting any dust, fumes or impurities into the atmosphere without undergoing appropriate treatment to prevent air pollution or other ill effects to life and property. The amendment further prohibits the use of any stationary internal combustion engine, discharging exhaust gas into the atmosphere without treatment.

The Traffic Act prohibits air pollution through Section 51 which requires that motor vehicle use proper fuels. The Rules promulgated under the Act provide that every vehicle be so constructed, painted and used as not to emit any smoke, or visible vapor.

Air pollution as a manifestation of nuisance is also prohibited under the Mining Act (Cap 306). Section 26 requires that a holder of prospecting or mining license who causes a nuisance or damage to a landowner or lawful occupier to pay reasonable compensation for such nuisance or damage.

3.4.2 The Working Environment

The two statutes relevant to this subject are the Factories Act (Cap 514) and the Mining Act (Cap 306). The primary environmental requirements under the Factories Act are that each factory must observe as high standards of cleanliness as are possible for the respective operations; avoid overcrowding, construct and maintain adequate ventilation, provide and maintain suitable natural or artificial lighting, as appropriate, provide drainage of floors and construct and maintain clean sanitary conveniences. The Minister for Labor may make rules specifying the requirements for these standards. All the standards prescribed and the rules promulgated by the Minister are however to be enforced by the local authority with the jurisdiction over the area in question.

3.4.3 Radiation Control

Since 1982, Kenya decided to join in the global movement for the use of nuclear energy for peaceful purposes, a movement lead by the International Atomic Energy Agency (IAEA). Most of such uses are in the fields of medicine, agriculture, energy and environmental monitoring. The dangers of injury to the public prompted the adoption of the Radiation Protection Act (Cap 243) in November 1984 to provide according to its citation, protection of the public and radiation workers from the dangers arising from the use of devices or materials capable of producing ionizing radiation and for connected purpose.

The Act prohibits the unauthorized manufacture, production, possession or use, sale, disposal, lease, loan or dealership, import, export of any irradiating device or radioactive material. All authorized buyers, sellers, users, of such device must be properly licensed.

3.4.4 Management of Hazardous Waste

In the foregoing section, we saw that radiation protection focuses largely on protection of human beings against injury by such wastes or radiations. The Public Health Act is also concerned with the protection of human health. Section 75 of the Constitution whose purpose is protection from the deprivation of property, empowers the government to acquire property “in circumstances where it is necessary to do so because that property is in a dangerous state or injurious to the health of human beings or animals or plants.” This is the closest reference to the protection of the environment and its resources.

3.5 Legislation on specifically protected areas

These are areas which through Gazettement by the government are designated as protected by law. Applicable statutes are the Forest Act, Cap 385, the Wildlife (Conservation and Management) Act, Cap 376 and the Water Act 2002. The principal legislation dealing with the management of wildlife resources is the Wildlife (Conservation and Management) Act of 1989. Wildlife in Kenya is classified as a national heritage held in trust for the benefit of the public. The administrative agency charged with the control and management of national parks and management of wildlife in general is the Kenya Wildlife Service (KWS). This regulatory regime requires that the Minister can declare that a given area is a national park, nature reserves or a sanctuary by gazette notice. The Act also provides for various offences and penalties thereof for those who enter and reside, hunt, collect products of bees or animals or their trophy, introduction of alien species, disturbing or quarrying, animals, damaging geological, pre-historic, archeological or marine and other scientific objects or structures lawfully placed in the parks, sanctuaries or reserves. In addition Cap 376 also provides for the regulation of the movement of tourists through the parks, as well as licenses for access thereto.

3.6 The Environmental Management and Co-ordination Act (EMCA)

The Environmental Management and Co-ordination Act No. 8 of 1999 is an Act of Parliament that provides for the establishment of an appropriate legal and institutional framework for the management of the environment. As earlier provided, prior to its enactment in 1999, there was no framework environmental legislation. Kenya’s approach to environmental legislation and administration was highly Sectoral and legislation with environmental management components had been formulated largely in line with natural resource sectors as aforementioned.

EMCA was developed as a framework law, and this is due to the fact that the Act is thus far, the only single piece of legislation that contains to date the most comprehensive system of environmental management in Kenya. The Act provides for the establishment of an appropriate legal and institutional framework for the management of the environment in Kenya and for matters connected therewith and incidental hereto. The Act is based on the recognition that

improved legal and administrative co-ordination of the diverse Sectoral initiatives is necessary in order to improve national capacity for the management of the environment, and accepts the fundamental principle that the environment constitutes the foundation of our national, economic, social, cultural and spiritual advancement. Section 3 of the Act enunciates the General Principles that will guide the implementation of the Act. Every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the environment. It is worth noting that the entitlement to a clean and healthy environment carries a correlative duty. Hence, there is not only the entitlement to a clean and healthy environment, but also the duty to ensure that the environment is not degraded in order to facilitate one's own as well as other persons' enjoyment of the environment.

3.6.1 Protection and Conservation of the Environment

Part V of E.M.C.A. provides legal tools for sustainable management of the environment. It covers the protection and management of wetlands, hilly and mountainous areas, forest, environmentally significant areas, the ozone layer and the coastal zone. It further provides for the conservation of energy and biological diversity, access to genetic resources and environmental incentives. This Part of EMCA delegates onto the Director General various responsibilities to ensure protection and sustainable management of the environment. In addition, the part also gives the Minister in charge of environmental affairs the mandate to give orders, directions or regulations and standards vide gazette notice.

3.6.2 Environmental Impact Assessment

The importance of public participation in decision-making in environmental matters is further highlighted by the requirement for Environmental Impact Assessment (EIA) study report under Part VI of the Act. Any person, being a proponent of a project is required to apply for and obtain an E.I.A licence from NEMA before he can finance, commence, proceed with, carry out, execute, or conduct any undertaking specified in the 2nd Schedule of the Act. The EIA study report is published and the public is given a maximum period of sixty days for inspection of the report and submission of oral or written comments on the same. Any person may extend this period on application. The EIA process, thus, gives individuals and communities a voice in issues that may bear directly on their health and welfare and entitlement to a clean and healthy environment.

3.6.3 Environmental Audit and Monitoring

Part 7 of the Act (Sections 68-69) gives NEMA the responsibility of carrying out environmental audits of all activities that are likely to have significant effect on the environment. In consultation with lead agencies, the Act also authorises NEMA to carry out environmental monitoring of all environmental phenomena and operations of industry, projects or activities to determine their impacts.

3.6.4 Waste Management Regulations, 2006

These Regulations apply to all categories of waste as is provided for. According to the regulations, no person should dispose of any waste on a public highway, street, road, recreational area or in any public place except in a designated waste receptacle. Any person whose activities generate waste shall collect, segregate and dispose or cause to be disposed off of such waste in the manner provided for under these Regulations. Any person whose activities generates waste has an obligation to ensure that such waste is transferred to a person who is licensed to transport and dispose off such waste in a designated waste disposal facility. Any person, whose activities generate waste, should segregate such waste by separating hazardous waste from non-hazardous waste and shall dispose of such wastes in such facility as is provided for by the relevant Local Authority. Any person who owns or controls a facility or premises which generates waste should minimize the waste generated by adopting the following cleaner production principles, namely:

- ❖ improvement of production process through:
 - i. conserving raw materials and energy
 - ii. eliminating the use of toxic raw materials within such time as may be prescribed by the Authority
 - iii. reducing toxic emissions and wastes
 - iv. monitoring the product cycle from beginning to end by:
 - a. Identifying and eliminating potential negative impacts of the product.
 - b. Enabling the recovery and re-use of the product where possible.
 - c. Reclamation and recycling.
 - v. Incorporating environmental concerns in the design, process and disposal of a product.

Every trade or industrial undertaking should install at its premises anti-pollution technology for the treatment of waste emanating from such trade or industrial undertaking. No owner or operator of a trade or industrial undertaking should discharge or dispose of any waste in any state into the environment, unless the waste has been treated in a treatment facility and in a manner prescribed by the Authority in consultation with the relevant lead agency.

a. Standards for Liquid Waste

Table 5: The effluent generated from any facility should conform to the following limits:

PARAMETERS	PERMISSIBLE LIMITS
pH	6.5-9.8.5
Suspended solids	100 mg/l
Oil and grease	Nil
BOD	30 mg/l
COD	50 mg/l
Bio-assay test	90% survival of fish after 96 hours in 100% effluent

3.7 The Occupational Safety and Health Act, 2007

Is an Act of Parliament to provide for the safety, health and welfare of workers and all persons lawfully present at workplaces, to provide for the establishment of the National Council for Occupational Safety and Health and for connected purposes. This Act shall apply to all workplaces where any person is at work, whether temporarily or permanently. The purpose of this Act is to secure the safety, health and welfare of persons at work and protect persons other than persons at work against risks to safety and health arising out of, or in connection with, the activities of persons at work.

According to the Act, every occupier shall ensure the safety, health and welfare at work of all persons working in his workplace. Without prejudice to the generality of an occupier's duty under subsection (1), the duty of the occupier includes the provision and maintenance of plant and systems and procedures of work that are safe and without risks to health; arrangements for ensuring safety and absence of risks to health in connection with the use, handling, storage and transport of articles and substances; the provision of such information, instruction, training and supervision as is necessary to ensure the safety and health at work of every person employed, the maintenance of any workplace under the occupier's control, in a condition that is safe and without risks to health and the provision and maintenance of means of access to and egress from it that are safe and without such risks to health; the provision and maintenance of a working environment for every person employed that is, safe, without risks to health, and adequate as regards facilities and arrangements for the employees welfare at work; informing all persons employed of any risks from new technologies; and imminent danger; and ensuring that every person employed participates in the application and review of safety and health measures. Every occupier shall carry out appropriate risk assessments in relation to the safety and health of persons employed and, on the basis of these results, adopt preventive and protective measures to ensure that under all conditions of their intended use, all chemicals, machinery, equipment, tools and process under the control of the occupier are safe and without risk to health and comply with the requirements of safety and health provisions in this Act.

Every occupier shall send a copy of a report of risk assessment carried out under this section to the area occupational safety and health officer; every occupier shall take immediate steps to stop any operation or activity where there is an imminent and serious danger to safety and health and to evacuate all persons employed as appropriate. It is the duty of every occupier to register his workplace unless such workplace is expected from registration under this Act. An occupier who fails to comply with a duty imposed on him under this section commits an offence and shall on conviction be liable to a fine not exceeding five hundred thousand shillings or to imprisonment for a term not exceeding six months or to both.

It is also the duty of every occupier to prepare and, as often as may be appropriate, revise a written statement of his general policy with respect to the safety and health at work of his employees and the organisation and arrangements for the time being in force for carrying out that policy; and to bring the statement and any revision of it to the notice of all of his employees.

3.8 The National Health Care Waste Management Plan 2008-2012

The National Health Care Waste Management Plan of Action is a document intended for use by health managers and programme officers across the health sector (including those in the private health sector). The purpose of developing this plan was to provide a tool that gives health managers guidance in planning, implementing and monitoring the activities of health care waste management in health facilities.

This plan describes the situation of health care waste management on the basis of a survey which was conducted in order to document the situation of waste management in Kenya. A holistic approach has been recommended to include, clear delineation of responsibilities, occupational health and safety programmes, waste minimization and segregation. This document is designed to provide viable options to address the challenges encountered in planning for health care waste management in Kenya.

3.9 Kenya National Guidelines on Safe Disposal of Pharmaceutical Waste, 2001

The provisions of these guidelines describe a series of steps that need to be followed in order to dispose unwanted pharmaceuticals. The steps required include; identification of pharmaceutical waste, sorting of pharmaceutical waste by category, filling the relevant forms to seek authority from the DHMT and the Chief Pharmacist among other persons to dispose such waste. Upon obtaining all the relevant approvals, the disposal of the pharmaceutical waste shall be effected under the supervision of the local pharmaceutical waste disposal team or the Waste Management Team (WMT).

The recommended methods for disposing of unwanted pharmaceuticals include:

- ✓ The use of either medium temperatures incineration at a minimum of 850°C or high temperature incineration exceeding 1200°C with two chamber incinerator for solids, semi-solids and powders for controlled substances e.g. anti-neoplastics.
- ✓ Engineered sanitary landfill to be used for disposal of expired or unwanted pharmaceuticals.
- ✓ Sewer disposal for diluted liquids, syrups, intravenous fluids, small quantities of diluted disinfectants and antiseptics.

3.9.1 National Policy on Injection Safety and Medical Waste Management

The mission statement of this policy is to ensure safety of health workers, patients, and the community and to maintain a safe environment through the promotion of safe injection practices and proper management of related medical waste. This is the first document of the Ministry of Public Health and Sanitation that is explicit on the need to address health waste management problems. The policy objectives spell out the need to advocate for support and implementation of proper management of medical waste among others.

Some of the guiding principles for the implementation of this policy include:

- ✓ Establishment of organizational structures at all levels for all the implementation of injection safety and related medical waste.
- ✓ The policy also addresses the need for environmental protection through appropriate waste disposal methods.
- ✓ Minimization of risks to patients, health workers, communities and the environment through application of safer injection devices and sharps waste disposal methods.
- ✓ Advocating for the strengthening of the necessary human resource capacity through training and sensitization for safe waste disposal

The provision of sustained supplies and equipment for waste management through strengthened logistics system addresses the need for commensurate investment in waste handling requirements. A unique strategy recommended also is the advocacy of best waste management practices through behaviour change communication as a key element in the strategy.

3.10 Radiation Protection Act, Cap 243

The Radiation Protection Act, Chapter 243, aims to control the; import, export, possession and use of radioactive substances and irradiating apparatus. Under this Act in section 9, a license is required to handle any radioactive substances or irradiating apparatus from the National Radiation Protection Board.

Handling here includes the method of disposing of radioactive waste products, transportation of radioactive materials, storage, use and maximum working hours that employees are expected to work with radioactive materials. Under this Act also, institutions generating this category of waste shall be expected to apply for a license from the same board.

4. CONSULTATIONS AND PUBLIC PARTICIPATION (C&PP)

The integration of public participation/involvement of stakeholders in EIA process is very important in terms of its implication for sound decision making and the sustainability of development activities. In this regard, the Kenya EIA Procedures provide for the involvement of stakeholders and the public in the assessment and review of proposed undertakings. This is achieved through a number of mechanisms, including the administration of questionnaires.

Public participation is a key component of an EIA and is used to integrate citizens into the environmental decision-making process. Traditional decision-making approaches such as closed-door discussions between politicians and experts are no longer appropriate. Public participation, if it is to be democratic, must foster trusting relationships through open and honest negotiations between proponents and the public (Barrington et al., 2003).

But it should be evident, when necessary, that a plan for public involvement was developed early in the process. The public should be provided with sufficient information about the proposed project and properly understand the project and issues to be able to give informed comments and participate fully in the process (Huang et al., 2003). It is important that there is evidence that all public comments are considered in the formulation of the list of concerns. All public comments should be recorded without judgment or prioritizing in the initial stages of the process (UNEP, 2002; Huang et al., 2003).

The public must be involved early in the process (Barrington et al., 2003). The public must not be placed in a reactive position. Decisions must not be evaluated after they have been made but rather participants must be involved at all stages of the EIA process. The public must be given sufficient time to digest information and prepare its comments, while keeping the whole procedure within a reasonable time frame.

Public and Stakeholders' involvement in the EIA process is essential and may lead to enormous benefits for the proponent, stakeholders and the nation. Where this is ignored, conflicts and problems may be created for project implementation and sustainability. Not only does the involvement of the public in the EIA process often strengthen the project, but public participation is required by the Environmental Management and Coordination Act (Environmental Impact Assessment) (EMCA-1999). The participation of beneficiaries and partners and the public in general has been identified as an essential component in ensuring sustainable and conflict free development.

To accomplish the mission of getting the public's opinion on the proposed project, one on one discussion with neighbors to gather the public opinions on the proposed laboratory project. The respondents included business people, patients and the residents of the region. All the respondents were in support for the project.

4.1 Concerns raised by the participants

4.1.1 Creation of job opportunities

All the respondents are eager to see the project implemented. Due to high rates of unemployment in Kenya, they believe that during construction, skilled and non-skilled workers will be contracted and after completion, it will create employment opportunities for the residents as laboratory technicians, security personnel, management agents, cleaners and care takers.

4.1.2 Improvement of infrastructure

Respondents are expecting that after the completion of the project, there will be reconstruction of the roads and/or pavements around the site for its easy accessibility. This is because they expect the proponent to improve some of the roads surrounding the site, something that has been assured by the proponent.

4.1.3 Gains in the Local and National Economy

Respondents are expecting gains in the local and National Economy through payment of relevant taxes, rates and fees by the project proponent to the government and the local authority. As well, in the implementation of the project, the proponent will purchase massive loads of construction materials with a high multiplier effect.

4.1.4 Environmental concerns raised by the respondents

a) Noise pollution

Respondents feared the possibility of high levels of noise in the project site as a result of construction. Causes of noise will include cutting equipment, construction machinery, metal grinding, large trucks carrying construction materials to the site. The proponent is expected to ensure good maintenance of the equipment in the construction as well as providing the workers with protective equipment such as noise muffles. The proponent is also expected to undertake his work during the day (between 6am and 6pm)

b) Dust Emissions

Respondents expressed concern over dust emissions within the development site and the surrounding areas, especially during the construction period. Dust emissions from building materials such as cement and sand could affect the people working in the neighborhood and workers health as it causes allergies, respiratory diseases, eye problems and visibility problem. To

minimize dust levels the proponent should ensure trucks carrying building materials such as soil and sand are covered and sprinkle the construction site with water to keep dust down as much as possible.

c) Increased water demand

Respondents fear that large quantities of water will also be used for construction in the mixing processes. They also raised concerns that after completion of the project, there will be an increase of population in the area leading to a strain on water resources. The proponent is expected to initiate roof water harvesting during rainy seasons to ensure there is sufficient water for domestic uses in the health facility. Also the proponent is expected to ensure that he fixes automatic water taps to help conserve water.

d) Solid waste generation

Respondents said that there is a possibility of large quantities of solid waste to be generated. During construction, empty cartons, empty paint and solvent containers and broken glasses left lying at the construction site will affect the aesthetic value of the surrounding environs as they are non-biodegradable. Sharp metals at the site might cause accidents to the workers. The Laboratory will also generate solid wastes such as medicinal wastes (syringes, needles and cotton wool) plastic paper bags, clothing, food stuffs. Therefore there is a need for the proponent to provide bins for the collection of the waste for the laboratory and contract a private company to ensure proper handling of the wastes. The incinerator meet the standard requirement, energy should be sufficiently done and regular inspection done for its effectiveness.

e) Generation of exhaust emissions

Respondents expressed fear of generation of exhaust emissions from the trucks transporting the building materials to the construction site. Emissions containing carbon dioxide and other gases may have an impact on the health of the workers and people in the neighborhood. The proponent is supposed to ensure that vehicle engines are switched off when not in use, equipment to be properly maintained as well as ensuring that non-leaded fuel is used. The chimney in the incinerator should be raised to standard this will help emissions rise high and prevent smoke being blown around the facility. Planting more trees around the facility is encouraged which will help refresh the air.

f) Risks of Accidents and Injuries to Workers and the public

Respondents fear that because of the intensive construction activities including erection and fastening of roofing materials, metal grinding and cutting, concrete work, steel erection and welding among others, construction workers will be exposed to risks of accidents and injuries. Such injuries can result from accidental falls from high elevations, injuries from hand tools and

construction equipment and cuts from sharp edges of metals and metal sheets among others. The proponent is expected to provide appropriate personal protective equipment to the workers as well as providing or setting up a first aid corner at the construction site to handle emergency cases.

The public could also be exposed to accidents such as falling debris. This will be avoided by ensuring that nobody is allowed within the development site unless he/she is in full protective gears.

g) Increased traffic jam in the area

Those operating from the surrounding areas of the site felt that traffic inconveniences will be high especially during the construction period, something which could inconvenience them. To avoid this, the proponent has proposed to improve on the access roads as well as increasing on inlets to the site

4.0 PROJECT ALTERNATIVE

4.1 Introduction

This chapter analyses the project alternative in terms of site, technologies and non-implementation. The purpose of including alternatives in the EIA is to identify and evaluate alternate actions that accomplish similar goals and promote sustainable development (Anderson et al., 2003). Alternatives should be economically feasible with minimal adverse environmental impacts and time delays. Diverse alternatives to the proposed action must be included in the EIA. Alternatives may include both design and location options (Steinneman, 2000).

In most cases, the EIA process often occurs too late in decision-making to consider a full range of alternatives. This can undermine EIA goals to encourage more environmentally sound and publicly acceptable solutions. Allowing new alternatives and objectives to evolve in relation to environmental conditions and public preferences may be a solution to most of the environmental and socio-economic problems associated with the implementation of new projects (Anderson et al., 2003).

4.2 No-action alternative

The ‘**no-action**’ alternative, which serves as a baseline for comparative analysis, must be included where the environmental impacts of taking the proposed action is too high compared to the impact of not taking the proposed action. The No project alternative option in respect to the proposed project implies that the status quo is maintained. This option is the most suitable alternative from an extreme environmental perspective as it ensures non-interference with the existing conditions.

Under No project option, the proponent’s proposal would not receive necessary approval from Authorities. The proposed construction would not be implemented. This option would however, involve several losses both to the proponent and the community as a whole. The No Project Alternative option is the least preferred from the socio-economic and partly environmental perspective due to factors such as the economic status of the Kenyans would remain unchanged; The local skills would remain under utilized (in terms of labor provision); Increased poverty and crime in Kenya due to lack of job opportunities; and The health sector would continue to suffer due to lack of enough health services in the area

4.3 Renovation option

Renovation of the existing project is also one of the alternatives in ensuring the environmental status of the area is not affected. But, it is quite clear that as per the current situation, the proposed project cannot be renovated. This may require parts of the new laboratory to sit on top of the existing Laboratory which is not tenable due to the excessive levels of demolitions to be carried out

and also that it may not have the structural strength / integrity of the building. In this regard, the best option is to provide a new laboratory for the facility and which is in line with the schedule of accommodation.

4.4 Relocation option

Relocation of the proposed project is also one of the alternatives in ensuring the environmental status of the area is not affected. But, it is quite clear that as per the current situation, the proposed project cannot be relocated. The reason behind this is that the proponent currently owns the proposed site of development, hence getting an alternative site could be a very expensive venture. Hence this is not an economically viable alternative. The laboratory will also serve the Machakos District Hospital, in which compound the facility will be constructed.

4.5 Waste Water Treatment Systems

The proponent has a variety of waste water treatment systems to choose from, which include the construction and utilization of bio-digesters, septic tanks, bio-box technologies or connecting to a sewer line.

4.5.1 Bio-digesters

The main physical features, the principles and process of bio-digestion are basically the same, regardless of the type of digester used. All bio-digesters degrade organic wastes to give methane which can be burnt to give energy. According to studies by Brown (1987), Silayo (1992) and Lekule (1996) the following advantages of the biogas technology were cited:

- ✓ It provides an alternative source of energy thus reducing the rate of deforestation
- ✓ It is a relatively cheap source of energy
- ✓ It improves crop-livestock-tree system through nutrient cycling
- ✓ It reduces time and workload of collecting fuel wood
- ✓ It reduces kitchen smoke-pollution thereby promoting human health
- ✓ It promotes good health through safe treatment of organic waste
- ✓ As a renewable source of energy, it provides a reliable power supply that is environmentally friendly
- ✓ It is a rich source of nitrogen, phosphorus (P), potassium (K) and other macro- and micronutrients

But it needs a lot of care. It is highly involving and needs a highly committed community that is cooperative. No detergents/chemicals should find their way into the bio-digester. This is difficulty to monitor in a population characterized by people of different culture and values to such systems.

This means the chances of a bio-digester failing are high. Once it fails, it can easily lead to environmental pollution.

4.5.2 Septic tank

This also one of the commonly utilized methods of treating sewage in urban set ups. But for a large urban population, it could be expensive to maintain and thus become an unsustainable way of handling wastewater. For this project, a septic tank and a soak could be appropriate option and sustainable way of managing wastewater provided it is built to the specified standards and well maintained.

4.5.3 Bio-box technology

Bio-box is a complete waste water treatment system (typically known as a packaged plant), suitable for establishments producing from 2m³ up to 320m³ (320,000 litres) of sewage per day. Typically, the establishment is not connected to a municipal sewerage system, and is thus responsible for disposing of its own effluent by means of a conservancy tank, septic tank or French drain.

A Bio-box sewage treatment plant treats the effluent on-site and produces clear, odourless and environmentally safe water for the irrigation of lawns, sports fields, golf courses and agricultural plots – or for filling dams where wildlife comes to drink, such as below a game lodge viewing platform, or simply to return it to the environment in streams, rivers or dams.

The system is modular in design and can thus be replicated to meet increasing demands for treatment from 2m³ to 320m³ (320,000litres) per day if required. Bio-box can treat both grey water (from laundries, baths, basins, kitchen sinks) and black water (toilet water). However, the technology needs electricity energy to run efficiently, hence if one can access a technology that needs no power to run, it becomes cheaper in the long run.

4.5.4 Connection to a Sewer Line

Following an assessment of the area surrounding the development site, it was established that a sewer line is available on site. This is therefore the only viable option to handle waste water.

5.0 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

5.1 Introduction

A summary of the potential impacts on the socio-economic and biophysical environment is given below. Impacts are assessed in terms of their magnitude (size) and significance (importance). Actions necessary to mitigate potential impacts are given. Impacts' monitoring requirements are summarized in a section of this report.

5.2 Construction phase- Potential Environmental and Social Impacts

Construction phase negative impacts would include: stress on infrastructure as a result of increased population and vehicle traffic, soil erosion, possible surface and ground water hydrology changes and water quality degradation, solid waste generation, noise pollution, dust emissions, generation of exhaust emissions, increased water demand, increased energy consumption, increased use of building materials, likely accidents; physical and economic displacement and diseases. To ameliorate against the potential negative effects:

- Awareness creation and education of the project communities regarding HIV/AIDS and other diseases.
- The contractor will ensure that all machines are well tuned and maintained to reduce amount of exhaust emission.
- We recommend that delivery of construction materials to the site be well coordinated to reduce vehicle traffic jams in the area as well as possible accidents. By reducing traffic jam, the amount of engine idling of transportation trucks and other vehicles will be reduced considerably thus reducing on the exhaust emission released to the atmosphere.
- All materials will be ordered as per need to avoid over piling on site which leads to destruction of materials and unnecessary obstruction.
- The construction will be done in design that will allow for natural ventilation and lighting as well as both vertical and horizontal ventilation. The incorporation of natural ventilation and lighting will contribute to the reduction of the amount of energy consumed in artificial ventilation and lighting. Landscaping and greening of the buildings will be a contribution to the ongoing beautification and greening of the city, a factor that will subsequently be beneficial to carbon sequestration within the city.
- To save on water, the construction would also incorporate water saving designs such as waterless urinals in common areas, self timing taps and low volume water closets. Water harvesting from the roof will be implemented to provide water for cleaning, landscaping and use in the toilets. Roof water harvesting will also lead to the reduction of the amount of runoff within the area hence controlling the flooding that afflicts parts of the city during the rain seasons.

- Emergency escape routes will also be incorporated during this stage.
- To safeguard against accidental falls, all balconies and staircases will be fitted with metal rails and grills.
- Waste handling cubicles will also be constructed during this stage.
- To protect the health of workers on the site, they should be provided with protective gears and the contractor ensures that they make full use of them. Workers should not be forced or allowed to lift heavy loads. All materials on site should not be piled to heights that are prone to accidental falls. First Aid kits and emergency numbers should be conspicuously displayed. This means that someone trained in administering first aid should be present at the construction site all the time of the work. An insurance cover by the contractor should be acquired to compensate for any unforeseen medical emergencies and injuries or destructions
- Provisions should be included during the construction period to allow for greening of public places. The proponent is committed to this.

On the other hand the anticipated positive impacts include: creation of alternative employment opportunities, improving growth of the economy, improved health services, and provision of market for supply of construction materials and other services.

5.3 Operational Phase- Potential Environmental and Social Impacts

5.3.1 The Scope of the EIA during the Operating Phase

After the initial general assessment of all the proposed facilities, installations, activities, the general environment in and around the Health Care Facility and discussion with the proponent, we focused our assessment on the following issues: -

- Environmental conservation activities and Environmental awareness
- Energy utilization and conservation
- Water Utilization and Conservation
- The Laboratory Operations
- Waste disposal and management
- Health and safety

5.3.2 Environmental Conservation Activities

It was observed that the Machakos Hospital has an incinerator. It is also connected to a sewer line to ensure management of liquid waste from the health care facility.

5.3.3 Water Utilization and Conservation

Water will be utilized in the bathrooms, sanitation services, in the laboratory operations and for general cleaning purposes. This water will be sourced from Machakos Water and Sanitation Company supply.

But it should also be noted that no roof water harvesting because the facility utilizes asbestos roofing materials. The proponent should initiate roof water harvesting and install water storage tanks within the facility. This means the roofing material has to be changed from asbestos to iron sheets.

5.3.4 Waste Disposal and Management

a. Liquid Waste Management (Human Excrement)

The Laboratory under assessment will be served by sewer line system. This means that flushing toilets will be fitted in each floor, both for men and women. The proponent has designed the sanitation facilities such that they will be fitted with easy to clean tiles on their walls. They should be constructed in such a way that they are friendly to the disabled.

b. Liquid Bio-Medical Waste

Handling of bio-medical waste is proving to be an overwhelming challenge for the health sector in general. However, within the broader theme of bio-medical waste, liquid bio-medical waste is emerging as particularly difficult to handle. Liquid biomedical waste is far more mobile and moves to a wider area after entering the subsurface water bodies or underground aquifers.

i. Challenge of Liquid Bio-Medical Waste

Most existing systems and technologies being used in handling liquid bio-medical waste are failing to address this problem. For instance, the routine exercise of pouring biomedical liquid waste is being questioned for posing higher infection threat to medical staff due to its susceptibility to spilling, splashing and aerosolising. Liquid bio-medical waste, if untreated, contains a wide variety of material that poses health hazards.

ii. Liquid bio-medical waste standards

According to the Waste Management Regulations (*EMCA provision, Sep. 2006*), liquid pathological and chemical waste should be appropriately treated before discharge into the sewer. Pathological waste must be treated with chemical disinfectants, neutralised and then flushed into the sewage system. Chemical waste should first be neutralised with appropriate reagents and then flushed into the sewer system.

The treated effluent should conform to the limits as provided for under Waste Management Regulations of 2006. These limits are applicable to hospitals that are either connected with sewers without terminal sewage treatment plant or not connected to public sewers for discharge into public sewers with terminal facilities. Minimal safety requirements where medical establishments cannot afford treatment of biomedical liquid waste, following measures should be undertaken to reduce risks:

- ✓ Patients with enteric diseases should be isolated to wards where their excreta can be collected in buckets for chemical disinfection. This is of utmost importance in cases of cholera outbreaks.
- ✓ No chemicals or pharmaceuticals should be discharged into the septic before undergoing neutralization
- ✓ Sludges from hospital cesspools should be dehydrated on natural drying beds and disinfected chemically (for example, with sodium hypochlorite, chlorine gas, or preferably chlorine dioxide).
- ✓ Sewage from health care facilities should never be used for agricultural, aqua-cultural, drinking water, or recreational purposes.

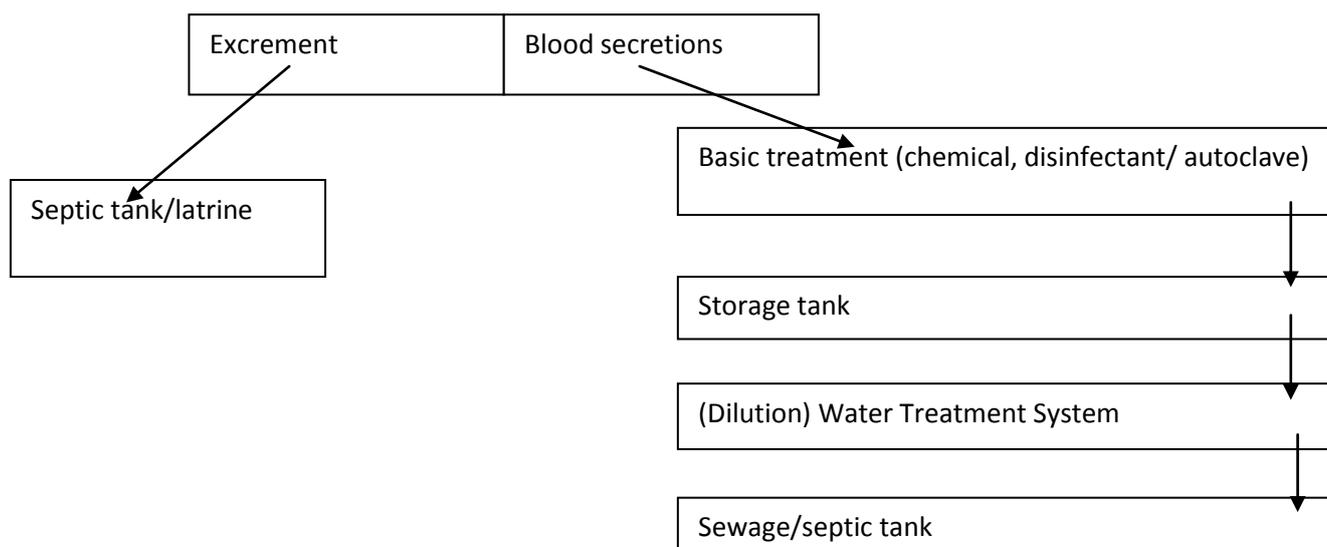


Figure 3: Diagrammatic presentation of the recommended liquid bio-medical waste treatment system

5.3.5 Solid Waste Generation and Management

In Kenya and the world over, health-care services inevitably generate wastes that may be hazardous to health or have harmful environmental effects. Potentially infectious waste such as; sharps, cultures from medical laboratories or infected blood, carry a higher risk for infection and injury than any other type of waste. Other wastes of significant importance include; body fluids, all body parts, human tissues, placenta and radioactive waste among others. The absence of proper management measures to prevent exposure to hazardous health-care waste (HCW) results in

important health risks to the general public, in- and out-patients as well as the medical and the supportive staff.

Improper disposal of health care solid waste may result in syringes and needles being scavenged and reused thus leading to significant numbers of hepatitis B, hepatitis C, and HIV infections among others. Even after the formulation of policies and laws on health care waste management, many health care establishments in Kenya still lack enforcement of legislation for handling, and disposal of health care waste. Furthermore, improper treatment or disposal of HCW such as open-air burning can constitute a significant source of pollution to the environment through the release of substances such as dioxins, furans or mercury. It is worthy to note that the proposed Facility is not peculiar and hence the above scenario applies to it. They generate what could be termed as Hospital Waste or Health Care Waste or Bio-Medical Waste.

Waste to be generated from the Health Care Facility includes sharps, bandages, cotton, syringes, paper, bottles, plastics and polythene (packaging materials) not to forget cultures and liquid waste.

A. Potential Health impacts of health-care waste

a) Types of hazards

Exposure to hazardous health-care waste can result in disease or injury. The hazardous nature of health-care waste may be due to one or more of the following characteristics:

- ✓ it contains infectious agents;
- ✓ it is genotoxic;
- ✓ it contains toxic or hazardous chemicals or pharmaceuticals;
- ✓ it is radioactive;
- ✓ It contains sharps.

b) Persons at risk

All individuals exposed to hazardous health-care waste are potentially at risk, including those within health-care facility that generate hazardous waste, and those outside these sources who either handle such waste or are exposed to it as a consequence of careless management. The main groups at risk are the following:

- ✓ medical doctors, nurses, health-care auxiliaries, and hospital maintenance personnel;
- ✓ patients in health-care establishments or receiving home care;
- ✓ visitors to health-care establishments;

- ✓ workers in support services allied to health-care establishments, such as laundries, waste handling, and transportation;
- ✓ Workers in waste disposal facilities (such as landfills or incinerators), including scavengers.

The hazards associated with scattered, small sources of health-care waste should not be overlooked; waste from these sources includes that generated by home-based health care, such as dialysis, and that generated by illicit drug use (usually intravenous).

c) Hazards from infectious waste and sharps

Infectious waste may contain any of a great variety of pathogenic microorganisms. Pathogens in infectious waste may enter the human body by a number of routes:

- ✓ through a puncture, abrasion, or cut in the skin;
- ✓ through the mucous membranes;
- ✓ by inhalation;
- ✓ By ingestion

Concentrated cultures of pathogens and contaminated sharps (particularly hypodermic needles) are probably the waste items that represent the most acute potential hazards to health. Sharps may not only cause cuts and punctures but also infect these wounds if they are contaminated with pathogens. Because of this double risk of injury and disease transmission sharps are considered as a very hazardous waste class. The principal concerns are infections that may be transmitted by subcutaneous introduction of the causative agent, e.g. viral blood infections. Hypodermic needles constitute an important part of the sharps waste category and are particularly hazardous because they are often contaminated with patient's blood.

d) Hazards from chemical and pharmaceutical waste

Many of the chemicals and pharmaceuticals used in the health-care establishments are hazardous (e.g. toxic, genotoxic, and corrosive, flammable, reactive, explosive, and shock-sensitive). These substances are commonly present in small quantities in the health-care waste; larger quantities may be found when unwanted or outdated chemicals and pharmaceuticals are disposed of. They may cause intoxication, either by acute or by chronic exposure, and injuries, including burns. Intoxication can result from absorption of a chemical or pharmaceutical through the skin or the mucous membranes, or from inhalation or ingestion. Injuries to the skin, the eyes, or the mucous membranes of the airways can be caused by contact with flammable, corrosive, or reactive chemicals (e.g. formaldehyde and other volatile substances). The most common injuries are burns.

Disinfectants are particularly important members of this group: they are used in large quantities and are often corrosive. It should also be noted that reactive chemicals may form highly toxic secondary compounds. Obsolete pesticides, stored in leaking drums or torn bags, can directly or indirectly affect the health of anyone who comes into contact with them.

During heavy rains, leaked pesticides can seep into the ground and contaminate the groundwater. Poisoning can occur through direct contact with the product, inhalation of vapours, drinking of contaminated water, or eating of contaminated food. Other hazards may include the possibility of fire and contamination as a result of inadequate disposal such as burning or burying.

The proposed Health Care Facility will be well equipped with firefighting equipment. All laboratory water sinks should be connected to a dilution chamber before reaching the main septic tank.

This is because chemical residues discharged into the sewerage system may have adverse effects on the operation of biological sewage treatment plants or toxic effects on the natural ecosystems of receiving waters. Similar problems may be caused by pharmaceutical residues, which may include antibiotics and other drugs, heavy metals such as mercury, phenols, and derivatives, and disinfectants and antiseptics. Although the Health Care Facility under study will not be connected to a sewer system, it will utilize a septic tank system, which has some biological functions as well.

e) Hazards from genotoxic waste

The severity of the hazards for health-care workers responsible for the handling or disposal of genotoxic waste is governed by a combination of the substance toxicity itself and the extent and duration of exposure. Exposure to genotoxic substances in health care may also occur during the preparation of or treatment with particular drugs or chemicals. The main pathways of exposure are inhalation of dust or aerosols, absorption through the skin, ingestion of food accidentally contaminated with cytotoxic drugs, chemicals, or waste, and ingestion as a result of bad practice, such as mouth pipetting. Exposure may also occur through contact with the bodily fluids and secretions of patients undergoing chemotherapy. The cytotoxicity of many antineoplastic drugs is cell-cycle-specific, targeted on specific intracellular processes such as DNA synthesis and mitosis. Other anti-neoplastics, such as alkylating agents, are not phase specific, but cytotoxic at any point in the cell cycle. Experimental studies have shown that many antineoplastic drugs are carcinogenic and mutagenic; secondary neoplasia (occurring after the original cancer has been eradicated) is known to be associated with some forms of chemotherapy.

Many cytotoxic drugs are extremely irritant and have harmful local effects after direct contact with skin or eyes. They may also cause dizziness, nausea, headache, or dermatitis. Special care in

handling genotoxic waste is absolutely essential; any discharge of such waste into the environment could have disastrous ecological consequences.

f) Public sensitivity

Quite apart from fear of health hazards, the general public is very sensitive about the visual impact of anatomical waste that is recognizable human body parts including fetuses. In no circumstances is it acceptable to dispose of anatomical waste inappropriately, such as on a landfill or together with other solid wastes.

In some cultures, especially in Asia, religious beliefs require that human body parts be returned to a patient's family, in tiny "coffins" to be buried in cemeteries. The Muslim culture, too, generally requires that body parts are buried in cemeteries.

B. Potential Public health impact of health-care waste

a. Impacts of infectious waste and sharps

For serious virus infections such as HIV/AIDS and hepatitis B and C, health-care workers particularly nurses and laboratory technicians are at greatest risk of infection through injuries from contaminated sharps (largely hypodermic needles). Other hospital workers and waste-management operators outside health-care establishments are also at significant risk, as are individuals who scavenge on waste disposal sites. The risk of this type of infection among patients and the public is much lower. Certain infections, however, spread through other media or caused by more resilient agents, may pose a significant risk to the general public and to hospital patients. For instance, uncontrolled discharges of sewage from field hospitals treating cholera patients have been strongly implicated in cholera epidemics. It is for this reason that we recommend the proper connection of laboratory discharge systems and not, under any circumstances be left to empty into the open.

b. Potential Impacts of chemical and pharmaceutical waste

While there is no scientifically documented incidence of widespread illnesses among the general public due to chemical or pharmaceutical waste from hospitals, many examples may be found of extensive intoxication caused by industrial chemical waste. Moreover, many cases of injury or intoxication result from the improper handling of chemicals or pharmaceuticals in health-care establishments. Pharmacists, anaesthetists, and nursing, auxiliary, and maintenance personnel may be at risk of respiratory or dermal diseases caused by exposure to such substances as vapours, aerosols, and liquids. To minimize this type of occupational risk, protective equipment should be provided to all personnel likely to be exposed. Premises where hazardous chemicals are used should be properly ventilated, and personnel at risk should be trained in preventive measures and

in emergency care in case of accident. It should be made mandatory for all workers to be in protective gears when within the facilities.

5.3.6 Emergency response

One person should be designated as responsible for the handling of emergencies, including coordination of actions, reporting to managers and regulators, and liaising with emergency services, and a deputy should be appointed to act in case of absence.

In health-care establishments, spillage is probably the most common type of emergency involving infectious or other hazardous material or waste. Response procedures are essentially the same regardless of whether the spillage involves waste or material in use, and should ensure that:

- ✓ The waste management plan is respected;
- ✓ Contaminated areas are cleaned and, if necessary, disinfected;
- ✓ Exposure of workers is limited as much as possible during the clearing up operation;
- ✓ The impact on patients, medical and other personnel, and the environment is as limited as possible.

Health-care personnel should be trained for emergency response, and the necessary equipment should be to hand and readily available at all times to ensure that all required measures can be implemented safely and rapidly. Written procedures for the different types of emergencies should be drawn up and well displayed. For dangerous spills, the clean-up operation should be carried out by designated personnel specially trained for the purpose.

5.3.7 Dealing with spillages

Spillages usually require clean-up only of the contaminated area. For spillages of infectious material, however, it is important to determine the type of infectious agent; in some cases, immediate evacuation of the area may be necessary. In general, the more hazardous spillages occur in laboratories rather than in health-care departments. Procedures for dealing with spillages should specify safe handling operations and appropriate protective clothing. An example of such a procedure is provided below. Appropriate equipment for collecting the waste and new containers should be available as should means for disinfection.

In case of skin and eye contact with hazardous substances, there should be immediate decontamination. The exposed person should be removed from the area of the incident for decontamination, generally with copious amounts of water. Special attention should be paid to the eyes and any open wounds. In case of eye contact with corrosive chemicals, the eyes should be irrigated continuously with clean water for 10-30 minutes; the entire face should be washed in a

basin, with the eyes being continuously opened and closed. Example of general procedure for dealing with spillages:

- i. Evacuate the contaminated area.
- ii. Decontaminate the eyes and skin of exposed personnel immediately.
- iii. Inform the designated person (usually the Waste Management Officer), who should coordinate the necessary actions.
- iv. Determine the nature of the spill.
- v. Evacuate all the people not involved in cleaning up if the spillage involves a particularly hazardous substance.
- vi. Provide first aid and medical care to injured individuals.
- vii. Secure the area to prevent exposure of additional individuals.
- viii. Provide adequate protective clothing to personnel involved in cleaning-up.
- ix. Limit the spread of the spill.
- x. Neutralize or disinfect the spilled or contaminated material if indicated.
- xi. Collect all spilled and contaminated material. [Sharps should never be picked up by hand; brushes and pans or other suitable tools should be used. Spilled material and disposable contaminated items used for cleaning should be placed in the appropriate waste bags or containers.
- xii. Decontaminate or disinfect the area, wiping up with absorbent cloth. The cloth (or other absorbent material) should never be turned during this process, because this will spread the contamination. The decontamination should be carried out by working from the least to the most contaminated part, with a change of cloth at each stage. Dry cloths should be used in the case of liquid spillage; for spillages of solids, cloth impregnated with water (acidic, basic, or neutral as appropriate) should be used.
- xiii. Rinse the area, and wipe dry with absorbent cloth.
- xiv. Decontaminate or disinfect any tools that were used.
- xv. Remove protective clothing and decontaminate or disinfect it if necessary.
- xvi. Seek medical attention if exposure to hazardous material has occurred during the operation.

(Adapted from: Reinhardt & Gordon (1991). Infectious and medical waste. Chelsea, MI, Lewis.)

5.3.8 Reporting accidents and incidents

All waste management staff should be trained in emergency response and made aware of the correct procedure for prompt reporting. Accidents or incidents, including near-misses, spillages, damaged containers, inappropriate segregation, and any incidents involving sharps should be reported to the Waste Management Officer (if waste is involved) or to another designated person.

The report should include details of:

- ✓ The nature of the accident or incident;
- ✓ The place and time of the accident or incident;
- ✓ The staff who were directly involved;
- ✓ Any other relevant circumstances

The cause of the accident or incident should be investigated by the Waste Management Officer (in case of waste) or other responsible officer, who should also take all possible action to prevent recurrence. The records of the investigation and subsequent remedial measures should be well documented.

5.3.9 Other Health and Safety issues to be considered in the Health Care Facility

It is highly recommended that all openings be well covered. All store-rooms should be well guarded with rails, a consideration that has already been undertaken by the proponent. To be installed in strategic positions within the Health Care Facility/Laboratory are fire extinguishers. However, it is recommendable that regular fire drills are carried out to sensitize all the Health Care staff on how to use them in case of fire outbreaks. Also to be provided and placed strategically are sand filled buckets within the facility.

5.4 De-Commissioning Stage

The economical life of the proposed project is expected to be between 50-80 years. At that point, the proponent shall have to vacate the site. The decommissioning exercise will have both positive and negative impacts:

5.4.1 Positive Decommissioning Impacts

a) Rehabilitation and Employment Creation

During the decommissioning stage, demolition or renovations will be done, creating job opportunities for the youth. As well, rehabilitation works will be undertaken for the proposed project site to restore it to its original state. This will include replacement of the topsoil and re-vegetation, which will enhance the aesthetic value of the area.

There will be need to employ people who will be involved in the reclamation of the site to near its original state.

5.5 Negative Decommissioning Impacts

a) Noise, Vibration and Dust

The earth moving works during top soil replacement will lead to significant deterioration of the acoustic environment within the area and the surrounding areas. This will be as a result of the

noise and vibration that will be experienced from machines and workforce being utilized. Dust will also be emitted affecting the surrounding environment.

The proponent will put in place mitigation measures for noise and dust pollution during the decommissioning phase. The following noise containment techniques could be employed to minimize the impact of temporary destruction noise at the site:

- Use of equipments designed with noise control elements
- Limit pick up trucks and other small equipment to a minimum idling time and observe a common-sense approach to vehicle use, and encourage workers to switch off engines whenever possible.
- Wetting the development incase of demolition to reduce dust

6. ENVIRONMENTAL MANAGEMENT/MONITORING PLAN

6.1 Introduction

The development of new laboratory activities will have some impacts on the biophysical environment, health and safety of its employees and members of the public, and socio economic well being of the local residents. Thus, its main aim focuses on reducing the negative impacts and maximizing the positive impacts associated with its activities through a programme of continuous improvement.

An Environmental Management/monitoring Plan has been developed to assist the proponent in mitigating and managing environmental impacts associated with the life cycle of the project. The EMP has been developed to provide a basis for an Environmental Management System for the project. It is noteworthy that key factors and processes may change in the course of the life of the project and considerable provisions have been made for dynamism and flexibility of the EMP. As such, the EMP will be subject to a regular regime of periodic review.

6.2 Management of Asbestos

It is recommended that when work with asbestos or work which may disturb asbestos is being carried out, the employers and the self-employed to prevent exposure to asbestos fibres. Where this is not reasonably practicable, they must make sure that exposure is kept as low as reasonably practicable by measures other than the use of respiratory protective equipment. The spread of asbestos must be prevented.

Worker exposure must be below an airborne exposure limit (Control Limit), given as 0.1 fibres per cm^3 . A Control Limit is a maximum concentration of asbestos fibres in the air (averaged over any continuous 4-hour period) that must not be exceeded.

In addition, short term exposures must be strictly controlled and worker exposure should not exceed 0.6 fibres per cm^3 of air averaged over any continuous 10 minute period using respiratory protective equipment if exposure cannot be reduced sufficiently using other means.

Respiratory protective equipment is an important part of the control regime but it must not be the sole measure used to reduce exposure and should only be used to supplement other measures. Work methods that control the release of fibres should be used. Respiratory protective equipment must be suitable, must fit properly and must ensure that worker exposure is reduced as low as is reasonably practicable.

6.2.1 Asbestos removal

Most asbestos removal work must be undertaken by a licensed contractor but any decision on whether particular work is licensable is based on the risk. Work is only exempt from licensing if:

- the exposure of employees to asbestos fibres is sporadic and of low intensity (but exposure cannot be considered to be sporadic and of low intensity if the concentration of asbestos in the air is liable to exceed 0.6 fibres per cm³ measured over 10 minutes); and
- it is clear from the risk assessment that the exposure of any employee to asbestos will not exceed the control limit; and the work involves:
 - ✓ Short, non-continuous maintenance activities. Work can only be considered as short, non-continuous maintenance activities if any one person carries out work with these materials for less than one hour in a seven-day period. The total time spent by all workers on the work should not exceed a total of two hours,
 - ✓ Removal of materials in which the asbestos fibres are firmly linked in a matrix. Such materials include: asbestos cement; textured decorative coatings and paints which contain asbestos; articles of bitumen, plastic, resin or rubber which contain asbestos where their thermal or acoustic properties are incidental to their main purpose (e.g. vinyl floor tiles, electric cables, roofing felt) and other insulation products which may be used at high temperatures but have no insulation purposes, for example gaskets, washers, ropes and seals,
 - ✓ encapsulation or sealing of asbestos-containing materials which are in good condition; or
 - ✓ Air monitoring and control, and the collection and analysis of samples to find out if a specific material contains asbestos.

Anyone carrying out work on asbestos insulation, asbestos coating or asbestos insulating board needs to:

- notify the enforcing authority responsible for the site where you are working (for example NEMA or the local authority);
- designate the work area;
- prepare specific asbestos emergency procedures; and
- Pay for your employees to undergo medical surveillance.

The management and / or handling of asbestos require any analysis of the concentration of asbestos in the air to be measured in accordance with the 1997 WHO recommended method. You must also comply with other health and safety legislation. It is important that the amount of time you or your employees spend working with asbestos insulation, asbestos coatings or AIB is

managed to make sure that these time limits are not exceeded. This includes the time for activities such as building enclosures and cleaning.

6.3 Environmental Monitoring and Auditing Program

There will be environmental management of any implications of the project that may not have been foreseen, which will include the administrative and production staff, the management, the public, the government and environmental experts.

Once a year, the project management will submit to the National Environment Management Authority (NEMA):

- A compilation of all monitoring data;
- A highlight of the activities related to environmental protection, environmental health, public health and safety and
- If the project has been cited for violation of environment and safety standards or regulations, certification from relevant authorities showing that the defect has been corrected or an acceptable plan of action is in place to correct the defect.

This can be termed as **the Annual Environmental Audit**. The following tables provide a summary of the monitoring that could be utilized.

The following tables form the core of this EMP for the construction, operational and decommissioning phases of this project. In general, the Tables outline the potential safety, health and environmental risks associated with the project and detail all the necessary mitigation measures, as well as the persons responsible for their implementation and monitoring. The EMP will be used as checklist in future environmental audits of the project.

Table 6: Occupational, Public Safety and Health Issues

Issues	Recommendations	Type of Action
Undercutting and tunneling (digging foundations) and presence of loose hanging rocks	<p>a. No undercutting and tunneling should be allowed in or around the project site so as to cause collapse or result to damage to property, injury or loss of life.</p> <p>b. No loose hanging rocks/material shall be allowed near or on the face of construction so as to endanger the safety of public.</p>	Administrative
Poor site management; no fencing, no warning notices/signage	<p>a. Warnings notices/signs of appropriate font size and in the national and local languages should be erected in appropriate places to warn the public of any danger e.g. 'Danger, no smoking'.</p>	Administrative

Lack of Personal Protective Equipment	<p>a. The following protective gear shall be used by persons working in the project site:</p> <ul style="list-style-type: none"> • protective helmets against falling objects • gloves to protect against cuts and bruises • protective shoes • safety goggles • overall/dust coat 	Administrative
Lack of safety training and absence of any individual in charge of safety within the project site	a. Project workers should be trained on safety, health and environmental issues; The construction site to have a person in charge of safety; Establishment of 'Safety, Health and Environment Committees' (SHEC) at the project site.	Administrative
Inadequate welfare facilities such as sanitation, first aid facilities and drinking water.	a. The project contractor should ensure provision of clean water and sanitation as well as well equipped first aid kit with trained first aiders within the project site	Administrative
Working from heights, use of ladders and conveyance of materials from heights	a. where use of ladders is required, they should be strong, firmly secured and have a hand rail; where materials are conveyed down slope by gravity, there should be adequate barriers to check material rolling down slope.	Management / Administrative
Disaster preparedness and response	Enhance training of the project workers on Disaster preparedness and response	Management / Administrative

Table 7: Environmental Issues

Issues	Recommendations	Type of Action
Negative landscape effects due to Presence of abandoned construction materials, pits and heaps of debris/wastes	a. Project proponent should establish site rehabilitation and/or after use plan. The after use plan should identify suitable beautification and landscaping plans to be implemented within and around the site.	Administrative
Dust emissions	a. The use of PPEs is recommended for both manual and mechanized operations while watering of the aggregates within the project site should be mandatory for mechanized operations	Administrative
Excessive noise and vibrations	a. Adherence to the Noise and Excessive Vibrations Regulations, 2009	Administrative

Table 8: Socio-Economic issues

Issues	Recommendations	Type of Action
Underage persons working in the construction site	a. Ensure that no minors work in the site	Administrative
Alcoholism and Drug abuse	a. Ensure no alcohol or drugs are available in the site	Administrative
Inadequate advisory services by relevant Government departments	a. Scheduled regular inspections and site meetings/Barazas	Administrative
HIV/Aids prevalence	a. Awareness creation on HIV/Aids in and around the construction site	Administrative

6.4 Environmental Management Plans (EMP)

For the effective implementation of the mitigation measures, monitoring and remedial requirements presented in the EIA, a systematic Environmental Management Plan (EMP) should be set up. Environmental Auditing of the project will be done against the EMP and advise the

necessary remedial actions required. The proponent and the Environmental Consultant through contractual means could enforce these remedial actions.

An Environmental Assessment has been completed for the proposed laboratory project, according to the requirements given in the EMCA 1999 and its Subsequent Legal Notice No. 101 of 2003. The environmental aspects that have been thoroughly studied include Air quality impact; Noise/vibration impact; Water supply and quality impact; Effect on vegetation; Disposal of storm waters; Energy supply and use; Waste management implications; Landscape and visual impact; Environmental Monitoring and Audit (EM&A) requirements. A brief summary of the mitigation measures is given below for ease of reference.

Table 9: Environmental monitoring/Management plans for the construction phase

Expected Negative Impacts	Recommended Mitigation Measures	Responsible Party	Time Frame	Estimated Cost (Kshs.)
High Demand of Raw materials	1. Source building materials from local suppliers who use environmentally	Resident Project Manager & Contractor	Throughout construction	Part of the main budget
	2. Ensure accurate budgeting and estimation of actual construction material requirements to ensure that the least amount of material necessary is ordered.	Resident Project Manager & Contractor	Throughout construction period	
	3. Ensure that damage or loss of materials at the construction site is kept minimal through proper storage.	Resident Project Manager & Contractor	Throughout construction period	
	4. Use of some recycled/refurbished or salvaged materials to reduce the use of raw materials and divert material from landfills.	Resident Project Manager & Contractor	Throughout construction period	
	5. Specify locations for trailers and equipment, and areas of the site that should be kept free of traffic, equipment, and storage.	Civil Engineer, Architect and Resident Project Manager	1 month	100, 000.00
	6. Designate access routes and parking within the site.	Civil Engineer, Architect and Project Manager	1 month	
	7. Introduction of vegetation (trees, shrubs and grass) on open spaces and their maintenance., especially at the front side of the development	Architect, Resident Project Manager & Landscape specialist	Monthly to Annually	
	8. Design and implement an appropriate landscaping programme to help in re-vegetation of part of the project area after construction.	Architect & Landscape specialist	During the beginning phase of the project	
Increased storm water, runoff and soil erosion	1. Roof water to be harvested and stored in underground/ground reservoirs for use in cleaning and in the toilets. To ensure the use of such water for the stated purposes, the building should be fitted with a dual water distribution system	The Civil Engineer, Mechanical Engineer and Resident Project Manager	During the beginning phase of the project	100, 000.00
	2. A storm water management plan that minimizes impervious area infiltration by use of recharge areas and use of	The Civil Engineer, Mechanical Engineer and Resident Project Manager	1 month	50, 000.00

	detention and/or retention with graduated outlet control structure will be designed.			
	3. Apply soil erosion control measures such as leveling of the project site to reduce run-off velocity and increase infiltration of storm water into the soil.	The Civil Engineer, Mechanical Engineer and Resident Project Manager	1 months	
	4. Ensure that construction vehicles are restricted to existing roads to avoid soil compaction within and around the project site.	The Civil Engineer, Mechanical Engineer and Resident Project Manager	Throughout construction period	50,000.00
	5. Ensure that any compacted areas are ripped to reduce run-off.	Civil /Mechanical Eng. and Project Manager	2 months	
	6. Open drains all interconnected will be provided on site.	Civil Engineer	Throughout construction	
	7. Roof catchments will be used to collect the storm water for some uses such as washing of floors and landscaping	Civil Engineer	Throughout construction period	
Increased solid waste generation	1. Use of an integrated solid waste management system i.e. through a hierarchy of options: reduction, sorting, re-use, recycling and proper disposal	Resident Project Manager & Contractor	Throughout construction period	
	2. Through accurate estimation of the sizes and quantities of materials required, order materials in the sizes and quantities they will be needed, rather than cutting them to size, or having large quantities of residual materials.	Resident Project Manager & Contractor	One-off	
	3. Ensure that construction materials left over at the end of construction will be used in other projects rather than being disposed of.	Resident Project Manager & Contractor	One-off	
	4. Ensure that damaged or wasted construction materials including cabinets, doors, plumbing and lighting fixtures, marbles and glass will be recovered for refurbishing and use in other projects	Resident Project Manager & Contractor	One-off	
	5. Donate recyclable/reusable or residual materials to local community groups, institutions and individual local residents	Resident Project Manager & Contractor	One-off	
	6. Use of durable, long-lasting materials that will not need to be replaced as often, thereby reducing the amount of construction waste generated over time	Resident Project Manager & Contractor	Throughout construction period	
	7. Provide facilities for proper handling and storage of construction materials to reduce the amount of waste caused by damage or exposure.	Resident Project Manager & Contractor	One-off	
	8. Purchase of perishable construction materials such as paints should be done incrementally to ensure reduced spoilage of unused materials	Resident Project Manager & Contractor	Throughout construction period	
	9. Use building materials that have minimal or no packaging to avoid the generation of excessive packaging waste	Resident Project Manager & Contractor	Throughout construction period	

	10. Use construction materials containing recycled content when possible and in accordance with accepted standards.	Resident Project Manager & Contractor	Throughout construction period	
	11. Reuse packaging materials such as cartons, cement bags, empty metal and plastic containers to reduce waste at the site	Resident Project Manager, Mechanical Engineer & Contractor	Throughout construction period	
	12. Dispose waste more responsibly by dumping at designated dumping sites or landfills only.	Resident Project Manager, Mechanical Engineer & Contractor	Throughout construction period	
	13. Waste collection bins to be provided at designated points on site	Project Manager, Mechanical Eng.& Contractor	Throughout construction period	
	14. Private waste disposal company to be contracted to transport and dispose the solid waste from site	Resident Project Manager, Mechanical Engineer & Contractor	Throughout the project life cycle	
Dust emission	1. Ensure strict enforcement of on-site speed limit regulations	Resident Project Manager & Contractor	Throughout construction	100,000.00
	2. Avoid excavation works in extremely dry weathers if and when possible	Resident Project Manager & Contractor	Throughout construction	
	3. Sprinkle water on graded access routes when necessary to reduce dust generation by construction vehicles	Resident Project Manager & Contractor	Throughout construction period	
	4. Personal Protective equipment to be worn	Resident Project Manager	Throughout construction	
Exhaust emission	1. Vehicle idling time shall be minimized	Resident Project Manager & Contractor	Throughout construction	50,000.00
	2. Alternatively fuelled construction equipment shall be used where feasible; equipment shall be properly tuned and maintained	Resident Project Manager & Contractor	Throughout construction period	
	3. Sensitize truck drivers to avoid unnecessary racing of vehicle engines at loading/offloading points and parking areas, and to switch off engines at these points	Resident Project Manager & Contractor	Throughout construction period	
Noise and vibration	1. Sensitize construction vehicle drivers and machinery operators to switch off engines of vehicles or machinery not being used.	Resident Project Manager & Contractor	Throughout construction period	50,000.00
	2. Sensitize construction drivers to avoid gunning of vehicle engines or hooting especially when passing through sensitive areas such as churches, residential areas and hospitals	Resident Project Manager & Contractor	Throughout construction period	
	3. Ensure that construction machinery are kept in good condition to reduce noise generation	Resident Project Manager & Contractor	Throughout construction period	
	4. Ensure that all generators and heavy duty equipment are insulated or placed in enclosures to minimize ambient noise levels.	Resident Project Manager & Contractor	Throughout construction period	
	5. The noisy construction works will entirely be planned to be during day time when most of the neighbors will be away at work.	Resident Project Manager & all site foreman	Throughout construction period	
Increased energy	1. Ensure electrical equipment,	Resident Project Manager	Throughout	Part of the

consumption	appliances and lights are switched off when not being used	& Contractor	construction period	main budget
	2. Install energy saving fluorescent tubes at all lighting points instead of bulbs which consume higher electric energy	Resident Project Manager & Contractor	Throughout construction period	
	3. Ensure planning of transportation of materials to ensure that fossil fuels (diesel, petrol) are not consumed in excessive amounts	Resident Project Manager & Contractor	Throughout construction period	
	4. Monitor energy use during construction and set targets for reduction of energy use.	Resident Project Manager & Contractor	Throughout construction period	
High Demand Water	1. Harness rainwater for some uses such as general cleaning, in the toilets & gardening, hence the need for a dual water distribution system within the building	Mechanical Engineer, proponent and Resident Project Manager	Throughout construction period	100,000.00
	2. Install water conserving taps that turn-off automatically when water is not being used as wells low flush toilets and waterless urinals	Resident Project Manager, proponent & Contractor	One-off	
	3. Promote recycling and reuse of water as much as possible (need for a dual water distribution system within the building)	Resident Project Manager & Contractor	Throughout construction period	
	4. Install a discharge meter at water outlets to determine and monitor total water usage	Resident Project Manager & Contractor	One-off	
	5. Promptly detect and repair water pipe and tank leaks	Resident Project Manager & Contractor	Throughout construction	
	6. Sensitize staff to conserve water by avoiding unnecessary toilet flushing etc.	Resident Project Manager & Contractor	Throughout construction	
	7. Ensuring taps are not running when not in use	Resident Project Manager & Contractor	Throughout construction	
Generation of wastewater	1. Provision of means for handling sewage generated by construction workers	Mechanical Engineer & Resident Project Manager	One-off	Part of the main budget
	2. Conduct regular checks for sewage pipe blockages or damages since such vices can lead to release of the effluent into the land and water bodies	Mechanical Engineer & Resident Project Manager	Throughout construction period	
	3. Monitor effluent quality regularly to ensure that the stipulated discharge rules and standards are not violated	Mechanical Engineer & Resident Project Manager	Throughout construction period	
Machinery/ equipment safety	1. Arrangements must be in place for the medical examination of all construction employees before, during and after termination of employment	Resident Project Manager, Developer & Contractor	Continuous	50,000.00
	2. Ensure that machinery, equipment, personal protective equipment, appliances and hand tools used in construction do comply with the prescribed safety and health standards and be appropriately installed maintained and safeguarded	Resident Project Manager, Developer & Contractor	One-off	
	3. Ensure that equipment and work tasks are adapted to fit workers and their ability including protection against mental strain	Resident Project Manager, Developer & Contractor	Continuous	

	4. All machines and other moving parts of equipment must be enclosed or guarded to protect all workers from injury	Resident Project Manager	One-off	
	5. Arrangements must be in place to train and supervise inexperienced workers regarding construction machinery use and other procedures/operations	Resident Project Manager	Continuous	
	6. Equipment such as fire extinguishers must be examined by a government authorized person. The equipment may only be used if a certificate of examination has been issued	Resident Project Manager	Continuous	
	7. Reports of such examinations must be presented in prescribed forms, signed by the examiner and attached to the general register	Resident Project Manager	Continuous	
Incidents, accidents and dangerous occurrences	1. Ensure that materials are stored or stacked in such manner as to ensure their stability and prevent any fall or collapse	Resident Project Manager	Continuous	
	2. Ensure that items are not stored/stacked against weak walls and partitions	Resident Project Manager	Continuous	
	3. All floors, steps, stairs and passages of the premises must be of sound construction and properly maintained	Resident Project Manager & Contractor	Continuous	
	4. Securely fence or cover all openings in floors	Resident Project Manager & Contractor	One-off	
	5. Ensure that construction workers are not locked up such that they would not escape in case of an emergency	Resident Project Manager & Contractor	Continuous	
	6. All ladders used in construction works must be of good construction and sound material of adequate strength and be properly maintained	Resident Project Manager & Contractor	One-off	
	7. Design suitable documented emergency preparedness and evacuation procedures to be used during any emergency	Resident Project Manager & Contractor	One-off	
	8. Such procedures must be tested at regular intervals	Resident Project Manager & Contractor	Every 3 months	
	9. Ensure that adequate provisions are in place to immediately stop any operations where there is an imminent and serious danger to health and safety and to evacuate workers	Resident Project Manager & Contractor	One-off	
	10. Ensure that the most current emergency telephone numbers posters are prominently and strategically displayed within the construction site	Resident Project Manager & Contractor	One-off	
	11. Provide measures to deal with emergencies and accidents including adequate first aid arrangements	Resident Project Manager & Contractor	Continuous	
	12. Ensure that provisions for reporting incidents, accidents and dangerous occurrences during construction using prescribed forms obtainable from the	Resident Project Manager, Developer & Contractor	Continuous	50,000.00

	local Occupational Health and Safety Office (OHSO) are in place.			
	13. Enforcing adherence to safety procedures and preparing contingency plan for accident response in addition to safety education and training shall be emphasized.	The Contractor, Resident Project Manager & Site Safety Officer	Continuous	
	14. Ensure that the premises are insured as per statutory requirements (third party and workman's compensation)	Developer	Annually	
	15. Develop, document and display prominently an appropriate SHE policy for construction works	Resident Project Manager, Developer & Contractor	One-off	
	16. Provisions must be put in place for the formation of a Health and Safety Committee, in which the employer and the workers are represented	Resident Project Manager	One-off	
occupational health and safety risks during construction period and occupational phase	1. Well stocked first aid box which is easily available and accessible should be provided within the premises	Resident Project Manager & Contractor	One-off	
	2. Provision must be made for persons to be trained in first aid, with a certificate issued by a recognized body.	Resident Project Manager & Contractor	One-off	
	3. Fire fighting equipment such as fire extinguishers and hydrant systems should be provided at strategic locations such as stores and construction areas.	Resident Project Manager & Contractor	One-off	
	4. Regular inspection and servicing of the equipment must be undertaken by a reputable service provider and records of such inspections maintained	Resident Project Manager & Contractor	Every 3 months	3
	5. Signs such as "NO SMOKING" must be prominently displayed within the estate, especially in parts where inflammable materials are stored	Resident Project Manager & Contractor	One-off	
	6. Enough space must be provided within the premises to allow for adequate natural ventilation through circulation of fresh air	Resident Project Manager & proponent/residents/contractor	One-off	
	7. There must be adequate provision for artificial or natural lighting in all parts of the premises in which persons are working or passing	Resident Project Manager & Contractor	One-off	
	8. Circuits must not be overloaded	Project Manager & Contractor/ proponent	Continuous	
	9. Distribution board switches must be clearly marked to indicate respective circuits and pumps	Resident Project Manager & Contractor	One-off	
	10. There should be no live exposed connections	Project Manager & Contractor/ proponent	Continuous	
	11. Electrical fittings near all potential sources of ignition should be flame proof	Project Manager & Contractor/ proponent	One-off	
	12. All electrical equipment must be earthed	Project Manager & Contractor/ proponent	One-off	
	13. Develop a suitable system for the safe collection, recycling and disposal of chemical wastes, obsolete chemicals and empty chemical containers to avoid their reuse for other purposes and to eliminate	Resident Project Manager & Contractor/ proponent/residents	One-off	
				50,000.00

	or minimize the risks to safety, health and environment			
	14. Ensure that all chemicals used in construction are appropriately labeled or marked and that material safety data sheets containing essential information regarding their identity, suppliers classification of hazards, safety precautions and emergency procedures are provided and are made available to employees and their representatives	Resident Project Manager & Contractor/ proponent/residents	One-off	
	15. Keep a record of all hazardous chemicals used at the premises, cross-referenced to the appropriate chemical safety data sheets	Resident Project Manager & Contractor/ proponent/residents	Continuous	
	16. There should be no eating or drinking in areas where chemicals are stored or used	Resident Project Manager & Contractor/ proponent/residents	Continuous	
	17. Provide workers in areas with elevated noise and vibration levels, with suitable ear protection equipment such as ear muffs	Resident Project Manager & Contractor/ proponent/residents	One-off	
	18. Ensure that construction workers are provided with an adequate supply of wholesome drinking water that should be maintained at suitable and accessible points.	Resident Project Manager & Contractor	One-off	
	19. Ensure that conveniently accessible, clean, orderly, adequate and suitable washing facilities are provided and maintained in within the site	Resident Project Manager & Contractor	One-off	
	20. Provision for repairing and maintaining of hand tools must be in place	Resident Project Manager & Contractor	One-off	
	21. Hand tools must be of appropriate size and shape for easy and safe use	Resident Project Manager & Contractor	One-off	
	22. Height of equipment, controls or work surfaces should be positioned to reduce bending posture for standing workers	Resident Project Manager & Contractor	One-off	
Oil Spills	1. A designated garage section of the site fitted with oil trapping equipments to be planned for changes. Such an area will be well protected from contaminating the soil	Resident Project Manager	Continuous	5,000.00n per month
Increased Food Supply/demand	1. Construction workers will be given breaks to go for lunch	Resident Project Manager & Contractor	Continuous	50,000.00
	2. Onsite canteen to supply food if possible	Resident Project Manager & Contractor	Continuous	
Hydrology and Water Quality Degradation	1. Hazardous substance control and emergency response plan that will include preparations for quick and safe clean up of accidental spills.	The Mechanical Engineer, Resident Project Manager, Contractor & the Developer	Continuous	<i>Part of erosion control</i>
	2. Hazardous-materials handling procedures to reduce the potential for a spill during construction	The Mechanical Engineer	Continuous	
Vector /Water Borne Disease Incidence	1. Complete refuse collection and handling service to be provided	Mechanical Engineer	Continuous	50,000.00

Possible Exposure to Diseases	1. Shall be mitigated by occupational health and safety standards enforcement	Contractor & all foremen	Continuous	
Increased Pressure on Infrastructure	1. Coordinate with other planning goals and objectives for region	Contractor and the Developer	Continuous	
	2. Upgrade existing infrastructure and services, if and where feasible.	Contractor and the Developer	Continuous	
Insecurity	1. Appoint security personnel operating 24 hours	Security Officer, Resident Project Manager & Police	Continuous	Part of general safety
	2. Body-search the workers on entry, to avoid getting weapons on site, and leaving site to ensure nothing is stolen.	Security Officer	Continuous	
	3. Ensure only authorized personnel get to the site	Security Officer	Continuous	
Air Pollution	1. Suitable wet suppression techniques need to be utilized in all exposed areas	The Contractor & Site Safety Officer	Continuous	Part of dust control
	2. All unnecessary traffic must be strictly limited on site; speed controls are to be enforced	The Contractor & Site Safety Officer	Continuous	
Emergence of new environmental concerns during the construction phase	1. Due to the nature of the project, the Firm of experts shall carry out monitoring and evaluation. More so an initial environmental audit will also be carried within a period of 12 months after commencement of the operations	Firm of Experts.	Continuous	100,000.00

6.5 Operational Phase EMP

The necessary objectives, activities, mitigation measures, and allocation of responsibilities pertaining to prevention, minimization and monitoring of significant negative impacts and maximization of positive impacts associated with the operational phase of proposed Health Care Project are outlined in the table below

Table 10: Environmental Management Plan for the operation phase

Environmental Concerns	Mitigation	Responsibility	Monitoring Means	Monitoring Frequency	Monitoring by:	Duration and Budget
Safety Likely open areas	Such holes should be filled with soil or covered with a concrete cover that is heavy enough not to be lifted by children to prevent accidental falls.	Management	Observation to ensure that any open pits are covered	One off activity	An EIA Expert and the management.	Ksh. 20,000
Safety Fire outbreak preparedness	-Place sand filled buckets in strategic places; Install a fire hydrant preferably near the main entrances; Train all workers in fire fighting and subject them to frequent fire drills; All windows should be fitted with openable grills	Management	Observation to ensure that all fire fighting mechanisms are put into place	Continuous activity	An EIA Expert and the management.	Ksh.20,000

Health and Safety For Patients and general public	Waste bins should never be placed within the patients' waiting shades, especially those holding medical waste	Management	Observation to ensure that this is implemented	Continuous activity	An Expert and the management. EIA	Ksh.5,000 per month
Health and Safety Lack of protective gears	All staff within the facility should be in protective gears at all times	Management	Observation to ensure that this is implemented	Continuous activity	An Expert and the management EIA	Ksh5,000
Health and Safety within the facility Accidents	Reporting all incidents and accidents to include details of: -The nature of the accident or incident; The place and time of the accident or incident; The staff who were directly involved; Any other relevant circumstances	Management	Observation to ensure that this is implemented	Continuous activity	An Expert and the management. EIA	
Health and Safety spillages	-Evacuate the contaminated area; Decontaminate the eyes and skin of exposed personnel immediately; Inform the designated person (usually the Waste Management Officer), who should coordinate the necessary actions.; Determine the nature of the spill; Evacuate all the people not involved in cleaning up if the spillage involves a particularly hazardous substance; Provide first aid and medical care to injured individuals; Secure the area to prevent exposure of additional individuals; Provide adequate protective clothing to personnel involved in cleaning-up; Limit the spread of the spill; Neutralize or disinfect the spilled or contaminated material if indicated; Collect all spilled and contaminated material. [Sharps should never be picked up by hand; brushes and pans or other suitable tools should be used. Spilled material and	Management	Observation to ensure that this is implemented	Continuous activity	An Expert and the management. EIA	

	<p>disposable contaminated items used for cleaning should be placed in the appropriate waste bags or containers.</p> <p>-Decontaminate or disinfect the area, wiping up with absorbent cloth. The cloth (or other absorbent material) should never be turned during this process, because this will spread the contamination. The decontamination should be carried out by working from the least to the most contaminated part, with a change of cloth at each stage. Dry cloths should be used in the case of liquid spillage; for spillages of solids, cloth impregnated with water (acidic, basic, or neutral as appropriate) should be used.</p> <p>-Rinse the area, and wipe dry with absorbent cloth.</p> <p>-Decontaminate or disinfect any tools that were used.</p> <p>-Remove protective clothing and decontaminate or disinfect it if necessary.</p> <p>-Seek medical attention if exposure to hazardous material has occurred during the operation.</p>					
Latrines and other public areas	The walls and floors of the latrines and walls of public areas should be fitted with white smooth tiles for easy cleaning	Management	Observation	One off activity	An EIA and the management.	Ksh.300,000
Water harvesting and storage facilities	Initiate roof water harvesting and install water storage tanks	Management	Observation are fixed	One off activity	An EIA and the management.	Ksh.200,000
Poor waste disposal	-Construct a well functioning incinerator -sort waste at source -connect all laboratory	Management	Observation	A continuous activity to ensure that appropriate	An EIA and the management.	Ksh.500,000

	sink to a functioning biomedical liquid waste treatment system.			solid and liquid waste management is established		
Lack of enough vegetation cover around the Health Care Facility	-The management should plan for the establishment of trees and other aesthetic plants within and around the facility	Management	Observation to ensure that appropriate tree species are established around the facility	Continuous activity to ensure that appropriate and adequate vegetation species are established around the facility	An EIA Expert and the management.	Ksh.10,000 per month

6.6 Decommissioning Phase

In addition to the mitigation measures provided in the tables above, it is necessary to outline some basic mitigation measures that will be required to be undertaken once all operational activities of the health care project have ceased. The necessary objectives, mitigation measures, allocation of responsibilities, time frames and costs pertaining to prevention, minimization and monitoring of all potential impacts associated with the decommissioning and closure phase of the project are outlined in the table below.

Table 11: Environmental Management/Monitoring Plan for the decommissioning phase

Recommended Mitigation Measures	Responsible Party	Time Frame
1. Demolition waste management		
1. All buildings, machinery, equipment, structures and partitions that will not be used for other purposes must be removed and recycled/reused as far as possible	Contractor, Proponent	One-off
2. All foundations must be removed and recycled, reused or disposed of at a licensed disposal site	Contractor, Proponent	One-off
3. Where recycling/reuse of the machinery, equipment, implements, structures, partitions and other demolition waste is not possible, the materials should be taken to a licensed waste disposal site	Contractor, Proponent	One-off
4. Donate reusable demolition waste to charitable organizations, individuals and institutions	Contractor, Proponent	One-off
2. Rehabilitation of project site		
1. Implement an appropriate re-vegetation programme to restore the site to its original status	Contractor, Proponent	One-off
2. Consider use of indigenous plant species in re-vegetation	Contractor, Proponent	One-off
3. Trees should be planted at suitable locations so as to interrupt slight lines (screen planting), between the adjacent residential area and the development.	Contractor, Proponent	Once-off

7. AUXILLIARY INFORMATION

7.1 Budget

TOTAL PROJECT COST

Kshs.50, 000, 000 (Fifty Million Shillings Only)

7.2 Monitoring Guidelines

Continuous observations and assessment is essential so that if unforeseen dangers are noticed, alternatives are sort for. Risk assessment of fire outbreaks, and others should not be ignored in the construction plan. Waste management within the project site should be strictly followed. Mitigation measures of storm water management are essential. Safety standards should constantly be maintained. In brief, monitoring guidelines could be based on the following parameters:

- Health and safety measures using such standards as the laid down regulatory framework
- Water demand, availability and use
- Waste management- Quality management systems- Laboratory Bio-safety
- Accidents and risk assessment arising from the use of water, roads, electricity and or any other amenity
- Conservation and establishment of vegetation cover

7.3 Reporting

Constant reporting by the site contractor to the architect is necessary to ensure the project is executed as per the architectural drawings. The safety officer should always remain on site to report any safety concerns for urgent mitigation. He should also at all times enforce safety requirements as per the relevant legislations. The contractor must consult the architect to maintain a clear understanding of all the aspects of the project.

7.4 Conclusion and Recommendations

During the preparation of this report for the proposed laboratory development it was observed and established that most of the negative impacts on the environment are rated low and short term with no significant effect. They are all localized with no residual effects. The positive impacts are highly rated and will benefit all stakeholders at large. The project proponent has proposed to adhere to prudent implementation of the Environmental Management Plan. They are obtaining all necessary permits and licenses from the relevant authorities and have qualified and adequate personnel to do the project as proposed. They have proposed adequate safety and health mitigation measures as part of the relevant statutory requirements

They could therefore be licensed to implement this project subject to adherence to the Environmental Management Plan proposed in this report and the statutory requirements.

8. APPENDICES

Architectural Designs and Drawings and NEMA Licenses

9. REFERENCES

- i. Ayliffe GAJ et al. (1992). *Control of hospital infection. A practical handbook*, 3rd ed. London, Chapman & Hall.
- ii. Beck EG, Schmidt P (1986). *Hygiene im Krankenhaus und Praxis. [Hygiene in the hospital and in medical practice.]* Berlin, Springer.
- iii. Block SS (1991). *Disinfection, sterilization, and preservation*, 4th ed. Philadelphia, Lea & Febiger.
- iv. Christen J (1996). *Dar es Salaam Urban Health Project. Health care waste management in district facilities: situational analysis and system development.*
- v. Daschner F (1997). *Praktische Krankenhaushygiene und Umweltschutz*, 2. Aufl. [Practical hospital hygiene and protection of the environment, 2nd ed.] Berlin, Springer.
- vi. Garner JS (1996). Guideline for isolation precautions in hospitals. The Hospital Infection Control Practices Advisory Committee. *Infection control and hospital epidemiology*, 17:53Ð80.
- vii. Garner JS, Favero MS (1986). CDC Guideline for hand washing and hospital environmental control. *Infection control*, 7:231-243.
- viii. Garner JS, Simmons BP (1983). CDC Guideline for isolation precautions in hospitals. *Infection control*, 4:245-325.
- ix. I. A. Pruss, E. Giroult and P. Rushbrook (1999) "Safe management of waste from health-care activities". Geneva, World Health Organisation.
- x. Mayhall CG (1996). *Hospital epidemiology and infection control*. Baltimore, MD, Williams & Wilkins.
- xi. Mehtar S (1992). *Hospital infection control. Setting up with minimal resources*. Oxford, Oxford Medical.
- xii. Ministry Of Health Kenya, The National Health Care Waste Management Plan 2008-2012
- xiii. Ministry of Health Kenya, 2007, National Policy on Injection Safety and Health Care Waste Management.
- xiv. Parker MT (1978). *Hospital-acquired infections: guidelines to laboratory methods*. Copenhagen, World Health Organization Regional Office for Europe (European Series, No. 4).
- xv. Philpott-Howard JN, Casewell MM (1994). *Hospital infection control. Policies and practical procedures*. London, Saunders.
- xvi. Republic of Kenya, *Reversing the Trends: The Second National Health Sector Strategic Plan- Annual Performance Report July 2007–June 2008 (Annual Operational Plan 3 Report)*
- xvii. Republic of Kenya, *Kitui District Vision and Strategy: 2005-2015, July 2005*

- xviii. Russell AD, Hugo WB, Ayliffe GAJ (1992). *Principles and practice of disinfection, preservation and sterilization*, 2nd ed. Oxford, Blackwell.
- xix. Rutala A (1995). *Chemical germicides in health care*. Morin Heights, Canada, Polyscience.
- xx. Steuer W (1992). *Hygiene in der .rtzlichen Praxis. [Hygiene in medical practice.]*Stuttgart, Fischer.
- xxi. Thofern E, Botzenhart K (1983). *Hygiene und Infektion im Krankenhaus. [Hygiene and infection in the hospital.]* Stuttgart, Fischer.
- xxii. St Gallen, Switzerland, Swiss Centre for Development Cooperation in Technology and Management (SKAT).
- xxiii. *StedmanÕs medical dictionary*, 26th ed. (1995). Baltimore, MD, Williams & Wilkins.
- xxiv. WHO. *Guidelines for drug disposal after emergencies*. Geneva, World Health Organization (unpublished document, in preparation; will be available from Department of Essential Drugs and other Medicines, World Health Organization 1211 Geneva 27, Switzerland).
- xxv. Wenzel RP (1997). *Prevention and control of nosocomial infections*, 3rd ed. Baltimore, MD, Williams & Wilkins.
- xxvi. WHO, 2005, Decision making Guide, Management of Solid Health Waste at Primary Health Care Centres.