

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) STUDY REPORT FOR NGONG' DUMPSITE, KAJIADO COUNTY



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Disclaimer:

This Environment and Social Impact Assessment study Report is based on the information made available by the client to the consultants and findings from field assessments. The information contained in this report is accurate and a truthful representation of all findings relating to the proposed project.

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ACRONYMS

BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
CBOs	Community Based Organisations
NGOs	Non-Governmental Organisations
EIA	Environmental Impact Assessment
ESIA	Environmental and Social Impact Assessment
SIA	Social Impact Assessment
PAP	Project Affected Persons
EMCA	Environmental Management and Coordination Act
EMP	Environmental Management Plan
EMP	Environmental Monitoring Plan
SDGs	Sustainable Development Goals
IWMF	Integrated Waste Management Facility
WB	World Bank
WRMA	Water Resources Management Authority
NEMA	National Environment Management Authority
KFS	Kenya Forest Service

EXECUTIVE SUMMARY

Introduction

Solid waste management is currently one of the main challenges facing county governments and other stakeholders who are mandated to ensure a sustainable solid waste management system in their respective counties. The poor management of solid waste has posed severe social, economic and environmental challenges as well as impacts, especially in cities and other urban areas due to rapid urbanisation and high population growth rate in such areas (NEMA, 2014).

This Environmental and social Impact Assessment (ESIA) for the decommissioning of Ngong' Dumpsite was carried out as per the Terms of Reference (ToR) provided by the National Environment Management Authority (NEMA). The EIA study was conducted in accordance with the requirements of the Environmental (Impact assessment and Audit) Regulations, 2003; as amended in 2015. This involved Polimi and UN-Habitat.

To adequately address the environmental issues emanating from the implementation of the proposed project, a team of experts carried out environmental and social screening for the project. This comprised of the mobilization, liaison and stakeholders consultations, a scoping exercise, desk and field studies, data analysis, impact assessment, and analysis of health and safety issues associated with the proposed project. Secondary data was collected from review of books, journals, newspapers, magazines, previous studies on solid waste management thesis, papers and reports, policies, regulations, development plans, laws and by-laws on solid waste management. Primary data was collected through observation of activities at the site, interviews of heads/spouses of households and officers in institutions within a 500 m radius from the dumpsite, key informants, photography, mapping and sketch maps.

Location

Ngong' dumpsite is located in Kajiado North sub county of Kajiado County situated in former province of the Rift Valley. It is among the 47 counties that constitute the republic of Kenya with an estimated population of 687,312 and an area of 21,292.7km² and bordered by Tanzania to the Southwest and Taita Taveta, Nairobi, Machakos, Narok and Kiambu Counties as its immediate neighbors (fig 1.0)

The Project

This project involves the decommissioning of the Ngong' dumpsite and implementation of recommendations stipulated by Kajiado County for the development of an Integrated Solid Waste Management system (ISWM).

The Government of Kenya and the County Government of Kajiado have identified solid waste disposal for Kajiado County as a priority problem and has requested the Italian Government for assistance in financing the construction of a new sanitary landfill (ISWM), under the proposed Integrated Waste Management Plan. The new sanitary landfill ISWM system proposed to be constructed through GOK financing in collaboration with the Italian government will include leachate collection, resource recovery, electricity generation and landfill gas collection but not limited to management systems as needed to result in environmentally acceptable pollution control. The proposed project will include operational equipment to spread, grade and cover solid wastes received by the landfill in a cost-effective manner. Implementation of a new sanitary landfill would allow for cessation of solid waste disposal operations at the existing disposal site at Ngong' dumpsite.

Therefore, before construction of a new sanitary landfill/Integrated Solid Waste Management System and decommissioning of the current disposal site, an environmental and social impact assessment study was a requirement. This was to provide inputs to the final design (as part of an interactive process of design and environmental/public assessment which is required by Environmental Management and Coordination Act (Cap 387) in order to obtain an optimally environmentally acceptable and cost-effective design). The final design was to incorporate mitigation measures to address potential adverse impacts and significant public concerns. Mitigate measures within the final design include construction details and operations and management plans for both the new waste management system and the decommissioned disposal site.

Ngong' dumpsite has major negative environmental impacts to the local environment as a result of uncontrolled and open dumping. These environmental impacts make it necessary to decommission the dumpsite. Lack of drainage ditches, poor management, lack of effective implementation of relevant solid waste management regulations, land use conflicts, poor geographical location of the dumpsite in relation to Ngong' town, ineffective recycling process at the site, waste scavenging, and inadequate disposal facilities are some of the major challenges facing the dumpsite. Its main impacts on the entire surrounding environment

include: air, soil and water pollution, health risks, interruption of education of Ngong' residents, poor sanitation, insecurity and encroachment by human informal settlement.

Formulation of Ngong' dumpsite closure plan will involve reference to the policy regarding closure plan with the aim of improving the current conditions and reduce the impacts on the environment. The post closure land use plan will also take into consideration at least ten years for the waste to stabilize and therefore the feasible land use for the dumpsite will be as a recreational park.

Justification of the project

The project involves implementation of the recommendations of the Kajiado County on solid waste management plan in accordance with the provisions of the constitution of Kenya 2010 for access to a healthy environment to every human being, which has been considered as a basic human right.

The eighth Sustainable development Goal emphasises the provision of safe clean water and safe environment. Further vision 2030 social pillar targets the implementation of an integrated solid waste Management system which the project seeks to achieve.

According to the Kajiado plan on sustainable environmental management there is need to rehabilitate, restore and manage Ngong' River Ecosystem in order to provide for improved livelihoods and enhanced biodiversity and sustainable supply of water for domestic, industrial and recreation purposes. Therefore decommissioning of Ngong' dumpsite will contribute to the achievement of these policy directions and strategic actions.

Objectives of the Environmental and Social Impact Assessment (ESIA)

The main objectives of the ESIA is to ensure that all environmental consequences due to the Ngong' dumpsite in its current state are evaluated and analyzed to warrant developing and operating a new Integrated Waste Management system for the county government of Kajiado. The environmental and socio-economic impacts evaluated and addressed as part of the mitigation measures incorporated into the facilities' final design.

Specific Objectives of the ESIA included the following

- To describe the site and its environmental status.

- To assess the socio-economic status of those directly and indirectly affected by the dumpsite.
- To collect baseline information of the project area with regards to climate, geology water, soils, roads, population, social economic factors and biological environment (fauna and flora)
- To review relevant legislations for such projects
- To acquire the views of the affected public and other stakeholders with regards to the presence of the dumping site.
- To determine land use conflicts existing between the dumpsite and its neighbourhood land uses,
- To determine the potential significant impacts of the project
- To propose alternatives to the project and/or project location
- To propose mitigation measures for the significant negative impacts
- To develop an EMP for the project

An outline of the methodology

The nature of decommissioning of a dumpsite calls for a full ESIA study to ensure public support, completeness and comprehensiveness of the report. During the assessment, the following steps were followed:

- Environmental Screening that identified the project as among those requiring EIA under schedule 2 of EMCA amendment ,2015,
- Environmental scoping to provide the key environmental issues
- Desktop studies for background information
- Public participation with stakeholders using interviews,
- Public participation with questionnaires and focus group discussions
- Topographical surveys

- Water, soils and air quality analysis

Project cost (Normally the cost of the project and not just the EIA)

Total cost of decommissioning Ngong' dumpsite is approximately Kshs.2.3.billion as

Stakeholder participation

ESIA sought views from the key stakeholders of the project. These included the project affected persons, communities living around the Ngong' dumpsite, Water Resources Management Authority, Private Service Providers (PSPs), companies or organized groups such as Nuru Waste Managers, waste pickers (scavengers), Oloolua Residents/local communities, Kajiado County, NEMA, Ministry of Environment and Forestry, Kenya Forest Service, Recyclers, Politicians/opinion leaders, Veterinary farmers, Religious leaders, Ngong' water and Sewerage company.

Environmental and Social Impact Assessment (ESIA)

The expected impacts from the projects are diverse in nature and will comprise of both long term and short term impacts. The short term impacts will occur during the decommissioning of the dumpsite and long term impacts will occur after the completion of integrated waste management facility that will contribute to improved health and provide a more pleasant environment for business and trade.

The project will mainly have positive impacts while mitigation measures will be proposed and designed for the anticipated negative impacts.

The positive impacts are both short term and long term and include the following:

Long term positive Impacts

- i. Improved health of the population through reduced cases of respiratory and water borne diseases
- ii. Improved water quality in Ngong' river and other surface streams
- iii. Improved solid waste management of Ngong' town
- iv. Improved aesthetic value of the area
- v. Reclamation of the dumpsite and potential redevelopment

- vi. Reduced pollution to downstream ecosystems
- vii. Reduced health hazards to downstream communities in Athi catchment
- viii. Demonstration for decommissioning model process of similar sites in other counties in the country
- ix. Creation of job opportunities during implementation and operational phases
- x. Improved physical infrastructure in the project area
- xi. Improved security
- xii. Reduced pollution on the cultivation of food crops in the riverine area irrigated with sewage
- xiii. Creation of conducive living and learning environment and habitation of neighbouring schools, churches and communities
- xiv. Reduced scavengers

Short- term positive Impacts

- i. Expand opportunities for small scale businesses in the area
- ii. Creation of job opportunities during construction and implementation phases
- iii. Removal of conditions creating attractions to child labour

The negative impacts are both short and long term

Long term Negative Impacts

- i. Loss of dumpsite linked livelihood
- ii. Emission of gases
- iii. Contamination of surface and ground water by leachates
- iv. Disruption of social networks

Short term Negative Impacts

- i. Disruption of socio economic activities in the project area

- ii. Leachate overflow and discharge into the river
- iii. Release and exposure of toxic and other gases to workers and the community
- iv. Destabilisation of bird community at the site
- v. Influx of heavy trucks and machinery in the area disrupting traffic flow
- vi. Loss of vegetation that has established in the areas of the dumpsite
- vii. Soil erosion in exposed and destabilized slopes
- viii. Atmospheric pollution by dust particles and greenhouse gases
- ix. Elevated noise and vibrations in the project environment
- x. Temporary influx of people in the area from outside environs

Conclusion and Recommendations

The main negative impacts of the closure of the dumpsite will include loss of vegetation, excavation, soil erosion, atmospheric pollution by dust and smoke emissions, oil pollution, loss of dumpsite livelihoods, disruption of social networks in the area, leachate discharge into the river, exposure to toxic gases, influx of heavy trucks and machinery in the area, increased noise and vibrations and influx of people in the area

The main positive impacts of the closure of the dumpsite include improved health of the people because there will be reduced cases of respiratory and water borne diseases, improved water quality in Ngong' river by reducing pollution to downstream ecosystem, improved solid waste management in Ngong' town, improved aesthetic value of the area, reclamation of the dumpsite and redevelopment, reduced health hazards to downstream communities in the Athi catchment, reduced fire outbreaks in the project areas, reduced scavengers, creation of job opportunities during implementation phases, conducive working and habitation environment for neighbouring schools, churches and communities, improved road infrastructure in the place, improved security and stoppage of cultivation toxic loaded food crops. The project will serve as model for development of integrated waste management/ sanitary landfill in other counties.

Many environmental impacts identified during the construction period are of short term and can be mitigated. Therefore supervision of the project implementation should be of high standard to ensure negative impacts are minimized, reduced and avoided

Positive impacts have long term positive impacts on the development of the area and on the welfare of the people as a whole. The project is expected to promote a clean and healthy environment in the town of Ngong', promote the economy, and enhance social economic standards of the population in the area and beyond. 80% of those who responded indicated that the dumpsite should be completely relocated. The project therefore is highly recommended and therefore should be approved for implementation.

CHAPTER ONE

INTRODUCTION

1.1 Background and Rationale for an Environmental and Social Impact Assessment

Kajiado County Government has proposed the decommissioning of Ngong' dumpsite and commissioning of an Integrated Waste Management System at Kerarapon. The decommissioning of the dumpsite has been necessitated by a myriad of environmental and socio-economic challenges associated with the dumpsite. Ngong' dumpsite is situated in Ngong' town, Kajiado North sub county, Kajiado County.

Kajiado is one of the largest administrative, commercial and administrative counties in Kenya (Annex 3). It has been experiencing rapid urbanization largely due to its geographic proximity to the capital city. The current population in Kajiado is estimated to be 687,312 people covering an area of 21,292.7 Km² projecting from the latest census of 2009. Kajiado North Sub County has a population of about 136,188 with urban population of Ngong' town at 20,657. According to the JIKA report 2010, the solid waste catchment of Ngong' town covers Kiserian and Ongata Rongai towns and generates about 40 tons of waste per day. Ngong' town, just like the larger Kajiado County has over the years experienced major challenges in managing solid waste. These include: Inappropriate and inadequate waste collection and transportation, access and inadequate infrastructure, funding limitations and constrained budget for Solid Waste Management (SWM) or illegal dumping which is a public health concern and is detrimental to the environment (JIKA, 2010).

It has been observed that half of the present solid waste generated is left uncollected or illegally dumped within the county and the remaining is carried to Ngong' disposal site. The disposal site, however, is an open dumping type landfill and this, therefore, has a detrimental effect on the surrounding environment. The major players in waste collection and transportation in this area include Private Service Providers (PSPs) and Community Based Organizations (CBOs) which are more involved in SWM but in an unstructured manner. A dumpsite can be described as a landfill for solid waste disposal. This is the oldest and most organized form of handling waste around the world. In most scenarios such disposal; sites are usually located at the outskirts of urban areas and are the primary sources of contamination and act as incubation sites to most disease vectors that have negative impact on human populations (NEMA, 2014).

1.2 Catchment Basin of the existing dumpsite

The catchment basin include upper Athi with Motoine River Dams, located along River Motoine which originates from Riu Swamp, north- west of Dagoretti Forest from springs issuing between lava flow with differing porosities and permeability as a result of vesicularity (Kahara, 2002). The river is heavily used for irrigation agriculture and other domestic chores in the settled Dagoretti area. It flows through two dams within Ngong' Forest namely, Karen Dam and Ngong' Forest Dam and two other dams in the Racecourse area. The area around Motoine River comprises of various land use types namely forest, grasslands, farmlands and built areas, i.e., buildings and roads (Annex 4)

1.3 Historical background of Ngong' Dumpsite

The dumpsite was established in 1970 and currently lies on a five (5) acre piece of land next to Ngong' market centres in Ngong' town. The dumpsite is geographically located in Kajiado County, Ngong' Ward at Ngong' Town. It is a public dumpsite managed by the County Council of Ole Kajuado. Ngong' is a town located at the foot of the Ngong' Hills approximately 25 kilometres Southwest of Nairobi Kenya. It is the largest town in Kajiado County with a population of 107,188 people according to the 2009 census. During the years of the British colonial rule the area around the Ngong' Hills was a major settler farming region. Today, Ngong' and its environs is a well-developed town providing a good residing place for many of Nairobi workers. The Ngong' Municipal market is the main market in the region and serves the Nairobi suburbs of Ngong', Ongata Rongai, Kiserian, Matasia, Oloolua and Karen. It is under the jurisdiction of the Ngong' Sub-county administration.

1.4 The Access Roads

The dumpsite is located in a difficult to reach area with narrow streets, alleys and deteriorated roads. Residents use alternative collection vehicles to access the current dumpsite such as semi-motorized carts, front-loaded tricycles, donkeys or handcarts especially during heavy rain season (plate, 1)

Plate 1: Donkeys as a means of transport



1.5 Land Use Planning and Management

Land use planning and management in Kenya is of great concern as poor planning has resulted in environmental, social and economic issues. The absence of a clearly defined land use policy in Kenya after years of independence has resulted in a haphazard approach to managing the different land use practices and policy responses (GoK, 2016). In Kajiado County land use activities, just like, the rest of the country is in conflict. For instance the Ngong' dumpsite is located next to schools, churches, residential areas, the market/town to mention but a few of the activities that are in serious conflict with the dumpsite. The land tenure systems in the country have enhanced land use conflicts. Ngong' dumpsite is located on government land thus can be subjected to use that the government deems necessary or as demand arises. Therefore the dumpsite was seen as idle land and thus was put into this use long before the development of Ngong' town. This has over the years attracted dumpsite workers and scavengers. The dumpsite currently poses serious environmental social and economic issues.

In addition, land use issues continue to be addressed through many uncoordinated legal and policy frameworks that have done little to unravel the many issues that affect land use management

CHAPTER TWO

ENVIRONMENTAL IMPACT ASSESSMENT APPROACH AND METHODOLOGY

2.1 Introduction

The EIA study was conducted in accordance with the requirements of the Environmental (Impact Assessment and Audit) Regulations, 2003; and Environmental (Impact Assessment and Audit) Regulations, (amendment), 2015. The Terms of Reference (TORs) is provided in Annex 5.

To adequately address the environmental issues emanating from the implementation of the proposed project, the team of experts carried out environmental and social Impact study. The environmental assessment was conducted by the experts in the field of soils for analysis, water quality assessment and air quality assessment. The social assessment comprised of the field surveys with questionnaires, interviews and focus group discussions. Also stakeholders' consultations and analysis of health and safety issues associated with the project.

2.2 Screening exercise

From the screening process, it was determined that the project could be categorised under category A according to the world bank guidelines that negative impacts can be mitigated. A project is categorised as category A if it is likely to have significant adverse environmental impacts that are sensitive, diverse and unprecedented, these impacts may affect an area broader than the site or facilities subjected to any activity. The Environmental Assessment for category A projects examines the projects potential negative and positive environmental impacts compares them with those of feasible alternatives and recommends any measures needed to minimize, mitigate or compensate for adverse impacts and improve environmental performance.

Consequently, it became necessary that an Environmental assessment through an environmental and social impact study as a tool would help in identifying, analyzing and developing practical mitigation measures for identified negative impacts. The screening exercise was conducted in line with the guidelines by National Environmental and Management authority-Kenya. 2003.

2.3 Secondary Data

Document analysis approach was employed to obtain relevant information on the political, social, economic and biophysical characteristics of the project area and its environs. Some of the documents reviewed include

- (a) Environmental Management and coordination Act,1999
- (b) Environmental Impact Assessment and Audit Regulation,2003
- (c) Population census report of ,2009
- (d) World bank policy on environmental assessment OP.4.02

2.4 Primary Data

The primary data collection involved household survey, resource analysis, consultation with relevant experts and authorities.

a) Household survey

House hold surveys were conducted between 5th and 28th April, 2018. The sample selected for the household survey was defined by the households and businesses directly affected by the proposed project. The targeted respondents consisted of people affected in the following ways

- (i) People living within villages bordering the dumpsite
- (ii) Persons with structures located within the dumpsite
- (iii) Persons picking wastes within the dumpsite
- (iv) Middlemen buying waste from waste collectors
- (v) Trucks ferrying wastes to the dumpsite
- (vi) CBO's earning a living from the dumpsite
- (vii) Farmers along Ngong' river

The total number of households interviewed living around the dumpsite were 200 households.

Environmental and Impact Assessment

The information gathered during the desktop and field studies was used to build up the baseline information of the Ngong' dumpsite. On the basis of acquired information, informed judgement and experiences from similar ongoing projects within Ngong', environmental and social impacts likely to emanate from the implementation of the project were made. Ultimately, the nature, magnitude and duration of both positive and negative environmental impacts were assessed and mitigation measures developed accordingly.

Assessment was more specifically of the following parameters

i) Social Impact Assessment

- a) Household surveys
- b) Income assessment of PAPs scavenging within the dumpsite
- c) Workshops
- d) Traffic Assessment on the main roads around the dumpsite
- e) Key information interviews
- f) Observation and surveys
- g) Questionnaire schedules

(ii) Environmental Impact Assessment

- (a) Water quality analysis
- (b) Soil sampling
- (c) Leachate analysis
- (d) Air quality analysis
- (e) Flora and fauna analysis within the project site

(c) Stakeholder consultation/public participation

In conforming to the current environmental legislations which emphasises on comprehensive stakeholder consultations, consultations were held with key stakeholders including

individuals, NGOs, Private sector institutions, government ministries and parastals. The aim of consultation was to introduce the project, and have reservations and views integrated in the study.

2.4.5 Soil sampling

Soil samples for analysis in the laboratory were collected 22nd April, 2018. Six samples were collected for each area randomly. The sampling was well distributed mainly at the periphery of the dumpsite. No samples were taken within the dumping area owing to the nature of substrate which was mainly waste material piled over many years therefore lacking in soil substrate. Soil samples were analyzed for texture, composition, CEC and heavy metals.

2.4.4. Water quality analysis

Water samples were collected in Ngong' sites around the dumpsite and sent for analysis for heavy metals, BOD and physic-chemical analysis.

1.4.5. Leachate Analysis

Leachate samples were collected along drainage channels where liquids were oozing from the dumped material. Similarly, leachate samples were collected within the dumping site where it collects and on the river embankments where it was seen to drain into the river.

1.4.6 Air quality analysis

The sampling was done between 5th and 21st April, 2018. Sampling was done in situ using a portable gaseous sampling meter. Gas samples were also collected for laboratory analysis. Test for methane, carbon dioxide, carbon monoxide, acidic gases, particulates and temperature was carried out.

CHAPTER THREE

BASELINE INFORMATION

3.1 Introduction

This chapter presents the baseline information for the Ngong' dumpsite. In this chapter the topographic assessment is examined, the flora and fauna of the area is described, current status of solid waste management at the dumpsite evaluated, status of water, air and soil quality examined and the socioeconomic status of the population around the dumpsite evaluated.

3.2 Flora

The vegetation around the dumpsite is made of weeds and bushes commonly found in disturbed places. The bushes are *Sesbania sesban*, *Cassia didymobotrya* mixed with weeds of *Solanum incanum*, and *Amaranthus africanus*. The trees behind the school are mainly *Grevillea robusta* and *Eucalyptus saligna*. The school field in the background is covered with Kikuyu grass (*Pennisetum clandestinum*), the church compound has a live fence of *Duranta plumieri* plants and a lush lawn of Kikuyu grass (*P. clandestinum*) dotted with Blue gum (*Eucalyptus saligna*) and Thika palm (*Filicium de ficiens*) trees. On the periphery of the dumpsite there are bushes of *Solanum incanum* and *Tithonia diversifolia* mixed with *Amaranthus hybridus*).

Plate 2: vegetation around the dumpsite



Source Field work, 2018

The natural vegetation in other sections of the dumpsite include Castor plants (*Ricinus communis*, *Cassia didymobotrya*) and a young *Acacia xanthophloe* spp. and weeds such as *Leonotis africana*.

Plate 3: Castor plantPlate and Cassia and Acaci plant



Field work, 2018

The Mathare slum vegetation

The Mathare slum area has vegetation such as *Grevillea robusta*, Blue gum (*Eucalyptus saligna*) and Bottle brush (*Callistemon salignus*) and bushes of *Sesbania sesban*, *Lantana camara* and *Tithonia diversifolia* scattered all over (plate 1.3)

Plate 4: Mathare slum of Ngong'



Field work, 2018

3.3 Crop farming at dumpsite

There are crops planted around the dumpsite such as Maize (*Zea mays*), mixed with Pinto beans (*Phaseolus vulgaris*), Kales (*Brassica oleracea*) and bananas (*Musa domestica*).

(Plate 4).

Plate 5: Crop farming at the dump site



Source Field Work, 2018

3.4 Fauna

The fauna here is made of birds of the dumpsite such as Pied crow (*Corvus albus*), Marabou stock, Speckled mousebird (*Colius striatus*), and Hadada ibis (*Bostrychia hagedash*). There is evidence of small mammals like rodents from the tunnels in the dumpsite. Domestic mammals are Pigs (*Susdomesticus*) and dogs (*Canisfamiliaris*) owned by the people who scavenge from the dumpsite.

a) Large mammals

Total county method was employed to survey large mammals utilising the dumpsite as well as IWM facilities at Kerarapon. The method was designed to give information on their distribution, habitat preference, population size and their conservation status and that of their

habitats. The data was also important to understand the effects of decommissioning and impacts on their habitat.

b) Herpetofauna species inventory

Amphibians were visually searched as good indicators in an ecosystem. The method was used to search for amphibians that aggregate at the breeding site or that are relatively abundant in a given area. Field observers involved walking slowly (1-2 hours) around or through areas perceived as breeding site or some other prescribed area systematically searching for amphibians. The data was intended to give information on amphibian species as bio indicators. The visual method was complimented through acoustic assessment of male call as an indirect assessment of presence or absence of amphibians.

(c) Avifauna species inventory

Birds were used as ecological indicators of the health of the area. They were further used as ideal indicators of types of waste materials, and in terms of their propensity to act as major threats to aviation industry. The birds are also at times vectors of diseases especially where they feed on infected animal wastes. A line transect method was used due to open nature of the dumpsites where the enumerator counted all the birds encountered on foot along a designated transects. The data collected was both visual observation and acoustic. The observer stratified the areas into riverine, grassland and dumpsite as well as residential areas in Ngong' while data was collected in zones along the riverine and open grassland areas characterising the IWM facility area at Kerarapon

3.5 The status of solid waste

Primary data was collected at the Dumpsite where the carrier vessels disposing at the dumpsite were noted down indicating the estimated tonnage, type of waste, origin of waste, time of delivery, cost of disposal and company or group delivering the waste. This was done in the month of February 2018.

3.5.1 Mode of waste delivery

Ngong' dumpsite received a relatively high number of vehicles from the private service providers as compared to the county trucks, with Lorries recording a higher number of deliveries of waste at the site. Also observed were the small scale deliveries by the CBO's who delivered waste at the dumpsite with wheel barrows and carts this deliveries were made

at a specifically designed section that's assigned for low carriage modes of waste deliveries. Market wastes were in most instances delivered by the county trucks indicating that the markets were being specifically served by the county vehicles.

Plate 6: Major mode of transport



Fieldwork, 2018

3.5.2 Estimated Tonnage

Results and analysis; Table 1 illustrates the type of vehicles in terms of numbers and the volume of waste received from each during the research study.

Table 1: Mode of transport and tonnage

Type of Vehicle	Wednesday		Thursday		Friday		Saturday		Sunday		Monday		Tuesday	
	No.	Ton.	No.	Ton.	No.	Ton.	No.	Ton.	No.	Ton.	No.	Ton.	No.	Ton.
Lorries	11	121	14	132	12	109	8	80	2	18	9	76	6	59
Pick-Ups	2	10	3	15	4	12	1	3	1	3	1	3	4	12
Skip Loaders	3	18	3	18	0	0	0	0	0	0	3	18	1	6
Mini-Lorries	1	7	0	0	3	18	1	8	0	0	3	21	2	14
Tippers	0	0	0	0	0	0	2	24	0	0	2	24	0	0
Handcarts	5	1	7	1.5	4	1	4	1	6	1.5	7	1.5	11	3
Total		157		166.5		140		116		22.5		143.5		94

*no- number of vehicles,

*Ton- Estimated disposed tonnage

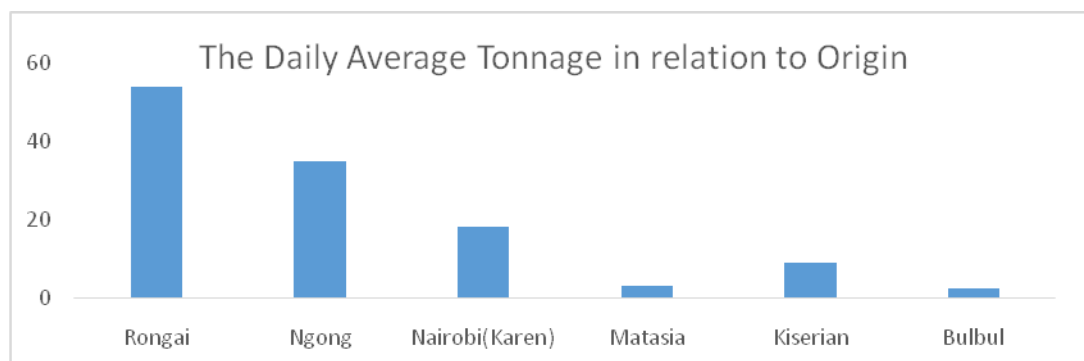
Fieldwork, 2018

Among the vehicles that did waste delivery, Lorries were the most followed by Pic-ups which was slightly higher than the handcarts. Keeping the exact number of handcarts that disposed at the dumpsite proved difficult though due to the fact that the cart deliveries were a portioned an outside section of the dumpsite for their specific disposals.

3.5.3 Waste Origin

According to the survey the origin of waste in tonnage indicates that a greater percentage of waste was from Rongai, followed by Ngong', then Karen (fig 1). Waste from Karen was delivered by Vijana Kwa Mazingira (Mazingira Bins), the only established PSP that owned vehicles marked with the company names. Others hired vehicles for waste deliveries.

Figure 1: Tonnage of waste from various places



The waste data analyzed according to the distinct days of data collection indicates that Sunday is the least active day with the lowest volume of waste received with the highest having been received on a Thursday.

Figure 5: Average daily tonnage

3.5.4 Types of waste

The waste analysis established that a greater portion of both the market and household wastes disposed at the dumpsite were organic waste, closely followed by plastic and paper waste. During the analysis it was noted that waste segregation at the household level was not practiced entirely with mixed waste collected and delivered at the dumpsite (plate 2)

Plate 7: Types of waste



Field work 2018

3.5.5 Cost analysis

The financial dynamics of waste delivery at Ngong' dumpsite can be said to be complex. An average of between Ksh. 400 -1000 depending on the carriage capacity of the vehicle, with a portion of the fee being allocated to the youth group as well as for paying for manual transfer of the waste. However the county claims little or no cash from the collection due to minimal infrastructural assistance into the dumpsite maintenance and operations.

3.5.6 Operation hours

Waste disposal at Ngong' dumpsite was mostly in between 8 am to 6pm with a few illegal dumpers managing to dump waste early in the morning or late at night colluding with the site management team. For instance during the study period, two illegal waste trucks were reported delivering waste from Wilson airport.

CHAPTER FOUR

RELEVANT POLICY LEGISLATIVE AND REGULATORY FRAMEWORK

4.1 Introduction

National, Legal and Institutional Framework Kenya has approximately 77 statutes that guides on environmental management and conservation. Most of these statutes are sector specific, covering issues such as public health, soil conservation, protected areas conservation and management, endangered species, public participation, water rights, water quality, air quality, excessive noise control, vibration control, land use among other issues. The National Environment Management Authority (NEMA) in conjunction with the various lead agencies studies proposed projects to ensure all aspects of the proposed project adheres to all Institutional Frameworks requirements. The institutional framework directly governing dumpsites projects are: Environmental Management and coordination Act (EMCA) of 1999 and its subsequent supplements the Environmental (Impact Assessment and Audit) Regulation, 2003; EMCA (Waste Management) Regulations, 2006 and EMCA (Water Quality) Regulations, 2006; EMCA (Controlled Substance) Regulations, 2007; EMCA (Noise and Vibration Control) Regulations, 2009; EMCA (Emissions Control) Regulations, 2006; EMCA (Wetlands, River Banks, Lake Shores and Sea Shore Management) Regulations, 2009 and EMCA (Conservation of Biological Diversity and Resources, Access To Genetic Resources and Benefit Sharing) Regulations, 2006, Land Acquisition Act (Cap.295), Land Act Way Leaves Act (Cap. 292), Public Roads and Roads Access Act (Cap. 399), Forest Act, Physical Planning Act (CAP 286), Local Government Act (CAP 265), Traffic Act Chapter 295, Public Health Ac (Cap. 242), Lakes and River Act Chapter 409, and the Penal Code (CAP 63) 514. The project should adhere to these legislations.

4.1.1 Environmental Management and Coordination Act of 2015

This project report shall be undertaken in accordance with the Environment (Impact Assessment and Audit) regulation 2003, which operationalize the environment management and coordination act 1999. The report shall be prepared in conformity with the requirements stipulated in the environmental management and coordination act no 8 of 1999 (EMCA) and the Environmental Impact Assessment and audit regulations 2003 regulation⁷ (1) and the second schedule. Part II of the said act which states that every person is entitled to a clean and healthy environment and has the duty to safeguard the same. In order to achieve the goal

of a clean environment for all, new projects listed under the second schedule of Section 58 of EMCA No 8 Of 1999 shall undergo an Environmental Impact Assessment. This includes development activities such as this new project. In addition to the legal compliance above, the following legal aspects shall also be taken into consideration or will be taken into consideration before commencement of the project.

4.1.2. Occupational Health and Safety, 2007

The said Act requires that before any premises are occupied or used a certificate of registration should be obtained from the chief inspector. The occupier must keep a general register with provision for health, safety and welfare of workers on site. Public Health Act Cap 242 Part IX section 115 of the Act states that no person or institution shall cause nuisance or condition liable to be injurious or dangerous to human health section 116 requires that local authorities take all lawful necessary and reasonable practicable measures to maintain their jurisdiction clean and sanitary to prevent occurrence of nuisance or condition liable to injuries or dangerous to human health. This will have to be provided for this project. Physical Planning Act, 1999 the said Act section 29 empowers the local authorities to reserve and maintain all land planned for open spaces, parks, urban forests and green belts. The same section allows for prohibition or control of the use and development of an area. Land Planning Act Cap 303 Section 9 of the subsidiary legislation (the development and use of land Regulations 1961) under which it requires that before the local authority submits any plans to the minister for approval, steps should be taken as may be necessary to acquire the owners of any land affected by such plans. Particulars of comments and objections made by the landowners should be submitted, which intends to reduce conflict of interest with other socio economic activities.

Other Relevant Laws include EMCA (Waste Management) Regulations, 2006. These Regulations guides on the appropriate waste handling procedures and practices. It is anticipated that, the proposed project will have to deal with large quantity of solid waste dumped over the years since the inception of the dumpsite.

According to the regulation, waste should be; segregated and grouped according to their similarity for example plastics, toxic, organic etc; all waste should be deposited in a designated dumping area approved by the local authority; all waste handlers engaged by the proponent should be licensed by NEMA and possess all relevant waste handling documents such as waste transport license, tracking documents, license to operate a waste yard,

insurance cover, vehicle inspection documents among others; all hazardous wastes are labeled as specified in section 24 (1-3) of the regulation. The fourth schedule lists wastes considered as hazardous and solvents, emulsifiers/emulsion, waste oil/water and hydrocarbon/water mixtures. EMCA (Noise and Vibrations Control) Regulations, 2009 These Regulations provides guidelines for acceptable levels of noise and vibration for different environments Section 5 of the regulation warns on operating beyond the permissible noise levels while section 6 gives guidelines on the control measures for managing excessive noises and copy of the first schedule indicating the permissible noise levels for different noise sources and zones. The project team should observe the noise regimes for the different zones especially when working in areas termed as silent zones which are areas with institutions and worship places. These areas are permitted exposure to sound level limits of not exceeding 40 dB (A) during the day and 35 dB (A) at night. The regulation states that a day starts from 6.01 a.m. to 8.00 p.m. while night starts from 8.01 p.m. – 6.00 a.m. during the day and night levels are maintained at 35 dB Part III of the regulation gives guidelines on noise and vibration management from different sources. Sections 11, 12 and 13 of the stated part give guidelines on noise and vibration management from machines, motor vehicles and night time construction respectively. Section 15 requires owners of activities likely to generate excessive noise to conduct an ESIA to be reviewed and approved by NEMA. EMCA (Air Regulations), 2014.

This Act is meant to ensure that all activities at least maintain ambient quality standards of air and any pollution to air (in particulate matter, dust or obnoxious and poisonous gases) needs to be sufficiently mitigated. County Governments Act, 2012 This Act delineates the roles and responsibilities of county governments with their administrations as well as the role of county citizens in public participation and consultations regarding projects at the county level. CPP is part of this project involving the county government and other stakeholders. HIV Aids Prevention and Control (Cap 246A) This Act is to promote public awareness about the causes, modes of transmission, consequences, means of prevention and control of HIV and AIDS. It also seeks to positively address and seek to address conditions that aggravate the spread of HIV infection. In the Ngong' dumpsite project, there will be awareness creation and sensitization on the workers and other persons on the risks of infections and fostering prevention and control. It is also recommended that condoms for use by workers will be availed at site to prevent infections.

4.1.3 National Policy Framework.

Several policies have been developed over the years to guide the development and management of proposed projects to ensure both economic and social sustainability these policies include; The National Poverty Eradication Plan (NPEP) The objective of the NPEP is to reduce the incidences of poverty in both rural and urban areas by 50 percent by the year 2015, as well as to strengthen the capabilities of the poor and vulnerable groups to earn income. It also aims to narrow gender and geographical disparities and create a healthy, better-educated and more productive population. This plan has been prepared in line with the goals and commitments of the World Summit for Social Development (WSSD) of 1995. Environmental & Social Impact Assessment Project Report for the Ngong'' dumpsite in in Kajiado County of Nairobi Metropolitan Region 21 The plan focuses on the four WSSD themes of poverty eradication; reduction of unemployment; social integration of the disadvantage people and creation of an enabling economic, political, and cultural environment which can be achieved through developing proper sanitation . The plan will be implemented by the Poverty Eradication Commission (PEC) formed in collaboration with Government ministries, Community Based Organization (CBO), private sector, Non-Governmental Organization (NGO), bilateral and multilateral donors. 2.9.3 The Poverty Reduction Strategy Paper (PRSP) The PRSP has the twin objectives of poverty reduction and enhancing economic growth. The paper articulates Kenya's commitment and approach to fighting poverty; with the basic rationale that the war against poverty cannot be won without the participation of the poor themselves. The proposed project through improving sanitation in the area will, contribute towards economic growth.

National Environmental Action Plan (NEAP) The NEAP for Kenya was prepared in mid 1990s. It was a deliberate policy whose main effort is to integrate environmental considerations into the country's economic and social development. The integration process was to be achieved through multi-sectoral approach to develop a comprehensive framework to ensure that environmental management and the conservation of natural resources forms an integral part of societal decision-making. The application of this plan is widening as the government through NEMA does not approve a development project unless the impacts of the proposed project are evaluated and mitigation measures proposed for incorporation in the project's development plan which is in line with the requirements of the NEAP.

Environmental and Development Policy (Session Paper No.6 1999) As a follow-up to the foregoing, the goal of this policy is to harmonize environmental and developmental goals so

as to ensure sustainability. The report provides comprehensive guidelines and strategies for government action regarding environment and development. It is recommended that the requirements of this policy are observed, as much by taking measures to enhance the water catchment by replanting trees, using clean energy to reduce deforestation, undertaking environment friendly practices during project implementation, take measures to reduce pollutants leading to eutrophication of water bodies both above- and underground water bodies; and Rehabilitate project affected areas and public infrastructure among others

4.1.4 International Policy Framework

Kenya is a signatory as well as a party to various international conventions, treaties and protocols relating to the environment which aims at achieving sustainable development. According to the Registrar of International Treaties and other Agreements in Environment (UNEP 1999), there are 216 treaties, 29 of which are of interest to Kenya. The country is a signatory to 16 such agreements, which range from use of oil, protection of natural resources and protection of the atmosphere. The agreements are both regional and international and become legally binding on Kenya upon Environmental & Social Impact Assessment Project Report for the dumpsite in Ngong' in Kajiado County of Nairobi Metropolitan Region. Ratification thereof by the rightfully designated Kenyan Authority. The agreements of interest to Kenya can be categorized as those for protecting natural resources, atmosphere and social wellbeing of man.

The National Environment Management Authority The responsibility of the National Environmental Management Authority (NEMA) is to exercise general supervision and, co-ordination of all matters relating to the environment and to be the principal instrument of government in the implementation of all policies relating to the environment. The Authority shall review the project report for the proposed project, visit the project site to verify information provided in the report and issue an ESIA license if it considers that all the issues relevant to the project have been identified and mitigation measures to manage them proposed.

World Bank Environmental and Social Safeguard Policies

Like in any project financed by, or with financial participation of, the World Bank, the environmental and social impact assessment safeguards as defined in the Bank's Operational Procedures (OPs) will be respected for the purposes of this project implementation. The WBG EHS guidelines as stipulated by the Bank should be strictly adhered to in this project

and the more stringent between the Bank's and local legislation should be complied with. WB classifies its projects into four Environmental Assessment categories according to the likely impacts on the environment they will have. This classification is as follows (only main conditions mentioned): (a) Category A: A proposed project is classified as Category A if it is likely to have significant adverse environmental impacts. (b) Category B: A proposed project is classified as Category B if its potential adverse environmental impacts on human populations or environmentally important areas—including wetlands, forests, grasslands, and other natural habitats—are less adverse than those of Category A projects. These impacts are site-specific; few if any of them are irreversible; and in most cases mitigation measures can be designed more readily than for Category A projects. Category C: A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impacts. Beyond screening, no further EA action is required for a Category C project. (d) Category FI: A proposed project is classified as Category FI if it involves investment of Bank funds through a financial intermediary, in subprojects that may result in adverse environmental impacts. This project is categorized as F1.

CHAPTER FIVE

PUBLIC PARTICIPATION

5.1 Introduction

The public consultation was carried out with key stakeholders of the project and the persons affected by the project and the communities living around the dumpsite. Specifically consultants were held with the following institutions, and their views were captured. The key stakeholders included;

- Ministry of Environment and Mineral resources
- Kajiado County environment director
- National Environment Management Authority
- Kajiado County government
- Kenya Wildlife services
- Kenya Forest Services
- Water Resources Management Authority

The following are examples of projects that were never fully implemented due to lack or poor public participation. They include:

- Asticom: Signed MOU for construction of a recycling facility stalled due to technicalities.
- Construct Consultant Ltd: Signed MOU to establish Solid waste recycling facility, benchmarked in Pakistan but identified site was found to be unsuitable for the proposed recycling plant and handling.
- NCA (Norwegian): Sustainable charcoal production policy.
- Private Refuse Handlers: Enabling environment for private entities to undertake refuse collection in major towns.
- NIA (Neighbours Initiative Alliance): Collaborated in operation of sand harvesting regulation and sustainable charcoal harvesting policy.
- City of Umea in Sweden: Collaborated in Governance for Integrated Environmental System on Waste and Water management, funded by the International Centre for Local Democracy.

- UN Habitat under Danish: Have held meetings with a view of possible collaboration for construction of a landfill.
- WWF (World Wildlife Fund): Collaboration in provision of predator lights and renewable energy – biogas technology to the rural community.
- Focused group discussions were held with persons affected by the project
- Middle men
- Communities living around the dumpsite
- Religious leaders
- Heads of schools around the dumpsites
- Dumpsite workers
- Meeting with the truck drivers ferrying wastes to the dumpsite
- Closeout general meeting with all the waste pickers and neighbours to the dumpsite
- Veterinary farmers

5.2 Key stakeholders' environmental concerns

- a) Ministry of environment and natural resources is in support of the project
- b) Kajiado County government is in need of proper waste management
- c) The dumpsite has been a source of pollution for Ngong' river
- d) The Kajiado county should ensure that there will be proper management of the new Integrated Waste Management facility proposed at Kerarapon
- e) An integrated approach in the management of the system should be established as a result of lessons learned from the previous system

Water resources Management Authority

- a) WARMA is concerned with the quality of water both surface and ground water

- b) The project should ensure that ground water is not polluted and the discharge to the river as a result of sanitary landfill is of good quality that it does not pollute the river even more
- c) Rehabilitation of Ngong' Dumpsite River riparian should be adequately be carried out and proper vegetation and weeds planted.

Ministry of transport

It is important to have a clean town to enable the town to competitively compare to other towns.

Athi Water Service Board

Ngong' River has been contaminated by wastes from Ngong' town. The dumpsite has been a source of solid waste polluting Ngong' River.

Conclusion

The public consultations introduced by the project by informing the stakeholders of the Kajiado county intention's to close down the Ngong' Dumpsite. This was carried out effectively and all the people involved in all activities at the dumpsite are aware of this plan.

The persons affected by the project were very concerned about the loss of their source of livelihood; the study held a series of meetings with individuals registered groups, middlemen and the entire group. The persons affected by the project would like to be compensated to enable them find another source of livelihood

The persons affected by the project at Ngong' dumpsite are vulnerable. They include youth, orphaned, households, female headed houses, and young children under 18 years, elderly women and elderly men.

The key concern was future source of livelihood since they have been relying on the dumpsite for many years. Majority have basic education and thus has no capacity to venture in to other areas form of livelihood. The groups are also represented by the majority of the youth have young families who have previously involved in criminal activities and have reformed as a result of venturing into businesses at the dumpsite.

It was observed that the number of female headed households, orphaned and young children working at the dumpsite is high. These are already vulnerable households, removing the dumpsite with them without proper plans to restore the households would make them even more vulnerable.

CHAPTER SIX

ENVIRONMENTAL AND SOCIAL IMPACT AND MITIGATION MEASURES

6.1 Introduction

The study should consider and assess the following key areas: Air quality, water quality, soil quality

6.1.1 Air quality,

The dumpsite is dusty and this has the potential to cause significant nuisance to people living close to the site and may endanger the health of those living and working around the dumpsite. Smoke from landfill gas burning in the dumpsite is of major concern since it could have effects on human health.

6.1.2 Odour

Odour is a significant problem for the people working in the dumpsite area and people living in the surroundings of the site. The main source of odour at the site is from the handling of the waste when it is unloaded from the waste trucks and at the sorting area.

6.1.3 Noise

The noise nuisance is produced by vehicles transporting the waste in the area and by the birds. In particular the residents along the transit road are mostly affected by trucks transit. Currently, available/utilized waste collection trucks include 10 water tractors and trailers, 5 standard trucks and 2 tipper trucks that are licensed to transport waste to the disposal site. A potential nuisance is noise from the dumpsite such as normal operation of vehicles transporting the waste to the site.

A baseline Air Quality Assessment for the project. This Air Quality assessment includes a description of the existing atmospheric environment for the proposed site and establishing the extent of the toxic gases levels in the existing dump site in Oloolua area. Quantification of the air emissions from the Project, assessment of potential air emission impacts in accordance with the relevant Project criteria, and identification of relevant air emission control measures.

6.1.4 Scope of work

The scope of work was as follows:

- Identifying suitable monitoring locations in cognizance of wind patterns within the vicinity of the site
- Undertaking monitoring for CO, CO₂, H₂S, VOCS, NO₂, and SO₂ utilizing active methods as opposed to passive diffusion tubes.
- Compiling the findings of the survey in a comprehensive air quality report

Figure 1: Google map showing the measurement points at Oloolua dump site in kajiado



Plate 8: The truck off loading the waste at the venue.



6.1.5 Meteorology


Meteorological data is essential for the development of a model of atmospheric dispersion that simulates the behaviour of pollutants in the atmosphere. Meteorological mechanisms



govern the dispersion, transformation, and eventual removal of pollutants from the atmosphere. The analysis of hourly average meteorological data is necessary to facilitate a comprehensive understanding of the ventilation potential of the site. The vertical dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness.


6.2 BASELINE MEASUREMENTS

6.2.1. Measurement location description

The measurements were carried out at six selected points at the Kaindi dumping site and Kibiku forest proposed project site respectively as described in table 2 and figure 1.

Photo	Descriptions
	<p>The location is at the center of the current dump site.</p>

	<p>The location is at the access road to the current dump site, approximately 80 meters from the first measurement location.</p>
<p>The proposed site</p>	
	<p>The area is at the middle of the proposed new site</p>

	<p>The location is at the gate, approximately 100 meters from the above location.</p>
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6.2.2. Measured Parameters

The parameters measured in ambient air at the proposed project site were:

- Sulphur dioxide
- Nitrogen dioxide
- Hydrogen sulphide
- Carbon dioxide
- Humidity
- Temperature
- VOCs

Further description of each of the above parameters is provided below.

6.2.3. Sulphur dioxide and nitrogen dioxide

Sulphur dioxide (SO₂) is a colourless, water-soluble gas that is reactive and has a pungent odour. Sulphur dioxide is detectable to the human nose at concentrations of around 0.5–0.8 parts per million (1400–2240 µgm⁻³). Concentrations of SO₂ in ambient air typically occur as a result of combustion processes, in particular the burning of high sulphur fuels, although specific industries such as manufacturing fertiliser also discharge SO₂. Sulphur dioxide is

subject to a series of transformation processes in the atmosphere, which can result in, sulphurous and sulphuric acids, sulphites and sulphates being formed.

Sulphur dioxide causes irritating effects by stimulating nerves in the lining of the nose and throat and the lung's airways. This causes a reflex cough, irritation, and a feeling of chest tightness, which may lead to narrowing of the airways. This latter effect is particularly likely to occur in people suffering from asthma and chronic lung disease, whose airways are often inflamed and easily irritated.

Asthmatics are generally considered the most sensitive group in the community to concentrations of SO₂. Other sensitive groups include those exercising. This is because SO₂ is very reactive and consequently the distribution of SO₂ along the conductive airways of the respiratory tract is non-uniform, depending on breathing volumes and types.






6.2.4. Nitrogen dioxide

NO₂ is a reddish-brown gas with a pungent and irritating odour. It transforms in the air to form gaseous nitric acid and toxic organic nitrates. NO₂ also plays a major role in atmospheric reactions that produce ground-level ozone, a major component of smog. It is also a precursor to nitrates, which contribute to increased respirable particle levels in the atmosphere.

NO₂ can irritate the lungs and lower resistance to respiratory infection. Sensitivity increases for people with asthma and bronchitis. NO₂ chemically transforms into nitric acid and, when deposited, contributes to Lake Acidification. NO₂, when chemically transformed to nitric acid, can corrode metals, fade fabrics and degrade rubber. It can damage trees and crops, resulting in substantial losses

Error! Reference source not found.2 provides the health effects of different Air Quality Index levels caused by nitrogen dioxide.

Table 2: Health effects of different Air Quality Index (AQI) levels caused by nitrogen dioxide

Category	AQI	Pollutant Concentration Breakpoints (ppb)	Nitrogen Dioxide (NO ₂)
 Very Good	0 - 15	0 - 50	No health effects are expected in healthy people.
 Good	16 - 31	51 - 110	Slight odor.
 Moderate	32 - 49	111 – 200	Odor.
 Poor	50 - 99	201 – 524	Air smells and looks brown. Some increase in bronchial reactivity in asthmatics.
 Very Poor	100 or over	525 or over	Increasing sensitivity for asthmatics and people with bronchitis.

6.2.5. Hydrogen Sulphide

Hydrogen, an abundant element that helps power the sun, also forms diverse compounds on earth ranging from water to hydrogen sulfide: a foul-smelling, colorless gas that forms when bacteria decompose dead animal and plant matter in stagnant low-oxygen water. Although hydrogen sulfide causes serious health problems at high exposure levels, it has several important commercial uses ranging from metallurgy to manufacturing.

- **H₂S at a Glance**

Hydrogen sulfide and water have similar structures, but intermolecular forces in H₂S are weaker than those in H₂O. These weaker forces cause hydrogen sulfide to boil at a lower temperature than water. The human body, volcanic gases, unrefined petroleum and natural gas all contain hydrogen sulfide. This gas is heavier than air so it often accumulates in low-lying areas. Food processing plants, paper mills and other industries can also create H₂S as a byproduct of their production processes.

- Hydrogen Sulfide: Nature's Chemical Helper

The main use for hydrogen sulfide is in the production of sulfuric acid and elemental sulfur. Manufacturers use sodium hydrosulfide, sodium sulfide and similar inorganic sulfides to create products such as pesticides, leather, dyes and pharmaceuticals. H₂S is used to prepare the inorganic sulfides you need to make those products. As a reagent and intermediate, hydrogen sulfide is beneficial because it can prepare other types of reduced sulfur compounds. A reagent is a starting participant in a chemical reaction. In a chemical process, an intermediate is a substance that the process creates. This substance, not the final product, can serve as raw material for the process's next step.

6.2.6. Sampling methodology

The sampling was based on active method as opposed to passive. Direct reading machines were deployed to collect the samples for a period of one hour per location, and average data recorded. Some of the equipment's used were:



Fig of meters used, MultiRae, CO meter, EVM analyzer, manufactured by the 3M Company

Table 3: Air Quality in the proposed project area (22nd April 2018) viewed against NEMA

Sampling Point/Parameter	Mid dump site (MP1)	Road near dumping (MP2)	Church compound (MP3)	Near residential (MP4)	Mid field (MP5)	Near gate (MP6)	EMCA 2014 (Air Quality)	WHO (AQG) <i>Max</i>
Coordinates	239558E 9849599N	239494E 9849464N	239429E 9849393N	238311E 9853832N	238234E 9853627N	238142E 9853367N		
Sulphur Dioxide ($\mu\text{g}/\text{m}^3$)	BDL	BDL	BDL	BDL	BDL	BDL	80	500
Carbon Monoxide (mg/m^3)	BDL	BDL	0.12	0.21	BDL	BDL	2.0	-
Carbon Dioxide (mg/m^3)	599	277	207	205	200	200	-	-
Oxides of Nitrogen (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	0.05	200
Hydrogen Sulphide ($\mu\text{g}/\text{m}$)	BDL	BDL	BDL	BDL	BDL	BDL	150	-
VOCs ($\mu\text{g}/\text{m}$)	1.60	1.43	BDL	BDL	BDL	BDL	600	-
Relative Humidity (%)	88.9	92	91	82.9	82.7	82.9	-	-
Temperature ($^{\circ}\text{C}$)	16.9	17.5	17.3	19.0	18.9	18.9	-	-

The table above shows results of the field measurements taken in the study site. Concentrations of Carbon monoxide in Church compound (MP3) and near the residential homes (MP4) were detectable ($0.2 \text{ mg}/\text{m}^3$) but tenfold lower than the guideline values ($2 \text{ mg}/\text{m}^3$). Sulphur dioxide, hydrogen, sulphide and oxides of nitrogen were below the detection limit. Although concentrations of VOCs and CO_2 were determined, they were well within the expected ranges.

Water, leachate and soil quality in the project area

Table 4: Water quality indicators in the proposed project area (sampled on 5-18 April 2018) viewed against NEMA guideline values (1st Schedule).

Sampling point/Parameter	NW-01 Mbagathi River	NW-02 Bore Hole	NW-03 Ngong' Water	NW-04 Ngong' Water	NW-05 Ngong' Water	NW-06 Ngong' Water	NL-01 Ngong' Leachate	NL-02 Ngong' Leachate	Guide line values
Coordinates	37238432 E 98495111 N	3723913 E 9849580 N	37239458 E 9849375N	37243156 E 9853663N	37239674 E 9854501N	37239829 E 9849432N	37239559 E 9849519N	37239565 E 9849646N	
Temperature (°C)			20.9	20.5	19.4		26.3	27.1	30
pH			7.35	7.05	6.03		7.22	7.53	6.5 - 8.5
Conductivity (μScm^{-1})			862	351	437		22.0	39.3	-
Nitrates (mg l^{-1})	0.0	0.0	6.1	0.0	0.0	0.0	34.3	65.9	10
Phosphates (mg l^{-1})	3.5	4.0	5.2	3.4	1.6	2.3	3.4	0.01	-
Lead (mg l^{-1})	113.1	24.1	140.5	116.7	86.1	106.3	-	91.3	0.05
Zinc (mg l^{-1})	17.2	7.2	8.3	9.1	8.3	6.9	-	5.4	1.5
Cadmium (mg l^{-1})	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.0

Environmental processes, which include physical, chemical and biological attributes interact at an ecosystem level to affect biota and the people living within the environment. Eight water quality parameters were determined and analyzed from eight sampling points. The water quality parameters analyzed showed that there were variations although generally within the NEMA standards/guideline values. In particular, the pH range was within the acceptable levels except at Ngong water (NW-05) where it was below (6.03). The pH range of a water body is largely related to total alkalinity which is a measure of pollution of a water body. Natural surface water and well water contain less alkalinity than sewage or waste water. pH is an important determinant of the biological availability of essential nutrients such iron and phosphorous. pH also governs the proportion of NH_4^+ to NH_4OH in water. NH_4OH is toxic to many aquatic organisms and may become a health risk to humans. Such water resources accessed by both domestic animals and humans can have concentrations of environmental parameters that cause negative effects. Typically, a dumpsite located in the lower parts of a growing urban environment accumulate pollutants from surrounding

environments often leading to formation offensive odours and a myriad other environmental problems.

The other water quality parameters of concern, especially heavy metal concentrations (lead, zinc and cadmium) in seven sampled points exceeded NEMA guideline values and could imply high risk, especially to the domestic animals (cattle, pigs, goats, sheep, etc) that use the water resources. Lead and Zinc were 10 to 100 higher than the recommended values in natural ecosystems (Table above).

In soil, concentrations of the determined parameters were lower than they were in water, and near background levels. Zinc, lead and cadmium were observed to be present in the eight sampled sites. It is likely that the environmental toxicants may find their way into the food chain since vegetables farms surround the dumpsite and as such bioaccumulation is a reality. Grazing of domestic animals in the fields around the dumpsite with soils that have this level of pollutants pose a risk to human beings as they use them for meat, such as chicken, goats and pork. The concentrations imply that water is highly contaminated than soil due to the fact that contaminants are more mobile in water than in soil.

Table 5: Concentration of soil quality indicators in the proposed project area (sampled on 18-21 April 2018) viewed against NEMA guideline values (1st Schedule).

Sampling point/Parameter	NS9	NS 10	NS 11	NS 12	NS 13	NS 14	NS 15	NS 16
Temperature (°C)	23.2	23.2	23.2	23.2	23.2	23.2	23.2	23.2
pH	6.51	6.79	7.52	6.84	6.87	6.74	6.74	6.76
Conductivity (μScm^{-1})	43.3	51.1	45.3	44.3	47.7	48.2	58.2	60.0
Lead (mg l^{-1})	15.57	17.73	18.73	25.40	16.19	16.81	19.25	20.06
Zinc (mg l^{-1})	2.74	5.11	3.78	4.67	8.07	5.85	4.07	4.07
Cadmium (mg l^{-1})	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Phosphates (mg l^{-1})	0.012	0.0	0.0	0.0	0.76	0.0	0.42	0.0
Nitrates (mg l^{-1})	0.45	0.26	0.09	0.17	0.51	0.21	0.62	0.27

Conclusions

Based on the results obtained from the measurements exercise, the baseline concentrations of all the parameters tested were below air quality criteria stated in (EMCA 2014,) air regulations, in all the four measurements points.

However from the existing dump site in Oloolua, there were traces of toxic gases recorded especially, VOCs and CO₂.

Recommendations

We highly recommend the proponent to establish proper waste management for the yet to be constructed dump site. All the transport vehicles should be subjected to pick only segregated waste from the source point. This will allow for proper management at the disposal site.

The proponent should formulate air quality survey schedule as a best practice and to ensure the compliance levels obtained as per the regulations

6.3.1 Birds vermin and insects

Birds, vermin and insects may cause a nuisance to people living close to the site. Bird's droppings can mess up clothes. The decommissioning will remove habitats for disease carrying vectors such as mosquitoes, mice, houseflies and cockroaches. The capping and alteration of the environment will displace nuisance species such as Marabou storks, cattle egrets, pied crows and African kites.

6.3.2. Littering

Litter causes a negative visual impact to many people, and may cause significant nuisance to people in the neighbourhood. Since the place is windy, there is a risk that waste could reach the nearby villages developments such as the settled areas, the schools and churches.

6.3.3. Waste transports and machinery

Frequent waste truck transports may disturb the residents around the road during the operation of the dumpsite. Currently available/utilized waste collection trucks include 10

waste tractors and trailers, 5 standard truck and 2 tipper trucks that are licensed to transport waste to the disposal site.

6.3.4. Environmental Health Risks and Safety

There are health and safety risks connected with the waste facility for the workers and visitors at the site and for the population living in the vicinity of the site. Health risks for the workers at the landfill site are normally associated with exposure to sharp, infected or toxic material at the site. Other risks are the hazards for explosions and fires caused by improper management of the waste or the landfill gas. Vehicle movements are a risk factor for incidents daily.

6.3.5 Emissions to surface water

Emission of pollutants into the surface waters such as Ngong' River was observed. This should be mitigated through relocation. Emissions to groundwater are also an important observation made during the field survey. Need to establish the ground water levels whether close to the surface in the landfill site. Both the vertical and horizontal water movement needs assessment.

6.3.6. Workers on site

A number of people work on this site earning their daily living requirements from the dump site, these include; Nuru waste managers and Waste pickers.

6.3.7. Compensation

The project should spell out how people depending on the Ngong' dumpsite should be compensated (waste pickers, people losing permanent housing and income). Estimated percentage of the population actually paying for the service range from 130 to 200 families which pay Kshs. 5,000 per day. Nuru group waste recyclers earn close to Kshs. 300 per day from waste management services.

Employment of the local residents in the project will provide incomes for residents. The project will stimulate the local economy in the long and short term.

6.3.8. Visual impact

Litter causes a negative impact. Since the weather in the area is windy, there is a risk that the light fractions of waste (typically plastics) could reach the nearby village where the

residences, schools and churches. Decommissioning of the dumpsite will transform the scenery of the dumpsite. The proposed recreation centre has an aesthetic effect on the general area.

6.3.9. Surface and ground water

Leachates into both the surface waters (such as Ngong' river) and ground water was observed

6.3.10 Ecological impacts

Rehabilitation will stop the establishment of alien and native plant species such as *Datura stramonium*, Sodom apple, *Parthenium hysterophorus*, *Sonchus asper* and *Lantana camara*. There will also be reduced opportunities for the cultivation and harvesting of toxin loaded food plants such as kales, tomatoes, spinach, amaranthus, saghetii and arrow roots.

CHAPTER SEVEN

SOCIAL ECONOMIC ANALYSIS

7.1.1 Introduction

The socio- economic survey was carried out for the area surrounding the Ngong'. Dumpsite. The project area is entirely in low income residential areas, people living in the project area are entirely dependent on livelihoods based on the dumpsite. In order to come up with the projected effects of the proposed project to the population around the projected area, a socio economic baseline survey was carried out from 12th to 17th April, 2018.

The main focus of the study was to come up with:

- a) Proper identification of the project affected persons and issuance of PAP identification, this also involved identification of people not directly affected by the project but living around project sites
- b) To find out sources of income and occupation of the people living around the project area and the project Affected Persons
- c) To establish the marital status of the PAPs and the number of household members who would be affected by the project.
- d) Levels of education of the household head and other members of the household
- e) The household expenditure, where the study focused in ascertaining the value and the level of access to food, school, medical care, savings, water
- f) Prevalence of diseases in the project area, type of healthcare accessed by the PAPs
- g) Status of water and sanitation in the project area
- h) Views of the community on the proposed project
- i) Reasons for choosing to live within the project area by the Project Affected persons
- j) Additional assistance that each PAP will require during relocation
- k) And the challenges that the proposed affected population saw to affect them in future

7.1.2 Findings from the social-economic survey interviews

In this section of the dumpsite closure and establishment of a new analysis a purposeful sampling was used in administering questionnaires that were targeting key representatives of the stakeholders involved in the Solid waste management in Kajiado County with much concentration on present dumpsite location and the specific proposed sites. Among the

stakeholders represented in the questioning were; Waste Pickers, Residents Association, Private Service providers, County officials and Youth representatives.

7.1.3 Nuru Youth Group Waste Pickers

The study found out that the group was registered as a Community Based Organization, with a total membership of 132, with a leadership committee that is elected on an annual basis. The first plastic sale in 2005, can be attributed to have been the motivational factor towards its formation. With a membership of about 45 members and since has had a constant increase to the present number. Due to the high number of members the subscription to the group membership was closed as at the period of the study. The members are involved in diverse avenues i.e. as pickers, buyers and breeders. Based on the type of waste, the pickers are divided into groups depending on the material they prefer while sorting i.e. plastics, food, cartons. According to the committee there was no definite amount of money that could be said to be the daily/salary per waste picker but the figures depended on the efforts of the specific picker in question but a rough estimate of 200-500 per day could be assumed.

Plate 9: Nuru CBO meeting



CBO consultative meeting

Truck management on waste of loading was noted to be super organized with every waste offloaded manually transferred to the deeper section of the site where vehicles would not access. This was done to ensure other vehicles found offloading zone upon arrival.

In relation to the establishment of the new facility, the member's representatives showed no displeasure however asked for the member's consideration in the employment opportunities at the facility.

An observation during the study also established that much space was occupied by sorted plastics that occupied a larger portion of the site, the group having procured a shredder earlier, were committed to the partial closure of the most dangerous and less utilized sections of the dumpsite by making the shredder operational if the power supply was connected.

7.1.4 Embulbul Environment Waste Management Project

This group was formed in 2014 and registered in the subsequent year, with a membership from Embulbul community. Its formation was triggered by the status uplift to township of Embulbul in 2014. Indicated support for the proposed project reasons being the current site is a source of pollution, poses health risk, proximate to settlements. But advocate for proper relocation procedures to avoid problem transfer. Key issues raised were that EIA reports on area projects are never done conclusively with the community being sidelined and lack of an open system in the entire project proposal.

7.1.5 Kerarapon Residents Association

The Kerarapon Residents association was represented by Mr. Robert Ouko who gave a very informative insight in relation to the proposed site for the waste facility this was due to his active participation at the community as a member of Water Resource Users Association- with the region being attributed to being the source of Mbagathi and Ngong' river, Member of the development committee of Kerarapon.

Plate 10: An interview with Kerarapon Association Representative



Residents Association consultative meeting

On his view which he insisted was a reflection of the Kerarapon stand, he insisted that public awareness on the waste facility had not been conducted in the area and thus would not

receive full community support unless the community was actively engaged and educated in relation to the project proposal. In his views, questions were rising why the project wouldn't be taken to areas such as Oloshoibon and Kimuka where there was less human settlements. Another issue raised during the interview was that the need to know that the facility had worked somewhere else and thus residents could refer in points of queries. Land grabbing and controversy surrounding the Vet farm in which the proposed site lies, where the kekonyokes (the original inhabitants of the land before donating to the government) are advocating for the return of the land to the community, will also need to be fully addressed to ensure success of such project.

Other issues of the Kerarapon residents association was how the project would handle the water pollution, dust, smell, birds , scavengers and insecurity issues that are always associated with waste facility world over.

Asked about the quarry being an alternative site, Mr. Ouko said that, such an idea would face even fieriest opposition basing that there was a court case in relation to the site, which was resolved outside court with an agreement baring the site from being turned into a waste management facility.

7.1.6 Private Service Providers

The stakeholders in this sector were worried about their roles in the new facility in the event of the project actualization. She insisted on the need to train all the involved stakeholders on the roles they'll assume at the new facility and during the project execution period. The PSP's viewed the project as a positive move in the sector considering that the access roads will be fixed and that their vehicles would spend less time during offloading as opposed to what was the case at the moment (plate 11).

Plate 11: An interview with the Private Service Providers

**Private Service Provider truck and Mrs. Teresia Mwhia**

7.1.7 The views of County officials of Kajiado County

On the status of the current dumpsite, the size was estimated to be 17,000m², neighboring Ngong' primary school. The neighboring village, Mathare, is said to have been constructed on the areas assigned for leachate treatment. Through the director there was reassurance on the ownership of the Vet farm where the proposed site for the new facility is located as well as the location of the current dumpsite. Enjoro Emune, a river that passes close to the dumpsite is on the water resources that could have adversely been affected by the dumpsite. Upon closure of the Ngong' dumpsite, the area has been scheduled to be converted into a recreational facility. It was also agreed that the director would assist in access of the Kajiado County Land Use policy from the planning department. On the operation of the dumpsite the county makes use of the group to manage the site with supervision from a selected county officer.

Plate 12: An interview with the Kajiado county director and deputy director of environment



7.2 Summary of findings from the Socio-Economic Survey

The findings were based on 45 responses, representing 100% of the total target respondents. The respondents included surrounding learning institutions; CBOs and churches including dumpsite workers (informal waste pickers).

Gender of respondents

According to the responses 96% of informal waste pickers in Ngong' and its surrounding are males with only 4% being female.

Marital status

Results indicate that the majority (80%) of informal waste pickers are married while 17% are single and 13% widowed. This shows that the social fabric is stable because the percentage of the respondents who are married is higher although the singles, widowed and divorced cannot be overlooked more so for dumpsite workers in Mathare slums of Ngong'.

Engagement of families' members in waste collection

A great majority 82%, of informal waste pickers /Dumpsite workers indicated that they engage their family members in informal waste collection. Therefore relocating of the dumpsite shall cause problems in some cases entire families.

The level of Education of the respondents

The highest level of education for the majority of respondents living around Ngong' dumpsite area 80% was primary school and 12 % secondary and a sizeable number (8%) had attained tertiary level of education.

Age distribution of respondents

The age distribution of respondents was high for ages between 20 and 30. Thus most of the respondents were young families.

Waste collection payment services

Waste collection in the town is done by the county government, private waste collectors or CBO's responsible for waste collection. The majority of the sampled households do not pay for waste collection services, 55%, 25%, 15% and 5% of household in low income, middle income, high income and peri-urban areas respectively do not pay for waste collection. The high number of households that do not pay for waste collection in low income areas can be attributed to inadequate sources of livelihood.

Averagely low, middle and high income household pay Kshs, 20, Kshs, 100 and Kshs, 200 respectively for waste collection services. Averagely, households in Ngong' town pay Kshs.160 for waste collection services. This survey revealed that the households who do not pay for the collection services (65%) were however willing to pay for the collection services. This therefore means that there are opportunities for investment in waste collection hence job creation and source of livelihoods especially in low income and peri-urban areas where employment is a major concern.

Occupation of the respondents

The main occupation for the residents of Mathare slums of Ngong' was small scale business at 40%, casual labour by 30% of the respondents, skilled labour by 20% of the respondents, formal and informal employment by 10% of the respondents. Thus the respondents' main occupation has been small scale business, casual labourer and skilled labourer. There is collection from the dumpsite as an occupation which is different when compared to other places in Ngong' town. This type of occupation is carried out by the respondents living in Mathare slums and is in line with their level of education.

Sources of income

Collection from the dumpsite was the main source of income for Mathare slum residents (60%), Small business was the second main sources of income for Ngong' township (20%)

residents. Formal employment as main sources of income was high in Ngong' town (10%) and casual and skilled employment was high in Gichagi of Ngong' suburbs (10%). 77% of the waste pickers earn an average of Kshs.200 (20USD) per day. Majority reported to earn less than Kshs.1000 only per day.

Disease prevalence

The main diseases reported by respondents were malaria, respiratory problems, typhoid and diarrhoea. In Mathare slums the main diseases reported by dumpsite workers were chest pain, skin rashes, coughs and muscle pain and a few instances of nausea and miscarriage.

Waste disposal

The survey established that 66% of the wastes are collected from open dumpsite and the rest (34%) from residential areas, streets, water courses, commercial establishments, industries and construction sites.

Among the respondents, 40% of the households practice open dumping, 20% use compost pits, 20% use back yard disposal, 10% road side disposal and 7% trenches and only 3% of household waste is collected for final disposal at the dumpsite. In low income areas, 40% use open dumping. This underscores the need of having central collection points within the Ngong' villages to address the challenge of initial waste disposal. 82% of the household respondents do not separate waste at the source with the majority being at low income areas. This can be attributed to lack of information, knowledge, skills and benefits of waste separation at the source.

The respondents' length of time at Ngong' dumpsite

The study established that 60% of the dumpsite workers (informal waste pickers) have lived in Ngong' for between 6-10 years; with 10% having lived in the town for more than 11 years and 23% for 1-5 years and the remaining 7% have lived in the town for less than 2 years.

The time spent working in the Dumpsite per day

Over 75% of the respondents spent more than eight hours per day collecting recyclables.

Challenges faced by dumpsite workers

The informal waste pickers face a myriad of challenges and health risks such as, lack of protective equipment to use while working at the dumpsite, fluctuations of prices, transportation, rain, insecurity, lack of finance, and theft of materials, lack of cooperation/coordination of technical services and insufficient quality of material. 90% of the waste pickers/ dumpsite workers do not take any precautionary measures in using Personal, protective Equipment. The common nature of accidents encountered include wounds caused by sharp cuts and most are bitten by dogs and flies.

Institutions in the project area

The key institutions in the project area include schools (Ngong' township secondary/primary schools, hospitals (Zam Zam medical services, Karen Hospital) churches (Ngong' Methodist churches, Ngong' catholic parish, and St. Joseph Catholic Church), Ngong' Mosque and tertiary institutions (St. Joseph vocational training college, St. Joseph catering institute) Agricultural Finance cooperation. Most school administrators reported that the dumpsite has been associated high rape cases, increased school dropouts and increased street children. The churches reported of increased smoke pollutants, insecurity and foul smell in the area.

Views on relocation/closure of dumpsite

The study realized that over 70% of the respondents support Ngong' relocation plans and 30% do not support. Those supporting the plan feel that closure of the dumpsite will reduce respiratory and water borne diseases, reduce scavengers, promote a clean and health environment, reduce fire outbreaks, reduce child labour, improve infrastructure in the area and provide conducive learning environment and habitation and will lead to a reduction of toxic loaded food crops. However some dumpsite workers (30%) whose livelihood is linked to the dumpsite were of the view that relocation/closure of the site will lead to loss of social networks and loss of their livelihood. Majority (over 90%) of respondents reported that they are not aware of the proposed development of integrated waste management facility at the vet farm in Kerarapon.

Proposed ways of rehabilitating/redeveloping the dumpsite

Over 40% of the sampled respondents want the dumpsite closed and redeveloped into the recreation area, 20% want the area to be built into a market centre, 5% want the area be converted to car park, 5% want informal dumpsite be built a factory for employing the youth

and 20% build residential area and only 10% prefer the site to be converted into school or learning institution.

(Source: Ngong' waste Management survey of March/April 2018)

CHAPTER EIGHT

PROJECT ALTERNATIVES

8.1 The No Project Alternative

The No project alternative will imply that the dumpsite remains and dumping of solid wastes continue. Currently the dumpsite is a health hazard to schools, churches and people living and scavenging for recyclable wastes within the dumpsite. The No project options consider the impact of the environment if the project is not implemented at all. Generally, it can be stated that the minor adverse impacts caused by the decommissioning of the dumpsite on soil, air, water resources, vegetation and disturbance to livelihoods to those who are scavenging for solid wastes can easily be mitigated. No project option however, would consequently result in a number of more significant negative impacts that affect the national economy of the country given that Ngong' town is a big town in Kajiado county. The negative impacts will include,

- a) Health complications inform of skin, diseases, eye infections, diarrhoea, typhoid, miscarriage
- b) Stagnated economic growth due to poor solid waste management system
- c) Continued littering of the town by trucks ferrying solid wastes to the dumpsite
- d) Continued pollution of surface and ground water by leachate oozing from the dumpsite
- e) Continued pollution of the atmosphere with toxic gases including methane, hydrogen sulphide and other greenhouse gases.

Lack of a functioning solid waste management system will imply that any potential investor in Ngong' must plan for the same. This will affect the cost and rate of development in real estate, industrial and commercial development with the overall negative impacts towards realisation of the targets and objectives of the countries vision 2030 (NEMA, 2014).

CHAPTER NINE

ENVIRONMENTAL MANAGEMENT PLAN

9.1 Introduction

Decommissioning of Ngong' dumpsite falls within Category A project according to world Bank operations, operation policy 4.02 categorization, this implies that negative impacts attributed to decommissioning of Ngong' Dumpsite will be mitigated as illustrated in this report's Environmental Management Plan

The following table forms the core of this EMP for the pre-decommissioning, decommissioning and post decommissioning phases of Ngong' dumpsite. The table should be used as checklist on site, especially during the site closure phase. Compliance with this EMP must be audited daily during the decommissioning phase and quarterly for four years biannually for the next three years and annually during the project lifespan.

Activity/Issue	Action required	Performance/Monitoring	responsibility	Freq	Budget
1.1. Planning	(a) The decommissioning must conform to the applicable permit conditions and the minimum requirements associated with the site classification, the closure plan and the recommendations of the leachate analysis, hydro geological surveys, soil tests and traffic	(a) Efficiency of compliance to all legislations	KCG	Continuous until end of construction	2,000000
	(b) The facilities i.e equipment and materials and human resources must be sufficient to ensure that the dumpsite decommissioning operations conform to both the closure permit conditions and relevant Minimum requirements	(a) Efficiency of equipment on site and adequacy of materials (b) Numbers of professional staff on site depending on activities and human capacity requirement	KCG	continuous	
	(c) All construction activities within the dumpsite must be limited to daylight	a) Number of complaints from	KCG		

	hours. should there be a need to undertake construction at night, written approval will be sought from the NEMA and KCG	neighbours b) Number of complaints from the workers			
1.2 Appointment of ECO	a) KCG to appoint an independent Environmental control officer (ECO who must monitor the contractor's compliance with the EMP	ECO employed for the project Monitoring reports	KCG	One off	200,000
	(c) KCG to provide the ECO and contractor and contractor with a copy of the EMP, design plans and relevant approvals pertaining to the decommissioning of this dumpsite	ECO qualification in relation to the assignment	KCG	continuous	
	(d) The priority of the CEO is to maintain the integrity of the closure conditions outlined in the EMP and must be enforced and adhered to at all time	ECO-outputs deliverables in relation to the EMPs	ECO	continuous	
	(e) The contractor to ensure that the construction crew attend an environmental briefing and training session presented by the ECO prior to commencing activities on site		ECO/contractor	Once off	
Method statement	a) The contractor will submit written method statements to the site manager for the activities identified by the Manager or ECO. Activities that will require method statements include: (i) concrete pre-cast and batching operation(if applicable) (ii) storage facilities for any hazardous substances	Monthly reports on activities listed in the method statement	Contractor, RE, ECO	As necessary	500,000

	<ul style="list-style-type: none"> (iii) emergency procedures (iv) site establishment (v) removal and clearing of vegetation (vi) materials, equipment and staffing requirements (camp establishment) (vii) transporting the materials and/or equipment to, from and within site (viii) the storage provisions for the materials and/or equipment (ix) the proposed rehabilitation procedures designed to implement the relevant environmental specifications (x) other information deemed necessary by the residents Engineer and /or ECO 				
1.3 Existing services and Infrastructure	a) the contractor shall ensure that the existing services(e.g. roads, pipelines, power lines and telephone services) are not damaged or disrupted unless required by the contract and with the permission of the RE	Monthly reports on the status of the services before and after project activities implementation	Contractor/ECO/site manager	continuous	300,000
	(b) the contractor shall be responsible for the repair and reinstatement of any existing infrastructure that is damaged or services that is disrupted	<ul style="list-style-type: none"> a) reports of complains b) records of repair and resentments undertaken 	contractor	As necessary	
	(c) Repair or reinstatement to be at the contractors cost and shall be prioritized above all other activities	<ul style="list-style-type: none"> (a) Timely achievement of milestones (b) Lack of interruption of services 	contractor	continuous	

	(d) At the time limit for the repairs be stipulated by the site Manager in consultation with the contractor		Contractor, RE, ECO	continuous	
1.4 site boundaries	a) The site boundaries within which the contractor may operate should be agreed to prior to the start of the site operations. The contractor should fence or demarcate these at the very start of the project. Access to the site should be restricted to ensure that the members of the public are not able to gain access other than via the designated, controlled access points	a) report cases of trespass through the site b) reported cases of missing items/machinery	Contractor, RE/ECO	continuous	none
1.6 site layout	a) Specific areas should be set aside within the site for various types of activities. The location of the contractor's camp, sanitary facilities and storage areas should be agreed prior to the commencement of work at the site and should be agreed in conjunction with the ECO, Engineer and contractor. These should all be kept in good condition throughout the project duration to prevent environmental degradation	(a) compliance to site plans ,site out in the design report	Contractor, RE, ECO	continuous	None
Working Hour	Normal working hours will apply as laid in the legislations governing the building industry. These should be agreed prior to the start of the project and should be in line with Kenyan labour ;laws	a) number of complaints from the workers working on overtime basis	Contractor, RE, ECO	Continuous	none
Environmental incidents	The contractor must take corrective action to mitigate an incident appropriate to the nature and scale of the incident and must also rehabilitate the residual environmental	Quarterly environmental audits Findings from NEMA inspectors	Contractor, RE, ECO	Continuous	Total cost of Matrix

	damage caused by the incident or by the mitigation measures themselves	report on the site			
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Activity/Issue	Action required	Performance/Monitoring	responsibility	Freq	Budget
1. Labour recruitment	a) Contractor shall as much as possible ensure semi- skilled labor from the local community to avoid conflict with residents	a) Number of semi-skilled labor employed from the community b) Complaints recorded by locals c) Compliance levels to labour laws during direct hands on approach. KCG internal policies in terms of recruitment and Kenya labourers must apply d) Appointed officer			
2. site establishment	Any construction camp required by the contractor must be established in an area as agreed with the ECO. The site for construction camp must not be an environmentally sensitive areas such as on a steep slope or on erodible soils. The area must be properly demarcated prior to establishment to prevent the construction camp from being unnecessarily large	a. Location of the camp site b. Markers in place c. Signboard on information conveyed	Contractor and RE	Once off	In bidding documents
3. Leachate management	a. Discharge of leachate from the dumpsite	a. Stabilization lagoons in			

	<p>must be properly contained for treatment and disposal</p> <p>b. The leachate should be analyzed regularly to determine the chemical composing, this will inform the threshold of treatment needed</p> <p>c. Leachate should never be released into the sewer system, storm drain and the river before proper treatment</p>	<p>place</p> <p>b. Treatment and disposal facilities in place</p> <p>c. Quality of the waste receiving environment</p> <p>e. water quality and other environmental quality status</p>			
4. Methane /hydrogen sulphide and other gas management	<p>a. Ventilation pipes be fitted with gas traps and flares should be installed</p>	<p>a. Gas collection system in place</p> <p>b. Meters installed for monitoring</p> <p>c.</p>	ECO., KCG	Continual	To be determined after the detailed design
5. General wastes	<p>a. Clearing of bushes, excavation and cutting should be restricted within the project area</p> <p>b. All solid waste will be collected at a central location at each site and will be stored temporarily until removal to an appropriately permitted landfill site</p> <p>c. No dumping within the surrounding areas is to be permitted. Where potentially</p>	<p>a. Regular site inspection reports</p> <p>b. Waste documentation and tracking</p>	Contractor, KCG	continuous	Cost to be determined at detailed design stage

	<p>hazardous substances are being disposed of, a chain of custody should be kept with the register as a proof of final disposal</p> <p>d. Waste generated at the site should be sorted by the contractor and disposed of in a suitable manner into different waste streams. Whenever possible recycling should be carried out</p> <p>e. Litter generated by the construction crew must be collected in rubbish bins and disposed of weekly at registered waste disposal sites</p>				
6. Liquid waste	<p>a. The contractor shall ensure that any liquid waste generated during decommissioning is disposed to a proper stabilizing lagoon</p> <p>b. No decommissioning liquid waste should be allowed to enter wastewater or natural drainage system</p> <p>c. Storm water should be to avoid possibility of surface flow entry into the site from</p>	<p>a. Undisturbed quality of water resources in the area</p> <p>b. Regular inspections on monthly basis</p> <p>c. Minimum or no case of pollution</p>	ECO ,contractor	continuous	Cost to be determined at detailed design stage

	adjacent area. Storm water drains in the area should be routinely inspected by the environmental officer for solid wastes to avoid blockages and associated problems				
7. Fire prevention and control	<ul style="list-style-type: none"> a. All reasonable and precautionary measures to prevent uncontrolled fires at the site due to decommissioning activities will be undertaken b. Accidental fires will be reported to emergency teams, as well control with appropriate equipment located at site and properly documented c. Ensure that there is basic firefighting equipment available on site as per requirement of the local emergency services 	<ul style="list-style-type: none"> a. Fire manuals available on site b. Health and safety awareness among staff c. Frequency of incidences/fatalities d. Daily inspections of works e. Firefighting equipment on site f. Number of drills and training sessions conducted 		continuous	2,000,000.00
8. Erosion control	<ul style="list-style-type: none"> a. Any construction materials should be screened or covered to prevent off-site movements and surplus material should be removed from site to an approved disposal site b. Stripping of vegetation should be limited to areas where civil works will be undertaken c. Berming of open 	<ul style="list-style-type: none"> a. Number of reported cases of flooding within the site b. Percentage of area exposed 	ECO, contractor	continuous	To be included in bid document

	trenches to prevent them from being washed away by runoff				
9. Dust control	<p>a. During decommissioning, phase windblown dust and sand may generate considerable negative impacts</p> <p>b. Mitigation measures such as the use of water bowyers and wetting down, as well as the erection of shade netting screens to prevent offsite movement of dust may also be required</p> <p>c. The use of straw stabilization or mulching of exposed sandy areas should also be considered</p>	Number of complains reported by the neighboring community	CECO, Contractor	continuous	To be include in bid document
10. Storm water management and control	a. Storm water will be managed according to NEMA and KCG guidelines for erosion control and vegetation management	<p>a. Number of meters of lined storm water drains</p> <p>b. Placement of storm water drains within and around the project site</p> <p>c. Minimum or no ponding of runoff in the area</p>	Contractor	Continuous	Cost to be determined at detailed design stage
11. Emergency procedures	a. The contractor shall submit method statements covering the procedures and response plan for the main activities, which could generate emergency solutions through accidents or neglect of responsibilities. The situations include, but not	<p>a. Incidences of emergency cases reported in the log book</p> <p>b. Emergency plans in place</p> <p>c. Presence of a well-equipped first aid kit</p> <p>d. Number of staff</p>	contractor		

12. Health and safety	<p>a. The contractor shall comply with all standards and legally required health and safety regulations as promulgated under the occupational Health and safety Act,2007 and associated regulations</p> <p>b. The contractor must provide and maintain personal protective equipment and facilities to employees working with hazardous chemical substances</p> <p>c. Official training in the correct fit, use, care, storage and limitation of personal protective clothing respiratory and hearing equipment must be given to the employees</p> <p>d. The site workers should be trained on basic first aid methods. First aid should be provided on site in case of accidents or minor ailments, aid kit at the site office of each camp/ or additional identified locations where needed</p>	<p>a. Health and safety awareness among staff</p> <p>b. Frequency of incidents / accidents and fatalities</p> <p>c. Health and safety gear for employees</p> <p>d. Number of employees trained on health and safety</p> <p>e. Number of reported accidents on site</p> <p>f. Presence of well-equipped first aid kit</p>	Contractor, RE	daily	Cost to be determined at detailed design stage
13. Air pollution	<p>a. Un-surfaced roads and temporary roads must be regularly graded and watered to</p>	<p>a. Number of complaints from neighbor community</p> <p>b. The service schedule/</p>	contractor	As when necessary	Cost to be included in bidding document

	<p>control dust</p> <p>b. Active earth work areas ,stock piles and loads of soil being transported must be watered to reduce dust</p> <p>c. Measure must be taken to immediately mitigate a situation in which excessive fugitive dust is observe. Works being undertaken must be undertaken with caution, or phase down while the source is being actively investigated and suppression measures are implemented</p> <p>d. All areas disturbed during closure of the site that are not required for specific activity must be re-vegetated</p> <p>e. Disturbed soils, slopes and areas of open excavation must be minimized to avoid wind erosion</p> <p>f. Diesel exhaust emissions from heavy machinery on site must be controlled and minimized by regular checks and servicing of vehicles. Any</p>	<p>reports of machineries/trucks on site</p> <p>c. Area of vegetated sites</p> <p>d. Reports and log book entries</p> <p>e. Site inspections reports</p>			<p>nt</p>
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	<p>construction vehicle found to be emitting excessive smoke should be stopped from the operations for some mechanical attention before it could continue</p>				
14. Surface and ground water	<p>a. The decommissioning of Ngong' dumpsite must preferably take place during the dry months. If construction activities take place in wet months appropriate measures must be taken to control storm water and implemented to prevent erosion</p> <p>b. Ensure that the excavated and stockpiled soil material is stored and bermed on the higher lying areas</p> <p>c. Vegetation clearance must be made for sanitation for the construction workers. Septic tanks on site to be emptied promptly when they fill up</p> <p>d. Construction vehicles are to be maintained in good working order, to reduce the probability of leakage of fuels and lubricants. No servicing of vehicles is to be undertaken in close proximity to watercourses</p>	<p>a. Construction work plans</p> <p>b. Quantities of sediments present in drainage channels</p> <p>c. Daily visual inspection of works sites and channels</p> <p>d. Level of turbidity in receiving water body</p>	KCG, ECO, contractor	Once off, monitor weekly	Cost to be include in the bidding document
15. Noise and vibration	<p>a. Construction and the use of construction</p>	Lack of complains from the community	Contractor	Monitor	Cost to be

<p>activities</p>	<p>machinery should be limited between 0600hrs and 1800 hr. on weekdays</p> <p>b. The contractor should use modern equipment, which produces the least noise</p> <p>c. Any unavoidable noisy equipment should be identified and located in an area where it has least impact. Noise shielding screens should be used and the operation of such machinery restricted to when it actually required</p> <p>d. Institute noise control measures throughout the decommissioning phase for all applicable activities, including the construction times</p>			<p>daily</p>	<p>include in bidding document</p>

Table 9: Monitoring indicators

Monitoring Aspects	Parameters	Target Level
Leachate All Monitoring wells	BOD COD TDS TSS Conductivity pH Dissolved Oxygen Nitrates Phosphates ORP Temperature Salinity Colour Heavy Metals e.g CU, Cd, Mn, Ni, Fe, Pb, Hg Piezometer Levels	Waste water limit levels by NEMA/WHO
Flora	Species composition Density Distribution Ecological attributes	Non Invasive species
Fauna	Species composition Density Distribution Ecological attributes	
Decommissioned	Erosion signs	

site	cap integrity vents status water ponding	
Gases	Type of gas Emission volumes	
community		
Socio economic trends	Income levels Income streams Alternative livelihoods established	Use pre-decommissioning state
Health	Type of diseases prevalence	Compare with general populations and pre-decommissioning levels

CHAPTER TEN

CONCLUSIONS AND RECOMMENDATIONS

According to the data gathered and processed from Ngong' dumpsite, it is apparent that Ngong' town is in need of proper solid waste management. The Ngong' dumpsite and its use has for a long time generated debate arising from various individuals, institutions and agencies.

The dumping of solid waste in this site has been a source of pollution for the Ngong' River. With regards to air pollution the residents reported that there is permanently foul smell and the air test confirmed this fact. The soils in the area are therefore relocation is inevitable.

However, the dumpsite has been a source of livelihood for the majority of the residents living around the dumpsite and individuals collecting directly from the dumpsite. Middlemen collecting from the dumpsite provide raw materials for various companies. Materials sorted from the dumpsite include papers, plastic bottles, glass, bones, food, plastic papers and animal feeds.

The main negative impacts of the closure of the dumpsite will include loss of vegetation, excavation, soil erosion, atmospheric pollution by dust and smoke emissions, oil pollution, material sites, loss of dumpsite livelihoods, disruption of social networks in the area, leachate discharge into the river, exposure to toxic gases, influx of heavy trucks and machinery in the area, increased noise and vibrations and influx of people in the area.

The main positive impacts of the closure of the dumpsite include improved health of the people i.e. reduced cases of respiratory and water borne diseases, improved water quality in Ngong' river basin by reduction of pollution to downstream ecosystem, improved solid waste in Ngong' town, improved aesthetic value of the area, reclamation of the dumpsite and redevelopment, reduced health hazards to downstream communities in the Athi catchment, reduced fire outbreaks in the project areas, reduced scavengers, creation of job opportunities during implementation phases, conducive working and habitation environment for neighbouring schools, churches and communities, improved road infrastructure in the place, improved security and reduced toxins on crops cultivated along the rivers/streams. The project will serve as model for development of integrated waste management/ sanitary landfill in other counties.

Many environmental impacts identified during the construction period are of short term and can be mitigated. Therefore supervision of the project implementation should be of high standard to ensure negative impacts are minimized, reduced and avoided

Positive impacts have long term positive impacts on the development of the area and on the welfare of the people as a whole. The project is expected to promote clean and health environment in the town of Ngong', promote the economy trade, improve health environment and enhance social economic standards of the population in the area and beyond. 80% of those who responded indicated that the dumpsite should be completely relocated. The project therefore is highly recommended and therefore should be approved for implementation.

SUMMARY OF THE MAJOR NEGATIVE IMPACTS AND MITIGATIONS FOR DECOMMISSIONING OF NGONG' DUMPSITE

a) Loss of sources of livelihood

Project affected persons will lose their main source of livelihood

Recommended mitigation measures include;

- Compensation for the persons affected by the project
- Employment in the decommissioning project
- Employment in the transfer stations at Kerarapon
- Construction of kiosks for small and medium enterprises for the project affected persons
- Employment in the recreation centre.

b) Disruption of social networks

The project affected persons have already developed social networks which will be broken on decommissioning of the dumpsite

Recommended mitigation measures are;

- Foster the retention of the social groups by engaging in similar activities
- Construction of community facilities like social hall
- Develop activities that youth will engage in such as environmental conservation, sports and arts

c) Water pollution

During excavation and compacting there will be a possibility of leachate discharge to the river

Recommended mitigation measures include

- Appropriate storm drains to be constructed to drain the leachate
- Identify sites containing high volume of leachate

d) Gaseous Emissions

During construction phase, there will be gases emitted from the dumpsite

Recommended mitigation measures include;

- Flaring of the gases
- Construction of vents

e) Loss of vegetation

Vegetation will be cleared to give way for the recreation centre

Recommended mitigation measures include;

- Minimize destruction of biodiversity
- Identify sites with rare vegetation that may require protection
- Embark on planting trees and grassing and care for the same during construction

f) Excavation and soil erosion

The excavations on the dumpsite will result on storm water flowing increase due to paving and changed natural flow patterns. This will include erosion may cause gulling

Recommended mitigation measures;

- Provision of channels and anti-scour pads especially in steep slopes
- Plant grass and trees along verges and embankments
- Dispose of the storm water at frequent intervals
- Control earthworks
- Dispose of excess excavated soil appropriately

- Use excess soil to recondition material sites

Socio Economic impacts and Mitigation measure

Socio Economic Impact assessment was done between 5th and 15th, April, 2018 to estimate changes ranging from socio-economic and cultural consequences of the proposed decommissioning of Ngong' Dumpsite. These included.

- a) Education patterns within people living in the area
- b) Health related issues
- c) Occupation
- d) Water and sanitation
- e) Household expenditure
- f) Loss of shelter
- g) Breakdown of economic generating activities
- h) Loss of shelter

The prediction in social changes is important in shaping the design of the project to minimize negative impacts to the social environment while maximising on positive impacts of the project

Social Impacts

The social impacts of the proposed project include;

- i) Loss of livelihood of the people scavenging within the dumpsite. From baseline socio- economic survey it was noted that most of the population depend solely on the above named economic activities, therefore decommissioning of the dumpsite will destroy sources their income generation activities.
- j) Loss of social relationship
- k) Loss of land to isolated individuals who claim to own sections of the dumpsite
- l) Loss of shelter to people living within the dumpsite

(a) Mitigation measures

In order to mitigate these factors the project implementation agency will have;

- a) Prior to decommissioning of the dumpsite, all PAPs should be properly resettled and alternative income generation activities for waste pickers sought

- b) After decommissioning of the dumpsite, consider the option of rehabilitating as a recreation centre
- c) Develop alternative housing facilities for PAPs within the dumpsite
- d) Facilitate the identification and subsequent relocation sites for the parts of the population such as the old and unemployed
- e) Assure the community of compensation through disclosure in public barazas (gatherings) on how compensation process will be handled
- f) Develop a credit scheme to offer loans to population living within the project area and link them to micro finance institutions
- g) Provision of transport for the portion of the community that will need to be resettled.
- h) Kajiado County should develop a programme to educate the farmers using raw sewer the dangers of using raw sewage for agriculture and river basin management.

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Annex I: Public involvement Summary

Main actors of the SWM system in Ngong' are: the County Government of Kajiado, through the Department of Environment and Natural resources; Private Service Providers (PSPs); Nuru Youth Group.

The County Government has the following tasks: interactions with PSPs and Nuru; planning of the SWM; street cleaning and collection from street containers for leasehold areas; surveillance of the Ngong' dumpsite and regulation of the access by trucks.

Officers from the Department of Environment claim that scarce resources are allocated for SWM, and that no charges are collected by the County Government. At the same time, licences for waste dealers and waste collectors are supposed to be released by NEMA and not by the County Government. Further investigations are needed in order to understand the capacity of the County Government to ensure the economic sustainability of the whole system.

PSPs are organized in associations and should be considered an important stakeholders as they provide the service of waste collection to most of households in Ngong'. They can also collect information on waste streams and contact a huge number of customers, having a key role in participation and awareness activities.

The coverage of the collection is ensured apparently on the basis of the private land tenure system, whether leasehold or freehold. In freehold areas the coverage is ensured by PSPs, while the County Government is charged with collection in leasehold areas. Further investigations on this aspect are required.

Nuru Youth Group is the Community based organization (CBO) responsible for the management of Ngong' dumpsite. Members of Nuru are waste pickers and waste traders. The role of Nuru is unofficially recognized by the County Government and PSPs.

Other CBOs, such as "Embulbul Oolua Environment and Solid Waste Management Project", have to be considered partially as PSPs, considering that waste collection and street cleaning are their purposes.

Annex 2: Main issues

Location of the New Facility

The County Government has proposed an area located in Kerarapon sub-location (Embulbul) known as “Vet Farm”. At the present, the area is accessible only through a road which goes across the surrounding forest. During interviews, many concerns have been raised by several stakeholders:

Environmental issues are mainly related to the existence of water springs in the area, which could be contaminated in case of lack of respect for safeguard buffers, or even depleted by excavations, as apparently has happened with other construction works (S.G.A.). Other issues are related to the contamination of Embakasi (Kibiko) forest.

Conflicts on land property and land use: according to interviews and articles on newspapers, a dispute between Kajiado North and Kajiado West Constituencies is in act on the land in object, which is probably subjected as well to phenomena of land grabbing. The County Government affirms that this land is public, so the dispute appears to be connected with its final use.

New sites have been proposed by the association of residents of Kerarapon (KEREAA), which is interested in maintaining the value of its property (probably depleted in presence of a treatment/disposal site). Those sites are: Oloshoibo; Kimoka.

Another site (the quarry located in Embulbul) has been identified by the PoliMI team. This site is apparently favored by some stakeholders, and opposed by others. A public act which forbids the use of the quarry for waste management has been mentioned, and it should be acquired

The identification of a new site should be done in agreement with the County Government, which pointed out a problem whether it would be necessary to purchase private lands. KEREAA seems to be intentioned to contribute to the purchasing; this contribution could be secured before affirming the unsuitability of the Vet Farm land. Moreover, in the identification of a new site, beside environmental issues, also environmental justice issue should be targeted through a decision not affecting powerless or voiceless urban communities.

Relationships between stakeholders, participation and awareness

Apparently, the area of Ngong' is characterized by several associations at the community level, and many actors seem to be in contact with others. Actors outer the network should be identified and targeted as well, but these strong relationships are an opportunity for promoting both participation and awareness. A lack of trust in institutions is present between some stakeholders. Even if it is not clear if this lack of trust is due to political reasons or it is mainly connected with the previous County Government, this topic has to be addressed.

Interviews demonstrate also a frequent misunderstanding between concepts of participation and awareness. Fears regarding the new facility have been in fact explained by stakeholders as due to the "lack of awareness", whether concerns about pollution are rather symptomatic of awareness. A correct description of the new concept of waste management and of the new facility should have been done following the trail of public participation. Consequently:

Public participation is needed, targeting the population and local chiefs in the area of the new plant, and key stakeholders of the SWM system in general.

Establishing a permanent board which includes representatives from the County Government, the Nuru Group, PSPs and residents' associations can be a proposal in order to promote integration between actors.

Accountability of the whole SWM system, together with the accountability of the subject managing the new facility (whether a private company or the County Government) should be pursued. Awareness on correct waste management should be done.

Capacity Building

Capacity building has been requested by several stakeholders, and most of them demonstrate a good aptitude toward their involvement in trainings and similar activities. Capacity building should address different targets:

Institutional actors (such as officers of the County Government) and technical staff in relationship with waste management, data collection, urban planning and participation.

Waste pickers, in orders to improve their way of separate recyclables from the waste and the safety measure, but also to transform them in actors of an awareness campaign, promoting separate collection as well.

Service Coverage

Apparently, with reference to a good service there will be willingness to pay, but affordability is not ensured. This topic needs further discussion in order to ensure service coverage also to poor areas.

Labour and Income Generation

In the present situation, the management of waste in Ngong' involves more than 33 Private Service Providers, while around 200 persons (of which 132 registered members of Nuru Y. G.) depend on selection and purchase of recyclables in the dumpsite.

Any intervention should not deplete income sources (e.g. the market of recyclables), considering that apparently this equilibrium is based mainly on self-organization and private market and not or just little on public funds. Even introduction of separation at source or other changes in waste collection, without a thoughtful set of rules, could have consequences. For example, a few years ago recyclables were diverted by other actors before reaching the landfill, affecting the livelihood of people working in the dumpsite but also preventing them from managing the dumpsite itself, with negative impacts on the accessibility of the site.

Beside, people currently working in the dumpsite may be unable to find alternative jobs due to low education levels or other issues, so job preservation is particularly important.

Therefore, the project should deal with following aspects:

The new facility should employ local people.

The job should be ensured for people currently working in the dumpsite.

The organization of the new facility should be discussed with Nuru Y. G., taking into account needs (e.g. training, schedule flexibility) and vulnerabilities (e.g. elderly people, gender inequalities), which will be assessed in a second stage of this work.

The organization of the new facility should be discussed with PSPs in order to ensure the maximum effectiveness of the collection service.

People living in the dumpsite of Ngong' should be provided with alternative solutions.

Annex 3: Map of Kenya Showing Kajiado County



Annex 4: Topographic Survey

NGONG' DUMP SITE TOPOGRAPHICAL SURVEY



@TU-Kenya

1. Introduction

In general, surveying is performed to determine the relative location or positioning of points on or near the earth's surface. More specifically, surveying is the science of making measurements, relative to known or assumed datum and standards; and applying the principles of mathematics to such measurements to determine the horizontal and vertical positions features. Surveying encompasses different categories such as ground topography, land survey, aerial photography and LiDAR survey, etc. In order to represent the topography of an area of interest, a topographical map that gives a graphical representation of the existing features is required. The ground topographic survey is essential in the establishment of the exact location of features.

In this regard, the Technical University of Kenya in collaboration with the County Government of Kajiado undertook a topographical mapping exercise of Ngong' Dumpsite. The purpose of this exercise was to determine the approximate area of the dumpsite, estimation of the volume of the waste material and generation of a topographical map of the site showing the existing ground features. Modern sophisticated equipment such as differential GPS equipment and UAV was used to achieve this exercise.

2. Field Survey Methodology

The methodology for undertaking the assignment was based on the overall scope of the assignment, which is to “Generation of Topographical map of the Ngong' Dumpsite”

2.1 Reconnaissance

Reconnaissance was conducted to familiarize with the working environment, get to know the locals, establishing the existing control points and to identify the most appropriate locations within the area of interest to set up new control points.

2.2 Equipment

The instruments used were:

- Three CHC GPS sets (receivers) for static and RTK observations.
- DJI Phantom 4 Pro for aerial imagery acquisition.

The following software packages were used in the analysis:

- HGO for processing of the GPS data.
- PIX4D for processing UAV Aerial Images
- Global Mapper for terrain analysis
- ArcGIS for generation of Topographical Map.

2.3 Horizontal and Vertical Determination of Control Points (X, Y, H)

The horizontal and vertical control was fixed using Differential Global Positioning System (DGPS). Two control stations was established in the site by carrying a geodetic GPS observation starting from Existing control points **D12 (N 9848679.860, E 238944.283, H 1860.423)** located near the Kajiado Sub-county offices. Three points were occupied for more than one hour. Since the GPS survey for the control points started at the known existing control points, the observed point's coordinates were therefore tied to the national grid. The control points monumented on the ground using 20mm PPR pipes of 12 inches long.

2.4 Provision of ground controls for aerial survey.

Temporary Ground control points (GCPs) were established using Real Time Kinematic mode (RTK). Temporary targets were used as ground photo control. The coordinates for these targets were obtained by use of differential GPS in RTK mode. These control points were established for georeferencing, optimization of camera locations and generation of the DEM.

2.5 Aerial Image Acquisition

DJI Phantom 4 professional; a rotary wing quadcopter UAV was used for the image data acquisition. The UAV was equipped with 20 megapixels, focal length of 2.8mm, and 4K resolution DJI FC300X camera. The camera has RGB band and operates in both manual and auto mode. To ensure a smooth and a safe flight mission, a pre-flight test was carried out to ascertain that every part of the UAV system functioned properly. A flight plan for the area was designed to ensure total coverage of the entire imaging area and at the desired percentage overlap. The UAV flew automatically capturing the images at the designed overlap. The images were downloaded and processed in a PIX4D photogrammetric software. The results obtained were 4 cm resolution ortho-mosaic and 5cm DEM.

2.6 Projection

Map Projection	Universal Transverse Mercator(UTM) Zone,37S
Spheroid	WGS 84
Unit of measurement	Meter
Latitude of origin	0 ⁰ (Equator)
Scale factor at the origin	0.9996
False Easting	500,000M
False Northing	10,000M
Datum	WGS84

3 Results

Existing Ground feature

The major existing features within the selected dumpsite boundary were electricity power line, temporary structures, streams, leachates, culverts and murrām¹ road. These features

¹A form of laterite (clay material) used for road surfaces in tropical Africa.

were identified on the ground and traced from the resulting high-resolution orthophoto. The contours were generated at an interval of 1m with base contour being 1810 and maximum contour – 1825m.

The position of the existing features is represented in the attached topographical map (See fig 1). The estimated volume of the waste material was determined based on the existing ground level (volume above ground level). The Dumpsite is enclosed by a stream and murram road. Table 1 below gives a summary of the findings.

Table 1: Dumpsite waste material extent and existing ground features

	Volume (Cubic meters)	Area (Acre)
	113, 400 approx.	6.71 approx.



Figure 1: An Orth-mosaicked Image from UAV showing the dumpsite area

Waste accumulated in the dumpsite

Slum area

Access road network

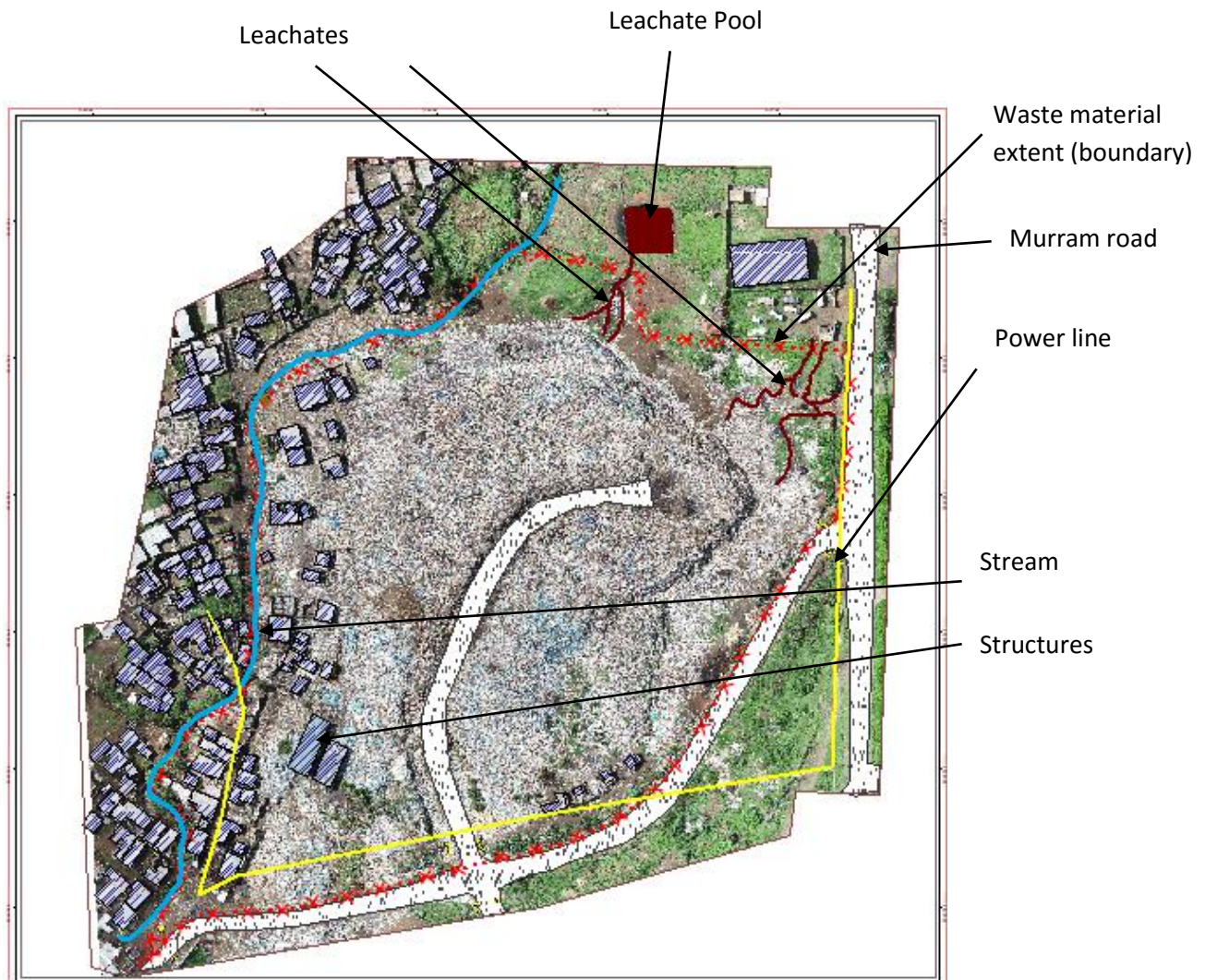


Figure 2: Resolved image showing features existing within the dumpsite

The dumpsite is bordered by a stream to the left and a murrum road to the right. Leachate flows and accumulates at the pool (top) while some flows towards the road. The approximate area occupied by the waste material was 6.71 acres. As can be seen on the map, some material fell outside the bounded area

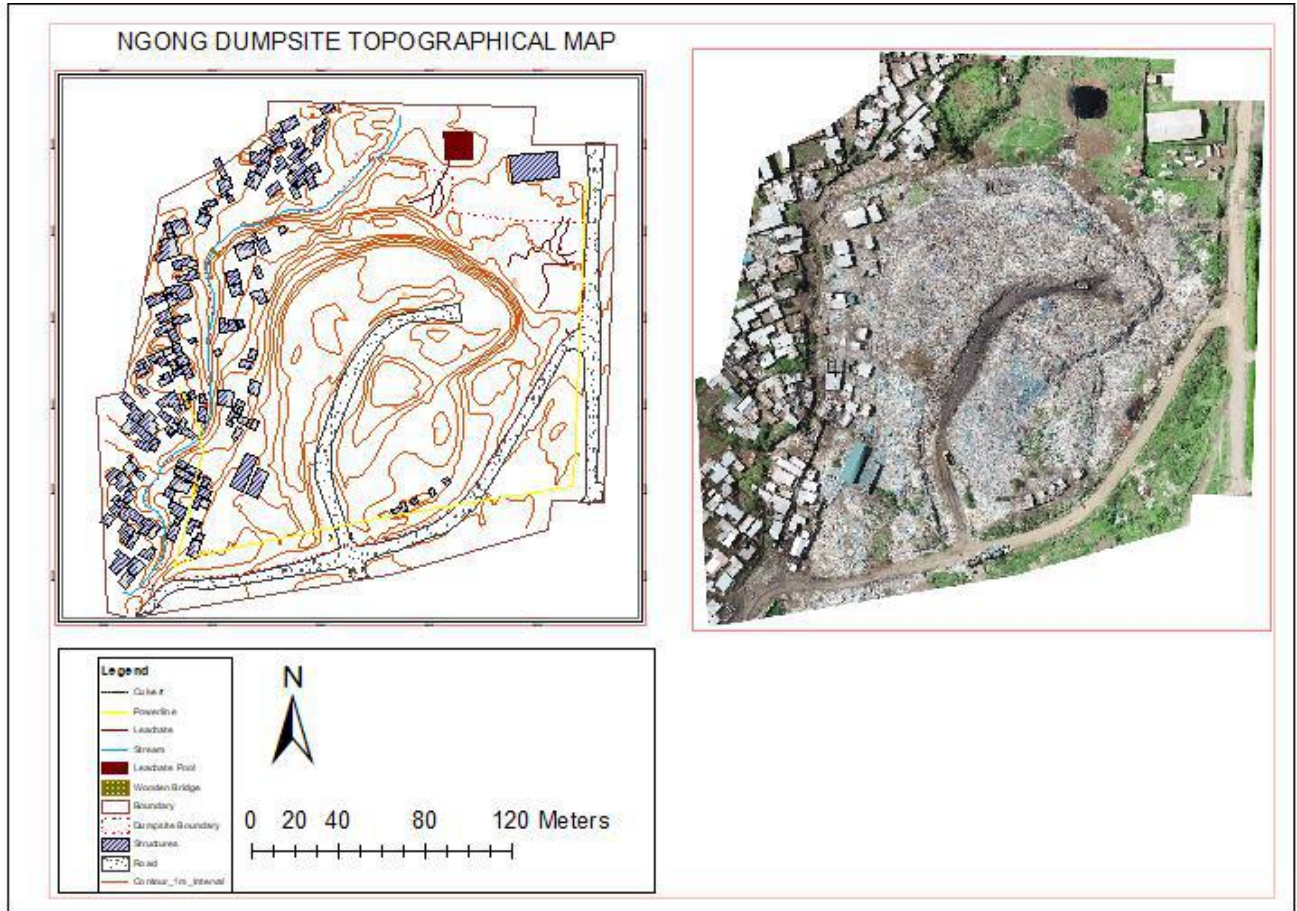


Figure 3: Topographical map of the dump site

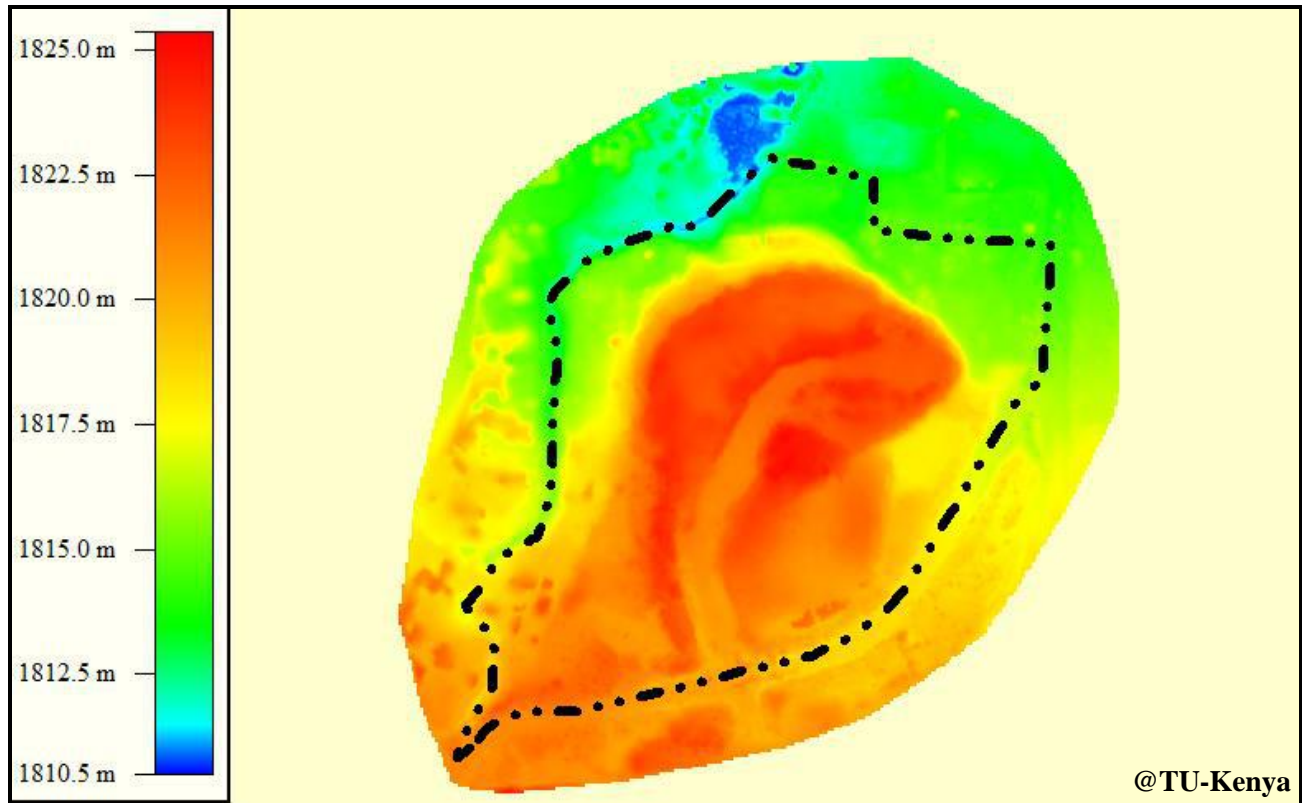


Figure 4: Showing DEM of the dump site

From the DEM, the lowest elevation was 1810.5 m while the highest point was 1825m. This gives a height difference of 14.5 m. Black dotted line indicates the extent of the waste material

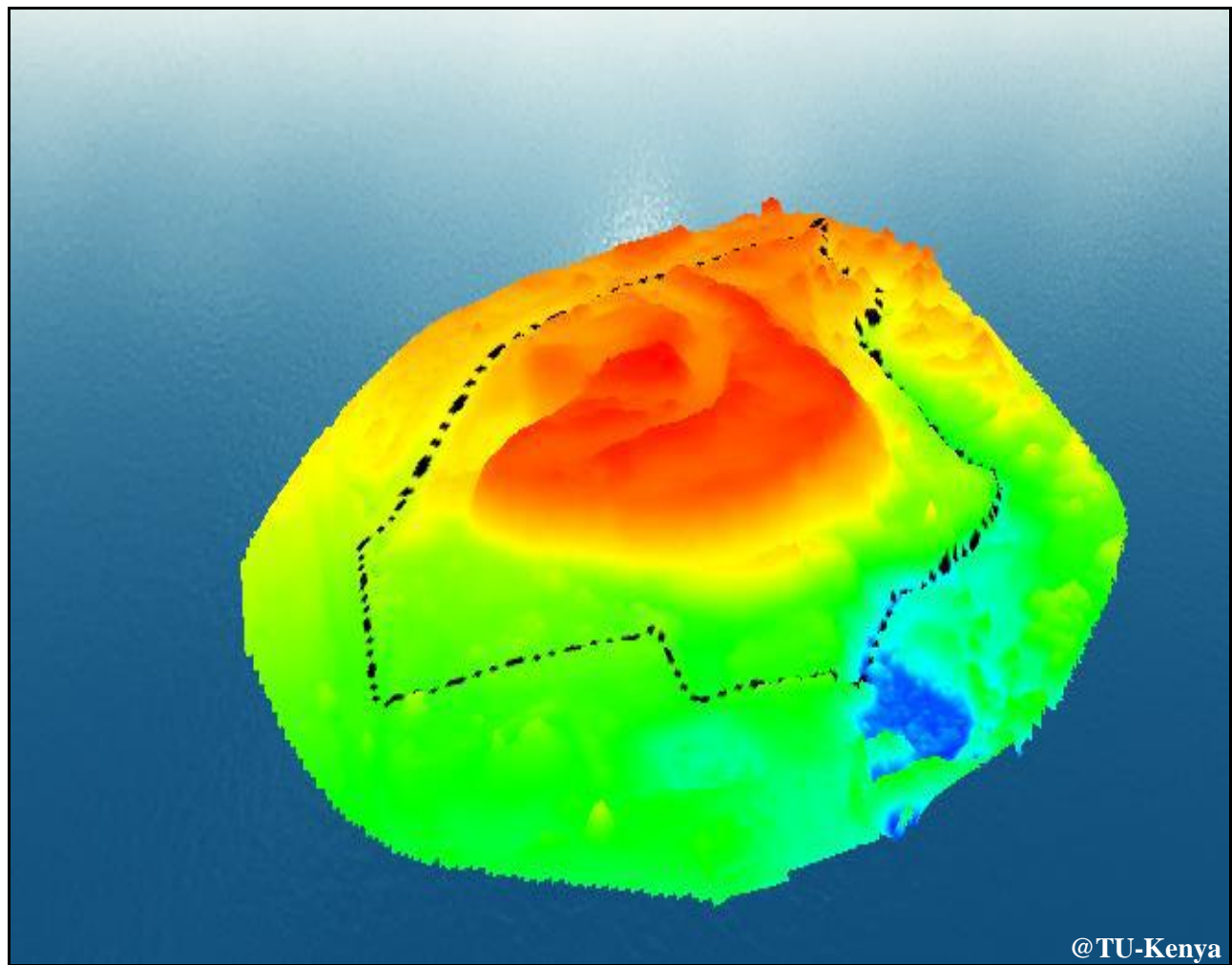


Figure 5: Showing 3D Visualization of the DEM at vertical exaggeration of 2.0



Figure 6: Showing an Ortho-mosaicked image of the site superimposed over the DEM

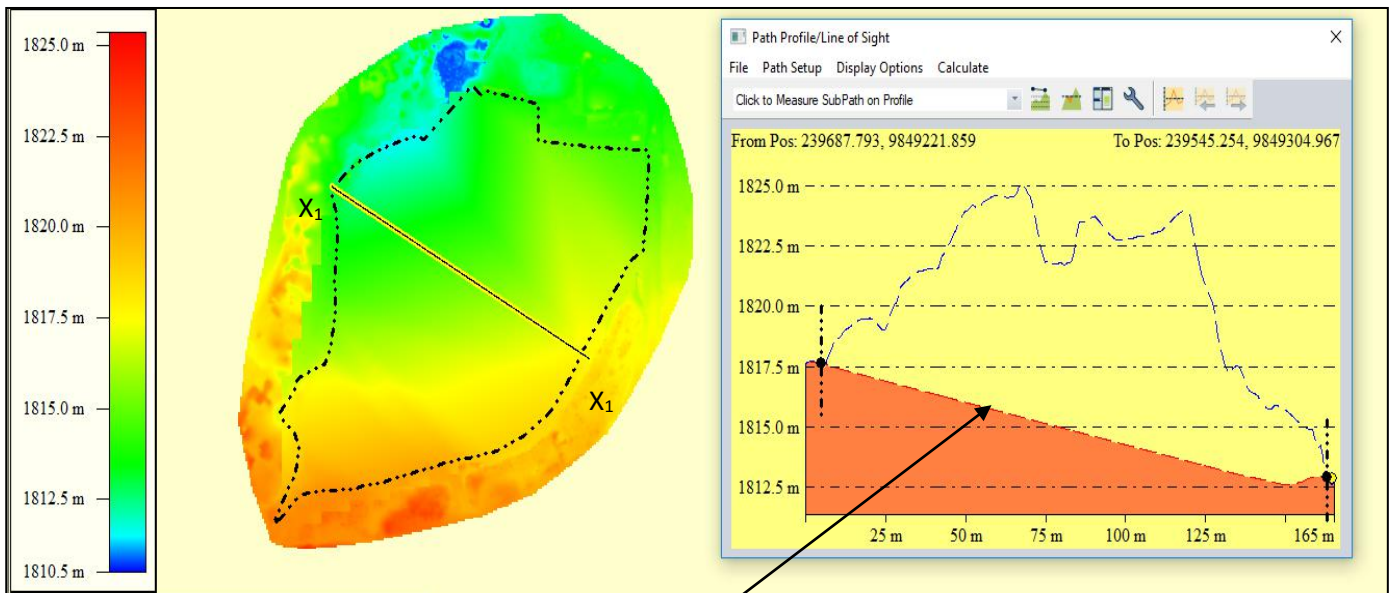


Normal ground level attained after waste material was compacted and covered with soil.

The dumpsite lies in a former quarry site.

Figure 7: Showing Dumpsite

Dumpsite Profile and Volume



Assumed ground level based on existing ground elevations

Figure 8: Showing Dumpsite

Figure 8: Profile (blue line) of the waste material (heap) sectioned along X_1-X_1

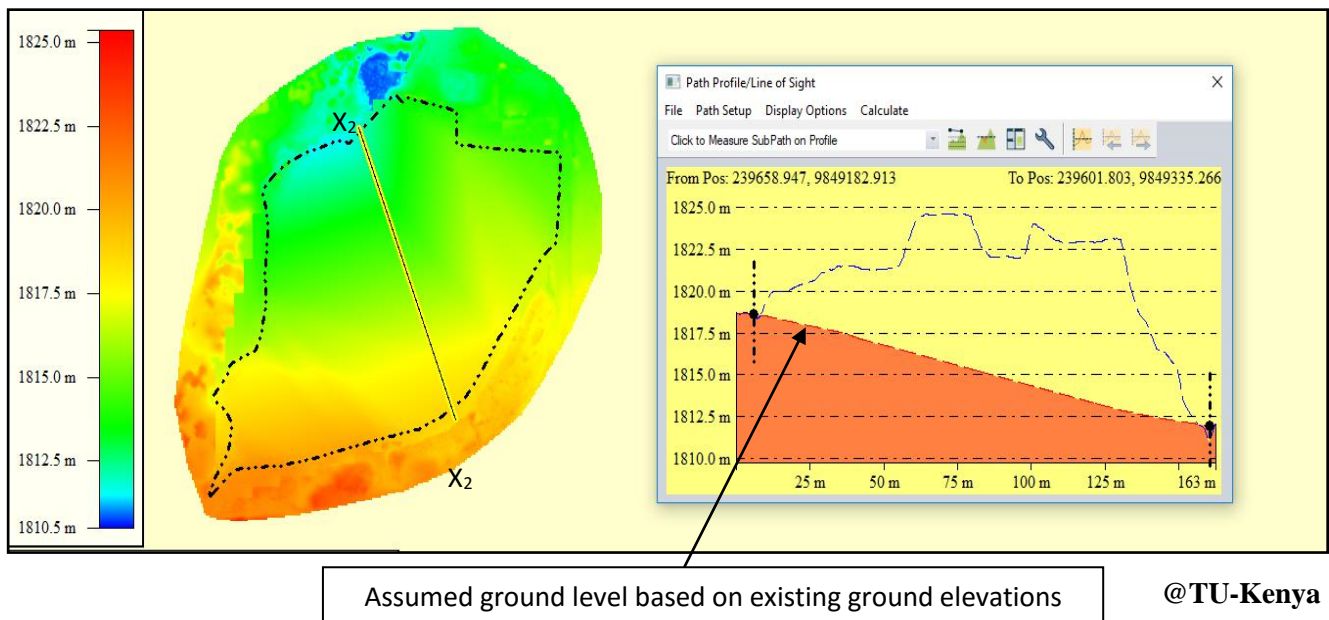


Figure 9: Profile (blue line) of the waste material (heap) sectioned along X_2-X_2

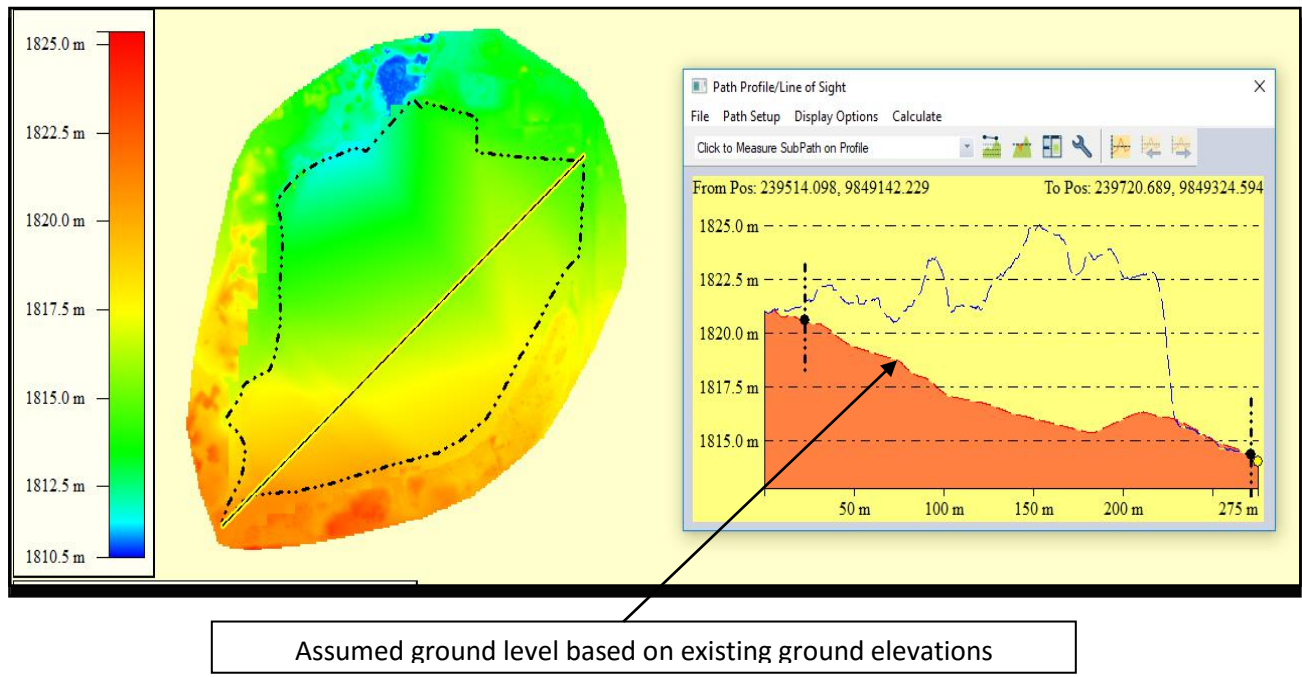
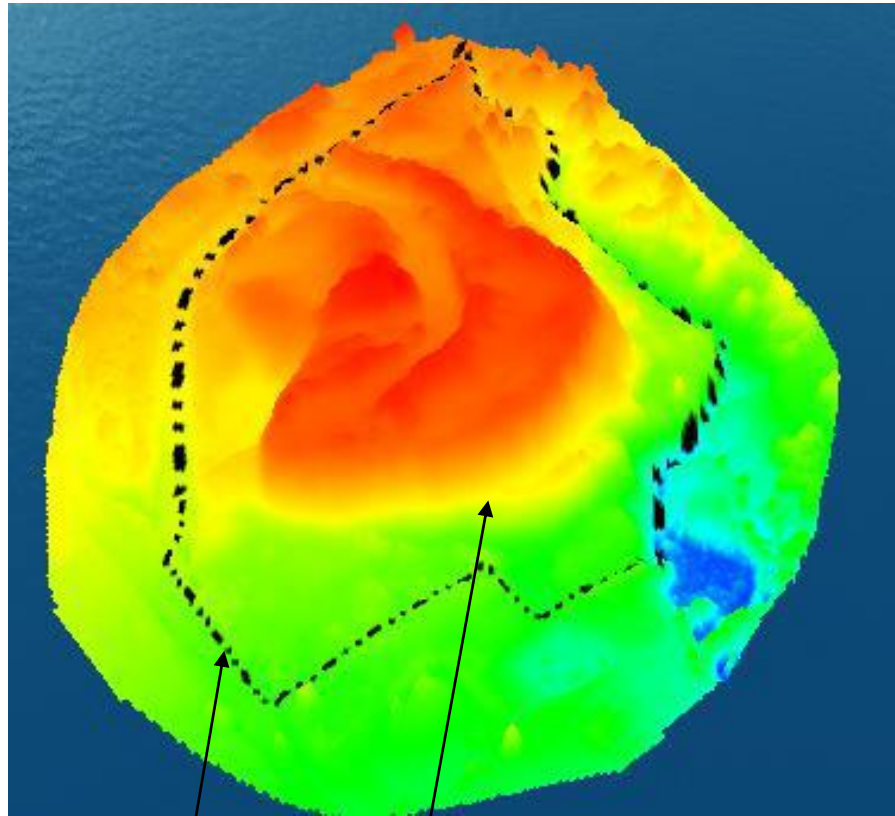


Fig 10: Undulating profile (blue line) of the waste material (heap) sectioned along X₃-X₃



Black Line indicating assumed ground level ad waste material extent

Waste material heap

The volume of the waste material was calculated based on the assumed existing ground level. The waste material volume estimation \approx 113,400 cubic meters.

Fig 11: 3D model of the waste material heap