PROJECT REPORT

FOR

ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROPOSED EXPLORATORY WELL DRILLING IN BLOCK 10BB, TURKANA SOUTH AND TURKANA CENTRAL DISTRICTS BY AFRICA OIL KENYA B.V.

By

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OCTOBER 2010

AfricaOil Corp.

EarthView Geoconsultants Ltd.

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We the undersigned, confirm that the contents of this report are a true representation for the Environmental Impact Assessment project report of the proposed exploratory well drilling in Block 10BB, Turkana Central and Turkana South Districts by Africa Oil Kenya B.V

Prof. Opiyo-Akech
(Team Leader and Director)

Sign…….

Date …….. …

Dr. Daniel Olago
(Lead Expert and Director)

Sign……. … …..

Date…….

AFRICA OIL PRE-DRILLING EIA REPORT

EXECUTIVE SUMMARY

This EIA report provides a critical examination of issues considered important in fulfilling the requirements of a clean, sustained and healthy environment. This report is primarily aimed at establishing the impacts of the proposed exploration well(s) to be drilled in (North Kerio, Mamba, Kamba and Chorea) in Block 10BB, Turkana South and Turkana Central Districts in Northern Kenya by Africa Oil Kenya B.V. and/or with its joint partner(s). The methodology used include review of available literature, meetings and consultations with local stakeholders and government officials, interviews and public consultation with the local residents, site visits to the project area and the surrounding area and the application of professional knowledge and experience.

Africa Oil is a Canadian Oil and Gas exploration company with interests in exploration in Kenya, Somalia and Ethiopia. Africa Oil holds operated and non-operated blocks in East Africa that contain under-explored plays in basins that have proven and productive analogues, or where the petroleum system is calibrated by existing well and seismic data. The current seismic and well database provides sufficient information to identify a large number of prospects and leads.

The project area lies in Turkana South and part of Turkana Central districts that is part of Block 10BB as per the sub division developed by the Government through the National Oil Corporation of Kenya (NOCK). NOCK has identified potential petroleum exploration regions in Kenya and demarcated them into blocks. Block 10BB is located in North Western Kenya and covers the southern part of Lake Turkana, the southern part of the Kerio Basin and most of the Lokichar Basin. These Tertiary age half-graben basins, trend generally north to south. The exploratory wells will be in Block 10BB that covers the entire Lokichar and Lokori Divisions and part of Keiyo Division in Turkana Central. The block has a fragile ecosystem with up to 90% of the landmass being arid while the remaining 10% can be classified as semi-arid. Several dry riverbeds including the River Kerio bed traverse the vast area. The study area is rural, sparsely populated and under-developed.

The purpose of this project is to determine whether or not there are economically viable oil deposits in Block 10BB by drilling exploratory wells. The success of the exploratory drilling will lead to drilling of more oil wells and subsequent production of the same. This, if successful, will have a significant positive impact in Kenya’s energy sector; will boost the Gross Domestic Product (GDP) and per capita income, and commercial production of the oil, which shall lead to an improvement of the socio-economic well being of the Northern frontier districts and the country in general.

The Government continues to rely on hydroelectric power as the main source of power supply in addition to a limited supply of geothermal energy which has not been fully harnessed. In the past ten years or so, the country has been affected by prolonged periods of drought and this has significantly affected the hydroelectric power supply which has been erratic and consequently leading to prolonged periods of power rationing impacting the industry and the country negatively. The insufficient hydroelectric power supply has been due to insufficient rainfall as well as deforestation and subsequent erosion in water catchment areas. This has often led to siltation in the hydroelectric reservoirs reducing the volume of water available for storage for hydroelectric power generation.

To improve on the security of energy supply, industries have had to invest in stand-by generators, which run on expensively imported diesel, thus pushing the cost of production even higher. The manufacturing industry has thus been faced with costly energy supply, which has in part resulted in high production costs. Thus, the availability of fossil fuels locally would significantly reduce the energy cost as well as production cost of industries. Following the discovery of hydrocarbons in the Muglad and Melut basins of the South Sudan rifts and by Tullow Oil and Heritage Oil in Uganda within the western branch of the East African Rift, several oil companies have intensified exploration efforts in the related Mesozoic and Early Tertiary rift basins of Kenya. Thus the current project, which involves exploratory drilling for oil prospects, would, if successful, provide an alternative source of energy which would help reduce reliance on oil imports, bring down costs, and also reduce reliance on hydroelectric power. The country would also stand to benefit through increased per capita income and foreign exchange accruing from oil exports.

The proposed project would also have a number of positive spin-offs. It will help in opening up the Northern frontier districts of Kenya which are still under-developed compared to other parts of the country. This would lead to increased exploitation and utilization of natural resources that abound in this region, such as mineral and livestock resources, as well as the development of its tourism potential. The government intends to initiate investment programs to spur development in this region and to open up trading and other opportunities with the neighboring countries. Thus, the proposed project is an important positive effort that would address these issues.

The project will be carried out in the Kerio Basin and most of the Lokichar Basin, Kenya at a distance of about 60km from Lodwar Town to the North and about 40km from Lokichar town to the south in Northern Kenya. The terrain in the area is relatively flat with rocky basaltic outcrops and is covered by plants which suit the dry, semi-arid environment to the North and rocky rugged terrain to the south. The proposed locations of the N. Kerio and Mamba exploratory wells is in flat terrain with, relatively soft sandy soils, no rocks, and sparse vegetation, while the Kamba and Chorea proposed drill sites are on rocky and rugged terrain.

The Drilling operation is expected to last for a period of 150 days, per site, from arrival on site and initial area preparations. The exploratory wells will be drilled using the rotary technique. In this method, a length of steel pipe (the drill pipe) with a drill bit on the end will be rotated to cut a hole called the well bore on the ground. As the depth of the well bore increases with progressive drilling, additional sections of drill pipe will be added to the top of the rotating drill string. A steel tower known as a derrick, which is an integral part of the drilling rig, is used to support the drill-pipe.

Based on the foregoing, and considering the positive socio-economic benefits of the proposed project, Africa Oil Kenya sought the services of Earthview Geoconsultants Limited to carry out an environmental impact assessment (EIA) of the proposed project. The EIA was subsequently undertaken from 1st to 5th May 2010. The framework and methodology adopted during the present EIA included, but was not limited to:

(i) Scaling and Scoping,
(ii) Review of Regulatory Framework and Institutions,
(iii) Comprehensive Environmental Assessment, Impact Identification as well as Suggested Mitigation measures, and finally
(iv) Recommendations of appropriate Environmental Management Plan.

The environmental parameters assessed during the present EIA include physiographic, geology and geological setting, soils and soil characteristics, climatology and air quality, surface and ground water potential and quality, flora and fauna, land resources, visual aesthetics, noise and vibrations, solid wastes and effluents, socio-economic and health and safety issues.

The policy and legislative framework upon which the EIA survey for the proposed project was based on includes: The Petroleum (Exploration and Production) Act, Cap. 308; The Occupational Safety and Health Act, No. 15 of 2007; Energy Policy (Sessional Paper No.4 of 2004); Environment and Development Policy, National Policy on Water Resources Management and Development (Sessional Paper No.1 of 1999); Mining Policy; Health Policy; the Economic Recovery for Wealth and Employment Creation Strategy; Environmental Management Coordination Act (EMCA) 1999; Energy Act, 2006; Mining Act Cap 309; Explosives Act, Cap. 115 Revised 1989; Public Health Act, Cap 242; Water Act 2002; Factories Act, Cap 515; Local Government Act, Cap 265, and Penal Code, Cap 63.

The Environment management and monitoring plan suggested should be followed and the proponent should strive to set high environmental standards at all times. From an environmental point of view, it is therefore objective to conclude that the project is viable and will not adversely affect the environment. However, the following recommendations should be considered during development and implementation of the drilling operations:

- If the initial drilling is unsuccessful, the company should ensure that the exploratory wells are securely plugged on completion of the exploratory drillings to avoid and/or minimize emissions of greenhouse and other toxic gases,
- Regular servicing of trucks, vehicles, drilling rig and compressors powered using fossil fuels is recommended so as to reduce exhaust emissions.
- Fossils fuels used to power the machinery should preferably be unleaded or low sulphur diesel.
- Cuttings pits should be properly lined with impermeable material.
- Aquifer zones should be sealed off during the drilling process to avoid groundwater contamination.
- On completion of the exploratory drillings, the cuttings pits will be back-filled
- Avoid clearing/altering any land unless necessary; if unavoidable, use best practices that minimize disturbance of the land resources, flora and fauna.
- Ensure that equipment is in good working order to ensure that there is less noise/air pollution nuisance to fauna.
- Hunting, trapping and gathering of wild flora and fauna by workers, when on and off duty should be strictly prohibited. This prohibition should extend to the purchase of these items from the indigenous population by workers.
- A procedure should be in place to avoid the release of hydrocarbons, hydrocarbon-containing substances, drilling muds, or any other potentially toxic substance into the aquatic environment and the surrounding area. In addition, storage of these materials should be in enclosed tanks whenever feasible or, if not, in lined mud pits or other approved sites.
- Initiate temporary and permanent erosion and sediment control measures, slope stabilization measures, and subsidence control and minimization measures near and around the operation area as necessary
- The company should liaise with the local authorities to designate a cuttings pit which shall be used to dispose of rock cuttings and drilling mud

- All waste generated at the campsite should be sorted, separated and stored in designated sealed dustbins and either incinerated, recycled or disposed off as appropriate.
- Any hazardous and toxic waste materials should be disposed of in accordance with national and internationally accepted standards.
- The proponent and his contractor should as much as practical source any unskilled labor needed from the project area
- The proponent should develop a cordial and harmonious working relationship with the local communities.
- Employees from outside the district should respect the cultures and traditions of the locals in order to avoid potential conflict situations.
- The proponent should liaise with the provincial administration and the police department to provide security during its operations.
- All staff working at the drilling rig should be appraised on safety requirements and have safety equipments available for their protection.
- The proponent should establish and maintain a high level of emergency preparedness to ensure incidents are responded to effectively and without delay.
- Sufficient stocks of spill containment booms, pads, absorbents, vacuum trucks etc. Should be on site throughout the operation.
- All rig personnel should have training in emergency spill response techniques Produced test oil if any, should be stored in appropriate containment prior to approved disposal.

The development and implemented drilling operations in the project area will use proven state-of-the-art techniques. Potentially minor adverse impacts can be avoided by good site management and operational practices and protocols.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This EIA has been prepared by Earthview Geoconsultants for Africa Oil Kenya B.V., the project proponent. The EIA report provides a critical examination of issues considered important in the fulfilling the requirements of a clean, sustained and healthy environment. This report is primarily aimed at establishing the impacts of the proposed exploratory well to be drilled in (North Kerio, Mamba, Kamba or Chorea sites) of Block 10BB (Figure 1.1), Turkana South and Turkana Central Districts in Northern Kenya by Africa Oil Kenya B.V. The methodology used includes review of available literature, meetings and consultations with local stakeholders and government officials, interviews and public consultation with the local residents.

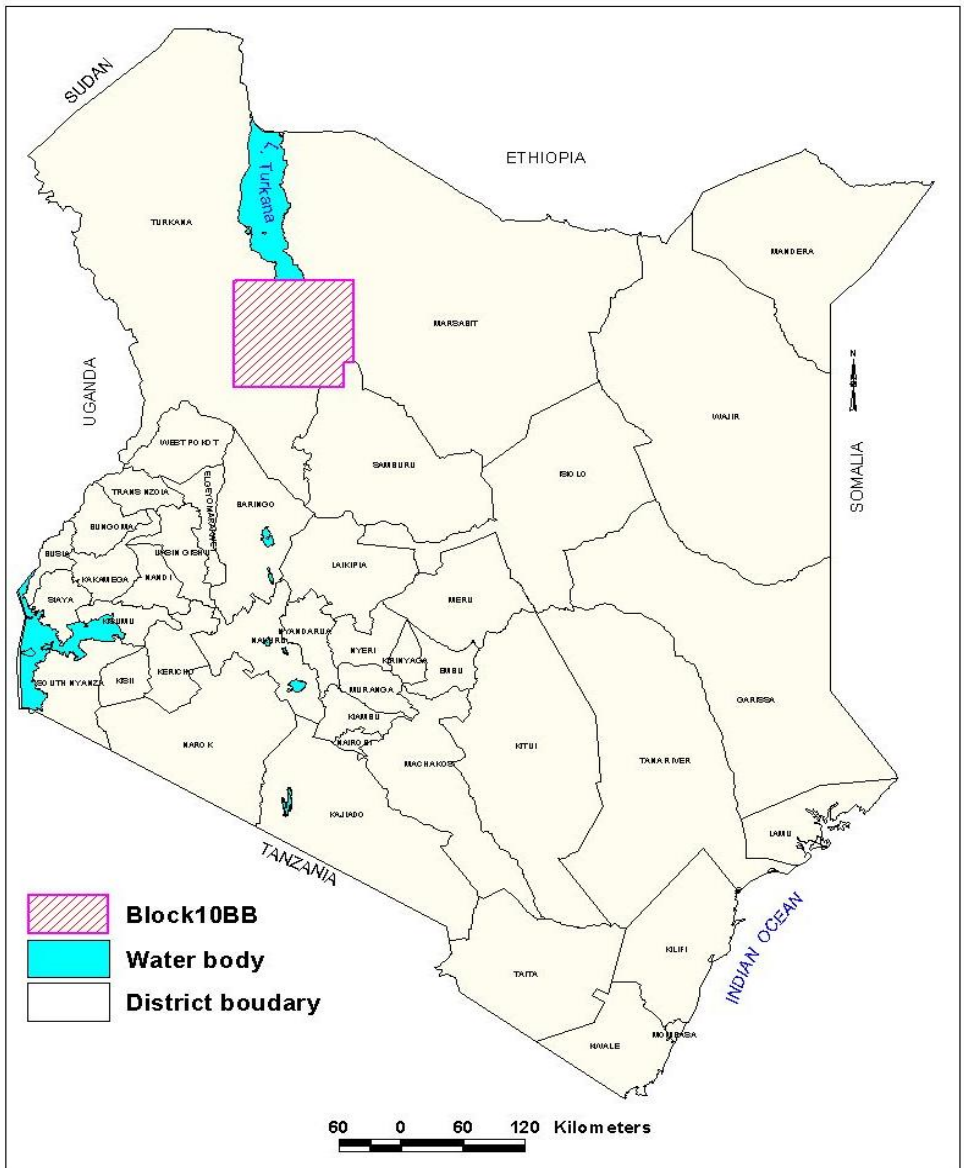

Figure 1.1: Location of the study area

The critical role that energy plays as an input to socio-economic development and environmental protection is now universally acknowledged, as it is an important vehicle for income and employment generation, and for satisfying basic human needs (Global Village Energy Partnership (GVEP) Kenya, 2006)). The international community is today confronted with the daunting task of reducing poverty and achieving sustained economic growth and development for the benefit of all. The provision of adequate and affordable energy services can play a decisive role in poverty reduction (GVEP Kenya, 2006).

National Oil Corporation of Kenya (NOCK) has identified potential petroleum exploration regions in Kenya and demarcated them into blocks. Africa Oil Kenya B.V. is proposing to start exploratory drilling in Block 10BB, Turkana South and Turkana Central districts after concluding the current seismic acquisition program.

1.2 Developer Identification

This EIA is carried out for Africa Oil Kenya B.V. (Pin No. P051212981B) with respect to the proposed exploratory wells (N. Kerio well, Mamba well, Kamba well and Chorea well) exploration in Block 10BB, Turkana South and Turkana Central Districts in Northern Kenya.

1.2.1 Addresses

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1.2.2 Activities of Africa Oil: An Overview

Africa Oil Corporation is a Canadian oil and gas exploration company with interests in oil exploration in Kenya, Somalia and Ethiopia.

Africa Oil holds operated and non-operated blocks in East Africa that contain under-explored plays in basins that have proven and productive analogues, or where the petroleum system is calibrated by existing well and seismic data. In Kenya, Africa Oil B.V. holds PSC licenses for Blocks 9, 10A and 10BB. The current seismic and well database provides sufficient information to identify a large number of prospects and leads. Some of the prospects and leads have the potential to target multiple stacked plays. Other prospects and leads will test only single plays, but with the potential to test stacked-play.

In Kenya, Block 9 and Block 10A are located in the Anza Graben. This is a Mesozoic basin that is related to the Muglad basin of southern Sudan, where the petroleum system is proven and productive. The Muglad Basin is an analogue and provides calibration for the oil potential of the area. Block 10BB lies within the eastern branch of the East African Rift, an area analogous to the Albertine rift where oil has recently been discovered by Tullow Oil and Heritage Oil, Uganda.

Currently, Africa Oil Corporation is undertaking Seismic operations in the block and proposes to commence drilling in Block 10BB in 2011.

1.3 Brief Site Description

The Block 10BB project area lies in Turkana South and part of Turkana Central districts in North Western Kenya and covers the southern part of Lake Turkana, the southern part of the Kerio Basin and most of the Lokichar Basin. These Tertiary age half-graben basins, trend generally north-south.

Exploratory drilling will be in the Turkana South district that covers the entire Lokichar and Lokori Divisions and part of Kerio Division in Turkana Central (Figure 1.2). The district is up to 90% arid while the remaining 10% semi-arid. The study area is currently not developed and remains largely pristine with sparse vegetation and concentrated temporary human settlement. Several dry river beds, including the River Kerio bed, traverse the vast area.

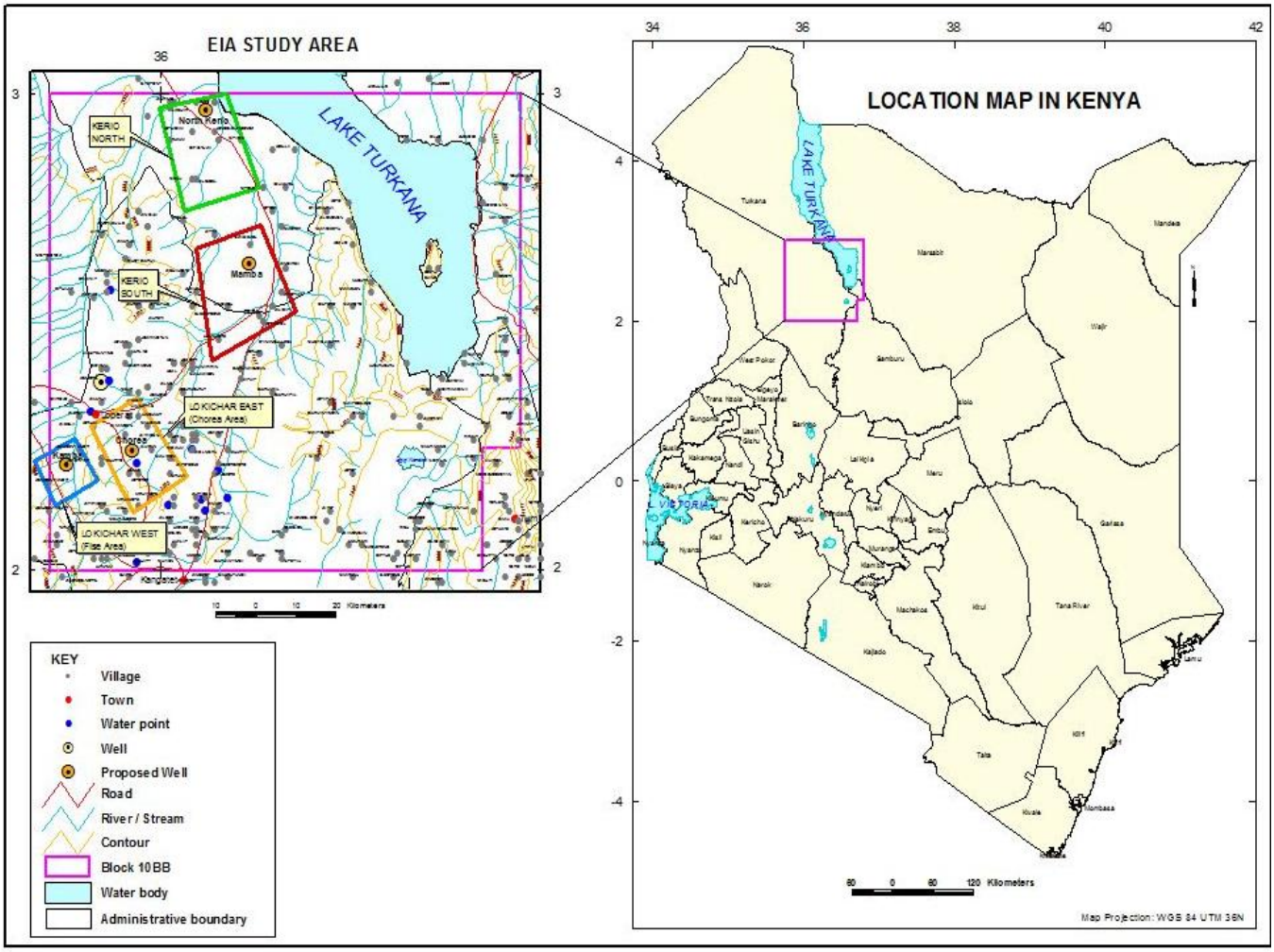

Figure 1.2: Location of the project area

1.4 Project Background, Development Rationale and Objectives

1.4.1 Project Background

Africa Oil Corp. is a Canadian oil and gas exploration company with interests in oil exploration in Kenya, Somalia and Ethiopia.

In 2008, the Government signed a Production Sharing Contract with Turkana Drilling Company who undertook the initial EIA study for the seismic operations in Block 10BB. Africa Oil Kenya B.V. thereafter acquired the Block from Turkana Drilling and is therefore continuing with the operations as per the Production Sharing Contract agreement with the Government of Kenya.

1.4.2 Project Rationale

Environmental degradation due to poorly implemented and executed development projects has been a major problem in Kenya. Due to this inherent problem, the Kenyan government through a Parliamentary Act harmonized the country's environmental laws under the Environmental Management and Coordination Act (EMCA) 1999, for the purposes of coordinating environmental management through the National Environment Management Authority (NEMA). EMCA 1999 makes EIA mandatory for all the projects specified in the Second Schedule of the Act.

The purpose of this project is to explore for commercially viable oil deposits in Block 10BB by drilling initial exploratory wells to ascertain the quantity and quality of any hydrocarbon deposits in the area. The success of this activity will lead to drilling of more oil wells and subsequent commercial production of the same. This would have a significant positive impact in Kenya's energy sector; boost the Gross Domestic Product (GDP) and per capita income, and shall lead to an improvement of the socio-economic well being of the Northern frontier districts and the country in general.

1.4.3 Project Justification

The critical role that energy plays as an input to socio-economic development and environmental protection is now universally acknowledged, as it is an important vehicle for income and employment generation and for satisfying basic human needs (GVEP Kenya, 2006). The international community is today confronted with the daunting task of reducing poverty and achieving sustained economic growth and development for the benefit of all. The provision of adequate and affordable energy services can play a decisive role in poverty reduction (GVEP Kenya, 2006).

Kenya has in the past relied on hydroelectric power as the main source of power supply in addition to a limited supply of geothermal power which has not been fully harnessed due to financial constraints. In the past ten years or so, the country has been affected by prolonged periods of drought and this has significantly affected the hydroelectric power supply which has been erratic and consequently leading to prolonged periods of power rationing impacting the industry and the country negatively. The insufficient hydroelectric power supply has been due to insufficient rainfall as well as deforestation and subsequent erosion in water catchment areas. This has often led to siltation in the hydroelectric reservoirs reducing the volume of water available for storage for hydroelectric power generation.

To improve on the security of energy supply, industries have had to invest in stand-by generators, which run on expensively imported diesel, thus pushing the cost of production even higher. The industry sector has thus been faced with costly energy supply, which has in part resulted in high production costs. Thus, the availability of fossil fuels locally would significantly reduce the energy cost as well as production cost of industries. Following the discovery of hydrocarbons in the Muglad and Melut basins of the South Sudan rifts and within the western branch of the East African Rift in Uganda, several oil companies have intensified exploration efforts in the related Mesozoic and Early Tertiary rift basins of Kenya. Thus, the current project, which involves exploratory well drilling, aims at determining whether or not there is oil in Block 10BB. If the hydrocarbon quantities in this block are abundant, the country stands to benefit from oil exportation to other countries thus increasing the per capita income and the GDP from foreign exchange.

The proposed project would also have a number of positive spin-offs. First, the project will help in opening up the Northern frontier districts of Kenya. This will then lead to the maximum utilization and exploitation of natural resources that abound in this region. The Northern frontier districts are endowed with a lot of potential, especially mineral, tourism, livestock resources and are culturally rich. The government intends to put up deliberate investment programs that are meant to address the problems of the northern region of Kenya. This is in an effort to bring the region up to the level of the more developed areas of the country. There is also national and international interest in the region as the frontier for development activities in southern Sudan. The region has a high investment potential, with mining, tourism, fishing, agriculture, and animal husbandry being major economic activities that have not been fully exploited. Thus the proposed project is an initial effort to tap into the resource potential of the region and will help in opening up trading opportunities with the neighboring countries.

Secondly, the project is in an Arid and Semi Arid Land (ASAL) region with minimal socio-economic development activities, and inadequate job opportunities. The initial exploration activities have created job opportunities albeit mostly for non-skilled personnel. The wages to the casual employees have been beneficial to the family members and to the communities as well, as the lifestyle in the area is largely communal. This has helped in easing the impacts of endemic poverty in the area. Further jobs will be created during the exploratory drilling phase; the success of the drilling tests will further spur complementary economic and social development in the area. For instance, investors in the transport and communication sector will be encouraged to venture into the area. Regular (mobile and fixed line) telecommunications services in the area are rather poor and only Lodwar and Lokichar towns have this service. For most of the area, one has to rely on satellite phones and radio communication systems. In addition, the transport system is extremely unreliable, since there are no public service vehicles in the area and the roads are impassable, especially in the rainy seasons.

1.4.4 Objectives

The objectives of the proposed exploratory drilling project in Block 10BB include, but are not limited to the following:

- To safely drill identified oil leads;
- To mitigate to the extent possible any potential environmental impacts and at the same time enhance economic and social benefits, and;
- To determine the oil potential of the drilled leads.

1.4.5 Development Partners

Africa Oil Corp. is a Canadian oil and gas exploration company with interests in exploration licenses in Kenya, Somalia and Ethiopia. The Company is partnering with Tullow Oil Plc., which recently discovered oil in Lake Albert, Uganda, in this venture.

1.5 Terms of Reference (TOR)

The following are the Terms of Reference (TOR) for the EIA:

- To hold appropriate meetings with the project proponent to establish the procedures, define requirements, responsibilities and a time frame for the proposed project.
- Carry out a systematic environmental assessment at the proposed project site and the surrounding area following the NEMA regulations and best international practice for an activity of this nature, and produce an Environmental impact assessment project report that contain among other issues, potential negative and positive impacts and recommendation of appropriate mitigation measures, to minimize or prevent adverse impacts of the proposed project.
- Provide a description of the proposed activities throughout the entire implementation process of the proposed project, with special focus on potential impacts to the surrounding environment and the socio-economic fabric of the local communities.
- Develop an Environmental Management and Monitoring Plan (EMP) and cost estimates for the implementation of the EMP.

CHAPTER 2:

METHODS

2.1 Overview of Methods

The general framework of the methods of baseline data collection used was as follows:

- Scaling and scoping (determination of geographical and other boundaries; preliminary assessment).
- Review of existing regulatory framework and institutional arrangements.
- Detailed environmental and social assessment and community sensitization undertaken from 21st July to 2nd August 2010.
- Impact identification and development of suggested mitigation measures.
- Development of an Environmental Management Plan including costs estimates and responsibility assignment.

An extensive field study (detailed environmental and social assessment, community sensitization, impact identification and development of mitigation measures) was conducted from the 21st of July to the 2nd of August 2010. The proponent provided GPS co-ordinates of the sites and additional coordinates were recorded for neighboring settlements and amenities. In addition, soil profile pitting was carried out in the proposed oil exploratory well drilling sites to determine the type of subsoil and its characteristics i.e. whether it is prone to water logging, leaching, salt accumulation etc.

Prior to the fieldwork, a preliminary study involving a desk-top study was conducted to review the available reports, design plans and maps in order to compile relevant biophysical and socio-economic information of the study area. The biophysical information was then compiled on environmental aspects such as topography, climate, hydrology, drainage, soils, geology/hydrogeology, vegetation and wildlife. The socio-economic environmental study covered information on issues such as population, literacy, social amenities (healthcare and schools), land use, land tenure, the social dimensions of well being and income levels, water supply, sanitation levels and security among other pertinent issues. Field visits were conducted in the study area in order to collect site specific information on the biophysical and socio economic environment and to cross check the accuracy of the secondary data compiled during the desk-top study.

2.2 Physiography and Geology

A literature review and field verification of the physiography, regional geology and geological setting of the project area was undertaken and the potential of related hazards such as subsidence, landslides, earthquakes, etc. were assessed in relation to the exploratory well drilling.

2.3 Soils

Primary soil data was obtained using the exploratory soil and agro-climatic zone map and report of Kenya (Sombroek *et al* 1982). Reference was also made in the previous Turkana Drilling Consortium project report (August, 2008) for a seismic survey EIA, of block 10BB. The scale used in this report was 1:50,000. A base map representing, among others, the proposed four exploratory well drilling site locations was also provided by Africa Oil Ltd (the current developers). Field data was collected through visual observation of soil units and profile pit

description. The profile pits description assisted in soil classification. Soils were classified according to FAO UNESCO soil legend (FAO-UNESCO, 1997). Parameters assessed in profile description included horizon designation, soil texture, color, structure, porosity and drainage. Surface physical characteristics were described to determine wind and soil-water erosion hazards, flooding, ponding and water logging potential. Surface stoniness and rockiness was also considered where machinery and equipment movement was envisaged during the exploration. A GPS was used to geo-reference the sampling points. A digital camera was used to capture the spatial attributes and images. Soil samples were collected for fertility and survey laboratory determination. Infiltration tests were determined in the field and core and disturbed samples were collected for soil water retention characteristics. Desktop work included soil map compilation and correlation to assign soil boundaries and harmonize the soil legend.

2.3.1 Infiltration Rates for the Soils of the exploratory well drilling sites (Mapping Units PI1, Y10 and D1+PI3)

Infiltration rates of the soil were obtained using the double ring infiltrometer equipment. The double ring infiltrometer is a way of measuring saturated hydraulic conductivity of the surface layer, and consists of an inner and outer ring inserted into the ground. Each ring is supplied with a constant head of water either manually or from mariotte bottles. Hydraulic conductivity can be estimated for the soil when the water flow rate in the inner ring is at a steady state. Water is directed onto a known surface area as provided by the inner ring where the actual measurements take place. The rate of infiltration is determined by the amount of water that infiltrates into the soils per surface area, per unit of time. Infiltration can be measured by either a single or double ring infiltrometer. Double rings are preferred because the outer ring, acting as a buffer water source, assists in reducing the error that may result from lateral flow in the soil.

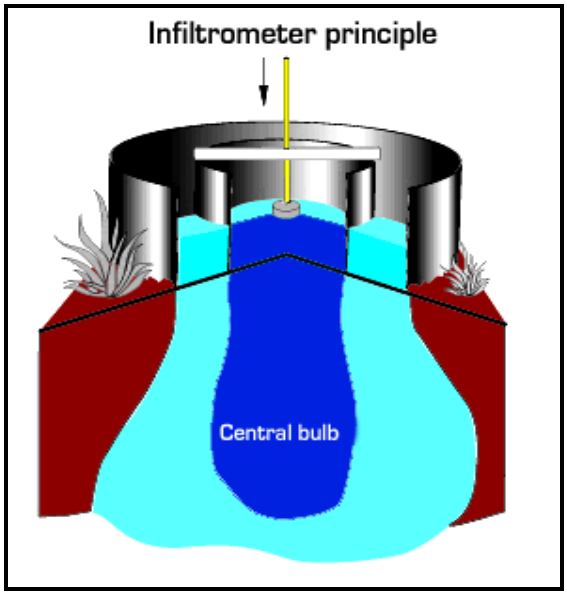

Figure 2.1: Schematic diagram showing vertical water flow from the inner ring made possible by the outer ring (buffering effect) accounting for the lateral flow. Source: www.sdec-france.com

The basic infiltration of different soils can be classified using table 2.1 below, developed by Landon (1984) for irrigation purposes. This is also suitable for appropriate planning of land/soil discharge of waste water and drilling mud required by the proponent.

Table Table 2.1: Infiltration categories

Class	Infiltration categories	Basic Infiltration rate (cm/hr)
1	Very slow (non-irrigable)	< 0.1
2	Slow	0.1-0.5
3	Moderately slow	0.5-2.0
4	Moderate	2.0-6.0
5	Moderately rapid	6.0-12.5
6	Rapid	12.5-25.0
7	Very rapid (overhead methods preferred)	>25.0

Source: Landon, 1984.

2.4 Winds and Precipitation

Wind and precipitation data was obtained from desktop studies and existing literature from Kenya Meteorological Department. In addition, wind data was supplemented by visual observations in the field.

2.5 Air

Determination of the ambient air quality in this rural setting was based on field observations.

2.6 Water

A literature review was conducted covering the existing boreholes for physio-chemical analysis from the initial EIA carried out for the Seismic survey.

2.7 Terrestrial Environment

Collection of baseline information for the terrestrial environment, including flora and fauna, was based on field observations and supported by literature review. Considerations included inventories of habitat types and species; vegetation cover and dominance levels; presence of rare and endangered species; presence of ecological reserves, and any critical ecosystem components. In addition, assessment was done to determine whether the area has experienced any known loss of habitat or biodiversity decline, and whether the proposed operations related to oil exploratory well drilling would have any adverse effect on the existing ecosystems, flora, and fauna.

The approach employed was through navigation by car following a map and GPS coordinates provided by the proponent on the general layout of the project area. Vegetation types and animal encounters of interest were recorded and, where possible, local names were included. Conventional and traditional uses of trees or shrubs were documented. Photographs of species of mammals, birds, reptiles, amphibians, and arthropods present at the time of observation were taken, noted down and identification of particular species confirmed by use of field guidebooks.

2.8 Aquatic Environment

Assessment of the aquatic ecosystems including floral and faunal components in the project area was based on field observations, supported by literature review. Considerations included inventories of habitat types and species; vegetation types, and dominance levels; presence of rare and endangered species; presence of ecological reserves, and any critical ecosystem

components. Further, assessment was done to determine whether the area has experienced any known loss of habitat or biodiversity decline, and whether the proposed operations related to oil exploratory well drilling would have any adverse effect on the existing ecosystems, flora and fauna. The approach employed was through navigation within the study area by car. Stops were made whenever any aquatic ecosystem was encountered. Once on the ground, a general classification of the area was conducted and the effects of the just concluded seismic exploration taken into account. Moreover, an inventory of species of mammals, birds, reptiles, amphibians, and arthropods present at the time of observation, or signs of presence, was noted down and identification of particular species confirmed by use of field guidebooks.

2.9 Land Resources and Natural Heritage Sites

The assessment was achieved through literature review and field observation. The issues of addressed included land use patterns in the area, as well as available natural and anthropogenic resources. Also considered was the impact of the seismic exploration that has already been done in the area on land use patterns and their sustainability.

2.10 Visual Aesthetics

An assessment of visual aesthetics was based on observations in the field. The following issues were considered: (i) visual and sunlight obstruction in the area; (ii) building structures and conformity to local planning authority; (iii) whether or not the built up environment would be an eyesore and visual obstruction would be an inherent problem to the community; and (iv) whether the proposed project establishment would significantly affect the landscape.

2.11Noise and Vibrations

The noise levels of the proposed sites, the camping site and the surrounding areas were measured using a dosimeter. A radial data plan was used to enable the mapping of noise intensity with distance from the proposed camping site and the exploration area.

2.12 Solid Wastes, Waste Oils and Effluents

This assessment was made by visual observation. Impacts as a result of the exploration activities in the area were considered. The current solid waste, waste oils and liquid effluent management was noted. Waste management in the nearby human settlements was also considered.

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2.13Socio-Economics

The methodologies employed include review of available literature, public meeting and consultation with local residents and their leaders. Formal questionnaires and interviews with interested parties and at household level were administered. Public consultation was conducted for the following reasons:

- To inform the local people and their leaders about the proposed project and its objectives, and highlight potential impacts and propose mitigations.
- To identify the diverse socio-cultural and economic setups found in the project area,
- To gather the concerns and views of the local people on the proposed project and impact that the ongoing seismic exploration exercise has had in the area, and

- To establish if the local people foresee any positive or negative impacts associated with the proposed project and if so, how they would like the issues mitigated.

2.14 Health and Public Safety

This assessment was done through literature review of the available health data in the area. Primary data was collected through interviews with key informants and from observations.

2.15 Infrastructure

The assessment was based on observations and interviews with key officers in charge of development and maintenance of infrastructure in the area.

2.16 Data Analysis and Significance Determination

Soil samples were taken to the National Agricultural Research Laboratories for soil survey tests.

The criteria for significance determination of the environmental impacts based on the data assessment are as follows:

Score 0 = no known impact	
Score -1 = slight negative impact	Score +1 = slight positive impact
Score -2 = moderate negative impact	Score +2 = moderate positive impact
Score -3 = strong negative impact	Score +3 = strong positive impact

The impacts are further classified as: actual or potential; direct or indirect; short term or long term. Risk levels are classified as low, medium and high.

CHAPTER 3:

DEVELOPMENT DESCRIPTION DETAIL

3.1 Field Location

The project will be carried out in the Kerio and Lokichar Basins in Northern Kenya (Figure 1.2, page 3). Four drilling prospects have been identified as follows; North Kerio, Mamba, Kamba and Chorea (Figure 1.2, page 3). The location of the proposed sites for the North Kerio and Mamba exploration wells is in flat terrain, relatively soft sandy soils, no rock outcrops, and sparse vegetation while the Kamba and Chorea sites are on rocky and rugged terrain.

3.2 Previous Activities in Block 10BB

An extensive seismic investigation of the western part of Lake Turkana Basin conducted in the 1980's by the Amoco Kenya Petroleum Company revealed the existence of a string of five large, N-S trending half grabens with up to 6-7km sedimentary fill, ranging in age from Paleocene to late Miocene-Pliocene (Lokichar, Lothidok, North Lokichar, North Kerio and Turkana Basins) and linked to the initial phases of the East African Rifting (Dunkelman et al.,1988 ;Morley et al.,1992, 1999; Tiercelin et al., 2004). Among these basins, two have been tested by deep exploration wells operated by Shell Exploration and Production Kenya B.V., the Loperot-1 well in Lokichar Basin, and the Eliye Springs-1 well in Turkana Basin, respectively.

In terms of source rocks, the Rock Eval and palynofacies results obtained on a section of cuttings in the three "black shale" intervals from the Loperot-1 well show that rocks with moderate to good oil source potential occur in the sampled sections (BEICIP, 2001). Such potential source rocks have accumulated in a fresh–water depositional environment, with possibly alternating 'open lake' or 'close to the shoreline conditions'.

3.3 Proposed Drilling Programme

The Company will carry out a logistical survey in order to determine the drilling camp layout and design, as well as specify the precise drilling and associated equipment that would be best suited to the local conditions, and that would have minimal environmental impact. Drilling is scheduled to commence in the first half of 2011, subject to obtaining environmental approval. The drilling program is scheduled to take around 150 days per location, and between 50 to 150 expert and casual workers will be involved in the work. The wells will be drilled sequentially, and not concurrently subject to drilling success.

3.4 Drilling Technique and Associated Facilities

3.4.1 Drilling Technique

The proposed well will be drilled as a vertical exploration well, using the rotary drilling technique where a length of steel pipe (the drill pipe) with a drill bit on the end will be rotated to cut a hole called the well bore on the ground (Figure 3.1). As the depth of the bore well increases with progressive drilling, additional sections of drill pipe will be added to the top of the rotating drill string. A steel tower, an integral component of the drilling rig, known as a mast is used to support the drill-pipe. Typically, such wells are drilled in sections, with the diameter of each section of the well bore decreasing in size with increasing depth. Before the actual drilling

commences, a large diameter pipe (conductor) will be lowered into a hole and cemented. This conductor pipe will provide a conduit for the return fluids during the drilling process and prevent unconsolidated material falling into the well bore and potential washout problems.

During drilling, the circulating system will pump a drilling fluid (normally sacks of mud mixed on site with water) into the well bore to cool the drill bit, remove rock chips, and control subsurface fluids. Typically, mud is circulated down through the hollow drill-pipe. The fluid exits the pipe through holes or nozzles in the drill bit, and returns to the surface through the space between the drill-pipe and the well bore wall. The company intends to use an environment-friendly fluid system in the drilling process, which will not pose any risk of contamination to subsurface formations, and the disposal of the fluid and the cuttings will be less problematic.

The drilling sites will have a blowout-preventer, which prevent oil, gas, and/or other subsurface liquids from leaving the well and escaping into the atmosphere and onto the adjacent ground.

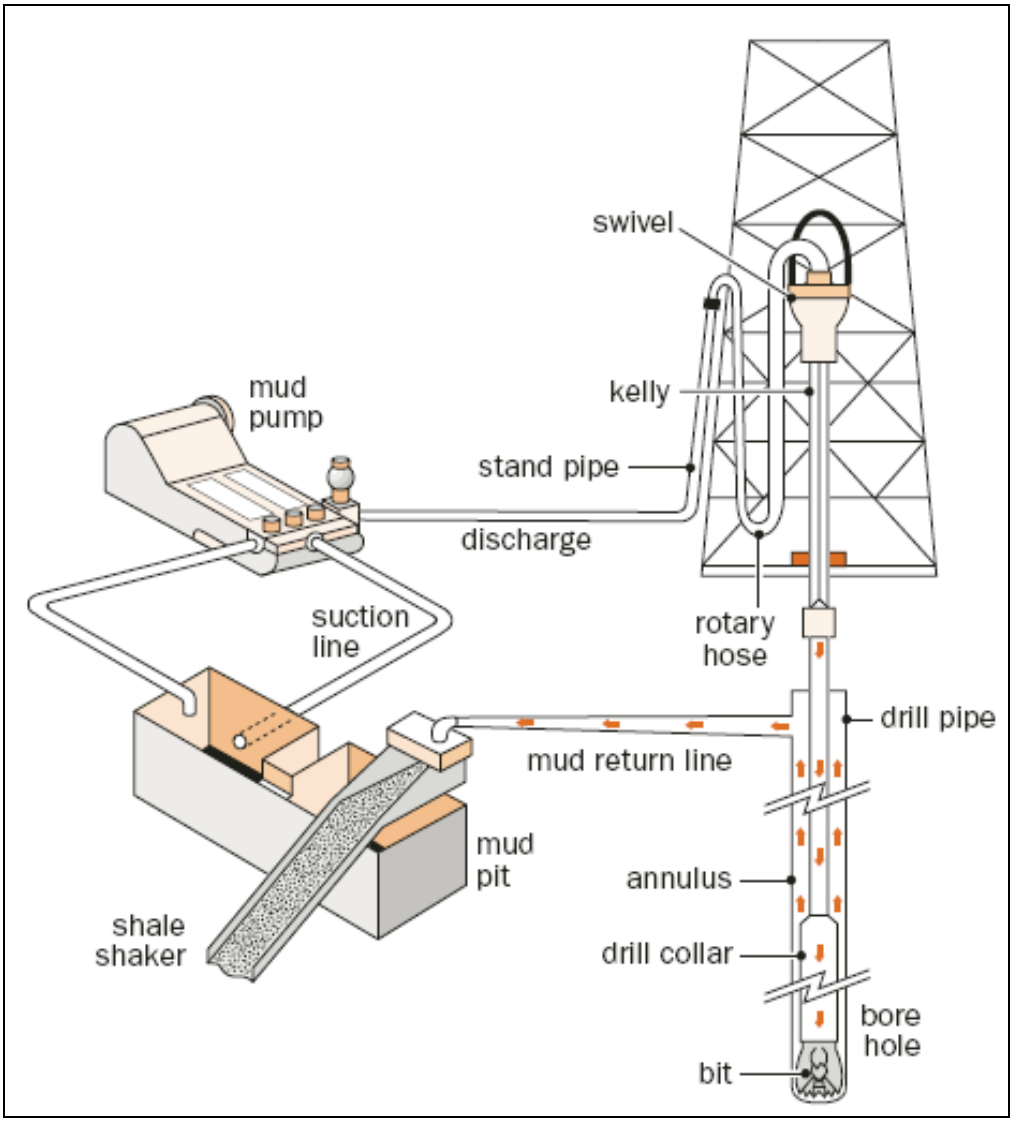


Figure 3.1: Basic set up in a drilling operation. (Adapted from E&P 1997)

3.4.1 Associated Facilities

(a) Campsite

The well site camp will be constructed with advice from recognized constructors, once its specific location has been agreed upon in consultation with the local communities. The area of the well site will likely be 1km×1km, and it will be fenced off and access controlled by a guarded gate. A typical (simplified schematic) of a drilling campsite is shown in Figure 3.2 below. The campsite will be designed to comfortably accommodate up to 150 persons at any one time.

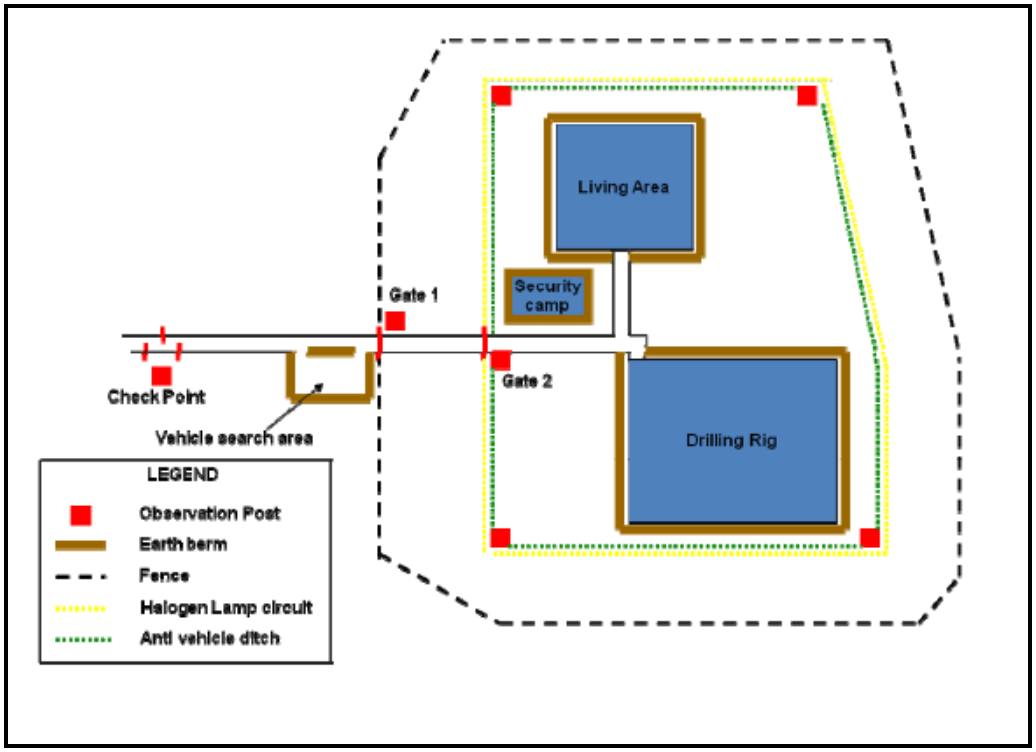


Figure 3.2: Typical drilling well site camp design.

(b) Water Reservoirs and Mud Pits

The Company shall construct water reservoirs near the well site to store drilling water for daily or any emergency drilling operation purposes. Mud pits will also be constructed to store drilling muds. The drilling muds have several functions, such as lubrication and cooling of the drilling bits, and bringing out the drill cuttings from the well bore etc. Several additives are mixed into the mud system to give the required properties. A simplified design of mud pits is illustrated in Figure 3.3 below. Mud pits are usually constructed from impermeable membranes and soil material and in essence should be surrounded by a raised bund which prevents the entry of run-off water from the well site and adjacent areas.

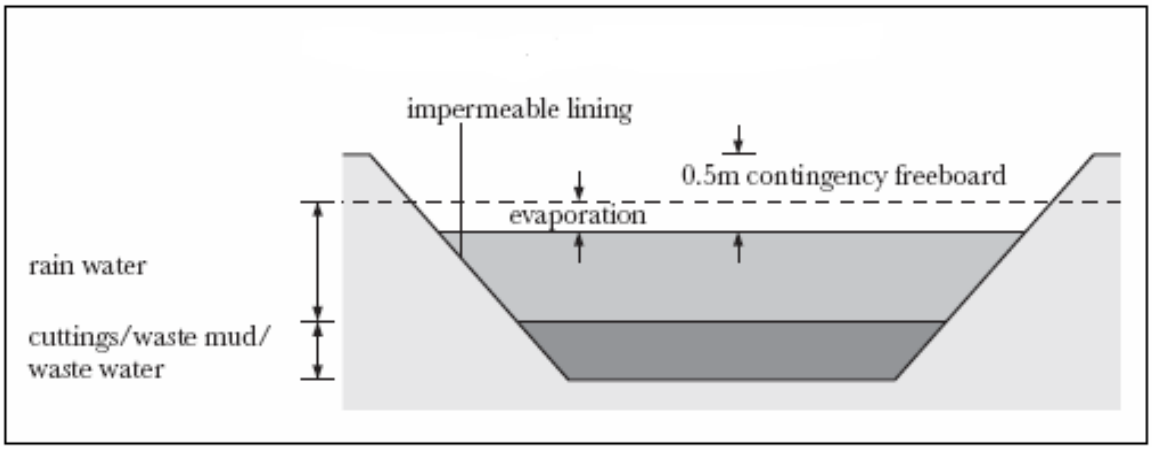


Figure 3.3: Shows the dimension of a mud pit (Adapted and modified from IUCN, 1993)

(c) Generators

Power generators will be required to drive the drilling rig and to power associated facilities. The generators will use low sulphur fuels and will have efficient exhaust systems.

3.5 Well Control Procedures

The Company shall put in place well control procedures which shall include, but not be limited, to the following elements:-

(a) a thorough assessment of the geology and formation pressures prevalent in the area;
(b) design of the drilling fluid program;
(c) well control procedures that shall be used by the drilling contractor, and;
(d) training and accreditation of both the drilling contractors and operator's site supervisory personnel.

3.6 Drilling Safety

The wells will be designed and engineered to international standards for maintenance of well control. Casing sizes and lengths and the intervals where the hole is cement sealed around the casing will be selected to maximize well control. During the drilling program, a temporary safety exclusion zone shall be established for non-drilling personnel within the campsite. The Emergency Response and Contingency Plans that the Company has used in its previous operations will be customized to take into account the unique aspects of the local conditions where the drilling will be taking place. All employees and contractors will be inducted and familiarized with the safety, emergency response and contingency plans that the Company will have put in place.

3.3 Operational Wastes and their Management

Wastes that will be generated by routine drilling operations, and from other areas in the drilling campsite, include:

- drill cuttings
- drilling waste fluids/muds
- Produced water/fluid mixture

- Sewage and grey water
- cooling waters
- domestic and industrial solid wastes and hazardous solid and liquid wastes,
- engine and waste oil

In order to minimize the environmental impacts of these wastes, they should be handled as specified in the Company Waste Management Plan and customized to local conditions, taking into consideration the technological and mitigation options as outlined in Chapters 6 and 7 of this Environmental Impact Assessment study report.

CHAPTER 4:

BASELINE ENVIRONMENTAL PARAMETERS OF THE STUDY SITE

This chapter provides details of the desktop studies, field survey and, soil chemical analysis results which are based on the methods applied in this environmental impact assessment study as outlined in chapter 2.

4.1 The Study Area

4.1.1 Geographical Aspects and Boundaries

The project area lies in Turkana South and part of Turkana Central districts (Figure 4.1). The sites targeted for drilling lie within the Kerio Basin and Lokichar Basin in Kerio and Lokichar divisions respectively. The district is up to 90% arid while the remaining 10% is semi-arid. The area is thinly populated with pastoralism being the main livelihood, and fishing a secondary one for those living close to the lake .The rainfall is low, normally less than 255mm/yr. The annual mean maximum temperature range is 30°C to 34°C, while the annual mean minimum temperature is 23.7ºC (Survey of Kenya, 1977).

Plate 4.1: Photo showing the study area (note the semi-arid nature of the area).

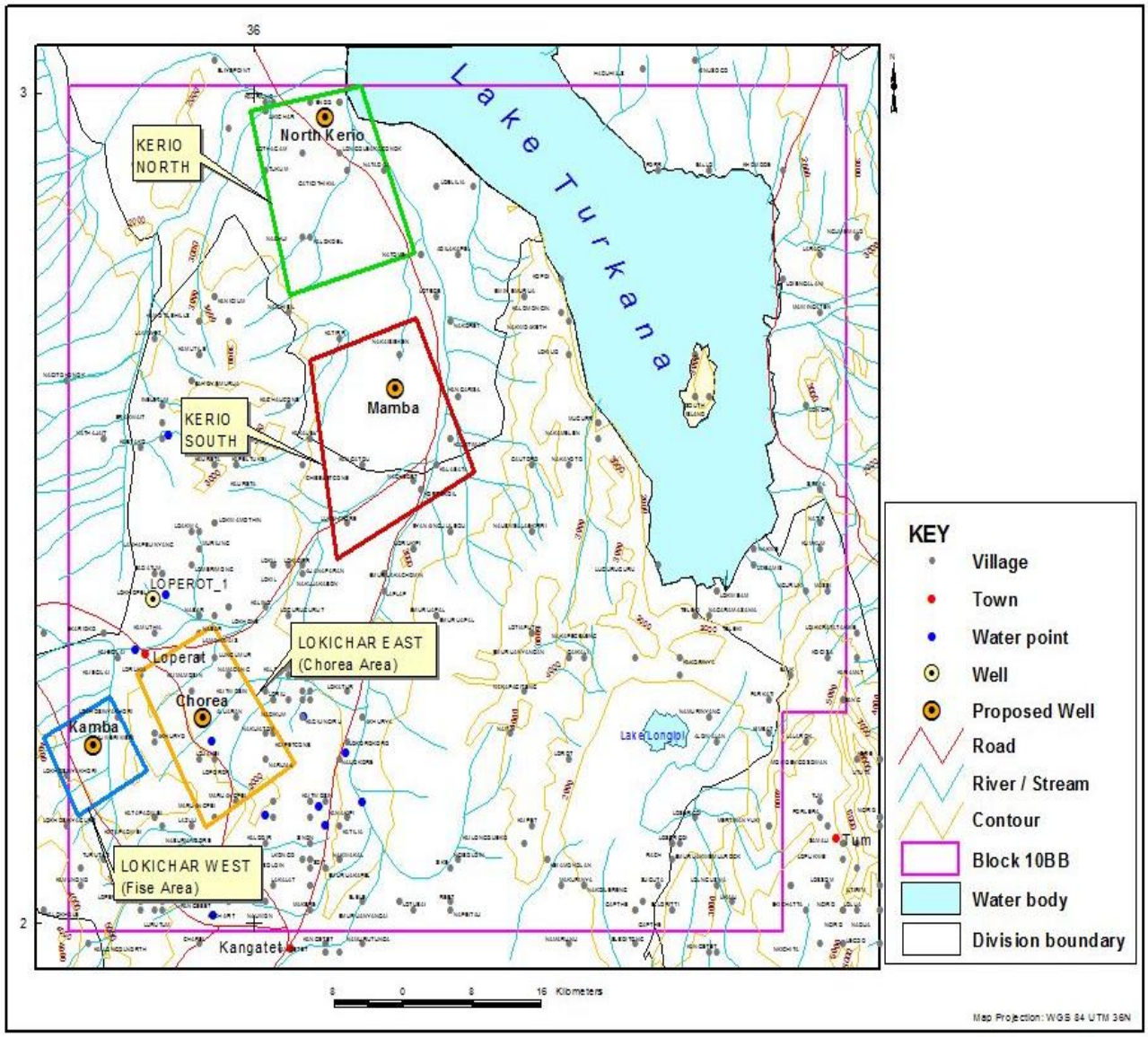


Figure 4.1: Geographical and physiographic features of the study area.

4.1.2 Administrative Set-up

Turkana Central and Turkana South are administrative districts located in the Rift Valley Province. The administrative headquarter of Turkana Central is Lodwar while that of Turkana South is Lokichar. There is one local authority, Turkana County Council, which still serves the larger Turkana district.

4.1.3 Infrastructure

The project area has gravel or/ and earth roads, that are in state of disrepair. The main Kitale - Lodwar road leading to the project area is constructed to bitumen standard, however, a large part of the road is in a sorry state of disrepair and require urgent attention from the relevant authorities.

The minor earth roads and tracks within the project area transverse luggas that are at times impassable. The roads leading to the proposed well exploratory drilling sites particularly in Kalapata location have been upgraded by the proponent and are currently passable by motor vehicles. There is also a temporary functional airstrip site near the BGP base camp.

The project area has no electricity supply and the BGP seismic survey base camp is relying on power generated by use of diesel generators. Fresh water supply for domestic and livestock use is inadequate and presents a major challenge in the area. The main source of water for the local communities is shallow groundwater, extracted through shallow wells that are equipped with hand pumps. The operations of the proposed project will require considerable amounts of fresh water supply and this will likely be sourced from boreholes to be drilled near the project sites, or transported from the nearest water source, e.g. Kitale town, to the site by water browsers.

4.1.4 Communication

Telecommunication facilities are lacking in the project area. Mobile telephony connectivity is scanty and satellite and/or radio communication is the only way to stay constantly in touch within the area and the outside world at their base camp.

4.1.5 Government, Non Governmental and Community based Organizations

The project area has several governmental and non-governmental agencies carrying out various programs such as water provision, education and health services. Government agencies include the Arid Lands Resources Management Programme (ALRMP). Non-governmental organizations include World Vision, RIAM and Merlin. Religious based organizations include the Reformed Church of East Africa and Christian Mission Fellowship, among others. Most of these organizations operate from Lodwar town.

4.2 Physiography and Geology

4.2.1 Physiography

The landform/topography is a kaleidoscope of mountains, hills, uplands, foot slopes, piedmont plains, sedimentary plains, lacustrine plains and floodplains. The expansive plains have elevations ranging between 437-768 m asl. Lava flows, which generally occur in a north-south direction, form the major central mountains and hills, including Auwerwer, Hadukhungele, Lokhoriokho and Nakuangale. The sedimentary plains on the western side of these mountains and hills break into piedmont plains of various parent materials. Other mountains and hills are found towards the north-eastern and south-eastern parts and they give way to lacustrine plains bordering Lake Turkana, the largest water body in the area (Figure 4.1). Denudation has been active within the study area and the once volcanic capped hills now reveal exposures of basement system rocks.

Lake Turkana receives runoff and sediment from a wide geographical area. The Omo River provides about 90% of the water that flows into the basin (Cerling, 1986), draining southward from the Ethiopian plateau where mid-year monsoonal rainfall exceeds 1500mm (Halfman and Johnson, 1988). The seasonal Turkwel and Kerio rivers contribute most of the remaining fluvial input; other water sources are insignificant in the lake's water budget (Yuretich and Cerling, 1983).

The two main rivers that traverse the project area are the Kerio and Turkwel rivers. There are also numerous seasonal as well as ephemeral streams (referred to locally as *luggas*) that flow for only a few hours or days after the rains (Walsh and Dodson, 1969). The flows are often torrential and flooding outside the shallow stream/river channels is a common phenomenon.The Turkwel River carries water into the lake for several months in a normal year. The river is approximately 300km long, rising from the slopes of Mt. Elgon (Dodson, 1971). For much of its length it runs from south to north and then swings eastwards at lower altitudes, finally to run from west to east into Lake Turkana, its mouth forming an extensive delta. The Turkwel and Kerio rivers have deposited a wide and expansive alluvium cover close to the lake shore; Rivers draining the eastern slopes of the mountain ranges bordering the lake have west-east alignments, flowing directly into the lake. Most of the lake shoreline in the southern part is rocky, consisting of layers of lava boulders or minor cliff faces where recent lava flows have extended to the water line. In the south-west corner of the lake, however, the shoreline opens out to form a gently curving arc with sandy and shingle beaches. The internal drainage system in southern Lake Turkana is due largely to the rainfall runoff west of Nyiro mountain and around the lake shore. Most rivers flowing into Lake Turkana have been forced to cut courses through a series of lava flows or pyroclastic accumulations.

4.2.2 Geology and Structures

The Kenya Rift, which is topographically well-defined throughout most of Kenya, splays out into a broader, less distinct zone of rifting within the vicinity of Lake Turkana. The Turkana Depression has generally been regarded as a diffuse zone of faulting, linking the rift segments to the north and to the south (Dunkelman *et al.*, 1988).

The geology of the area is dominated by rocks ranging from Precambrian (Neo-Proterozoic) to Recent age. These include:

(i) The Precambrian (Neo-Proterozoic) basement rocks consisting of a variety of gneisses and undifferentiated brecciated rocks;
(ii) Tertiary metamorphics such as quartzites and Tertiary lavas mainly basalts, phonolites, nephelinites, trachytes, andesites and overlying tuffs and gritty tuffs;
(iii) Pleistocene to recent deposits.

The general stratigraphic succession of the Lokichar basin is described by Morley et al. (1992) as consisting, in ascending order; of the Precambrian basement rocks, Turkana (Loperot) grits, volcanic rocks and Pliocene to Recent sediments.

The Precambrian metamorphic basement system rocks of Turkana south consists of a stratiform sequence of successive layers of differing lithology that represents a sedimentary succession which has been subjected to granitization and metamorphism of a high degree. These are comprised of an upper fine-grained pelitic series with crystalline limestones and quartzites overlying a series of course gneisses, migmatites and a variety of undifferentiated brecciated rocks. The gneisses are marked by an increase in granularity and are lighter in overall color. Localized bands of crystalline limestone and highly weathered quartzites are common. Due to the overlying thick sediment and volcanic cover of approximately 4-8 km (Wescott et al., 1999) the basement rocks are of no hydrogeological significance in Turkana south. Localized exposures of the basement rocks occur in river channels and on hills where they have been exposed due to erosion of the overlying volcanic cover.

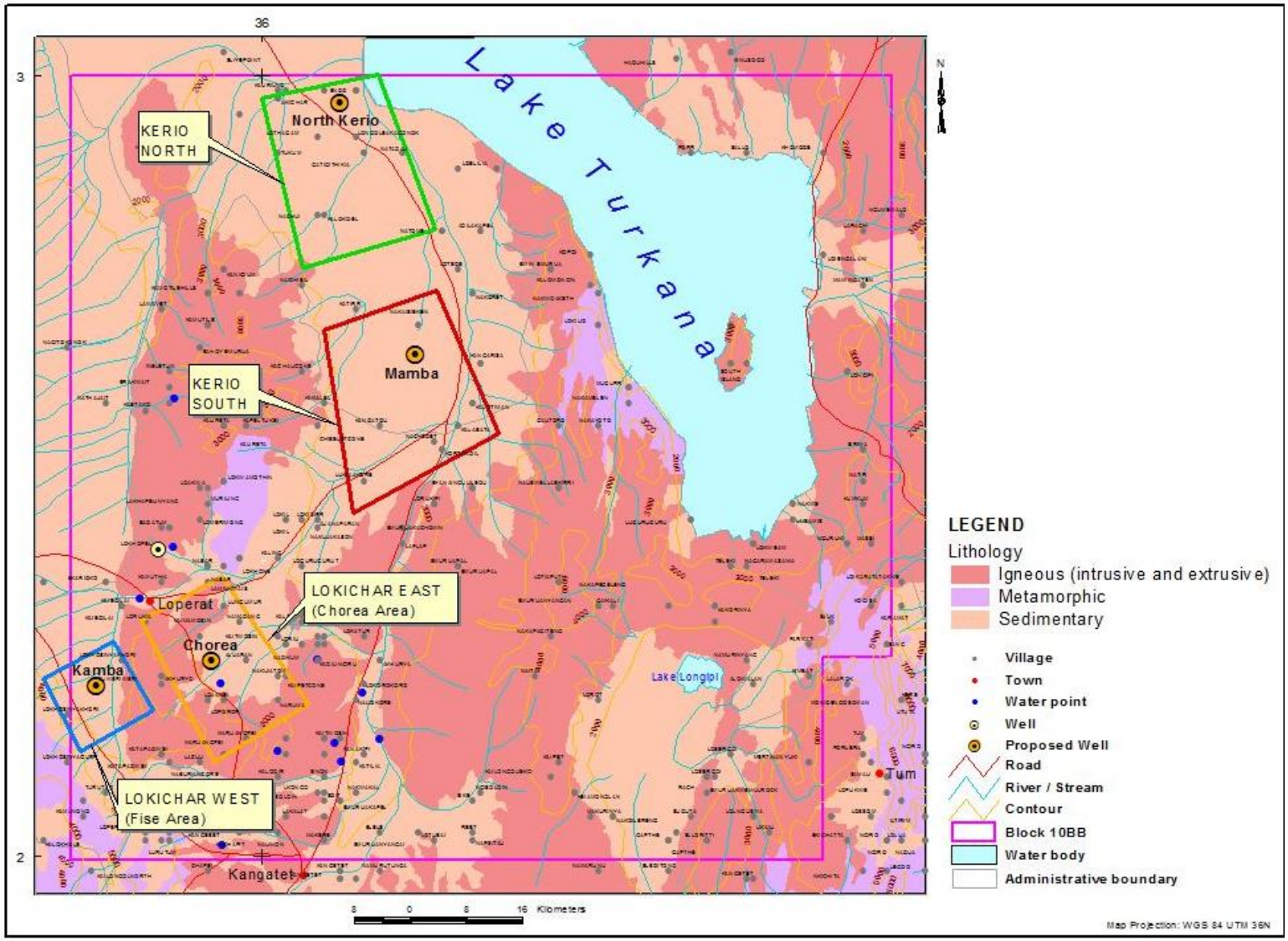


Figure 4.2 Geology of the study area

The Turkana grits occur in the eastern parts of Loperot area where they are overlain by Tertiary lavas. However, exposures of Turkana grits are poor and consist of more resistant calcareous rocks, while others occur along the escarpments where gullies are carved into talus of the retreating scarps. Faulting and gentle folding are characteristic and repetition of beds due to successive sediments of similar nature as well as strike faulting are a common occurrence.

Basalts overlie the Turkana grits and form the foundation of the hills in Turkana south. The hills are either flow remnants, denuded volcanic cones or, in most cases, intruded by large dyke-like bodies along major faults. The basalts are presumed to have covered most the eastern part where Turkana grits are now exposed but are overlain by thick alluvium cover to the west. Borehole logs and outcrops show that basalts are the dominant rock types within the intra-montane plains within the region. The basalts are highly resistant to weathering and this gives rise to their rugged and steep-sided topography. Their appearance varies little throughout the area: they are of medium to coarse porphyritic texture, with phenocrysts up to 0.5 cm of pyroxene (augite), olivine and plagioclase. The color varies from blue-grey to black. Most of the outcropping rocks are intensively fractured and borehole logs indicate that such fissured and fractured basalts are the most important local aquifer.

The phonolites overlie the basaltic sequences in the area and appear as remnants especially on the Auwerwer and Hadukhungale hills. The phonolites are somewhat fissile with typical platy jointing and usually have greenish grey aphanitic matrix containing occasional small anorthoclase phenocrysts. The phonolites outcrop locally at Katilia, Kachodin and Kerio areas among others.

Intra-montane plains are common and are underlain by moderately thick (10 to 40 m) layers of largely clayey sands, sandy clays and clayey alluvium, which in most cases covers a complex of fractured, weathered and fresh volcanics mainly basalts and phonolites. Records of borehole logs indicate that the sediments of the intra-montane plains usually extend to a depth of 10 to 35 metres, and within the Lokichar/Loperot sedimentary basin, the alluvium extends to over 50 m (Groundwater Survey (K) Ltd., 2001). The texture is generally clayey, although local sand lenses occur near the major river courses (luggas). Weathered volcanic sequences are suspected to underlie most of the plain at intermediate depths. The maximum thickness of the sediments in the Lokichar/Loperot basin ranges from 4-8 km and the stratigraphy is characterized by clayey alluvium, tuffs and gritty tuff, pyroclastics deposits, inter-bedded basalts, phonolites, nephelinites and sedimentary rocks, sub-volcanic sedimentary rocks and Precambrian basement rocks (Wescott et al., 1999; Mariita, 2003).

Extensive seismic investigations carried out in this area by project PROBE (Offshore L. Turkana) (Dunkelman et al., 1988; Dunkelman et al 1999) and by Amoco Kenya Petroleum Company (Morley et al., 1992; Morley et al., 1989) have revealed the existence of several N-S trending, large and deep half grabens dated from Paleocene to upper Miocene. NNW trending lineaments associated with mobile belts at depth are common and are responsible for the North to NNW trending Lokichar/Loperot Mesozoic basin (Smith and Mosley, 1993). Such NNW trending lineaments controlling the Lokichar/Loperot basin include Nyangea-Athi-Ikutha and Muglad-Anza-Lamu shear zones (NOCK, 1987), which have resulted from a weakened and stretched lithosphere in northern Kenya (Bosworth et al., 1986). The NNW lineaments are the foci of Tertiary volcanism where NNW trending volcanic hills occur. The main structural features in Turkana south are two parallel, north-south trending synclinal basins occupied by Lake Turkana to the east and Lokichar/Loperot plain to the west. The volcanic fringes of the synclines are moderately faulted and tilted, and the lava sheets are marked by low eastward and westward dips of about 2 to 6 degrees. The volcanic ridges and hills are characterized by

north-south trending faults having downthrows to the east and west. Due to the moderate faulting of the lava blocks, the basalts are expected to be widely fractured. To the west of the basin are the basement rocks forming the Loichangamatak hills while to the east to the basin are bounded by the Miocene volcanic rocks forming the Katigithigiria highlands (Napedet).

4.3 Soils

4.3.1 Soil Mapping Units

The following mapping units Y10, Ux7, PI1 and D1+PI3, cover the proposed exploratory well drilling sites in the survey area and thus represent the following landforms: piedmont plains, Uplands, lacustrine plains and a complex of dunes and lacustrine plains respectively. The soils are poorly drained to well drained, seasonally water logged, very shallow to deep, of various textures, ranging from saline and sodic (in various thresholds), clay loams to sandy clay, with some sites being stony and bouldery.

Mapping Unit PI1, Mamba Area

This mapping unit covers the proposed exploratory well drilling site. It is within the Kangirisae location of Kerio District (Figure 4.3). Its geology is tertiary basic igneous rocks mainly olivine basalts, partly covered by basic tuffs. The physiography is lacustrine plains consisting of gently undulating slopes. The soils are imperfectly drained, deep, dark brown, slightly saline and moderately sodic, gravelly sandy clay to clay with a compact epipedon. The study area is susceptible to moderate to severe windblown erosion. Consequently, the meso-relief consists of common sand dunes (1 m in height and about 3m in diameter) with gentle slopes. The dunes are partially stabilized by *Suaeda monoica* (*Echemee* in local dialect) *s*hrubs. The dunes act as surface runoff barriers that trap water which percolates slowly into the endopedon, supporting the growth of vegetation. Otherwise where these are absent the surface supports scanty vegetation and some areas are entirely bare. The study area is susceptible to seasonal flooding and at the time of field study (end of the rains); over wash and rill erosion features were noted. Further, surface capping and sealing were common features where the soil surface was moist and bare. Pressure also bears on the surface soil, whose texture is sandy loam (Tables 4.1 and 4.5), since the area is also used for livestock grazing, making the unit very fragile. The vegetation consists of scattered *Acacia tortilis* shrubs that are < 3 in height covering approximately 20% of the surface and *Suaeda monoica* present on sand dunes. *Cadaba spp* and *Indigofera* dwarf shrubs are also present on the surface in clusters.

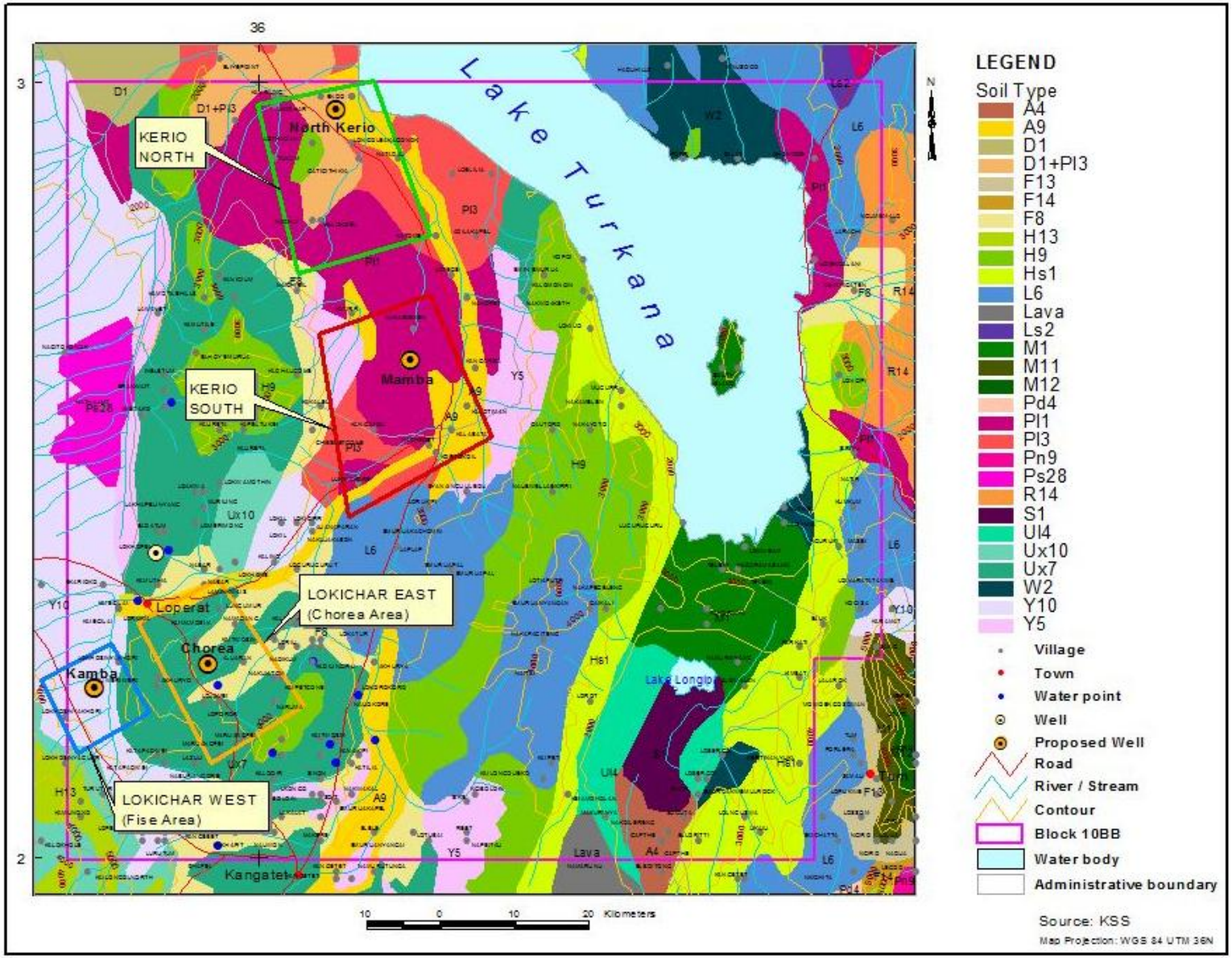


Figure 4.3: Soils of the study area.

From laboratory results (Table 4.5), the soil reaction indicates a pH range of 7.98 to 8.56. For classification purposes the pH is taken as 8.32 (Bw1 horizon) this is a moderately alkaline soil. The electrical conductivity indicates a soil that varies from none saline to slightly saline. However, the exchangeable sodium percentage gives a value of 15 in horizon Bw1 (Table 4.5). A value of 15 for ESP is regarded as the boundary between sodic and non-sodic soils (Landon, 1984). The cation exchange capacity for topsoil is 21.0 me%, rated as a moderate value (Landon, 1984). For B horizon, sodium (3.5 me %) is the second dominant cation after calcium (26.6 me %), with a CEC value of 22.8 me%, making the soils slightly saline and moderately sodic. The soils classify as *haplic Solonetz.*

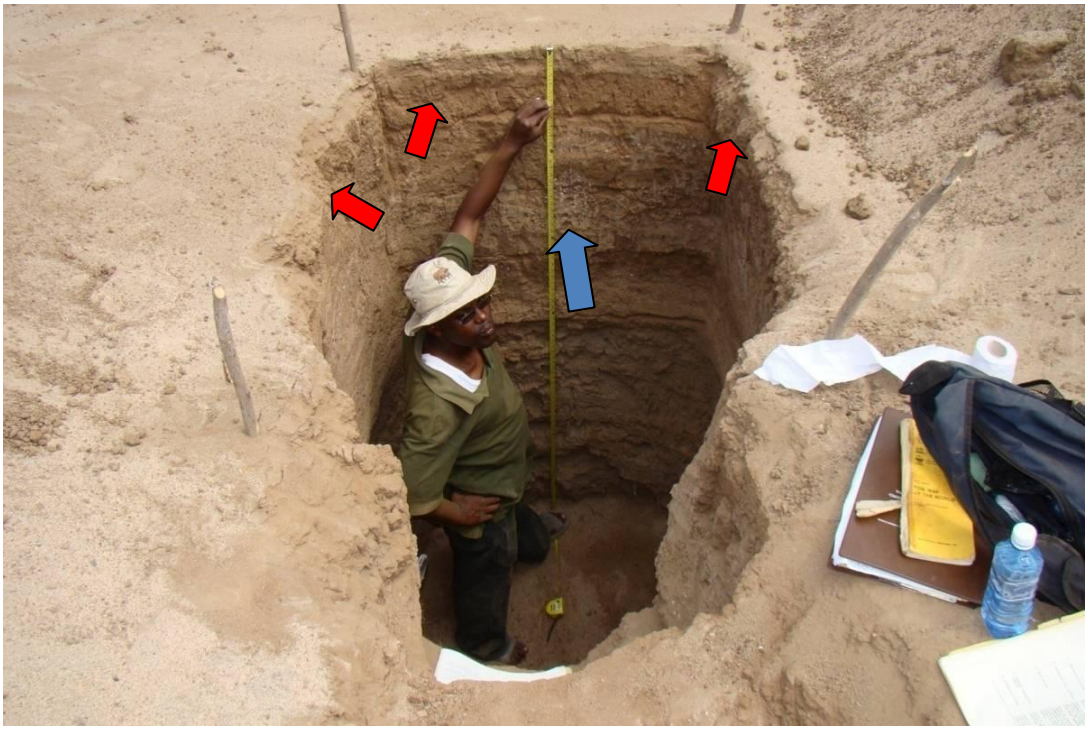


Plate 4.2: soil profile pit (PP: Mamba 001) showing soil horizons. Note the tonguing of the columnar soil structure connotative of a Natric –B horizon (red arrow) and compact B horizon (blue arrow) typical of Solonetz's.

Plate 4.3:(a) survey site showing, scanty Acacia tortilis vegetation (green arrow) and sand dunes (red arrow) partially stabilized by Suaeda monoica and (b) surface soil with quartzite pebbles(green arrow) and surface crusts (red arrows)

Mapping Unit D1 + PI3, North Kerio Area

The exploratory well location is within this unit located in Ngimuriae location of Kerio North (Figure 4.3). Its geology is lake deposits (pyroclastics and olivine basalts) and windblown deposits. The landform/topography is lacustrine plains (nearly level to gently undulating) with dune ridges. The meso-relief consists of common low dunes (1m in height and 3-5 m in diameter) with a convex regular shape stabilized by *Suaeda monoica*. The soils are locally moderately well drained (dune ridges) to predominantly poorly drained, very deep, dark brown, moderately calcareous, excessively sodic, clay loam to loamy sand, textures. Throughout the pedon there are primary minerals mostly quartzite and common very fine clay micas in the endopedon. The surface consists of local puffy salt crusts (2-4mm thick) micro relief. The salt is sharp and bitter in taste and is likely to be $NaNo_3/Na_2SO_4$ and/or Mg SO_4, going by the high values of sodium and magnesium (Table 4.6). There are extensive sandy clay loam textured bare patches covered by thin surface soil crusts in between the dunes and *Suaeda monoica* vegetation. There is overwash, rill and gulley erosion where sloppy. The area is susceptible to seasonal flooding and ponding. The surface sealing and crusting causes slow percolation of surface water. During the dry season, save for the locally salt patches, the bare patches are susceptible to windblown erosion due to the high sodium content that affects soil aggregate stability.

From laboratory results (Table 4.6), the soil reaction indicates a pH range of 7.94 to 10.2. For classification purposes the pH is taken as 8.19 (Bw1 horizon) this is a moderately alkaline soil. The electrical conductivity indicates a soil that is excessively saline. However, the exchangeable sodium percentage gives a value of 41 in horizon Bw1 (Table 4.6). A value of 15 for ESP is regarded as the boundary between sodic and non-sodic soils (Landon, 1984). The cation exchange capacity for topsoil is 25.6 me%, rated as a high value (Landon, 1984). For B horizon, sodium (9.5 me %) is the second dominant cation after calcium (26.5 me %), with a CEC value of 23.4 me%, and ESP of 41 making the soils excessively sodic. The soils are therefore excessively saline and sodic. The soils classify as *haplic Solonetz.*

Plate 4.4: (a): North Kerio Profile pit showing soil horizons (ABC) with a compact endopedon (red arrow) and (b) soil structure depicting angular blocky and granular surface soil (A/AB) and prismatic, platy and granular subsurface (B-horizon) soil.

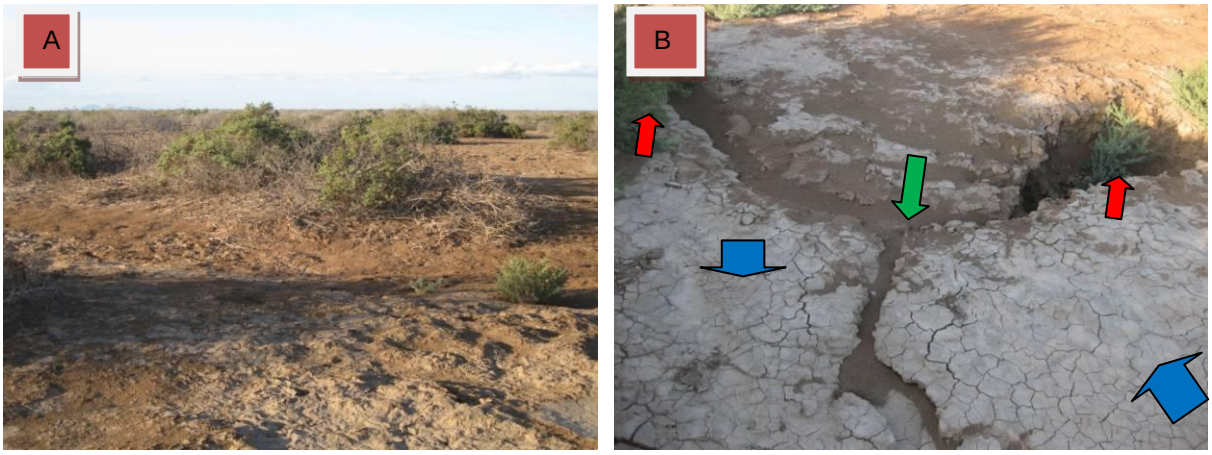


Plate 4.5 (a): North Kerio exploratory drill site area showing sand dunes partially stabilized by Suaeda monoica vegetation and (b) local surface salt crusts (blue arrows) and a rill /potential gulley (green arrow) forming where there is a gentle slope. Note the *Suaeda monoica* vegetation which is salt tolerant establishing where the water percolates and hence eventually stabilizing the rill (red arrows).

Mapping Unit Y10, Kamba Area

This mapping unit covers the exploratory drill site. It is within the Katioko location in Loperot division, Turkana central (Figure 4.3). Its geology is alluvium from undifferentiated basement

system rocks mainly gneisses. The landform/topography is piedmont plain, consisting of nearly level to gently undulating slopes (0-5%) of irregular pattern. The soils are moderately well drained, moderately deep, dark brown, locally stony, sandy loam to gravely clay, slightly saline and strongly sodic. The surface consists of sandy soil (Table 4.7) and surface gravels and stones that occupy about 30% of the site. The gravels are about 5 cm in diameter and predominantly angular in shape while the stones are >7.5 cm, some of angular while others of rounded shape. Rock outcrops in form of basaltic dyke occur on the surface at about 30-40m intervals. There is sparse vegetation of *Acacia tortilis, Acacia reficiens* and *Indigofera* dwarf shrub. The area also serves as grazing grounds with goats and camels being predominant. Trampling and low vegetation cover makes the exploratory well drill site very fragile.

From laboratory results (Table 4.7), the soil reaction indicates a pH range of 8.04 to 8.48. For classification purposes the pH is taken as 8.04 (Bw1 horizon) this is a moderately alkaline soil. The electrical conductivity indicates a soil that is moderately saline. However, the exchangeable sodium percentage gives a value of 20 in horizon Bw1 (Table 4.7). A value of 15 for ESP is regarded as the boundary between sodic and non-sodic soils (Landon, 1984). The cation exchange capacity for topsoil is 29.8 me%, rated as a high value (Landon, 1984). For B horizon, sodium (6.0 me %) is the second dominant cation after calcium (24.6 me %), with a CEC value of 29.8 me%, and ESP of 20 making the soils moderately saline and strongly sodic. The soils classify as *haplic Solonetz.*

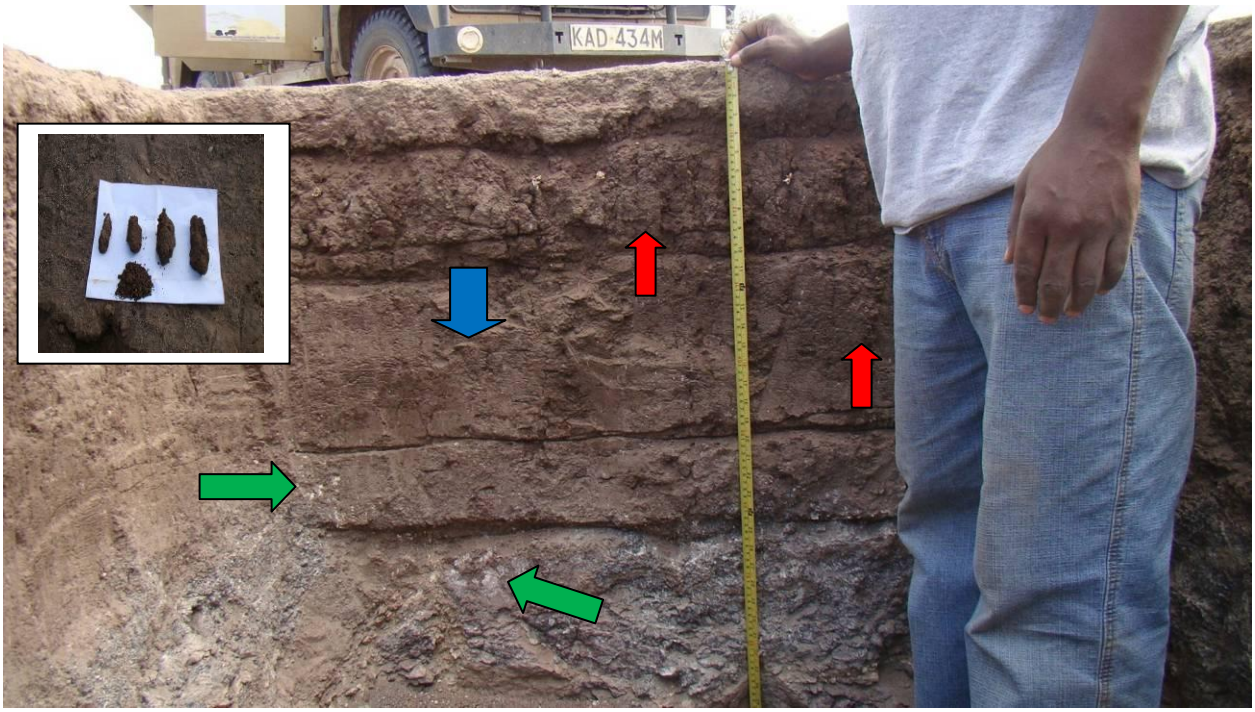


Plate 4.6: Kamba--profile pit Katioko, Loperot showing soil horizons. The unit is moderately deep with a compact- b horizon (blue arrow). The green arrow shows carbonates present in the B and C-horizons. Note the columnar structure in the B-horizon (red arrows and inset) typical of the Natric-B of a Solonetz.

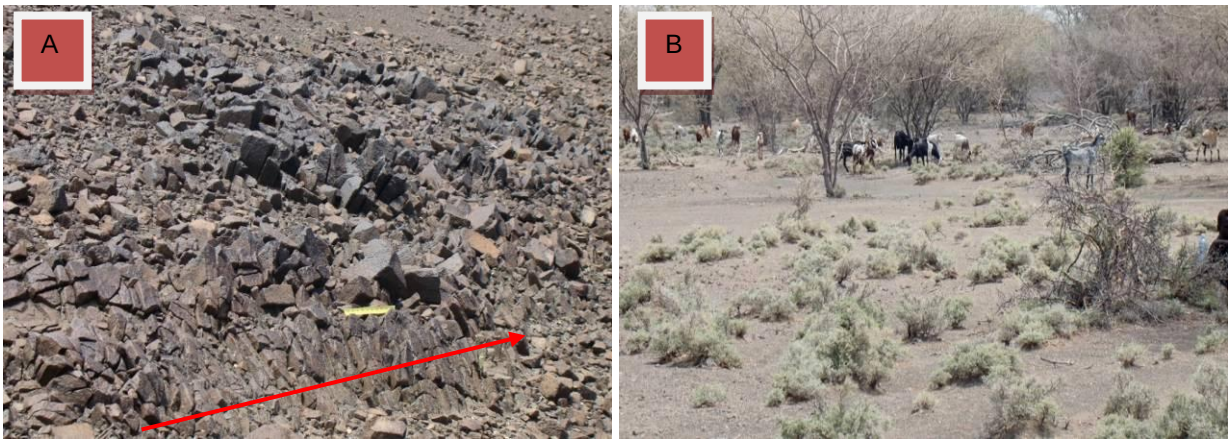


Plate 4.7(a) contrasting surface-scape of the Kamba drill site, showing a basaltic dyke (red arrow) and surface stones occupying about 30% of the surface and (b) goats grazing on the scattered vegetation of Indigofera spp (background) shaded by Acacia

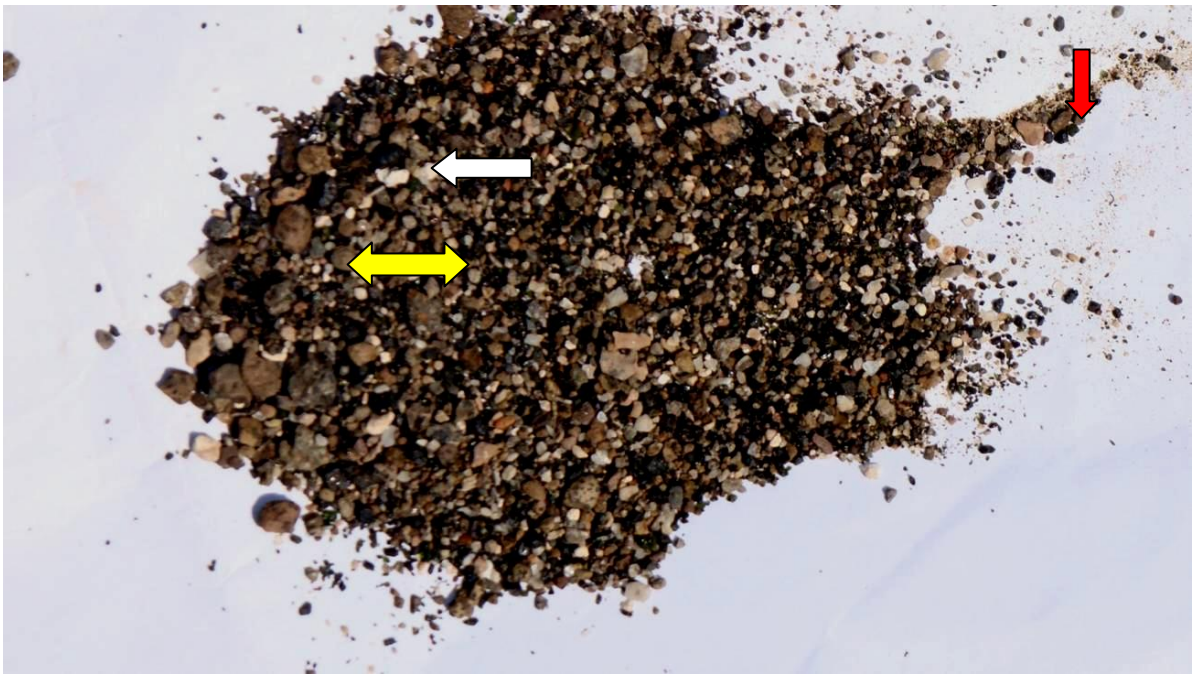


Plate 4.8: Surface pebbles of the Kamba exploratory well drill site with quartzite (red arrow), volcanic obsidian (white arrow) and fluorite (yellow arrow) minerals. The minerals contribute to the dark soil surface color but in essence the soil color is lighter qualifying for an ochric 'A' horizon. This, in conjunction with other diagnostic properties, makes it classify as a haplic Solonetz.

Mapping Unit Ux7, Chorea Area

This mapping unit covers the Chorea exploratory well drill area. It is south of Loperot town, Lokichar East (Figure 4.3). The geology of the area is undifferentiated volcanic rocks mainly basalts. The physiographic unit is uplands at differentiated levels consisting of rolling topography and base level variables. The macro relief is gently undulating to undulating uplands. The soils are well-drained, very shallow, dark brown, gravely, sandy loam (stony mantle phase). The surface stones and boulders cover 90% of the surface. The site classifies as rubble land (FAO, 1977, Kenya Soil Survey 1987).The unit supports scattered *Acacia*

reficiens vegetation and *Aloe turkanensis*. However, where the vegetation anchors in waterways, erosive forces make the trees fall due to the shallow soil.

From laboratory results (Table 4.8), the soil reaction indicates a pH of 8.65. This makes the soils strongly alkaline. Since the soils are very shallow only the surface horizon was considered. The electrical conductivity indicates a soil that is moderately saline (Table 4.8). From the pH and electrical conductivity results the soils are moderately saline and sodic. The cation exchange capacity is 28.2 me%, rated as a high value (Landon, 1984). The soils classify as *lithic Leptosols.*

Plate 4.9: The Chorea exploratory drill site showing a shallow mini-pit excavation with an AC sequence of soil horizon. The depth reached is 15 cm. Basalt rock outcrops [blue arrows (continuous in the subsurface)] and surface stones occupy more than 90% of the surface

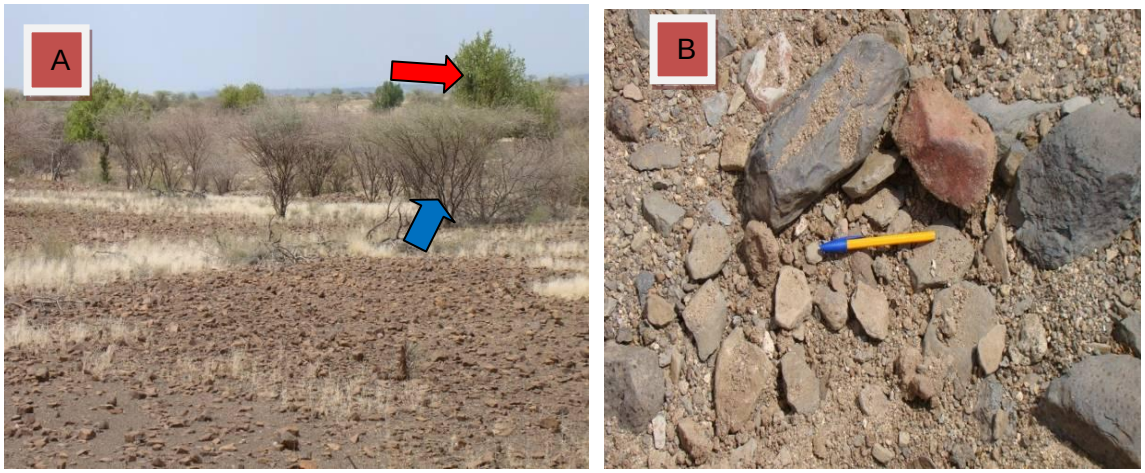


Plate 4.10 (a): Chorea drill well site showing surface stones (foreground) and Acacia reficiens (blue arrow) and Balanities aegyptiaca (red arrow) on sandy waterways and (b) surface basalt stones some having undergone oxidation

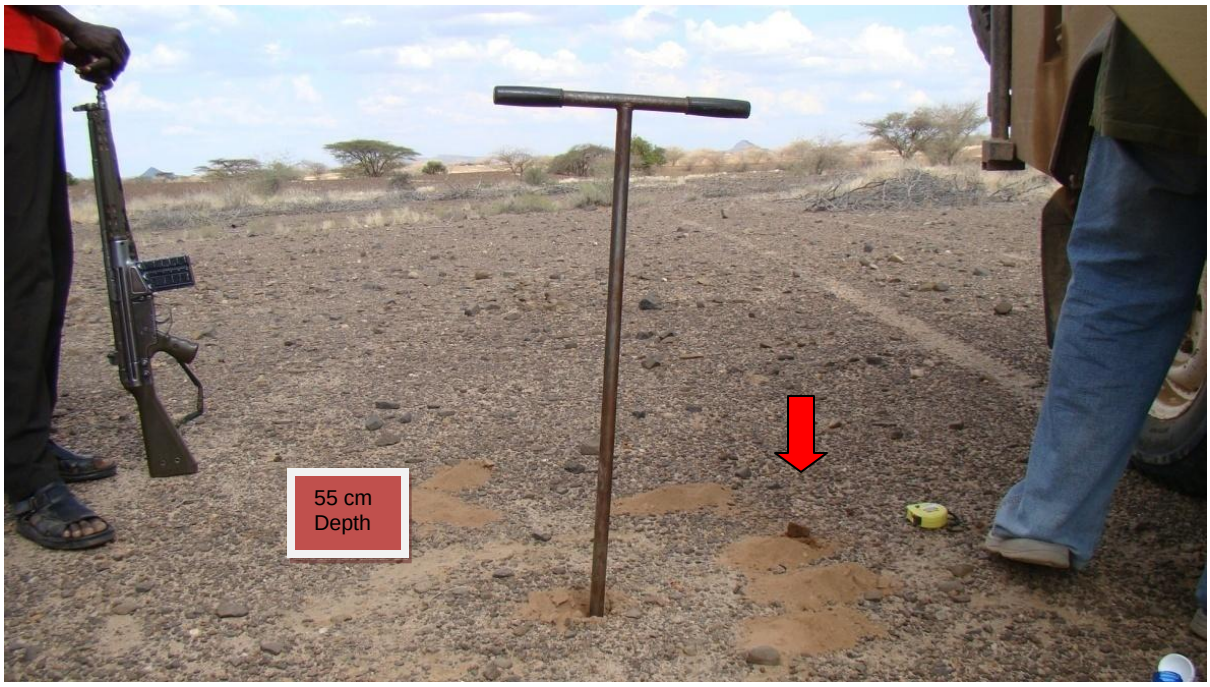


Plate 4.11: Possible site for locating mud pits showing less stony surface condition and moderately deep sandy loam textured soil (red arrow)

Table 2Table 4.1: Soil mapping unit description for Mapping Unit PI1, Mamba

Profile Pit	PP: Mamba 001 Kangirisae, Kerio
Coordinates	855424, 292457 (UTM x,y coordinates WGS84)
Parent material	Basic igneous rocks (mainly olivine basalts)
Physiography	Lacustrine plains (gently undulating)
Drainage	Imperfectly drained
Vegetation/Land use	Natural /Pastoral shrubland with scattered *Acacia tortilis*, *Suaeda monoica* and *Cadaba spp*
Rock outcrops	None
Depth	deep
Soils general	The unit consists of deep, dark brown, sandy clay, to clay soils. They have an ABC sequence of horizons with a clear to gradual boundaries that have a smooth to wavy topography. The soils are coarse, angular blocky, and columnar; and fine to moderate sub-angular blocky, structures (B horizon), with strong grades respectively.
Color(moist): **A- Horizon** **B- Horizon**	 Dark brown Dark brown
Structure **A-horizon** **B-horizon**	 medium, moderate grade angular blocky; fine, moderate grade, granular; Coarse, angular blocky and columnar, with strong grades respectively and fine to moderate sub-angular blocky with moderate to strong grades (compact --B).
Consistency (dry, moist, wet) **A-horizon** **B-horizon**	 Slightly hard to hard when dry; very friable when moist; slightly sticky and slightly plastic when wet Slightly hard to hard when dry; friable to firm when moist; slightly sticky to sticky and plastic when wet
Texture **A-horizon** **B-horizon**	 Gravelly Sandy Loam Sandy Clay to Clay
Diagnostic properties	Natric B horizon
Soil classification	***haplic Solonetz***

Table 4.2: Soil mapping unit description for Mapping Unit D1+PI3, North Kerio

Profile Pit	PP: N. Kerio 002 Ngimuriae, North Kerio
Coordinates	844633, 328111 (UTM x,y coordinates WGS84)
Parent material	lake deposits (pyroclastics and olivine basalts) and windblown deposits
Physiography	lacustrine plains (nearly level) with dune ridges
Drainage	Poorly drained
Vegetation/Landuse	Natural shrubland of *Suaeda monoica* established on dunes
Rock outcrops	None
Depth	Very deep
Soils general	The unit consists of deep, dark brown, gravelly clay loam to loamy sand soils. They have an ABC sequence of horizons with a gradual to clear boundaries that have a wavy to smooth topography. The soils are medium to coarse, angular blocky and columnar structure exhibiting moderate and strong grades respectively; medium platy, and fine structure of strong and moderate grades respectively (B horizon). Fine quartzite and mica primary minerals are present throughout the profile. Manganese and Iron cutans are present in B and c horizons.

Color(moist): **A- horizon** **B- horizon**	 Dark brown (7.5 YR 4/4) Dark brown (7.5 YR 3/4& 7.5YR 4/4)
Structure **A-horizon** **B-horizon**	 medium, moderate grade angular blocky; fine to medium, moderate grade, granular; medium to coarse, angular blocky and columnar structure exhibiting moderate and strong grades respectively; medium platy, and fine structure of strong and moderate grades respectively (presence of carbonates)
Consistency (dry, moist, wet) **A-horizon** **B-horizon**	 Slightly hard to hard when dry; friable when moist; slightly sticky and plastic when wet hard when dry; friable to firm when moist; sticky and slightly plastic to plastic when wet
Texture **A-horizon** **B-horizon**	 Sandy Clay Loam Gravelly Clay Loam to Loamy Sand
Diagnostic properties	Natric B horizon
Soil classification	***haplic Solonetz***

Table 4.3: Soil mapping unit description for Mapping Unit Y10, Kamba

Profile Pit	PP: Kamba 003 Katioko Loperot
Coordinates	855424, 292457 (UTM x,y coordinates WGS84)
Parent material	Alluvium from undifferentiated basement system rocks mainly gneisses
Physiography	Piedmont plain (nearly level to gently undulating)
Drainage	Moderately well drained
Vegetation/Land use	Natural shrub/pastoral shrubland with sparse vegetation of *Acacia tortilis, Acacia reficiens* and *Indigofera spp* dwarf shrub
Rock outcrops/surface stones	basaltic dyke (5% of surface), gravels and stones (5cm and >7.5 cm diameter respectively; 30% of surface)
Depth	Moderately deep
Soils general	The unit consists of moderately deep, dark brown, sandy loam to gravelly clay soils. They have an ABC sequence of horizons with clear boundaries that have a wavy to smooth topography. The soils are medium to coarse, columnar. Fine angular blocky structured exhibiting strong grades respectively; and fine granular structure of moderate grade (B horizon). Fine, common carbonate concretions are found in B-horizon (21-58 cm).
Color(moist): **A- horizon** **B- horizon**	 Dark brown (7.5 YR 4/4) Dark brown (7.5 YR 3/4)
Structure **A-horizon** **B-horizon**	 Medium to coarse--angular blocky, of strong grades and fine to medium granular of moderate grade; Medium to coarse, columnar and fine angular blocky structured, exhibiting strong grades respectively; and fine granular structure of moderate grade
Consistency (dry, moist, wet) **A-horizon** **B-horizon**	 Soft, when dry; very friable when moist; non- sticky and non- plastic when wet Slightly hard to hard when dry; firm when moist; sticky and plastic when wet

Texture **A-horizon** **B-horizon**	 Sand Sandy Loam to gravelly Clay
Diagnostic properties	Natric B horizon
Soil classification	***haplic Solonetz***

Table 4.4: Soil mapping unit description for Mapping Unit Ux7, Chorea

Profile Pit	Chorea 004 Chorea Loperat
Coordinates	826498, 248961 (UTM x,y coordinates WGS84)
Parent material	undifferentiated volcanic rocks mainly basalts
Physiography	The macro relief is gently undulating to undulating uplands
Drainage	Well drained
Vegetation/Landuse	Natural vegetation consisting of *Acacia reficiens, Balanities aegyptiaca* and *Aloe turkanensis*
Rock outcrops/surface stones	basaltic outcrops, gravels, stones and boulders (90% of surface)-rubble land
Depth	Very shallow
Soils general	The unit consists of very shallow, dark brown, gravelly sandy loam soils. They have an AC sequence of horizons with abrupt boundaries that have an irregular to broken topography. The soils are fine, granular structured with gravels and moderately strong grades (A horizon).
A-	
Structure **A-horizon**	The soils are fine, granular structured with gravels and moderately strong grades
Consistency (dry, moist, wet) **A-horizon**	Slightly hard to hard, when dry; firm when moist; slightly sticky and slightly plastic (limited by gravels) when wet
Texture **A-horizon**	gravelly Sandy Loam
Diagnostic properties	Depth and continuous hard rock/cemented layer
Soil classification	***lithic Leptosol***
Chorea alternative site 004A	
coordinates	N 02°15'12.9'', E035°55'53.4''
Texture	***Sandy loam***
Bulk density	***1.8 g/cm*** ^{3}
Depth	***55cm—moderately deep***

Table 4.5: Laboratory data for soils of mapping Unit PI1

Profile Pit: Mamba 001	Soil Analytical Data				
Horizon	A	Bw1	Bw2	Bw3	C
Soil depth cm	0-20	20-45	45-70	70-98	98-200+
Lab. No. /2010	4192	4193	4194	4195	4204
Soil pH-H_2O (1:2.5)	8.54	8.32	7.98	8.00	8.56
Elect. Cond. mS/cm	0.18	0.60	1.61	1.21	1.61
Carbon %	0.07	0.04	0.04	0.04	N/D*
Sand %	8	6	6	4	62
Silt %	66	50	50	36	26
Clay %	26	44	44	60	10
Texture Class	SL	SC	SC	C	SL
Cat. Exch. Cap. me%	21.0	22.8	22.0	22.7	23.0
Calcium me%	39.6	26.6	26.3	24.5	25.1
Magnesium me%	1.4	0.8	0.9	0.4	0.1
Potassium me%	0.76	0.22	0.40	0.22	0.04
Sodium me%	2.0	3.5	4.5	3.0	0.3
Sum me%	43.7	31.2	32.1	28.1	25.5
Base %	208	137	146	124	111
ESP	9	15	20	13	1

Key:
SL - Sandy Loam
SC - Sandy Clay
C - Clay

Table 4.6: Laboratory data for soils of mapping Unit D1+PI3

Profile pit: N. Kerio 002	Soil analytical data					
Horizon	A	AB	Bw1	Bw2	C1	C2
Soil depth cm	0-8	8-33	33-66	66-88	88-140	140-190+
Lab. No. /2010	4196	4197	4198	4199	4205	4206
Soil pH-H_2O (1:2.5)	7.94	7.68	8.19	8.94	8.91	10.2
Elect. Cond. mS/cm	2.30	19.4	13.7	11.2	7.62	9.09
Carbon %	0.16	0.21	0.06	0.07	N/D*	0.0
Sand %	62	38	64	80	48	0
Silt %	4	26	22	12	26	30
Clay %	34	36	14	8	26	70
Texture Class	SCL	CL	SL	LS	SCL	C
Cat. Exch. Cap. me%	25.6	24.4	23.4	20.8	23.3	22.2
Calcium me%	24.1	25.7	26.5	28.3	27.6	28.6
Magnesium me%	2.9	2.4	0.8	0.8	0.4	1.8
Potassium me%	1.3	0.5	0.5	1.0	0.9	1.8
Sodium me%	5.7	9.5	9.5	9.5	9.3	9.3
Sum me%	33.9	38.1	37.4	39.6	38.2	41.6
Base %	133	156	160	190	164	187
ESP	22	39	41	46	40	42

Key:
SL - Sandy Loam
SC - Sandy Clay
C – Clay

Table 4.7: Laboratory data for soils of mapping Unit Y10 and Ux7

Profile pit: Kamba-003	Soil analytical data					Profile Pit: Chorea-004A
Horizon	A	Bw1	Bw2	C1	C2	AC
Soil depth cm	0-12	12-28	28-51	51-64	64-93	0-18
Lab. No. /2010	4200	4201	4202	4203	4207	4208
Soil pH-H_2O (1:2.5)	8.48	8.04	8.06	8.18	8.44	8.69
Elect. Cond. mS/cm	1.40	2.9	1.30	0.30	0.12	4.56
Carbon %	0.07	0.04	0.01	0.11	0.01	0.02
Sand %	98	20	14	70	66	20
Silt %	2	62	38	14	16	56
Clay %	0	18	48	16	18	24
Texture Class	S	SL	C	SL	SL	SL
Cat. Exch. Cap. me%	29.8	29.8	29.2	29.8	29.8	28.2
Calcium me%	28.5	24.6	26.8	25.4	27.3	25.2
Magnesium me%	4.8	2.6	1.9	3.2	1.3	1.1
Potassium me%	0.4	0.4	0.3	0.5	0.6	0.7
Sodium me%	7.2	6.0	4.5	3.3	1.0	1.2
Sum me%	41.0	33.6	33.5	32.4	30.1	28.2
Base %	137	113	115	109	101	100
ESP	24	20	15	11	3	4

Key:
SL - Sandy Loam
SC - Sandy Clay
C – Clay

Table 4.8: Chorea 4A alternative site texture and bulk density of surface soil

Sample Description	Depth (cm)	Lab. No. /10	% Sand	% Silt	% Clay	Texture Grade	Bulk Density g cm^{-3}
	0-18	4212	80	6	14	SL	1.8

KEY: SL …….. Sandy Loam

4.3.2 (a) Mapping unit PI1 (Mamba-001)

From the measurements, the basic infiltration rate for the lacustrine plains soils (Mapping unit PI1) is 0.35 cm/hr which is categorized as slow (table 4.9).

Plate 4.12: Mamba exploratory well drill site (Mapping unit PI1). Hammering the infiltration rings in place and (b) dry run testing of the equipment, both rings have water.

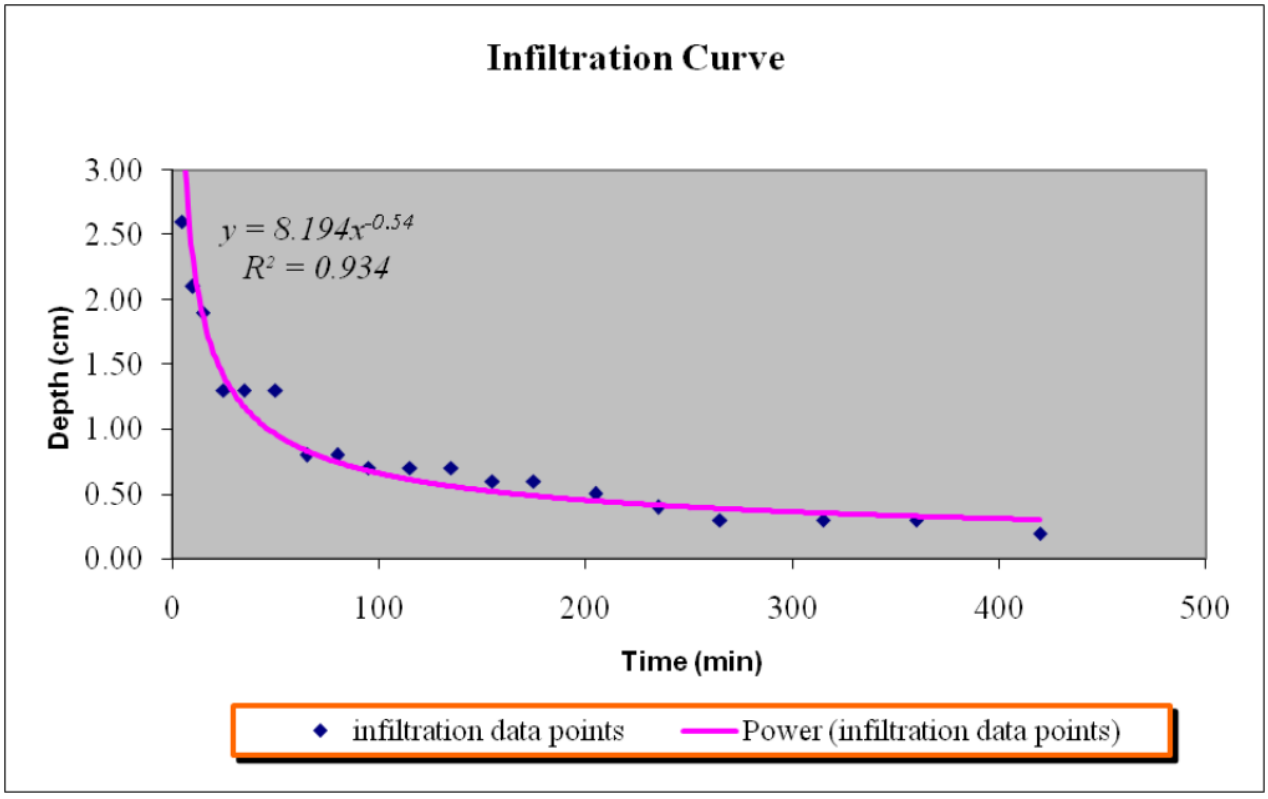


Figure 4.4: Graph showing the saturated basic infiltration rate (cm/min) of Mamba exploratory well drill site (Mapping unit PI1). The stable state is realized after 5 hours

Table 4.9: Basic infiltration rate measurements for mapping unit PI1

Time (min)	height (cm)	h'/ t' (cm/min)	H1'/t1' (cm/hr)
5	2.60		
10	2.10	0.1	6.00
15	1.90	0.07	4.20
25	1.30	0.065	3.90
35	1.30	0.043333	2.60
50	1.30	0.028889	1.73
65	0.80	0.03	1.80
80	0.80	0.024	1.44
95	0.70	0.021111	1.27
115	0.70	0.017273	1.04
135	0.70	0.014615	0.88
155	0.60	0.013333	0.80
175	0.60	0.011765	0.71
205	0.50	0.0105	0.63
235	0.40	0.009565	0.57
265	0.30	0.008846	0.53
315	0.30	0.007419	0.45
360	0.30	0.006479	0.39
420	0.20	0.005783	0.35

h'= change in height(cm)
T'= change in time (min)
Basic infiltration rate =h'/t'(cm/hr)

The soils of the lacustrine plains have a compact B-horizon typical of solonetz. The infiltration rate at the surface soil was rapid due to the soil texture (Sandy Loam) with well distributed grain sizes and the friable angular blocky soil structure with many macro and meso pores (Table 4.1). The B-horizon has a columnar structure and is compact with a sandy clay to clay texture (Table 4.1). The infiltration rate is drastically slowed and reaches a constant value of 0.35 cm/hr at six hours (Figure 4.5). This unit experiences seasonal flooding and compaction due to animal grazing, predominantly goats which feed on the sparse *Acacia tortilis* and *Indigofera* dwarf shrubs. The compaction accelerates soil structure degradation. The unit is slightly saline and moderately sodic (Table 4.5) affecting negatively soil structure stability.

The unit is therefore unsuitable for surface water discharge/drainage and protection measures are therefore required to guard against soil and groundwater pollution.

4.3.2 (b) Mapping unit Y10 (Kamba-003)

From the measurements, the basic infiltration rate for the piedmont plains soils (Mapping unit Y10) is 0.17 cm/hr which is categorized as slow (table 4.9).

Plate 4.13: (a) Kamba exploratory well drill site (Mapping unit Y10). Preparing surface for core ring samples (red arrow) and infiltration equipment and water jerry cans (yellow arrow) and (b) pre-wetting core sample soil horizon for eventual sampling.

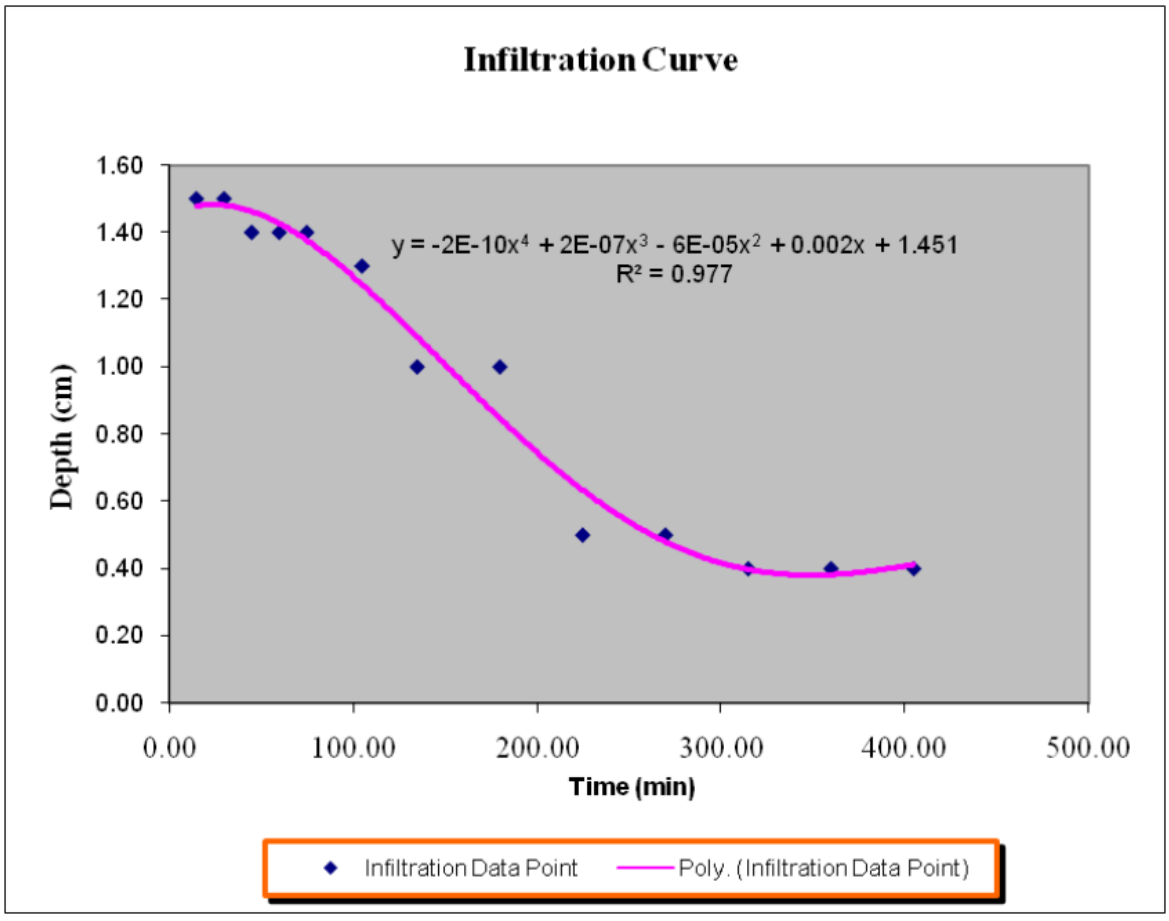


Figure 4.5: Graph showing the saturated basic infiltration rate (cm/min) of Kamba exploratory well drill site (Mapping unit Y10). The stable state is realized after 6 hours

Table 4.10: Basic infiltration rate measurements for mapping unit Y10

Time (min)	height (cm)	h'/ t' (cm/min)	H1'/t1' (cm/hr)
15.00	1.50	0	0
30.00	1.50	0	0
45.00	1.40	0.003333	0.20
60.00	1.40	0.002222	0.13
75.00	1.40	0.001667	0.10
105.00	1.30	0.002222	0.13
135.00	1.00	0.004167	0.25
180.00	1.00	0.00303	0.18
225.00	0.50	0.004762	0.29
270.00	0.50	0.003922	0.24
315.00	0.40	0.003667	0.22
360.00	0.40	0.003188	0.19
405.00	0.40	0.002821	0.17

h'= change in height

t'= change in time

Basic infiltration rate =h'/t'

The soils of the piedmont plains are moderately deep with a thin surface layer. There is moderate surface sealing that slows initial surface water percolation during the infiltration test. When this is broken water infiltrates rapidly. The B-horizon has sandy loam to clay textured soils with fine particle matrix and a firm columnar structure (Table 4.3). Drainage pores are thus reduced and therefore slowing the infiltration rate significantly reaching a constant value of 0.17 cm/hr at six and a half hours (Figure 4.6). This unit experiences moderate seasonal flooding and compaction due to animal grazing, predominantly goats and camels which feed on the *Acacia tortilis A. reficiens* and *Indigofera* dwarf shrubs (plate 9). The surface compaction caused by trampling accelerates soil structure degradation. Further, the unit has a compact B-horizon and is moderately saline and strongly sodic (table 4.7) affecting negatively soil structure stability.

The unit is therefore unsuitable for surface water discharge/drainage and protection measures are therefore required to guard against soil and groundwater pollution.

4.3.2 (c) Mapping unit D1+PI3 (N. Kerio -002)

The basic infiltration rate for the complex of lacustrine and a dunes soil (Mapping unit D1+PI3) is 0.30 cm/hr which is categorized as slow (table 4.9).

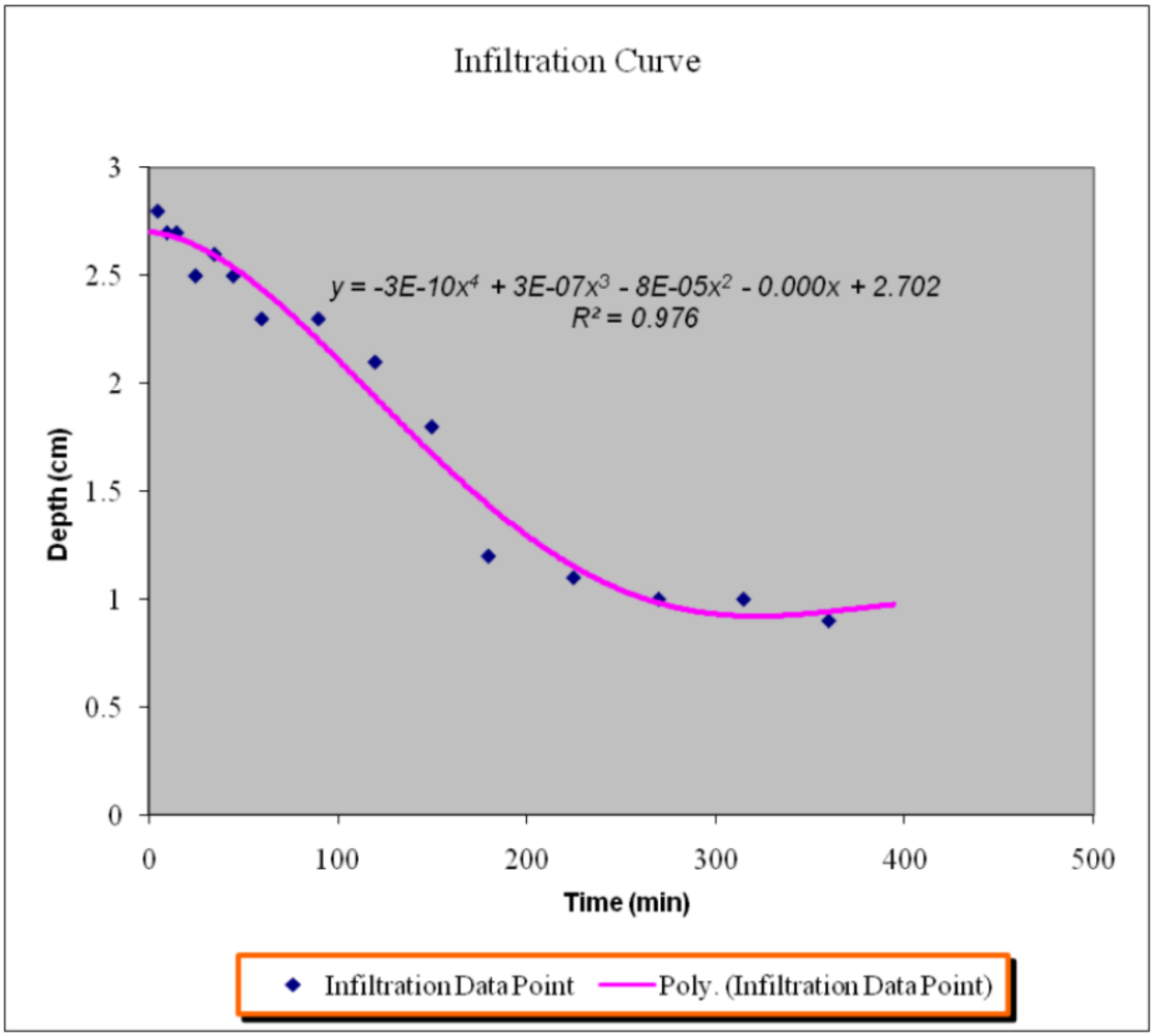


Figure 4.6: Graph showing the saturated basic infiltration rate (cm/min) of north Kerio-002 exploratory well drill site (Mapping unit D1+PI3). The stable state is realized after six and a half hours

Table 4.11: Basic infiltration rate measurements for Mapping unit D1+PI3

Time	Height	h'/t' (cm/min)	h'1/t'1 (cm/hr)
0	2.8	0	0
5	2.8	0	0
10	2.7	0.02	1.20
15	2.7	0.01	0.60
25	2.5	0.015	0.90
35	2.6	0.006667	0.40
45	2.5	0.0075	0.45
60	2.3	0.009091	0.55
90	2.3	0.005882	0.35
120	2.1	0.006087	0.37

150	1.8	0.006897	0.41
180	1.2	0.009143	0.55
225	1.1	0.007727	0.46
270	1	0.006792	0.41
315	1	0.005806	0.35
360	0.9	0.005352	0.32
405	0.8	0.005	0.30

The soils of the association of lacustrine plains and dunes are deep and stratified with a thin crusted surface layer. There is a weak surface sealing that slows initial surface water percolation during the infiltration test. This is, however, countered by the presence of surface calcium salts that flocculate the clay particles therefore improving surface soil structure. The infiltration rate starts slowly then increases after a short time when the surface crust is broken, becoming rapid till the B horizon is reached. The B horizon is a compact layer with prismatic and platy soil structure that impedes water flow due to the poor pore matrix distribution (plate 6, table 4.2.). The compact and stratified horizons texture varies from clay loam to loamy sand. The fine particle fraction of the soil matrix further impedes percolation. At this stage, vertical water movement is slowed until stability is realized at 6 hours at a value of 0.3 cm/hr. The basic infiltration rate compares well with Mamba site [0.35 cm/hr (Mapping unit PI1)] with a similar soil classification (Figure 4.3, Table 4.2). This unit experiences seasonal flooding and ponding. The subsoil was moist at the time of field study shortly after the rains. The unit is excessively saline and sodic making it very fragile.

The unit is therefore unsuitable for surface water discharge/drainage and protection measures are therefore required to guard against soil and groundwater pollution.

4.3.3 Fertility status of the study area

The following is a summary of the soil fertility status of mapping units (PI1, D1+PI3, Y10 and Ux7) which form the study area

4.3.3 (a) Soil Mapping PI3 (mamba-001)

The soils of the lacustrine plains have a near neutral pH (6.96) and are low in nitrogen and organic carbon. Soil phosphorous is high in supply while potassium, calcium and magnesium are adequately supplied in the soil. The micronutrients manganese, iron and sodium are in adequate supply save for copper and zinc which are low in supply (table 5.3).

4.3.3 (b) Soil Mapping D1+PI3 (North Kerio-002)

The soils of the lacustrine plains and dunes complex have a slight alkaline pH (7.43) and are low in nitrogen and organic carbon. Soil phosphorous and potassium are in adequate supply while calcium and magnesium are in high. The micronutrients manganese, copper, iron and zinc are in adequate supply while sodium is in high supply (table 5.3).

4.3.3 (c) Soil Mapping Y10 (Kamba-003)

The soils of the piedmont plains have a medium alkaline pH (8.01) and are low in nitrogen and organic carbon. Soil phosphorous and potassium are in low supply while calcium and

magnesium are in high supply. All the micronutrients save for sodium (high in supply) are in low supply (table 5.3).

4.3.3 (d) Soil Mapping Ux7 (Chorea-004A)

The soils of the uplands have a medium alkaline pH (8.07) and are low in nitrogen and organic carbon. Soil phosphorous and potassium are in low supply while calcium and magnesium are in high supply. All the micronutrients are in adequate supply save for zinc which is low in the soil (table 5.3).

Table 4.12: Soil Fertility Status for the study sites

	Soil Analytical Data							
Field	**Mamba-001**		**Kerio-002**		**Kamba-003**		**Chorea-004A**	
Sample designation	**0006F**		**012F**		**015F**		**17**	
Lab. No/2010	4209		4210		4211		4212	
Soil depth cm	0-20		0-20		0-20		0-20	
Fertility results	value	Class	value	class	value	class	value	class
Soil pH	6.96	near neutral	7.43	slight alkaline	8.01	medium alkaline	8.07	medium alkaline
Total Nitrogen %	0.01	Low	0.01	low	0.07	low	0.01	low
Org. Carbon %	0.05	Low	0.05	low	0.56	low	0.06	low
Phosphorus ppm	234	High	10.2	adequate	0.4	low	1.0	low
Potassium me%	0.37	Adequate	0.47	adequate	0.10	low	0.22	low
Calcium me%	13.1	Adequate	69.9	high	37.8	high	69.7	high
Magnesium me%	2.38	Adequate	6.03	high	4.00	high	5.37	high
Manganese me%	0.41	Adequate	0.78	adequate	0.02	low	0.26	adequate
Copper ppm	0.25	Low	2.03	adequate	0.21	low	4.27	adequate
Iron ppm	32.7	Adequate	60.5	adequate	0.43	low	15.0	adequate
Zinc ppm	1.87	Low	7.17	adequate	0.98	low	1.80	low
Sodium me%	1.65	Adequate	9.80	high	4.98	high	1.19	adequate
Elect. Cond. mS/cm			3.50	high	3.35	high	0.25	adequate

4.4 Climate

The area is classified as semi arid and arid land (ASAL) and is characterized by harsh climatic conditions for most of the year. Temperatures range between 29°C and 41°C, depending on the time of the year (Sombroek *et al* 1982). The area is hot and dry for most part of the year and this explains why the vegetation cover is relatively low. Wind speeds range from 22-28 m/s measured at 50m height. Though low compared to Lodwar with 44-48 m/s wind speeds, the wind in the study area causes windblown erosion especially around Nakaalei where there are sand dunes.

The agro-climatic zones in Kenya have been subdivided into seven parts ranging from humid (ACZ I) to very arid (ACZ-VII), based on annual temperature, rainfall and evaporation (Sombroek et al., 1982). Accordingly, the agro-climatic zone classification boundaries are based on moisture availability zones, a ratio based on average annual rainfall and average annual potential evaporation (r/E_0). Since temperature is also considered, the ACZ's are further given a temperature classification based on altitude and mean annual temperature. Thus, ACZ VII (moisture- based classification) is further classified as ACZ VII-1; the last digit classifies the temperature. In this case, meaning, fairly hot to very hot (mean annual temperature range--24 °C-30 °C, and an altitude of 0-900 m). Most of the study area is in Agro-climatic zone VII (ACZ V11-1) and a small unit in Agro-climatic zone VI, [(ACZ VI-2) around Loriu plateau Figure 3.3].

These classify as very arid (rainfall of 150 to 300 mm per year) and arid (rainfall of 300 to 550 mm per year) respectively. ACZ V11 covers the area from Lodwar and most of the study area and only varies at the southwestern and southeastern parts which are in ACZ V1-2 towards the eastern and western parts of Kangetet division and around Katilia area. The rest of the area is in ACZ VII comprising of Loperot, Kachodin, Kerio, Loiyangalani locations and Loriu plateau within the study area.

Rainfall is unreliable and famine is a constant threat. Flash floods are common during the rains and with the inherent sparse vegetation cover in the area, this leads to degradation of the soil.

4.5 Air Quality

The air quality is good as the area is rural, sparsely populated, generally undeveloped and far removed from major towns, cities, agricultural and industrial centers that are major contributors to air pollution. There is some natural pollution related to windblown dust as the sometimes strong easterly winds blow across the sparsely vegetated surface. Minimal and transient air pollution is also as a result exhaust fumes and dust released by of the few vehicles traversing the survey area, and dust raised by herds of grazing animals.

Plate 4.14: Whirl wind blowing in Chorea site (Red arrow). These dust storms affect the Quality of air and contribute to erosion in the area.

4.6 Surface and Groundwater Resources and Quality

4.6.1 Surface water

Lake Turkana is the main surface water body in the area and is replenished largely by the Omo River from the North. The second largest river, Turkwel River, is now being dammed for hydroelectric power generation at Turkwel Gorge 150 km west of the lake. The other large but seasonal river is Kerio. The waters of these rivers are, however, murky due to high content of silt/alluvial clays and therefore not likely suitable for domestic and/or industrial uses. Other surface waters are mostly ephemeral streams that flow only during and shortly after the rains. The flows are often torrential and flooding outside the shallow stream/river channels is a

common phenomenon. Water pans and earth dams are significantly absent in the study area. Most of the inhabitants of the area get their water from shallow, hand dug wells within the luggas, while those living next to Lake Turkana may also use its waters for domestic and livestock use. Also noted in the study area is a bottomland within an upland landform, at Lokwamising, with a high water table yielding water through spring outlets. This area is used as a grazing ground by the local community and the water is used for human and livestock consumption.

4.6.2 Groundwater

Groundwater resources form the most available source of water supply in the study area is exploited through boreholes and shallow wells excavated in luggas. The water is often clear but some recently dug wells have yielded somewhat murky water. The water is used both for domestic and livestock consumption. Some boreholes have, however, dried up due to lack of recharge which has contributed to fluctuating levels of the water table (e.g. boreholes at Kanga'kipur area-- Kerio river basin, Lomunyenkuprat and at Napusimoru area) whereas others have slightly saline water. Even though the mean rainfall is less than 550 mm per annum, a combination of alluvial and/or fractured volcanic aquifers ensures that the overall potential for groundwater development in the investigated area is considered to be reasonable. However, the hydrogeological conditions are variable, and strongly linked to the physiography and secondary features.

Turkana south is dominated by vast plains and towering volcanic capped hills and the lava sheets are anticipated to continue underneath the alluvial deposits of the plains. Basalts, in particular, have a tendency to be very massive. This can be an unfavorable attribute for groundwater storage, considering that older lava flows (such as the basalts and phonolites of Turkana south rarely posses significant primary pore space. Instead, groundwater is mostly stored in secondary features, such as fissure zones, fractures, cooling and shrinkage joints, lithological contacts and Old Land Surfaces (OLS). In strongly stratified or fractured lavas, substantial yields can be obtained from relatively thin but highly permeable, water bearing layers. Often, the thickness of these individual aquifers is limited to a few metres. Individual aquifers formed within OLS, pyroclastic layers and contact zones generally produce in the range of 1 to 2 m^3/hr. This means that several consecutive water strikes are generally required to obtain a reasonably high discharge. Yields in excess of 5 m^3/hr can be achieved from boreholes located in "open" faults and fissure zones. Although faults and fractures are often associated with water bearing zones, it should be noted that they might also form barriers to groundwater flow especially when filled with clays (Mulwa, 2001; Mulwa et al, 2005). Evidence from borehole logs confirm that most groundwater resource in this area is tapped from fractured aquifers developed within the basalts.

Within the plains, direct recharge from rainfall is estimated to be low (0-3%), due to a combination of irregular, erratic and unreliable rainfall and a generally clayey underground. However, a fairly high portion of rainfall (5-10%, or ≅30-60 mm/year) is expected to infiltrate into the fractured basalts and phonolites of the higher grounds. Groundwater drainage from the hills is responsible for replenishment of the adjacent aquifers on the plains and as well as lowlands. Indirect recharge from seasonal streams and rivers is difficult to quantify. However, it can be assumed that the effective precipitation (i.e. the portion of rainfall that is drained as streamflow) over the hills and the intra-montane plains is probably close to 20%. Most of the surface water disappears before the streams reach their ultimate destinations, i.e. Lake Turkana. Even if only

15% of the streamflow were lost through the river bed, this would still be equivalent to 3% (or approximately 10-17 mm/year) of the total rainfall. While this may not seem much, it must be noted that recharge from streamflow concentrates the effective precipitation of a large area into a relatively narrow zone bordering the main drainage channels.

4.6.3 Water Quality

Water sampling was carried out from selected locations in the study area for the purpose of water quality analysis. The quality analysis results of surface water show that the water is slightly acidic to slightly alkaline (6.75-9.02) and turbidity of the water is highly variable ranging from low to high turbidity (15 – 307 N.T.U). The water is often colored (40-255 mgPt/l) and has high content of iron (2.23-5.7 mg/l) and magnesium (6.8-37.9 mg/l), and low to high fluoride content (0.68-3.5 mg/l). Such water may require treatment before it can be used for domestic purposes. The other chemical characteristics are, however, satisfactory.

The physical and chemical properties of groundwater from the operational boreholes in Turkana south district can be summarized as below:

Parameter	Attributes
Color	clear (<5 mgPt/l); however, groundwater from Luaga shallow well is colored (75 mgPt/l)
Total Dissolved Solids (TDS)	ranges from 305.7 to 4787 mg/l
Taste	Good
Turbidity	ranges from 0 to 865 N.T.U
Odor	None
Hardness	moderate to very low but highly variable depending on aquifer formation
Iron	ranges from 0.017 to 2.62 mg/l
Magnesium	ranges from 6.82 to 51.99 mg/l
Fluoride	ranges from 0.19 to 7.6 mg/l
Manganese	ranges from < 0.01 to 16 mg/l
pH	slightly acidic to slightly alkaline (6.68 to 8.67)

.

Based on the above physical and chemical properties, the groundwater in the study area is highly variable; some is good for domestic, agricultural and industrial purposes, whereas some is not suitable for these purposes. Groundwater having relatively high content of fluoride, iron, magnesium and manganese will require treatment before it can be used for domestic and/or other purposes.

Table 4.13: Groundwater quality.

PARAMETERS											
Lab Sample Nos.	**1749**	**1750**	**1751**	**1752**	**1753**	**1754**	**1755**	**1756**	**1757**	**1758**	**WHO limits**
Field Sample Nos.	**B/H TC001**	**B/H TC004**	**B/H TC005**	**B/H TC006**	**Lugga S/Well TC007**	**Lokwamsing Bottomland TC010**	**Kangatet-Morlem TC011**	**Katilia B/H TC012**	**Kangirisae TC015**	**Napusimoru B/H TC018**	
pH	8.67	6.78	6.68	7.44	7.38	9.02	6.75	8.1	7.45	7.98	6.5-8.5
Color (mgPt/l)	< 5	< 5	< 5	<5	7 5	40	255	< 5	100	< 5	15
Turbidity (NTU)	2	2	Nil	1	865	15	307	10	205	80	5
PV (mgO_2/l)	1.19	,<0.4	1.98	1.19	14.6	8.27	6.72	4.38	<0.4	4.38	
Conductivity (25°C) (□S/l)	1458	493	771	1657	837	1474	231	605	326	4090	
Fe (mg/l)	0.08	0.02	0.017	0.05	2.62	2.23	5.7	1.1	3.24	1.1	

Mn (mg/l)	< 0.01	0.06	< 0.01	<0.01	16	0.14	0.4	0.2	0.12	0.01	
Ca (mg/l)	10.4	35.2	14.4	14.4	91.2	17.6	25.6	20.8	28.8	5.6	
Mg (mg/l)	51.99	26.3	28.2	28.2	30.2	37.9	6.8	6.82	10.22	18.5	
Na (mg/l)	222	21.6	310	310	42.8	246	10.5	102	22.1	900	200
K (mg/l)	2.2	1.6	1	1	1	0.2	0.3	0.2	0.4	0.2	
Total Hardness ($mgCaCO_3/l$)	240	196	152	152	352	200	92	80	114	90	500
Total Alkalinity ($mgCaCO_3/l$)	560	230	5162	5162	412	658	106	210	146	214	
Cl (mg/l)	85	4	97	97	3	30	4	40	6	1165	250
F (mg/l)	3	0.45	0.9	0.9	0.19	3.5	0.68	2.5	0.8	7.6	1.5
Nitrate (mg/l)	6.4	1.3	14	14	0.64	0.7	0.56	1.205	1.8	3.2	10
Nitrite (mg/l)	0.032-0.02		0.01	0.01	0.113	0.041	0.106	0.113	0.214	0.061	
Sulphate (mg/l)	8	5.14	117	117	<0.3	24.3	<0.3	25.4	<0.3	130	400
Free Carbon Dioxide (mg/l)	10	10	16	16	68	Nil	6	6	8	Nil	

Sourced from previous EIA Study of block 10BB

4.7 Terrestrial Environment

4.7.1 Habitat types and associated flora species

The ecosystems in Turkana are unique in terms of environmental characteristics with the ecosystem being influenced by the following physical factors: climate at regional as well as continental scales; by topographic effects on rainfall and landscape water redistribution, geomorphic effects on soil and plant available water at the landscape to regional scales; and by water redistribution and disturbance at local and patch scales (Coughenour and Ellis, 1993).

The study area is an ASAL region with heterogeneous and highly variable habitat conditions that are influenced by prevailing soil units and water availability.

Floral composition Mamba Area

The Mamba well site is located on a high level structural plain with partially stabilized dunes that support the scattered vegetation. The locals refer to the area as *Kanyuda* which means dunes. The partly sodic and saline character of the soils does not support a lot of vegetation. The southern part of the study area was characterized by a near barren landscape with scattered *Acacia tortilis* of less than 15% present at the fringes and annual grasses (*Aristida*), *Senna spp* and a wild member of the cucumber family *Citrullus colocynthis* growing along waterways, rills and dunes. Other vegetal species found in the area include *Indigofera spp*, *Cadaba farinosa*, *Acacia mellifera, Indigofera spp.* and *Boscia spp* . The northern section of the study site comprises of up to 40% scattered bush.

Plate 4.15: (a) scattered Acacia tortilis shrubland(b) wild cucumber Citrullus colocynthis growing next to a dune (Red arrow).(c) shows sand dunes (blue arrows) and annual grasses (Green arrow) growing in the background.

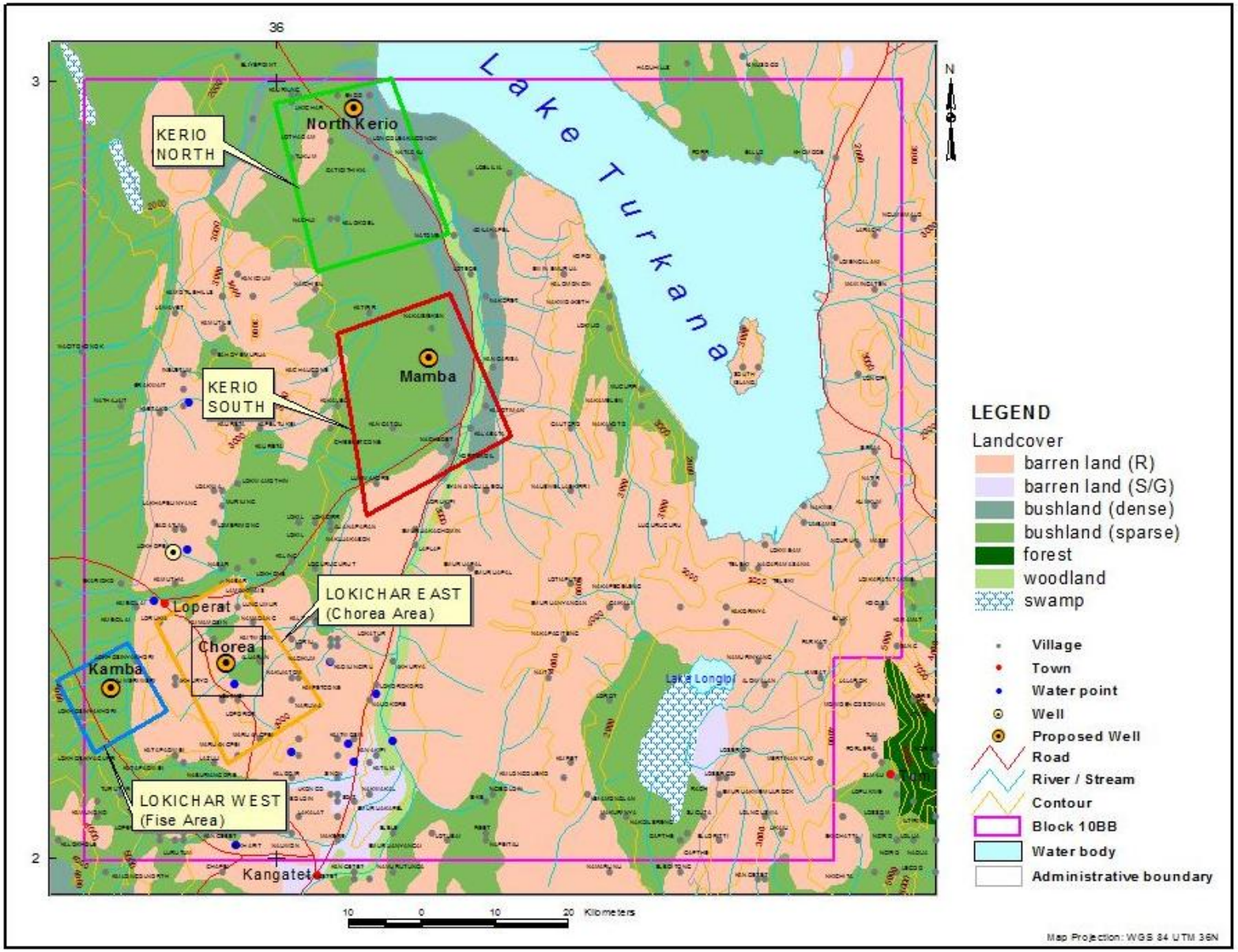


Figure 4.7: Vegetation of the study area

North Kerio area floral composition

The North Kerio site is found on a sedimentary plain characterized by poorly drained, sodic and highly saline soils which support only the salt tolerant shrub *Suaeda monoica* which dominates the landscape covering up to 60% of the immediate area.

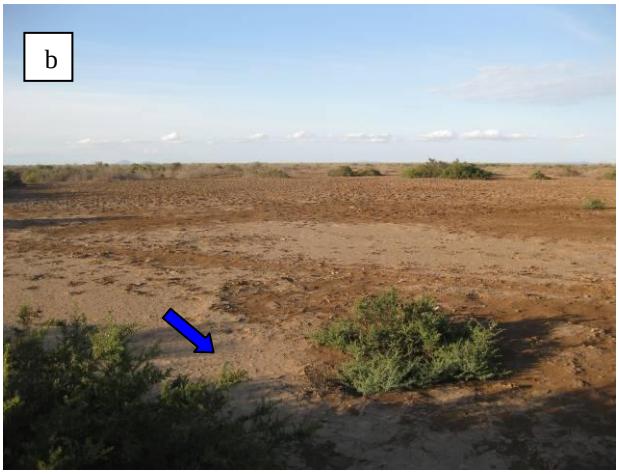


Plate 4.16: (a) Suaeda monoica growing in a crevice, the shrub plays an important role in stabilizing the landscape. (b) Note the surface salinity of the soil where Suaeda monoica is growing (Blue arrows). (c) Plate showing general vegetation of the immediate area. Note some of the leaves of the deciduous *Suaeda monoica* have been shed (Green arrow)

Kamba area floral composition

The vegetation of the area is influenced by the *Auwerwer* plateaus. Shrubs found in the area are generally of less than 3metres in height dominated by *Acacia reficiens* with scattered *Acacia tortilis* trees up to 6 metres in height. Also present are *Indigofera spp* dwarf shrubs.

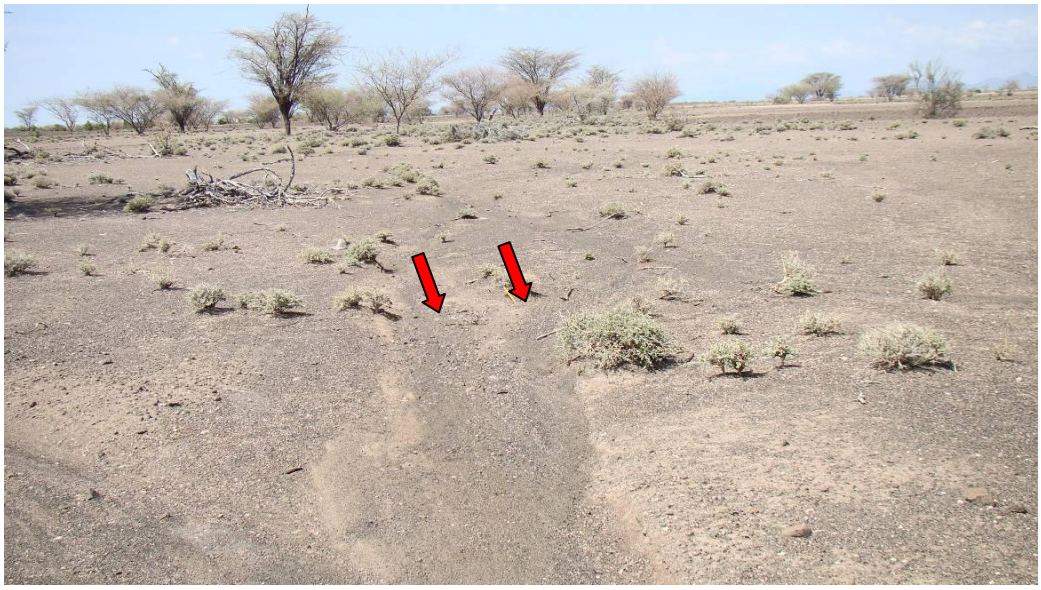
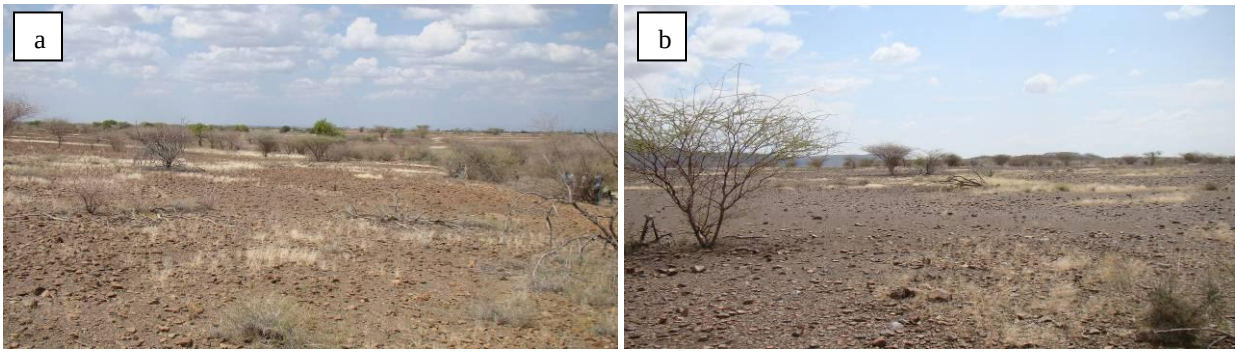


Plate 4.17: Background showing the general vegetation of Kamba area, it was characterized by scattered Acacia tortilis bushes, and Indigofera dwarf shrubs along the waterways. Note the waterway in the foreground. (Red arrows)

Chorea area floral composition

The landscape is characterized by surface rockiness atop an upland plateau; vegetation found in the area is scattered shrub land with the dominant species being *Acacia reficiens*, *Acacia tortilis*, *Cadaba farinosa* covering up to 20% of the immediate area, *Indigofera spp* dwarf shrubs and annual *Aristida spp* grasses. Most of the shrubs were greater than 3 metres but less than 6 metres in height.



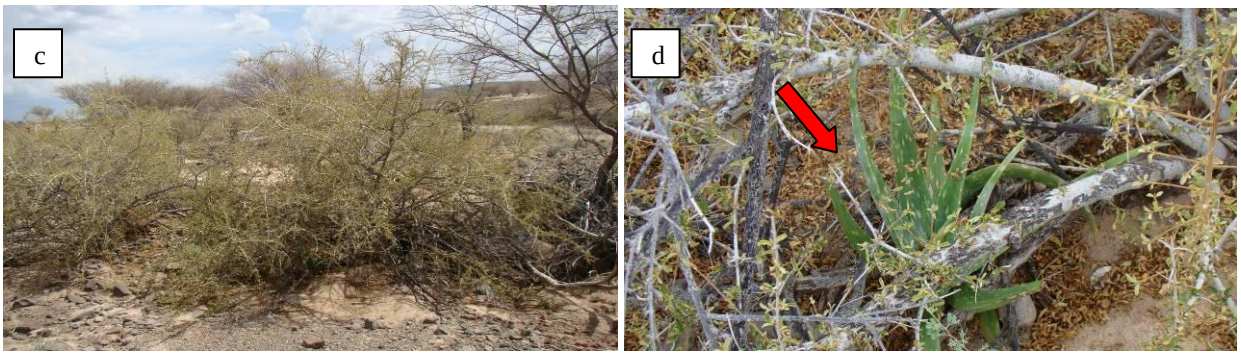


Plate 4.18: General vegetation in Chorea area, Note the wild Aloe growing in between a bush (Red arrow).

4.7.2 Faunal Species

Fauna includes a variety of mammals species such the dikdiks, hares, ground squirrels and jackals, various species of arthropods (spiders, ticks, scorpions, ants, butterflies, wasps and beetles), reptiles (snakes, skinks and other lizards), and birds such as the Buffalo weaver, Fork-tailed drongo, Namaqua dove, Brown-necked crow, Eastern pale chanting goshawk, White bellied go away bird and Carmine Bee-eater.

Plate 4.19: Various faunal species found within the study site

4.8 Aquatic Environment

The major aquatic ecosystems within the block are the Lake Turkana, River Kerio, and River Turkwel and associated ephemeral streams (luggas). The area is of great global significance for both terrestrial and aquatic conservation, harboring a wide variety of unique plants, mammals, birds, reptiles, amphibians and arthropods species.

Common plant species in this ecosystem include emergent macrophytes such as the grasses *Paspalidium germinatum* and *Sporobolus spicatus* which cover the seasonally exposed shallows and provide important nurseries for fish (Hughes & Hughes 1992), and Pondweed (*Potamogeton spp)* found in the shallow bays of Lake Turkana (Hughes & Hughes 1992). The watercourses of Rivers Kerio, Turkwel and their lugga systems are characterized by riverine forests with the dominant species being *Acacia tortilis, Balanites aegyptiaca, Salvadora persica, and Hyphaene coriacea. Calotropis procera* and *Prosopis juliflora* are common in disturbed areas.

Mammals in the area include olive baboon, wild dog, striped hyena, caracal, warthog hippopotamus Grant's gazelle, reticulated giraffe, Beisa oryx, hartebeest, topi, dikdik, and gerenuk. Also present in the area are lion and cheetah which have both been classified as vulnerable by IUCN whilst the plains and Grevy's zebras have been classified as endangered. Reptilian species include Nile crocodile, puff-adder, cobra and saw-scaled viper. 47 fish species, seven being endemic, live in Lake Turkana (Fitzgerald 1981; KWS 2001). At least 350 species of aquatic and terrestrial birds are known to occur in the Turkana area with Lake Turkana serving as an important breeding habitat and stopover for migrant birds (Bennun & Njoroge, 2001).

4.8.1 Aquatic flora

The vegetation followed the river floodplains, with *Salvadora persica* and *Maerua crassifolia,* both evergreen shrubs, marking the extent of the floodplains boundary. Other species found were *Acacia tortilis, Ziziphus mucronata, Balanites aegyptiaca,* and *Hyphaene compressa. Calotropis procera* was frequently encountered in disturbed areas prone to seasonal flooding. The species was an indicator of a high water table and probably alkaline substrate conditions.

4.8.2 Aquatic Fauna

Fauna species found within the confines of the aquatic ecosystems included: various birds' species such as sacred ibises, black headed plover, and hammerkop; insects as such the dragon flies; fish species e.g. catfish, and herpetiles such as frogs and geckos. Littoral species found in the aquatic environments include various orders of crustaceans.

4.9 Visual Aesthetics

The area has a pristine and rugged scenic beauty with hills, extensive plains, and several sand rivers (luggas). The varying landscape relaxes the eye and spots of interest manifests themselves as surface stones and various rocks of varied colors in uplands, that yield to gentle sandy plains and to hill masses. Intensely dissected piedmonts are followed by flood plains and sand dunes before changing once again into uplands. Presence of abundant birdlife and scanty wildlife augment the aesthetics of the environment.

4.10 Noise and Vibrations

Ambient noise in the project area is of low level as it is in a rural setting where there are neither industries nor significant traffic.

4.11 Offensive Odors

No offensive odors were detected other than the areas surrounding the settlements, and more specifically, locally associated with pit latrines used by the local communities.

4.12 Land Resources and Natural Heritage Sites

The project area has varied land resources ranging from vast tracts of land with sparse vegetation to water resources of River Turkwel and Lake Turkana. Vegetation that include acacia trees species are useful browse and pasture area for livestock. The river and the lake are, however, a considerable distant away from the project site and its resources may not be accessible to the residents. Residents in the area are largely pastoralists and the main livestock types are cattle, goats, donkey and sheep. Pastoralism is the main land use in the project area, thus pasture and browse is a key land resource. There are pockets of gypsum deposits especially at Napusimoru area though mining has not been fully commercialized.

4.13 Archaeological, Historical and Cultural Sites

There are no significant cultural, historical, archaeological or protected resources or areas on or near the project site. Individual villages, clans and households have their own revered areas such as *Laibon* burial sites and/ or public meeting areas. The burial sites can be identified as they are marked by stacking stones on the grave.

4.14 Effluents, Solid Wastes and Waste Oils

There is no significant solid waste or waste oil in the project area. There are minimal activities concentrated in shopping centers within the project area that can generate solid waste or oil waste at present. There are no adequate provisions for solid waste management and no sewerage system for effluent management. Plastic bags waste litter the villages as there are no designated dumping sites in the area. Liquid effluent is managed through latrines which, are not only few but also inadequate.

4.15 Social Characteristics

Demography

The proposed project site is a sparsely populated area. The proposed exploratory well sites are found are in Kalapata location, Lokichar Division in Turkana South District, which has an estimated population of 148,528 people according to Central Bureau of Statistics projections. The other proposed site is found within Turkana Central District within the sparsely populated Kerio Division. The district has an estimated population of 167,445 people with a growth rate of 3.3% per annum. Central Division that consists of Lodwar town has the highest density of 11.9 persons per square kilometer.

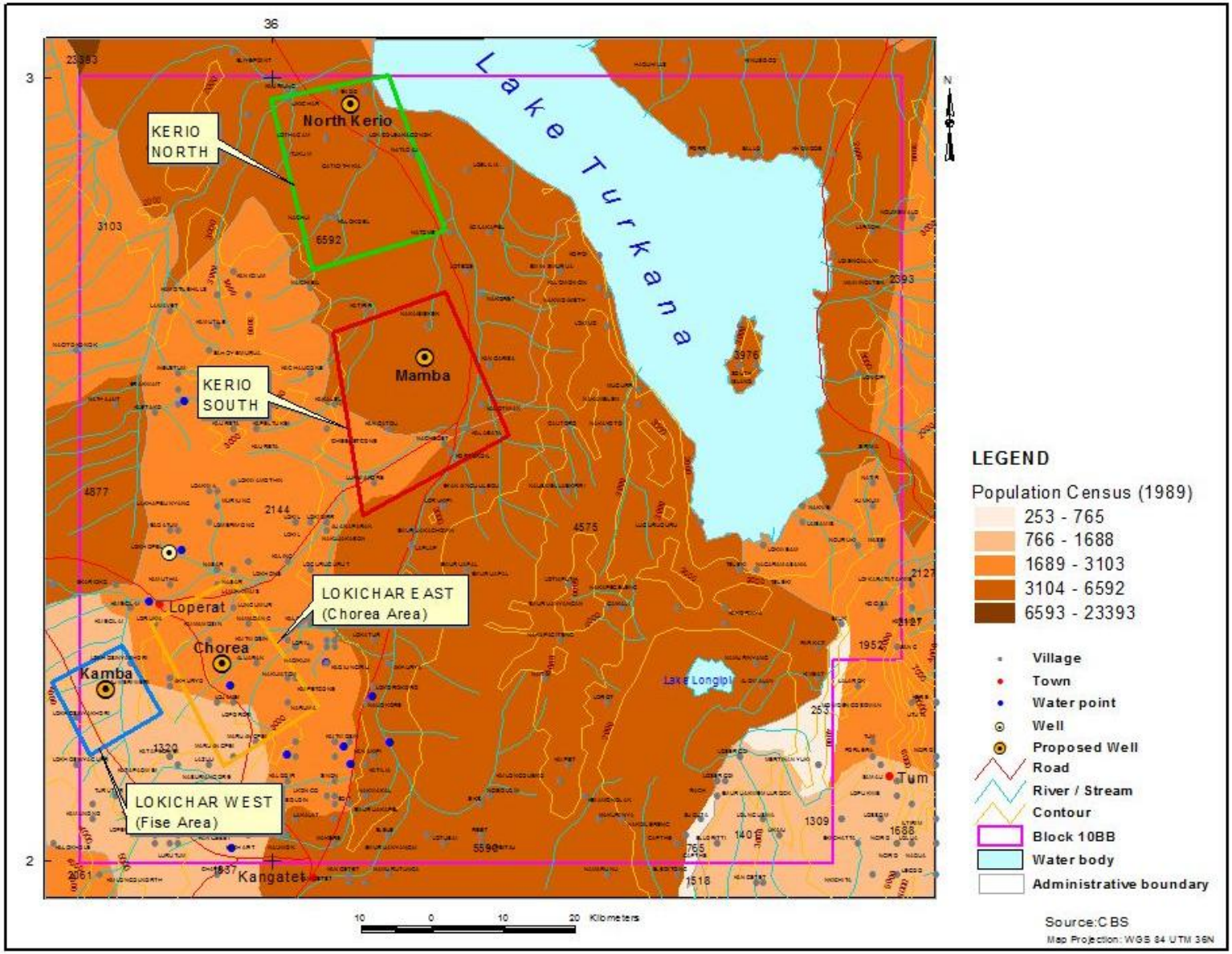


Figure 4.8: Population map of the study area

Education

There are six primary schools in Kerio division and one newly constructed CDF funded secondary school located at Kerio shopping centre, which is also the headquarter of the division. Other secondary schools are found in Lokichar and Lodwar towns. The transition rate from primary to secondary school is still low in comparison to other parts of the country. Some of the issues affecting the education sector in the area include:

- Early marriages especially among girls
- Acute famine leading to food insecurity and as a result low school turn out.
- Pastoralist lifestyle affects school going children through frequent family movement. In the same vein, some pupils drop out of school to herd family livestock.
- Poverty level in the area are high and may be contributing to the low transition level from primary to secondary school level
- Inadequate teachers and other teaching aid

Housing

Housing in the project area varies from semi permanent to temporary structures. Human settlements are concentrated within administrative centers where essential social services like provision of potable water, schools and dispensaries are available. Watering points for livestock is also a major determinant for siting of human settlement. In addition, there are temporary houses known as *manyatta* that serve as resting points for livestock herders in transit in search of water and pasture.

Land Tenure System

The land tenure system is communal. Land is collectively owned by the community and managed on their behalf by the Turkana County Council as trustees. Pasture and settlement lands have no land ownership documents.

Social Support Services

The proposed project area is in an arid area that is largely disadvantaged in terms of social amenities and infrastructural development. Social services are few and far apart while infrastructure like road, electricity and communication facilities are generally lacking. Notwithstanding some of the social facilities in the area include schools, dispensaries and religious sanctuaries. Security is of concern particularly during dry seasons when other pastoral communities may raid the area for livestock. There is also competition for water and pasture for livestock, as well as district boundary issues that often spark tribal animosity particularly between the locals and the neighboring Pokot community. There are functional district security and intelligence committees that assist each other in propagating peaceful and harmonious coexistence in the area.

Community Stability

The project area is inhabited by the Turkana people, a pastoral community with closed culture tradition that is slowly weighing in under the influence of western civilization especially in the urban centers. Most of the local residents are Christians though tradition religious beliefs still dominate parts of the project area. Government administrators at the grassroots level, community elders, and cultural leaders referred to as Laibons, play a significant role in nurturing

the youth in decision-making as well as in conflict resolution. There are administration police camps at Kerio and Lokichar Township. In addition, there are police stations at Lokichar, Lokori and Lodwar town. Livestock husbandry is undertaken collectively as a measure to safe guard the animals from livestock rustlers.

4.16 Economic Setting

The stronghold of the project area's economy is pastoral livestock production. The sub-sector is a source of livelihood for over 60% of the inhabitants. Nonetheless, cattle rustling, frequent disease outbreaks, water scarcity, low productivity and poor marketing hamper expansion of the sector. The rest of the population (20%, 12% and 8%) depend on agro-pastoralism, fishing and casual and formal labor in urban and peri-urban areas respectively (FAO, 2007). Crop production is carried out along the Kerio and Turkwel rivers and on the arable flood plains and is both rain fed and irrigated. Main crops cultivated are maize, sorghum, beans and cassava.

The project area is a pastoral region thus the constant movements of the pastoralists coupled with high levels of poverty (according to FAO, 2007 approximately 62% of the inhabitants of the larger Turkana area are classified as absolutely poor) have not permitted growth of an efficient market infrastructure for livestock and its products.

Plate 4.20: Fishing in L. Turkana is also an important economic activity

Plate 4.21: Livestock rearing is also a very important economic activity in the area.

Labor Force

There exists a readily available pool of unskilled labor force. Many of the young unemployed school leavers are available for any type of work, since there are hardly any job opportunities at the few urban centers in the area. Currently, BGP is undertaking seismic survey within the block. The company has engaged approximately 100 non-skilled workers drawn from across the block.

Transport and Traffic

Physical accessibility and transportation in the project area is constrained by the poor condition of the road and transport network. Most of the roads are dilapidated and are impassable during wet seasons and many lack bridges or are loose surface road. Public transport in the area is unreliable and sparse. There are few public service buses plying the main Kitale – Lodwar route; Lorries are also a major transport option.

Plate 4.22: Road condition shortly after a downpour

4.17 Health Setting

Health Services and Diseases

The project area has limited government run health centers and dispensaries distributed at location levels. Kerio location has one health centre while Kalapata location has a CDF sponsored dispensary under construction. Lokichar Township has two health facilities, one run by the government and the other by Reformed Church of East Africa. The general assessment of the health facilities is that they cannot handle serious emergency services or a major outbreak. In particular the government run health centre at Lokichar is ill equipped in terms of personnel and facilities. However, Lodwar town has the only district hospital that serves the entire larger Turkana area.

The health facilities at Lokichar and the district hospital may be useful should any emergencies occur during the proposed project. The facilities can be accessed from Loperot where the BGP camp is located as well as from Kangirisae and Kerio shopping centre. The health facilities in the project area face the following key challenges:

- Lack of adequate medical personnel
- Inadequate medical facilities including drugs and other supplies
- Unreliable source of energy and
- Inadequate water supply

According to the Clinical officer at the Reformed Church Lokichar Health Centre was established in 1973 and has an inpatient capacity of 26 beds. The health facility has an operational laboratory with one laboratory technician, one old ambulance and has no operating theatre. The facility has no morgue and there is no regular doctor. The health facility handles a large number of out-patients estimated at between 150 to 200 on Mondays and Tuesdays. The number, however, reduces to an average of 50 patients per day in the rest of the week. The facility gets regular assistance from UNICEF, Merlin, RCEA and Ministry of Health that seconds nurses and other medical officers.

Malaria is one of the most prevalent diseases treated in health facilities in the larger district. Respiratory Tract Infection is the second most common. The two diseases account for over 60% of cases attended to in the health facilities in the district. Other diseases in the area include skin diseases, diarrhea, pneumonia and urinary tract infections among others. Snake and scorpion bites also cause health hazards in the area.

Security and Public Safety

The proposed project is largely a pastoral livestock production area and insecurity commonly revolves around livestock rustling, conflict over water and pasture, and district boundary disputes. Administration police in collaboration with Kenya police reserve (KPR) provide security. At the BGP base camp there is a twenty-four hour security surveillance provided by the administration police and KPR officers.

According to the Turkana South District Commissioner, the government has also put up security measures along the Kitale – Lodwar road. These measures include administration police camps with 130 officers along the highway; a GSU camp at Turkwel, an anti-stock theft unit at Kainuk, and a Kenya Wildlife Service Base at the Turkana South game reserve. In addition, there is a district security and intelligence committee that meets regularly to review security issues. It comprises of officers from the provincial administration, the Kenya Police, KWS, the National Security Intelligence Service, and the Administration Police. The government has also recruited close to 300 police reserves spread at village level to further boost security. Non-governmental organizations and other government agencies are also engaged in peace building efforts through public awareness creation and education. There is an operational law court at Lodwar town.

4.18 Corporate Social Responsibility

The proponent has set in motion an elaborate system to engage the locals in its corporate social responsibility. This is a great step for the proponent even as the company is still operating on capital investment. Some of the actions already taken include:

- Establishment of two community committees that are based at Kerio and Lokichar divisions.
- Donation of Ksh 1.5 million to each committee for CSR projects in the year 2010. Some of the projects considered in this first phase include bursaries for needy students, classrooms constructions and renovation of a dispensary at Kalapata division.

The proponent is also keen on assisting the community in developing and providing water points like water wells and boreholes.

4.18.1 Community Views

The EIA team made extensive field visits in the project area, held public meetings with the local people and consulted stakeholders using household questionnaires. Some of the issues raised by the community members and stakeholders are as follows:

Positive Views

- The proponent may assist the communities realize priority projects such as supporting in provision of potable water, educational bursaries, health facilities among others
- The project will enhance security situation in the area as more security personnel will be deployed in the area

- The project will uplift the livelihood of the local people through provision of job opportunities
- The project will lead to economic growth not only for the area but for the entire nation
- The project will create opportunities for people to create wealth through trading and supplies opportunities to oil industry workers for instance by providing food such as milk, and livestock like sheep and goats
- The proposed project will spur development in other related infrastructural like roads, communication facilities and water supply
- Improved infrastructure will make access to market for livestock and livestock products easier
- Successful drilling of oil will improve lifestyles as new ways of income generation shall be realized

Concerns

- Lack of public awareness and education about the project may lead to conflict
- The proposed project may lead to land use conflict with pastoralist communities
- In the process of transporting goods and machineries for use, unscrupulous people may dump hazardous wastes in the project area
- Occupational hazards during operation may lead to accidents to local workers
- Casual employment opportunities should be reserved to the local people
- Africa Oil community committees should be as representative as possible
- Possible noise and vibration pollution
- The project will lead to air pollution from vehicular emissions and dust generation
- Oil spill into ground and water way may affect human lives and livestock
- Vehicles may lead to accidents to livestock and people
- The proposed project may lead to displacement of local residents from their settlements
- The project may infringe on community water resources.
- If oil is finally struck this may lead to insecurity particularly from neighboring republics

The community members who attended the public meetings did welcome the proposed project but appealed for adherence to environmental safeguards, labor as well as human rights. The community having already seen the benefit of the ongoing seismic survey phase is optimistic that more benefits will be realized in the area. However, the communities want the proponent to work closely with the local communities through the community committees.

4.18.2 Housing and Recreational Facilities for Africa Oil Staff

Africa Oil in collaboration with BGP already has an existing base camp approximately seven kilometres from the nearest proposed exploratory well drill site referred to as Kamba. The camp has technical and office area, accommodation, sanitation and recreational facilities.

4.2 HSE Management

The company proposes to strengthen its environmental management systems and decrease instances of the waste generation. Innocuous material or innocuous mud will be used as often as possible. Drilling waste fluids will be recycled, and waste drilling fluids purified with the water purification unit before being discharged in accordance with the clause of drill environmental regulations. After the exploration well has been drilled the drill location and camp area will be restored and reclaimed to as close as original condition.

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All the field operation procedures must adhere to the HSE rules and regulations, stipulated in the drilling contract which will comply with OGP Guidelines (International Association of Oil and Gas Producers). The EIA recommendations will form an integral part of the drilling contract

In order to ensure the health, safety of the workforce and environment protection, the company will comply with the following:

- Follow the health, safety and environment rules of the Oil and Gas Producers (OGP) and locality country regulation, laws and bye-laws.
- Establish effective and practical HSE management.
- Drilling contractor will have in place its own HSE MS (Health Safety Environment Management System)
- Ensure all relevant HSE procedures are in place and that all personnel are compliant.
- Deploy enough protection articles for health, safety, and environment and ensure that sufficient finance is available and it is committed to drilling operations.
- Personnel (including the local employees) will professional HSE training.
- All staff and local workers will be provided with the appropriate PPE (Personal Protective Equipment).

CHAPTER 5:

KENYAN LAWS AND INTERNATIONAL PRACTICES

5.1 Kenyan Legislation

The oil exploration and production processes have the potential to cause a broad range of impacts on the environment – economic, social and cultural impacts, atmospheric, terrestrial, and aquatic, being the major ones. The nature and extent of these impacts will obviously depend on the nature and size of the project, the natural environment, and the environmental management systems that may be in place to prevent, control and minimize pollution. The legislative and institutional frameworks to regulate such operations fall on the government within whose jurisdiction they are carried out. It is also the onus of the government to enforce those laws. Subordinate legislation and standards or guidelines will flow from the primary enactment – the Environmental Management and Co-ordination Act, 1999 - as the need arises. Under the Act, Kenya is obliged to enact legislation giving effect to international treaties, conventions and agreements (to which she is a party) on environmental management. She is also expected to enforce them. The Act further establishes the National Environment Tribunal to hear appeals and referrals from anyone aggrieved by the decision of the National Environment Management Authority or any of its committees or officers.

5.1.1 The Constitution of Kenya, 2010

The new Constitution of Kenya, 2010 (referred to here as “the Constitution”), promulgated on August 27, 2010, encapsulates the right to a clean and healthy environment in the Bill of Rights (Chapter 4, Article 42). Anyone claiming that their right under this Article has been violated or is threatened may go to court for redress, and the court may make appropriate orders to stop or prevent any act or omission causing harm to the environment (Article 70). However, the detailed provisions relating to the environment and natural resources lie within Chapter Five which deals with land and the environment.

The State has the obligation to ensure that the environment and natural resources are sustainably exploited, managed and conserved, and that the benefits derived from them are equitably shared among the Kenyan people. The public must also be encouraged to participate in managing, protecting and conserving the environment. In addition, the State is obligated to establish environmental impact assessment, environmental audit and environmental monitoring systems. Moreover, it is required to protect the genetic resources and biological diversity, avoiding activities that may endanger the environment (Article 69).

Any transaction which involves the grant of a right to exploit a natural resource within Kenya by anyone, including the national government, to another person, must be ratified by Parliament. Parliament must also ratify such an agreement if it is entered into on the date the Constitution comes into effect, or after. Parliament is mandated to enact legislation to classify the transactions relating to the environment that must be ratified (Articles 71, 72).

One of the principles of land policy in Article 60 states that land in Kenya shall be held, used and managed equitably, efficiently, productively and sustainably, and in accordance with sound conservation and protection of ecologically sensitive areas. These principles are to be implemented through a national land policy developed and reviewed regularly by the national government and through legislation.

Land in Kenya is classified as public, community or private land (Article 61). Public land includes all minerals and mineral oils as defined by law; government forests (except those lawfully owned or used by specific communities as grazing areas or shrines); all rivers, lakes and other water bodies as defined by an Act of Parliament; the territorial sea, the exclusive economic zone and the sea bed; the continental shelf; the land between the high and low water marks; and any other land that is not classified as private or community land. These various sub-classifications of public land will be held by the national government in trust for the people of Kenya and will be administered by the National Land Commission. Parliament will stipulate how public land may be disposed of or used (Article 62).

The new Constitution establishes the National Land Commission whose functions are to manage public land on behalf of the national and county governments; recommend a national land policy to the national government; conduct research related to land and the use of natural resources; and monitor and oversee land use planning throughout the country, among other things (Article 67).

The county assembly is empowered to legislate and may approve plans and policies for the management and exploitation of the county's natural resources (Article 185). In the event that there is a conflict between national and county legislation concerning matters falling within the jurisdiction of both levels of government, national legislation will prevail if it applies uniformly throughout Kenya and any of the laid down conditions are satisfied. One such condition is that the national legislation is necessary for the protection of the environment (Article 191).

The Constitution defines "land" as including the surface of the earth and the subsurface rock; any body of water on or under the surface; marine waters in the territorial sea and the exclusive economic zone; natural resources completely contained on or under the surface; and the air space above the surface. "Natural resources" are defined as the physical non-human factors and components, whether renewable or non-renewable, including sunlight; surface and groundwater; forests, biodiversity and genetic sources; and rocks, minerals, fossil fuels and other sources of energy (Article 260).

Current, Transitional and Consequential Legislation

All the laws in force before the effective date (August 27, 2010) continue in force until the new laws are passed. However, they must be read with the alterations, adjustments or exceptions necessary to bring them into conformity with the Constitution.

Parliament will be required to revise, consolidate and rationalize the existing land laws, revise sectoral land laws in terms of the principles of land policy (Article 68). It has the mandate to enact legislation necessary to govern any matter in the Constitution. There are specific periods set out in the Fifth Schedule for this process. Nonetheless, Parliament may by a two-thirds majority vote, extend the prescribed period by a year. This power may be exercised only once in respect of any particular matter and only in exceptional circumstances. The Attorney-General is required in consultation with the Commission for the Implementation of the Constitution, to prepare the relevant Bills in respect of new legislation and table them before Parliament as soon as reasonably practicable so as to enable enactment within the specified periods.

Should Parliament fail to enact any particular legislation within the prescribed time, any person may petition the High Court on the matter. The court will then make an order directing the Attorney-General and Parliament to enact the law, and specify a time-frame within which it

should be done. If Parliament fails to act in terms of the order, the Chief Justice must advise the President to, and the President must, dissolve Parliament. The new Parliament then takes up the responsibility of enacting that legislation, and if it fails to do so, the entire process begins again.
The time specifications for passing the laws regarding land and environment matters are as follows:

- regulation of land use and property (Article 66) - 5 years
- legislation on land (Article 68) - 18 months
- agreements relating to natural resources (Article 71) - 5 years
- legislation on the environment (Article 72) - 5 years
- community land (Article 63) - 5 years

All the rights and obligations of the Government of Kenya existing immediately before the promulgation of the Constitution will continue as those of the national government, unless there is an express provision to the contrary in the said Constitution. It is specifically provided that the provisions of Article 71 (on agreements relating to natural resources) will not take effect until Parliament enacts laws providing for the classes of transactions it must ratify and that relate to: (i) the granting of rights or concessions for the exploitation of natural resources and (ii) those that are entered into on or after the effective date (Sixth Schedule, section 8 (3)).

The Constitution vests the national government with the functions of protecting the environment and natural resources in order to establish a durable and sustainable system of development, particularly water protection, securing sufficient residual water, hydraulics and the safety of dams, and energy. The energy policy including electricity and gas networks and energy regulation is explicitly listed as a responsibility of the national government (Fourth Schedule, sections 22, 31). The control of air and noise pollution and other public nuisances fall under the scope of the county governments' powers, as do electricity and gas networks and energy regulation. In addition, county governments have the role of implementing specific national government policies on natural resources and environmental conservation, including soil and water conservation and forestry (Fourth Schedule, sections 3, 8, 10). However, the provisions of the Constitution relating to county governments stand suspended until the first elections for county assemblies and governors are held.

Parliament must make laws for the transfer in phases from the national government to the county governments of the legislative functions assigned to them within three years from the date of the first election of the assemblies (Sixth Schedule, section 15).

What the process will mean for the new laws

The new laws must be enacted in conformity with the provisions of the new Constitution as the supreme law of the land. The former Constitution (the Constitution of Kenya, Revised 2001) stood repealed when the new one came into effect, subject only to the extension of application of the provisions required to be retained for a smooth transition to the implementation of the new Constitution. All the current laws remain in force until the new ones – 49 in total (listed in the Fifth Schedule) - are passed by Parliament and given presidential assent. Where applicable, the provisions of the existing laws must be construed with those of the new Constitution. In the event that there is a conflict, the provisions of the Constitution will prevail over those of the existing law. The manner of interpretation of the Constitution is set out in Article 259. It will take up to five years to enact all the 49 laws that will give effect to the

constitution in its entirety if Parliament adheres to the strict time frames for all the laws as required.

The rigid provisions ensure that the processes of enactment and implementation are kept in motion and that no-one will take over the implementation to their advantage as against the interests of the Kenyan people. The first crucial step in the process is to set up the Commission for Implementation of the Constitution (Sixth Schedule, section 5). The Bill creating the Commission (The Commission for the Implementation of the New Constitution Bill) was published August 23, 2010. The Commission will consist of nine members and will oversee the drafting of the Bills and the subsequent enforcement of the laws that will implement the new Constitution.

5.1.2 The Petroleum (Exploration and Production) Act, Cap. 308

This statute is the only legislation expressly dealing with the exploration and production of oil. Its purpose is to regulate the Government's negotiation of petroleum agreements relating to oil exploration, its development, production and transportation. It confers on the Government all petroleum existing in its natural state in Kenya and the continental shelf - subject to any other rights existing under the law.

The Act, its regulations, as well as the terms and conditions of the existing petroleum contract, together govern oil operations. The Minister may issue non-exclusive exploration permits for specified areas. A person given such a permit may enter upon those areas and prospect or carry out geological and geophysical surveys. The Minister also has the power to make regulations to govern petroleum operations, conservation of petroleum resources, safety measures, environmental protection and the prevention of pollution.

In every petroleum agreement, there are implied obligations on the part of the contractor to conduct its operations with sound professional and technical skills. The contractor is also expected to take necessary measures to conserve petroleum and other resources, and protect the environment and human life. Products, equipment and services available locally should be used (section 9). If the rights of the owner or occupier of private land are disturbed, or the land or other property on it damaged in the course of the petroleum operations, the contractor must pay a fair and reasonable compensation. Should the contractor fail to pay or if the owner or occupier is dissatisfied with the amount offered, the latter has recourse in the courts which will determine the compensation and enforce payment if necessary. "Private land" is interpreted to include land under a grant, lease or license from the Government.

5.1.3 The Environmental Management and Coordination Act, 1999

The National Environmental Management Authority (NEMA) is mandated to monitor the operations of any industry, project or activity to determine its immediate and long-term effects on the environment. Part VIII of the Act lays down provisions pertaining to environmental quality standards. It establishes a Standards and Enforcement Review Committee for the Authority. Broadly, the Committee's functions are, among other things, to –

(a) recommend quality standards for various uses of water;
(b) analyze conditions for discharge of effluents into the environment;
(c) collect and interpret data from industries on the levels of effluents;
(d) advise NEMA to authorize necessary action to prevent or decrease water pollution from abandoned undertakings;
(e) Advise NEMA on quality standards with regard to air quality, emission standards, and guidelines on air pollution control.

It is an offence to contravene the water pollution control standards. Effluents are not to be discharged except into the sewerage system. NEMA issues the license for that, but also has the power to cancel it if the holder contravenes the provisions of the law, and if it is considered in the interest of the environment or in the public interest to do so.

The Authority also issues guidelines and regulations for the management of categories of hazardous wastes. The discharge of any hazardous substance, chemical, oil or mixture containing oil into any waters or other parts of the environment is an offence. In addition to the sentence imposed, the offender will be required to pay the cost of removing the hazardous waste including any costs the Government may incur in restoring the environment, and pay compensation to any affected third parties.
Minimum standards are provided for noise and vibration pollution, and subject to the Civil Aviation Act, Cap. 394, the emission of noise in excess of the standards is an offence (section102). However, temporary exemptions as regards noise standards may be allowed for up to three months for activities such as demolitions, fireworks, firing ranges and specific heavy industry on specified terms and conditions. Where this exemption is granted, workers exposed to excessive noise levels must be adequately protected from harm.

NEMA is also required to establish procedures to measure and determine noxious smells, minimum standards for the control of environment pollution by such smells, or guidelines for measures to abate those smells, whether they occur naturally or stem from human activities.
An environmental inspector is required to monitor compliance with the established environmental standards, enter upon land without a warrant, and order the immediate closure of any undertaking which pollutes or is likely to pollute the environment in contravention of the Act. The Environmental (Impact Assessment and Audit) Regulations, 2003, made under this statute stipulate that anyone proposing or executing a specified project must prepare a project report. NEMA may issue an environmental impact assessment license if it is satisfied that the project will have no significant impact on the environment, or that the project report discloses sufficient mitigation measures.

5.1.4 The Environmental Management Coordination (Fossil Fuel Emission Control) Regulations, 2006

NEMA runs a system for inspection of all internal combustion engines for emissions. Any internal combustion engine must pass tests demonstrating that it complies with the laid down standards for the control of air pollution or contamination. It is an offence to operate an internal combustion engine which emits smoke or other pollutant in excess of the emission standards. The cost of clearing pollution through fuel emission is borne by the polluter.

5.1.5 The Environmental Management and Co-ordination (Wetlands, River Banks, Lakeshores and Seashore Management) Regulations, 2009

These Regulations apply to all wetlands in Kenya, whether on public or private land. The objectives of the management of wetlands and wetland resources as set out in the Regulations are: to conserve and sustain the use of wetlands and their resources; to integrate the sustainable use of wetlands resources into the local and national management of resources for socio-economic development; to conserve water catchments and control floods; to ensure sustainable use of wetlands for ecological and aesthetic purposes for the common good of the citizens; to protect wetlands as the habitat for certain species of flora and fauna; to provide for public participation in the management of wetlands; to enhance educational research and related activities; and to prevent and control pollution and siltation.

The Minister for Environment may declare an area a protected wetland, and once such a declaration is made, the activities there will be restricted to research, eco-tourism, restoration and enhancement. The National Environment Management Authority ('the Authority') must take measures to prevent and control the degradation of wetlands. Except for a few permitted uses of wetland resources, a permit and an environmental impact assessment license are required for all activities on wetlands. A temporary permit may be issued for use of the wetland for emergency use of water and special research projects. Users, owners and occupiers of land have a duty to prevent the degradation or destruction of wetland and preserve its ecological and other functions.

The objectives of the management of river banks, lakeshores and the seashore are: to facilitate their sustainable use and conservation by and for the benefit of the people living in the area; to integrate the sustainable use of these areas into the local and national management of national resources for their socio-economic development; to enhance education and research and to prevent siltation of rivers and lakes and control pollution or other activities likely to degrade the environment. A developer intending to undertake a project which may significantly impact river banks, lakeshores and the seashore must carry out an environmental impact assessment and environmental audit. Persons who were already carrying out such activities prior to the coming into effect of the Regulations must comply with them within six months.

5.1.6 The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009

There is a general prohibition (with some exceptions) on loud, unreasonable, unnecessary or unusual noise that may annoy, disturb, injure and endanger the comfort, rest, health or safety of others and the environment. In determining whether a sound amounts to noise, the factors to be considered are time, proximity to a residential area, level of intensity, whether it is recurrent, intermittent or constant, whether it is enhanced mechanically or electronically, or whether the polluter can control it with little effort or cost.

Excessive vibrations are those that exceed 0.5 cm. per second beyond the boundary of the source property or 30 metres from any moving source. The Regulations set out certain noise levels for specified areas or facilities above which noise may not be made - the only exception being where such noise is necessary to preserve life, health, safety or property. The situations where noise may exceed the permitted levels are limited to emergency situations, warning devices such as police, ambulance and fire sirens, and national celebrations.

Noise or excessive vibration from the operation or repair of machinery, motor vehicles and construction equipment must be within the prescribed levels. The same applies to any commercial or industrial activity. Work engaged in at night must be controlled, unless it is of an emergency nature, or is domestic in nature and is being carried out in a building by a resident there, or is a public utility construction. The lead agency is required to ensure that mines and quarries where explosives and machinery are used are located in designated areas not less than 2 km. away from human settlements.

Persons carrying out construction, demolition, mining or quarrying operations must, during the environmental impact assessment process, identify natural resources, land uses or activities that may be affected by noise or excessive vibrations, determine the measures required to minimize or eliminate their adverse impact, and incorporate the needed reductions in the plans and specifications. Anyone seeking to install or modify a sound source likely to emit noise or excessive vibration must apply for a license to do so from the Authority.

The Kenya Bureau of Standards, the Mines and Geology Department, the Ministry of Physical Planning and the local authorities, among others, are designated mapping bodies for the purpose of making and approving strategic noise or vibration maps. Every mapping body must take immediate action to mitigate any significant noise or excessive vibration that may cause damage to the environment or human beings. Persons carrying out activities that were emitting noise or excessive vibration immediately before the Regulations came into force must comply with them within six months.

5.1.7 The Environmental Management and Co-ordination (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit Sharing) Regulations, 2006

There is a prohibition on any activity that may have an adverse impact on the ecosystem, lead to the introduction of any exotic species or lead to unsustainable use of natural resources, without a license from the Authority. The Authority regulates access and use of any threatened species to ensure its regeneration and maximum sustainable yield. It is also mandated to monitor the status and components of biological diversity and take necessary measures to prevent and control their depletion. Conservation and promotion of biological diversity applies to environmentally significant areas such as land, sea, lakes or rivers declared by the Minister to be protected natural environment systems.

Anyone intending to access genetic resources must apply to the Authority for an access permit. The holder of such a permit is required to facilitate the active involvement of the Kenyan citizens and institutions in carrying out the activities covered by the permit. Such facilitation includes the enjoyment of both monetary and non-monetary benefits arising from the right of access granted and the use of genetic resources.

5.1.8 The Environmental Management and Co-ordination (Water Quality) Regulations, 2006

Rule 4 seeks to prevent water pollution by banning the depositing of any liquid, solid or gaseous substance into or near a water source so as to pollute it. Lakes, rivers, streams, springs, wells and other water sources are protected from the unlawful discharge of effluent. Without an Environmental Impact Assessment license no one may draw ground water or carry on any activity near such water sources that would adversely impact on the water quantity and quality. In addition, no one may undertake any development activity within a minimum of six and a maximum of thirty metres on either side of a river or stream (rule 6). The discharge of all types of pollutants into the aquatic environment must comply with the standards set out in the Regulations. The permissible standard for the discharge or oil and grease into the environment is nil (rule 11, Schedule 3). The Regulations provide the water quality parameters to be monitored by a gas and oil undertaking for its discharge of effluent into the environment (rule 12, Schedule 4). The pollution of water meant for fisheries, wildlife, recreation or any other uses is also prohibited.

5.1.9. The Environmental Management and Co-ordination (Waste Management) Regulations, 2006

Every industrial undertaking has the obligation to mitigate pollution by installing at its premises anti-pollution equipment for treating the waste it generates (rule 14). Discharge or disposal of any waste in any form into the environment is not permitted without prior treatment (rule 15). An

Environmental Impact Assessment license must be obtained by anyone intending to engage in any activity likely to generate hazardous waste (rule 17).

5.1.10. The Explosives Act, Cap. 115

There are restrictions on storage and possession of explosives. A permit is required to purchase and use blasting materials as well as to convey explosives within Kenya. Every occupier of a factory must make special rules for the safety of the employees and the public, and ensure that they are enforced. An inspector of explosives may ban, restrict or regulate the use of explosives in places where blasting may endanger life or property. The use or transport of explosives, in the working of a mine, quarry, excavation or other project is forbidden, in the absence of an explosives manager. The explosives manager is responsible for the safety of every person who may be employed on the project, whether under his direct supervision or not. There are stringent rules - the Explosives (Blasting Explosives) Rules - made under the Act to ensure the safe handling and transportation of explosives.

5.1.11. The Energy Act, Cap. 12 of 2006

This legislation lays down provisions for the regulation of energy, and the protection of consumer, investor and stakeholder interests, setting up the Energy Regulatory Commission toward those ends. Other provisions relate to requirements for licensing for the generation, supply, importation and exportation, transmission and distribution of energy.
The Act applies to persons engaged in –

- the import, export, generation, transmission , distribution, supply or use of energy;
- the import , export, transport, refining, storage and sale of petroleum or petroleum products; and
- the production, transport, distribution and supply of any other form of energy.

Petroleum imported or produced locally for the Kenyan market, petroleum products, equipment, facilities and installations, must conform to the relevant Kenya Standard. If this standard does not exist, the relevant international standards approved by the Kenya Bureau of Standards apply. Similarly, materials and apparatus used must comply with those standards. People engaged in the petroleum business are also subject to the standards pertaining to environment, health and safety, and must conform to the relevant laws (section 95).

If a fire, explosion, oil spill, injury or fatality occurs in the course of transporting petroleum, or operating a petroleum facility, the operator or transporter must immediately clean up the polluted or damaged environment, at his own expense (section 98).

In considering applications for licenses, the Commission considers the need to protect the environment and to conserve the natural resources in accordance with the Environmental Management and Coordination Act of 1999. In that connection, there must also be compliance with the Environmental (Impact Assessment and Audit) Regulations, 2003. NEMA will consider the applicant's ability to operate in a manner that will protect the health and safety of users of the service as well as the public who would be affected by the project.

5.1.12. The Public Health Act, Cap. 242

This legislation focuses on securing and maintaining health. It is the duty of every local authority to take measures to maintain the locality in clean and sanitary condition and to

prevent or remedy any nuisance that may cause injury to health, and to take legal proceedings against anyone causing such nuisance (section 116).

The Minister may make rules (a) as to the standard or standards of purity of any liquid which may be discharged as effluent after treatment, and (b) to establish or ban trade premises or factories likely to cause offensive smells or discharge liquid or other material that may cause such smells, or pollute streams, or are otherwise likely to be a nuisance or dangerous to health (section 126).

Local authorities must take necessary and reasonably practicable measures to prevent pollution of any supply of water (which the public has a right to use and does use for domestic purposes) that may endanger health. They must also purify any such water supply that has become polluted. They should also take legal or other measures against any person polluting such water supply or any stream so as to cause a nuisance or danger to health (section 129).

5.1.13. The Water Act, 2002

The purpose of this Act is to provide for the management, conservation, use and control of water resources, and for the acquisition and regulation of rights to use water, as well as the regulation and management of water supply and sewerage services.

There is a clear delineation of the management of water resources from the provision of water services. The Water Resources Management Authority is created to develop guidelines and procedures to manage water resources, monitor the National Water Resources Management Strategy, and hear and determine applications for permits. In addition, it regulates and protects the quality of water resources form adverse impacts and is further mandated to manage and protect water catchments. The Regulatory Board deals with licensing, determines standards for the provision of water services, and monitors compliance with the established standards regarding water facilities. Acts that would cause or be likely to cause pollution of any water resource are strictly forbidden, and constitute an offence.

The regulation of water for industrial use and effluent discharge is dealt with by the Regulations, which also lay down the standards and monitoring guidelines for the discharge of effluent into the environment.

5.1.14. The Occupational Safety and Health Act, No. 15 of 2007

This Act applies to all workplaces. Its purpose is to secure the safety, health and welfare of persons at work and to protect other persons against risks to safety and health arising out of the activities of people who work there.

The Director of Occupational Safety and Health Services is mandated to issue codes of practice on safety and health regulations. “Code of practice” is interpreted as including ‘a standard, a specification and any other documentary form of practical guidance’. The occupier’s duty to ensure the safety, health and welfare of all persons at work in his premises includes providing a working environment and work procedures that are safe. The occupier must also have a written statement of policy on the safety and health at work of his employees. In addition, he must have a thorough safety and health audit of his workplace carried out at least once a year.

The likely emission of poisonous, harmful, or offensive substances into the atmosphere should be prevented, and where such incidents occur, they must be rendered harmless and inoffensive. An occupational safety and health officer may enter and examine a workplace in which he has reasonable cause to believe that explosive, highly inflammable or any other hazardous materials are stored or used. Machinery, protective gear, and tools used in all workplaces have to comply with the prescribed safety and health standards. Dust, fumes or impurity must not be allowed to enter the atmosphere without appropriate treatment to prevent air pollution or harm of any kind to life and property.

5.1.15. The Local Government Act, Cap. 265

This legislation establishes local government authorities and defines their functions. Local authorities have the power to prevent various forms of pollution under section 163(e) by controlling or prohibiting all businesses, factories and workshops which, "by reason of smoke, fumes, chemicals, gases, dust, smell, noise, vibration or other cause, may be or become a source of danger, discomfort or annoyance to the neighborhood…"

Every local council is empowered to regulate sewerage and drainage generally (section 176) and to establish and maintain sewerage and drainage works within or outside its area (section 168). A local authority may refuse to grant or renew a license, or cancel it on various grounds, some of which are (a) that it would cause nuisance or annoyance to the residents; and (b) that the method adopted or proposed to prevent noxious or offensive vapours, gases or smells arising from the trade are not efficient (section 165).

5.1.16. The Physical Planning Act, Cap. 286

The Physical Planning Act was enacted to provide for the control of physical development plans. Development consent must be obtained from the local authority otherwise the development will be considered void and be discontinued. The Act establishes Physical Planning Liaison Committees to determine development applications relating to industrial location, dumping sites or sewerage treatment which may have adverse impact on the environment.

If a local authority is of the opinion that proposals for industrial location, dumping sites, sewerage treatment, quarries or any other development activity will have adverse impact on the environment, the applicant will be required to submit an environmental impact assessment report for consideration.

5.1.17. The Penal Code, Cap. 63

The following constitute offences under section 175 of the Penal code:

- Acts or omissions that cause injury, danger, annoyance or inconvenience to the public.
- Fouling the atmosphere in any place, thereby making it noxious to the health of people in the vicinity.
- For trade purposes, making loud noises or discharging offensive smells in circumstances causing annoyance to others.

5.2 LAND TENURE

5.2.1 Types of Land Tenure

Land tenure systems range from the rights to transfer, use, develop, mine or lease, to a variety of others. The holder may choose to transfer or pass on one or more of these rights together, with or without limitations, depending on the system in issue. As has been stated, land in Kenya is classified as public, community or private.

The Constitution vests public land in the national government in trust for the people of Kenya. Land which at the effective date of the new Constitution was unalienated government land falls under this system and is provided for by the Government Lands Act which contains the framework from which the Wildlife (Conservation and Management) Act (Cap. 376) was enacted. By virtue of these statutes expanses of land are designated as national reserves and parks or forest reserves with the aim of protecting both forests and wildlife. Consequently, the rights of conservation and management are vested in the state, and these land masses cannot be used for any other purposes. However, it is clear that human encroachment onto these protected areas is an ever-present threat, and indeed has already occurred and is continuing in many parts of the country, as for instance human settlement in the Mau Forest Reserve and pastoralists grazing their cattle in wildlife zones. Public land also means any other land declared to be public land by an Act of Parliament in force on the effective date or enacted after that date (Article 60 (1)(n)).

Community land vests in and is held by communities on the basis of common interests such as clan, ancestry or ethnicity. The communal group lays down guidelines for the use of the land and every member has equal rights to its use. Rights of use (such as for pastoral purposes) may not flow to non-members except by agreement of the entire group. This kind of tenure is governed by the Trust Land Act (Cap. 288) which, read together with the Constitution (Article 63), vests the land in the county governments in trust for the areas' indigenous people. Ownership of land following adjudication under the Land (Group Representatives) Act, Cap. 287 (popularly known as group ranches) also falls under this category. Article 63 will be given effect when Parliament enacts the necessary legislation.

Private land consists of (a) registered land held by any person under any freehold nature; (b) land held by any person under leasehold tenure; and (c) any other land declared private land by an Act of Parliament (Article 64). Under private ownership the rights that an individual proprietor of land will enjoy depend on the statute under which that ownership is registered – whether freehold, leasehold or absolute proprietorship. Freehold tenure is conferred under the Registration of Titles Act (Cap. 281), the Government Lands Act (Cap. 280) and the Land Titles Act (Cap. 282) and gives unlimited rights of use. The owner may sell it, lease it, charge or mortgage it, subject only to the regulatory powers of the state. Absolute proprietorship is conferred by the Registered Land Act (Cap. 300) and grants essentially the same rights as one would get under freehold. The Registered Land Act applies to former customary land and registered Trust land. The Act confers an absolute and indefeasible title on the registered owner (section 27). Under the Act, the absolute rights to the land can only be restricted where the government exercises its right to compulsorily acquire the land for public purposes. Leasehold tenure derives title from a freehold or absolute proprietorship but for a limited specified time on condition of development or the payment of rent or the meeting of some other condition.

5.2.2 Land Use Regulation

The Constitution grants the State power to regulate all land uses, or interests in or rights over land in the interest of defense, public safety, public order, public morality, public health or land use planning (Article 66).

Most land in Kenya is held under private freehold tenure by individuals and private corporations. As much as some systems of land tenure confer unlimited rights of use, this is not quite the case. The government has the power to compulsorily acquire land for public use – one of which is biodiversity conservation. This power is derived from the Constitution. Although the Constitution guarantees protection of the right to property, or interest in or right over property of any kind, Article 40 permits the compulsory acquisition of property in accordance with the land policy. It may be for a public cause or in the public interest but compensation must be paid promptly – and in full. The law must permit any person who has an interest in or right over that property to seek redress in court.

Where the land is acquired on behalf of the government, the Commissioner, while dealing with the issue of compensation, may agree with the proprietor of the land that that person, instead of an award, will instead receive a grant of land commensurate in value to the amount of compensation which would have been awarded. The compensation may be in the form of a lump sum of money or in installments or in any other form that may be agreed (the Land Acquisition Act (Cap. 295)).

Compulsory acquisition of land in Kenya for conservation purposes is well-recognized. All that is required is a declaration of intent by the government to designate certain land as protected for conservation. The Wildlife (Management and Conservation) Act contains key measures for consideration in situations where development and other land uses are contemplated:

- The Minister may degazette a national park, reserve or local sanctuary after giving 60 days' notice of that intention. Parliament must, however, approve the order (section 7). Degazettement of a protected area reverses its status of a conservancy so as make it private land or enable it to be put to some public use or uses.
- Any activity such as the use of aircraft or motor vehicles that is likely to disturb animals within a national park is prohibited (sections 12 and 35).
- Where the Minister is satisfied that in order to secure the safety of the flora and fauna or to preserve the habitat and ecology within a national park, reserve or sanctuary, it is necessary to restrict or forbid any activity in the adjacent area, he may declare it a protected area and prohibit those activities (section 15).
- The Wildlife Director or his agent (the Commissioner of Lands) or any authorized officer of the Service may close a portion of a national park or any road or part of a road within the park to the public or any class of people, for a period for the protection of animal or plant life, or for the safety of the public, or for the protection of a road, or for climatic reasons, *or for any other reason* (emphasis added) (Regulation 4).

5.2.3 Community and Individual Resistance to Competing Land Uses

Although economic development is inevitable, local communities may resist and have been known to resist the setting aside of land in which they have an interest, and this is understandable as it adversely affects their lives in many ways. However, the law makes no provision for the seeking of permission to acquire Trust or other land which the state has the

powers to seize, neither have these communities the 'right to refuse' to give up the land. The position is no different even if the members of the local community do not agree among themselves on a common stand for or against the proposed acquisition.

Under the Land Acquisition Act, interested parties are entitled to be heard, to produce evidence and to question witnesses at an inquiry for compensation once a notice of intention to acquire land has been published by the Commissioner of Lands. The inquiry is merely one to establish the validity of compensation claims and to establish the award. There is no consideration of the question as to whether the acquisition is justified and should take place or whether the interested parties agree to the acquisition or not. The legal position is that the land has already been acquired by the government by the time the inquiry begins, despite the fact that it has yet to take possession it. However, the principle of public participation covers more than the inquiry on compensation. Although it is not set out in the Constitution, it is expected that the local community that is likely to be affected by the project will be given the opportunity to participate openly during the Environmental Impact Assessment process in all the development and environment decisions that will affect them, having been given all the relevant information. This right to participation is a recent phenomenon, introduced with the enactment of the Environment Management and Coordination Act of 1999.

As regards private land, while the owner has legal and enforceable rights upon it, Kenyan law does not give that person property rights to wildlife that may be found on the land. Ownership of wildlife is vested in the state. It is clear from the preamble of the Wildlife (Conservation and Management) Act that the end purpose of managing and conserving wildlife is to benefit *the nation in general and individual areas in particular* (emphasis added) by means of cultural, aesthetic, scientific and economic gains. In so doing, full account must be taken of the varied forms of land use and the inter-relationship between wildlife conservation and management and other forms of land use.

The Land Acquisition Act gives the government power to take over land or any portion of it anywhere in the country for the purpose of development. This power must of course be exercised constitutionally – and fair and reasonable compensation paid - otherwise it may be challenged in court. As indicated, ownership of wildlife vests solely in the state, and the Kenya Wildlife Service, as agent of the government, is responsible for wildlife both within and outside the protected areas. Oil in its natural state within Kenya also belongs to the government. The Petroleum (Exploration and Production) Act, Cap. 308, goes as far as to give a contractor the power to enter onto private land in order to carry out oil operations, as long as the owner or occupier of the land is given forty-eight hours' notice of that intention. A fair and reasonable compensation must be paid for any disturbance of the rights of the owner or occupier of the land, or for any damage occasioned to the property as a result of the activities of the contractor while engaged there (section 10). The government may authorize a contractor to engage in operations within any specified area and the Minister has power to make regulations for the opening up of areas for petroleum operations (section 4). Under the petroleum agreement, the contractor is expected to adopt measures to protect the environment and human life.

The profits from wildlife therefore belong to the government. However, there are a few recognized privately managed conservancies, one of which is the Mara – previously run by the Trans Mara County Council, for the Masai people, and now under a public-private partnership. It is managed by a non-profit company. Some of the profits gained are ploughed back into the conservancy while the rest is set aside for the local council and the residents.

In summary, the powers of the government over land – whether individual, communal or public – are conferred by the Constitution of the land and cannot therefore be challenged as long as they are exercised properly under the law for the promotion of the public benefit. Persons whose rights or interests in land are likely to be extinguished by compulsory acquisition have legal recourse in the courts of the land – but only on the ground that the laid-down process was not followed. In that case the court may quash the acquisition as being unconstitutional. Other than compulsory acquisition, where a person considers that he has legitimate rights or interests that are likely to be interfered with by other specified land uses in any way, again, that person may seek redress in the courts.

5.3 INTERNATIONAL PRACTICES

5.3.1 The International Association of Oil and Gas Producers (OGP)

The International Association of Oil and Gas Producers (OGP) was established to represent its members' interests at governmental, United Nations agencies and international bodies concerned with regulating the exploration and production of oil and gas. It has since expanded these interests to include all aspects of exploration and production operations, with particular emphasis on the safety of personnel and protection of the environment. It further seeks to establish common industry positions on these issues. To that end, it has a Standards Committee that seeks to provide the oil industry with a series of international standards that are recognized and used locally worldwide. It does this by monitoring, coordinating and influencing the development of international standards to meet the needs of OGP members. In this regard, it consults and coordinates with other national, regional and international standards bodies such as the American Petroleum Institute (API), the Australian Petroleum Production & Exploration Association Limited (APPEA), the European Committee for Standardization (CEN), and the International Standards Organization (ISO).

The Standards Committee has developed a set of international standards for the oil and gas industry based mainly on the American Petroleum Institute specifications together with OGP member documents and other relevant input from the industry. The vision for the work is "Global standards used locally worldwide". The Committee works to harmonize standards at national, regional and international level, in order to establish a common position for the global oil and gas industry. A list of American and European adoptions of ISO standards are published in: 'Global Standards Used Locally Worldwide.'[1]

OGP has published an International Standards Catalogue containing guidelines for use in the petroleum and natural gas industries.[2] It is compiled from data received from the members of the Standards Committee, and drawn from international standards used in their own organizations. Inter-governmental and non-governmental organizations such as the United Nations Environmental Program (UNEP), as well as the International Union for the Conservation of Nature (IUCN) and the World Bank (among others) also have an input in the guidelines. The objective of the publication is to make available to the industry these international standards. It is hoped other similar standards will replace regional, national and company standards.

[1] Alain Loppinet (CEN TC12 Chairman), List of ISO TC67 Standards with the adoption in CEN and in API on December 31, 2008 (07/01/2009)

[2] Catalogue of International Standards Used in the Petroleum and Natural Gas Industries, Report No. 362, January 2005.

International Standards are prepared only by recognized international Standards Development Organizations (SDOs). Only two SDOs have produced standards related to the oil and gas industries. They are the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). Some regional and national SDOs and industry organizations have developed standards found to be acceptable for use internationally. Examples are the American Petroleum Institute, the British Standards Institution (BSI) and the Australian Petroleum Production and Exploration Association Limited.

Both the departments of Occupational Safety and Health and the Environment are the custodians and enforcers of the various technical standards used by the industries. Technical standards are crucial to the oil and gas industry as they improve efficiency and eliminate waste, and ensure operations are safe.

5.3.2 The American Petroleum Institute (API)

The United States' federal and state governments have regulatory agencies to protect the environment from the effects of oil exploration and production. The Environmental Protection Agency is the primary federal agency for environmental protection. Regulations cover waste, air quality, and ground water protection. Guidelines have been developed by a workgroup coordinated by the American Petroleum Institute for the proper and safe management of oil exploration and production waste by commercial firms engaged in that business.[3] Although their main purpose is to guide the waste management facility owners to operate in a manner that will protect the environment as well as human health, they are also of significant value to the oil and gas industry.

The American Petroleum Institute is the main United States association for the oil and gas industry. Its standards program is now part of the international program. API's standards, recommended practices and specifications address various key aspects of the oil and gas industry, including exploration and production, refining, protection against fire and the use of safe equipment and operations through sound engineering practices. They are also known to help improve efficiency and cost-effectiveness of operations, safeguard health and protect the environment. Most oil field regulation varies from state to state in the United States and interpretations can also vary, giving rise to disputes.

5.3.3 BSI British Standards

BSI British Standards is the world's first national standards organization, globally recognized for its production of standards and information products that promote and share best practice. It serves the interests of a wide range of industry sectors – manufacturing and service industries, businesses, as well as governments and consumers in the production of standards. Its ISO 9001 Quality Management Systems Requirements is the most popular standard worldwide. The second most popular global standard is the BS EN ISO 14001 Environmental Management Standard. It provides a framework for organizations to control the environmental impacts of their activities, products and services, as well as continually improve their environmental performance. This and other standards and publications help businesses become greener, and help save money and reduce waste.

[3] Guidelines for Commercial Exploration and Production Waste Management Facilities", Exploration and Production Waste Management Facility Guidelines Workgroup, March 2001

The IEC is the world's leading organization that prepares and publishes International Standards for electricity and electronics. Its focus is on safety and performance, the environment, electrical energy efficiency and renewable energies. The IEC also manages conformity assessment systems that certify that equipment, systems or components conform to its International Standards.

5.3.4 The Australian Petroleum Production & Exploration Association Limited (APPEA)

The Australian Petroleum Production & Exploration Association Limited (APPEA) is the top national body representing Australia's oil and gas exploration and production. It encourages and supports member companies to comply with applicable laws, regulations, standards and guidelines for the protection of the environment and in their absence adopt the best practicable means to prevent or minimize environmental impacts.[4]

5.3.5 The European Committee for Standardization (CEN)

The European Committee for Standardization (CEN) develops standards on a wide range of subjects. It seeks to develop the European economy in global trade and in the area of the environment. The standards developed by CEN are also applied as national standards in each of its member countries, every conflicting national standard having been withdrawn.

5.3.6 The Regional Association of Oil and Natural Gas Companies in Latin America (ARPEL)

This Association consists of approximately 30 oil and natural gas companies, representing over 90 per cent of the region's upstream and downstream sectors. It seeks to boost cooperation among states and companies as well as share improvements of the industry's environmental performance in exploration and production.

5.4 BEST PRACTICES

The common thread running through the interests of these industry associations is the recognition that oil companies should adopt best practices when operating in nations (particularly developing countries) that have inadequate environmental laws. ARPEL's 1997 Code of Environmental Conduct states that "all plans, programmes and actions that are developed by the oil industry must, at all stages, be guided by the best available environmental protection practices". The terms "best practice", "best operating practices", "international standards", "guidelines", "guiding principles" and other similar terms are apparently used interchangeably. The World Bank Group's Environmental, Health, and Safety Guidelines ("EHS Guidelines") contain general and industry-specific guidelines for good international practice as regards performance benchmarks and measures on pollution prevention and abatement.[5] All World Bank-financed projects are required to refer to the guidelines.

5.4.1 Environmental Principles

So far, there exists no treaty regulating the oil industry standards within individual nations. The standards and guidelines developed by the oil industry in collaboration with non-governmental

[4] Australian Petroleum Production and Exploration Association Limited (APPEA), "Environmental Policy", June 1997
[5] "Environmental, Health and Safety (EHS) Guidelines", International Finance Corporation (World Bank Group), April 30, 2007

and inter-governmental groups are the only major attempt to introduce and foster uniformity of standards and operating practices globally.

Three broad types of standards to improve environmental performance emerge from the available voluntary guidelines of the international oil and gas industry, namely equipment, environmental practices and environmental management systems and procedures.
From the environmental principles emerging from the codes of conduct and environmental guidelines developed by the above-mentioned oil industry organizations and other bodies, and recognized as being best practices, Alexandra S. Wawryk[6] has identified five that when adequately implemented, should help to minimize the harmful environmental and cultural impacts of oil and gas exploration and production. These practices are:

5.4.2 Environmental Impact Assessment (EIA)

Environmental Impact Assessment ensures that the implications of decisions affecting the environment are taken into account before those decisions are made. It requires that an analysis of the likely effects of the proposed project on the environment be made and recorded in a study report.

5.4.3 Social Impact Assessment (SIA)

Development interventions must of necessity have social impacts on human settlements. There are a wide range of these, some of which are –

- Soil erosion or degradation
- Air pollution
- Water pollution
- Noise and vibration pollution
- Malodors
- Discharge of wastes
- Interference with cultural practices
- Interference with historical and cultural sites
- Conflict with regard to the sharing of water and other resources
- Displacement
- Distress of animals within conservancies and other animal habitations

These impacts must be identified, measured and managed in a way that minimizes the negative ones while enhancing those that benefit the individual residents and the community at large. It is therefore vital that those likely to be affected are given an opportunity to have an input in the manner in which the project should be carried on in the best interests of everyone concerned. Social Impact Assessment can therefore be described as a system of appraisal of the impacts of a proposed project on the everyday lives of persons and communities whose environment will be affected by the project. The established stages in Social Impact Assessment[7] are as follows:

1. Describe the relevant human environment/area of influence and baseline conditions.

[6] "Minimizing the Environmental and Cultural Impacts of Oil Operations in Emerging Economies: Transnational Oil Companies and Voluntary International Environmental Standards".

[7] Vivek Misra, "Social Impact Assessment Methodology"

2. Develop an effective public plan to involve all potentially affected public.
3. Describe the proposed action or policy change and reasonable alternatives.
4. Scoping to identify the full range of probable social impacts.
5. Screening to determine the boundaries of SIA.
6. Predicting responses to impacts.
7. Develop monitoring plan and mitigation measures.

5.4.4 Environmental Management Systems (EMS)

An Environmental Management System is a management tool enabling an organization of any size or type to –

- identify and control the environmental impact of its activities, products or services;
- continually improve its environmental performance; and
- implement a structured approach to setting and achieving environmental objectives and targets.

Some key elements of EMS are:

1. Environmental Policy - a statement of what the organization intends to achieve.
2. Environmental Impact Identification - identification and documentation of the actual and potential environmental impacts of the organization's operations.
3. Objectives and Targets - an environmental audit which forms the basis of determining these.
4. Environmental Management Plan - the methods which the organization will use to achieve its objectives and targets.
5. Continual Review – progress review towards the targets and objectives set by the company to protect the environment.
6. Audit Review and Monitoring Compliance – undertaken regularly to ensure EMS objectives are being achieved.

5.4.5 Environmental Performance Evaluation (EPE)

This principle has been used globally by organizations in various sectors to improve environmental performance and increase operational efficiency. The process entails analyzing and reporting an organization's environmental performance against criteria set by its management.

The ISO 14031 international standard is used for measuring environmental performance. By it an organization's management can gauge whether it is meeting its set standards. It is the standard that assists organizations obtain the highly prized ISO 14001 certification. It is found to be useful even without Environmental Management Systems (EMS) in place. In such a situation, the organization may evaluate its performance by identifying its environmental aspects, isolating the most significant, establishing its environmental performance criteria and assessing its performance against that standard. The organization may then proceed to improve its environmental performance where it is found wanting.[8]

[8]David Putnam," ISO 14031: Environmental Performance Evaluation", Draft Submitted to Confederation of Indian Industry for publication in their Journal, September 2002

5.4.6 Environmental Monitoring, Auditing and Reporting

The objective of this process is to determine whether the measures taken to mitigate adverse environmental impacts as indicated in the environmental impact assessment study report were effective or not.

Whereas all these principles are widely accepted as best practices, the extent to which emphasis is given to each by individual organizations in various jurisdictions may vary. The emphasis on continual improvement is, however, likely to raise environmental standards. In a nutshell, however, the minimum expected of oil companies is compliance with the local environmental legislation, regulations, standards and guidelines for the protection of the environment. Where these do not exist or are otherwise inadequate, it is expected that the company will use the best practices (generally recognized as those accepted internationally) that will ensure the safety and health of personnel and the protection of the environment.

CHAPTER 6:

ANALYSIS OF PROJECT ALTERNATIVES, DESIGN AND TECHNOLOGY

6.1 Project Sites

The Kenyan government through previous exploration works by various companies has identified a number of 'blocks' with potential for oil and gas. These blocks are found in coast, eastern, northeastern and rift valley provinces and Kenya's territorial waters and exclusive economic zones in the Indian Ocean.

The project site in Block 10BB identified by the Kenyan government for the grant of oil and natural gas exploration licenses to interested foreign investors who have the capability to carry out works. Africa Oil Kenya B.V was granted an exploration license by the government in the named project area that encompasses the Kerio and Lokichar Basins. Oil exploration and the identification of specific sites for drilling is a very precise science. For these reasons, the concept of 'alternative site' does not apply, as each block within the country is agreed upon by the Government of Kenya and the interested party, and subsequently licensed, while the specific target to be evaluated through drilling is based on very precise data processing. However, techniques such as directional drilling can be used to avoid interference with sensitive or critical above-ground environments, facilities, or infrastructure.

6.2 Drilling Technique

The project proposes to employ vertical drilling. Given that the areas selected are very sparsely populated and in the natural state (not built up), there is no compelling reason to employ directional drilling methods.

6.3 Campsite Design

The campsite should be built and equipped in such a manner that it can comfortably accommodate up to 150 personnel on site at any one time. It shall be sited (without compromising the prospective oil target) and constructed with advice from professionals, security personnel, and local community leaders. It shall be located at a reasonable distance away from any village, fenced off, and have controlled access.

6.4 Water Reservoirs, Drilling Muds and Pits

Pit construction and management measures should include[9]:

- Installation of an impermeable liner
- Liners should be compatible with the material to be contained and of sufficient strength and thickness to maintain the integrity of the pit. Typical liners may include synthetic materials, cement / clay type or natural clays, although the hydraulic conductivity of natural liners should be tested to ensure integrity;
- Construction to a depth of typically 5 m above the seasonal high water table;
- Installation of measures (e.g. careful placement of beams) to prevent natural surface drainage from entering the pit or breaching during heavy storms;

[9] The IFC (2007) guidelines (see reference list) are referred to in these sections.

- Installation of a perimeter fence around the pit or installation of a screen to prevent access by people, livestock and wildlife (including birds);
- Regular removal and recovery of free hydrocarbons from the pit contents surface;
- Removal of pit contents upon completion of operations and disposal in accordance with the waste management plan;
- Reinstatement of the pit area following completion of operations.

6.5 Exhaust Gas and Fugitive Emissions

Exhaust gas emissions produced by the combustion of gas or liquid fuels in turbines, boilers, compressors, pumps and other engines for power and heat generation, or for water injection or oil and gas export, can be the most significant source of air emissions from onshore facilities. Air emission specifications should be considered during all equipment selection and procurement.

Methods for controlling and reducing fugitive emissions should be considered and implemented in the design, operation, and maintenance of facilities. The selection of appropriate valves, flanges, fittings, seals, and packing's should consider safety and suitability requirements as well as their capacity to reduce gas leaks and fugitive emissions.

6.6 Operational Wastes

Waste materials should be segregated into non-hazardous and hazardous wastes for consideration for re-use, recycling, or disposal. Waste management planning should establish a clear strategy for wastes that will be generated including options for waste elimination, reduction or recycling or treatment and disposal, before any wastes are generated. A waste management plan documenting the waste strategy, storage (including facilities and locations) and handling procedures should be developed and should include a clear waste tracking mechanism to track waste consignments from the originating location to the final waste treatment and disposal location.

6.6.1 Drilling Fluids and Cuttings

Diesel-based drilling fluids should not be used. Spent fluids should be contained for re-use or disposal.

Feasible alternatives for the treatment and disposal of drilling fluids and drilled cuttings should be evaluated and included in the planning for the drilling program. Alternative options may include one, or a combination of, the following:

- Injection of the fluid and cuttings mixture into a dedicated disposal well (Figure 6.1);
- Injection into the annular space of a well (Figure 6.1);
- Storage in dedicated storage tanks or lined pits prior to treatment, recycling, and / or final treatment and disposal;
- On-site or off-site biological or physical treatment to render the fluid and cuttings non-hazardous prior to final disposal using established methods such as thermal desorption in an internal thermal desorption unit to remove NADF for reuse, bioremediation, land farming, or solidification with cement and / or concrete;
- Burial of the drilling muds in man-made or natural pits or landfills that have liners.

Final disposal routes for the nonhazardous cuttings solid material should be established, and may include use in road construction material, construction fill, or disposal through landfill including landfill cover and capping material where appropriate. In the case of land farming it should be demonstrated that subsoil chemical, biological, and physical properties are preserved and water resources are protected.

Plate 1Plate 6.1: Disposal Well and Annular Slurry Injection (U.S. Department of Energy, 2005)

6.6.2 Produced Water

Produced water contains a complex mixture of inorganic (dissolved salts, trace metals, suspended particles) and organic (dispersed and dissolved hydrocarbons, organic acids) compounds, and in many cases, residual chemical additives (e.g. scale and corrosion inhibitors) that are added into the hydrocarbon production process.

Feasible alternatives for the management and disposal of produced water should be evaluated and integrated into production design. The main disposal alternatives may include injection into the reservoir to enhance oil recovery, and injection into a dedicated disposal well drilled to a suitable receiving subsurface geological formation. Other possible uses such as irrigation, dust control, or use by other industry, may be appropriate to consider if the chemical nature of the produced water is compatible with these options. Produced water discharges to surface waters or to land should be the last option considered and only if there is no other option available. Discharged produced water should be treated to meet national and international standards/guidelines for water effluents.

Produced water treatment technologies will depend on the final disposal alternative selected and particular field conditions. Technologies to consider may include combinations of gravity and / or mechanical separation and chemical treatment, and may require a multistage system containing a number of technologies in series to meet injection or discharge requirements. Sufficient treatment system backup capability should be in place to ensure continual operation and or an alternative disposal method should be available.

To reduce the volume of produced water for disposal the following should be considered:

- Adequate well management during well completion activities to minimize water production;

- Recompletion of high water producing wells to minimize water production;
- Use of down-hole fluid separation techniques, where possible, and water shutoff techniques, when technically and economically feasible;
- Shutting in high water producing wells.

To minimize environmental hazards related to residual chemical additives in the produced water stream where surface disposal methods are used, production chemicals should be selected carefully by taking into account their volume, toxicity, bioavailability, and bioaccumulation potential.

6.6.3 Cooling Waters

If cooling water is used, it should be discharged to surface waters in a location that will allow maximum mixing and cooling of the thermal plume to ensure that the temperature is within 3 degrees Celsius of ambient temperature at the edge of the defined mixing zone or within 100 meters of the discharge point. If biocides and / or other chemical additives are used in the cooling water system, consideration should be given to residual effects at discharge using techniques such as risk based assessment.

6.6.4 Sewage, Grey Water and Putrescible Wastes

The domestic sewage will be treated in septic tanks followed by the soak pit system. Black and grey water should be treated separately.

6.6.5 Drainage and Storm Waters

Separate drainage systems for drainage water from process areas that could be contaminated with oil (closed drains) and drainage water from non-process areas (open drains) should be available to the extent practical. All process areas should be bunded to ensure drainage water flows into the closed drainage system and that uncontrolled contaminated surface run-off is avoided.

Drainage tanks and slop tanks should be designed with sufficient capacity for foreseeable operating conditions, and systems to prevent overfilling should be installed. Drip trays, or other controls, should be used to collect run-off from equipment that is not contained within a bunded area and the contents routed to the closed drainage system.

Storm-water flow channels and collection ponds installed as part of the open drainage system should be fitted with oil / water separators that are regularly maintained. Storm-water runoff should be treated through an oil / water separation system able to achieve an oil and grease concentration of 10 mg/L.

CHAPTER 7:

ENVIRONMENTAL IMPACT ASSESSMENT

7.1 Impact Identification, Evaluation, Prediction and Mitigation

7.1.1 Physiography and Geology

No alterations to physiography and geology are envisaged. Natural geohazards are relatively insignificant in this area. Based on the available but rather limited seismic data, the area can generally be categorized as a seismic and the risk of earthquakes is rather insignificant. In addition, the risk of subsidence and landslides is insignificant as well (the area is generally flat lying and far from elevated regions).

Suggested mitigation:

None

7.1.2 Soils

The soils of lacustrine plains (mapping unit PI1) and complex of lacustrine plains and dunes (mapping unit D1+PI3) have a compact B-horizon that becomes very compact with increase in depth. The surface soil is granular and loose in nature where bare patches are exposed. Grazing by animals was evident in PI1 unit. Both units have sand dunes and are severely susceptible to wind erosion in the dry season. Seasonal flooding was also evident. The soils had a moist endopedon. Surface ponding, though not observed during the time of study, is expected in the wet season, due to the surface sealing and crusting nature of the surface soils. The units are also slightly to excessively saline and moderately to excessively sodic thereby, negatively affecting soil structure stability. Compaction has degraded the surface soil structure (PI1), decreasing porosity and water permeability. The infiltration test indicates slow percolation as a result of fine textured and poorly structured (columnar/platy) subsoil; with poor pore matrix distribution.

The soils of the piedmont plains and uplands (Mapping units Y10 and Ux7), are shallow to moderately deep, have medium angular blocky and granular/loose soil, where there are bare patches. The units are gravelly and stony with mapping unit Ux7 classifying as rubble land. The piedmont plains support sparse *Acacia tortilis* and *A. reficiens*, *Indigofera spp vegetation, annual grasses* that are palatable for animal grazing. There are bare patches in between the sparse vegetation. Trampling by goats and camels has degraded the surface soil structure, through compaction, affecting water permeability negatively. The piedmont plains unit is also susceptible to windblown erosion. The two units are also moderately saline and strongly sodic affecting negatively soil structure stability. These two units are very fragile and any significant mechanical disruption of soils or vegetation would further degrade the units into badlands.

The lacustrine plains and complex of lacustrine plains and dunes units are unsuitable for surface water discharge/drainage, and require, therefore, that any drainage channels or waste disposal pits should be lined by impervious materials e.g. clay or synthetic fabrics to avoid contamination of shallow unconfined groundwater that underlies the area. The uplands and piedmont plains have very shallow to moderately deep soils respectively. They are also stony and bouldery respectively. This poses special challenges where discharge of surface water is

concerned. Further, pit excavation would require specialized machinery and equipment, a costly exercise.

Suggested Mitigations:

The waste types anticipated as a result of the exploratory well drilling operation are drill cuttings, waste mud and wash water among others. These are the primary concerns as far as land/soil discharge of waste is concerned.

- Pit excavation of the uplands (Chorea-004A, Mapping unit Ux7) exploratory drill site is not feasible due to the surface conditions. There exists an alternative site within 600m from the exploratory drill site where this can be done. The alternative site (N 02°15'12.9'', E035°55'53.4'') is less stony, with moderately deep sandy loam soils and a bulk density of1.8 g/cm^3 (table 4.4, plate 13). The flow of drill mud, waste water and drill cuttings to the pits can be achieved via piping. The piedmont plain (Kamba, mapping unit Y10) exploratory drill site is less stony and has some bare patches that are moderately deep and lacking an underlying duripan or a continuous hard rock. Pits can be excavated with specialized machinery (wheel/crawler excavators) in these patches. Avoid locating the pits where there in natural vegetation growing, if practicable, due to the fragile nature of the respective units.
- For the lacustrine plains and dunes unit (North Kerio-002, Mapping unit D1+PI3) and lacustrine plains (Mamba-001, mapping unit PI1), the soils are slightly to excessively saline and moderately to excessively sodic, and any surface water spillage may cause soil structural degradation that would result in caving in of the pits. This is due to the high sodium content in the soil that acts as a dispersion agent and deflocculates soil colloids to granular form. Suitable lining material should therefore be used when constructing the waste mud pits. Further, D1+PI3 unit surface soils are locally saline (salt patches) and this would impact on the lining material used. For example, the use of mortar screed (cement and sand) as a lining material would form cracks since the water used would be contaminated. This is risky to the excavated structure and surface and subsurface contamination would be the outcome. Caving of walls in sodic soils' pits is common. Suitable synthetic material or use of bricks should therefore be used in this particular unit. Where the lining material is bricks, the mortar should be mixed with non saline water.
- Since the rate of water infiltration is slow, it would be wise to consider the use of many pits starting with the settling pit, followed by the waste mud disposal basins (second order settling process). The slope regime in PI1 allows for the easy location of the waste mud pits in a cascading manner. All the pits should be lined appropriately preferably using synthetic material. However, mapping unit D1+PI3 is nearly level to level and this arrangement is not practical. The excessive sodium content in the unit also poses more challenges. Therefore the use of bricks as a lining material for the storage pits is recommended.
- The design of the waste mud pits should conform to the guidelines given by the IUCN and E& P forum on Oil and Gas exploration for mangrove areas (IUCN, 1993) on land drilling operations.
- Minimize the quantity of drilling waste by recycling of water and mud
- Select relatively inert drilling muds, e.g. use water based mud like bentonite and minimize the use of biocides.
- Recovery, reuse and recycling of materials should follow the general guidelines outlined in UNEP-production waste management guidelines chapter (E&P, 1997).

- Upon decommissioning of the exploratory well, backfilling of the cuttings / mud pits should be carried out. The recycled mud should be detoxified and the inert material may be mixed with the excavated soil and the landfill restored to its original landform type.

7.1.3 Climate

No major impacts are envisaged on the microclimate of the area.

Suggested mitigation:

- None

7.1.4 Air Quality

The key issue is to maintain good air quality while carrying out the operations. Exhaust gases, fugitive gases, and transient dust should be minimized in and around the campsite and drilling area.

Suggested mitigations:

- Ensure the exploratory well is securely plugged and abandoned (P&A) on completion of the exploratory drilling to avoid and/or minimize emissions of toxic gases.
- Employees to be provided with dust (face) masks as continuous and prolonged inhaling of particulate matter and aerosols may eventually lead to development of health related complications.
- Restrict movement and speed of vehicles to minimum to minimize on sand and dust generation in form of particulate matter. Machinery and vehicles should be switched off when not in use as appropriate.
- Regular servicing of trucks, vehicles, drilling rig and compressors powered using fossil fuels is recommended so as to reduce exhaust emissions.
- Fossils fuels used to power the machinery should preferably be unleaded or low sulfur diesel.
- Where unavoidable, minimize site clearance as much as possible.
- Burning of litter should be done rapidly and in a time of low wind movement, preferably in areas shielded by vegetation.

7.1.5 Surface and Ground Water Resources and Effluents

Water is a key resource in the project area since the local people are mainly pastoralists. The scarcity of water has often led to conflicts and there is need to protect water resources since they form a crucial basic component to the pastoralists. The project area does not have piped water and surface water is extremely scarce. Groundwater therefore forms an important water supply source in this area. There are a number of factors which may contribute to groundwater degradation during the oil exploratory drilling.

The waste generated during exploratory drilling is likely to pose significant environmental challenges. Improper handling and discharge of waste and toxic substances during drilling can pose a threat to the surrounding environment and communities. Groundwater is particularly susceptible to contamination, often leading to profound health impacts to local people and wildlife. The most significant source of water pollution during drilling is inappropriate disposal of

produced water. Reserve pits, also called oil sumps or ponds are another source of contamination. These sumps are open pits for storing drilling wastes e.g. drilling mud that may contain oil and other chemical additives. During periods of exceptionally heavy rains and floods, the pits can overflow contaminating surface water sources and soil. If the pits are not lined or are not land filled when exploratory drilling is over, oil and other toxins can seep into the groundwater through the earthen walls.

Suggested mitigation:

- Reserve pits should be properly lined with impermeable material.
- Aquifer zones should be sealed off during the drilling process to avoid groundwater contamination.
- On completion of the exploratory drilling, the reserve pits have to be back-filled.
- Liquid effluents should preferably be treated before discharge.
- Hazards and toxic waste material should be managed according to international protocols and practices and comply with local regulations as well.

7.1.6 Terrestrial Environment

- **Camp and Drill Rig Construction Phase**

Some of the waste that could be generated during this phase include: solid and industrial waste would be generated during the construction of the drilling facilities. Much of the solid wastes would be expected to be non-hazardous in nature; consisting of containers and packaging materials, miscellaneous wastes from equipment assembly and presence of construction crews (food wrappers and scraps), and woody vegetation. Industrial wastes would include minor amounts of paints, coatings, and spent solvents. Most of these materials would likely be transported off-site for disposal.

- **Drilling phase**

The types of wastes related to drilling, and best practices in their mitigation, have been outlined in Chapters 3 and 6, respectively.

Potential impacts to the terrestrial environment could result due to poor design and construction of the proposed project facilities and poor choice of equipment.

Suggested mitigations:

- Based on internationally acceptable choices of technology and material, a Waste Management Plan should be developed and adapted to the local conditions.
- Ensure that equipment are in perfect working order and cause minimal noise/air pollution nuisance to humans, livestock and wildlife.
- A safety data sheet should be maintained (MSDS) for all potentially hazardous materials, as well as supporting documentation for the transport, use and disposal of such materials.
- Used motor oil and filters from vehicles and generators should be removed from the area for proper disposal. Used motor oil should not be used for dust suppression on access roads. Disposal of chemicals and motor oil should be documented, including quantities involved and disposal locations.

- An emergency response and plan should be prepared to prevent and contain any accidental oil discharges or fuel spillages. All fuel and fluid storage areas should be bunded and the containment capacity of the bund should exceed the maximum amount of stored fuel or fluid. All equipment should be fitted with drip trays and stationary fuel storage facilities should have secondary containment.
- Waste should be sorted out (hazardous, non-hazardous, solid or liquid, etc.) accordingly and disposed of appropriately.

7.1.7 Aquatic Environment

Aquatic environments will be susceptible to contaminants that are conveyed off the camp and drill site by runoff or groundwater seepage, or by inappropriate disposal of the solid wastes generated.

Suggested mitigations:

- Based on internationally acceptable choices of technology and material, a Waste Management Plan should be developed and adapted to the local conditions to protect aquatic environments.
- Equipment should be properly maintained to avoid incidences of leakage.
- Catchment basins for collecting and storing surface runoff should be included in the project design;
- Pits should be appropriately lined;
- Used motor oil and filters from vehicles and generators should be properly disposed of;
- A log of any chemicals and motor oil disposed of should be maintained. This should include the quantity disposed of and the disposal location;
- Drainage systems should be designed and maintained in a manner that will maintain natural water flow regimes, avoid blocking surface drainage, and avoid erosion,
- All surface run-off from the camp should be diverted away from any water source to reduce chances of contamination; and
- Upon cessation of drilling, an abandonment and decommission EMP should be devised and effected as per NEMA regulations.

7.1.8 Land Resources and Natural Heritage Sites

The area does not have any significant land resources or heritage sites. For this reason, it is expected that the impact of the proposed drilling project will be negligible. However, a cautious approach to drilling needs to be taken in order to avoid any potential negative impact.

Suggested mitigations:

- Cutting of trees and clearing of vegetation should only be done within the operation area.
- Consultation with local leaders and elders should be done prior to cutting of any large trees within the operation area
- Use of heavy machinery should be limited within the designated operation areas only.
- Sustained public awareness and sensitization about the proposed project should be implemented throughout the project lifespan.

7.1.9 Visual Aesthetics

The area is relatively pristine and has a natural beauty that should be retained...

Suggested mitigations:

- Adoption of environmentally congruent camp design concepts and use of environmentally friendly technology during drilling would help to maintain the visual aesthetics of the area.
- Backfilling of degraded areas should be encouraged to restore the environment.
- Machinery to be used in the proposed operation should be in good working condition and regularly serviced to prevent any spillage of oil or fuel.

7.1.10 Noise and Vibrations

Ambient noise in the survey area is of low level as it is in a rural setting where there are neither industries nor significant traffic.

Suggested mitigations:

- Heavy machinery and equipment should be operated only when necessary and within specified working hours to avoid any unnecessary nuisance.

7.1.11 Offensive Odors

The main sources of odorous emissions (continuous or non-continuous) may include: combustion sources from sanitary facilities, power generation equipment, exhaust gases from vehicles and equipment, and fugitive emissions. Principal pollutants from these sources include nitrogen oxides, sulphur oxides, carbon monoxide, and particulates**.**

Suggested mitigations:

- Equipment should be in good working order and regularly maintained.
- High standard, efficient, and well maintained sanitation and effluent treatment and disposal facilities should be installed at the campsite and operation area.
- Effluent treatment and disposal facilities should be located downwind of the camp and working sites.
- Vehicles and other machineries should be serviced regularly.

7.1.12 Archaeological, Historical and Cultural Sites

There exists no significant archaeological, historical or cultural site near or within the project site. However, the proponent and his team should appraise themselves with the local culture and traditions prior to commencement of works.

Suggested Mitigations:

- The proponent should work closely with local elders and leaders during operation.

7.1.13 Solid Waste and Waste Oils

The proposed exploratory oil drilling will generate waste materials that include drill mud and rock cuttings. Domestic waste from the campsite will also be generated due to an influx of people as workers and suppliers into the area. Drill rig operation uses a lot a lot of water and similarly discharges a lot of wastewater into the environment.

Waste oils and petroleum used in vehicles and drilling rig machineries may spill or leak into the ground and sea. This may degrade soils and water quality thus affecting domestic water users in the area.

Suggested Mitigations:

- Based on internationally acceptable choices of technology and material, a Waste Management Plan should be developed and adapted to the local conditions.
- The company should liaise with the local authorities in order for them to designate a reserve pit which shall be used to dispose rock cuttings and drilling mud
- All waste generated at the campsite should be sorted, separated and dumped in designated dustbins and either incinerated or recycled where applicable.
- Any hazardous and toxic waste materials should be disposed of in accordance with national and internationally accepted standards.
- Oil drip traps should be maintained regularly as per a maintenance schedule for maximum performance particularly in the garage area.
- A well designed waste water treatment plant should be constructed at the site prior to the commencement of works
- Crude oil from well testing should be stored in tanks and /or burned in flare facilities. The oil should not be spilled nor be discharged in unlined pits.

7.1.14 Social Impacts

The proposed project will attract a concentration of people into the area. They may come in as suppliers, business people or as employees. The influx of people is likely to minimally affect the current socio-cultural setup. The new source of livelihood as a result of the proposed project is unlikely to divert residents from their current pastoral lifestyle. Some of the social issues identified by the community members and their leaders include:

- The community suggested that unskilled labor opportunities that will be realized should be reserved for local youths
- The project may lead to land use conflicts with local pastoral community
- If economically viable oil is discovered, neighboring countries may attack the area. This may also lead to internal conflicts if not carefully handled
- The proposed project may require a lot of water yet the resource is scarce in the area.
- The project may encroach on pasture area for livestock

Suggested mitigations:

- The proponent and his contractor should as much as practical source unskilled labor from the project area
- The proponent should continuously educate the community members to understand the workings of the company in order also to tame expectations

- The proponent should continue with the cordial and harmonious working relationship with the local communities and where possible assist through corporate social responsibilities endeavors
- During the proposed exploratory drilling operation the proponent should develop alternative sources of fresh water
- The proponent should work closely with other agencies already in the area like the County council, ALRMP among others
- Employees from without the district should appraise themselves to the local way of life to avert any possible conflicts with the locals
- The company should liaise with the provincial administration and the police department to provide security during operation.

7.1.15 Economic Impacts

The proposed project is sited in an area that has no significant socio-economic development but with a potential for growth if positively exploited. Infrastructure in the area is non-existence and no industrial activity takes place either. The main economic activity is pastoral livestock production. This is, however, hampered by persistence drought and lack of reliable market to sell livestock and their products. There is minimal retail trade as well as formal employment in the civil service departments like police, schools and dispensaries.

The proposed well drilling operations will have significant positive economic impact in the area. There shall be direct employment opportunities for non-skilled labor and business opportunities for traders from both within and outside the block. The fact that the proponent is entering into the second phase of the oil-prospecting project may stimulate essential service providers and infrastructural development in the area. These may include telecommunication, public service vehicles, electric power supply and road construction among others.

Suggested mitigations:

- The proponent and his contractor should source available materials for use at the base camp from within the area where available
- The company should as far as is practical employ non-skilled labor force from the local communities.
- The proponent should liaise with other organizations to initiate their services in the area
- Consultations with local leaders should be sustained throughout the project cycle.

7.1.16 Occupation, Health and Safety Impacts

The proposed well drilling operations may exposure workers to occupational and health hazards. Such hazards may be related to activities of the operation of machineries at the drilling rig and at the camp site. Issues of concerns on occupational health and safety include:

- Fire and explosion
- Air quality
- Hazardous materials
- Well blowouts,
- Emergency preparedness and response

The project area has no major hospital that can handle serious emergencies and outbreaks. The base camp within the project area will be equipped with hand held fire fighting equipments that can be used during fire emergencies. However, no fire fighting engines are in the area.

There are security concerns in some parts project area related to cattle rustling and banditry. The proponent should at all times make use of the provincial administration and police during operations.

Suggested mitigations:

- Health and safety in nearby communities should be assured through implementation of safe operating practices by workers, restrictions on activities that produce loud noises during night time hours, restrictions on earthmoving and refuse burning activities to preclude downwind impacts on communities or sensitive receptors, and installation and maintenance of adequate site security to prohibit entry by unauthorized persons.
- Convenient sanitary facilities for both sexes shall be provided and cleanliness shall be ensured as per set health standards at the camps.
- All staff working at the drilling rig should at all times have the correct PPE (Personnel Protection equipment)
- The proponent should establish and maintain a high level of emergency preparedness to ensure incidents are responded to effectively and without delay.
- An ERP (Emergency Response Plan) will be in place before any operations commence.
- The company should ensure that it has adequate firefighting equipment and engines available and trained personnel to operate them at all times.
- The company should often implement a risk assessment and security plans in conjunction with the local authorities and provincial administration.
- Regular fire fighting, BOP drills etc. will be carried out at a frequency to be determined.
- The approved EIA and its recommendations will form an integral part of the drilling contract
- Safety awareness on machinery use at the drilling rig should be created through training and regular safety meetings to be held.
- Adherence to environmental health and safety regulations set by the local authority and the company and will be an integral element of the drilling contract.
- Worker health and safety should be assured through the development and implementation of standard workplace practices and the company HSE/OHS policies.
- Any potential ignition sources should be kept to a minimum and adequate separation distance between potential ignition sources and any flammable materials maintained where necessary

7.1.17 Positive Impacts Perceived by the Communities

The local communities in the project area see several positive impacts associated with the proposed project. The communities also want the proponent to make every effort possible to ensure environmental protection during the proposed project. Some of the positive issues identified include:

- The project will provide employment opportunities to the local residents
- The project will promote infrastructural development for instance roads, communication facilities and electricity among others.
- The project will lead to new sources of income generation in the area thus an improvement in living standards.
- The project will spur economic growth in the area and in the entire nation
- The project will improve trade and commerce through opening up of supplies opportunities to pastoralists.
- The project is likely to lead to development of more social amenities like schools, health facilities, banking, and water supply points among others.

- It will lead to improved security in area
- The community will benefit from CSR initiatives by the company for instance educational bursaries, construction of classrooms and dispensaries

7.2 Categories and Significance of Impacts

This categorization of the impacts, contrasting baseline with all components of the survey and post-survey impacts of the project, takes into account the likely potential effects, *in the event of non-compliance with the mitigation measures specified above (see section 2.2)*.

The impacts are further classified as: actual or potential; direct or indirect; short term or long term. Risk levels are classified as low, medium and high.

Table 7.1: Scoping scores and impact classification

Parameter assessed	Baseline				Development and Operation			
	Pressures/Impacts	Duration of Impacts	Risk Level	Impact Score	Pressures/Impacts	Duration of Impacts	Risk Level	Impact Score
Physiography and Geology	None	-	-	0	None	-	-	0
Soils	Compaction by grazing animals and machinery, wind erosion, water erosion	Long-term	HIGH	-2	Gullying, excavations, aggregate materials, compaction by animals, vehicles and machinery	Long-term	HIGH	-2
Climate	Global climate change	Long-term	HIGH	-1	None	-	-	0
Air Quality	Dust generated by wind and enhanced by low vegetation cover	Long-term	MEDIUM	-1	Spread of mainly dust and exhaust gases by vehicular traffic and power generators	Short/Long-term	medium	-2
Surface and Ground water	Pollution of shallow groundwater in luggas from humans and livestock	Short/long-term	HIGH	-2	disposal of drilling and sanitary wastes	Short/long-term	HIGH	-2
	High demand for potable groundwater sources	Short/long-term	N/A	-3	New boreholes commissioned	Short/long-term	N/A	
Terrestrial environment	Minimal land degradation	Long - term	MEDIUM	-1	Minimal floral and faunal disturbance.	Short/Long-term	medium	-1
Aquatic environment	water source contamination siltation / Land degradation	Long-term	MEDIUM	-1	-Water contamination by wastewaters.	Short/ long-term	Medium	-1
Land Resources	Land degradation	Long-term	MEDIUM	-1	Local disposal of wastes	Short-term	LOW	-1
Offensive Odors	Local, related to human/livestock organic wastes	Short-term	LOW	0	Improper disposal of effluent and solid waste and uncontrolled exhaust emissions	Short/ Long-term	MEDIUM	-1
Archaeological, cultural sites, Landscape	Sacred sites, Yaa Shrines, Oasis	Long-term	LOW	0	Disturbance of Sacred sites	Long-term	HIGH	0
Economic setting	Slow economic growth rate	Long-term	LOW	-1	Diversification of alternative livelihoods, job creation, etc. New investors coming to the area	Short/Long-term	LOW	2
Social setting	Stable community	Long-term	MEDIUM	2	Opening of markets, migrants, etc. Interaction with outside world	Long-term	MEDIUM	-1
Health setting	Inadequate provision of services	Long-term	MEDIUM	-1	Vulnerability to dusts/gases, accidents at workplace and surrounding areas Impact related to solid waste disposal during decommissioning	Short/Long-term	HIGH	-2

CHAPTER 8:

ENVIRONMENTAL MANAGEMENT PLAN

8.1 Institutional Arrangements

The policy, legal and institutional framework has been discussed at length in Chapter 5. The proponent will need to make local institutional arrangements in order to ensure the optimal functioning of the Environmental Management Plan (EMP). It will also be essential for Africa Oil Kenya B.V. to liaise with the local authorities in the area to keep them appraised of their operating procedures, changes, or developments that may be of concern to local interests. It is also essential that there is liaison with any emergency rescue teams. Finally, it is critical for the company to maintain good relations with the community through reliable and factual information distribution. The company should cooperate with other recognized community organizations in order to minimize environmental, social, health and safety impacts through coordinated awareness campaigns and other avenues of public education and information exchange.

8.2 Environmental Management Plan (EMP)

The EMP for the proposed project provides all the details of project activities, impacts, mitigation measures, time schedules, costs, responsibilities and commitments proposed to minimize environmental impacts of activities, including, monitoring and evaluation during implementation, operation and decommissioning phases of project. It should be noted that well abandonment and decommissioning will require a separate EIA study report and license from NEMA and is, therefore, not covered in this EMP.

Table 8.1: Environmental management plan (EMP)

Environmental Issue	Mitigation	Monitoring Parameters	Monitoring Frequency	Management Measures / Responsibility	Net Effect	E.g. Cost (Ksh.)
Physiography and Geology	- None	None	None	-	-	Nil
Soils	- See section 6.1.2	Checking of soil stability by soil expert	Quarterly	- Avoid/minimize activities that can extensively impact on soil structure and stability	Soil conservation	As appropriate
Climate	- None	None	None	-	-	Nil
Air Quality	- See section 6.1.4	Check dust levels	Quarterly	- Monitor use and status of vehicles and machinery.	Preservation of air quality	As appropriate
Water Resources and Effluents	- See section 6.1.5	- Adherence to riparian zones - Microbial load in potable water - Treated effluent, if Any	Quarterly	- Checks on adherence to riparian zones - Implementation of waste/effluent management plan	- Protected surface and groundwater resources - Safe water supply	As appropriate
Terrestrial Environment: Flora and Fauna	- See section 6.1.6	- Protection of ecologically Sensitive areas. - Area of Vegetation cleared.	Quarterly	- Adherence to EMP - Rehabilitation plan developed for post-drilling period Planting of wind and dust breaks around the drilling site	- Minimize disturbance of Flora and Fauna.	As appropriate
Aquatic Environment	- See section 6.1.7	- Aquatic habitats - Areas cleared of vegetation	Quarterly	- Adherence to EMP - Rehabilitation plan developed for post-drilling period	- Avoid alteration of aquatic habitats - Avoid disturbance to flora and fauna	As appropriate
Land Resources and Natural Heritage Sites	- See section 6.1.8	- Visual inspections	Monthly	- Consultation with local stakeholders	- Protected and preserved land resources and natural	As appropriate

					- heritage sites	
Visual Aesthetics	- See - section 6.1.9	None	None	- Project design and - drawings refers (drilling and camp sites)	- Acceptable visual effects	Nil
Noise and Vibrations	- See - section 6.1.10	Noise levels using dosimeter	As appropriate	purchase vibrometer/ dosimeter	Noise and vibration maintained at an acceptable level	As appropriate
Offensive Odors	- See - section 6.1.11	- Regular checks and servicing on sanitation and machinery/vehicles	- Every other day for sanitation - As - appropriate for machinery/ - vehicles	- Implementation of - maintenance schedules	- Clean - environment	As appropriate
Solid Wastes, Waste Oils	- See - section 6.1.12	- Visual for solid - wastes, oils and - grease for waste oils	- Visual - checks - every other - day	- Implementation of waste management plan	- Cleanliness maintained and pollution - checked	As appropriate
Social Impacts	- See - section 6.1.13	- Monitor social impacts	- As appropriate	- Regular consultation /discussions with local - leaders/ stakeholders - Africa Oil Kenya B.V. complies - with all applicable - legislative, statutory, local by-laws & respects - community traditions and culture	- Improved - social - harmony, acceptance, cooperation and community empowerment	As appropriate

Economic Impacts	- See section 6.1.14	- Periodic assessments of economic impact on the community	- As appropriate	- Regular consultations with local stakeholders - Employ local people as appropriate	- Quantified and measurable impacts	As appropriate
Occupation, Health and Safety Impacts	- See section 6.1.15	- Inspection for compliance to OHS and HSE policies - Adherence to security protocols	- Every other day	- Africa Oil Kenya B.V complies with all applicable legislative, - Statutory, local by-laws & communal rites. - Security protocols adhered - Relationship building with provincial administration - Enlighten community on government findings on - alleged disposal of - hazardous wastes	- Health well maintained - Safety assured -	As appropriate
Positive impacts perceived by the community	- See section 6.1.16	-As appropriate	- As appropriate	- As appropriate	- Community empowerment	As appropriate

8.3 Timeframe and Cost of Implementation of the Project

The project will be launched in the first half of 2011, and the cost of the project is about US $ 6million

CHAPTER 9:

CONCLUSIONS AND RECOMMENDATIONS

9.1 Summary of the Project Components

Africa Oil Kenya B.V. acquired a Production Sharing Contract (PSC) from its predecessor company Turkana Drilling Consortium (K) Ltd and obtained Exclusive Prospecting Rights (EPR) for Block 10BB. Through the initial EIA study for seismic survey. Turkana Drilling was granted a license by NEMA to explore for oil and natural gas in Block 10BB which was later given to Africa Oil Kenya B.V. and commenced seismic operations mid 2010. The seismic operation is complete and the Company has pre-selected areas where the exploratory well(s) will be dug. The company intends to drill initial exploratory well for the purpose of evaluating the hydrocarbons prospects safely, evaluate the prospects without adverse impact to the environment, and determine the hydrocarbon potential of the designated prospect.

The proposed exploratory well drilling will use environmentally friendly state-of-the-art technology, and conform to international HSE standards. Africa Oil Kenya B.V. has undertaken an extensive EIA study that aims at examining the current environmental, social, cultural and psychological setting on the ground. The company is therefore conscious about the need for a proactive environmental and social approach. There are possible impacts from the proposed seismic operation that have been identified and appropriate mitigation measures suggested. Members of the public interviewed had a positive view of the proposed project and are happy with the open approach that the company has taken in involving the local communities by setting up local committees to handle cases of employment opportunities and other matters on behalf of the company at grass root levels and in providing assistance as have been seen through development projects. The mitigation measure suggested in this report and the environment management plan developed will ensure that the project is technically, environmentally and socially sound and acceptable

9.2 Recommendations

The development and implementation drilling operations in the project area will use proven state of the art techniques. Potentially minor adverse impacts can be avoided by good site management and construction practices, particularly related to solid and liquid waste management.

The Environment management and monitoring plan suggested should be followed and the company should strive to set high environmental standards at all times. From an environmental point of view, it is therefore objective to conclude that the project is viable and will not adversely affect the environment. However, the following recommendations should be considered during development and implementation of the drilling operations:

- If the initial exploratory drilling is unsuccessful, the company should ensure that the exploratory wells are securely plugged on completion of the exploratory drillings to avoid and/or minimize emissions of greenhouse and other toxic gases,
- Regular servicing of trucks, vehicles, drilling rig and compressors powered using fossil fuels is recommended so as to reduce exhaust emissions.
- Fossils fuels used to power the machinery should preferably be unleaded or low sulphur diesel.
- Minimize site clearance as much as possible.

- Burning of litter should be done rapidly and in a time of low wind movement, preferably in areas shielded by vegetation.
- Reserve pits should be properly lined with impermeable material.
- Aquifer zones should be sealed off during the drilling process to avoid groundwater contamination.
- On completion of the exploratory drillings, the reserve pits have to be back-filled
- Avoid clearing/altering any land unless necessary; if unavoidable, use best practices that minimize disturbance of the land resources, flora and fauna.
- Ensure that equipment are in good working order and cause less noise/air pollution nuisance to fauna.
- Hunting, trapping and gathering of flora and fauna by workers, when on and off duty should be strictly prohibited. This prohibition should extend to the purchase of these items from the indigenous population by workers.
- A plan should be put into place to avoid the release of hydrocarbons, hydrocarbon-containing substances, drilling muds, or any other potentially toxic substance into the aquatic environment and the surrounding area. In addition, storage of these materials should be in enclosed and bunded tanks whenever feasible or, if not, in lined mud pits or other approved sites.
- Initiate temporary and permanent erosion and sediment control measures, slope stabilization measures, and subsidence control and minimization measures near and around the operation area as necessary
- The company should liaise with the appropriate authorities to designate a reserve pit which shall be used to dispose rock cuttings and drilling mud
- All waste generated at the campsite should be sorted, separated and stored in designated dustbins and incinerated, recycled, or disposed off appropriately
- Any hazardous and toxic waste materials should be disposed of in accordance with national and internationally accepted standards.
- The proponent and his contractor should as much as is practicable source unskilled labor from the project area
- The proponent should develop a cordial and harmonious working relationship with the local communities.
- Employees from outside the district should appraise themselves to the local way of life to avert any possible conflicts with the locals
- The company should liaise with the provincial administration and the police department to provide security during operation.
- All staff working at the drilling rig should have PPE appropriate for their duties
- The proponent should establish and maintain a high level of emergency preparedness to ensure incidents are responded to effectively and without delay (ERP)

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APPENDICES:

1. Minutes of the meeting
2. Copies of laboratory results
3. Certificates
4. Pin number
5. Other relevant documents

Application Reference No. PR/7764

Registration No: 0008076

For official use

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY (NEMA)

THE ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION ACT

ENVIRONMENTAL IMPACT ASSESSMENT LICENCE

This is to certify that the Project Report/Environmental Impact Assessment Study Report received from AFRICA OIL KENYA B.V. (Name of individual/firm) P.O. BOX 63298-00619, NAIROBI (Address) submitted to the National Environment Management Authority in accordance with the Environmental Impact Assessment & Audit Regulations regarding PROPOSED EXPLORATORY WELL DRILLING IN BLOCK 10BB (title of project) whose objective is to carry on DETERMINATION OF THE PRESENCE OF OIL BY DRILLING EXPLORATORY TEST WELLS (briefly describe purpose) located at TURKANA SOUTH AND TURKANA CENTRAL DISTRICT (locality and district) has been reviewed and a licence is hereby issued for implementation of the project, subject to attached conditions.

Dated this 4TH day FEB of 20 11

Signature .....

(SEAL)

Director General
The National Environment Management Authority

CONDITIONS OF LICENCE

1. This licence is valid for a period of 24 MONTHS (time within which the project should commence) from the date hereof.
2. The Director–General shall be notified of any transfer/variation/surrender of this licence.

P. T. O.

1.0 General Conditions

1.1 This project is for the proposed exploratory well drilling in Block 10BB in Turkana South and Central Districts only.

1.2 The license shall be valid for 24 months from the date of issue.

1.3 Without prejudice to the other conditions of this license, the proponent shall implement and maintain an environmental management system, organizational structure and allocate resources that are sufficient to achieve compliance with the requirements and conditions of this license.

1.4 The Authority shall take appropriate action against the proponent in the event of breach of any of the conditions stated herein or any contravention to the Environmental Management and Coordination Act, 1999 and regulations therein.

1.5 This license shall not be taken as statutory defence against charges of environmental degradation or pollution in respect of any manner of degradation/pollution not specified herein.

1.6 The proponent shall ensure that records on conditions of licenses/approval and project monitoring and evaluation shall be kept on the project site for inspection by NEMA's Environmental Inspectors.

1.7 The proponent shall submit an Environmental Audit report in the first year of occupation/operations/commissioning to confirm the efficacy and adequacy of the Environmental Management Plan, if the drilling operations last for one year or more.

1.8 The proponent shall comply with NEMA's improvement orders throughout the project cycle.

2.0 Drilling Conditions

2.1 The proponent shall put up a project signboard as per the Ministry of Public Works standards showing the NEMA EIA license number among other details.

2.2 The proponent shall ensure that all excavated material and debris is collected, re-used and where need be, disposed off as per the Environmental Management and Coordination (Waste Management) Regulations of 2006.

2.3 The proponent shall ensure strict adherence to the provisions of Environmental Management and Coordination (Noise and Excessive Vibrations Pollution Control) Regulations of 2009.

2.4 The proponent shall ensure strict adherence to the Occupational Safety and Health Act (OSHA), 2007.

2.5 The proponent shall ensure that drilling workers are provided with adequate personal protection equipment (PPE), sanitary facilities as well as adequate training.

2.6 The proponent shall ensure strict adherence to the Environmental Management Plan developed throughout the project cycle.

2.7 The proponent shall ensure that the development adheres to zoning specifications issued for development of such a project within the jurisdiction of relevant Local Authorities, with emphasis on approved land use for the area.

3.0 Operational Conditions

3.1 The proponent shall obtain a permit to drill the camp borehole from the Water Resources Management Authority (WRMA).

3.2 The proponent shall ensure that domestic and industrial solid waste are properly handled and disposed as per the Environmental Management and Coordination (Waste Management) Regulations of 2006.

3.3 The proponent shall ensure that all waste water is disposed as per the standards set out in the Environmental Management and Coordination (Water Quality) Regulations of 2006.

3.4 The proponent shall ensure that all drainage facilities are fitted with adequate functional oil water separators and silt traps.

3.5 The proponent shall ensure that appropriate and functional efficient air pollution control mechanisms are installed in the facility to control all air emissions.

3.6 The proponent shall ensure that all equipment used are well maintained in accordance with the Environmental Management and Coordination (Noise and Excessive Vibration Pollution Control) Regulations of 2009.

3.7 The proponent shall ensure that all workers are well protected and trained as per the Occupational Safety and Health Act (OSHA) of 2007.

3.8 The proponent shall comply with the relevant principal laws, by-laws and guidelines issued for development of such a project within the jurisdiction of Kenya Wildlife Service, Water Resources Management Authority, Ministry of Lands and Settlement, Ministry of Energy and relevant Local Authorities.

3.9 The proponent shall ensure that environmental protection facilities or measures to prevent pollution and ecological deterioration such as proper rehabilitation of the site, occupational health and safety mechanisms are designed, constructed and employed simultaneously with the proposed project.

4.0 Notification Conditions

4.1 The proponent shall seek written approval from the Authority for any operational changes under this license.

4.2 The proponent shall ensure that the Authority is notified of any malfunction of any system within 12 hours on the NEMA hotline No. **020 6006041** and mitigation measures put in place.

4.3 The proponent shall keep records of all pollution incidences and notify the Authority within 24 hours.

4.4 The proponent shall notify the Authority in writing of its intent to decommission the facility fourteen (14) days in advance.

5.0 Decommissioning Conditions

5.2 The proponent shall ensure that a decommissioning plan is submitted to the Authority for approval at least fourteen (14) days prior to decommissioning.

5.3 The proponent shall ensure that all pollutants and polluted material is contained and adequate mitigation measures provided during the phase.

Application ReferenceNo:...PR/7764
Certificate No: ....0000056....

For official use

THE ENVIRONMENTAL MANAGEMENT AND COORDINATION ACT

CERTIFICATE OF TRANSFER OF ENVIRONMENTAL IMPACT ASSESSMENT LICENCE

This is to certify that the Environmental Impact Assessment Licence No:.....0008076.....

Issued on. .....04/02/2011.....(date) to.....AFRICA OIL KENYA B.V.....

.BOX 63298-00619,...NAIROBI.....(name of previous holder) of .....(address)

regarding PROPOSED EXPLORATORY WELL DRILLING IN BLOCK 10BB .....(title of project) .....

.....whose objective is to ...DETERMINATION OF THE.....

..PRESENCE OF OIL BY DRILLING EXPLORATORY TEST WELLS.....

(briefly describe purpose) located at...TURKANA SOUTH AND TURKANA CENTRAL DISTRICT

(locality and district) has been transferred to .....TULLOW KENYA B.V.....

(name of new holder) of .....P.O. BOX 63298-00619, NAIROBI.....(address)

with effect from ..7TH OCTOBER 2011..... (date of transfer) in accordance with the provisions of the Act.

Dated this .....21ST..... day ...OCT..... of 20...11.....

Signature.....

(SEAL)

for *Director General*
The National Environment Management Authority

Important notes.

1. the transferee as well as the transferor of a licence under this regulation shall be liable for all liabilities, and the observance of all obligations imposed by the transfer in respect of the licence transferred.
2. the transferor shall not be responsible for any future liabilities or any obligations so imposed with regard to the licence from the date the transfer is approved.

GPK (L)

Application Reference No: PR/7764

Certificate No: 0001253

For official use

THE ENVIRONMENTAL MANAGEMENT AND COORDINATION ACT

CERTIFICATE OF VARIATION OF ENVIRONMENTAL IMPACT ASSESSMENT LICENCE

This is to certify that the Environmental Impact Assessment Licence No: 0008076

Issued on 21ST OCTOBER, 2011 (date) to TULLOW KENYA B.V.

(name of individual/firm)

of P.O. BOX 63298-00619, NAIROBI (address) regarding

the proposed Exploratory Well Drilling in Block 10BB (title of project)

whose objective is to determine the presence of oil by drilling exploratory test wells

(briefly describe purpose)

located at Turkana South and Turkana Central Districts (locality and district) has been varied to extension of license validity for an additional twenty-four (24) months

(nature of variation) With effect from 14th May, 2013 (date of variation) in accordance with the provisions of the Act.

Dated this 24TH day of MAY 2013

Signature .....

(SEAL)

Director General

The National Environment Management Authority

GPK (L)