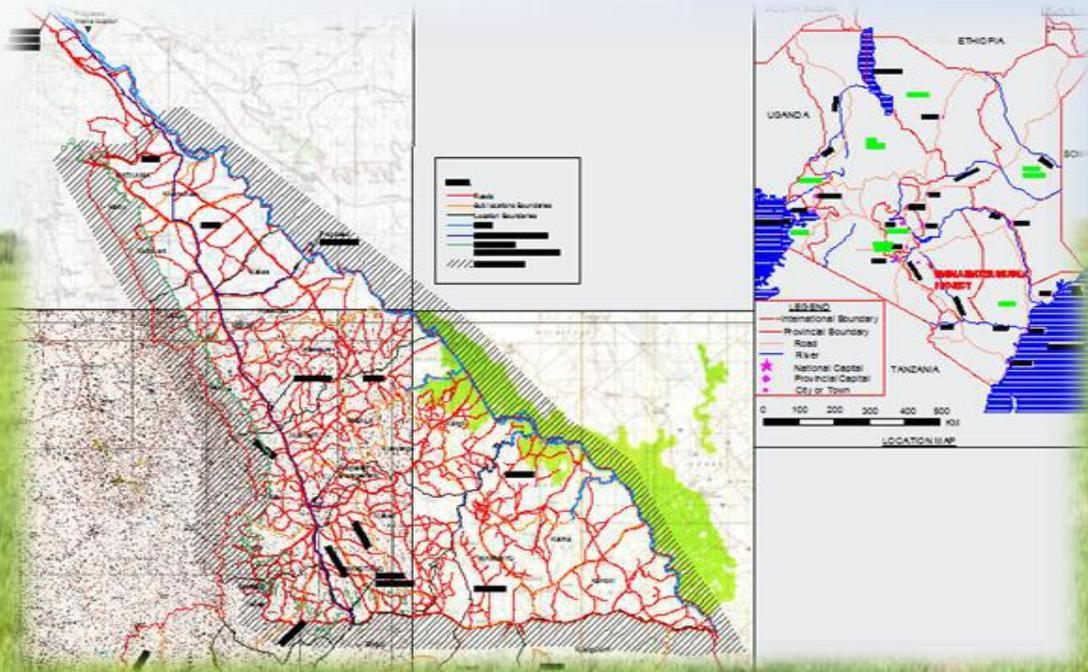




# CONSULTING SERVICES FOR PREPARATION OF DETAILED DESIGN, BIDDING DOCUMENTATION, SUPERVISION AND COORDINATION OF MWALA WATER SUPPLY SYSTEMS IN TANATHI WATER SERVICES BOARD AREA

## ENVIRONMENTAL IMPACT ASSESSMENT PROJECT REPORT FOR ONE PRODUCTION BOREHOLE AT MAKUTANO



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## ABBREVIATIONS

AWSB	Athi Water Services board
DISP	Dispensaries
EMCA	Environmental Management and Coordination Act
EMP	Environmental Management Plan
ESIA	Environmental and Social Impact assessment Report
IC	Individual connection
km	Kilometre
KSHS	Kenya shillings
l	Litre
l/hr	Litre per hour
l/h/d	Litre per head per day
m	Metre
m.a.s.l	metres above sea level
MDGS	Millennium Development Goals
mm	millimetre
m <sup>3</sup>	Cubic metre
m <sup>3</sup> /hr	Cubic metre per hour
m <sup>3</sup> /day	Cubic metre per day
NC	Not connected
NEMA	National Environment Management Authority
OP	Operational Policy
PRSP	Poverty Reduction Strategy Paper
p/km <sup>2</sup>	Person per square kilometer
TAWSB	Tanathi Water services Board
WB	World Bank

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## COMPLIANCE

In undertaking this task, the lead expert Eng. Stephen Mwaura endeavored to comply with the legal requirements provided for and to guide the practices, activities and conduct of environmental impact assessment, as contained in the National Environmental Management and Coordination Act (EMCA 1999), the compliance to Environmental (Impact Assessment and/ Audit) Regulations, 2003 and other subsequent legislations relating to the environment. The required professionals standards and practices have been applied in carrying out this work according to the provisions provided for by the NEMAs code of practice and professional ethics and conduct for environmental impact assessment and audit experts.

**This environmental impact assessment has been conducted and prepared by:**

<b>Environmental Expert</b>	<b>Category</b>	<b>Reg. No.</b>	<b>Signature</b>
Eng. Stephen Mwaura	Lead Expert	7284	
Esther Ngoiri Ndung'u	Associate Expert	6848	
Beatrice Njoki Karanja	Associate Expert	7014	

**This EIA Report has been prepared on behalf of:**

(Proponent) Mr. /Mrs. /Ms. ....

**ATHI WATER SERVICES BOARD,**

**P.O Box 45283-00100 NAIROBI**

**NAIROBI, KENYA.**

Sign: \_\_\_\_\_ Date: \_\_\_\_\_

## EXECUTIVE SUMMARY

Athi Water Services Board (AWSB) and Tanathi Water services Board, are one of the eight regional Water Services Boards under the ministry of Water and Irrigation. The regional Boards were created to deliver reforms in the Water Sector and were mandated to provide water and sanitation services throughout the country.

Mwala and Masii towns in Mwala District, Machakos County face acute water shortages. The daily water demand is about 200m<sup>3</sup>/hr against a current supply of 17m<sup>3</sup>/day. The World Bank through International Development Association through Athi and Tanathi Water Services Boards wish to fund the Rehabilitation/ Augmentation of Mwala Water Supply to bridge the gap between water demand and supply. Drilling of one production borehole at Makutano on Plot LR. NO. Mwala/ Mathunthini /442 is one of the key components of the project.

The project area is located on the eastern side of Mango basement hills range and the proposed site is covered by brown sandy soils underlain by gneisses of the Mozambican Orogenic Belt. Generally, the project area has medium groundwater potential. The borehole will be drilled at site **VES 15** to depth of **130m** which will ensure that the envisaged entire aquifer zone will be fully penetrated.

In order to comply with the legal requirement stipulated in the Environmental Management and Coordination Act 1999 and the subsequent Legal Supplement of 2003, this environmental impact assessment report has been prepared. The investigation examined the potential impact of the project on the immediate surroundings with due regard to all phases from the construction through to completion and implementation. It encompassed all aspects pertaining to the physical, ecological, social-cultural, health and safety conditions at the site and its environs during and after drilling. The study was based on the laid down scientific quantitative and qualitative procedures with the most recent methodologies and analysis required in EIA and strictly adheres to the relevant legislative framework governing the drilling industry.

Based on the field observations and discussions with the public in the project area during the field visits, drilling of the one-production borehole is not expected to cause significant negative environmental and social impacts since its implementation will not result in resettlement or health and safety concerns of high magnitude. From the scoping survey most of the identified potential negative impacts can be mitigated during implementation of the project. The few potential negative impacts identified are effectively mitigatable with implementation of the ESMP.

## **1.0 INTRODUCTION**

Makutano and Masii Towns face acute water shortages. In an effort to provide enough water to the residents of the two towns, Mwala Water and Sanitation Company Limited has been wishing to drill a borehole at a strategic location so as to use the distribution tank at King'atuani to serve the two Towns. The World Bank through International Development Association, Athi and Tanathi Water Services Boards wish to fund the Rehabilitation/ Augmentation of Mwala Water Supply to bridge the gap between water demand and supply. Drilling of one production borehole at Makutano on Plot Lr. No. Mwala/ Mathunthini /442 is one of the key components of the project.

### **1.1 Justification of the project**

Lack of safe water for domestic use is the biggest problem in the area and a hindrance to a better lifestyle for the people. This has led to a great desire to provide water to this area and as a result, the drilling of one production borehole at Kyamwai. Currently, only one borehole is providing about 17 cubic meters of water per day. The Client requires about 200 cubic meters of water daily for Mwala Water Supply. There is a glaring gap between the demand and availability of drinkable water for daily use in this area.

The EIA Scoping and public consultations/awareness was done during initial visits and this provided baseline information for the project. This was supplemented by information from consulting engineers preliminary design report. In view of the benefits resulting from provision of good quality water to the people of Mwala who are currently suffering from acute shortage of water for domestic consumption, the fact that the project is in line with vision 2030 to reduce the population without access to safe domestic water supports the need of the project and its implementation.

### **1.2 Project objectives**

The objective of the project is to develop more potable water supply for the Kyamwai and entire Mwala community and ensure sustainability and compliance with NEMA EIA/EA regulations and World Bank Safeguard Policies during the project cycle i.e. construction, operation and decommission phases of the project. The activities of the project will be analyzed and assessed to identify the potential benefits and losses and to formulate mitigation measures for the negative impacts or losses to the target community and the wider area.

The summary of these objectives is as follows;

- To identify the potential environmental impacts resulting from the proposed interventions.
- To assess the significance of these impacts
- To assess the alternative plans, designs and sites of proposed project
- To propose the mitigation measures against these negative effects

- To generate baseline data on how mitigation and evaluation measures are carried out during implementation of the project.
- To present information on environmental impacts of proposed alternatives.
- To prepare environmental management and monitoring plans for the proposed project.
- To assess the compliance of the project with provisions of legal, institutional frameworks as provided in EMCA 1999 and World Bank Operational Policies.
- To suggest measures to prevent health and safety hazards and to ensure security in the working environment for the employees, residents and for the management in case of emergencies. This encompasses prevention and management of the foreseeable accidents and hazards during both the construction and occupational phases.

### **1.3 Scope of the report**

The study was conducted to identify the proposed project implementation activities in order to identify the associated potential positive and negative impacts in order to formulate the necessary mitigation measures at an early stage. The negative and positive impacts of the project activities were assessed in form of benefits and losses to the community and in the light of the mitigation measures before the decision are made on the way forward. The decision to approve or disapprove the project implementation lies with NEMA.

The EIA study includes assessment of impacts of the project during construction, operation and decommissioning activities on the following;

- Physical environment
- Flora and Fauna
- Land use
- Social economic aspects
- Public and occupational health and safety.

The study assessed the impacts of the proposed development on the environment in accordance with EMCA (1999) covering the following;

- Baseline information
- Activities of the project
- Design of the project
- Materials to be used
- Methodology
- Assessment of potential environmental impacts of the project and mitigation measures
- Economic and social impacts to the local community and mitigation measures
- Health and safety measures

- Environmental management and monitoring plan

### **1.3.1 Scoping process**

The impacts of the proposed project were assessed through project site visits and the following;

- Evaluation of the location and the current land use of the affected plots.
- Evaluation of the design and proposed construction activities, materials and methodology
- Discussion with the project neighbours the potential impacts related to project implementation activities and corresponding mitigation measures

### **1.4 Methodology**

Environment screening in which the project is identified as among those requiring Environmental Impact Assessment under schedule 2 of EMCA, 1999.

The study was carried out through:

- Desk studies and literature review
- Field survey
- Public participation/ sensitization by consultative interviews with neighbors

### **1.5 Cost estimates**

The NEMA environmental lodgment fee is a minimum of Kshs 10,000 or 0.1% of the project budget. The capital costs of the proposed borehole drilling project are estimated to be Kshs 3,532,000.00, therefore the NEMA lodgment fee will be **Kshs 10,000**.

## 2.0 BASELINE INFORMATION

### 2.1 Nature of the project

The proponent intends to drill a borehole with a daily abstraction capacity and a depth of 130 metres for purposes of producing water and supplementing water to Kyamwai residents and entire Mwala community. The boreholes in this area have variable yields ranging between 0.84 and 18.0m<sup>3</sup>/hour. The proposed borehole is expected to give a yield within the upper half of this range.

### 2.2 Administrative Location

The study site is located on Plot Lr. No. Mwala/ Mathunthini /442 within Kyamwai Village, located some 1.5km off the Makutano- Kitui Road in Machakos County. The site lies on Coordinates 37°28'27.7"E, 01°23'50.6"S.

Administratively the site is located in Makutano in Mwala district and in Kyamwai Village. Water from the borehole is meant to serve the areas in Mathunthini sub-location with an estimated population of 2,786 people and augment water supply to Makutano town.

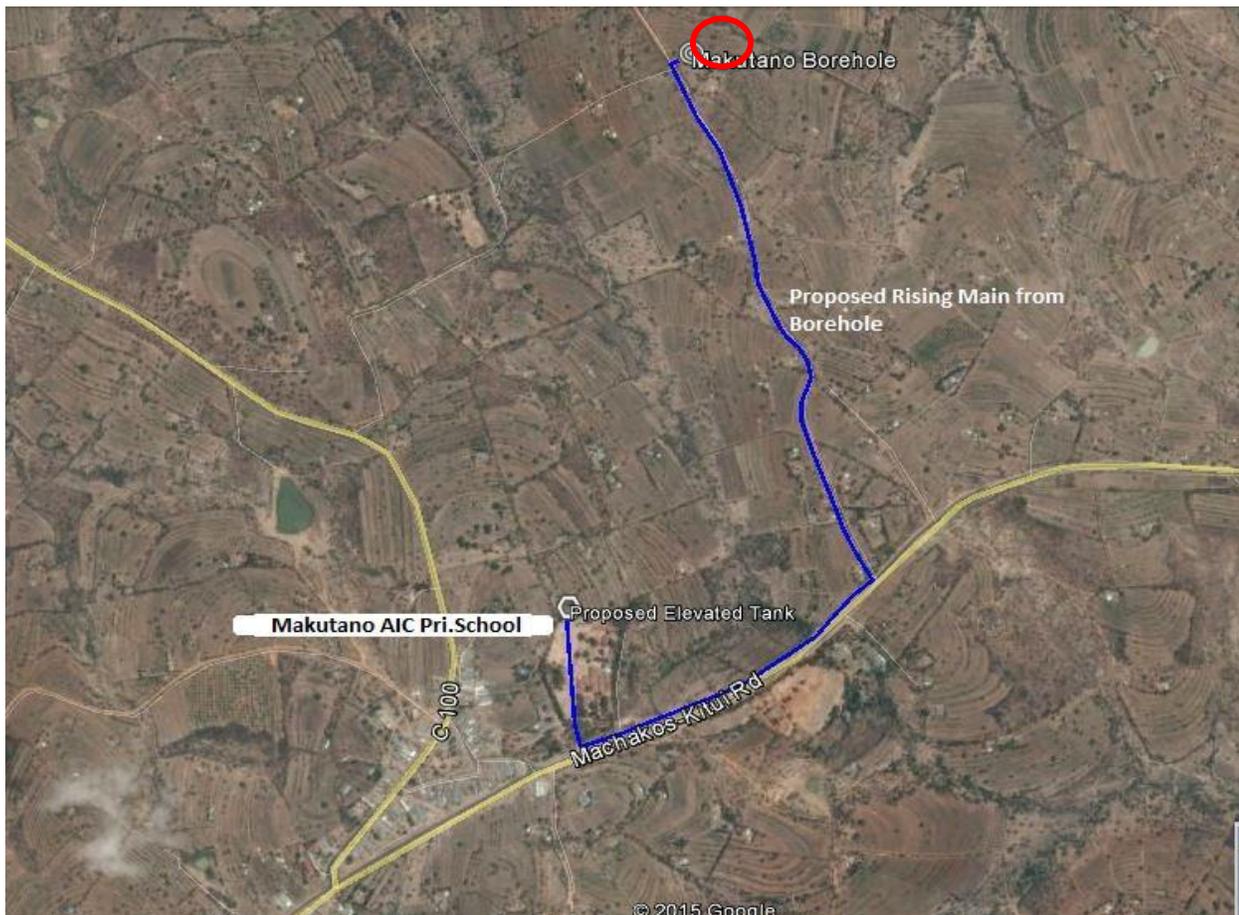


Figure 1: Google map showing the proposed development site

### **2.3 Land use**

Mwala Sub-County is mostly a dry countryside with scarce vegetation. Within Mwala, trees can be established in various niches in the farm such as boundaries, scattered in cropland and others. Most of the people in Mwala have at least one tree scattered or in hedges within cropland. The most common tree species in the Mwala are *Mangifera indica*, *Grevillea robusta*, *Croton megalocarpus*, *Eucalyptus camaldulensis* and *Persea Americana* (Bourne M. et al, 2015)

Mwala faces a challenge of low agricultural productivity, which threatens the ability to achieve food security for the growing population. The low productivity can be attributed to a number of factors including climate variability and low soil fertility as it lies in the arid to semi-arid area in the country. The soils are sandy loam and can be used for agricultural activities if the area was to receive adequate rainfall. The soils exhibit low water holding capacity and low amount of humus in some of the areas in Mwala District.

However, agriculture is one of the main economic activities carried out in Mwala. Some of the crops grown include maize, sorghum, millet, vegetables, mangoes, pulses and red chilli pepper-an emergent cash crop with potential under low rainfall. These crops are well adapted to the temperatures and rainfall patterns in the area.

Livestock farming is also practiced in the sub-county. This includes keeping of dairy cattle, beef cattle, sheep and goats as well as donkeys that are used for transport and labour. The animals are kept on small scale and large scale by some of the farmers. This depends on the land available, water and pastures resources in a given part of the county. This sector is very important as it helps to enhance food security and provide income to the farmers.

### **2.4 Topography**

The general physiography of the area is strongly controlled by the geology with areas underlain by rocks resistant to erosion such as granitoids and quartzites being generally higher than those underlain by easily erodable rocks such as gneisses and schists. Local topography is well captured in the map below:-

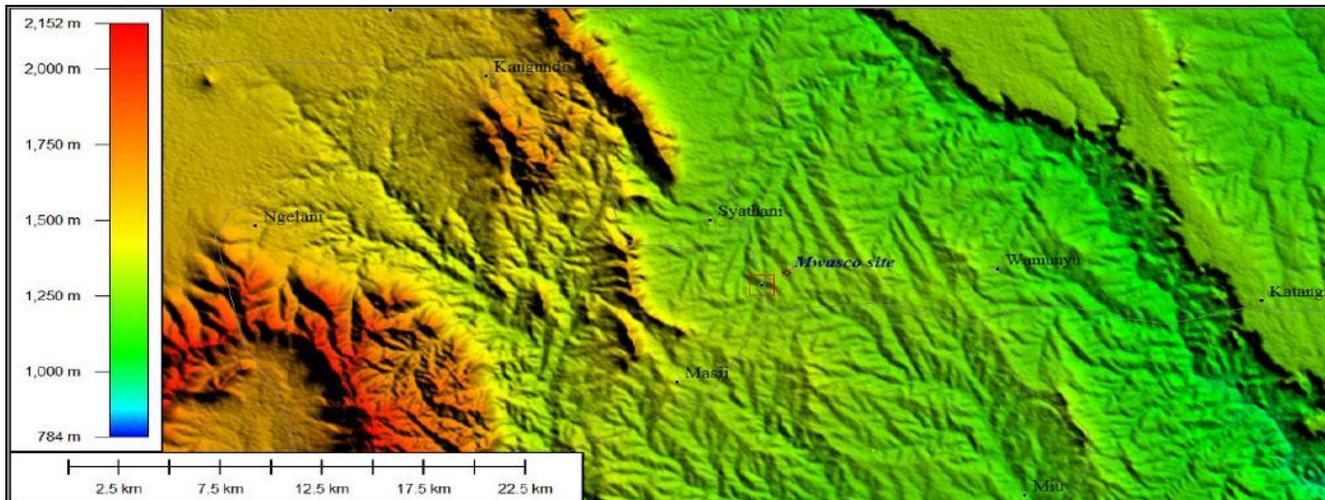


Figure 2: Topography at selected site

## 2.5 Climate

The study area is characterized by an almost equatorial type of climate. The area is relatively warm/cool with the coldest months experienced in July and August. The wet seasons are normally in April and May and are generally warm. The rainfall is about 900mm per year and decreases steadily to the east where the climate is increasingly semi arid.

Temperatures range between 20 - 30 degrees Centigrade though there are slight variations depending on the season.

## 2.6 Soils

The study area is mostly covered by brown sandy soils, though facies of black cotton soils are common especially along the drainage channels.

## 2.7 Drainage

Rivers Muvwana and Embui are the main drainage system in the area. There are numerous seasonal tributaries that rise in the hills and join the river in a dendritic fashion, with the main flow being north-south in conformity with the regional geological strike

## 2.8 Geology

### 2.8.1 Regional geology

The greater part of the area is occupied by rocks of the Basement System. Within the surrounding area, relatively few rock outcrops are observed, due to the thick overburden. The Basement rocks here are mainly gneisses and schists. Kyanite gneisses were mapped near the junction of the Kiu and Mombasa roads by B.H. Baker in 1952. He described the rocks as containing large euhedral porphyroblastic, (large, well-formed crystals which were formed during the process of metamorphism), crystals of kyanite coated with graphite. Schists are found inter-bedded, consisting almost entirely of mica (biotite).

Much of the Basement System is bedded. The granitoid gneisses however, are homogeneous and un-bedded, a buff to dirty cream in colour and medium-grained.

### **2.8.2 Geology of the Proposed Project Area**

Based on the existing geological information the main rock types in the project area include granitoid gneisses, pelitic schists and gneisses and muscovite gneisses.

The granitoid gneisses are usually homogenous, un-bedded rocks forming large masses whose outline controls the directional trend of the surrounding metamorphic rocks. In hand specimen they massive with uniform texture and a fine gneissose banding which become obliterated when the grain is coarser. Petrographically, they consist of orthoclase, microcline, albite, quartz and biotite with muscovite being sometimes present in small amount.

The schists mainly vary from muscovite –rich varieties to biotite –rich varieties. The shists are usually coarse grained and shiny and are almost entirely dominated by quartz and micas. The gneisses vary from biotite gneisses to hornblende gneisses and are usually massive, fairly foliated with quartz, microcline, biotite and hornblende as dominant minerals. Muscovite gneisses are rare and are found in the vicinity of Uuni Hills, and biotite is usually replaced by muscovite.

Formation / lithology to be penetrated:-

- Top Soils
- Weathered subsurface regolith (Decomposed Gneisses)
- Weathered/ fractured Gneisses
- Fresh gneisses (increasingly compact and fresh with depth).

### **2.8.3 Structural Geology**

In the general project area, no clear evidence of faults or fracture zones was observed. Water bearing fissures, however, may occur within the intersection points of the different structural units. This formation is known to have undergone some faulting. The faults, however, do not continue in the overlying formations, and are therefore generally obscured and deep buried.

Faulting will have the highest impact on hard and massive rock types; elastic formations such as tuffs and weakly consolidated deposits will bend (fold) rather than break (fault).

Consequently, they tend to suppress the radius of influence and the magnitude of the damage caused by tectonic events. In relatively plastic rocks, the porosity will not increase in the area affected by the fault. Hard layers such as lavas, on the other hand, will be broken by fractures and joints, thus giving rise to increased (secondary) porosity.

## **2.9 Hydrogeology**

### **2.9.1 Background**

The hydrogeology of an area is determined by the nature of the parent rock, structural features, weathering processes and precipitation patterns. Especially in the Precambrian shields, metamorphic rocks are highly compact and have virtually no intergranular (or primary) porosity. While mostly solid, non-porous, and absolutely impervious at the scale of a hand specimen, these rocks have a type of porosity that can be termed as fracture (or secondary) porosity. This implies that they can hold water in a network of fissures, cracks, joints, fractures or faults.

The secondary porosity is caused by systems of "macro pores" and "micro pores". Macro pores are fissures and fractures of structural origin. Micro pores are interstices created by weathering. These two types of secondary porosity are usually closely related, as cracks and fissures facilitate the percolation of water and hence more intensive weathering. The aquifers in the metamorphic rocks are characterized generally by a very low primary and (depending on the degree of fracturing) highly variable secondary porosity.

The thickness and mineral characteristics of the weathered layer play an important role in the amount of groundwater it can hold and the hydraulic conductivity (i.e. the ability of water to flow). Topography, drainage pattern, rainfall and evaporation are some of the major factors, which determine the occurrence of groundwater.

### **2.9.2 Groundwater Occurrence**

Within the survey Area, groundwater occurs in:-

- weathered zones above the crystalline Basement rocks,
- fractured zones within the crystalline bedrock, and
- Shallow alluvial deposits along the main drainage channels.

### **2.9.3 Recharge**

Recharge is the process through which water is added to the groundwater reservoir. Some aquifers do not receive any recharge at all; in this case, the water is connate or fossil, and pumping results in irreversible depletion. Usually, aquifers with little recharge and consequently long residence times are marked by high levels of mineralization and salinity. Unless the underground water body is of vast extent, it is essential that not more water be abstracted than the annual amount of replenishment.

The two major processes are probably direct recharge at surface (not necessarily local) and indirect recharge via faults and/or other aquifers.

Direct recharge is obtained through downward percolation of rainfall or river water into aquifer. If the infiltration rate is low due to the presence of an aquiclude (such as clay), the recharge to the aquifer is low. Percolation will depend on the soil structure, vegetation cover and the state of erosion of the parent rock. Rocks weathering to clayey soils naturally inhibit infiltration and

downward percolation. Aquifers may also be recharged laterally if the rock is permeable over a wide area.

### 2.9.4 Discharge

Discharge from aquifers is either through natural processes as base-flow to streams and springs, or artificial discharge through human activities. However considering the few number of boreholes in the area this form of discharge is not much pronounced.

### 2.10 Existing boreholes in the project area

Four boreholes have been drilled within a radius of 6km radius from the selected site. Their data is tabulated below:-

*Table 1: Data for nearest boreholes*

Serial No. "C-"	Owner	Direction (Km)	Total Depth (m)	W.S.L (m)	W.R.L (m)	Tested Yield (m <sup>3</sup> /hr)	P.W.L (m)
2407	DWD	3.5 NE	104	88	20	0.84	57.4
4039	Wambua J. M.	3.2 SW	92	74	10	8.16	20.5
13674	Mwala Mixed Sch	6 SW	80	42	56	8.0	70
-	Kanyuuku S.H.G	4.4 NW	110	45, 50	44.0	18.0	92
<b>Range</b>			<b>80 – 110.0</b>	<b>42 – 88.0</b>	<b>10 – 56.0</b>	<b>0.84 – 18.0</b>	<b>20.5 – 92.0</b>

The boreholes in this area have variable yields ranging between **0.84 and 18.0m<sup>3</sup>/hour**. The proposed borehole is expected to give a yield within the upper half of this range.

From the records, there is NO borehole which is located within 800m radius. Thus there is no any foreseen interference with the existing boreholes or the groundwater abstraction trends.

### 2.11 Water quality

The water quality of the aquifers in the area is expected to be drawn from deeper fracture systems. These aquifers are adequately recharged from the surface thus the chemical characteristics of groundwater that is relatively young and potable is expected. The water is likely to be highly mineralized and hard, but not brackish. Seasonal changes may however occur, whereby an increase in salinity is experienced during the dry season.

Due to the nature of the surrounding Basement rocks, high levels of calcium are envisaged, which may lead to encrustation of pipe-works. It is therefore recommended to use uPVC casings and screens inside the borehole, and galvanized steel mains (high quality – Class C) and collector pipes.

Indications of the permissible thresh holds of the various elements is given on the table below:-

*Table 2: Water quality data showing Kenyan and WHO standards*

Parameter	Max. WHO guideline	Kenyan Standards (drinking)	Unit
pH	6.5-8.5	6.5-8.5	pH Scale
Colour		50	mgPt/l
Turbidity	5	25	N.T.U.
Conductivity		2,500	μS/cm
Permanganate Value		10	mgO <sub>2</sub> /l
Iron	0.3	1.0	mg/l
Manganese	0.4	0.5	mg/l
Calcium		200	mg/l
Magnesium	0.1	150	mg/l
Sodium	200		mg/l
Potassium			mg/l
Total Hardness	500	500	mgCaCO <sub>3</sub> /l
Total Alkalinity	500		mgCaCO <sub>3</sub> /l
Chloride	250	600	mg/l
Fluoride	1.5	1.5	mg/l
Nitrate	10	30	mgN/l
Nitrite	3.0		mgN/l
Ammonia			mgN/l
Total Nitrogen			mgN/l
Sulphate	250	600	mg/l
Orthophosphate			mgP/l
Total suspended solids			mg/l
Free Carbon Dioxide			mg/l
Dissolved Oxygen			mgO <sub>2</sub> /l
Total Dissolved Solids	1,000	1,500	mg/l
Others			

## 2.12 Economic Activities

The main economic activities include farming, beekeeping, trade, dairy farming, limited coffee, eco-tourism, businesses and manufacturing. The primary agricultural products include mangoes, pawpaws (papaya), watermelons, maize, cow peas, beans, pigeon peas and lentils, and livestock.

## 2.13 Health Facilities

The project area is served by one hospital, 13 private dispensaries and health centres and 37 public dispensaries and health centers. Mwala District Hospital is the only hospital in the project area

## **2.14 Educational Facilities**

### **2.14.1 Primary Schools**

The enrolment in primary schools was obtained from the Sub County Education Office in Makutano Town. The total enrolment in Primary Schools in the Sub County was 45,250 pupils in 2015. The project area covers part of the sub county. Thus, the number of pupils in the project area is computed.

### **2.14.2 Secondary Schools**

The enrolment in secondary schools was obtained from the Sub-County Education Office in Makutano Town. The total enrolment in secondary schools in the sub county in 2015 is 4,708 students. The project area covers part of the sub county. Thus, the number of secondary schools students in the project area is computed.

### **3.0 POLICY, LEGAL AND REGULATORY FRAMEWORK**

#### **3.1 Introduction**

There is a growing concern in Kenya and at global level that many forms of development activities cause damage to the environment. Development activities have the potential to damage the natural resources upon which the economies are based. A major national challenge today is how to maintain sustainable development without damaging the environment.

Environmental impact assessment is a tool for environmental management, which has been identified as a key component for sustainable development. According to section 58 of the Environmental Management and Coordination Act (EMCA) No.8 of 1999, second schedule 9 (i) (amended in 2015), and Environmental (Impact Assessment and Audit) Regulation, 2003 requires new projects to undergo Environmental Impact Assessment while ongoing projects to undertake Environmental Audits.

The report of the same must be submitted to National Environment Management Authority (NEMA) for reviewing, approval and issuance of the relevant certificates. This was necessary as many forms of developmental activities cause damage to the environment and hence the greatest challenge today is to maintain sustainable development without degrading the environment.

#### **3.2 POLICY PROVISIONS**

##### **3.2.1 The Constitution**

In the Constitution of Kenya, 2010, the State clearly undertakes to carry out the following:

- a) Ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits;
- b) Work to achieve and maintain a tree cover of at least ten per cent of the land area of Kenya;
- c) Protect and enhance intellectual property in, and indigenous knowledge of, biodiversity and the genetic resources of the communities;
- d) Encourage public participation in the management, protection and conservation of the environment;
- e) Protect genetic resources and biological diversity;
- f) Establish systems of environmental impact assessment, environmental audit and monitoring of the environment;
- g) Eliminate processes and activities that are likely to endanger the environment; and
- h) Utilize the environment and natural resources for the benefit of the people of Kenya.

“Every person has the right to a clean and healthy environment, which includes the right—

- (a) to have the environment protected for the benefit of present and future generations through legislative and other measures, particularly those contemplated in Article 69; and
- b) To have obligations relating to the environment fulfilled under Article 70” reads the excerpt from section 42 of the Constitution of Kenya, 2010.

Thus, every activity or project undertaken within the republic must be in tandem with the state’s vision for the national environment as well as adherence to the right of every individual to a clean and healthy environment. The proposed borehole drilling is a central development activity that utilizes sensitive components of the physical and natural environment hence need for clearly spelt out environmental management plan to curb probable adverse effects to the environment.

### **3.2.2 National Environment Action Plan (NEAP)**

According to the Kenya National Environment Action Plan (NEAP, 1994) the Government recognized the negative impacts on ecosystems emanating from economic and social development programmes that disregarded environmental sustainability. In this regard, establishment of appropriate policies and legal guidelines as well as harmonization of the existing ones have been accomplished and/or are in the process of development. Under the NEAP process, EIA was introduced and among the key participants identified were the County Development Committees under the County Commissioner.

### **3.2.3 National Policy on Water Resources Management and Development**

The National Policy on Water Resources Management and Development (1999) enhances a systematic development of water facilities in all sectors for promotion of the country’s socio-economic progress, it also recognizes the by-products of this process as waste water. It, therefore, calls for development of appropriate sanitation systems to protect people’s health and water resources from institutional pollution.

Development projects, therefore, should be accompanied by corresponding waste management systems to handle the waste water and other waste emanating there from. The same policy requires that such projects should also undergo comprehensive EIAs that will provide suitable measures to be taken to ensure environmental resources and people’s health in the immediate neighborhood and further downstream are not negatively impacted by the emissions.

In addition, the policy provides for charging levies on waste water on quantity and quality (similar to polluter-pays-principle) in which case those contaminating water are required to meet the appropriate cost on remediation, though the necessary mechanisms for the implementation of this principle have not been fully established under the relevant Acts. However, the policy provides for establishment of standards to protect the water bodies receiving waste water, a process that is ongoing.

### **3.2.4 Sessional Paper No. 6 of 1999 on Environment and Sustainable Development**

Among the key objectives of the Sessional Paper No. 6 of 1999 on Environment and Sustainable Development (1993) are: -

- a) To ensure that from the onset, all development policies, programmes and projects take environmental considerations into account,
- b) To ensure that an independent environmental impact assessment (EIA) report is prepared for any development before implementation,
- c) To ensure that effluent treatment standards which will conform to acceptable health standards.

The policy recommends the need for enhanced re-use/recycling of residues including wastewater and increased public awareness raising and appreciation of clean environment as well as the participation of stakeholders in the management of wastes within their localities. Regarding human settlement, the paper encourages better planning in both rural and urban areas and provision of basic needs such as water, drainage and waste disposal facilities among others for decent housing of every family.

### **3.2.5 Vision 2030**

Vision 2030 is divided into three fundamental pillars: Economic, Social and Political pillars. The social pillar aims at realizing a just and cohesive society enjoying equitable social development in a clean and secure environment.

Social Strategy, paragraph 5.4 of the strategy envisions Kenya becoming a nation that has a clean, secure and sustainable environment by 2030. So as to realize this strategy, provision of clean safe drinking water to the residents of Kyamwai, Mwala is one of the stepping stones needed for realization of the strategy.

## **3.3 LEGAL FRAMEWORK**

The key national laws that govern the management of environmental resources in the country have been briefly discussed below. It is noteworthy that wherever any of the laws contradict each other, the Environmental Management and Co- ordination Act 1999 prevails.

### **3.3.1 The Environment Management and Co-Ordination Act, 1999**

According to the Environmental Management and Co-ordination Act (EMCA, 1999, Second Schedule Part XII) and subsequent Environmental (Impact and Audit) Regulations, 2003, it is mandatory to get environmental clearance for certain development projects. Generally, EMCA Act of 1999 regulates all other interactions of development projects, water projects included, with the environment. It also paves the way for establishment of area-specific legislation to protect and conserve individual components of the environment.

### **Relevance**

The Project shall maintain a clean and healthy environment and has a duty to safeguard and enhance environmental management, in operational phase, the project shall ensure that conservation of biological diversity shall be observed. It will also ensure that air quality standards are maintained as per NEMA's Standard and Enforcement Review Committee requirements. The proponent shall adhere to the disposal of wastes requirement in such a manner as not to cause pollution to the environment or ill health.

### **3.3.2 The Environmental (Impact Assessment and Audit) Regulations, 2003**

This is a supplementary legislation to the EMCA Act of 1999. It gives additional "punch" to the essence of conducting Environmental Impact Assessments and Audits. It offers guidance on the fundamental aspects on which emphasis must be laid during field study and outlines the nature and structure of Environmental Impact Assessments and Audit reports. The legislation further explains the legal consequences of partial or non-compliance to the provisions of the Act.

### **Relevance**

The proposed project, falls under the second schedule of section 58 in EMCA, 1999 and with that requires an EIA study. As stipulated by the legal notice No. 101, 2003, part VI, section 31 (3) (a) (i) and (ii), the borehole requires an EIA which will provide baseline information upon which subsequent environmental control assessment and management shall be based upon.

### **3.3.3 The Environmental Management and Coordination (Wetlands, River Banks, Lake Shores and Sea Shore Management) Regulations, 2009**

This is a supplementary legislation to the EMCA Act of 1999 with particular emphasis on management of wetland and wetland resources, river banks, lake shores and Sea shore. Sections 4 and 5 of Part II as well as sections 16, 17, 18 of part III of the legislation provide guidelines for conservation and sustainable use and conservation of the said environmental components, and enhance them where necessary when carrying out any activity therein.

### **Relevance**

It is paramount that this legislation be integrated during planning, construction and operation of the project.

### **3.3.4 The Environmental Management and Coordination (Water Quality) Regulations, 2006**

This subsidiary EMCA regulations apply to drinking water, water used for industrial purposes, agricultural purposes, recreational purposes, fisheries and wildlife, and any other purposes. It stipulates quality standards for sources and discharge of water to any environmental receptors within an activity area.

Section 6(c) of Part II of the legislation limits development activity to "...within full width of a river stream or a minimum of six metres and a maximum of thirty metres on either side of based on the highest flood level."

### **Relevance**

- It is thus fundamental to analyze water qualities and check for conformity to stipulated legal standards in this supplementary legislation. Full physical, chemical and bacteriological analysis will be conducted before the water is put to any human use.

### **3.3.5 The Environmental Management and Coordination (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit Sharing) Regulations, 2006**

This legislation aims at enhancing preservation of biodiversity and safeguarding of endangered and rare plant and animal species within any human activity area.

Section 4 of the legislation expressly prohibits any activity which may have adverse effects on any ecosystem, lead to introduction of alien species in a given area or result in unsustainable utilization of available ecosystem resources.

### **Relevance**

Drilling of borehole in the proposed may result in removal of some existing natural vegetation. For this to occur, the relevant authority, NEMA in this case, will require a detailed EIA on the proposed project and projected impacts before issuing a license for commencement.

### **3.3.6 Environmental Management and Co-ordination (Waste Management) Regulations 2006**

These are described in Legal Notice No. 121 of the Kenya Gazette Supplement No. 69 of September 2006. These Regulations apply to all categories of waste as provided in the Regulations. These include industrial wastes, hazardous and toxic wastes, pesticides and toxic substances, biomedical wastes and radio-active substances.

These Regulations outline requirements for handling, storing, transporting, and treatment /disposal of all waste categories as provided therein. Wastes contaminated with petroleum product are considered to be hazardous. The project will have to abide by these regulations in dealing with waste management especially the provisions of Industrial, Hazardous and toxic wastes which may be generated during operations.

### **Relevance**

The proponent should ensure that waste is handled, stored, transported and disposed properly as per this regulation.

### **3.3.7 Environmental Management and Coordination (Noise and Excessive Vibration Pollution) Control Regulations, 2009**

These Regulations prohibit making or causing any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. It also prohibits the Contractor from excessive vibrations which annoy,

disturb, injure or endanger the comfort, repose, health or safety of others and the environment or excessive vibrations which exceed 0.5 centimetres per second beyond any source property boundary or 30 metres from any moving source.

Table 4 below shows the permissible noise levels as set in the First Schedule to these Regulations.

*Table 3: Maximum permissible noise levels*

Zone		Sound Level Limits dB(A)		Noise Rating Levels (NR)	
		(Leq, 14h)		(Leq, 14h)	
		Day	Night	Day	Night
A	Silent Zone	40	35	30	25
B	Places of worship	40	35	30	25
C	Residential: Indoor Outdoor	45	35	35	25
		50	35	40	25
D	Mixed residential (with some commercial and places of entertainment)	55	35	50	25
E	Commercial	60	35	55	25

Time Frame

Day: 6.01 a.m. – 8.00 p.m. (Leq, 14h)

Night: 8.01 p.m. – 6.00 a.m. (Leq, 10h)

Regulation 13 of these Regulations provides for construction at night. Regulation 13 (1) states that “Except for the purposes specified in sub-Regulation (2) hereunder, no person shall operate construction equipment (including but not limited to any pile driver, steam shovel, pneumatic hammer, derrick or steam or electric hoist) or perform any outside construction or repair works so as to emit noise in excess of the permissible levels as set out in the Second Schedule of these regulations”.

Regulation 13 (2) states that “This Regulation shall not be deemed to prohibit

- a) any work of an emergency nature;
- b) work of a domestic nature on buildings, structures or projects being undertaken by a person residing in such premises; or
- c) public utility construction, or, with respect to construction of public works, projects exclusively relating to roads, bridges, airports, public schools and sidewalks:

Provided that, if any domestic power tool, including but not limited to mechanically powered saws, sanders, grinders and lawn and garden tools used outdoors, is operated during the night time hours, no person shall operate such machinery so as to cause noise within a residential building or across a residential real property boundary where such noise interferes with the comfort, repose, health or safety of members of the public within any building or outside of a building, at 30 metres or more from the source of the sound”.

Regulation 14 of these Regulations provides for noise, excessive vibrations from construction, demolition, mining or quarrying sites. Regulation 14 (1) states that “Where defined work of construction, demolition, mining or quarrying is to be carried out in an area, the Authority may impose requirements on how the work is to be carried out including but not limited to requirements regarding

- a) machinery that may be used, and
- b) The permitted levels of noise as stipulated in the Second and Third Schedules to these Regulations”.

Regulation 14(3) further states that “Any person carrying out construction, demolition, mining or quarrying works shall ensure that the vibration levels do not exceed 0.5centimetres per second beyond any source property boundary or 30metres from the moving source”.

Regulation 15 of these regulations states that “Any person intending to carry out construction, demolition, mining or quarrying work shall, during the Environmental Impact Assessment studies

- a) identify natural resources, land uses or activities which may be affected by noise or excessive vibrations from the construction, demolition, mining or quarrying;
- b) determine the measures which are needed in the plans and specifications to minimize or eliminate adverse construction, demolition, mining or quarrying noise or vibration impacts; and
- c) incorporate the needed abatement measures in the plans and specification”.

Table 4 below shows the contents of the second schedule of these regulations.

*Table 4: Maximum permissible noise levels for construction sites (measurement taken within the facility)*

Facility		Maximum Noise Level Permitted (Leq) in dB (A)	
		Day	Night
(i)	Health facilities, educational institutions, homes for disabled etc	60	35
(ii)	Residential	60	35
(iii)	Areas other than those prescribed in (i) and (ii)	75	65

Time Frame

Day: 6.01 a.m. – 6.00 p.m. (Leq, 14h)

Night: 6.01 p.m. – 6.00 a.m. (Leq, 14 h)

**Relevance**

The machines and technology used to drill the borehole will result to noise. Under the regulation the Contractor will be required to undertake daily monitoring of the noise levels within the project area during construction period to maintain compliance.3.3.8 Water Act, 2002

Part II, section 3 states:” Every water resource is hereby vested in the State subject to any rights of user granted by or under this Act or any other written law. Under Section 5, the right to the use of water from any water resource is vested in the minister for the time being in charge of water resources except to the extent that it is alienated by or under the Act or any other written law. Consequently, a water permit must be obtained before using any water resource.

**Relevance**

Management of this resource is significant during the operations of the project. Over-pumping and pollution of water should therefore be avoided.

**3.3.9 The Public Health Act (CAP. 242)**

Part IX section 115 of the Act states that no person/institution shall cause nuisance or condition liable to be injurious or dangerous to human health. Section 116 requires Local Authorities to take all lawful, necessary and reasonably practicable measures to maintain their jurisdiction clean and sanitary to prevent occurrence of nuisance or condition liable for injurious or dangerous to human health. Such nuisance or conditions are defined under section 118 and include nuisances caused by accumulation of materials or refuse which in the opinion of the medical officer of health is likely to harbor rats or other vermin.

**Relevance**

The proponent intends to prevent nuisances within the project jurisdiction as indicated in the Environmental Management Plan.

**3.3.10 Physical Planning Act (CAP 286)**

Section 24 of the Physical Planning Act gives provision for the development of local physical development plan for guiding and coordinating development of infrastructure facilities and services within the area of authority of County, municipal and town council and for specific control of the use and development of land. The plan shows the manner in which the land in the area may be used. Section 29 of the physical Planning Act gives the county councils power to prohibit and control the use of land, building, and subdivision of land, in the interest of proper and orderly development of its area. The same section also allows them to approve all development applications and grant development permissions as well as to ensure the proper execution and implications of approved physical development plans. On zoning, the act empowers them to formulate by- laws in respect of use and density of development.

Section 30 states that any person who carries out development within an area of a local authority without development permission shall be guilty of an offence and the development shall be invalid. The act also gives the local authority power to compel the developer to restore the land on which such development has taken place to its original conditions within a period of ninety days. If no action is taken, then the council will restore the land and recover the cost incurred thereto from the developer. In addition, the same section also states that no person shall carry out development within the area of a local authority without development permission granted by the local authority. At the same time, sub-section 5, re-enforce it further that, no licensing authority shall grant under any written law, a license for commercial use for which no development permission had been granted by the respective local authority.

Section 36 states that if in connection with development application a local authority is of the opinion that, the proposed activity will have injurious impact on the environment, the applicant shall be required to submit together with the application an Environmental Impact Assessment report. The environmental impact assessment report must be approved by the National Environmental Management Authority (NEMA) and followed by annual environmental audits as spelled out by EMCA 1999. Section 38 states that if the local authority finds out that the development activity is not complying to all laid down regulations, the local authority may serve an enforcement notice specifying the conditions of the development permissions alleged to have been contravened and compel the developer to restore the land to its original conditions.

### **Relevance**

The Act is relevant during the construction of the project.

#### **3.3.11 Occupational Health and Safety Act 2007**

This legislation provides for protection of workers during construction and operation phases. It is tailored at implementation of the EHS plan in compliance with the relevant sections of this Act.

**Subsection 17 - Drainage of floor-** Where any process is carried on which renders the floor liable to be wet to such an extent that the wet is capable of being removed by drainage, effective means shall be provided and maintained for draining off the wet.

**Subsection 18 - Sanitary conveniences -** Sufficient and suitable sanitary conveniences for persons employed in the factory/ work places shall be provided, maintained and kept clean, and effective provision shall be made for lighting the conveniences and where persons of both sexes are, such conveniences shall afford proper separate accommodation for persons of each sex.

**Subsection 21 – Prime movers -** Every flywheel directly connected to any prime mover and every moving part of any prime mover, shall be securely fenced, whether the flywheel or prime mover is to be situated in an engine –house or not

- a. Head and tailrace of every water wheel and of every water turbine shall be securely fenced.

- b. Every part of electric generators, motors and rotary converters and every flywheel directly connected thereto shall be securely fenced unless it is in such a position or of such construction as to be safe to every person employed or working in the premises as it would be if securely fenced.

Subsection 22 -Transmission Machinery- Every part of transmission machinery shall be securely fenced unless it is in such a position or of such construction as to be safe to every person employed or working in the premises, as it would be if securely fenced. Efficient devices or appliances shall be provided and maintained in every room or place where work is carried on by which the power can promptly be cut-off from transmission machinery in that room or place.

Every machine intended to be driven by mechanical power shall be provided with an efficient starting and stopping appliance, the control of which shall be in such a position as to be readily and conveniently operated by the person operating the machine.

**Subsection 25 - Construction and maintenance of fencing-**All fencing or other safeguards provided in pursuance of the foregoing provisions shall be of substantial construction, constantly maintained, and kept in position while the parts required to be fenced or safe guarded are in motion or in use except when any such parts are necessarily exposed for examination and for any lubrication or adjustments shown by such examination to be immediately necessary.

**Subsection 13 – Cleanliness** -Every factory/work places shall be kept in a clean state and free from effluent arising from any drain, sanitary convenience or nuisance.

**Subsection 14 – Overcrowding** -A factory/ work place shall not while work is carried on be so overcrowded as to cause risk of injury to the health of the persons employed therein. Standard cubic space allowed for every person in a workroom should not be less than three hundred and fifty cubic feet.

**Section 51 Air pollution** - Preventive measures shall be put in place during operation of the project to prevent fumes and exhaust gases from entering into the atmosphere.

### **Relevance**

The Act is relevant both during construction and operation phases of the project due to the fact that the project will involve workers at all stages. Various health hazards are likely to emanate from the proposed project's drilling activities. Health issues will therefore be integrated into the project to ensure safety of workers.

### **3.3.12 Land Act**

It is an act of parliament that gives effects to Article 68 of constitution to revise, consolidate and rationalize land laws; to provide for sustainable administration and management of land based resources.

The land acquisition for the project will be guided by the constitution and laws of Kenya. The new laws that handles matters of compensation for the land and valuation of assets include; the Land Act 2012, the Land Registration Act 2012 and National Land Commission Act, 2012.

The National Land Commission (the "**Commission**") will have wide powers in the management and administration of public, private and community land. Allocation of public land to private persons will be managed and supervised by the Commission. In addition, land available for allocation will be *gazetted* and notices published in at least two local dailies, prior to commencement of the allocation process.

The new laws require all land in Kenya, whether private, public or community land, to be registered. The new laws therefore make provision for the registration of community land.

The Land Act 2012 provides of the sustainable administration and management of land and land based resources. It also provides for (compulsory) acquisition of land. The Act sets out the guiding values and principles of land management and administration and requires public officers and institutions to observe such values and principles. As for land tenure, the Act specifies the following forms (a) freehold; (b) leasehold; (c) such forms of partial interest as may be defined under this Act and other law, including but not limited to easements and (d) customary land rights where consistent with the constitution.

The National Land Commission, established by Article 67 of the Constitution, shall manage public land on behalf of the national government and county governments in accordance with this Act and shall prescribe guidelines for the management of public land by all public agencies, statutory bodies and state corporations in actual occupation or use of public land.

The Act furthermore provides for among many other things, land allocation and land settlement and creation of the Land Settlement Fund.

### **Relevance**

The parcel of land (Plot Lr. No. Mwala/ Mathunthini /442) in which the drilling will take place belongs to the late Mutuku Mbuvi. However his wife who is the rightful inheritor of the land has consented to freely give out the land for the drilling of proposed borehole. (See attached consent letter in Annex 3).

## **3.4 WORLD BANK OPERATIONAL POLICIES**

### **3.4.1 Environmental Assessment Operational Policy OP 4.01**

Environmental Assessment is used in the World Bank to identify, avoid, and mitigate the potential negative environmental impacts associated with Bank lending operations. Drilling of one production borehole at Makutano will result to mild negative impacts to the environment which will be mitigated as the proposed project is categorized under category B under World Bank Categorizations criteria.

**Category A:** A proposed project is classified as Category A if it is likely to have significant adverse impact on the environment. A project with complicated impact or unprecedented impact which are difficult to assess is also classified as Category A. The impact of Category A projects may affect an area broader than the sites or facilities subject to physical construction.

**Category B:** A proposed project is classified as Category B if its potential adverse environmental impact is less adverse than that of Category A projects. Typically, this is site specific, few if any are irreversible, and in most cases normal mitigation measures can be designed more readily.

**Category C:** A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impact. Projects that correspond to one of the following are, in principle, classified as Category C.

Drilling of one production borehole at Makutano is a project whose impacts to the environment are less adverse to the environment and can be mitigated as they are site specific. The project does not traverse in any protected habitat, international water way, indigenous persons regions. The proposed project has been assigned to category B which requires preparation of an Environmental Impact Assessment report that will recommend any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental impacts and performance.

### **3.4.2 Natural Habitats OP 4.04**

This policy seeks to ensure that World Bank-supported infrastructure and other development projects take into account the conservation of biodiversity, as well as the numerous environmental services and products which natural habitats provide to human society. The policy strictly limits the circumstances under which any Bank-supported project can damage natural habitats (land and water areas where most of the native plant and animal species are still present).

Specifically, the policy prohibits Bank support for projects which would lead to the significant loss or degradation of any Critical Natural Habitats, whose definition includes those natural habitats which are either:

- legally protected,
- officially proposed for protection, or
- Unprotected but of known high conservation value.

In other (non-critical) natural habitats, Bank supported projects can cause significant loss or degradation only when there are no feasible alternatives to achieve the project's substantial overall net benefits and acceptable mitigation measures, such as compensatory protected areas, are included within the project.

This policy will not be triggered since there is no loss or degradation of any Critical Natural Habitats within the project areas.

### **3.4.3 Physical Cultural Resources OP 4.11**

This directive defines the cultural property as having archaeological, paleontological, historical, religious and unique natural values. There are no known physical cultural resources within the proposed site thus this policy is not triggered. However, to manage chance finds during construction, the ESIA provides relevant guidance in Annex 6.

### **3.4.4 Involuntary Resettlement OP 4.12**

The Bank's OP 4.12 is triggered in situations involving involuntary taking of land and involuntary restrictions of access to legally designated parks and protected areas. The policy aims to avoid involuntary resettlement to the extent feasible, or to minimize and mitigate its adverse social and economic impacts.

It promotes participation of displaced people in resettlement planning and implementation, and its key economic objective is to assist displaced persons in their efforts to improve or at least restore their incomes and standards of living after displacement. As the drilling will be done on private land, prior consent has been acquired from the land owner to drill the borehole on their land (See attached consent letter in Annex 3). In this case, the land owner requires no compensation for drilling of the borehole within their land.

The policy prescribes compensation and other resettlement measures to achieve its objectives and requires that borrowers prepare adequate resettlement planning instruments prior to Bank appraisal of proposed projects.

### **3.4.5 Operational Policy 4.36: Forests**

The Bank's current forests policy aims to reduce deforestation, enhance the environmental contribution of forested areas, promote afforestation, reduce poverty, and encourage economic development.

Combating deforestation and promoting sustainable forest conservation and management have been high on the international agenda for over two decades. However, little has been achieved so far and the world's forests and forest dependent people continue to experience unacceptably high rates of forest loss and degradation. The Bank is therefore currently finalizing a revised approach to forestry issues, in recognition of the fact that forests play an increasingly important role in poverty alleviation, economic development, and for providing local as well as global environmental services.

Success in establishing sustainable forest conservation and management practices depends not only on changing the behavior of all critical stakeholders, but also on a wide range of partnerships to accomplish what no country, government agency, donor, or interest group can do alone.

The new proposed Forest Strategy suggests three equally important and interdependent pillars to guide future Bank involvement with forests:

- Harnessing the potential of forests to reduce poverty,
- Integrating forests in sustainable economic development, and
- Protecting vital local and global environmental services and forest values.

This policy is not triggered since there is no forest within the project area.

### **3.5 INSTITUTIONAL FRAMEWORK**

The National Policy on Water Resources Management and Development and the Water Act 2002, presently guides water resources management. The overall goal of the national water development policy is to facilitate the provision of water in sufficient quantity and quality and within a reasonable distance to meet all competing uses in a sustainable, rational and economical way. This policy separates policy formulation, regulation and services provision and defines clear roles for sector actors within a decentralized institutional framework and includes private sector participation and increased community development.

Under the policy, the Ministry of Water, Environment and Natural Resources is responsible for policy development, sector co-ordination, monitoring and supervision to ensure effective Water and Sewerage Services in the Country, sustainability of Water Resources and development of Water resources for irrigation, commercial, industrial, power generation and other uses. The Ministry of Environment, Water and Natural Resources executes its mandate through the following sector institutions:

#### **3.5.1 Water Services Regulatory Board (WASREB)**

The regulatory Board is responsible for the regulation of the water and sewerage services in partnership with the people of Kenya. The mandate of the regulator covers the following key areas;

- a) Regulating the provision of water and sewerage services including licensing, quality assurance and issuance of guidelines for tariffs, prices and disputes resolution.
- b) Overseeing the implementation of policies and strategies relating to provision of water services licensing of Water Services Boards and approving their appointed Water Services Providers,

- c) Monitoring the performance of the Water Services Boards and Water Services Providers,
- d) Establish the procedure of customer complaints,
- e) Inform the public on the sector performance,
- f) Gives advice to the Minister in charge of water affairs.

### **3.5.2 Water Resources Management Authority (WRMA)**

The authority is responsible for sustainable management of the Nations Water Resources;

- a) Implementation of policies and strategies relating to management of Water resources
- b) Develop principles, guidelines and procedures for the allocation of water, Development of Catchments level management strategies including appointment of catchments area advisory committees,
- c) Regulate and protect water resources quality from adverse impacts,
- d) Classify, monitor and allocate water resources.

### **3.5.3 Water Services Trust Fund (WSTF)**

This body assists in the financing of the provision of Water Services to areas of Kenya which are without adequate water services. This shall include providing financing support to improved water services towards;

- a) Capital investment to community water schemes in underserved areas
- b) Capacity building activities and initiative among communities
- c) Water services activities outlined in the Water Services Strategic Plan as prioritized by the Government
- d) Awareness creation and information dissemination regarding community management of water services
- e) Active community participation in the management of water services

### **3.5.4 Water Services Boards (WSBS)**

The WSBS are responsible for the efficient and economical provision of water and sewerage services in their areas of jurisdiction. Athi Water Service Board is among the seven catchment Boards established under the Act mandated to;

- a) Develop the facilities, prepare business plans and performance targets
- b) Planning for efficient and economical provision of Water and sewerage services within their areas of jurisdiction;
- c) Appointing and contracting Water Service Provider
- d) Asset holding of Central Government facilities

### **3.5.5 Water Services Providers (WSPS)**

Water Service Providers are the utilities or water companies. They are state owned but have been commercialized to improve performance and run like business within a context of efficiency, operational and financial autonomy, accountability and strategic, but minor investment.

### **3.5.6 National Environment Management Authority (NEMA)**

The authority is mandated to carry out, among others, the following activities in the sector;

- Promote the integration of environmental considerations into development policies, plans, programmes and projects, with a view to ensuring the proper management and rational utilization of environmental resources, on sustainable yield basis, for the improvement of the quality of human life in Kenya
- Undertake and coordinate research, investigation and surveys, collect, collate and disseminate information on the findings of such research, investigations or surveys.
- Identify projects and programmes for which environmental audit or environmental monitoring must be conducted under this Act.
- Initiate and evolve procedures and safeguards for the prevention of accidents, which may cause environmental degradation and evolve remedial measures where accidents occur e.g. floods, landslides and oil spills
- Undertake, in cooperation with relevant lead agencies, programmes intended to enhance environmental education and public awareness, about the need for sound environmental management, as well as for enlisting public support and encouraging the effort made by other entities in that regard.
- Render advice and technical support, where possible, to entities engaged in natural resources management and environmental protection, so as to enable them to carry out their responsibilities satisfactorily.

### **3.5.7 County Environmental Committees**

These are Government's representatives in the County level. They are mandated to perform the following functions on behalf of NEMA:

- Responsible for the proper management of the environment within the county in respect of which they are appointed.
- Perform such additional functions as are prescribed by the Act or as assigned by the Minister.

## **4.0 PUBLIC PARTICIPATION AND SOCIO-ECONOMIC IMPACTS**

### **4.1 Background**

Public consultation is useful for gathering environmental data, understanding likely impacts, determining community and individual preferences, selecting project alternatives and designing viable and sustainable mitigation and compensation plans.

One of the key information sources used during the Environmental Impact Assessment exercise was the consultative public participation. This exercise was carried out on 13th October 2015 by a team of experienced qualified environmental experts via administration of pre-designed questionnaires and by interviewing neighbors surrounding the proposed project site. Individual interviews were conducted on fifteen (15) persons, four (4) of whom were female and 11 of whom were male who consisted of site neighbors and other stakeholders. The purpose for such interviews was to identify the positive and negative impacts and subsequently promote and mitigate them respectively. It also helped in identifying any other miscellaneous issues which may bring conflicts in case project implementation proceeds as planned.

### **4.2 Objectives of the Public Consultations**

The overall goal of the consultation process was to disseminate project information and to incorporate the views of the project beneficiaries and project neighbors in the design of the mitigation measures and a management plan.

The specific aims of the consultation process were to:

- Improve project design and, thereby, minimize conflicts and delays in implementation;
- Facilitate the development of appropriate and acceptable entitlement options;
- Increase long term project sustainability and ownership;
- Provide clear and accurate information about the project to the beneficiary community;
- Obtain the main concerns and perceptions of the population and their representatives regarding the project;
- Obtain opinions and suggestions directly from the affected communities on their preferred mitigation measures.

### **4.3 Key issues**

The stakeholders consulted gave both positive and negative views, as well as suggestions for the proponent to consider during construction and operation phases of the borehole project. Their views are as discussed below:

### **4.3.1 Positive Issues**

**4.3.1.1 Employment opportunities:** The persons interviewed were positive that during the proposed project construction, the project will create numerous employment opportunities for the persons and companies involved in the proposed project, ranging from the consultants, contractors and the casual laborers who shall be contracted.

**4.3.1.2 Tackling water shortage:** The respondents were positive that the proposed borehole would lead to increased water supply in the area and reduce the problem of water shortage. It would also make water more accessible to the area residents.

**4.3.1.3 Area development:** The residents interviewed were positive on the proposed project's ability to provide water as a key to development. Water as according to them would reduce time spent fetching water in this semi-arid area. Time would therefore be created to engage in more income generating activities. Children would also have more study time.

**4.3.1.4 Improving growth of economy:** The project will lead to area development which will have a ripple effect on the country's economy. By curbing water shortage in the area, more investments are likely to be carried out in the area contributing to the gross domestic product.

**4.3.1.5 Improved sanitation:** The respondents were positive of the project contributing to improved sanitation and improved health standards. An increased supply of water would mean more water for cleaning activities. Children would also benefit from the clean source of water which would also reduce the occurrences of water- borne diseases.

### **4.3.2 Negative Impacts**

**4.3.2.1 Dust emissions:** There were concerns over possibility of generation of large amount of dust within the project site and surrounding areas as a result of excavation works. The residents suggested that the proponent should ensure that dust levels at the site are minimized through sprinkling water in areas being excavated and along the tracks used by the transport trucks within the site. Additional mitigation measures presented within the ESMP will be fully implemented to minimize the impacts of dust generation.

**4.3.2.2 Air pollution:** Project construction activities involving ground excavations are likely to generate dust and gaseous emissions that could cause breathing problems. However, these impacts will cease after project drilling activities are completed. Appropriate dust control measures e.g. minimizing ground disturbance will be used. Additional mitigation measures presented within the ESMP will be fully implemented to minimize the impacts of air pollution.

**4.3.2.3 Noise:** During the excavation phase, there will be an increase in noise levels around the project site. Proper maintenance of the machinery and other equipment used on the site as well as the restriction of construction activities in the stipulated 0800hrs to 1700hrs on weekdays as well as 0800hrs – 1300hrs on Saturdays is advised to reduce the effect of noise generated.

**4.3.2.4 Loss of property:** One member of the community will suffer loss of land and or other properties on the same land. This is the most significant impact of all in the project area.

However she has voluntarily offered her land for free to the project which will benefit her and the rest of the community.

**4.3.2.5 Population influx:** The rapid increase in population may result in strain of infrastructure services e.g. electricity, road network and water supply systems which may get overloaded before the design period. The high population may also lead to excessive generation of solid waste which does not presently have an elaborate collection and disposal system. The waste will therefore accumulate in the market centres and environs leading to the problems being encountered in other towns such as Nairobi e.g. Emission of malodorous gases and blockage of drainage system ultimately forcing their way into the nearby water sources. Increase in population may result in benefits owing to increased consumer base but may also lead to insecurity problems which overwhelm the current set up. Therefore mitigation measures should be formulated by the relevant institutions before the onset of these impacts;

- The planning department should be involved at all stages of new developments to accommodate changes. Administration to continuously monitor changes in insecurity levels and formulate new approaches to counter them

#### **4.4 Summary of Socio- Economic Impacts**

From the public consultations, socio-economic impacts arising from implementation of the project were found to be numerous. Most of the expected socio-economic impacts deemed positive though few potential negative impacts were also identified. Some of the positive impacts identified include:

- Savings arising from reduced price and time spent fetching water
- Increase in the government revenue generation
- Creation of employment during construction and operation phases of the project
- Boost in business of construction materials and consumables especially during construction phase
- Increased value of land and property in the project area and environs
- The community will save time when the project brings water near their homes
- Time and money saved by the community in the project area will be used in economic activities thereby improving the quality of life.
- Diseases related to the quality of water consumed which are currently frequent in the area will decrease e.g. Typhoid, amoebiasis

#### **4.5 Summary of the Negative Impacts and the Mitigation Measures**

Potential negative impacts identified include:

- Increased dust emissions due to excavation works
- Increased noise levels from the machinery used in the project site

- Increased air pollution from ground excavation activities and gaseous emissions
- Loss of property i.e. private land that will be acquired for drilling of the project
- Population influx emanating from the area development

#### **4.6 Summary of mitigation measures**

Some of the mitigation measures are listed here below. Additional mitigation measures presented within the ESMP will be fully implemented to minimize the negative impacts.

- Sprinkling water in areas being excavated and along the tracks used by the transport trucks within the site
- Minimizing ground disturbance to control dust emissions
- Proper maintenance of the machinery and other equipment used on the site
- Restriction of construction activities in the stipulated 0800hrs to 1700hrs on weekdays as well as 0800hrs – 1300hrs on Saturdays
- Administration to continuously monitor changes in insecurity levels and formulate new approaches to counter them

#### **4.7 Summary of Recommendations from the Public Consultations**

The following recommendations are suggested that should assist the project to roll out smoothly with support from community members.

- The project should forge and always ensure close contacts and collaboration with the respective local administrators, mainly location chiefs. They will play a key role in community mobilization, sensitization and coordination of community activities in their respective areas of jurisdiction. The contact person from Athi Water Services Board who the community members will be liaising with should be agreed on and the information widely shared with the affected communities.

#### **4.8 Grievance Redress Mechanism**

A grievance redress mechanism (GRM) will be established to receive, evaluate and facilitate the resolution of Affected Person's concerns, complaints and grievances about the social and environmental performance at the level of the project. The GRM will aim to provide a time-bound and transparent mechanism to voice and resolve social and environmental concerns linked to the project. A well-defined grievance redress and resolution mechanism will be established to resolve grievances and complaints in a timely and satisfactory manner.

##### **4.8.1 Objective of Grievance Redress Mechanism**

The objective of the grievance redress mechanism is to resolve complaints as quickly as possible and at the local level through a process of conciliation; and, if that is not possible, to provide clear and transparent procedures for appeal.

## **4.8.2 Key People coordinating Grievance Redressal**

A community liason person from the Contractor will be designated as the key officer in charge of Grievance Redressal. The RE's office will assist in keeping the copies of the records of grievances

## **4.8.3 Procedure**

### **4.8.3.1 Access Point/ Complaint Uptake**

The complaints will be received at agreed point e.g. contractor's office/ RE's office. The complaints will be made in writing, verbally, over the phone, by fax, emails or any other media. Any complaint received verbally shall be put in writing for them to be considered.

### **4.8.3.2 Grievance Register**

All complaints will be logged in writing and maintained in a database. The complaints received shall be assigned a number that will help the complainant track progress.

The officer receiving the complaints shall try to obtain relevant basic information regarding the grievance and the complainant. The grievance register shall entail; the date of the complaint, issues raised, location of complaint show the issues raised and location of complaints circle around.

The database shall also show complaints resolved, complaints that have gone to mediation and date the complaint is resolved

### **4.8.3.3 Assessment, Acknowledgement and Response**

After registering the complaint in the Grievance Redressal Registration and Monitoring Sheet, the community liason person will study the complaint made in detail and forward the complaint to the concerned officer with specific dates for replying and redressing the same. He will hold meetings with the affected persons / complainant and then attempt to find a solution to the complaint received. If necessary meetings have to be held with the concerned affected persons / complainant and the concerned officers to find a solution to the problem and fix up plans to redress the grievance. The deliberations of the meetings and decisions taken will be recorded. The Community Liason Officer designated for Redressal of Grievances will be actively involved in Redressal activities.

All complaints must be responded will be normally be done within 14 working days and notified to the concerned in a written form. Should the Grievance be not solved within this period, this would be referred to the next level of Grievance Redressal, which is a grievance committee will be formed.

However, if the community liason person feels that adequate solutions are worked out the problem and it would require a few more days for actions to be taken, he can decide on retaining the issue at the first level by informing the complainant accordingly. However, if the complainant requests for an immediate transfer of the issue to the next level, it would be accepted and the issue would be taken to the next to the grievance committee.

Where there is an agreement between the complainant and the client or contractor on how the complaint will be resolved, a minute will be drafted and signed by both parties. After due implementation of it, a new minute will be signed stating that the complaint has been resolved.

#### **4.8.3.4 Reporting**

The Community Liason Person will prepare a monthly report on the Grievance Redressal issues of the project detailing the level of complaints, resolved or umresolved and any outstanding issues to be addressed. Monthly reports will include analysis of the type of complaints, levels of complaints and action taken to reduce complaints.

## **5.0 ANALYSIS OF ALTERNATIVES**

### **5.1 Introduction**

The Environmental Impact Assessment Study should identify and assess alternatives to the proposed development/project. Only the best alternative (one with the least adverse impacts) should be selected based on less negative impacts and cost-benefit analysis. An important alternative to be analyzed always is the “no project”. This is a very important analysis because it helps the proponents measure the impacts from the project against those which would have taken place without the project. In this section, the alternatives to the proposed drilling of borehole are discussed.

### **5.2 The No Project Alternative**

The no-action alternative is often defined by the baseline information and is crucial in the assessment of impact because other alternatives are weighed with reference to it. This alternative would mean that the project does not proceed.

The no project alternative option in respect to the proposed project implies that the status quo is maintained. This option is the most suitable alternative from the extreme environmental perspective as it ensures non-interference with the existing conditions. Under no project alternative, the proponent’s proposal would not receive the necessary approval from NEMA, proposed project would not be constructed and there would be no demand for the development. This option will however, involve several losses both to the community as a whole.

Development of the project on the other hand will improve water provision to the residents living within Kyamwai. The no project option will however lead to the following (general) major negative and long term impacts:

- The targeted populations (for water provision) will continue to experience a supply deficit. The water requirements of the supply area will not be met.
- Stagnating growth of the sub-county; and
- There will be loss of productivity and reduced ability to create wealth.

This scenario is not acceptable on either social or environmental grounds.

### **5.3 Relocation Option**

The hydrological survey attached in Annex 4 has identified the parcel of land as the best area to excavate and put up a borehole. Furthermore, the owner of the land has already consented and given out his land freely to the proponent to be used for the project.

Assuming the proposed project will be given a negative response by the relevant authorities including NEMA and WRMA, it would lead to a situation like no other project alternative

option; the other consequences of this would be a discouragement to local/private investors. From the bone statements relocation of the project to different site is not viable hence it's ruled out.

#### **5.4 Incremental alternatives**

Incremental alternatives are modifications or variations to the design of a project that provide different options to reduce or minimize environmental impacts. There are several incremental alternatives that can be considered, including:

- The design or layout of the activity
- The technology and materials to be used in the activity

##### **5.4.1 Layout alternatives**

An assessment of the fauna, flora and ecological processes within the proposed excavation work areas have been done during this EIA phase. It was found that the project will have minimal impact on the environment. The EIA report thus recommends the proposed borehole drilling.

##### **5.4.2 Alternative construction materials and technology**

The proposed project will be constructed using modern, locally and internationally accepted materials to achieve public health, safety, security and environmental aesthetic requirements. Equipment that save energy and water will be given first priority without compromising on cost or availability factors. The use of locally sourced stones, cement, sand (washed and clean), metal bars, pipes and fittings that meet the Kenya Bureau of Standards requirements is recommended.

## **6.0 POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS AND ASSOCIATED MITIGATION MEASURES**

This Chapter identifies and discusses both positive and negative impacts associated with the proposed project and their mitigation measures. The anticipated impacts and corresponding mitigation measures are discussed in Phases namely: design, construction, operation and decommissioning Phases.

The study has predicted and evaluated anticipated impacts using acceptable standard methods of impact prediction and evaluation. The significance of impacts is subjective, and expert judgments were used. Public participation and consultation with the community were conducted to reduce uncertainty.

### **6.1 POSITIVE IMPACTS DURING PLANNING AND DESIGN PHASE**

#### **6.1.1 Employment opportunities**

With the planning and design phase of the proposed project, there will be employment opportunities especially for professionals. Those involved in planning and design include engineers, surveyors, environmentalists and sociologists among others. Those employed will improve their living standards from the fees they will be paid for their services.

#### **6.1.2 Creation of awareness**

During the planning and design phase of the proposed project, the community was informed of the project and their views sought on the same. In this way, awareness was created for both the community and the Proponent. The Proponent was able to put into practice the useful advice from the community when planning and designing the Project.

### **6.2 NEGATIVE IMPACTS DURING PLANNING AND DESIGN PHASE**

The Consultant has mobilized a team of skilled and unskilled human resource to undertake the surveys and other studies required to complete the designs. Mobilization of the skilled and non-skilled labor and the process of disclosure and consultations among the residents and other stakeholders has however led to heightened expectations and speculations.

With the foregoing, it is envisaged that there will be minimal to no negative impacts during the planning and design stage.

#### **Mitigation:**

Impacts during this phase of the project are not significant. However, the Design Team shall take necessary measures to document any concerns and address them on as they occur. In that regard, the Design Team has incorporated an Environmental Expert in the team and taken time to sensitize and alert the residents of the on goings.

## **6.3 POSITIVE IMPACTS DURING CONSTRUCTION PHASE**

### **6.3.1 Employment opportunities**

With the drilling of the proposed borehole, there will be employment opportunities for both skilled and unskilled workers. This will be beneficial both from the economic and social point of view. Economically, it means abundant unskilled labor will be used in production. Socially these people will be engaged in productive employment and minimize social ills like drug abuse and other criminal activities.

Several workers including casual laborers and engineers are expected to work on the site for a period of time. Semi-skilled, unskilled and formal employees are expected to obtain gainful employment during the period of construction.

The project will provide employment for youths and provide support to the Government of Kenya initiatives on creation of jobs.

### **6.3.2 Creation of a market for construction/ Stimulation of the local economy**

The project will require materials such as cement, chemicals, some of which will be sourced locally and some internationally. This will provide a ready market for suppliers in and outside the project area.

Construction phase will also stimulate local economy through procurement of construction material and provision of labour by the locals. This will lead into increased capital flow and demand for goods and services will increase.

## **6.4 NEGATIVE IMPACTS DURING CONSTRUCTION**

### **6.4.1 Disease transmission through social interaction**

The activities related to borehole drilling will attract the informal sector business and unemployed people, and this will lead to increased interactions of people which might lead to spread of diseases such as HIV/AIDs.

### **Mitigation**

Special trainings will be conducted for employees on HIV, and related social health risks.

### **6.4.2 Loss of property**

One member of the community will suffer loss of land where the borehole will be drilled. The parcel number is Mwala/Muthunthini/442 under the name of Mutuku Mbuvi. However she has voluntarily offered her land for free to the project which will benefit her and the rest of the community.

### **6.4.3 Anticipated loss of vegetation cover**

An unavoidable part of any development in general is the clearance and loss of areas of vegetation which currently characterize the site of the development area. During construction, a small amount of vegetation will be cleared to give way for the proposed borehole project. Not only may vegetation be lost, but also faunal habitats may also be lost or at least partly destroyed.

The significance of the vegetation loss (where vegetation is still existing) during the site clearance (where necessary) is minimal.

#### **Mitigation**

- Retention of trees and shrubs, where possible on the potential sites for screening of the visual impact;
- Where the proposed project requires the removal of any vegetation, care will be taken to minimize the destruction or damage of trees.
- Re planting of destroyed trees in cleared areas where works are complete.

### **6.4.4 Noise generation**

Noise is unavoidable during the construction period. The drilling works will most likely be a noisy operation due to the machines (driller), incoming vehicles to deliver drilling and construction materials and communication among workers. The noise generated during any construction is at best described as part of a normal occupational hazard that workers in the construction industry face. Noise levels in construction works are usually below the threshold limit (90 dBA) that workers can be exposed in an 8 hours working day and is consequently not of any major concern. Operations and people in the neighbourhood are likely to be affected since noise beyond 85 dBA (can be transmitted up to 30 metres away) is itself a nuisance. The significance of noise impacts depends on whether the project would increase noise levels above the existing ambient levels by introducing new sources of noise. Noise and vibration impacts would be considered significant if the project would result in: a substantial permanent increase in ambient noise levels of more than 90 dBA (can be transmitted to over 30 metres away) in the project vicinity; exposure of persons to or generation of excessive ground-borne vibration or noise levels and a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project. The effects of noise include:

- a) Noise interferes with communication and can lead to tinnitus (ringing in the ears);
- b) Nuisance;
- c) Fatigue and tiredness, reduced efficiency, low morale and severe and permanent loss of hearing which may persist for several hours due to prolonged exposure to noise;
- d) Deterioration of the environment within the project site and the surrounding areas through vibrations produced by heavy construction machinery;
- e) Weakening of adjacent buildings resulting into cracking of their walls by vibrations.

**Mitigation:**

- Adhere to the Noise and Excessive Vibration Pollution (Control) Regulations 2009 which requires putting in place measures that will mitigate noise pollution.
- Minimize noise at the site and in the surrounding areas through:
  - i. Properly servicing and maintaining and tuning drilling machinery such as generators and other heavy duty equipment to reduce noise generation; and
  - ii. Placing noisy equipment in sound proof rooms or in enclosures to minimize ambient noise levels.
- Minimize the impacts of temporary drilling noise and vibration by:
  - i. Planning the drilling work to take place only during the day when the neighbors are also at work
  - ii. Maintaining reasonable working hours so as to reduce the number of complaints concerning noise from the workers and neighbors
  - iii. Operating shorter shift periods for workers who come in direct contact with high concentrations of noise or other hazards.
  - iv. Posting notices at the construction site informing the public of the construction activities, time and day.
  - v. Providing ear protective devices to prevent high frequency noise emitted by the high frequency machines during construction phase.

**6.4.5 Air Quality**

Dust will be emitted during excavation and related earthworks. This is likely to affect site workers, in extreme situations leading to respiratory problems. Stock piles arising from the drilled area could also cause dust emissions if blown away by wind. Smoke will be generated from the vehicles and the drilling equipment. The magnitude will however depend on the condition of the machines and the vehicles during the drilling period.

**Mitigation:**

- Minimizing the number of motorized vehicles on use;
- Rehabilitate disturbed areas;
- Provide scour checks on over-15% slopes or when working in loose soils;
- Use predetermined tracks;
- Avoiding machinery working in seasonally marshy areas, pans and floodplains;
- Wet all active construction areas as and when necessary to reduce dust;
- Undertake staff training and allocate roles to trained/responsible staff members.
- Provide dust masks to people visiting the site and have extra ones for site visitors
- Stockpiles of the earth should be watered if dry to minimize dust from blowing
- All fuel powered equipment including the generator will be serviced and maintained in optimal working conditions to mitigate against exhaust emissions.

- Workers and any other people at the site should wear face masks at all times to avoid carbon monoxide poisoning

#### **6.4.6 Soil Compaction**

As machines and people move on ground the soil is compacted. Compaction has the undesired effect of hindering air and water penetration beneath the soil surface and thus limiting aerobic activities of soil dwelling organisms. This may have negative consequences on soil productivity on a localized scale. Compaction also enhances run-off during the rainy season resulting into soil erosion.

#### **Mitigation:**

- Strictly control construction vehicles to ensure that they operate judiciously and over designated areas to reduce soil compaction
- Rip off any compacted areas after construction to allow aeration of soil and ease infiltration of water into the soil.

#### **6.4.7 Solid waste generation**

The major solid waste will be the drilled cuttings. There will be some solid containers such as cement, bentonite and gravel bags and other packets with materials and equipment to be used during implementation of the project. Other solid waste will be generated from the composite housing of the drilling crew.

#### **Mitigation:**

- a) Excavation debris, remaining gravel pack e.t.c. should be burned and/or disposed in sanitary dumpsite before the project is commissioned.
- b) Some of the drilled materials will be used in the borehole construction by back-filling the annular space. All excavated material from the draining channel will be used to refill it.
- c) Drilling crew to be encouraged to dump their personal wastes in designated covered dustbins
- d) Do not secure a solid waste disposal site within a radius of 50M of the proposed borehole site

#### **6.4.8 Groundwater pollution**

Water, especially for domestic use should be of high quality and wholesome. Poor water quality could be of great concern to human and animal health. The water that seeps into the ground may be contaminated to some degree and eventually affects the quality of the groundwater and indeed, borehole water. Percolation of water from sanitary systems I.e. toilets and refuse disposal sites poses a serious threat to the preservation of groundwater quality.

Protection of groundwater quality depends on the well design and the methods and materials used to construct the well. Some of the deficiencies in well construction are: -

- a) Insufficient or substandard well casing
- b) Inadequate seal between the well casing and the borehole
- c) Poor welding of casing joints
- d) Lack of sanitary protection at wellhead.
- e) Use of well pits.

### **Causes of Pollution of Groundwater**

Groundwater can be polluted by poisonous or pathogenic substances or by other detrimental changes in its quality especially through: -

- a) Poisonous substances such as compounds of lead, cadmium, chromium cyanide, fluoride or mercury
- b) Chemicals for plant protection, herbicides, pesticides and plant growth regulators.
- c) Sewerage, refuse or garbage
- d) Detergents, fats, petroleum products
- e) Colouring agents such as dyes, paints and aromatic substances
- f) Metabolic and decomposition products of micro organisms and fertilizers Acids, alkalis and salts.

### **Mitigation**

- a) Groundwater quality must be safeguarded by a correct territorial planning and protection of surface waters since these are strictly linked to ground water resources.
- b) Ensure that all potential sources of pollution are eliminated for example by ensuring that the sewage disposal system are well protected and does not leak even during exhaustion
- c) The proponent will adhere to the regulations set by the ministry of water Resources, Management and development on the amounts to be extracted from a borehole and the number of pumping hours. This helps to reduce wastage and misuse of this resource.
- d) Use water based drilling fluid
- e) Case the well as it passes through the water table
- f) Proper housekeeping within and around the rig will be observed before, during and after drilling, while proper clean up procedures will be undertaken in case of drilling fluid and oil spills.

### **6.4.9 Workers accidents and hazards**

Construction workers are likely to have injuries and hazards as the construction works unavoidably expose workers to occupational health and safety risks. The workers are also likely to be exposed to risk of accidents and injuries resulting from accidental falls and injuries from hand tools and construction equipment.

**Mitigation:**

- To reduce the workers accidents and hazards the Proponent will develop and commit the Contractors to Site Occupational Health and Safety rules and regulations as stipulated in the Occupational Safety and Health Act, 2007;
- All construction workers should be advised of the dangers associated with construction work;
- Workers should be provided with suitable personal protective equipment (PPE);
- Provision of adequate sanitary facilities to workers;
- Train all workers on Safety Health and Environment (SHE) with an aim of improving awareness;
- Trenches over 1.5m deep or wherever soil conditions dictate should be shored and secured against accidental entry by workers and the public;
- Install safety signage along the work areas;
- Where construction activities interfere with the movement of traffic, the site should be signed and controlled by trained flagmen/flag women and lit by night.

**6.4.10 Hazardous wastes**

Accidental oil and diesel spills would be caused by leaking of drums holding the diesel and oil that are stored on the site. The machines being used at the site could also cause oil spill especially if they are not well maintained or during regular maintenance. However, the occurrence of these wastes is expected to be minimal. Seepage of hydrocarbon products such as oils, grease and fuel if not carefully handled will result into contamination of water thus rendering it not go for both domestic and animal use. During the dry season spilled fuel, oils and lubricants could result into fire risks.

**Mitigation:**

- Ensure that the drilling crew is aware of the procedures to be followed for dealing with spills and leaks;
- Ensure that spills are immediately removed along with all contaminated material and disposed of at an approved hazardous landfill site;
- Ensure that all contaminated material is stored in a banded area before being disposed of;
- Ensure that a suitable spill kit is available on site, to be applied to all contaminated areas that will absorb / breakdown the spills. The quantity of such materials shall be able to handle the total volume of the hydrocarbon stored on site; and
- Ensure that all diesel and oil drums are stored in a banded area with the respective tags like “Danger” or its pictorial representation.
- Caution to be observed when transporting diesel and oil to, from and within the site. It is recommended that if possible, this be done using qualified oil transporters
- Repairing and maintenance and greasing of vehicles and construction plants must be carried out off the site (petrol station or garage) to avoid fuels and lubricants spills at the project site and contamination of the water

#### **6.4.11 Geological risks**

The ubiquitous drilling and digging of the ground soil for water, weakens the soil surface with an enhanced porosity as its ultimate result. With such vulnerability and lesser soil cohesion, the ephemeral soil might trigger erosion in the underground. Due to this, boreholes may cause negative environmental effects on ground water with high tendency of land subsidence (collapse) which may affect structures and infrastructure. Boreholes could lead to potential landmines, earthquakes or tremor.

#### **Mitigation:**

- The proponent will be advised to carry out a hydrogeologist survey to determine the suitability of the area for the drilling of a borehole
- Temporary casings may also be installed during drilling in case they notice the soil strata is weak to prevent the borehole walls from collapsing which should be replaced by stronger casings
- Drilling be done in the presence and supervision of a hydro-geologist

### **6.5 POSITIVE IMPACTS DURING OPERATION PHASE**

Just as in the construction phase, there are positive impacts associated with the operation phase of the proposed project. These positive impacts are discussed below.

#### **6.5.1 Improved water quality and quantity**

Improved water quality will in turn reduce exposure to water borne diseases to the consumers. General hygiene in the served areas will improve through use of acceptable water quality.

#### **6.5.2 Creation of job opportunities**

During operation phase, there will be employment opportunities especially, for those who will be employed to manage, maintain the installed equipment. This will improve the living standards of these employees. Furthermore the increased supply of water within Kyamwai will most likely create self-employment.

#### **6.5.3 Improved performance and living standards within the project area**

Water provision is one of the MDG goals for 2015. Provision of water and clean environment has been identified as one of the key pillars for alleviation of poverty. It is therefore envisaged that the continued existence of the project area as a sustainable settlement is reliant of the supply of clean potable water for each and every person. This will immensely contribute to the property value, land value and aesthetic value of the project area while ensuring that the population in this area remains healthy and productive. Access to water will in the long term result in improved income levels and health of the people, this consequently leads to poverty reduction.

#### **6.5.4 Creation of wealth**

The proposed development will ultimately provide revenues to the exchequer and expand the wealth base for the nation as a whole. It will pump both liquefied and tied up wealth hence

making the nation gain. It will also go a long way in cementing the value of the project area and its neighborhood as a whole.

#### **6.5.5 Reduced exposure to health risks and improved nutrition**

Improved water quality for domestic consumption reduces the risk to the health of the consumers and dependants of water resources that could translate into financial saving through less related expenditures.

#### **6.5.6 Education benefits to girl child**

Availability of water will remove the burden of collecting water for girl child leading to academic pursuits. Academic pursuit of the girl child at early stage leads to further education and competitiveness in the job market which is an exit route from poverty.

### **6.6 NEGATIVE IMPACTS DURING OPERATION PHASE**

#### **6.6.1 Groundwater depletion**

This may result from excessive abstraction of the water from the borehole i.e. beyond the permitted limit.

#### **Mitigation:**

- The borehole should be installed with a Master Meter and an Airline/ Piezometer to monitor ground water abstraction and to facilitate regular measurements of the static water level in the borehole, respectively
- The maximum ground water abstraction permitted from the borehole is limited to the authorized volume per day for the domestic/industrial use only subject to availability from 60% of the tested yield for a maximum abstraction period not exceeding ten (10) hours per day
- Install auto-shut water taps to reduce water wastage

### **6.7 IMPACTS DURING DECOMMISSIONING PHASE**

This involves demolition of the borehole and its abandonment after a certain period. There are varied reasons for the abandonment of a borehole; these include inadequate water or drying up of the aquifer due to activities uphill, poor water quality, defective construction and legal implications.

During the abandonment period, a lot of caution needs to be observed so that the materials can be reused on another project and to avoid contamination of the remaining water in the aquifer. Effective abandonment of a borehole depends on knowledge of the construction carried out at the source, geology and hydrogeology of the area. The importance of a full characterization

increases as the complexity of the borehole yield, site geology and the risk of aquifer contamination.

Proper records should be maintained during project implementation and later filed with the Water Resources Management Authority (WRMA) as required. Water level and any obstruction around the vicinity of the project need to be identified. Obstructions such as pumps, pipes, wiring must be pulled out and be used in alternative project. Scrap metal such as Iron sheets can be sold to metal scrap for safe disposal.

#### **6.7.1 Record keeping and documentation and environmental policy**

In accordance with the EMCA (1999), records of environmental issues, relevant licenses and permits need to be kept and availed to NEMA officers when necessary to prove compliance. These include: water abstraction permits; accident registers and a list of all hazardous materials on site. In addition, inspection records, environmental records, discharge-monitoring reports, relevant project licenses, amongst others are to be documented and kept safely. For efficient management of the borehole and to facilitate further assessments in compliance with the law, it is recommended that the following records be kept always at the project proponent's office in addition to those mentioned above:

- Records in environmental issues and periodic review notes;
- Records of violations and notification of authorities' correspondence in relation to the environment; and
- Situational reports made to NEMA in accordance with Section 68(3) of the EMCA, 1999

## **7.0 ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN (ESMP)**

### **7.1 Introduction**

This Environmental Impact Assessment Project Report complies with the requirements of the Environmental Management and Co-ordination Act (EMCA) of 1999 and takes into consideration the applicable local, World Bank Safeguard policies and other international standards and best practices. As a requirement in EMCA, the report should provide for a detailed Environmental and Social Management Plan (ESMP).

The ESMP presented in this Chapter summarizes the key impact elements identified and the remedial measures, the actions to be taken by various parties and the monitoring activities. An indication of the time scale for implementation and cost involved is also provided. The ESsMP can be further expanded during implementation with documented procedures and guidelines for work practices so as to be as responsive to the situations that various Contract Parties will encounter. The Parties should formulate procedures and practices and maintain records as required by the Act (EMCA, 1999). The implementation of the ESMP should be done within the provisions of the law and for the ultimate benefit of the stakeholders in the project area. The effectiveness of the ESMP shall be monitored and assessed during spot checks, formal inspections and at the end of the project when an overall audit of the works shall be carried out.

Detailed environmental management plan is presented below:

Table 5: Environmental and Social Management Plan

Impact	Mitigation Measure	Institutional Responsibility	Time Frame	Budget Kshs
Noise generation	<ul style="list-style-type: none"> <li>• Install portable barriers to shield compressors and other small stationary equipment where necessary; Use of quiet equipment (i.e. equipment designed with noise control elements);</li> <li>• Limit pickup trucks and other small equipment to a minimum idling time and observe a common-sense approach to vehicle use, and encourage workers to shut off vehicle engines whenever possible;</li> <li>• Provision of appropriate personnel protective equipment;</li> <li>• Construct mainly during the day (8:00 – 17:00); and</li> <li>• Consider labor based construction methodologies</li> <li>• Provide timely notifications to neighboring communities ahead of the beginning of works to provide public information about the project schedule.</li> </ul>	Contractor	Throughout construction period	100,000
Dust emissions	<ul style="list-style-type: none"> <li>• Minimizing the number of motorized vehicles on use;</li> <li>• Rehabilitate disturbed areas;</li> <li>• Provide scour checks on over-15% slopes or when working in loose soils;</li> <li>• Use predetermined tracks;</li> <li>• Avoiding machinery working in seasonally marshy areas, pans and floodplains;</li> <li>• Wet all active construction areas as and when necessary to reduce dust;</li> </ul>	Contractor	Throughout construction period	80,000

Impact	Mitigation Measure	Institutional Responsibility	Time Frame	Budget Kshs
	<ul style="list-style-type: none"> <li>• Undertake staff training and allocate roles to trained/responsible staff members.</li> <li>• Provide dust masks to people visiting the site and have extra ones for site visitors</li> </ul> <p>Stockpiles of the earth should be watered if dry to minimize dust from blowing</p>			
Soil compaction	<ul style="list-style-type: none"> <li>• Care should be taken to avoid spoil location in land that could otherwise be used for productive purposes.</li> <li>• Strictly control construction vehicles to ensure that they operate judiciously and over designated areas to reduce soil compaction</li> <li>• Rip off any compacted areas after construction to allow aeration of soil and ease infiltration of water into the soil.</li> </ul>	Contractor	Throughout construction period	100,000
Hazardous wastes	<ul style="list-style-type: none"> <li>• Ensure that the drilling crew is aware of the procedures to be followed for dealing with spills and leaks;</li> <li>• Ensure that spills are immediately removed along with all contaminated material and disposed of at an approved hazardous landfill site;</li> <li>• Ensure that all contaminated material is stored in a banded area before being disposed of;</li> <li>• Ensure that a suitable spill kit is available on site, to be applied to all contaminated areas that will absorb / breakdown the spills.</li> <li>• Ensure that all diesel and oil drums are stored in a</li> </ul>	Contractor	Throughout construction period	10,000

Impact	Mitigation Measure	Institutional Responsibility	Time Frame	Budget Kshs
	<p>banded area with the respective tags like “Danger” or its pictorial representation.</p> <ul style="list-style-type: none"> <li>• Caution to be observed when transporting diesel and oil to, from and within the site. It is recommended that if possible, this be done using qualified oil transporters</li> <li>• Repairing and maintenance and greasing of vehicles and construction plants must be carried out off the site (petrol station or garage) to avoid fuels and lubricants spills at the project site and contamination of the water</li> </ul>			
Solid waste generation	<ul style="list-style-type: none"> <li>• Construction waste should be recycled or reused as much as possible to ensure that materials that would otherwise be disposed off as waste are diverted for productive uses;</li> <li>• The Proponent shall put in place measures to ensure that construction materials requirements are carefully budgeted and to ensure that the amount of construction materials left on site after construction is kept minimal;</li> <li>• Minimization of solid waste during construction of the proposed project through use of durable, long-lasting materials that will not need to be replaced often, thereby reducing the amount of construction waste generated over time;</li> <li>• Skips and bins should be strategically placed within the campsite and construction site, they should also be adequately designed and covered to prevent</li> </ul>	Contractor	Throughout construction period	200,000

Impact	Mitigation Measure	Institutional Responsibility	Time Frame	Budget Kshs
	<p>access by vermin and minimize odour. They should also be emptied regularly;</p> <ul style="list-style-type: none"> <li>• Provide portable sanitary conveniences for the construction workers for control of sewage waste. A ratio of approximately 25 workers per chemical toilet should be used.</li> <li>• Measures to ensure that waste materials from the project are disposed at suitable sites will be taken. These will include engaging only reputable truckers and conducting appropriate spot checks to verify that disposal are done in accordance with the requirements of NEMA;</li> <li>• The ultimate fate of the wastes should be monitored so that they are not illegally disposed of;</li> </ul>			
Vegetation loss	<ul style="list-style-type: none"> <li>• The Contractor will ensure proper demarcation of the project area to be affected by the construction works;</li> <li>• Strict control of construction vehicles to ensure that they operate only within the area to be disturbed by access routes and other works;</li> <li>• Retention of trees and shrubs, where possible on the potential sites for screening of the visual impact;</li> <li>• Where the proposed route requires the removal of any vegetation, care will be taken to minimize the destruction or damage of trees.</li> <li>• Re planting of destroyed trees in cleared areas where works are complete.</li> </ul>	Contractor	Throughout construction period	30,000

Impact	Mitigation Measure	Institutional Responsibility	Time Frame	Budget Kshs
Worker accidents and hazards	<ul style="list-style-type: none"> <li>• To reduce the workers accidents and hazards the Proponent will develop and commit the Contractors to Site Occupational Health and Safety rules and regulations as stipulated in the Occupational Safety and Health Act, 2007;</li> <li>• All construction workers should be advised of the dangers associated with construction work;</li> <li>• Workers should be provided with suitable personal protective equipment (PPE);</li> <li>• Provision of adequate sanitary facilities to workers;</li> <li>• Train all workers on Safety Health and Environment (SHE) with an aim of improving awareness;</li> <li>• Trenches over 1.5 m deep or wherever soil conditions dictate should be shored and secured against accidental entry by workers and the public;</li> <li>• Install safety signage along the work areas; Where construction activities interfere with the movement of traffic, the site should be signed and controlled by trained flagmen/flag women and lit by night</li> </ul>	Contractor	Throughout construction period	50,000
Groundwater pollution	<ul style="list-style-type: none"> <li>• Groundwater quality must be safeguarded by a correct territorial planning and protection of surface waters..</li> <li>• Ensure that all potential sources of pollution are eliminated</li> <li>• The proponent will adhere to the regulations set by the ministry of water Resources, Management and development on the amounts to be extracted from a borehole and the number of pumping hours.</li> </ul>	Contractor and Water Service Provider	Throughout construction period and operation phase	50,000

Impact	Mitigation Measure	Institutional Responsibility	Time Frame	Budget Kshs
	<ul style="list-style-type: none"> <li>• Use water based drilling fluid</li> <li>• Case the well as it passes through the water table</li> <li>• Proper housekeeping within and around the rig will be observed before, during and after drilling.</li> </ul>			
Groundwater depletion	<ul style="list-style-type: none"> <li>• The borehole should be installed with a Master Meter and an Airline/ Piezometer to monitor ground water abstraction and to facilitate regular measurements of the static water level in the borehole, respectively</li> <li>• The maximum ground water abstraction permitted from the borehole is limited to the authorized volume per day for the domestic/industrial use only subject to availability from 60% of the tested yield for a maximum abstraction period not exceeding ten (10) hours per day</li> <li>• Install auto-shut water taps to reduce water wastage</li> </ul>	Contractor / WRMA	Throughout construction period	100,000
Air quality	<ul style="list-style-type: none"> <li>• All fuel powered equipment including the generator will be serviced and maintained in optimal working conditions to mitigate against exhaust emissions.</li> <li>• Workers and any other people at the site should wear face masks at all times to avoid carbon monoxide poisoning</li> </ul>	Contractor	Throughout construction period	50,000
Geological risks	<ul style="list-style-type: none"> <li>• The proponent will be advised to carry out a hydrogeologist survey to determine the suitability of the area for the drilling of a borehole</li> <li>• Temporary casings may also be installed during drilling in case they notice the soil strata is weak to</li> </ul>	Contractor	Throughout construction period	No additional costs

Impact	Mitigation Measure	Institutional Responsibility	Time Frame	Budget Kshs
	prevent the borehole walls from collapsing which should be replaced by stronger casings <ul style="list-style-type: none"> <li>• Drilling be done in the presence and supervision of a hydro-geologist</li> </ul>			
Increase in HIV/AIDS prevalence and other STIs	<ul style="list-style-type: none"> <li>• The Resident Engineer should ensure that prevention and management of STIs occurrences as a result of social interaction between immigrant workers and local populations is conducted through:</li> <li>• Selecting appropriate locations away from concentration of human settlements for construction camps;</li> <li>• Education and sensitization of workers and the local communities on STIs including provision of condoms to the project team and the public;</li> <li>• The contractor has to institute HIV/AIDS awareness and prevention campaign amongst workers for the duration of the contract</li> <li>• The contractor should ensure that the project workers are sensitized on the local culture.</li> </ul>	Contractor	Throughout construction period	100,000
<b>Total Budget</b>				<b>870,000</b>

## 7.2 Monitoring Responsibilities

In order to implement the environmental monitoring plan, it is recommended that the supervisor identified as in the above EMP to oversee environment and monitoring aspects including the pollution control, dust emissions control and geological risks, management of sanitation and occupational health and safety throughout the project area. The supervisor is also expected to co-ordinate and monitor environmental management during construction and provide monitoring schedules during operations. Other recommended participants include the respective County Environmental Officers, Water Offices and the Physical Planning Offices as well as the Athi Water Services Board among others. The responsibility relationship is as follows;

- i. Athi Water Services Board will be responsible for coordination activities and liaisons, particularly in regard to the identification of project sites, construction and social linkages.
- ii. The Water Offices will ensure that the contractor is observing all measures associated with water resources management rules
- iii. AWSB will liaise with the Environment Offices on matters of environmental and social nature. The beneficiary communities will be responsible for overseeing the implementation of the environmental monitoring plan established under this report.
- iv. The National Environmental Management Authority (NEMA) through the County Environment Office shall be responsible of surveillance of environmental and social aspects of the project implementation. It will be expected that the concerns will be communicated through the public relations person for prompt attention whenever they arise
- v. WRMA to conduct periodic monitoring of the groundwater level and water quality.

## 7.3 Environmental Monitoring Guidelines

Upon completion and commissioning of the borehole project, it will be necessary to establish appropriate operational guidelines on environmental conservation and social linkages to enable the operations' management identify critical environmental and social issues and institute appropriate actions towards minimizing associated conflicts. Basically, the guidelines cover among other areas environmental management/monitoring programmes, standard operation procedures, compliance monitoring schedule and environmental audit schedules as required by law.

**Table 6: Environmental and Social Monitoring Plan**

<b>Indicators</b>	<b>Responsibility</b>	<b>Frequency</b>
Confirm appropriateness of construction work plan and suitability of construction site arrangements	AWSB	Upon commencement and monthly thereafter
Health and safety records at the site	AWSB	Weekly on a

<b>Indicators</b>	<b>Responsibility</b>	<b>Frequency</b>
Local medical clinic inquiries Number of local/migrant workers at the		continuous basis
Water abstraction/ water rights – water meter measurements	AWSB / WRMA	Monthly
Borehole yield	WRMA	Annually
Water quality of borehole to be assessed for pH, SS, E. Coli, TN and TP	WRMA	Before and after construction works
Conflicts about water accessibility: user satisfaction survey	WRMA	Quarterly after completion of construction.

## **8.0 CONCLUSION AND RECOMMENDATIONS**

### **8.1 Conclusion**

The primary objective of the proposed project is to enhance access to a stable water supply for the proponent. The hydro-geological survey carried out revealed that the hydro-geological conditions within the proposed project site are favorable for the drilling of the borehole. The proposed borehole will be drilled to a depth of approximately 130 meters so as to penetrate fully into the water bearing formation so as to generate the authorized volume per day in order to meet the demand.

The positive impacts that will accrue as a result of the implementation of this project will include: availability of reliable and safe water for domestic use, improved efficiency, and enhanced biological diversity and reduced dependency on other sources water.

Groundwater from the proposed borehole is expected to be fresh. However, on completion of drilling works, a water sample should be referred to a competent laboratory for physical, chemical and bacteriological analysis before water is availed for use.

### **8.2 Recommendations**

The hydro-geological conditions underlying the proposed site are favorable for drilling a borehole. The recommendation of this study that the proposed project be allowed to proceed on strict condition that the environmental management plan is implemented and follow-up is made to ensure compliance as may be directed by NEMA. Recommendations for the prevention and mitigation of adverse impacts are as follows: -

1. The proposed borehole should be drilled at a minimum diameter of 203mm to enable casing with 153mm casings and screens following the design recommended by the supervising hydro-geologist
2. The borehole should be properly gravel packed and sealed to avoid any contamination from shallow sub-surface water, taking particular note of the guidelines given in the accompanying addendum on borehole drilling, design and construction from the supervising hydro-geologist.
3. The borehole should be fitted with a master water meter to monitor groundwater abstraction, and an airline for monitoring of the water levels.
4. The drilling, construction and test pumping of the borehole should be supervised by a qualified hydro-geologist.

5. The supervising Hydro-geologist should ensure that the contractor collects all solid waste and construction debris from the site and disposes into the approved dumpsites.
6. Follow all recommendations made in the authorization letter from Water Resources Management Authority.
7. Diligence on the part of the contractor and proper supervision by the Supervising Hydro-geologist is crucial for mitigation impacts.
8. The use of an environmental checklist would also ensure that measures are implemented throughout the implementation and operation phases in order to prevent or avert any negative impacts.

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## **ANNEXES**

Annex 1: Site Photography

Annex 2: Public Consultation forms

Annex 3: Consent Letter

Annex 4: Plot Ownership Details

Annex 5: Hydrogeological Survey Report

Annex 6: Sample Chance Find Procedure

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**ANNEX 1**

**SITE PHOTOGRAPHY**

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## SITE PHOTOGRAPHY

PLATE NO:	PHOTOGRAPH	REMARKS
<p>1. Position on the plot where the proposed borehole shall be sunk</p>		<p>The position was chosen after a qualified geologist surveyed the area and finally chose that particular point as the most appropriate for situating the borehole.</p>
<p>2. Access road next to the proposed project site</p>		<p>Drilling activities should be carried out with due consideration to the road users e.g. mitigate against road obstruction during transport of machinery to the site.</p>
<p>3. Small scale farming near the project site</p>		<p>Water shortage is a major problem within the project area. Such small scale farming relies heavily on irrigation. Long term strategies to improve water supply should be undertaken by the relevant authorities.</p>

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**ANNEX 2**

**PUBLIC CONSULTATION FORMS**

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**Consulting Services for Preparation of Detailed Design, Bidding Documentation, Supervision and Coordination of Mwala Water Supply Systems in Tanathi Water Services Board Area**

**Environmental Impact Assessment (EIA) and Resettlement Action Plan (RAP) – Proposed Rehabilitation of Mwala Water Supply System in Mwala Sub-County of Machakos County**

**Questionnaire**

Please answer the following questions to the best of your knowledge without favoring any party. Your contribution will enable National Environment Management Authority (NEMA) to make an informed decision in relation to the proposed development.

Name: BIENSON MUTISO MUTIKU Sex: MALE

Representing Plot/Lr No: 442

Contact: 0701114766

**General**

Athi Water Services Board intends to rehabilitate the Mwala water supply system in Mwala Sub-County of Machakos County.

1. Which is the main source of water in this area?

- Mwala Mini Water Supply System
- Wamunyu Water Supply
- Mbiuni Water Supply
- Community water organizations
- Shallow wells / Boreholes
- Any other KATHULA DAM

Is it reliable? Yes / No. (Please tick one)

2. Do you think the proposed water supply system will have any impact on the following if implemented? If YES, please comment.

Water supply YES

I will be using it.

Sanitation

washing using it.

Vegetation

ploughing using water from that bore hole.

Health

I will be washing using it.

Economic status

planting of fruit trees using water.

3. What are some of the positive impacts you can attach to this project?

- It will assist me in
- both agriculture
- irrigation
- planting vegetables.

4. What are some of the negative impacts you can attach to this project?

- N/A
- 
- 
- 
- 

5. What are some of the challenges you experience in this area? (Please tick)

- Water Shortage ✓
- Waterborne diseases ✓
- Garbage Collection
- Security ✓
- Any other... Latrines

6. Which are some of the infrastructural facilities that you would like to see developed in this area?



- Bridges
- roads
- Earth dams

7. In your opinion, should these proposed rehabilitation of the water supply system be implemented? Yes / No. (Tick one and give reasons).

positive development

8. Any other comments you would like to make in relation to this proposed project?

Anything recommended I will accept.

Signature: *[Signature]* Date: *[Signature]* 13/10/2015

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This survey was carried out by: *Esther Ngom Ndungu*

Cell phone number: *0729080250* on: *13/10/2015*

Signature: *[Signature]*



Consulting Services for Preparation of Detailed Design, Bidding Documentation, Supervision and Coordination of Mwala Water Supply Systems in Tanathi Water Services Board Area

Environmental Impact Assessment (EIA) and Resettlement Action Plan (RAP) – Proposed Rehabilitation of Mwala Water Supply System in Mwala Sub-County of Machakos County

Questionnaire

Please answer the following questions to the best of your knowledge without favoring any party. Your contribution will enable National Environment Management Authority (NEMA) to make an informed decision in relation to the proposed development.

Name: DAVID KISING'O MUSILA Sex: MALE

Representing Plot/Lr No: 417

Contact: 0735967209

General

Athi Water Services Board intends to rehabilitate the Mwala water supply system in Mwala Sub-County of Machakos County.

1. Which is the main source of water in this area?

- Mwala Mini Water Supply System
- Wamunyu Water Supply
- Mbiuni Water Supply
- Community water organizations
- Shallow wells / Boreholes
- ✓ Any other KWANSHULA DAM

Is it reliable? Yes / No. (Please tick one)

2. Do you think the proposed water supply system will have any impact on the following if implemented? If YES, please comment.

Water supply YES (WATER FOR DOMESTIC USE)



I WILL BE USING IT FOR WASHING

Sanitation

I WILL BE USING IT GENERAL CLEANLINES.

Vegetation

IF WE PLANT TREES, IT WILL HELP THE BEST OF ENVIRONMENT.

Health

IT WILL BECOME FULL OF SICKNESS

Economic status

TIME SPENDS LOOKING FOR WATER WILL BE REDUCED.

3. What are some of the positive impacts you can attach to this project?

- IT WILL ASSIST ME BOTH
- IRRIGATION
- BOTH AGRICULTURE
- PLANTING VEGETATION

4. What are some of the negative impacts you can attach to this project?

- N/A
- 
- 
- 

5. What are some of the challenges you experience in this area? (Please tick)

- Water Shortage
- Waterborne diseases
- Garbage Collection
- Security
- Any other...  LACK OF TRAINING

6. Which are some of the infrastructural facilities that you would like to see developed in this area?

- ROADS
- ~~BETTER~~ BUDGES.
- LEACH SAM

7. In your opinion, should these proposed rehabilitation of the water supply system be implemented? Yes/No. (Tick one and give reasons).

IT IS A POSITIVE DEVELOPMENT.

8. Any other comments you would like to make in relation to this proposed project?

~~ITS A POSITIVE DEVELOPMENT.~~  
ANYTHING RECOMMENDED BY THE AUTHORITY I WILL AGREE.

Signature: (M) Date: 13/10/2015

**FOR OFFICIAL USE ONLY**

This survey was carried out by: Esther Ngom Ndungu

Cell phone number: 0729080250 on: 13/10/2015

Signature: ERIN



**WATER**  
Sustaining Life, Promoting Progress



**Consulting Services for Preparation of Detailed Design, Bidding Documentation, Supervision and Coordination of Mwala Water Supply Systems in Tanathi Water Services Board Area**

**Environmental Impact Assessment (EIA) and Resettlement Action Plan (RAP) – Proposed Rehabilitation of Mwala Water Supply System in Mwala Sub-County of Machakos County**

**Questionnaire**

Please answer the following questions to the best of your knowledge without favoring any party. Your contribution will enable National Environment Management Authority (NEMA) to make an informed decision in relation to the proposed development.

Name: DOUGLAS MGOVI MUKU Sex: MALE

Representing Plot/Lr No: 442

Contact: 0710 227858

**General**

Athi Water Services Board intends to rehabilitate the Mwala water supply system in Mwala Sub-County of Machakos County.

1. Which is the main source of water in this area?

- Mwala Mini Water Supply System
- Wamunyu Water Supply
- Mbiuni Water Supply
- Community water organizations
- Shallow wells / Boreholes
- Any other KWALA DAM

Is it reliable? Yes / No. (Please tick one)

2. Do you think the proposed water supply system will have any impact on the following if implemented? If YES, please comment.

Water supply

NO YES



Sanitation

washing it

Vegetation

ploughing using water from that bore hole.

Health

there with no sickness of water borne diseases

Economic status

planting crops using that water

3. What are some of the positive impacts you can attach to this project?

- it will assist me in both
- agriculture
- irrigation
- planting vegetables

4. What are some of the negative impacts you can attach to this project?

- N/A

5. What are some of the challenges you experience in this area? (Please tick)

- Water Shortage
- Waterborne diseases
- Garbage Collection
- Security
- Any other latrines

6. Which are some of the infrastructural facilities that you would like to see developed in this area?



**WATER**



**Consulting Services for Preparation of Detailed Design, Bidding Documentation, Supervision and Coordination of Mwala Water Supply Systems in Tanathi Water Services Board Area**

**Environmental Impact Assessment (EIA) and Resettlement Action Plan (RAP) – Proposed Rehabilitation of Mwala Water Supply System in Mwala Sub-County of Machakos County**

**Questionnaire**

Please answer the following questions to the best of your knowledge without favoring any party. Your contribution will enable National Environment Management Authority (NEMA) to make an informed decision in relation to the proposed development.

Name: Francis Kulu Sex: MALE

Representing Plot/Lr No: .....

Contact: 0704335562

**General**

**Athi Water Services Board** intends to rehabilitate the Mwala water supply system in Mwala Sub-County of Machakos County.

1. Which is the main source of water in this area?

- Mwala Mini Water Supply System
- Wamunyu Water Supply
- Mbiuni Water Supply
- Community water organizations
- Shallow wells / Boreholes ✓
- Any other

Is it reliable? Yes / No. (Please tick one)

2. Do you think the proposed water supply system will have any impact on the following if implemented? If YES, please comment.

Water supply

interference the water people was some fee to get water



Sanitation

is fairly

Vegetation

not so good but half

Health

is not so better but Very Good; but when its raining

Economic status

is so low because of lack of water within our area

3. What are some of the positive impacts you can attach to this project?

- When project has started within
- Lack of transported from main town to
- We just within mwela and Kamondo
- 

4. What are some of the negative impacts you can attach to this project?

- But it can do good when
- when every body is because of his
- are clothes within
- With water we can work hard

5. What are some of the challenges you experience in this area? (Please tick)

- Water Shortage
- Waterborne diseases
- Garbage Collection
- Security ✓
- Any other... But just within our area

6. Which are some of the infrastructural facilities that you would like to see developed in this area?



- We have ~~no~~ <sup>no</sup> trees within.
- We also need dams for animals
- We to open other project within

7. In your opinion, should these proposed rehabilitation of the water supply system be implemented? Yes/ No. (Tick one and give reasons).

Because in our area there was no water but now we have water for drinking but not for farming.

8. Any other comments you would like to make in relation to this proposed project?

With water we can work hard and we education our child's within very well.

Signature: *[Signature]* Date: 13/10/2015

**FOR OFFICIAL USE ONLY**

This survey was carried out by: Esther Ngoin Ndung'u

Cell phone number: 0729080250 on: 13/10/2015

Signature: *[Signature]*



**Consulting Services for Preparation of Detailed Design, Bidding Documentation, Supervision and Coordination of Mwala Water Supply Systems in Tanathi Water Services Board Area**

**Environmental Impact Assessment (EIA) and Resettlement Action Plan (RAP) – Proposed Rehabilitation of Mwala Water Supply System in Mwala Sub-County of Machakos County**

**Questionnaire**

Please answer the following questions to the best of your knowledge without favoring any party. Your contribution will enable National Environment Management Authority (NEMA) to make an informed decision in relation to the proposed development.

Name: SABINA KATUMBI Sex: F  
KISINGU

Representing Plot/L.r No: 417

Contact: 0700788090

**General**

**Athi Water Services Board** intends to rehabilitate the Mwala water supply system in Mwala Sub-County of Machakos County.

1. Which is the main source of water in this area?

- Mwala Mini Water Supply System
- Wamunyu Water Supply
- Mbiuni Water Supply
- Community water organizations
- Shallow wells / Boreholes
- Any other

Kyenganga Stream - STREAM

Is it reliable? Yes / No. (Please tick one)

2. Do you think the proposed water supply system will have any impact on the following if implemented? If YES, please comment.

Water supply  
water for domestic use



Sanitation

Will improve in the area.

Vegetation

Planting of trees.

Health

Water borne diseases will reduce

Economic status

time spend looking for water will be reduced.

3. What are some of the positive impacts you can attach to this project?

- time spend looking for water will be reduced
- planting trees will be additional.
- 
- 

4. What are some of the negative impacts you can attach to this project?

- N/A
- 
- 
- 

5. What are some of the challenges you experience in this area? (Please tick)

- Water Shortage ✓
- Waterborne diseases ✓
- Garbage Collection
- Security ✓
- Any other..... schools have no water at all

6. Which are some of the infrastructural facilities that you would like to see developed in this area?

- Roads
- Bridges
- EARTH DAM

7. In your opinion, should these proposed rehabilitation of the water supply system be implemented? Yes / No. (Tick one and give reasons).

It is a positive development

8. Any other comments you would like to make in relation to this proposed project?

Anything recommended I will

Signature: SABINE Date: 13/10/2015

**FOR OFFICIAL USE ONLY**

This survey was carried out by: Esther Ngoini Ndung'u

Cell phone number: 0729080250 on: 13/10/2015

Signature: EMO





**Consulting Services for Preparation of Detailed Design, Bidding Documentation, Supervision and Coordination of Mwala Water Supply Systems in Tanathi Water Services Board Area**

**Environmental Impact Assessment (EIA) and Resettlement Action Plan (RAP) – Proposed Rehabilitation of Mwala Water Supply System in Mwala Sub-County of Machakos County**

**Questionnaire**

Please answer the following questions to the best of your knowledge without favoring any party. Your contribution will enable National Environment Management Authority (NEMA) to make an informed decision in relation to the proposed development.

Name: WINFRED KATUNGE MBDVI Sex: F

Representing Plot/Lr No: 442

Contact: 0710227864

**General**

**Athi Water Services Board** intends to rehabilitate the Mwala water supply system in Mwala Sub-County of Machakos County.

1. Which is the main source of water in this area?

- Mwala Mini Water Supply System
- Wamunyu Water Supply
- Mbiuni Water Supply
- Community water organizations
- Shallow wells / Boreholes
- Any other (Kwag Nthula dam)

Is it reliable? Yes / No. (Please tick one)

2. Do you think the proposed water supply system will have any impact on the following if implemented? If YES, please comment.

Water supply

Yes. Water will be readily available



In association with



Losai Management Limited

Sanitation

Water will be used for cleaning purposes

Vegetation

It will be used for irrigation

Health

Water borne diseases will reduce

Economic status

Irrigation will increase money when you sell the products

3. What are some of the positive impacts you can attach to this project?

- Water for irrigation
- Water for cleaning
- 
- 

4. What are some of the negative impacts you can attach to this project?

- 
- N/A
- 
- 

5. What are some of the challenges you experience in this area? (Please tick)

- Water Shortage ✓
- Waterborne diseases ✓
- Garbage Collection
- Security ✓
- Any other... Latrines

6. Which are some of the infrastructural facilities that you would like to see developed in this area?

- Roads.....
- BRIDGES.....
- EARTH dams.....

7. In your opinion, should these proposed rehabilitation of the water supply system be implemented? Yes/No. (Tick one and give reasons).

It is a POSITIVE development.....

8. Any other comments you would like to make in relation to this proposed project?

Nothing recommended. Will accept.....

Signature: ~~.....~~ Date: 13/10/2015.....

**FOR OFFICIAL USE ONLY**

This survey was carried out by: Esther Ngom Ndunge.....

Cell phone number: 0729080250..... on: 13/10/2015.....

Signature: .....



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**ANNEX 3**

CONSENT LETTER

---

MUTUNGE MUTUKU MBUVI,  
P.O Box 109,  
MASII.  
18<sup>th</sup> NOVEMBER 2015.

TO WHOM IT MAY CONCERN

DEAR SIR/MADAM,  
RE: LETTER OF NO OBJECTION PLOT NO.

I being the rightful inheritor of land registration number MWALA/MATHUNTHINI/442 registered under name MUTUKU MBUVI ID/KT.112430 who is my late husband have no objection to sinking of Mathunthini borehole in my land. I suggest provision of water from the borehole to my homestead.

Yours faithfully  
Mutunge Mutuku Mbuvi,  
ID NO. 30871267,



LHT Print.

Witnesses

Benson Mutiso Mutuku, - Son  
I.D NO. 1466731, Cell Phone No. 0701114766



Faith Mutindi Mutiso, - Granddaughter  
I.D No. 32850299, Cell Phone No. 0703853000



Id No Douglas MBUVI  
Cellphone no. 0710227858

Mutuku - Son - ID No. 13423299  


---

**ANNEX 4**

**PLOT OWNERSHIP DETAILS**

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REPUBLIC OF KENYA

THE REGISTERED LAND ACT  
(Chapter 300)

# Land Certificate

REGISTRATION DISTRICT

TITLE No.

M A C H A K O S

MWALA/MATHUNTHINI/442

*This is to certify that* MUTOKU MBUVI (ID/KTL.112430)

of Mathunthini, Mwala Location

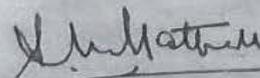
is (~~are~~) now registered as the absolute proprietor(~~s~~) of the land comprised in the above-mentioned title, subject to the entries in the register relating to the land and to such of the overriding interests set out in section 30 of the Registered Land Act as may for the time being subsist and affect the land.

Given under my hand and the seal of the

M a c h a k o s District Registry

this twenty-ninth day of June, 1978.





Land Registrar

---

**ANNEX 5**

**HYDROGEOLOGICAL SURVEY REPORT**

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**HYDROGEOLOGICAL SURVEY REPORT**

**FOR**

**ONE PRODUCTION BOREHOLE AT MAKUTANO**

**FOR**

**MWALA WATER AND SANITATION COMPANY LIMITED**

**MWALA DISTRICT**

**MACHAKOS COUNTY**

Signed .....  
HILLARY K. MURIUKI  
LICENSE No. WD/WP/161)

**Date:** .....

**Ref: GSC/HSR /2015/10-003**

### PERTINENT DATA

<b>CLIENT</b>	<b>MWALA WATER AND SANITATION COMPANY LIMITED P.O BOX 248 MASII</b>
<b>PROJECT</b>	Rehabilitation/ Augmentation of Mwala Water Supply
<b>LOCALITY</b>	Kyamwai
<b>DISTRICT/COUNTY</b>	Mwala District Machakos County
<b>POSITION</b>	GPS coordinates 37 M 330265, UTM 9845491
<b>DATUM</b>	WGS 84
<b>ALTITUDE</b>	1295m
<b>MAP SHEET NUMBER</b>	Map Sheet 149/4;
<b>RECOMMENDED DEPTH</b>	130m

## EXECUTIVE SUMMARY

Mwala and Masii towns in Mwala District, Machakos County face very acute water shortages. The daily water demand is about 200m<sup>3</sup>/hr against a current supply of 17m<sup>3</sup>/day! The World Bank through International Development Association through Athi and Tanathi Water Services Boards wish to fund the Rehabilitation/ Augmentation of Mwala Water Supply to bridge the gap between water demand and supply.

Drilling of the proposed borehole and construction of the Mwala Weir are some of the key components of the project.

The study area is located on the eastern side of Mango basement hills range. The selected site is covered by brown sandy soils underlain by gneisses of the Mozambican Orogenic Belt.

Generally, the project area has medium groundwater potential.

On the basis of the data obtained from this survey, it is recommended that a borehole be drilled at site **VES 15** to depth of **130m**. This will ensure that the envisaged entire aquifer zone will be fully penetrated.

It is further recommended that: -

- All stages of drilling should be supervised by qualified personnel to ensure that procedures of borehole construction and completion are adhered to as per the regulations of the Ministry of Water and Irrigation.
- Drillers log and test pumping data should be carefully analyzed to give the correct rating of the submersible pump.
- A 2-liter sample of water from the borehole be taken to a competent laboratory for a full physical, chemical and bacteriological analysis before the water is put to any human use.
- Upon completion the borehole should be fitted with a piezometer and master meter to facilitate static water level measurements in the borehole and monitoring the daily groundwater abstraction, respectively.
- An Environmental Impact Assessment be carried out as per the requirements of National Environment Management Authority (NEMA)

## **ABBREVIATIONS AND ACRONYMS**

ASL	above sea level
BGL	Below ground level
EC	Electrical Conductivity
GPS	Global Positioning System
HEP	Horizontal Electrical Sounding
m	Meters
mm	millimeters
m <sup>3</sup>	Cubic meters
NEMA	National Environment Management Authority
OLS	Old Land Surface
Ppm	Parts Per Million
PWL	Pumping Water Level
SHG	Self Help Group
UTM	Universal Traverse Mercator
VES	Vertical Electrical Sounding
WGS	World Geodetic System
WRMA	Water Resources Management Authority
WSL	Water Struck Level
WRL	Water Rest Level

## GLOSSARY OF TERMS

<b>Alluvium</b>	General term for detrital material deposited by flowing water.
<b>Aquifer</b>	A geological formation or structure, which stores and transmits water and which is able to supply water to wells, boreholes or springs.
<b>Colluvium</b>	General term for detrital material deposited by hill slope gravitational processes, with or without water as an agent usually of mixed texture.
<b>Confined aquifer</b>	A formation in which the groundwater is isolated from the atmosphere by impermeable geologic formations. Confined water is generally at greater pressure than atmospheric, and will therefore rise above the struck level in a borehole.
<b>Development</b>	In borehole engineering, this is the general term for procedures applied to repair the damage done to the formation during drilling. Often the borehole walls are partially clogged by an impermeable “wall cake”, consisting of fine debris crushed during drilling, and clays from the penetrated formations. Well development removes these clayey cakes, and increases the porosity and permeability of the materials around the intake portion of the well. As a result, a higher sustainable yield can be achieved.
<b>Fault</b>	A larger fracture surface along which appreciable displacement has taken place.
<b>Gradient</b>	The rate of change in total head per unit of distance, which causes flow in the direction of the lowest head
<b>Grit</b>	Coarse sandstone of angular grain
<b>Hydraulic head</b>	Energy contained in a water mass, produced by elevation, pressure or velocity.
<b>Hydrogeological</b>	Those factors that deal with subsurface waters and related geological aspects of surface waters.
<b>Infiltration</b>	Process of water entering the soil through the ground surface.
<b>Joint</b>	Fractures along which no significant displacement has taken place
<b>Lava sheet</b>	Lava flow, in parts very thick, covering a large area.
<b>Percolation</b>	Process of water seeping through the unsaturated zone, generally from a surface source to the saturated zone.
<b>Permeability</b>	The capacity of a porous medium for transmitting fluid
<b>Phenocrysts</b>	Large, conspicuous crystals in porphyritic rocks (i.e. rocks with visible mineral crystals in a generally fine groundmass)
<b>Phonolite</b>	Compact and fine textured volcanic rock, belonging to the trachyte-group (together with <i>trachyte ss.</i> and <i>latite</i> ). Defined by a high portion of feldspar (40-90%) and feldspathoidic minerals (10-60%: analcite, nepheline, leucite, etc.), and very low to negligible quartz content (0-2%). Incorporated dark coloured minerals (0-40%) most commonly include hornblende, olivine, melanite and

acmite. The structure is porphyritic with common phenocrysts of sanidine (orthoclase, or Potassium-feldspar) and nepheline.

<b>Piezometric level</b>	An imaginary water table, representing the total head in a confined aquifer: it is defined by the level to which water would rise in a well.
<b>Pyroclastic rocks:</b>	Group of rocks consisting of volcanic dust, ashes, lapilli and coarse lumps of lava explosively thrown up in molten condition and deposited by gravity. Hardened masses of dust, ashes and lapilli are known as <i>tuff</i> , while coarse, consolidated pyroclastic debris is referred to as <i>agglomerate</i> .
<b>Porosity:</b>	The portion of bulk volume in a rock or sediment that is occupied by openings, whether isolated or connected
<b>Pumping test:</b>	A test that is conducted to determine aquifer and/or well characteristics
<b>Recharge</b>	General term applied to the passage of water from surface or subsurface sources (e.g. rivers, rainfall, and lateral groundwater flow) to the aquifer zones.
<b>Static water level</b>	The level of water in a well that is not being affected by pumping (a.k.a. "rest water level")
<b>Transmissivity</b>	A measure for the capacity of an aquifer to conduct water through its saturated thickness (m <sup>2</sup> /day)
<b>Tuff</b>	Here: hardened volcanic ash.
<b>Unconfined</b>	Referring to an aquifer situation whereby the water table is exposed to the atmosphere through openings in the overlying materials (as opposed to confined conditions).
<b>Yield</b>	Volume of water discharged from a well.

## 1. INTRODUCTION

### A. Background

Makutano and Masii Towns face acute water shortages. In an effort to provide enough water to the residents of the two towns, Mwala Water and Sanitation Company Limited has been wishing to drill a borehole at a strategic location so as to use the distribution tank at King'atuani to serve the two Towns.

The World Bank through International Development Association, Athi and Tanathi Water Services Boards wish to fund the Rehabilitation/ Augmentation of Mwala Water Supply to bridge the gap between water demand and supply.

This report gives in detail the findings and recommendations of a groundwater exploration within Makutano and King'atuani areas.

### B. Location and accessibility

The study site is located within Kyamwai Village, located some 1.5km off the Makutano- Kitui Road in Machakos County. Reference can be made to the attached maps and the sketch to identify the site.

Administratively the site can be described thus:-

Administrative unit	Name
District	Mwala
Division	Mwala
Location	Makutano
Sub - location	Mathuithini
Village	Kyamwai

*Table 6: Administrative units*

The site is accessible in all weather.

### C. Current Water Sources

Currently, only one borehole is providing about 17 cubic meters of water per day.

### D. Water Demand

The Client requires about 200 cubic meters of water daily for Mwala Water Supply.

### E. Climate

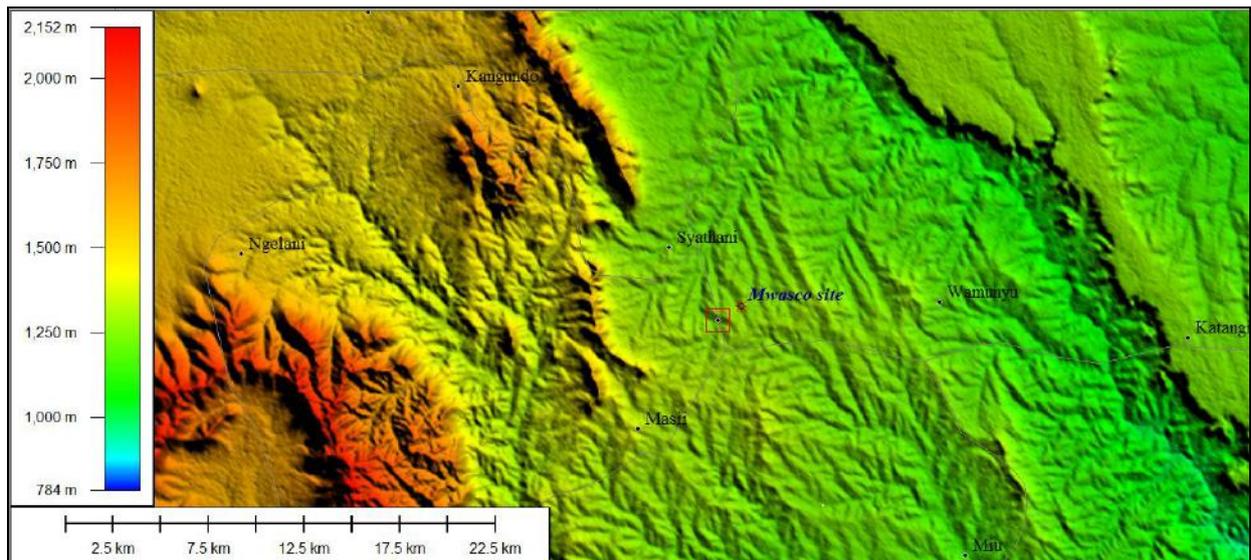
The study area is characterized by an almost equatorial type of climate. The area is relatively warm/cool with the coldest months experienced in July and August. The wet seasons are normally in April and May and are generally warm. The rainfall is about 900mm per year and decreases steadily to the east where the climate is increasingly semi arid.

Temperatures range between 20 - 30 degrees Centigrade though there are slight variations depending on the season.

### F. Topography

The general physiography of the area is strongly controlled by the geology with areas underlain by rocks resistant to erosion such as granitoids and quartzites being generally higher than those underlain by easily erodable rocks such as gneisses and schists.

Local topography is well captured in the map below:-



*Map 1 : Topography at selected site*

### **G. Soils**

The study area is mostly covered by brown sandy soils, though facies of black cotton soils are common especially along the drainage channels.

### **H. Drainage**

Rivers Muvwana and Embui are the main drainage system in the area. There are numerous seasonal tributaries that rise in the hills and join the river in a dendritic fashion, with the main flow being north-south in conformity with the regional geological strike.

## 2. GEOLOGY

### *A. Regional Geology*

The greater part of the area is occupied by rocks of the Basement System. Within the surrounding area, relatively few rock outcrops are observed, due to the thick overburden. The Basement rocks here are mainly gneisses and schists. Kyanite gneisses were mapped near the junction of the Kiu and Mombasa roads by B.H. Baker in 1952. He described the rocks as containing large euhedral porphyroblastic, (large, well-formed crystals which were formed during the process of metamorphism), crystals of kyanite coated with graphite. Schists are found inter-bedded, consisting almost entirely of mica (biotite)

Much of the Basement System is bedded. The granitoid gneisses however, are homogeneous and un-bedded, a buff to dirty cream in colour and medium-grained.

### *B. Geology of the Survey Area*

Based on the existing geological information the main rock types in the study area include granitoid gneisses, pelitic schists and gneisses and muscovite gneisses.

The granitoid gneisses are usually homogenous, un-bedded rocks forming large masses whose outline controls the directional trend of the surrounding metamorphic rocks. In hand specimen they massive with uniform texture and a fine gneissose banding which become obliterated when the grain is coarser. Petrographically, they consist of orthoclase, microcline, albite, quartz and biotite with muscovite being sometimes present in small amount.

The schists mainly vary from muscovite –rich varieties to biotite –rich varieties. The schists are usually coarse grained and shiny and are almost entirely dominated by quartz and micas. The gneisses vary from biotite gneisses to hornblende gneisses and are usually massive, fairly foliated with quartz, microcline, biotite and hornblende as dominant minerals. Muscovite gneisses are rare and are found in the vicinity of Uuni Hills, and biotite is usually replaced by muscovite.

Formation / lithology to be penetrated:-

- Top Soils
- Weathered subsurface regolith (Decomposed Gneisses)
- Weathered/ fractured Gneisses
- Fresh gneisses (increasingly compact and fresh with depth).

### *C. Structural Geology*

In the general study area, no clear evidence of faults or fracture zones was observed. Water bearing fissures, however, may occur within the intersection points of the different structural units. This formation is known to have undergone some faulting. The faults, however, do not continue in the overlying formations, and are therefore generally obscured and deep buried.

Faulting will have the highest impact on hard and massive rock types; elastic formations such as tuffs and weakly consolidated deposits will bend (fold) rather than break (fault).

Consequently, they tend to suppress the radius of influence and the magnitude of the damage caused by tectonic events. In relatively plastic rocks, the porosity will not increase in the area affected by the fault. Hard layers such as lavas, on the other hand, will be broken by fractures and joints, thus giving rise to increased (secondary) porosity.

### **3. HYDROGEOLOGY**

#### ***A. Background***

The hydrogeology of an area is determined by the nature of the parent rock, structural features, weathering processes and precipitation patterns. Especially in the Precambrian shields, metamorphic rocks are highly compact and have virtually no intergranular (or primary) porosity. While mostly solid, non-porous, and absolutely impervious at the scale of a hand specimen, these rocks have a type of porosity that can be termed as fracture (or secondary) porosity. This implies that they can hold water in a network of fissures, cracks, joints, fractures or faults.

The secondary porosity is caused by systems of "macro pores" and "micro pores". Macro pores are fissures and fractures of structural origin. Micro pores are interstices created by weathering. These two types of secondary porosity are usually closely related, as cracks and fissures facilitate the percolation of water and hence more intensive weathering. The aquifers in the metamorphic rocks are characterized generally by a very low primary and (depending on the degree of fracturing) highly variable secondary porosity.

The thickness and mineral characteristics of the weathered layer play an important role in the amount of groundwater it can hold and the hydraulic conductivity (i.e. the ability of water to flow). Topography, drainage pattern, rainfall and evaporation are some of the major factors, which determine the occurrence of groundwater.

#### ***B. Groundwater Occurrence***

Within the survey Area, groundwater occurs in:-

- weathered zones above the crystalline Basement rocks,
- fractured zones within the crystalline bedrock, and
- Shallow alluvial deposits along the main drainage channels.

#### ***C. Recharge***

Recharge is the process through which water is added to the groundwater reservoir. Some aquifers do not receive any recharge at all; in this case, the water is connate or fossil, and pumping results in irreversible depletion. Usually, aquifers with little recharge and consequently long residence times are marked by high levels of mineralization and salinity. Unless the underground water body is of vast extent, it is essential that not more water be abstracted than the annual amount of replenishment.

The two major processes are probably direct recharge at surface (not necessarily local) and indirect recharge via faults and/or other aquifers.

Direct recharge is obtained through downward percolation of rainfall or river water into aquifer. If the infiltration rate is low due to the presence of an aquiclude (such as clay), the recharge to the aquifer is low. Percolation will depend on the soil structure, vegetation cover and the state of erosion of the parent rock. Rocks weathering to clayey soils naturally inhibit infiltration and downward percolation. Aquifers may also be recharged laterally if the rock is permeable over a wide area.

#### ***D. Discharge***

Discharge from aquifers is either through natural processes as base-flow to streams and springs, or artificial discharge through human activities. However considering the few number of boreholes in the area this form of discharge is not much pronounced.

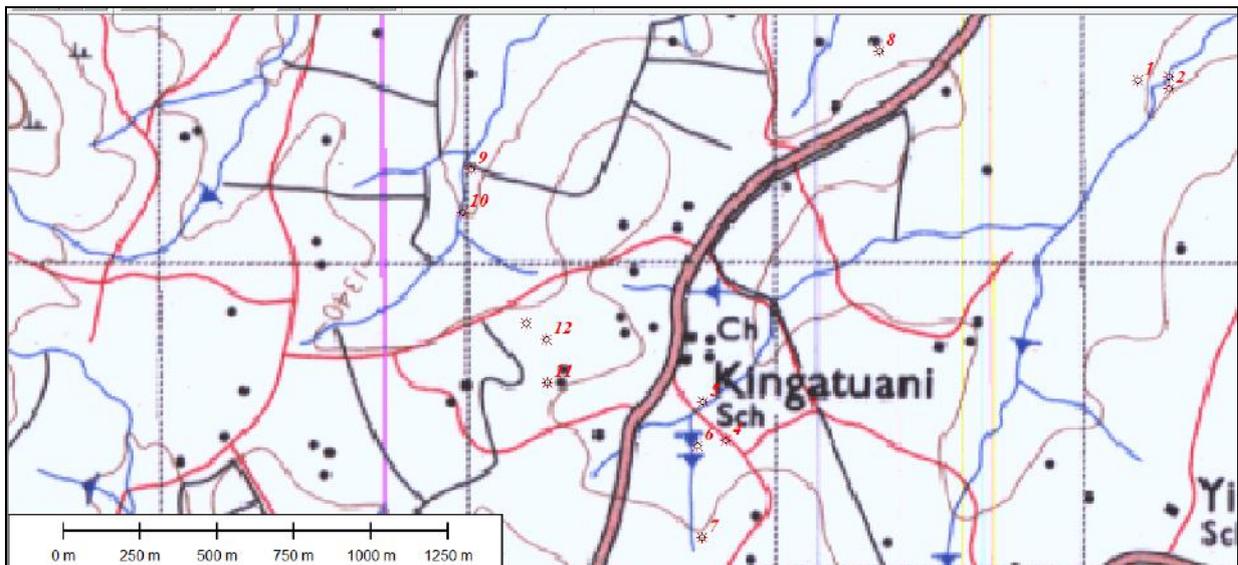
## 4. EOPHYSICS

### A. Vertical Electrical Soundings

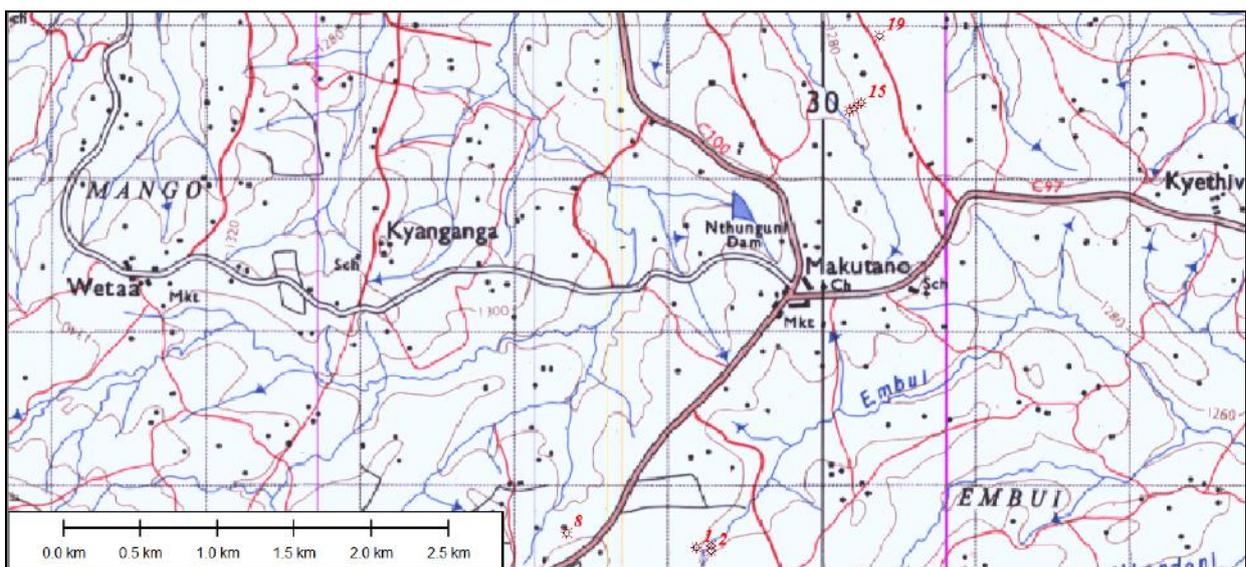
To assess the local sub-surface characteristics 19 Vertical Electrical Sounding (V.E.S) Curves MWALA WATER VES 1-19 were carried out to horizontal spread of 150m.

Under Vertical Electrical Sounding, current is introduced to the ground using two outer electrodes A& B and the potential difference measured using the inner electrodes M& N. Resistivity readings are then taken at predetermined spacing and plotted on a log- log graph.

An ABEM SAS 1000 Geophysical set was deployed and the Shlumberger Array adopted. Spatial location of the VES curve is shown in the maps below while its model is illustrated in section 4.2.



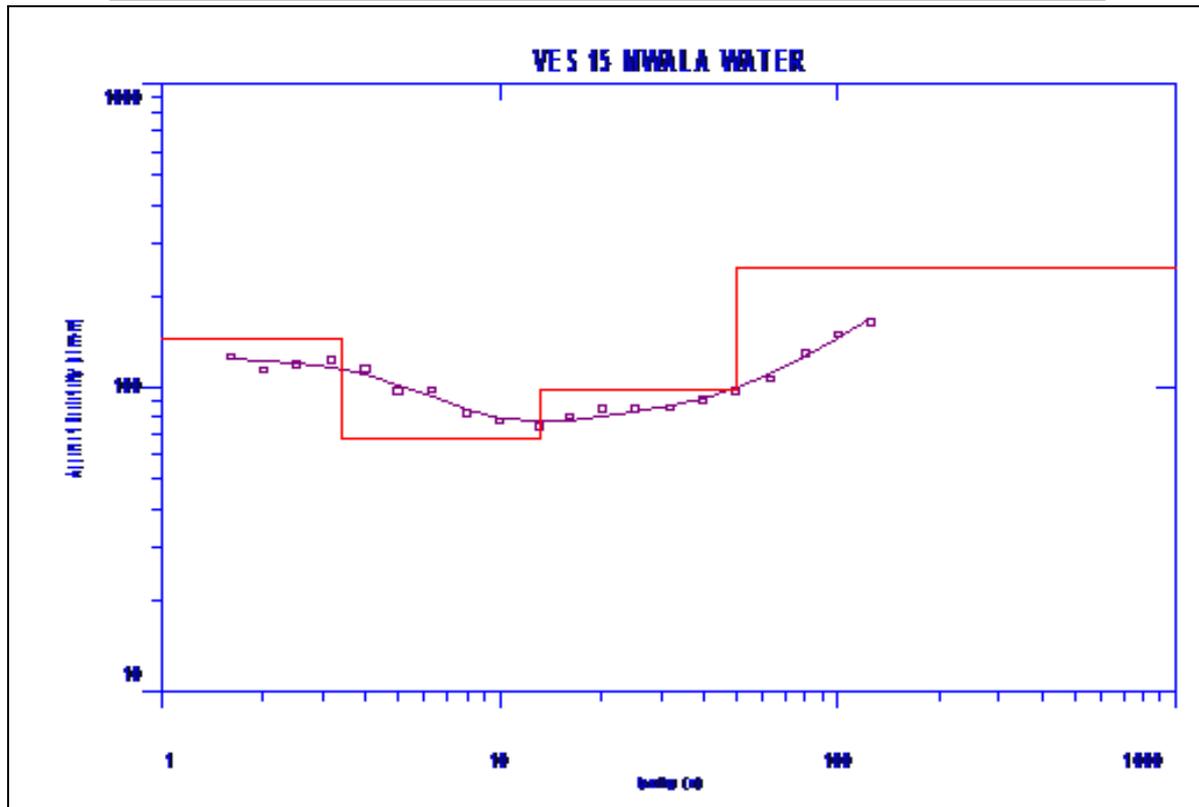
*Map 2: Distribution of VES sites around King'atuani*



*Map 3: Distribution of VES sites around Makutano*

*B. Geophysical models*

**VES 15: Co-ordinates Degrees 037° 28' 27.7"E; 01° 23' 50.6"S, Alt 1295m ASL**



**MODEL: VES 15 MWALA WATER**

LAYER	RESISTIVITY	THICKNESS	DEPTH
1	145.6	3.4	3.4
2	68.4	9.8	13.2
3	98.0	36.8	50.0
4	250.0		

**DATASET: VES 15 MWALA WATER**

NUMBER	AB/2	MN	RESISTIVITY
1	1.600000	0.500000	126.389999
2	2.000000	0.500000	114.339996
3	2.500000	0.500000	119.000000
4	3.200000	0.500000	123.000000
5	4.000000	0.500000	114.800003
6	5.000000	0.500000	97.250000
7	6.300000	0.500000	98.199997
8	8.000000	0.500000	82.000000
9	10.000000	0.500000	77.620003
10	13.000000	0.500000	74.730003
11	16.000000	0.500000	80.300003
12	20.000000	5.000000	85.000000
13	25.000000	5.000000	85.000000
14	32.000000	5.000000	86.000000
15	40.000000	10.000000	91.000000
16	50.000000	10.000000	98.000000
17	63.000000	10.000000	107.000000
18	80.000000	10.000000	130.000000
19	100.000000	25.000000	150.000000
20	125.000000	25.000000	165.000000

***C. Geophysical Interpretations***

<b>Resistivity Curve Number</b>	<b>Depth to expected formation (m)</b>	<b>True Resistivity in Ohms (<math>\Omega</math>)</b>	<b>Expected formation</b>
<b>VES 15 MWALA WATER</b>	0 – 3.4	145.6	Top dry soils
	3.4 – 13.2	68.4	Highly weathered regolith
	13.2 – 50.0	98.0	Highly weathered/ Fractured basement
	Below 50.0	250.0	Weathered to fresh basement

***Table 7: Showing expected formations and stratigraphy***

## 5. AQUIFER CHARACTERISTICS

### A. Available data

Four boreholes have been drilled within a radius of 6km radius from the selected site. Their data is tabulated below:-

Serial No. "C."	Owner	Direction (Km)	Total Depth (m)	W.S.L (m)	W.R.L (m)	Tested Yield (m <sup>3</sup> /hr)	P.W.L (m)
2407	DWD	3.5 NE	104	88	20	0.84	57.4
4039	Wambua J. M.	3.2 SW	92	74	10	8.16	20.5
13674	Mwala Mixed Sch	6 SW	80	42	56	8.0	70
-	Kanyuuku S.H.G	4.4 NW	110	45, 50	44.0	18.0	92
<b>Range</b>			<b>80 – 110.0</b>	<b>42 – 88.0</b>	<b>10 – 56.0</b>	<b>0.84 – 18.0</b>	<b>20.5 – 92.0</b>

*Table 8: Data for nearest boreholes*

### B. Borehole Data Analyses and Aquifer Outline of the Area

The available data indicates that several water struck levels occur within drilled depth of between 42 and 88m bgl.

The boreholes in this area have variable yields ranging between **0.84 and 18.0m<sup>3</sup>/hour**. The proposed borehole is expected to give a yield within the upper half of this range.

### C. Impacts to Abstraction Trends and Analyses of Boreholes within 800m from the Proposed Site

From the records, there is NO borehole which is located within 800m radius.

Thus there is no any foreseen interference with the existing boreholes or the groundwater abstraction trends.

### D. Calculation of Aquifer Properties

To calculate the area Aquifer Properties, testing pumping data of Kanyuuku SHG borehole was adopted.

**In summary**, the borehole has the following parameters:-

Total drilled depth:	110m,
Tested yield:	18.0m <sup>3</sup> /hr,
Water Struck Levels:	45, 50m
Water Rest Level:	44m
Pumping Water Level:	92m
Draw down:	48m

The borehole has fairly penetrated the productive aquifer and thus will be fair enough to deduce the aquifer properties of the project Area.

### E. Estimation Aquifer Transmissivity

The raw test Pumping Data of the above boreholes in Table 3 were not available to assist in calculation of Aquifer Transmissivity using **Jacob's formula (Driscoll 1986)**:

Thus, in absence of proper pump test data, the **Logan method of approximation** has been employed (Logan, 1965). This method however has errors of 50% or more and is thus used for estimation

purpose only. The derivation of the aquifer properties is based on the data of Kanyuuku SHG borehole.

Aquifer Transmissivity (T) is thus estimated as follows:-

$$T = 1.22Q/\Delta S \quad \text{Where: } Q = \text{Yield per day}$$

$$\Delta S = \text{Draw down}$$

$$T = 1.22/48 \times 432 = \mathbf{10.98\text{m/day}}$$

**F. Hydraulic Conductivity**

The Hydraulic Conductivity (K) is estimated as follows:

$$K = T/\text{Aquifer Thickness}$$

Based on the geological logs of the boreholes in the area, the cumulative aquifer thickness for the purpose of this calculation has been estimated at 9m.

Thus,

$$K = 10.98 / 9 = \mathbf{1.22\text{m/day}}$$

**G. Specific Capacity**

The aquifer Specific Capacity (S) = Q/Δs.

$$\text{Where: } Q = \text{Discharge (m}^3\text{/day)} = 432\text{m}^3\text{/day}$$

$$D = \text{Drawdown (m)} = 48\text{m}$$

$$S = 9\text{m}^2\text{/day}$$

**H. Groundwater Flux**

The Groundwater Flux (F) is estimated based on borehole *C- 2407 and C- 4039* which more or less share the same aquifers.

$$F = K.i.h.w \quad \text{Where } K\text{- Hydraulic Conductivity} = 1.22\text{m/day}$$

$$i \text{ - Slope} = 21 / 6700$$

$$h\text{- Aquifer Thickness} = 9\text{m}$$

$$w\text{- Arbitrary distance, } 2000\text{m}$$

Thus;

$$F = 1.22 (21/6700). 9.2000 = \mathbf{68.83\text{m}^3\text{/day}}$$

**I. Water quality**

The water quality of the aquifers in the area is expected to be drawn from deeper fracture systems. These aquifers are adequately recharged from the surface thus the chemical characteristics of groundwater that is relatively young and potable is expected. The water is likely to be highly mineralized and hard, but not brackish. Seasonal changes may however occur, whereby an increase in salinity is experienced during the dry season.

Due to the nature of the surrounding Basement rocks, high levels of calcium are envisaged, which may lead to encrustation of pipe-works. It is therefore recommended to use uPVC casings and screens inside the borehole, and galvanized steel mains (high quality – Class C) and collector pipes.

Indications of the permissible thresh holds of the various elements is given on the table below:-

Parameter	Max. WHO guideline	Kenyan Standards	Unit
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		<b>(drinking)</b>	
pH	6.5-8.5	6.5-8.5	pH Scale
Colour		50	mgPt/l
Turbidity	5	25	N.T.U.
Conductivity		2,500	µS/cm
Permanganate Value		10	mgO <sub>2</sub> /l
Iron	0.3	1.0	mg/l
Manganese	0.4	0.5	mg/l
Calcium		200	mg/l
Magnesium	0.1	150	mg/l
Sodium	200		mg/l
Potassium			mg/l
Total Hardness	500	500	mgCaCO <sub>3</sub> /l
Total Alkalinity	500		mgCaCO <sub>3</sub> /l
Chloride	250	600	mg/l
Fluoride	1.5	1.5	mg/l
Nitrate	10	30	mgN/l
Nitrite	3.0		mgN/l
Ammonia			mgN/l
Total Nitrogen			mgN/l
Sulphate	250	600	mg/l
Orthophosphate			mgP/l
Total suspended solids			mg/l
Free Carbon Dioxide			mg/l
Dissolved Oxygen			mgO <sub>2</sub> /l
Total Dissolved Solids	1,000	1,500	mg/l
Others			

*Table 9: Water quality data showing Kenyan and WHO standards*

## 6. CONCLUSIONS AND RECOMMENDATIONS

### *A. Recommendations*

From both the hydrogeological and geophysical studies carried out, the borehole is recommended to be drilled at **VES 15 to a depth of 130m.**

The boreholes in this area have variable yields ranging between **0.84 and 18.0m<sup>3</sup>/hour.** **The proposed borehole is expected to give reasonable yield due to the good recharge.**

The site has been marked with a temporary wooden peg and pointed out to Mr. Peter Mwasuna, (cell phone number 0723275907) of Mwala Water and Sanitation Co. Ltd. It has also been accurately plotted on the attached map extract.

It was not possible to get a site near the King'atuani distribution due to the poor groundwater potential.

It is further recommended that: -

- Upon completion the borehole be fitted with a piezometer and master meter to facilitate static water level measurement in the borehole and monitoring the daily groundwater abstraction, respectively.
- a 2 liter sample of water from the boreholes be taken to a competent laboratory for a full physical, chemical and bacteriological analysis before the water is put to any human use
- All stages of drilling should be supervised by qualified personnel.
- Drillers log and test pumping data should be carefully analysed to give the correct rating of submersible pump to avoid over pumping.

### *B. Construction*

A direct circulation rotary method should be used, though cable tool method can also be used, it is slow and time consuming.

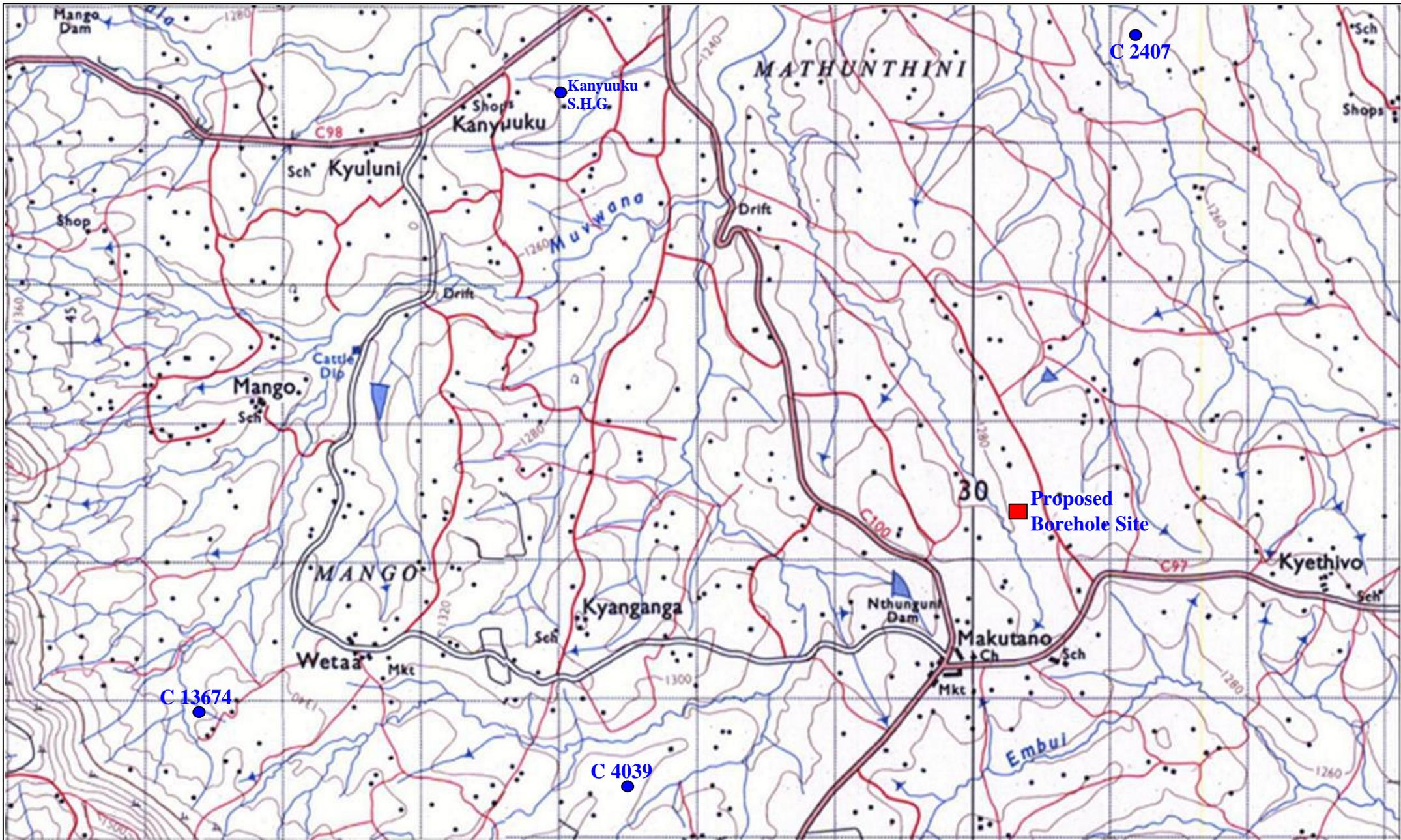
The following recommendations are made:-

- The well should be drilled at a minimum diameter of 203mm to enable casing with 153mm casings and screens. The overburden requires a slightly wider diameter to accommodate the working casings.
- Mild steel casings and plasma slotted screens or UPVC screens and casings of a suitable wall thickness should be used. Torched slots are not recommended since they allow ingress of fine sands into the bore compromising both the efficiency and the lifespan of the well.
- Gravel pack to be well rounded and have an average diameter of 2- 4mm of well sorted sand
- Well development should be carried out for a minimum of 4 hours or more until all the fines are expelled from the well. This shall ensure that the aquifers fully open up
- The stick up casing should be 0.5m high and a concrete plinth 1.5m \* 1.5m \* 1.5m, of which 0.5m should be above ground.

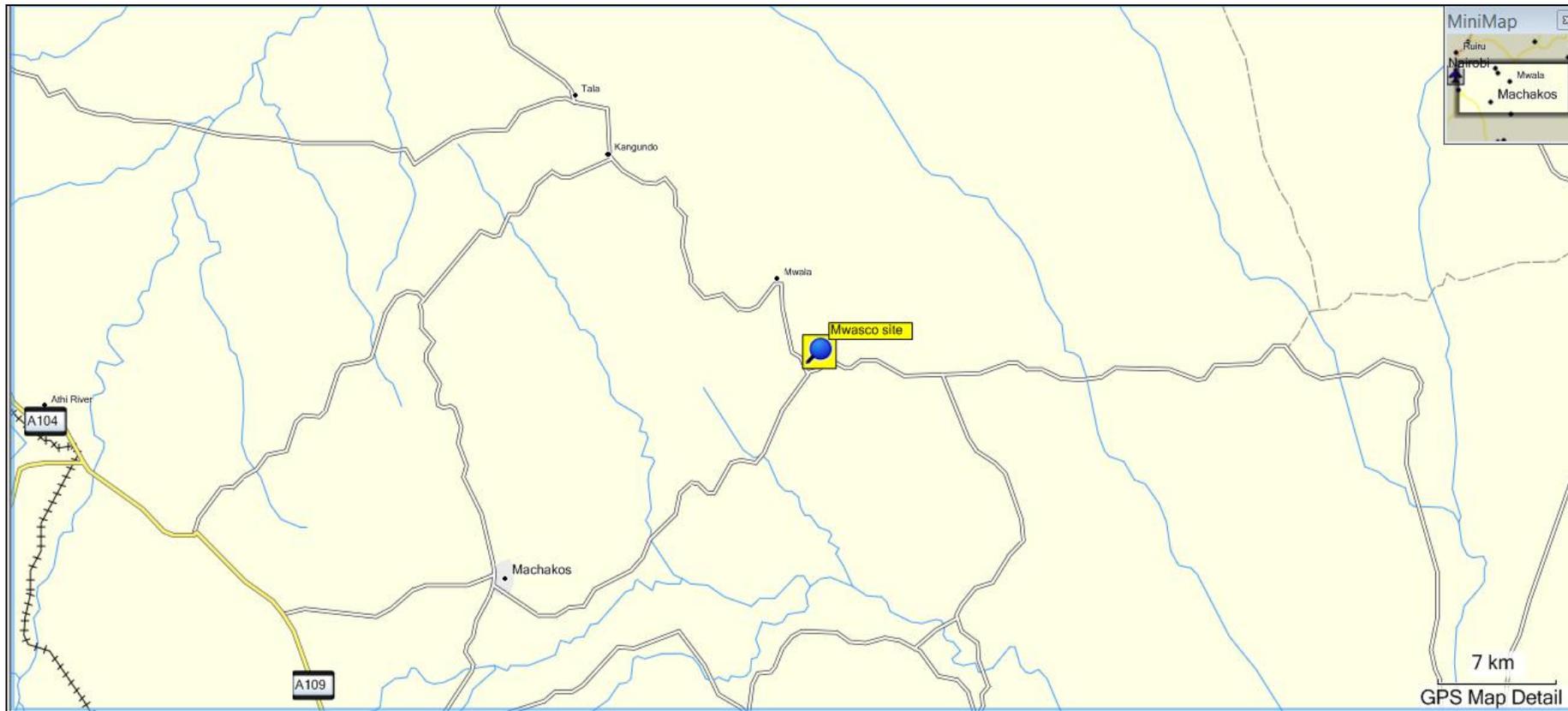
### *C. Conclusions*

Implementation of this project is not expected to have any serious adverse effect on the environment.

However an Environmental Impact Assessment (EIA) should be carried out as per NEMA requirements.

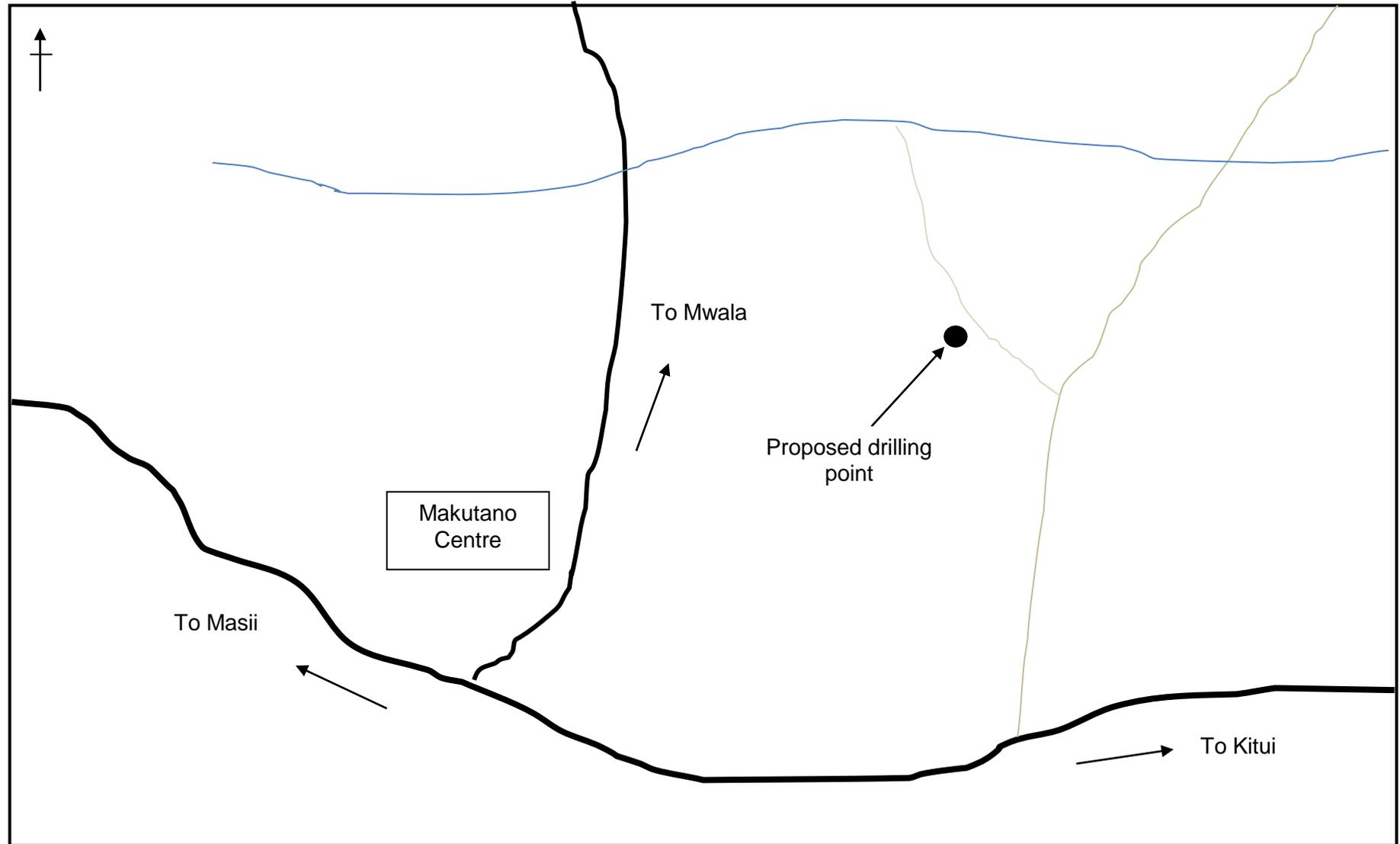


Map 4: A map extract of Map sheet 149/4 (Kangundo) showing location of proposed drilling site. Scale 1: 50,000

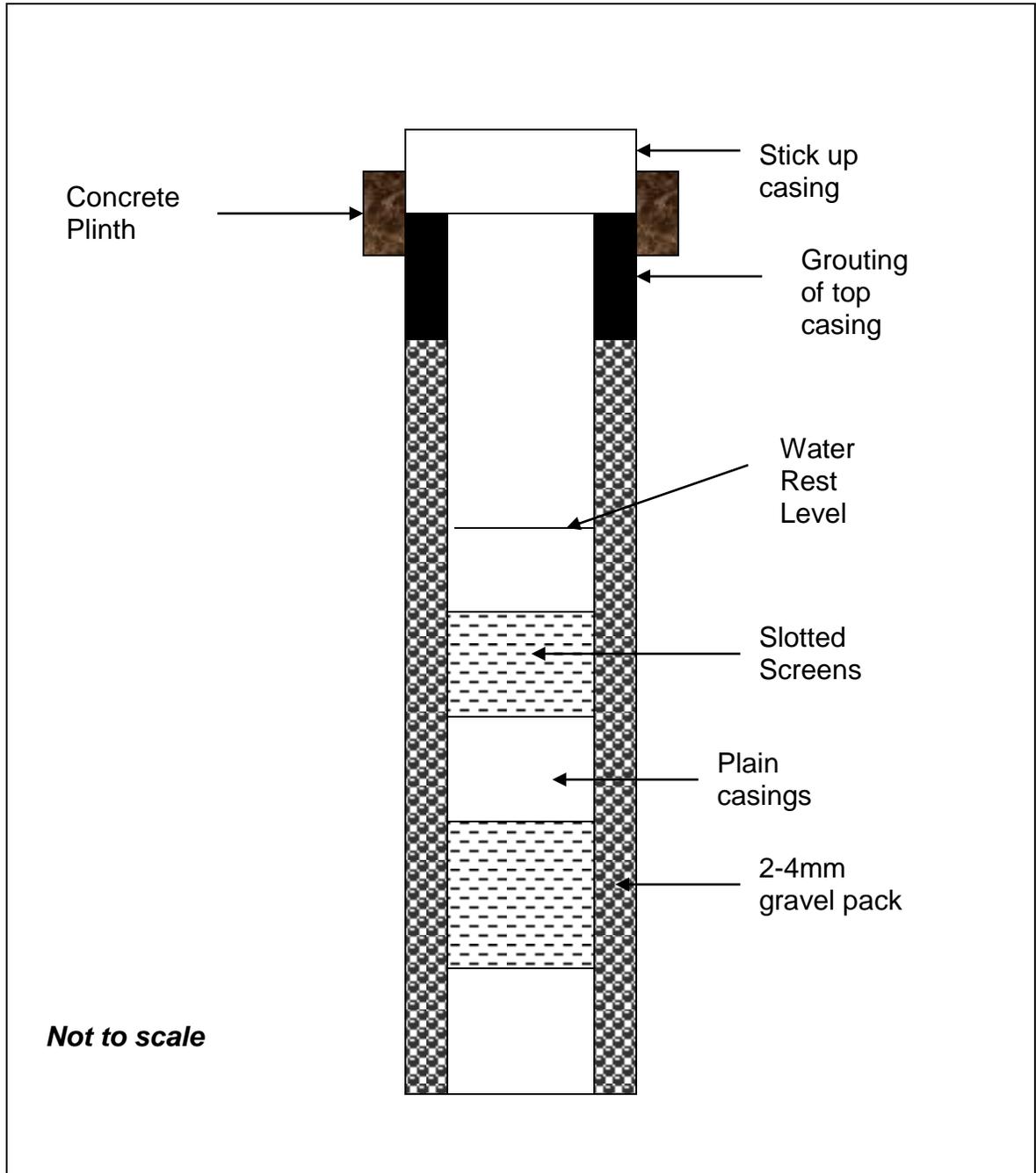


*Map 5: Relative location of selected site*

SKETCH 2 SHOWING DIRECTIONS TO PROPOSED DRILLING SITE



A SCHEMATIC DIAGRAM OF A BOREHOLE



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**ANNEX 6**

**SAMPLE CHANCE FIND PROCEDURE**

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## **Chance Finds Procedures**

Chance finds procedures should be incorporated into the EMP and civil works contracts.

If the Contractor discovers archeological sites, historical sites, remains and objects, including graveyards and/or individual graves during excavation or construction, the Contractor shall:

- Stop the construction activities in the area of the chance find;
- Delineate the discovered site or area;
- Secure the site to prevent any damage or loss of removable objects. In cases of removable antiquities or sensitive remains, a night guard shall be arranged until the responsible local authorities or the Ministry of Sports, Culture and the Arts take over;
- Notify the supervisory Project Environmental Officer and Project Engineer who in turn will notify the responsible local authorities and the Ministry of Sports, Culture and the Arts immediately (within 24 hours or less);

Responsible local authorities and the Ministry of Sports, Culture and the Arts would then be in charge of protecting and preserving the site before deciding on subsequent appropriate procedures. This would require a preliminary evaluation of the findings to be performed by the archaeologists of the National Museums of Kenya. The significance and importance of the findings should be assessed according to the various criteria relevant to cultural heritage, namely the aesthetic, historic, scientific or research, social and economic values.

Decisions on how to handle the finding shall be taken by the responsible authorities and the Ministry of Sports, Culture and the Arts. This could include changes in the layout (such as when finding irremovable remains of cultural or archeological importance) conservation, preservation, restoration and salvage.

Implementation for the authority decision concerning the management of the finding shall be communicated in writing by relevant local authorities.

Construction work may resume only after permission is given from the responsible local authorities or the Ministry of Sports, Culture and the Arts concerning safeguard of the heritage.