ENVIRONMENTAL IMPACT ASSESSMENT
STUDY REPORT
ON
DRILLING OF ONE PRODUCTION BOREHOLE
FOR
GITHUNGURI PRIMARY SCHOOL
IN
THUTHUREKI VILLAGE, GITHUNGURI SUB-LOCATION, GITHUNGURI LOCATION, GITHUNGURI DIVISION, GITHUNGURI DISTRICT, KIAMBU COUNTY

This environmental impact assessment (EIA) project report is submitted to the National Environmental management Authority (NEMA) in conformity with the requirement of the Environment Management and Co-ordination Amendment Act (2015) and the Environmental (Impact Assessment and Audit) Regulations, 2013.

DISCLAIMER

This Environmental Impact Assessment Project Report provides the findings and recommendation following Environmental Assessment by an environmental expert as stipulated in the EMCA AMMENDMENT ACT (2015) and a legal gazette notice 2003, for the drilling of one production borehole within **THUTHUREKI VILLAGE** Area, **Githunguri** Sub-County, **KIAMBU** COUNTY. The project scope includes drilling, development and test pumping. This report is one of the documents required for approval of a proposed development project. The approval of the project report does not override other legal requirements.

EXECUTIVE SUMMARY

GITHUNGURI PRIMARY SCHOOL which in this case is the proponent intend to drill a production borehole on their parcel of land, **L.R. NO: GITHUNGURI/ GITHUNGURI/663** within **THUTHUREKI VILLAGE** Area, **Githunguri** SUB-COUNTY in **KIAMBU** COUNTY to supply water for domestic purposes. The proponents' parcel of land has unreliable water supply and it is within this background that the proponent proposes to drill one production borehole on their piece of land.

Ground water resource is usually renewable and gets replenished naturally. Sustainable management is however recommended for longer productivity. The production borehole water will be for domestic purposes. The proponent commissioned a qualified hydrogeologist to conduct a survey for the purpose of looking for water for domestic use.

This report contains the specific site description of the proposed site, hydrogeological survey report, public participation information, baseline information of the project area, environmental and social impacts of the project and their specific mitigation measures, policy and legal framework defining the project (Environment Management and Co-ordination Amendment Act (2015), The Occupational Safety and Health Act, 2007, Registered Lands Act, Cap 300, The Land Adjudication Act, Cap 95, Way Leaves Act, Cap 292, The Lake and River Act, Cap 409, The Forest Act, 2005, The Science and Technology Act, Cap 250, The Water Act, 2002, The Public Health Act, Cap 242, The County Government Act, 2012, Building Code and Physical Planning Acts and international legislation) were reviewed.

The site is situated in **THUTHUREKI VILLAGE** area within **Githunguri Sub-County, Kiambu County**. The route map is attached in the hydro geological survey report.

Planning and design involved qualified and registered hydrogeologists, Water Resources Authority (**WRA**), Environmental Impact Assessment expert, drilling contractors and the Local Government. There are maps, photos, a permit from WRA, a hydrogeological report supporting this phase of the project cycle. The hydro geological investigation conducted by the hydrogeologist indicates that a borehole can be drilled at the proposed site to a maximum depth of **200 metres**.

The project scope will involve drilling, development and test pumping. After drilling is complete and all the piping, motors, valves, taps are put in place the borehole will be ready for the consumer. Operations will involve abstracting water for domestic use as per the WRA permit. When and if the

borehole is no longer found to be fit, it will be decommissioned by the proponent after seeking advice and guidance from experts.

The project objective is to drill one production borehole for domestic purses. On the other hand the EIA study objectives for the proposed project were:

1. To identify environmental, economic, social and health impacts,
2. To acquire views/opinion of the public and neighbors on the impacts of the project, and
3. Develop an Environmental Management Plan for the project.

The consultant reviewed relevant documents relating to the assignments to have in-depth understanding and to gain sufficient background information regarding the project. A review of various policies, regulatory and relevant legal documents was also carried out.

Field visits were conducted to do physical inspections of the project site in order to acquire information on the state of environment. Several photos of the project site were taken for inclusion in this report. The study also sought public opinion/views through Consultation and Public Participation (CPP) exercise. Questionnaires were administered to the public and interviews held with neighbors. The questionnaires have been included in this report.

This Environmental Impact Assessment examined the potential positive and negative impacts of the project on the immediate surroundings with due regard to all the phases from planning and design, drilling, operation and decommissioning. It encompassed all aspects pertaining to the physical, ecological, socio-cultural, health and safety conditions at the site and its environs during and after construction. Environment, Health and Safety (EHS) section addresses environment.

The main objective of the EHS on the proposed project is to develop guidelines for protecting, managing and responding, processes, situations/conditions that might compromise health, safety and security of workers and ecological wellbeing. To avoid or reduce negative environmental impacts, mitigation measures were proposed and an environmental management plan (EMP) formulated. The proponent is also expected to observe recommendations in the Environmental Management Plan (EMP) and carry out annual environmental audits once the project is in operation.

The drilling contractor and the supervising hydrogeologist should ensure that the mitigation measures proposed for the drilling phase are adhered to while the proponent is responsible for subsequent monitoring as proposed by the EMP. An Environmental Management Plan (EMP)

outline has been developed to ensure sustainability of the site activities from planning and design through operation to decommissioning.

The plan provides a general outlay of the activities, associated impacts, mitigation action plans and appropriate indicators for monitoring. Implementation timeframes and responsibilities are defined, and where practicable, the cost estimates for recommended measures are provided. There are also guidelines for addressing environmental health and safety. This project is recommendable for approval by the National Environment Management Authority (NEMA) for issuance of an EIA license subject to annual environmental audits after operating for one year. This will be in compliance with the Environment Management and Co-ordination Amendment Act (2015) and the Environmental Impact Assessment and Audit regulations, 2003.

ACCRONYMS

EMCA	Environmental management Coordination Act
EIA	Environmental impact assessment
EA	Environmental Audit
DTH	Down the hole Hammer
WRA	Water Resource Authority
NEMA	National Environmental Management Authority
EMP	Environmental management plan
PPE	Personal Protective Equipment
TDS	Total dissolved solutes
NCG	Nairobi County Government
m bgl	Metre below ground level
KM	Kilometers
mm	Millimeter
0_C	Degrees centigrade
N	North
S	South
E	East
W	West

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 CHAPTER ONE: INTRODUCTION

1.1 Project Background

THUTHUREKI VILLAGE is an area within Githunguri Sub-Location, Githunguri Location, Githunguri Division, Githunguri District, **Kiambu** County, Kenya. **The site is situated Thuthureki area, 7km south-east of Githunguri town off Githunguri-Kiambu-Nairobi road.** The proponent land area generally has inadequate water supply thus prompting the proponent to sink the proposed borehole in order to establish a reliable water supply source. **The client presently relies on a shallow well and rainwater harvesting which is inadequate. A borehole water supply forms the best option of a sustainable source**. If the client won't be authorized to sink a borehole at the site, they will rely on water vendors which are expensive and unreliable.

Therefore this Environmental Impact Assessment study has been commissioned in line with the requirements of National Environment and Management Authority (NEMA) as stated in The Environment Management and Co-ordination Amendment Act (2015) and stipulated in the Environmental (Impact Assessment and Audit) Regulations 2003 Legal Notice No. 101, before commencement of the project.

This Environmental Impact Assessment is to identify both positive and negative impacts of the proposed project to the environment and propose mitigation measures in the Environmental Management Plan developed to address potential negative impacts, during the construction, operation and decommissioning phases of the project, for overall environmental sustainability.

1.2 Project and Environmental Impact Assessment Objectives

The project objective is to drill one borehole in **THUTHUREKI VILLAGE area** to develop water supply for domestic water use. On the other hand the EIA study objectives for the proposed project were:

- To identify environmental, economic, social and health impacts.
- To solicit views/opinion of the public and neighbors on the impacts of the project, and
- Develop an Environmental Management Plan for the project.

1.3 Scope of the EIA Study

Arising from above objectives (Project and EIA), the scope of Environmental Impact Assessment include the following:

- The baseline conditions of the project area,
- Description of the proposed project,
- Relevant legislative, policy and administrative frameworks,
- Views/opinions of the public,
- Identification of significant adverse impacts to the environment,
- Mitigation measures to adverse impacts, and
- An Environmental Management Plan for the proposed project.

In March, the proponent contracted EIA/EA expert to conduct an Environmental Impact Assessment study for the proposed boreholes. Terms of reference, which, defined duties of the expert were as follows:

- To study the proposed location of the project
- To look into the objectives of the project
- A concise description of the national environmental legislative and regulatory framework, baseline information and any other relevant information related to the project
- The technology, procedures and processes to be used, in the implementation of the project
- The products, by- products and waste generated by the project
- A description of the potentially affected environment
- The environmental effects of the project including the social and cultural effects and the direct, indirect, cumulative, irreversible, short term and long term effects anticipated
- Alternative technologies and processes available and reasons for preferring the chosen technology and processes
- Analysis of alternatives including project site, design and technologies and the reasons for referring the proposed site design and technologies
- An environmental management plan proposing the measures for eliminating, minimizing or mitigating adverse impacts on the environment, including the cost, time frame and responsibility to implement the measures.
- Provision of an action plan for the prevention and management of foreseeable accidents and hazardous activities in the course of carrying out activities or major industrial and other development projects
- The measures to prevent health hazards and to ensure security in the working environment for the employees and for the management of emergencies

- An identification of gaps in knowledge and uncertainties which were encountered in compiling the information
- An economic and social analysis of the project
- An indication of whether the environment of any other state is likely to be affected and the available alternatives and mitigating measures and such other matters as the authority may require

1.4 Methodology

1.4.1 Environmental Screening

Environmental screening was carried out to determine whether an EIA study is necessary for this project and at what level of evaluation. This took into consideration the requirements of the Environmental Management and Coordination Act (EMCA amendment, 2015) and specifically the second schedule of the same act. From the screening process, it was understood that this project will not cause significant impacts on the environment.

1.4.2 Environmental Scoping

In scoping, the focus was on environmental impacts of great concern. Environmental issues were categorized into physical, natural/ecological and social, economic and cultural aspects. Impacts were also classified as immediate and long-term impacts. This will include assessment of the proposed project in respect of but not limited to:

- Project Background: this will give the brief history of the proposed project site, the parties involved and justification of the project in terms of demand or lack of the same, the project area, relevant policy and legislation, identification of any associated project, or any planned projects including products within the region which may compete for the same resources; the project including products, byproducts, processes both at implementation and operational level, resources required for successful implementation and operation of the project and the different options considered. The proposed project objectives; both in the short and long run; and how they are linked to the overall objectives.
- Present environmental conditions: description of the project site, ecological zoning as well as the state of the environment and its surroundings. Attempts will state if it is already suffering from degradation. If the latter is true, the causes of the original degradation will be established and if possible, the state of the environment before the observed degradation, Identification of Environmental Impacts: the report will distinguish between significant

positive and negative impacts, direct and indirect impacts and immediate and long term impacts which are unavoidable and / or irreversible,

- Present environmental conditions: description of the project site, ecological zoning as well as the state of the environment and its surroundings. Attempts will state if it is already suffering from degradation. If the latter is true, the causes of the original degradation will be established and if possible, the state of the environment before the observed degradation.
- Identification of Environmental Impacts: the report will distinguish between significant positive and negative impacts, direct and indirect impacts and immediate and long term impacts which are unavoidable and / or irreversible.
- Analysis of the alternatives to the proposed project: this will involve description of alternatives and identifying alternatives that would achieve the same objectives. Alternatives will be compared in terms of potential environmental impacts; capital and operating costs; suitability under local conditions; and institutional training and monitoring requirements.
- Community/ Stakeholder Consultations: these will be undertaken to determine how the project will affect the local people / various stakeholders.
- Cost- Benefit Analysis: to evaluate the economics of the project and establish its viability in terms of the expected environmental concerns and measures.
- Evaluation: an indication of how the information gathered will be evaluated to give optimum results.
- Development of an Environmental Management Plan (EMP): to mitigate negative impacts, recommending feasible and cost effective measures to prevent or reduce significant negative impacts to acceptable levels.
- Development of a Monitoring Plan: this will be used in monitoring the implementation of the mitigation measures and the impacts of the project during construction and operational phases, including an estimate of capital and operational costs, and Make necessary recommendations pertaining to the proposed development.

1.4.3 Desktop Study

This involved reviewing of hydrogeological survey report, online literature study on water situation in the County, also looking into NEMA guidelines, legal and institutional frameworks. Documents containing climatic, demographic and hydrological data for the fore-mentioned County were also relied upon.

1.4.4 Site Visits and Public Participation

Field visits were meant for physical inspections of the project site in order to gather information on the state of environment and the current water situation. Several photos of the project site were taken for inclusion in this report. The study also sought public opinion/views through Consultation and Public Participation (CPP) exercise. Questionnaires were administered to the public and interviews held with neighbors. The questionnaires have been included in this report.

1.4.5 Reporting

In the entire exercise, the proponent, the hydro-geologist and EIA experts contacted each other on the progress of the study and signing of various documents. The proponent will have to submit six copies of this report alongside a CD to the National Environment Management Authority for review and issuance of an EIA license.

All the materials and workmanship used in the execution of the work shall be of the best quality and description. Environmental concerns need to be part of the planning and development process and not an afterthought. It is therefore advisable to avoid land use conflicts with the surrounding area through the implementation of the Environmental Management Plan (EMP).

2 CHAPTER TWO: BASELINE INFORMATION ON THE AREA

2.1 Project Activities

The proponent **Githunguri Primary School with the support of the government of Kenya through Ministry of Water and Sanitation & Irrigation** wishes to drill a borehole to abstract water for **domestic use**. The estimated water requirement is **30 m^3 per day.** The most reliable water supply for the proponent is from ground water resources. This resource is renewable and gets replenished naturally. Sustainable management is however recommended for longevity by taking into account the scientific tests results and applying in the borehole equipping process in order to protect the aquifer.

2.2 Project Site Location:

The site is situated in **THUTHUREKI VILLAGE** area, **THUTHUREKI VILLAGE** Location of **Kiambu** County. It lies within the **1:50,000** Survey of Kenya topographic sheets for Kiambu (**No. 148/2**). The site is situated Thuthureki area, 7km south-east of Githunguri town off Githunguri-Kiambu-Nairobi road. The coordinates of the recommended point are:-252629E; 9881903S at an elevation of 1940m amsl.

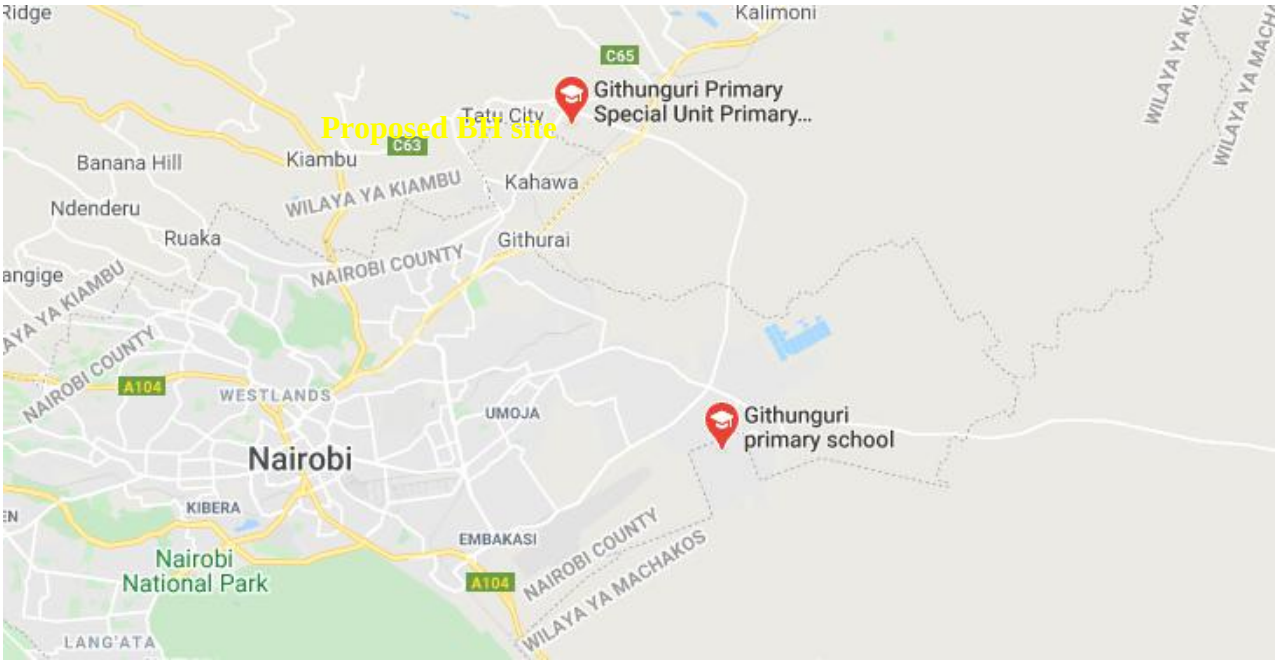

Figure 2.1: satellite extract of the proposed Borehole site general location (Adapted from Google Earth)

2.3 Climate

2.3.1 Precipitation

Specifically, from Nairobi/Dagoreti weather station, located 40 km away from the site shows that the climate of the project area is of the semi-humid temperate, tropical lower highland type. The average annual rainfall figure for the area is approximately 800-950mm. The rainfall pattern exhibits a bi-modal distribution, with wet seasons in March-May and October-December. Between 70 and 85% of precipitation falls during these rainy seasons.

The climate is warm and temperate in Nairobi (represented within THUTHUREKI VILLAGE area). Nairobi has a significant amount of rainfall during the year. This is true even for the driest month. This climate is considered to be Cfb according to the Köppen-Geiger climate classification. The temperature here averages 19.0 °C. The average annual rainfall is 869 mm.

2.3.2 Temperature:

Average annual temperatures range from 10 to 26ºC, with average minima and maxima of 12-14ºC, and 24-26ºC, respectively. The warmest period occurs from January to March. Average potential evaporation is between 1550 and 2200mm per year.

The driest month is July, with 14 mm of rainfall. With an average of 191 mm, the most precipitation falls in April. The warmest month of the year is March, with an average temperature of 20.7 °C. July has the lowest average temperature of the year. It is 16.7 °C.

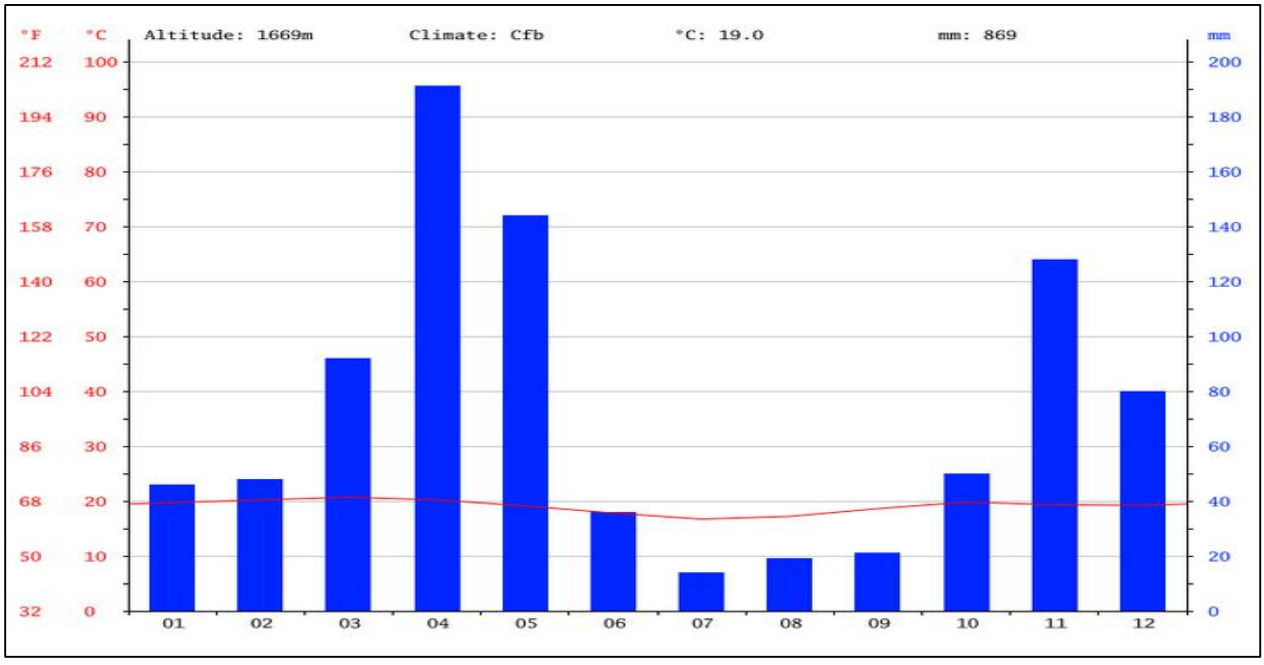

Figure 2.2: Annual precipitation models (Adapted from climatedata.org)

2.4 Socio-Economic Activities

Agriculture is the predominant economic activity in the county and contributes 17.4 per cent of the county's population income. It is the leading sub sector in terms of employment, food security, income earnings and overall contribution to the socio-economic well-being of the people.

2.5 Project Cycle

The hydrogeological survey report was carried out by a qualified hydrogeologist in order to find a source of water within the compound. In this case, a hydrogeological report has been annexed at the back of this report for further review. A permit was obtained from the WRA and an EIA license from NEMA as part of the planning process. Once permission has been granted by the relevant authorities, drilling can commence. This can last a number of days depending on the type of drilling rig and geological formation.

In order to predict impacts for this project on the human and natural environment, it is important to describe its various phases and the activities to be carried out in each phase. These have been described below.

2.5.1 Planning and Design

The planning and design of the project has been done by a number of individuals and organizations. The project proponent has been involved in the planning of the borehole as she is the beneficiary of the project. Registered hydrogeologist conducted the field investigations which included geomorphological interpretation and hydrogeological reconnaissance to establish overview impression of the area. This led to the hydrogeological survey report that is in the annex. Part of the planning has also involved the WRA for providing the authorization/permit to conduct the drilling. The WRA authorization permit has been attached. This EIA project report is part of the planning process as it outlines both positive and negative impacts the borehole will have on the environment during drilling, operation and decommissioning and provides workable mitigation measures.

2.5.2 Conflict Resolution

Conflicts emanate from disagreements where two or more land/water users are interested in the same limited resource. Questionnaires were administered to the stakeholders and anyone who had an objection to the proposed project was required to air their views via the same medium. This acted as a conflict resolution measure. There were no complaints regarding the proposed project and the questionnaires are in the annex section. However, no conflict is expected as the proponent legally

owns the land on which the borehole is to be drilled. To the best of the EIA experts, no conflicts are expected to arise.

2.5.3 Borehole drilling

Borehole drilling will be carried out using an up to date mounting rotary rig. This stage will take an approximated **Kshs. 1.4 million** to complete successfully. All skilled and unskilled labor shall come from the drilling company. The contractor shall carry out the drilling works using rotary drilling equipment. During the drilling, geological rock samples shall be collected progressively at every 2 metres interval and logged by the project geologist. The contractor shall record water struck and water rest levels. The contractor shall be held solely and entirely responsible for the completion and the safety of the works and shall indemnify the proponent against all claims that may arise as a result of carrying out the works. The project geologist may stop the drilling operations if in his own opinion sufficient water supply has been obtained or formation is unfavorable to drill further.

i) Mobilization and setting up

In this stage all plant, materials, equipment and personnel shall be transported to the proposed site ready to begin the construction. This stage will require an approximated **Kshs. 100,000** to complete successfully. Access to the borehole drilling location will be the responsibility of the proponent. A minimum area of 20 m^2 will be provided to drill comfortably. Reasonable clean, secured and good space will be left for the contractors' camp site. The contractor will be responsible and will provide security for his plants, equipment and personnel. The contractor shall adhere to the mitigation measures proposed so reduced the potential human and environmental impacts that may be experienced at this stage of the project cycle.

ii) Borehole Drilling, installation, development, testing of a production borehole

The following activities shall take place; An 8" diameter from ground level to **200 m** shall be drilled, Supply and installation of 6" diameter steel plain casing (4mm thick), Supply and installation of 6" diameter steel machine cut screen casing (4 mm thick), Water supply for drilling and domestic purposes at the site, Supply and installation of gravel pack, Well development before test pumping and Drilling will be done using hydraulic rotary rig having down the hole (DTH) hammer capability and a compressor for drilling a borehole.

iii) Drilling machinery and equipment

The main drilling machinery and equipment are the rig (mounted) and Compressor. A sketch of a completed borehole is shown in the figure below. The main pipe has a filter at the bottom which removes basic impurities. The motorized pump at the top of the pipe pumps the water from the bottom of the pipe to the top and then along the pipe to the building. A filter above ground removes further impurities.

3 GEOLOGICAL DETAILS

3.1 Geology of the project area

The geology of the project area therefore comprises a succession of deep soils and gravels of quaternary age, lavas and pyroclastics rocks of Cainozoic age, while the underlying Neoproterozoic system comprises the Pre-Cambrian Schists and gneisses of the old Mozambiquan belt.

3.2 Geology of the General Study Area and Immediate Environs

3.2.1 Nairobi Trachytes (Tvt_2)

In the project area the Trachytes occur as several thin flows separated by aquiferous sediments, which account for the increase in borehole yields with increase in depth in this region. The trachyte accumulation in this area is about 20 to 60 metres thick though this thickness increases westwards and South westwards to about 100 metres under Nairobi area. This formation is to the SW of the project area

3.2.2 Nairobi Phonolite (Tvp_3)

The geological succession consists of the Nairobi Phonolite at the top, which overlies the Athi Series probably with a disconformity. The Nairobi Phonolite consists of a number of lava flows ranging from 30-40m thick and attaining over 75m at the Embakasi area. The thickness of the formation in the project site is approximately 70 metres. The phonolite is tough dark grey lava commonly referred to as 'block trap'. If is occasionally vesicular with a fissile and platy flow texture.

3.2.3 Upper Athi Series ($Tvtf_2$)

In the project area, the series comprises light grey tuffs, but it may occur as lake deposits (yellowish brown) as observed in samples of boreholes drilled near the project and east of Nairobi City Centre. The Series is weathered and provides various aquiferous zones. The thickness of the series increases westward, but its presence has not been accurately established in this area.

3.2.4 Middle Athi Series (T)

The Middle Athi Series consists of basalt flows and basalt sands, and agglomerates. The lavas are rich in plagioclase feldspars and the sands often have a clayey fraction. The Lower Athi Series are predominantly clayey deposits.

3.2.5 Kapiti Phonolite (KP)

The Kapiti Phonolite series is composed of several flows with intercalations of argillaceous layers. It is characterized by lenticular feldspar phenocrysts. Locally it is slightly vesicular to glassy and

resembles the pahoehoe type lava. Its lower contact with the Basement System defines the sub-Miocene erosional surface on which it was deposited.

3.2.6 Neoproterozoic system

The rocks are crystalline gneisses, schist, and granulites of the Archaean Basement System. During Archaean age an extensive deposit of material was laid down in a depression, most probably in a sea. East-West compression following the deposition of the Basement System sediments resulted in their subjection to intense heat, pressure and deformation, transforming the succession into a metamorphic series of crystalline schist, gneisses and granulites. The compression and folding of the Basement System rocks led to the formation of hills which, later were extremely eroded leading to buried Inselbergs. These rocks are unlikely to be encountered during drilling works at the selected borehole site since they are more than 400 metres below ground level.

3.3 Structural Geology

Generally, the structures in the Basement System rocks are fairly complicated while those in the volcanics are fairly simple (Figure 2) (Fairburn, 1963; Saggerson, 1991). In the eastern part of Nairobi, faulting is rare and only minor faults were observed in the northern part of this area (Fairburn, 1963). Two small faults throwing east were recorded in the volcanics, one in the Thika valley and the other in the Thiririka valley. The volcanic rocks in the eastern part are consistently horizontal or near horizontal over a wide area.

3.4 Project costs

The average cost for boring this waterhole will be around **Kshs. 1.5million**. Even if this amount is a lot, it also means that the project proponent has access to pure drinking water and other domestic uses. Also, deep boreholes, like the proposed project, do not run dry even in draught conditions.

Table 3.1: Project Costs

Activity	Cost (Kshs.)
Mobilization and setting of equipment	100,000
Drilling and related works	1,400,000
Total	**1,500,000**

Table 3.2: Time frame of project

Activity	**Commencement date**	**Estimated time frame**
Planning and design	August, 2019	1 month
Site surveying and measurements and preparation of hydrogeological survey report	November, 2019	2 weeks
Registration to relevant authorities	June , 2020	1 months
Environmental Impact Assessment	June, 2020	1 months
Drilling and related works	After approval by NEMA	2 weeks
Commissioning	Approval drilling	1 day
Decommissioning	Cannot be determined at this point	To be determined

3.4.1 Decommissioning

i) Scope

This section intended to highlight the practical procedure that will assist with the decommissioning of redundant boreholes or wells in the context of protecting groundwater. It suggests a number of best practice options and it is understood that other factors (for example ground and site conditions or health and safety issues) will be carefully considered before any final decisions are made by expert, site specific advice will be sought.

ii) Legal Framework

The Water Resources Authority (**WRA**) is responsible for the protection of "controlled waters" from pollution under the Water Act, 2002. It is an offence to cause pollution of controlled waters either deliberately or accidentally. "Controlled waters" includes all watercourses and groundwater contained in underground strata (or aquifers). WRA also has a specific duty to prevent groundwater pollution.

iii) Backfilling

The borehole will be backfilled with clean (washed), uncontaminated, excavated materials such that the permeability of the selected materials are similar to the properties of the geological strata against which they are placed. The backfilled borehole will then mimic the surrounding natural strata and groundwater flow and quality will be protected. UNDER NO CIRCUMSTANCES WILL POTENTIALLY POLLUTING MATERIALS BE USED AS INFILL.

iv) Conversion to groundwater monitoring points

Redundant boreholes have the potential for conversion into groundwater monitoring boreholes. The ideal borehole construction and completion is dictated by the geological strata encountered and its intended use. Boreholes which intersect a single aquifer unit may be cased through the unsaturated zone, but open hole (or screened) below the water table. Boreholes in complex geologies are likely to require casing over most of the depth of boreholes with the exception of the aquifer unit(s) of interest. These details will be established when considering conversion of the borehole to a monitoring point along with the ultimate purpose that the monitoring facility will serve.

WRA has a duty to monitor groundwater quality and water table elevation, and a network of Agency and privately owned boreholes and wells is used for this purpose. New monitoring points are often required to improve coverage or to replace boreholes which have been taken out of use.

v) Removing head works and casing

During decommissioning, the contractor will ensure that the borehole is free from all obstructions that may interfere with the sealing of the hole. In particular, the pump and pipe work will be removed together with any other infrastructure. The condition of any borehole casing and grout must be examined to ascertain whether its retention in the hole would prejudice any of the objectives of the abandonment.

The advice of a specialist well contractor will be sought over these issues. If it is decided that the well casing needs to be removed, various techniques are available to do this and the well contractor can advise on the most appropriate technique for a given site.

vi) Sealing the top of the borehole

In order to prevent potentially contaminated surface run-off or other liquids entering the backfilled borehole, it will be necessary to complete the backfilling of all boreholes with an impermeable plug and cap. The final 2 metres (from ground level down) will be filled with cement, concrete or Bentonite grout and a concrete or cement cap of suitable strength will then be installed over the top of the borehole and surrounding ground, such that its diameter is at least one meter greater than the diameter of the backfilled borehole.

3.5 Impacts of the Proposed Project

3.5.1 Positive impacts of the project

The project is anticipated to have the following positive impacts:

i. It will provide adequate water supply for the domestic needs for the proponent
ii. It will save the proponent the problem of acute water shortage especially during the dry seasons
iii. It will increase the value of the land which is a benefit to the proponent
iv. It will create employment particularly during the construction and operational phases
v. It utilizes just a small part of the land and the benefits are great
vi. The proponent can supply the neighborhood with water since the current source is inadequate.

3.5.2 Negative impacts of the project

The project is anticipated to have the following negative impacts:

i. It will lead to abstraction of ground water
ii. It will cause minimal soil erosion during drilling process
iii. It will cause minimal air pollution due to dust generation and exhaust fumes from the vehicles during the drilling process and transport of materials.
iv. There will be noise pollution during drilling caused by the drilling machines and also material transport vehicles
v. It may cause accidental spillage during drilling.

NB:

All the anticipated negative impacts stated above will be adequately mitigated as shown in the EMP.

4 CHAPTER THREE: PROJECT ALTERNATIVES

Several alternatives to the project including water sources, site and drilling technology were considered during the EIA process. The alternatives given here below:

4.1 Alternative Water Sources

The supply is currently from roof catchments, private borehole and the water vendors in the area. However, the sources are insufficient and cannot sustain the proposed domestic water supply. This problem worsens during prolonged dry spells and water rationing. Thus the proposed borehole is expected to serve as an alternative to this source and ensure that the project has enough and reliable water supply. The other alternative water sources are from nearby private boreholes and water vendors whose price is high.

4.2 Alternative Site

The following project alternatives to the proposed water project were considered and their advantages and disadvantages outlined.

1. No Project option

This alternative would mean that the project does not proceed.

Advantages

- ✓ The proposed site will remain as it is without disturbance.
- ✓ There wouldn't be ground compaction as a result of heavy machinery use.
- ✓ There would be no soil or water contamination from the alien materials that will be introduced in the earth's system.
- ✓ Air pollution from dust as a result of the drilling process will not occur.

Disadvantages

- ✓ The proponent will not have reliable water supply for domestic use.
- ✓ There will be no creation of employment across the project cycle.
- ✓ The expected income to the developer and the economy will not be realized
- ✓ The value of land might improve but it will remain underdeveloped.
- ✓ There will continue to be a water shortage especially when the rains fail.

2. Underground water abstraction

Advantages

- ✓ It will provide reliable water supply to the proponent.
- ✓ Operational and maintenance costs are low
- ✓ Plans and designs have already been done for the proposed project
- ✓ Less time will be used for drilling
- ✓ It will utilize a small section of the total land area

Disadvantages

- ✓ It is expensive to drill the borehole
- ✓ This will translate to lower income for the project proponent or developers
- ✓ Underground water utilization will not be optimized sustainably

2. Rainwater harvesting

Advantages:

- It is cheaper than the proposed project
- Encourages water storage and conservation
- It will be easier to construct and manage
- It will serve individual users directly
- It is water of good quality if harnessed properly.

Disadvantages:

- Water harvesting is limited to the rainy season therefore they are an unreliable source of water supply to the proponent
- Rainwater collected would not be sufficient
- There will be no saving of money and water will have to be bought from water vendors after much deliberation, alternative 2 was found to be the superior alternative and was therefore adopted.

The proposed drill sites have already been identified by the hydrogeologist.

5 CHAPTER FOUR: POLICY AND LEGAL FRAMEWORK

Kenya's Environmental Legal Framework

5.1 Environment Management and Co-ordination (Amendment) Act, 2015

Part II of the Environment Management & Coordination (Amendment) Act, 2015 states that every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the environment. In order to partly ensure this is achieved, Part VI of the Act directs that any new programme, activity or operation should undergo environmental impact assessment and a report prepared for submission to the National Environmental Management Authority (NEMA), who in turn may issue a license as appropriate.

Part VIII section 72 of the Act prohibits discharging or applying poisonous, toxic, noxious or obstructing matter, radioactive or any other pollutants into aquatic environment. Section 73 require that operators of projects which discharges effluent or other pollutants to submit to NEMA accurate information about the quantity and quality of the effluent. Section 74 demands that all effluent generated from point sources be discharged only into the existing sewerage system upon issuance of prescribed permit from the entity or from the licensee. Finally, section 75 requires that parties operating a sewerage system obtain a discharge license from NEMA to discharge any effluent or pollutant into the environment.

Section 87 Sub-section 1 states that no person shall discharge or dispose of any wastes, whether generated within or outside Kenya, in such a manner as to cause pollution to the environment or ill health to any person, while section 88 provides for acquiring of a license for generation, transporting or operating waste disposal facility. According to section 89, any person who, at the commencement of this Act, owns or operates a waste disposal site or plant or generate hazardous waste, shall apply to the NEMA for a license. Sections 90 through 100 outline more regulations on management of hazardous and toxic substances including oils, chemicals and pesticides.

Finally the Environmental Impact Assessment Guidelines require that a study be conducted in accordance with the issues and general guidelines spelt out in the Second and third schedules of the Environmental Regulations (2003). These include coverage of the issues on Schedule 2 (ecological, social, landscape, land use and water considerations) and general guidelines on Schedule 3 (impacts and their sources, project details, national legislation, mitigation measures, a management plan and environmental auditing schedules and procedures.

5.2 The Occupational, Safety and Health Act, 2007

PART VII –MACHINERY SAFETY

i) All plant, machinery and equipment whether fixed or mobile for use either at the workplace or as a workplace, shall only be used for work which they are designed for and be operated by a competent person.

ii) Every part of an electric generator, motor and rotary converter and every flywheel directly connected thereto shall be securely fenced.

iii) Every machine intended to be driven by mechanical or any other type of 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

iv) Suitable striking gear or other efficient mechanical appliances shall be provided and maintained and used to move driving-belts to and from fast and loose pulleys which form part of the transmission machinery and any such gear or appliances shall be so constructed, placed and maintained as to prevent the driving belt from creeping back on to the fast pulley

i) Every employer shall –

Be responsible for the safe condition of tools and equipment used by his employees, including tools and equipment which may be furnished by the employees

Ensure that no equipment or portable power tools shall be used in an environment that contains or is likely to contain flammable vapors or substances unless they are intrinsically safe for such environments

ii) Where any machine in a workplace is a machine intended to be driven by mechanical power

–every set-screw, bolt or key on any revolving shaft spindle, wheel or pinion shall be so sunk, encased or otherwise effectively guarded as to prevent danger and

All spur and other toothed or friction gearing which does not require frequent adjustment while in motion shall be completely encased

An importer, manufacturer, designer or supplier of machinery, plant and equipment shall avail information concerning the correct installation, use, maintenance and disposal of the machinery, plant and equipment and provide information on any likely hazards and means to prevent or control them

A person who sells or lets on hire, or as agent of the seller or hirer, causes or procures to be sold or let on hire, knowing it to be for use in a workplace in Kenya, any machine intended to be driven by mechanical power which does not comply with the requirements of this section commits an offence and shall on conviction be liable to a fine not exceeding two hundred thousand shillings

5.3 Waste Management Standards (Legal Notice 120: The Environmental Management Coordination (Water Quality) Regulations)

This Legal Notice on Water Quality provides that anyone who discharges effluent into the environment or public sewer shall be required to apply for Effluent Discharge License. The license for discharge is Ksh 5,000 while annual license fee for discharge into the environment will be Ksh. 20,000 or Ksh 100,000 depending on the facility. Noncompliance with the regulations attracts a fine not exceeding Ksh 500,000 and the polluter pay principle may apply depending on the court ruling. Table 4 in the next page, gives waste water discharge guidelines from NEMA.

Table 5.1: Quality Standards for Sources of Domestic Water

Parameter Guide	Value (max allowable)
PH	6.5 –8.5
Suspended solids	30 (mg/L)
Nitrate-NO3	10 (mg/L)
Ammonia –NH3	0.5 (mg/L)
Nitrite –NO2	3 (mg/L)
Total Dissolved Solids	1200 (mg/L)
Scientific name (E.coli)	Nil/100 ml
Fluoride	1.5 (mg/L)
Phenols	Nil (mg/L)
Arsenic	0.01 (mg/L)
Cadmium	0.01 (mg/L)

Lead	0.05 (mg/L)
Selenium	0.01 (mg/L)
Copper	0.05 (mg/L)
Zinc	1.5 (mg/L)
Alkyl benzyl sulphonates	0.5 (mg/L)
Permanganate value (PV)	1.0 (mg/L)

5.4 Waste Management Standards (Legal Notice 121: The Environmental Management Coordination (Waste Management) Regulations)

The regulation provides that a waste generator shall use cleaner production methods, segregate waste generated and the waste transporter should be licensed. The notice further states no person shall engage in any activity likely to generate any hazardous waste without a valid Environmental Impact Assessment license issued by the National Environment Management Authority. Hazardous waste will not be generated from this development. The project proponent will ensure that waste is segregated and a licensed waste transporter is contracted to disposed solid waste. The regulation provides that a waste generator shall use cleaner production methods, segregate waste generated and the waste transporter should be licensed. The notice further states no person shall engage in any activity likely to generate any hazardous waste without a valid Environmental Impact Assessment license issued by the National Environment Management Authority. Hazardous waste will not be generated from this development. The project proponent will ensure that waste is segregated and a licensed waste transporter is contracted to disposed solid waste.

5.5 Waste Management Standards (Legal Notice 61: The Environmental Management and Coordination (Noise and Excessive vibration pollution) (Control) Regulations, 2009

This regulation prohibits any person to cause unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment.

5.6 The Registered Lands Act, Cap 300

This Act provides for the absolute proprietorship over land (exclusive rights). Such land as in the project areas can be acquired by the state under the Land Acquisition Act.

5.7 The Land Adjudication Act, Cap 95

Provides for ascertainment of interest prior to land registration under the Registered Lands Act.

5.8 Way Leaves Act, Cap 292

Provides for certain undertakings to be constructed e.g. pipelines, a pathway etc., through or under any land the project is in under the provision of the Act.

5.9 The Science and Technology Act, Cap 200m

Section 4 of the Act provides for a council whose functions include;

To ensure the application of the results of scientific activities to the development of agriculture, industry and social welfare in Kenya.

To advise the Government on the scientific and technological requirements for the conservation of the natural and social environment in Kenya.

5.10 The Water Act, 2016

Provides that applications for permits for the same purpose or for different purposes shall receive consideration in accordance with the circumstances of each use.

The Ministry of Water is vested with the duty to conserve and regulate the use of natural water resources (estuaries, surface, ground water and marine). The Act prohibits the release of waste water without a permit and also spells out penalties for pollution of water. The Ministry through the Water Resource Management Authority regulates the use of water and the drilling of boreholes.

The Act vests the water in the start and gives the provision for the water management including irrigation water pollution, drainage control and obstruction. It is the main legislation governing the use of water especially through water permit system.

5.11 The Public Health Act, Cap 242

The Public Health Act regulates activities detrimental to human health. The owner(s) of the premises responsible for environmental nuisances such as noise and emissions, at levels that can affect human health, are liable to prosecution under this Act. An environmental nuisance is one that causes danger, discomfort or annoyance to the local inhabitants or which is hazardous to human health.

It provides for the securing of public health and recognizes the important role of water. It also provides for prevention of water pollution by stakeholders among their local authorities (County Councils).

The environmental management plan (EMP) advices the Proponent on safety and health aspects,

potential impacts, personnel responsible for implementation and monitoring, frequency of monitoring, and estimated cost.

5.12 The Lake and River Act, Cap 409

The Act provides for protection of rivers, lakes and associated flora and fauna. The provisions of this Act may be applied to the management of the project.

5.13 The County Government Act, 2012

AN ACT of Parliament to give effect to Chapter Eleven of the Constitution; to provide for county governments' powers, functions and responsibilities to deliver services and for connected purposes

Section104. (2) The county planning framework shall integrate economic, physical, social, environmental and spatial planning.

Section 115. (1) Public participation in the county planning processes shall be mandatory and be facilitated through—

(b) Provision to the public of clear and unambiguous information on any matter under consideration in the planning process, including—

(i) clear strategic environmental assessments;

(ii) Clear environmental impact assessment reports;

(iii) Expected development outcomes; and

(iv) Development options

Section 120. (3) A tariff policy adopted under subsection (1) shall reflect the following guidelines

h) Promotion of the economic, efficient, effective and sustainable use of resources, the recycling of waste and other appropriate environmental objectives;

5.14 The Forest Act, 2005

The Act provides for the establishment, control and regulation of central forests and forest areas in the Nairobi area and on un-alienated government land.

5.15 Physical Planning Act, Cap 286

Section 36 states that Local Authority may if deem necessary require a submission of environment impact assessment report together with development application if they feel the project has some injurious effects on the environment.

Section 33 gives the director authority to grant the applicant development permission or refuse to grant the applicant such development permission by stating the ground of refusal.

The Proponent is conducting an environmental impact assessment study for approval by NEMA.

5.16 Penal Code Act (Cap.63)

Section 191 of the penal code states that if any person or institution that voluntarily corrupts or foils water for public springs or reservoirs, rendering it less fit for its ordinary use is guilty of an offence.

Section 192 of the same Act says a person who makes or vitiates the atmosphere in any place to make it noxious to health of persons /institution, dwelling or business premises in the neighborhood or those passing along public way, commits an offence.

5.17 Wildlife Conservation and Management Act, Cap 376

This Act provides for the protection, conservation and management of wildlife in Kenya. The provisions of this Act should be applied in the management of the project.

Part III Section 13 subsection (I) stipulates that any person who not being an officer of Kenya Wildlife Service hunts any animal in a National Park shall be guilty of a forfeiture offence and liable to a fine or imprisonment. Subsection 2 of the Act likewise provides that any person who, without authorization conveys into a National Park, or being within the area thereof, in possession of, any weapon, ammunition, explosive, trap or poison, shall be guilty of a forfeiture offence.

The Act provides that no person is allowed to use any aircraft, motor vehicle or mechanically propelled vessel in such a manner as to drive, stampede or unduly disturb any protected animal or game animal. Therefore it will be prudent that the construction workforce is conversant with the provisions of this Act.

5.18 Environmental Vibration Pollution (Control) Regulations, 2009

These regulations were published as legal Notice No. 61 being a subsidiary legislation to the Environmental Management and Co-ordination (Amendment) Act, 2015. The regulations provide information on the following:

- Prohibition of excessive noise and vibration
- Provisions relating to noise from certain sources
- Provisions relating to licensing procedures for certain activities with a potential
- emitting excessive noise and/or vibrations and

- Noise and excessive vibrations mapping

According to regulation 3 (1), no person shall make or cause to be made any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. Regulation 4 prohibits any person to *(a)* make or cause to be made excessive vibrations which annoy, disturb, injure or endanger the comfort, repose, health or safety of others and the environment; or *(b)* cause to be made excessive vibrations which exceed 0.5 centimeters per second beyond any source property boundary or 30 metres from any moving source. Regulation 5 further makes it an offence for any person to make, continue or cause to be made or continued any noise in excess of the noise levels set in the First Schedule to these Regulations, unless such noise is reasonably necessary to the preservation of life, health, safety or property.

5.19 International Legislation

This EIA is also based on internationally respected procedures recommended by the World Bank operational directives 4.01 and environmental assessment source book volume II which provides the relevant sectoral guidelines. As such this EIA is intended to meet the expectations of international financiers and Kenyan adjudications.

6 CHAPTER FIVE: PROJECT JUSTIFICATION

Water scarcity in Kenya has been an issue for decades, as only a small percentage of the country's land is optimal for agriculture, and the year-round climate is predominantly arid. Rapid urbanization has also pushed urban dwellers away from the city, where there is no sufficient water supply.

Therefore the major objectives of the project include:

- Provision of adequate water supply for the proponent for domestic use
- Curbing the problem of water shortage especially during the dry seasons

Currently, the population living in this area gets water from the private boreholes, water vendors and roof catchment, but the supply is insufficient for the client's needs. Water from the proposed borehole will be used for domestic purposes within the plot. Water demand is estimated at **30m^3/day.**

7 CHAPTER SIX: METHODOLOGY

The EIA process took into account the following methods to gather data:

7.1 Questionnaires

The EMCA, 2015 calls for effective stakeholder participation and public consultation in the EIA process. Consultations ensure that the views of affected and interested parties are incorporated as early as possible in the project design and implementation process so as to subsequently minimize the project's potential negative impacts on the environment.

Stakeholder consultation process in this project involved the administration of questionnaires to the members of public that were available and ready to co-operate with the EIA team. In the Appendices are questionnaires bearing the feedback of the respondents. All the respondents did not have a problem with the proposed project and were enthusiastic about the development.

7.2 Hydrogeological surveys

The hydrogeological survey used geophysical methods to assist in the assessment of geological subsurface conditions. More information about this is in the hydrogeological survey report.

8 CHAPTER SEVEN: ENVIRONMENTAL AND SOCIAL IMPACTS OF THE PROPOSED PROJECT

8.1 Environmental Impacts

8.1.1 Underground water depletion

Ground-water depletion is primarily caused by un-sustained ground-water pumping. Some of the negative effects of ground-water depletion include increased pumping costs, deterioration of water quality, reduction of water in streams and lakes, or land subsidence. Such effects, while variable, happen to some degree with any ground-water use. Ground water can be recharged (deposited) by infiltration from precipitation, surface water, or applied irrigation water; it can be kept in storage (saved); and it can be discharged naturally to streams, springs, or seeps, or transpired by plants (withdrawn).

Mitigation measures:

1. Proper monitoring of number of boreholes being authorized by the Water Resources Management Authority within the proposed area.

2. The project proponent should not exceed the water usage limit per day.

3. Alternate water usage with rain water when available.

4. Encourage rain water harvesting and use that water for non-domestic uses like cleaning floors and watering flowers. Store the rain water in tanks for future use.

5. Monitor and meter the water system to determine the largest water consumption areas; monitoring also can help detect leaks in water systems (this step is more relevant to industrial water users).

6. Community service participation like tree planting.

8.1.2 Reduced surface-water flows

In most areas, the surface- and ground-water systems are intimately linked. Ground-water pumping can alter how water moves between an aquifer and a stream, lake, or wetland by either intercepting ground-water flow that discharges into the surface-water body under natural conditions, or by increasing the rate of water movement from the surface-water body into an aquifer. In either case, the net result is a reduction of flow to surface water, though the full effect may take many years to develop.

Mitigation measure:

Proper management and conservation of the catchment zones through tree planting.

8.1.3 Soil Compaction

Soil compaction will be minimal as the drilling will only take place within a 3 day period.

Mitigation:

1. The contractor will always use a predetermined route to the site
2. Unnecessary heavy machines will be avoided.
3. Operations will be timed to take place during the dry season when the soils are dry to reduce the risk of soil compaction

8.1.4 Soil pollution

Soil pollution may arise due to spillages of oil/grease and construction materials during construction, operation or decommissioning stage.

Mitigation:

1. Spillages will be minimized by using right machinery that is regularly serviced and operators who are qualified following the operations instructions strictly.
2. In case of accidental spillages, the leaking fluid should be tapped into a container and later dumped in a safe manner
3. The contractor and the management will ensure effective wastewater management
4. Foreign material will be removed from the site as soon drilling is complete

8.1.5 Oil pollution

Oil pollution may occur during the drilling and in the operation phase.

Mitigation:

1. Proper storage, handling and disposal of oil and oil wastes
2. Maintain machinery and equipment to avoid leaks
3. Maintenance of drilling vehicles will be carried out in the contractor's yard

8.1.6 Soil Erosion

Soil erosion may occur during the drilling phase. During drilling, the site will be dug out and top soil exposed. Erosion would probably be minor for this project due to the flat terrain, permeable soils and lack of proximity to surface water drainages.

Mitigation:

1. Control earthworks especially if works begin in the rainy season
2. Loose soils will be compacted when necessary
3. The contractor will ensure management of excavation activities
4. Activities will be controlled especially if drilling will take place during rainy conditions
5. Provide soil erosion control structures on the steep sides during drilling

8.1.7 Loss of biodiversity

No vegetation will be cleared to pave way for the drilling.

Mitigation:

1. Access to the site should be via a designated route for the rigs and other vehicles
2. No unnecessary cutting of vegetation should be done at the site

8.1.8 Noise pollution

Mitigation:

1. Keep members of the public away from the drilling site during drilling
2. Warn the sensitive neighboring establishment 5 days before drilling commences.
3. Maintain plant equipment to avoid annoying noises
4. Construction activities to be restricted to daytime
5. Workers in the vicinity of high-level noise to wear safety and protective gears

8.1.9 Air quality/particulate matter (dust)

Vehicular/equipment engine exhaust emissions will be minor and temporary during construction. Air quality impacts will be temporary during construction. The project will not generate significant vehicle trips to the area. Vehicular and equipment exhaust emissions during project operations will, thus, have a minor incremental/cumulative impact locally and regionally.

Particulate matter (dust) would be generated by excavation and the movement of construction vehicles. It is not possible to accurately estimate the particulate concentration that might occur at the site because it is dependent on meteorological conditions and soil moisture.

Mitigation:

1. Discourage idling of vehicles i.e. vehicle and equipment engines will be turned off when not in direct use to reduce exhaust emissions.

2. Regular maintenance drilling plant and equipment
3. Engage sensitive drilling workers
4. Provide Personal protective Equipment such as nose masks to the workers on site
5. The contractor will water the site with exposed soil surfaces twice each day during dry weather.

8.2 SOCIAL IMPACTS

8.2.1 Water supply

Safe, reliable and cheap water supply for domestic use by the proponent

8.2.2 Hazard

Hazards due to falls are not possible as the borehole diameter is 8" in length. Hazards due to electric shocks are possible during pump installation.

Mitigation measures:

1. The management will ensure that electric wiring is checked and that shocks are prevented at all costs
2. Underage children and unauthorized person will not be allowed near the borehole vicinity as it will be cordoned off.

8.2.3 Contamination

Typically, groundwater is naturally clean and safe for consumption. Because the overlying soil acts as a filter, groundwater is usually free of disease-causing microorganisms. However, contamination may occur following improper installation of well casings or caps, after a break in the casing or as a result of contaminated surface water entering the well. Contamination can also occur if boreholes are drilled in fractured bedrock without an adequate layer of protective soil and with less than the recommended minimum casing length.

Mitigation measures:

1. Sealing off of upper aquifer to avoid contamination caused by seepage from pit latrines and septic tanks
2. Construction of well head slab to avoid surface run-off in to the borehole
3. Ensure proper installation of borehole casing avoiding breakages.

Testing Well Water for Microbiological Contamination

New boreholes should be disinfected by the borehole driller at the time of construction to eliminate any microbiological contamination that may have occurred during drilling. This should be done before collecting a sample for microbiological testing. Existing boreholes should be tested two or three times a year. The best time to sample the borehole water is when the probability of contamination is greatest. This is likely to be after an extended dry spell, following heavy rains or after lengthy periods of non-use.

Borehole Maintenance

Proper siting, location, construction and maintenance of the borehole will help to minimize the likelihood of contamination. The well cap should be checked regularly to ensure that it is securely in place and watertight. Joints, cracks and connections in the borehole casing should be sealed. Pumps and pipes should also be checked on a regular basis, and any changes in water quality should be investigated.

8.2.4 Safety (worker exposure, safety impacts)

Hazards generally comparable to conventional drilling methods, with special provisions anticipated for high noise levels and site-specific contamination issues.

Mitigation measures:

1. Worksite monitoring and personal protective equipment (PPE) required, as appropriate, for mechanical, noise, and potential contaminant exposure hazards. Typically 3-5 people operate drilling equipment.
2. Standard risks associated with the use of heavy equipment and hydraulics. Prevented by establishment of authorized/limited-access exclusion zones to be maintained during setup and drilling process.
3. Risk levels typical of those associated with any mobile, truck-mounted heavy equipment. Encourage employees to concentrate on their duties to avoid occupational accidents. Employees should also be encouraged to avoid negligence while on duty

8.2.5 Creation of employment especially during drilling

The government's policy is clear on the priority it gives enterprises keen on creating employment to the citizens. The drilling of the borehole will create employment during the drilling.

8.2.6 Promotion of secondary development

Secondary developments come as a result of the existence or creation of a development project in a given area. In this particular case, the project may lead the proponent getting more water both for domestic and commercial use. This will eventually contribute positively to the local communities.

9 CHAPTER EIGHT: POTENTIAL NEGATIVE IMPACTS AND MITIGATION MEASURES

Table 9.1: Potential Negative Impacts and Mitigation Measures

Aspect Number	Possible Impacts	Details	Mitigation measures
1	Occupational health and safety	Construction phase: The residents and workers may be exposed to dust and noise	• Provide the necessary PPEs • Switch of the machines when not in operation • Communicate and Display emergency signs • Avoid working at night • Create awareness on safety and health of the contract employees
2	Injuries/accidents to workers.	Workers or the residents may be injured by the materials or equipment working on the site.	• Erect a perimeter wall to keep off unauthorized persons in the site. • Provide PPEs and ensure that they are always worn while workers are on site • Ensure that only trained workers run the machines • Provide First Aid facilities.
3	Air pollution	Air may be polluted during construction phase due to the engines doing the work and dust	• Ensure that the engines are well maintained • Only operate them when needed. • Water the ground before drilling
4	Noise	There will be noise from the machines used for construction.	• Machines will be run only when necessary and within working hours (8-5pm)

10 ENVIRONMENTAL MANAGEMENT PLAN

Table 10.1: Environmental Management Plan

Project phase	Impact	Proposed mitigation measures	Cost		Impact	Proposed mitigation measures
Drilling and construction phase	Damage to local roads	Movement of heavy trucks and vehicles restricted to essential travel only	work tickets-100	Contractor proponent	Drilling	work tickets
	Noise & vibration	Supply Ear muffs to staff Avoid unnecessary raving of vehicles and compressors Schedule drilling activity to day time only	Ear muffs-1,000	Contractor	4days	Ear muffs issue records Drilling time records No. of complaints of high vibration levels
	Dust	Supply and ensure staff use dust masks Moisten the drill hole to reduce particulate matter generation Schedule drilling activity to day time only	Dust masks-1,000 Water-10,000	Contractor	Continuous	Dust masks issue records
	Waste water	Manage water use to reduce waste Direct the waste water to the flowers Create storage for later use of watering flowers Excess waste directed to natural drainage channel	Labour 500	Contractor	One day	No flood channels spilling offs No. of complaints from neighbours of flooding water
	Solid waste	Use drilling debris for landscaping Use stone chips for construction Restore affected area to reduce impact	Labour 500	Contractor proponent	Once	No debris on site
	Fossil fuel emissions	Ensure vehicles and machines are properly serviced as per service manuals	vehicles/machine servicing-35,000	Contractor	Continuous	Vehicle and machine service records

	Oil and grease spillage	Ensure vehicles and machines are properly serviced as per service manuals Have on board mechanic to stop all incidental leaks as they occur Use only parts from reputable dealers	vehicles and machines servicing-35,000	Contractor	2weeks	Vehicle and machine service records
	Borehole collapse	Ensure use of appropriate steel casings and screens as per hydro geologists report	Casings & screens 1,400,000	Contractor Proponent	1week	Purchase record of materials Hydro geologist design
	Borehole contamination	Use bentonite seal and recommended size of surface casing to control groundwater contamination	Sanitary seal 3,000	Contractor Proponent	One day	Record of contamination
	High energy consumption	Use KLPC power during low demand times in the day Install automatic switch & timer control Explore use of solar pump	Switch/ timer 15,000	Proponent	continuous	Installation records Meter records
Operation phase	Solid waste	Donate serviceable parts to charitable organizations Sell obsolete parts to accredited waste handling contractors	None	Proponent	Periodic Annual	Donation records
	Maintenance and servicing	Conduct regular inspections for boreholes Ensure installation of water meter to monitor groundwater abstraction Install airline for groundwater levels monitoring Use unleaded in vehicles Ensure workers and staff use PPEs Provide security at the station	Inspection 10,000 quarterly	Proponent	Periodic quarterly	Inspection reports Meter readings records Use of PPEs records Incidences/ Occurrences records

	Waste water	Develop EDCP plan and implement	EDCP development 3,000 implementation 200,000	Proponent	Continuous	Effective EDCP in place
	Minimize water consumption and efficient water use	Promptly detect and repair water pipe and tank leaks Ensure taps are not running when not in use Install water conserving taps that turn-off automatically when water is not being used Install a discharge meter at water outlets to determine and monitor total water usage Alternate groundwater with rain harvested water usage	Leaks detection 1,000/month Replacing taps 500/moth Discharge meter 10,000/5years	Proponent	Continuous	No leakage seen/records of rectified leaks Records of taps purchased and replaced Functional meter installation date
	Possible over exploitation of groundwater	Promptly detect and repair water pipe and tank leaks Ensure taps are not running when not in use Install water conserving taps that turn-off automatically when water is not being used Install a discharge meter at water outlets to determine and monitor total water usage Alternate groundwater with rain harvested water usage Adhere to safe yield of borehole Enforce water allocation plan	Groundwater Water level Monitoring	Proponent/ WRA	Periodic	Water level records Meter records
	Aquifer degradation	Protect catchment to enhance water infiltration Soil and Water Conservation within catchment	Catchment conservation	Proponent or WRA	Periodic annual	Catchment conservation structures Forested/ afforested

		Adhere to safe yield of borehole Enhance natural and artificial recharge				area % Meter records
	Highly mineralized groundwater	Carry out physical, chemical and bacteriological analysis Carry out soil test Use reverse osmosis for drinking water Use appropriate chemical to correct soil composition/PH	Water quality test 15,000 RO equipment 25,000 Lime/fertilizer 5,000	Contractor or Proponent	0nce Continuous	Water quality report Soil chemical report
	HIV/AIDS	Create awareness on staff Liaise with local dispensary/ health providers for supply of condoms	Awareness creation 2,000 Condom supply	Contractor or Proponent	Periodic Annual	Awareness creation reports Condoms supply records
	Accidents and occupational hazards	Awareness creation on OHS Supply and ensure staff use of gloves, shoes and hats, PPEs Ensure only accredited firms undertake servicing Erect warning signs and perimeter fence during drilling and decommissioning phases Ensure all electrical works are properly insulated protected and guarded Take insurance cover for vehicles, equipment and personnel Ensure only trained staff handle vehicles, machines and equipment Provide first aid kit on vehicles and drilling camp site Liaise with local dispensaries to provide emergency services	PPEs 20,000 Insurance cover 50,000 First aid-5,000	Various contractors Proponent	Periodic Half yearly	OHS awareness creation reports PPEs supply and issue records Active Insurance covers Service provider firms records Incidences/ Occurrences records

Cross cutting issues	Solid waste (scrap materials and demolition debris	All machinery, equipment, structures and partitions that will not be used for other purposes must be removed and recycled/reused as far as possible All pipes, screens must be removed and sold, recycled, reused or disposed of at a licensed disposal site Recycle/ reuse demolition debris Use debris in landfills of quarry sites Donate serviceable parts to charitable organizations Sell obsolete parts to accredited waste handling contractors Backfill with clean (washed), uncontaminated material so that it shall mimic the surrounding natural strata and groundwater flow and quality will be protected Identify replacement borehole site	Laour 15,000 Transport 5,000	Proponent	Once off	Donation/ sale records No demolition debris on site Restored ground condition Transportation of unusable debris records
	Land aesthetics	Soil erosion prevention to be undertaken on decommissioning Cap borehole to avoid land wastage Harvest rainwater to enhance infiltration to the ground Re-vegetate/Restore the project site with local vegetation	Soil and water conservation structures Rainwater harvesting fixtures	Proponent	Once off	Construction records/designs Physical inspection
	Pollution of groundwater	Bores should be encased to a reasonable depth Boreholes should be sealed with sanitary seal to prevent ingress of surface water or shallow	Surface casing inserted down to firm A 1*1*0.5 sanitary concrete well head put around surface casing	Contractor/ proponent	Once off	Construction records/designs Physical inspection

		groundwater				
Decommissionin	Loss of service and benefits	Siting of replacement and drilling Redeployment of workforce to new site	New borehole 2.50m Staff redeployment record	Proponent	Once off	New borehole in place Redeployment records

11 COMPLIANCE TO THE RELEVANT REGULATIONS AND REQUIREMENTS

The proponent is committed to compliance with the relevant law and regulations. This is demonstrated by:

1. Carrying out Environmental Impact Assessment before commencement of the project as required by Environmental (Impact and Audit) regulations, 2003.
2. He has also put measures in place to control noise pollution by, for example, only operating between 0800hrs to 17hrs and using well maintained equipment during drilling. This is a requirement by the Noise and Vibration Control Act.
3. Obtaining of a Permit from WRA
4. Committed to adhere to all the measures recommended under potential negative impacts and the EMP

12 DECOMMISSIONING PLAN

It is highly recommended that he puts in place rehabilitation measures that will be undertaken in case the borehole ceases. The objective of this process is to leave the site in an acceptable and utilizable state for future generations' needs. In this respect the table below outlines the basic principles, not limited, that need to be adhered to during the process.

Table 12.1: Decommissioning Plan

ITEM No.	ACTIVITY	ACTION REQUIRED	RESPONSIBLE PARTY	FREQUENCY
1	Dismantling plan	Lay down a clear dismantling plan of the stand and the borehole	proponent	Once
2	Removal of materials from the site and disposal	It should be done in an appropriate manner that does not affect the environment with and outside the site and health and safety of neighboring communities. The materials can also be used for other projects or sold as scrap metal dealers in case of metallic materials. Shall use approved agents and adherence to legislation	Githunguri Primary Schhool, Approved decommissioner such as Engineers	Once
3	Rehabilitation	The area under rehabilitation or decommissioning should be demarcated with the danger tape to prevent human and vehicular access. It should also be left in a state that it is useful for future generation. Plant trees if possible or flowers	Approved decommissioned such as Engineers	Once
4	Monitoring of the premises after decommissioning	Post decommissioning monitoring	NEMA	Continuous

13 CONCLUSION

Long-term ground-water-level data from individual boreholes provide the information needed to monitor ground-water depletion locally. Periodic assessments of changes in ground-water storage could be made by measuring more boreholes over larger areas at 5- to 10-year intervals. Such changes could be documented for major aquifers and then compiled into regional and national assessments.

In order to preserve and optimize the use of our critical ground-water resources, science can provide the information necessary to make informed choices on issues that have long-term environmental and ecological effects. For many boreholes in Kenya, the basic data needed for such assessments are not available, and hence our knowledge of the water budget for them is limited.

Water Resource Authority (WRA) is given the task of monitoring the groundwater abstraction hence ensuring that boreholes are drilled sustainably for now and the future generations. The proponent has made all the necessary applications with WRA and this EIA report is one of the requirements by the WRA before drilling commences.

The lead expert considers that the development will have an insignificant impact on the environment and is unlikely to have a substantial influence on underground water, since mitigation measures will be strictly adhered to by all the parties involved. Furthermore, the lead expert considers that the counteractive measures as outlined in this document presented by the developer can preclude noise and atmospheric pollution from the development from having any severe effect on the neighboring establishments. No major impact on the geological conservation value of the site is involved. Thus the lead expert concludes that the development will not have any considerable impact on landforms, landscape and built up environment.

14 REFERENCES

1. ***Hydrogeological survey report*** *– Ministry of Water & Sanitation and Irrigation Registered hydrogeologist, Joseph Nzomo, Ann J. Kapkiai and Charles Munduyi*

2. ***Republic of Kenya (1998)****. Laws of Kenya: The Local Government Act, Cap 265. Government Printer, Nairobi.*

3. ***Republic of Kenya (1998).*** *Laws of Kenya: The Science and technology Act, Cap 250. Government Printer, Nairobi.*

4. ***Republic of Kenya (1999).*** *The Environmental Management and Co-ordination Act, No. 8 of 1999. Government Printer, Nairobi.*

5. ***Republic of Kenya (1999)****. The Environmental Management and Co-ordination Act, No. 8 of 1999. The Environmental (Impact Assessment and Audit) (Amendment) Regulations, 2009. Government Printer, Nairobi.*

6. ***Republic of Kenya (2003)****. Legislative Supplement No. 31, Legal Notice No. 101: The Environmental (Impact Assessment and Audit) Regulations, 2003. Government Printer, Nairobi.*

7. ***Republic of Kenya (2007)****. Laws of Kenya: The Occupational, Safety and Health Act, 2007. Government Printer, Nairobi.*

8. ***Republic of Kenya. Physical Planning Act, CAP 286.*** *Government Printer, Nairobi*

15 APPENDICES

1. *Questionnaires of public participation.*
2. *Hydrogeological Survey Report – Ministry of Water & Sanitation and Irrigation Registered hydrogeologist, Joseph Nzomo, Ann J. Kapkiai and Charles Munduyi*
3. *Land Title:* ***L.R. NO: GITHUNGURI/ GITHUNGURI/663***
4. *Copy of Authorization from Water Resources Authority (WRA).*
5. *Copy of the certificate of the lead expert*

FORM 7 (r.15(2))

nema
mazingira yetu | shai wetu | wajibu wetu

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY(NEMA)

THE ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION ACT

ENVIRONMENTAL IMPACT ASSESSMENT/AUDIT (EIA/EA) PRACTICING LICENSE

License No : NEMA/EIA/ERPL/11891

Application Reference No: NEMA/EIA/EL/15987

M/S **ANN JELIMO KAPKIAI**
(individual or firm) of address

P.O. Box 48363-00100, Nairobi

is licensed to practice in the capacity of a (Lead Expert/Associate Expert/Firm of Experts) **Lead Expert** registration number **7697**

in accordance with the provision of the Environmental Management and Coordination Act Cap 387.

Issued Date: **2/19/2020** Expiry Date: **12/31/2020**

Signature…..

(Seal)
Director General
The National Environment Management Authority

P.T.O.

ISO 9001: 2008 Certified