Environmental and Social Impact Assessment (ESIA) Study Report for the Proposed 4 MW Geothermal Captive Power Plant at Menengai Geothermal Field in Nakuru County

Proponent	Firm of Experts
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Date: November 2024

CERTIFICATION

Certification by Lead Experts

We, **Envasses Environmental Consultants Limited** hereby confirm that this Environmental and Social Impact Assessment Study Report has been prepared by ourselves pursuant to Section 58 of the Environmental Management and Coordination Act Cap. 387 of the Laws of Kenya.

Signed by Lead Experts on 18th November 2024

Name	Role	Signature
Mr. Simon Nzuki (Lead Expert No. 1350)	Team Leader	
Mrs. Jane Gitau (Lead Expert No. 2015)	Stakeholder Engagement Expert	

Certification by Proponent

We, **Karsan Ramji and Sons Limited**, hereby confirm that this Environmental and Social Impact Assessment Study Report has been prepared and submitted to NEMA with our authority pursuant to Section 58 of the Environmental Management and Coordination Act Cap. 387 of the Laws of Kenya.

Signed for and on behalf of: **Karsan Ramji and Sons Limited**

Name: MR. KISHOR VARSANI

Designation: MANAGING DIRECTOR

Signature: 

ACKNOWLEDGEMENTS

The preparation of this ESIA Study Report was carried out with the support of several personnel and stakeholders. The proponent through Dr. George Muia in collaboration with Geothermal Development Company (GDC) staff i.e. Mr. Hillary Mwawasi, Mr. Pascal Namanyala, Mr. Peter Mading, Mr. Peter Echapan, Ms. Fridah Nkatha and Ms. Miriam Chelagat facilitated site visits and community engagements alongside providing data and information on the proposed project. The stakeholders included the local community as well as State Agencies represented by Ecosystem Conservator - Kenya Forest Service (KFS), Nakuru, Deputy County Commissioner – Nakuru North Sub-County, Assistant County Commissioner – Kiamaina Division and the Chiefs – Kabatini, Rurii, Kiamaina, Menengai, Mulukariro and Kirima Locations.

Sampling and analysis of ambient air and noise level measurements was undertaken by Lahvens (K) Limited to whom we are grateful.

Envasses Environmental Consultants Limited staff supported data collection and analysis, facilitated stakeholder engagement meetings as well as preparation of the draft and final ESIA Study Report. To this end we acknowledge the input of Mr. Omar Said, Mr. Kennedy Kijana, Ms. Hyrine Masese, Ms. Fridah Khamalishi and Ms. Rhoda Mutanu.

EXECUTIVE SUMMARY

Geothermal Development Company (GDC) is mandated with surface exploration, drilling, resource management, early generation and promotion of direct utilization of geothermal in Kenya. The geothermal resources are located within the Rift Valley with an estimated potential of between 7,000 MW to 10,000 MW spread over 14 prospective sites i.e. Menengai, Olkaria, Suswa, Longonot, Eburru, Arus-Bogoria, Lake Baringo, Korosi, Paka, Lake Magadi, Badlands, Silali, Emuruangogolak, Namarunu and Barrier. In line with these mandates, GDC prepared and submitted two (2) ESIA study reports to NEMA on geothermal drilling projects in Menengai i.e. proposed installation of 5-10 MWe Modular Geothermal Power Plants at Menengai Caldera (NEMA/EIA/5/2/827) and Menengai West Geothermal Drilling Project (NEMA/EIA/5/2/1569) in 2012 and 2019 respectively. These projects have since been licensed and to date, GDC has drilled and tested over 50 wells at the Menengai Caldera, each with an estimated production of 170 MWe. Furthermore, GDC initiated a heat park project in 2020 at the Menengai Geothermal Field whose aim is to promote sustainable industrial development and reduce reliance on fossil fuels.

Subsequently, Karsan Ramji and Sons Limited (KRSL), entered into a steam supply agreement with GDC to set up a 4 Megawatt (MW) captive power generation unit at Main Well 18A within the Menengai Geothermal Field to power their proposed cement plant and pozzolana drying. Pursuant to Section 58 of the Environmental Management and Coordination Act (EMCA), Cap. 387 of the Laws of Kenya, power and infrastructure projects including geothermal development are listed under the Second Schedule (10b) as high risk and hence subject to an ESIA Study process. To comply with this legal requirement, the proponent contracted Envasses Environmental Consultants Limited to prepare an ESIA Study Report.

The Third Schedule of the Environmental Management and Coordination (Impact Assessment and Audit) Regulations, 2003, informed the approach and methodology used in data collection, analysis and reporting. Data collection methods included reconnaissance survey carried out in June 2024 to assess the site status and baseline conditions of the project area, literature review, environmental media sampling and analysis (ambient air and noise level measurements), stakeholder engagement meetings as well as questionnaires. The results of the ESIA study demonstrate that the project will have both positive and negative environmental and social impacts. The positive impacts include reducing the cost of production and enhancing profitability of the company, providing a market for goods and services, decreasing Green House Gases (GHGs) emissions (~2,700tCO_2/MW annually) thus lowering the proponent's carbon footprint, potential scaling up the use of geothermal energy and creating awareness for its benefits among other industry players, employment creation and revenue generation to GDC and the Kenya government.

Despite the benefits, the proposed project poses environmental and social risks at installation, operation and possible decommissioning phases. Impacts at installation phase include loss of vegetation cover, impact of sourcing raw materials from the environment, health and safety risks, harmful radiation exposure, air and noise pollution, water demand and waste management. Mitigation measures will include landscaping and tree planting to offset losses from vegetation clearance, obtaining raw materials from sites which are licensed as per EMCA Cap. 387 of the Laws of Kenya, recycling and reusing of materials, providing Personnel Protective Equipment (PPE) to the workforce and visitors, implementing strict radiation safety protocols and monitoring systems, sensitizing workers on water conservation, managing wastes through adequate collection bins and contracting a NEMA licensed waste handler for their disposal.

At operational phase, the main concerns will be air and noise pollution, decline in well productivity, brine and waste management, health and safety risks, fire hazards and emergencies. Air pollution will emanate from release of Non-Condensable Gases (NCGs) such as hydrogen sulphide, carbon dioxide, ammonia, methane, hydrogen, nitrogen and argon which constitutes 5.9% by weight on average of the steam. Carbon dioxide and hydrogen sulphide are the dominant components in the NCG accounting for 98% and 1.59% by weight on average respectively. The most relevant pollutant considered is hydrogen sulphide because of its potentially significant increase during the operational phase. Hydrogen sulphide presents an unpleasant odour at relatively low concentrations and toxic if it's above 150 g/m^3 as per the First Schedule of the Environmental Management and Coordination (Air Quality) Regulations, 2014. Mitigation measures will include provision of adequate and appropriate gas masks to workers and visitors to the plant and enforcement on their use, installation of hydrogen sulphide abatement systems such as Stretford, LO-CAT or Sulferox processes and monitoring plan to facilitate early detection and warning. Noise pollution should be mitigated through regular maintenance and servicing of machinery/equipment to ensure that they are in good condition.

The productivity of Main Well 18A may decline to unsustainable levels over time in which case the proponent will utilize alternative Well No. 35 for steam production, reinject the brine back into the geothermal reservoir (Well No. 34) and monitor the amount of geothermal fluid extracted. Furthermore, rehabilitation of the existing evaporation ponds should be carried out prior to brine disposal. The proponent should also ensure the health and safety of employees and visitors to the plant by providing adequate and appropriate PPE and limiting working hours as per the Occupational Safety and Health Act (OSHA), 2007. In addition, an emergency response plan should be prepared and prominently displayed in strategic areas at the plant, regular fire drills undertaken as well as provision of adequate firefighting equipment.

A decommissioning phase is possible in the event of permanent decline (Unsustainable levels) in well productivity, closure of the plant by government agencies due to non-compliance with environmental regulations as well as natural calamities such as earthquakes, volcanic eruptions. Key environmental and social concerns at this phase will be economic decline, health and safety risks, and waste generation. To mitigate the impacts, the proponent should prepare and submit a due diligence decommissioning audit report to NEMA for approval at least three (3) months in advance.

Despite the anticipated negative environmental and social impacts, the proposed project has significant benefits which range from reducing the cost of production and enhancing profitability of the company, providing a market for goods and services, decreasing the GHGs emissions hence lowering KRSL carbon footprint, potential scaling up the use of geothermal energy and creating awareness for its benefits among other industry players, employment creation and income to the government. However, the ESIA Study acknowledges the importance of addressing the environmental and social risks of the project to ensure its sustainability and hence proposes a suite of Environmental Management and Monitoring Plans (EMMPs) corresponding to each project phase. Implementing the EMMPs will significantly reduce or in some cases reverse the project's negative environmental and social impacts. On this basis, this report recommends the issuance of an EIA License pursuant to the Environmental Management and Coordination Act (EMCA), Cap. 387 of the Laws of Kenya.

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ACRONYMNS

AD	Active Directory
AQM	Ambient Air Quality Monitor
CBOs	Community Based Organizations
CEREB	Central Region Economic Block
CIDP	County Integrated Development Plan
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CSR	Corporate Social Responsibility
DOSHS	Directorate of Occupational Safety and Health Services
EA	Environmental Audit
EARS	East African Rift System
EDL	Effluent Discharge License
EIA	Environmental Impact Assessment
EMCA	Environmental Management and Coordination Act
EMMPs	Environmental Management and Monitoring Plans
EPRA	Energy & Petroleum Regulatory Authority
ESCP	Environmental and Social Commitment Plan
ESIA	Environmental and Social Impact Assessment
ESMPs	Environmental and Social Management Plans
ESSs	Environmental and Social Standards
ETIP	Energy Transition & Investment Plan
FCRS	Fluid Collection and Reinjection System
FI	Financial Intermediaries
FiT	Feed-in-Tariffs
FPIC	Free, Prior, and Informed Consent
GDC	Geothermal Development Company
GHGs	Green House Gases
GPRS	General Packet Radio Service
GRM	Grievances Redress Mechanism
H_2S	Hydrogen Sulphide
HCVs	Heavy Commercial Vehicles
KFS	Kenya Forest Service
KPLC	Kenya Power and Lighting Company
KRSL	Karsan Ramji and Sons Limited
LCD	Liquid Crystal Display
LTE	Long Term Evolution
$MtCO_2e$	Metric Tons of Carbon Dioxide Equivalent
MW	Megawatt
NCA	National Construction Authority
NCG	Non-Condensable Gases
NEMA	National Environment Management Authority
NG-CDF	National Government Constituency Development Fund
NGOs	Non-Governmental Organisations
NO_x	Nitrogen Oxides
ORC	Organic Rankine Cycle
OSHA	Occupational Safety and Health Act
PM_{10}	Particulate Matter
PPE	Personnel Protective Equipment
SDGs	Sustainable Development Goals
SLM	Sound Level Meter
SO_x	Sulphur Oxides
TORs	Terms of References
TVA	Tectono-Volcanic Axes

1 INTRODUCTION

1.1 Background information

Geothermal Development Company (GDC) is mandated with surface exploration, drilling, resource management, early generation and promotion of direct utilization of geothermal in Kenya. The geothermal resources are located within the Rift Valley with an estimated potential of between 7,000 MW to 10,000 MW spread over 14 prospective sites i.e. Menengai, Olkaria, Suswa, Longonot, Eburru, Arus-Bogoria, Lake Baringo, Korosi, Paka, Lake Magadi, Badlands, Silali, Emuruangogolak, Namarunu and Barrier. In line with these mandates, GDC prepared and submitted two (2) ESIA study reports to NEMA on geothermal drilling projects in Menengai i.e. proposed installation of 5-10 MWe Modular Geothermal Power Plants at Menengai Caldera (NEMA/EIA/5/2/827) and Menengai West Geothermal Drilling Project (NEMA/EIA/5/2/1569) in 2012 and 2019 respectively. These projects have since been licensed and to date, GDC has drilled and tested over 50 wells at the Menengai Caldera, each with an estimated production of 170 MWe. Furthermore, GDC initiated a heat park project in 2020 at the Menengai Geothermal Field whose aim is to promote sustainable industrial development and reduce reliance on fossil fuels.

Subsequently, Karsan Ramji and Sons Limited (KRSL) (Annexures 1 & 2), entered into a steam supply agreement with GDC to set up a 4 Megawatt (MW) captive power generation unit at Main Well 18A within the Menengai Geothermal Field to power their proposed cement plant and pozzolana drying. The project site is geo-referenced at **Latitude 0°12'16.21"S** and **Longitude 36° 05'43.40"E** (Figures 1 & 2). Pursuant to Section 58 of the Environmental Management and Coordination Act (EMCA), Cap. 387 of the Laws of Kenya, power and infrastructure projects including geothermal development are listed under the Second Schedule (10b) as high risk and hence subject to an ESIA Study process. To comply with this legal requirement, the proponent contracted Envasses Environmental Consultants Limited to prepare an ESIA Study Report.

1.2 ESIA approach and methodology

The Third Schedule of the Environmental Management and Coordination (Impact Assessment and Audit) Regulations, 2003 informed the approach and methodology used in preparing the ESIA study report. The data collection methods employed included reconnaissance survey carried out in June 2024 to assess the site status and baseline conditions of the project area, literature review of relevant documents, environmental media sampling and analysis (ambient air and noise level measurements), stakeholder engagement meetings as well as questionnaires.

1.2.1 Reconnaissance survey

The consultant carried out a reconnaissance survey of the site on 6th June 2024. The objective of the survey was to undertake a screening and scoping exercise to identify key environmental and social issues that would be addressed by the study, carry out stakeholder mapping, establish key informants contacts and data requirements for the ESIA process. Environmental screening and scoping were informed by the Second Schedule of the Environmental Management and Coordination (Impact Assessment and Audit) Regulations, 2003. As per this Schedule the issues considered were ecological, socio-economic, landscape use and changes and water (Table 1).

Following the reconnaissance survey, the consultant prepared a Scoping report and Terms of Reference (TORs) pursuant to Regulation 11 of the Environmental Management and Coordination (Impact Assessment and Audit) Regulations, 2003 which were approved by NEMA (Annexure 3).

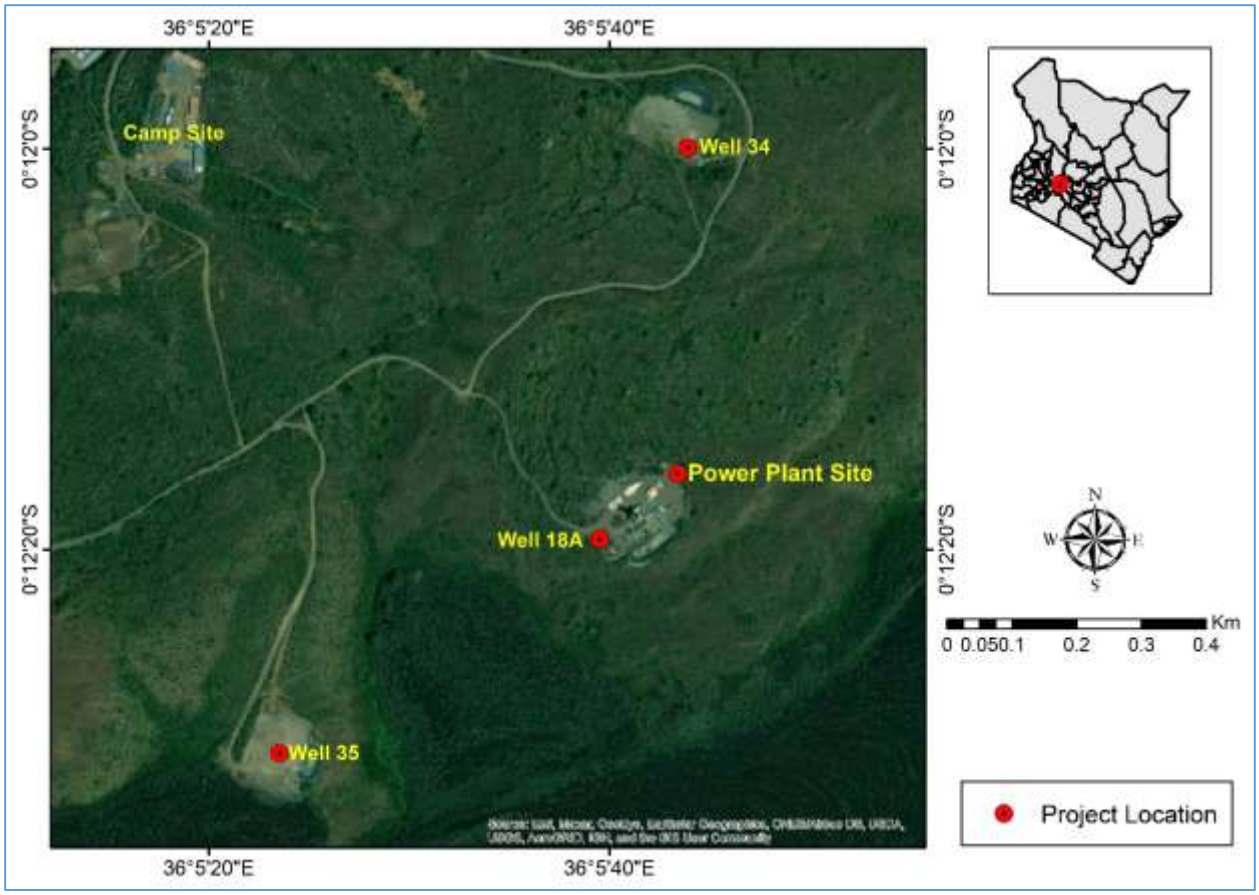


Figure 1: Location of the proposed project site (Google Earth, June 2024)

Figure 2: A section of the proposed project site (Source: Reconnaissance survey, June 2024)

Table 1: The scoping and screening criteria used during the reconnaissance survey on the potential environmental and social impacts of the proposed 4 MW Geothermal Captive Power Plant (Source: Environmental Management and Coordination (Impact Assessment and Audit), Regulations, 2003)

Scoping issues	Key considerations	Reconnaissance survey findings
Ecological considerations	Biological diversity	• Impact on vegetation cover and fauna
	Sustainable use	• Insignificant
	Ecosystem maintenance	• Insignificant
Social considerations	Economic impact	• Reducing the cost of production and enhancing profitability of the company • Providing a market for goods and services • Reducing GHGs emissions (~2,700tCO_2/MW annually) thus lowering the proponent's carbon footprint • Potential scaling up the use of geothermal energy and creating awareness for its benefits among other industry players • Employment creation • Revenue generation to GDC and the Kenya government
	Social distribution and cohesion	• The stakeholders have been engaged and their concerns will be addressed during project implementation
	Effects on human health	• Air quality degradation causing respiratory diseases
	Immigration or emigration	• N/A
Landscape	Views opened or closed	• Insignificant
	Visual impacts	• Vegetation clearance on a section of the project site
	Compatibility with surrounding area	• The project is compatible with the surrounding ecosystem
	Amenity opened or closed	• Insignificant
Land use	Proposal effects on surrounding land uses and land use potential in the project area	• The project is consistent with land use in the area
	Proposal effects on the current land use potential in the project area	• Insignificant
Water	Water sources (quality and quantity)	• No surface water resources (Streams, dams or water pans) within or near the project site
	Drainage pattern or system	• Insignificant

1.2.2 Literature review

Literature review provided data and information on biophysical profile of the site (climate and meteorology, hydrology, topography, geology and soils), biological communities (terrestrial flora and fauna) and socio-cultural environment (population demographics, community structure, cultural properties, land use and cover, economic activities, planned development and public utility infrastructure) within the project area. Additionally, literature review was used to bridge gaps in data and information collected during site visits and monitoring activities with respect to the scope of the ESIA. Documents reviewed included geothermal power plant designs, ESIA Study Reports for the proposed installation of 5-10 MWe Modular Geothermal Power Plants at Menengai Caldera (NEMA/EIA/5/2/827) and Menengai West Geothermal Drilling Project (NEMA/EIA/5/2/1569),

published works and grey literature on project area, Nakuru County Integrated Development Plan (CIDP), 2023-2027, and Policy and Legal Instruments by the National and County Governments.

1.2.3 Baseline environmental media sampling and sampling analysis

Ambient air and noise levels baseline environmental media data was collected in collaboration with Lahvens (K) Limited. The results will be used to provide a benchmark for implementing the Environmental and Social Monitoring Plans proposed in the ESIA study report throughout the project cycle. The approaches and methods used for sampling and analysis of baseline environmental media are discussed below.

1.2.3.1 Ambient air quality

Mobile, static and active monitoring was done by using AQM-09 which integrates the main ambient gases and meteorological parameters (Figure 3). The target value was converted into voltage signal by operational amplifier circuit, and then filtered through high-precision AD data acquisition system. In this method, particulates mainly used laser scattering method to produce different scattering light according to different particle diameters under laser scattering conditions. The scattered light intensity was collected by a response device, and the particle 4 concentration was obtained after amplification, filtering and AD acquisition. The obtained gas concentration and particulate matter concentration were displayed on LCD screen in real time, and potentially transmitted to cloud platform or environmental protection through GPRS, 4G LTE and other network signals, to realize the monitoring of regional environmental quality.

Figure 3: Ambient air quality measurements at the project site boundaries (Source: Field work, June 2024)

1.2.3.2 Noise level measurements

Noise levels were evaluated using a Sound Level Meter Model UT – 351, C150107874. SLM was mounted on at 2.0m above ground level and at least 3.5m away from any sound reflecting surfaces at a boundary position and measurements taken at timed intervals of 15 minutes every one-hour period and stored in SLM's memory (Figure 4). Noise level measurement was achieved via initial examination of existing noise sources of significance. The sound level meter was placed on the microphone to reduce any wind interference during measurements.

Further, the equivalent noise level (LAeq), the maximum sound pressure level (Lmax) and the minimum sound pressure level (Lmin) during that measurement period were recorded. Factors to consider such as time, duration and predictability of the noise emission, amplitude and frequency of the noise emission, nature of the source, location of noise sensitive receptors, ambient and background noise level, nature and character of the locality, presence of special acoustic characteristics and the incongruity or familiarity of the noise during noise survey and site placement

were put into consideration. Moreover, as each individual measurement was being taken, the nature of the noise climate in the area was assessed and recorded. This comprised an auditory observation by the surveyor, as well as identifying those noise incidents which influenced the sound level meter readings during that measurement period.

Figure 4: Acoustic level measurements at the proposed project site (Source: Fieldwork June, 2024)

1.2.4 Stakeholder engagement

Stakeholder engagement is a legal requirement under Article 69 of the Kenya Constitution, 2010 and Regulation 17 of the Environmental Management and Coordination (Impact Assessment and Audit) Regulations, 2003. Hence and prior to commencement of the ESIA process, the consultant conducted a stakeholder mapping and analysis to determine the individual, groups and institutions that will be affected by and have an interest in the project. The consultant then prepared a comprehensive list of all the stakeholders in consultation with the proponent and categorized them based on interest and influence (Figure 5 & Table 2).

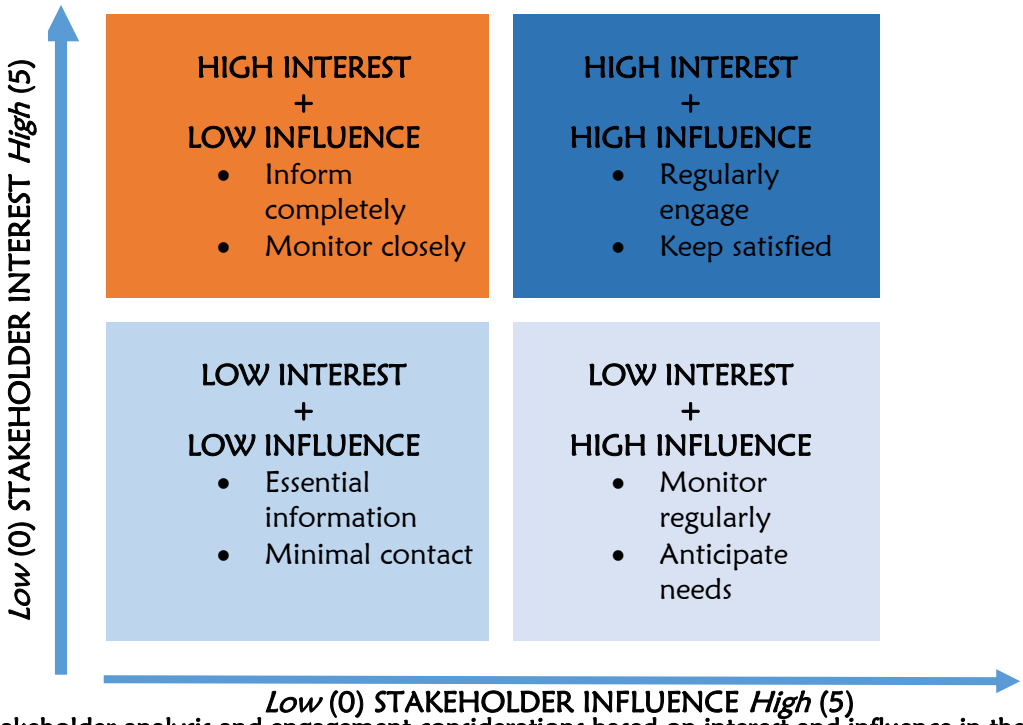


Figure 5: Stakeholder analysis and engagement considerations based on interest and influence in the project

Table 2: Key categories considered during stakeholder identification and analysis

Key stakeholder group	Stakeholders engaged
National Government Agencies	• Ministry of Interior and National Administration (Deputy County Commissioner – Nakuru North Sub-County, Assistant County Commissioner – Kiamaina Division, Chief - Kabatini, Rurii, Kiamaina, Menengai, Mulukariro and Kirima locations • Kenya Forest Service (Ecosystem Conservator – Nakuru and Forester – Menengai station) • Geothermal Development Company
County Government	• County Government of Nakuru
Local community	• Residents from Gituamba, Menengai, Kiamaina, Makao, Rurii, Kabatini, Bahati, Maili Sita, Maili Saba, Maili Tisa, Ahero and Kagoto
Opinion Leaders	• Office of the Area Member of the National Assembly (Bahati Sub-County) • Office of the Area Member of the County Assembly (Kabatini, Kiamaina and Bahati Wards)

Following the analysis, four stakeholder consultation meetings were held and included;

1. Courtesy meeting with government agencies (Ministry of Interior and National Administration and KFS) held on 27th June 2024
2. Kick off meeting to sensitize stakeholders including local community and government agencies on the proposed project held on 28th June 2028 at Maili Saba Police post in Kabatini Location
3. Second Stakeholder meeting to review the draft ESIA study report held on 5th November 2024 at Dhanji Vocational Training Centre at Kagoto area
4. Third Stakeholder meeting to review and validate the draft final ESIA study report held on 15th November 2024 at National Government Constituency Development Fund (NG-CDF) Social Hall at Kiamaina area

Additionally, questionnaires were administered to the local community as a supplementary method of stakeholder engagement to enrich the ESIA process besides the meetings. The views, comments and information gathered from the stakeholders were subsequently synthesized and incorporated into the final ESIA study report alongside the proceedings of the meetings which are provided as annexures.

2 PROJECT DESIGN AND DESCRIPTION

2.1 Overview of Menengai Geothermal Project

The Menengai Geothermal Project (estimated potential of 1,600 MW) was initiated in 2020 and a market survey rolled out to determine the appetite of industry players to participate in the GDC's Industrial Park and zoned the area for different participants. In 2021, GDC requested for an Expression of Interest for the use of steam which Karsan Ramji & Sons Limited (KRSL) participated. Further, GDC shared the tariffs for the different products (steam, brine and land rates) with shortlisted companies and requested for detailed proposals which KRSL submitted with technical input from TOSHIBA. Thereafter, KRSL won the award and entered into a geothermal steam supply agreement with GDC.

2.2 Production well pad and fluid collection and reinjection system

2.2.1 Production well pad

The proposed project will involve installation, operation and possible decommissioning of a 4 MW captive power generation unit at Main Well 18A within the Menengai Geothermal Field to power a proposed cement plant and pozzolana drying. Other components will include drying plant and cooling towers (Figures 6 & 7).

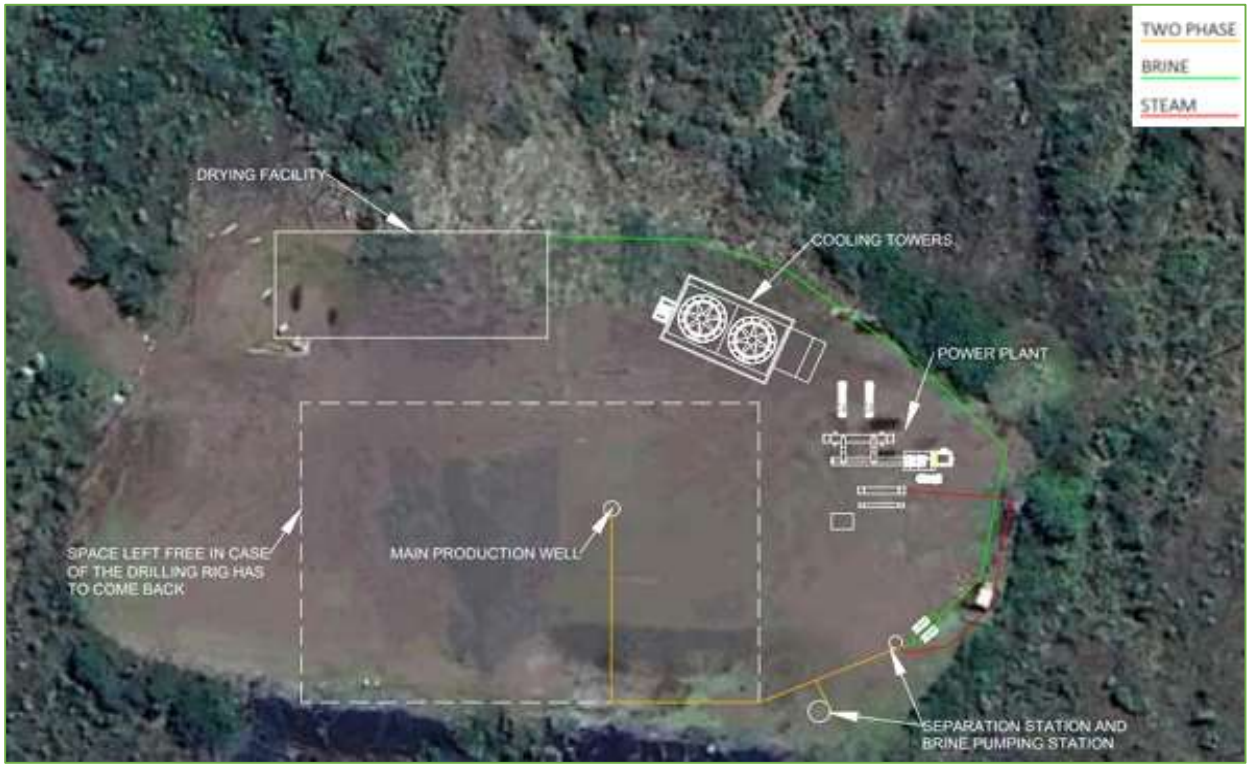


Figure 6: Layout of the production well pad (Source: Karsan Ramji & Sons Limited, June 2024)

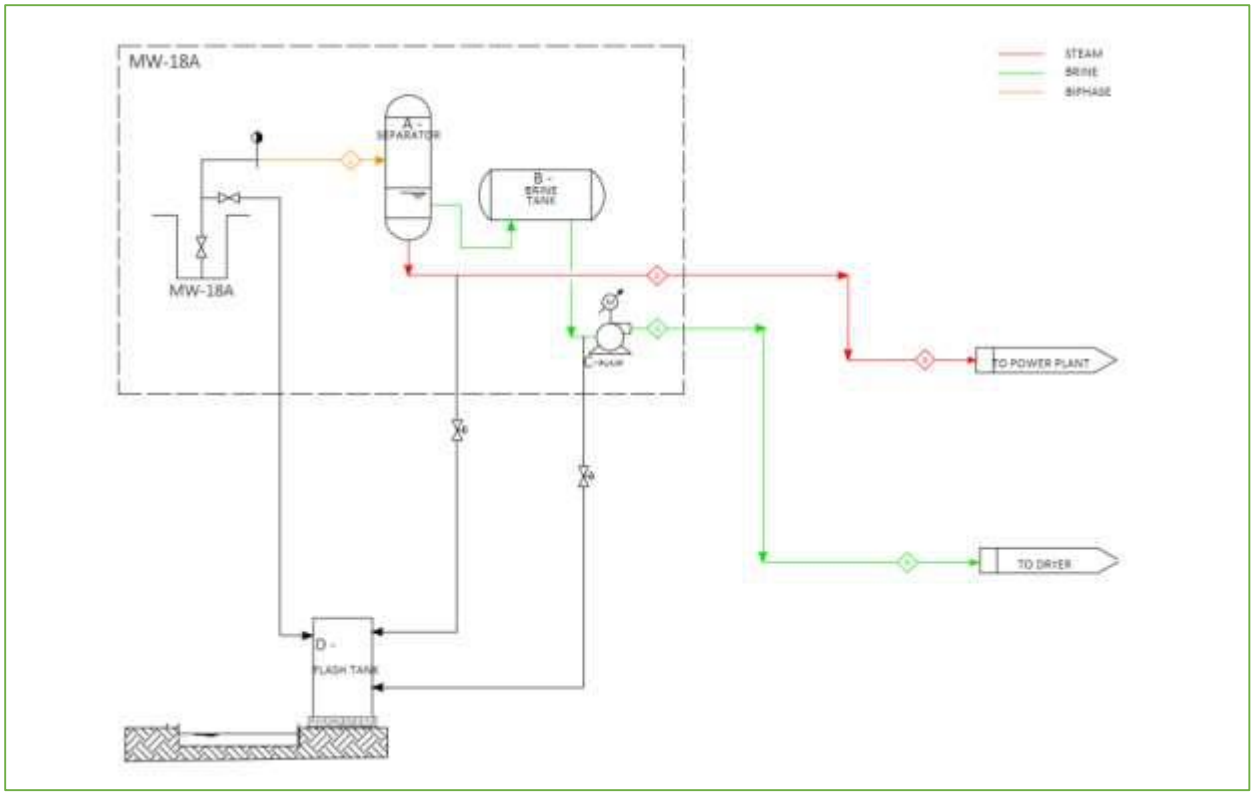


Figure 7: The systematic representation of power production process (Source: Karsan Ramji & Sons Limited, June 2024)

The production well pad consists of two wells with a Main Well 18A (Figure 8), separator, water and atmospheric flash tanks. The two-phase main pipeline will be approximately 100 m long and connected to a Webre separator that utilizes centrifugal force to separate water and steam. The separator features a tangential inlet, causing water droplets to be forced to the outer spiral path, and the steam stream exits from the bottom.

Thereafter, steam will be sent to the power plant through a 70 m long pipeline and brine to a horizontal tank to accumulate without increasing the size of the separator. A flash tank will be utilized for the geothermal fluid discharge during commissioning and start-up phases and emergency. The tank is provided with rocks on top to work as a muffler in case of only steam venting.

The steam separator/demister will separate liquid, droplets or mist from the steam up to a certain dryness factor before it enters the turbine. The steam will expand through the turbine resulting in rotation of the turbine and generator. A crossover carries the steam from the turbine to the condenser where it is mixed with cooling water. The condensed steam/cooling water mixture is then pumped into the drying plant for heating pozzolana (700 tonnes per day) prior to reinjection in Well No. 34 located at **Latitude 0°11'59.04"S** and **Longitude 36° 5'43.12"E** (Figure 9). The reinjection is undertaken to prevent environmental pollution as well as maintain the geothermal reservoir's integrity. In order to avoid silica deposition and achieve the desired steam flow rate for the plant design, a higher wellhead pressure is required. Table 3 shows the design parameters for the project.

In times of decline or Main Well 18A being offline, make up Well No. 35 which is at **Latitude 0°12'30.06"S** and **Longitude 36° 5'23.59"E** on the eastern side of Menengai discontinuity will be utilized for steam production (Figure 10).

Figure 8: Top (Left) and bottom (Right) sections of Main Well 18A (Source: Reconnaissance survey, June 2024)

Figure 9: Re-injection Well No. 34 within the project area (Source: Reconnaissance survey, June 2024)

Table 3: Design parameter for Main Well 18A (Source: Karsan Ramji & Sons Limited, June 2024)

Parameter	Value
Steam + Non-Condensable Gases (NCG) flow, t/h	51
NCG content, %wt (Steam + NCG flow)	1.6
Brine flow, t/h	50
Total Mass Flow, t/h	101
Wellhead pressure, bar	17.88
Total calculated enthalpy, kJ/kg	1,853

Figure 10: Make up well No. 35 within the project area (Source: Reconnaissance survey, June 2024)

2.2.2 Fluid Collection and Reinjection System

The Fluid Collection and Reinjection System (FCRS) is composed of a production Well 18A, separator, water and atmospheric flash tanks, master valve, brine booster pump, steam and brine pipeline connecting the well separation system to the power and dryer plants respectively.

The reinjection system is composed of the following:

- Condensate pipeline at the plant outlet up to the interface point with GDC
- Condensate reinjection pump, if any
- Pipeline for the cold brine from the dryer system outlet up to the interface point with GDC one cold brine reinjection pump, if needed.

The conditions in FCRS sections are shown in Table 4 below.

Table 4: Conditions of flows in the FCRS (Source: Karsan Ramji & Sons Limited, June 2024)

No.	Component	Pressure, bar (a)	Temperature (°C)	Total flow (t/h)
1.	Separator inlet	17.41	205.14	101.74
2.	Separated steam	17.04	204.29	52.11
3.	Plant steam inlet	16.56	202.98	52.11
4.	Pumped brine	19.51	205.21	48.79
5.	Dryer system brine inlet	18.85	205.02	48.79
6.	Condensate plant outlet	Depending on the power plant technology		

2.3 Plant design

Two wellhead production unit designs i.e. steam turbine and binary plants were assessed to determine the best option for power generation. The preferred design will be determined after adoption of the 4 MW wellhead power production unit conceptual design report (Annexure 4) and further market scouting entailing a request for a proposal from both binary and steam turbine manufacturers to deepen the analysis of technical-economic competitiveness of the plants.

2.3.1 Steam turbine plant

The steam turbine plant (Figure 11) can be designed in two configurations: counter pressure (atmospheric discharge) and condensing. The former grants the minimum cost but features low efficiencies and complete discharge of the geothermal fluid into the atmosphere, causing possible reservoir depletion. The latter features a higher complexity due to the presence of the condenser, cooling system, and non-condensable gas extraction system but grants good efficiency and partial reinjection of the fluid.

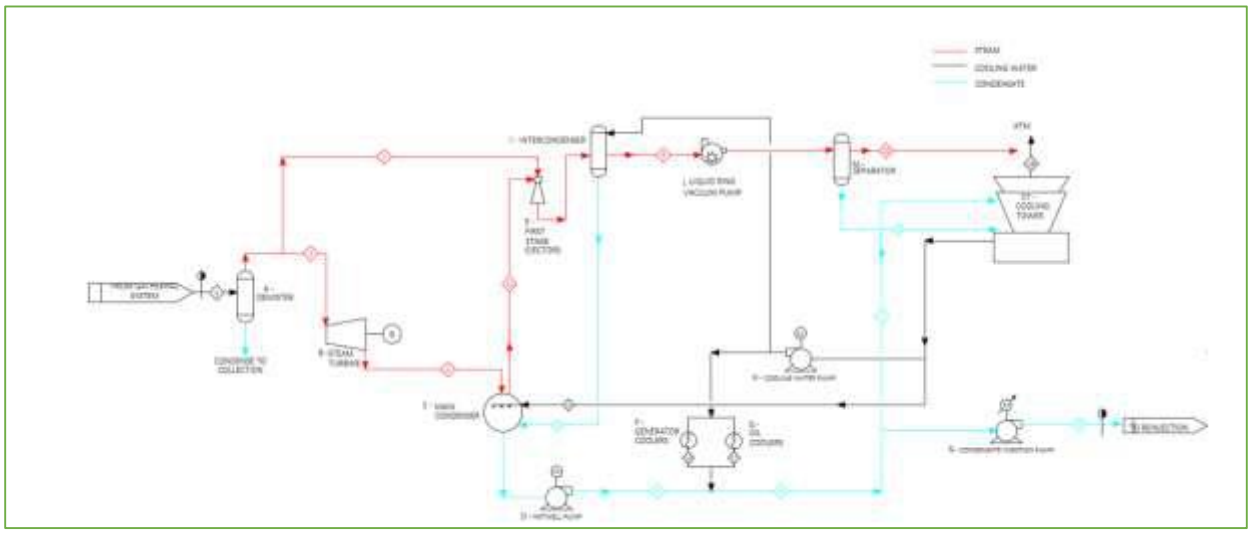


Figure 11: The systematic representation of steam turbine plant (Source: Karsan Ramji and Sons Limited, 2024)

<u>Steam and turbo-generator system</u>

This system conveys high-pressure steam to the power plant from the well's separation unit. The assumed conditions at the power plant inlet are shown in Table 5 below.

Table 5: Steam plant inlet conditions (Source: Karsan Ramji & Sons Limited, June 2024)

Parameter	Value
Pressure, bar	16.8
Temperature, °C	202.5
Flow rate, t/h	32.3
NCG, %wt (Flow rate)	1.6
Enthalpy, kJ/kg	2,751.9

The steam turbine power plant is composed of the following components:

- Demister to remove any remaining moisture from the steam
- Condensing steam turbine, configured as a single flow axial unit

<u>Condenser system</u>

In the system, a direct contact type main condenser is foreseen, which condenses the exhaust steam from the turbine using the cooling water from the wet cooling tower.

Cooling water system

The cooling water system comprises of a tower, generator and oil coolers, hot-well and water pumps. The hot-well pumps transfer the condensate to the cooling tower, where the water is cooled and returned to the condenser to begin the cycle again.

Gas removal system

Non-Condensable Gases (NCG) are extracted from the main condenser through a hybrid system composed of ejectors and liquid ring vacuum pumps. An inter-condenser is foreseen between the ejectors and liquid ring vacuum pumps to cool down the NCGs and remove water from the motive fluid and at the condenser outlet. A portion of the main steam is diverted to the ejectors. Non-Condensable Gases (NCG) after the separator are directed to the cooling tower fan stacks where they are mixed and distributed to the atmosphere.

2.3.2 Binary plant

A binary plant uses a secondary working fluid operating in a closed cycle to generate electricity. In this case, the common binary plant that is Organic Rankine Cycle (ORC) was preferred (Figure 12). The assumed conditions at the power plant inlet are the same as the steam turbine as presented in Table 5. The ORC is composed of primary heat exchangers, turbines, feed pumps, condenser, recuperator (if any), knock-out drums and cooling water system.

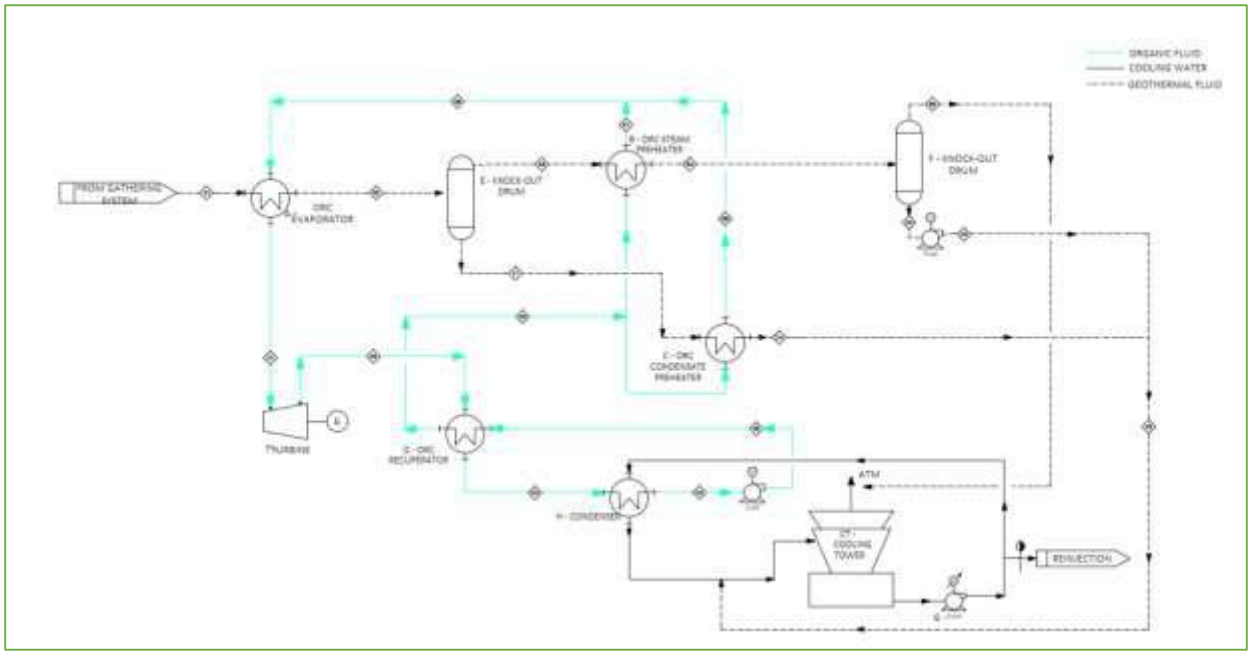


Figure 12: The systematic representation of binary plant (Source: Karsan Ramji and Sons Limited, 2024)

Organic Rankine Cycle (ORC)

The primary heat exchangers are designed in a shell and tube configuration, with the geothermal steam flowing in the tubes allowing easier cleaning. The system features an evaporator and pre-heaters fed by geothermal steam, vapor component of the geothermal fluid and corresponding liquid stream (condensate) respectively.

Downstream the evaporator, a knock-out drum, integrated into the heat exchangers or as an independent piece of equipment, separates the steam and the condensate feeding the pre-heaters.

Another knock-out drum separates the condensate and NCG + steam stream at the ORC outlet. The former will be mixed with the condensate exiting the pre-heater coming from the first knock-out drum before the make-up and reinjection line, while the latter is mixed and distributed to the atmosphere with the volume of air driven by the tower fans. An internal heat exchanger, the recuperator or regenerator, transfers heat from the turbine outlet low-pressure organic vapor to the organic liquid from the pump. A condenser, configured as a shell and tube heat exchanger with cooling water flowing in the tubes, condenses the low-pressure organic vapor from the recuperator into a liquid flow feeding the pump.

Cooling water system

The cooling water system comprises of a tower, generator and oil coolers, and water pumps. It cools the water from the condenser through evaporation. In the process, part of the water evaporates; thus, a make-up of condensate from the knock-out drums will grant the water balance in addition to the reinjection.

2.4 Land ownership

The proposed project lies within Menengai Geothermal Field which is under the management of GDC. The proponent, KRSL, has a geothermal steam supply agreement with GDC for usage of the area for installation and operation of 4 MW captive power generation unit at Main Well 18A (Annexure 5).

2.5 Project budget

The project budget is estimated to a total of Kenyan Shilling One Billion, Two Hundred Million Only (KES 1,200,000,000) (Annexure 6). The statutory charge of 0.1% payable to NEMA is therefore KES 1,200,000. The payment is done via the e-citizen platform after receipt of an invoice from NEMA.

3 BASELINE ENVIRONMENTAL AND SOCIAL CONDITIONS

The assessment of baseline environmental and social conditions of the project site was carried out using both primary and secondary data sources. This section details on the findings of the baseline monitoring which will form the basis for impact and mitigation measures monitoring and improvement of the geothermal power plant environmental and social performance during the entire project cycle.

3.1 Status of geothermal energy in Kenya

The geothermal energy capacity in Kenya is ~940 MW and expected to increase to ~2,587 MW by 2040 (EPRA, 2022) (Figure 13). In the first quarter of 2023, geothermal power output increased by 46%, reaching 1,506.33 GWh, playing a crucial role in compensating for a 47% decline in hydropower due to drought conditions. This performance underscores geothermal energy's reliability as a stable power source, vital for maintaining the national grid's integrity. Further, geothermal energy (29.9%) accounted for the highest interconnected electric capacity in Kenya in 2022. This was followed by hydropower (27.5%), fossil fuel (21.3%), wind (14.3%), solar (6.9%) and bioenergy (0.07%).

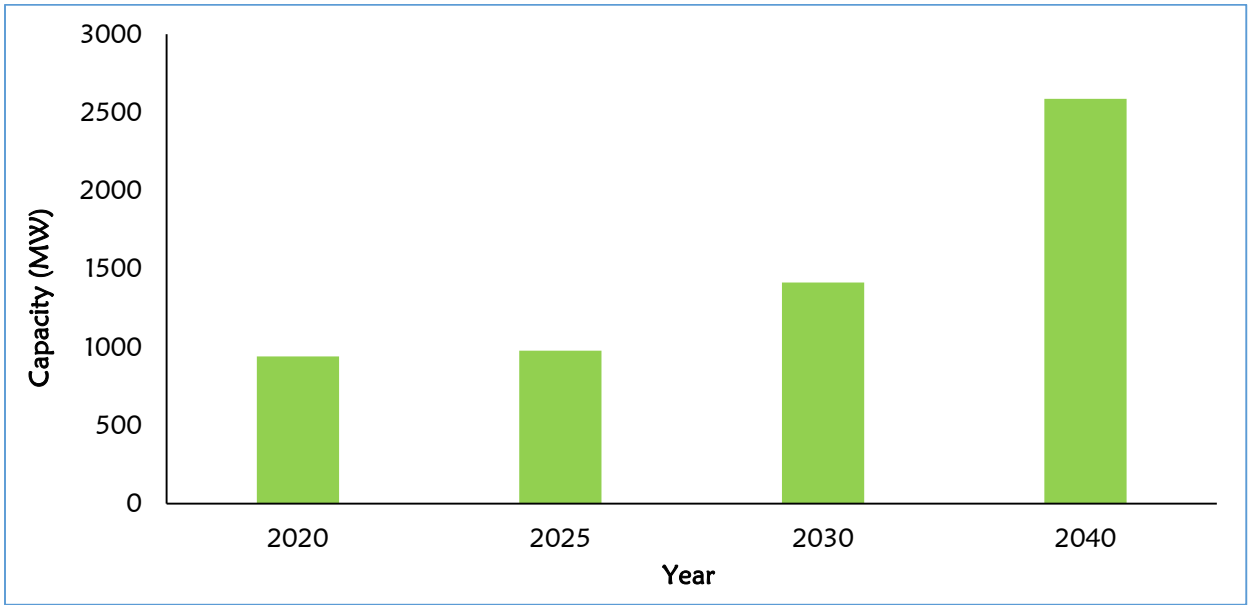


Figure 13: Geothermal energy projections in Kenya from 2020 to 2040 (Source: EPRA, 2022)

3.2 Bio-physical profile

3.2.1 Climate

The project area is classified into two main agro-climatic zones. The lowland areas of Mogotio and Kisanana in the north are located in semi-arid zone IV with an annual rainfall of 800 mm and mean temperatures of 30°C. Njoro, Bahati and parts of Kampi ya Moto divisions with an altitude of between 1800 m and 2400 m above sea level and average rainfall of between 760 mm and 1270 mm per year fall within a dry sub-humid equatorial climatic zone. Around Nakuru area, mean annual rainfall is approximately 900 mm. Rainfall is bimodal with the long and short rains occurring in March to July and September to November respectively. Temperatures vary with topography and range from 9.4 °C to 29.3 °C (Figure 14).

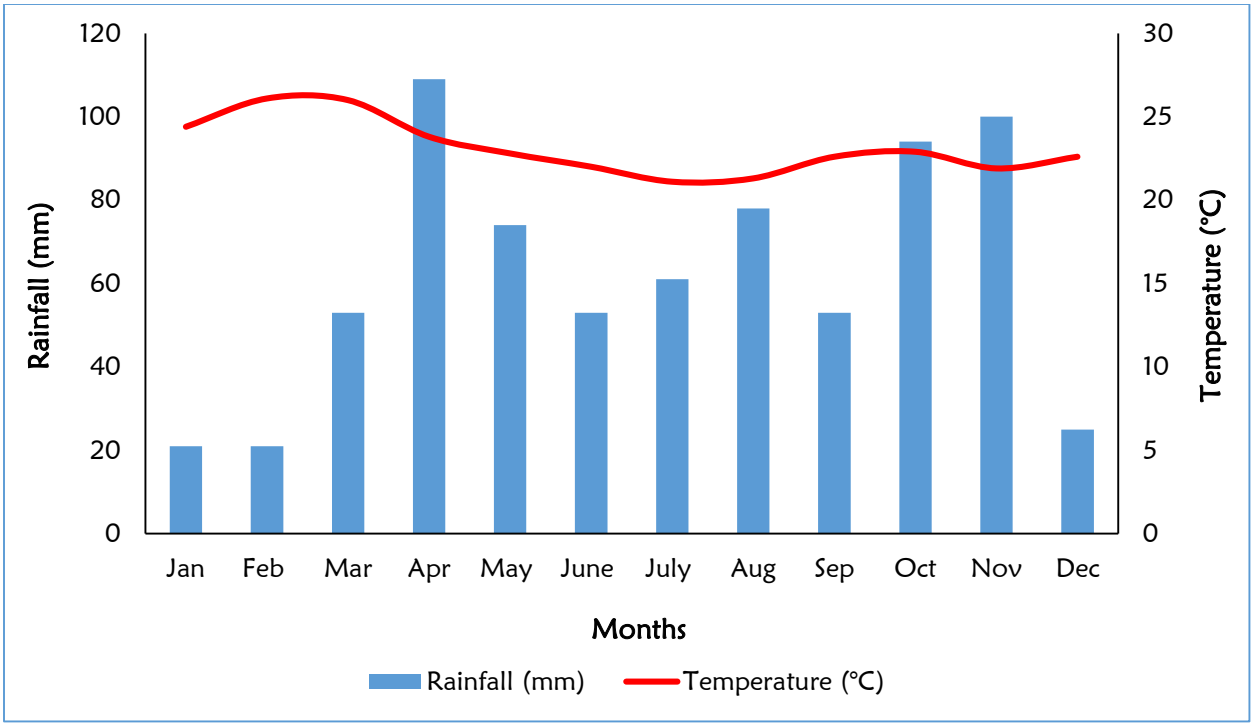


Figure 14: Average rainfall and temperature distribution for Nakuru County in 2023 (Source: World Weather Online, June 2024)

3.2.2 Topography

The project site lies within the Menengai Geothermal Field characterized by large and expansive caldera covering an area of approximately 88 km^2. The caldera features steep and rugged walls that rise to an elevation of 2,278 m above mean sea level from the crater floor. The floor of the caldera is uneven, dotted with numerous lava flows and domes, reflecting its volcanic origins and ongoing geothermal activity. This rugged terrain is interspersed with fissures and faults associated with the East African Rift System (EARS).

3.2.3 Geology and soils

Menengai Caldera is a massive shield volcano located within the East African Rift System (EARS) that extends for 3500 km from the southern end of the Red Sea through to the Indian Ocean off Mozambique and approximately 200-250 km wide. The Menengai Caldera is characterized by two trachytic main rock series by age. The older one is that of Pliocene which is characterized by two successive strata. The earlier one is of Pliocene and is characterized by phonolitictrachytes. These appear to have formed during volcanic processes before the formation of the caldera as depicted by their outcrops on its walls. Overlying the phonolitictrachytes is the successive stratum that comprises welded vitreous tuffs and ignimbrites. These extend briefly outwards from the ring structure, except markedly longer extensions towards south east and north-west, with bias towards northwest direction. This implies a major direction of flow during the volcanic episode.

The younger rock series is recent (Quaternary) and is characterized by trachyte flows. Glassy flows are common among the recent series. This series cover almost all the caldera floor and its occurrence depicts products of volcanic processes that accompanied or followed after the caldera-collapse. However, the caldera does not show any sign of volcanic activity presently and forms a

major resource for geothermal energy development. Two rift floor tectono-volcanic axes (TVA), Molo and Solai, are important in controlling the geothermal system at the caldera.

Upper Menengai lavas cover the floor of the caldera concealing the rocks of the older volcano composed of peralkaline and silica-oversaturated trachyte flows, and scoria cones (Macdonald et al., 2006). Fumaroles are also found randomly distributed in the caldera with its steam having low contents of carbon dioxide, hydrogen sulphide, hydrogen, methane and nitrogen. Gas geothermometry based on carbon dioxide and hydrogen sulphide indicates that the reservoir temperatures are greater than 250°C (Simiyu, 2008).

Soils are vitric Andosols developed on volcanic ash and are well drained, moderately to deep, dark to reddish brown, stony and saline having low to moderate fertility.

3.2.4 Hydrology

The Menengai area lies on the rift floor that gently slopes northwards. On the east, Bahati and Marmanet scarps bound the eastern inner rift trough and are relatively higher and wetter grounds. To the west, the rift floor slopes gently into a series of ridges connecting Mau-Londiani-Kilombe hills. The surface drainage system is therefore largely internal from the east and the western scarps. On the rift floor, the drainage is mainly from Menengai Caldera northwards with the exception of the drainage from the southern rim into Lake Nakuru. The permanent rivers in the area are Molo and Rongai in the North West area. The perennial rivers are the Crater and Olbanita streams in the eastern parts. The North-South, North East-South West, and North West-South West trending fault/fracture systems provide underground channels resulting to stream water disappearing underground at some areas interrupting the Olbanita stream at several places. Other surface water bodies include Lakes Nakuru and Solai, and the Olbanita swamp.

Lake Nakuru represents the intersection of a piezometric and topographic surface. The ground water around and northwest of Lake Nakuru is controlled by a sedimentary formation comprising of sediments and reworked pyroclastics. The boreholes to the north and northwest of the lake show water contamination indicating interconnection. The same sedimentary formations are found in the boreholes located in the east of Menengai caldera implying connectivity with the North-South running Solai tectonic axis. On the eastern rim, a cold spring occurs at the foot of the caldera, further confirming that the southern part of the Solai tectonic axis is an important control for groundwater movement. The Olbanita swamp is located in an area dominated by dry and thermally anomalous boreholes. The productive ones are characterized by very shallow, low-yield aquifers that get depleted fast since the deeper formations are impervious. These are perched water bodies adjacent to the swamp. The swamp owes its existence to impervious bedrocks that have been affected by hydrothermal alteration. The formations underlying the swamp are the ignimbrite beds that show marked hydrothermal alteration.

3.2.5 Baseline air quality

Air quality survey was conducted for short term exposure levels as the preferred time weighted averages in order to measure and quantify the air pollutant so as to determine the current existing conditions. The results of the gaseous concentrations and particulate parameters were thereafter correlated against the Environmental Management Coordination (Air Quality) Regulations, 2014 (Annexure 7). The findings of the monitoring indicated that all parameters were within the standards prescribed under the First Schedule of the Environmental Management and Coordination (Air Quality) Regulations, 2014 (Table 6).

Table 6: Average results for particulate matter and gaseous parameters (Source: Lahvens (K) Limited, 2024)

Monitoring Locations	$PM_{2.5}$ µg/m³	PM_{10} µg/m³	CO mg/m³	SO_2 ppm	NO_2 ppm	O_3 ppm	H_2S µg/m³
East Project Boundary 1 (EPB-1) N: -0° 12' 18.072" E: 36° 05' 43.152"	2.50	11.80	<0.001	0.0005	0.0011	0.0184	<0.01
West Project Boundary 2 (WPB-2) N: -0° 12' 16.4664" E: 36° 05' 41.640"	4.80	13.67	<0.001	0.0012	0.0018	0.0189	<0.001
North Project Boundary 3 (NPB-3)-GDC Well 18 N: -0° 12' 19.332" E: 36° 05' 41.28"	1.60	5.20	<0.001	0.0011	0.0012	0.0169	<0.01
Air Quality Regulations, 2014	**-**	**-**	**4**	**0.191**	**0.2**	**0.12**	**150**

3.2.6 Baseline noise levels measurements

Noise levels measurement was conducted at three selected locations within the project site. The survey locations were referenced as Project Boundary (PB)-1 to PB-3. The obtained acoustic results were thereafter correlated against the Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 to ascertain compliance. (Annexure 7) The highest and lowest diurnal noise emissions were recorded at the West Project Boundary 2 (49.30 dBA) and GDC-Well 18A (44.0 dBA) respectively while the average Leq at the project site averaged 46.3 dBA. The average noise levels across all the survey locations complied with the Environmental Management and Coordination (Noise and Excessive Vibrations Pollution) (Control) Regulations, 2009 (Table 7).

Table 7: Summary results of noise levels measurement (Source: Lahvens (K) Limited, 2024)

Measured Sound Pressure Level (Noise) (dBA)	Diurnal LAeq average results	Noise Regulations, 2009
East Project Boundary 1 (EPB-1) N: -0° 12' 18.072" E: 36° 05' 43.152"	45.60	*55*
West Project Boundary 2 (WPB-2) N: -0° 12' 16.4664" E: 36° 05' 41.640"	49.30	*55*
Geothermal Development Company (GDC)-Well 18A Site (GDCW18) N: -0° 12' 19.332" E: 36° 05' 41.28"	44.0	*55*
Average	**46.3**	***55***

3.3 Ecological profile

The vegetation in the Menengai Caldera includes a mix of indigenous and exotic plant species adapted to the local climate and soil conditions. Previous studies have documented a total of 81 plant species from five sites within the Caldera comprising of herbs (46%), shrubs (22%), grasses (17%) and trees (15%). Common plant species found at the project site include *Searsia lucida, Ficus glumosa Delile, Tarchonanthus camphoratus* and *Roman cassie* (Figure 15).

Further, previous studies have documented a total of six mammals (Cheetah, Slender mongoose, Tree hyrax, Hare, Kirk's dik-dik and Reed bucks) and seven birds (Guinea fowl, Doves, Eagles, Crows, Weaver birds, Hornbill and Horus swift) within the Caldera. Nevertheless, for the project site, the most dominant fauna are reptiles comprising of snakes and gecko lizards. Moreover, mammals, bird and wildlife species weren't sighted at the project site.

Figure 15: Existing vegetation cover at the project site (Source: Reconnaissance survey, June, 2024)

3.4 Social, cultural and economic profile

3.4.1 Population

The project area lies in Kabatini location within Kabatini ward in Nakuru-North Sub-County. Kabatini location where the project site lies has a population of approximately 5,957 people comprising of 2,887 males and 3,070 females. The sub location has 1,528 households with a population density of 1,001 persons per km^2 (Kenya National Bureau of Statistics, 2019).

3.4.2 Community structure

The project area is mainly inhabited by the Agikuyu community who are the natives. The pattern of human settlements is both linear and nucleated attributed to the presence and accessibility of various social amenities as well as a well-developed infrastructure network encompassing roads, water supply, and electricity. Moreover, these settlement patterns are significantly influenced by the agricultural potential of the region, with areas characterized by fertile soils attracting higher concentrations of population.

3.4.3 Land use

Land use in the area includes geothermal well production stations, vegetation, camp site and roads. The project lies within other existing geothermal power stations such as Sosian Menengai and Menengai II (Figure 16).

Figure 16: Menengai II Geothermal power station within the project area (Source: Reconnaissance survey, June 2024)

3.4.4 Sources of livelihoods

The major economic activities within the area include agriculture, livestock keeping, transport, tourism, formal and informal employment. To boost economic productivity and competitiveness, Nakuru is a member of Central Region Economic Block (CEREB) consisting of nine other Counties namely Embu, Kirinyaga, Kiambu, Meru, Muranga, Tharaka Nithi, Laikipia, Nyeri, and Nyandarua. Central Region Economic Block (CEREB) leverages economies of scale in the region in order to improve the livelihoods of people through joint implementation of projects and programme. Central Region Economic Block (CEREB) contributes the second largest share of the Country's economy at 23.8% of the total National Gross Domestic Product (Gross County Product Report, 2021).

3.5 Environmental profile

3.5.1 Transport infrastructure

The County had a total road network of 10,067 km out of which approximately 92.6% and 7.4% are unpaved and paved respectively. The project site is within Menengai Caldera and can be accessed via a murram road off Nakuru-Sigor road.

3.5.2 Water supply

The main water resources in Nakuru County comprise of rivers, shallow wells, springs, dams, pans and boreholes. The water resources in the area include Wanyororo spring, Crater stream (Kandutura) and boreholes. During the reconnaissance survey, no surface water resources (Streams, dams or water pans) were observed within or near the project site.

3.5.3 Waste management

The management of liquid waste in Nakuru County is very poor with approximately 3.4% sewerage coverage. The prevalent onsite services are poor and due to inefficient transport and treatment, approximately 65% of untreated wastes end up into the environment. It is estimated that only 15.3% of the households are connected to main sewer line and 76.9% of the households use pit latrines. During the survey, it was noted that there was no sewer line within the project area and GDC have designated reinjection wells for disposal of brine from the geothermal fluids during the operational phase.

4 ENVIRONMENTAL AND SOCIAL IMPACTS AND MITIGATION MEASURES

The project will have both positive and negative impacts at all stages of implementation.

4.1 Project benefits

The proposed geothermal power plant will have significant benefits to the proponent and both the national and county government. There will be both direct and indirect benefits which include;

1. Reducing the cost of production and enhancing profitability of the company

The cement industry in Kenya consumes ~4 Gigajoule/tonne of cement with ~110 kWh of electrical energy needed. The cost of electricity from conventional sources such as fossil fuels, hydropower among others is ~KES 15.90 per kWh, resulting to a cost of ~KES 1,749 per tonne of cement. In contrast, geothermal energy provides electricity at a lower rate, ~KES 6.63 per kWh, which translates to an electricity cost of ~KES 729 per tonne. This difference of KES 1,020 per tonne will result in substantial savings since energy accounts for approximately 30-40% of total production costs in the cement industry. Additionally, geothermal energy offers a stable and reliable source of power improving the company's profitability and market competitiveness.

2. Providing a market for goods and services

The proposed project will create market for goods and services during installation and operational phase. The project will source raw materials including power and drying plants, cooling towers, building blocks, cement, steel, among others costing approximately KES 1,000,000,000. Additionally, the project will require services such as EIA, plumbing, electrical fittings/repairs, security among others.

3. Reducing GHGs emissions thus lowering the proponent's carbon footprint

Geothermal energy has significant potential to reduce GHG emissions in cement production compared to conventional power sources which contribute ~8% of the world's carbon footprint. Each tonne of cement produced using fossil fuels results in ~0.8 tonnes of CO_2 emissions. By utilizing geothermal energy, the proponent will reduce GHGs emissions, approximately 2,700tCO_2/MW annually, thereby lowering the carbon footprint. Furthermore, implementing geothermal energy in cement manufacturing aligns with the Kenya Energy Transition & Investment Plan (ETIP), 2023-2050, which aims to achieve Net Zero carbon emissions.

4. Potential scaling up the use of geothermal energy and creating awareness for its benefits among other industry players

The project will demonstrate the viability of using geothermal energy for cement production, which can be replicated by other manufacturers in Kenya and beyond. By successfully implementing a 4 MW power plant and a drying unit using geothermal steam, the proponent will set an example of how geothermal energy can be effectively integrated into cement manufacturing processes. By demonstrating the potential to lower energy costs and increase competitiveness through geothermal energy, the project will raise awareness among other industry players about the benefits of adopting this renewable source.

5. Employment creation

The project will offer a wide spectrum of employment opportunities throughout the project cycle, for both skilled and unskilled workers. The workforce will include contractors, masons, carpenters, welders, painters, plumbers, engineers and electricians among others.

6. **Revenue generation to GDC and the Kenya government**
The Kenya government will earn revenue in terms of taxes generated during the acquisition of licenses and products consumed during installation phase i.e. the proponent will be required to pay a 0.1% statutory fee of the project cost to NEMA and construction material will be taxable 16% VAT. Additionally, GDC will earn revenue from early generation.

4.2 Negative environmental and social impacts

Although the proposed geothermal power plant will have positive impacts, there will be negative impacts at installation, operational and decommissioning phases. The significance of these impacts (environmental risk rating) is based on likelihood and consequence considered within the context of without and with mitigation measures. The latter assumes that the recommended mitigation measures and the Environmental Management Plan (EMP) are implemented and effective in mitigating the impacts (Guidance Note – IUCN Environmental & Social Management System Manual, 2020).

Likelihood represents the possibility that a given risk event is expected to occur. The likelihood is established using the following five ratings: Very unlikely to occur (1), Not expected to occur (2), Likely – could occur (3), Known to occur - almost certain (4) and Common occurrence (5).

Consequence refers to the extent to which a risk event might negatively affect environmental or social receptors (Table 8).

Table 8: Rating consequence of environmental and social risks

Consequence level	Description
Severe (5)	Adverse impacts on people and/or environment of very high magnitude, including very large scale and/or spatial extent, cumulative, long-term (permanent and irreversible); receptors are considered highly sensitive.
Major (4)	Adverse impacts on people and/or environment of high magnitude, including large scale and/or spatial extent of certain duration but still reversible if sufficient effort is provided for mitigation; receptors are considered sensitive.
Medium (3)	Adverse impacts of medium magnitude, limited in scale (small area and low number of people affected), temporary, impacts are relatively predictable and can be managed and/or mitigated.
Minor (2)	Adverse impacts of minor magnitude, very small scale and only short duration, may be easily avoided, managed, mitigated.
Negligible (1)	Negligible or no adverse impacts on communities, individuals, and/or on the environment.

Impact significance is established by combining likelihood and consequence of a risk event (Table 9). The significance rating signals how much attention the risk event will require during project development and implementation as well as mitigation measures to be put in place.

Table 9: Environmental and social impacts significance

		Likelihood of occurrence				
		Very unlikely to occur (1)	Not expected to occur (2)	Likely (3)	Known to occur (4)	Common occurrence (5)
Impact	Severe (5)	Moderate	High	Very high	Very high	Very high
	Major (4)	Low	Moderate	High	Very high	Very high
	Medium (3)	Low	Moderate	Moderate	High	Very high
	Minor (2)	Low	Low	Moderate	Moderate	High
	Negligible (1)	Very low	Low	Low	Low	Moderate

Table 10 below illustrates the risk impact significance for the proposed project.

Table 10: Risk and impact significance matrix for the geothermal power plant

Environmental impact	Magnitude of impact at installation phase		Magnitude of impact at operational phase		Magnitude of impact at decommissioning phase	
	WOM	WIM	WOM	WIM	WOM	WIM
Loss of vegetation cover						
Impacts of obtaining raw materials from the environment						
Air pollution						
Noise pollution						
Brine management						
Decline in well productivity						
Health and safety risks						
Fire hazards and emergencies						
Harmful radiation exposure						
Water use and effluent management						
Solid waste management						
Storm water management						
Oil spills						
Economic decline						

***WOM**; Without Mitigation, **WIM**; With Mitigation

Legend

Impact magnitude	Colour
Negligible	
Low	
Moderate	
High	

4.3 Installation phase impacts

4.3.1 Loss of vegetation cover

Site preparation will involve vegetation clearance and civil works. The proposed site is endowed with a number of tree species including *Searsia lucida*, *Ficus glumosa Delile*, *Tarchonanthus camphoratus* and *Roman cassie*. These trees will have to be felled to pave way for the installation activities. Vegetation cover plays an important role in preventing soil erosion, carbon sequestration and habitat for other organisms among others. Therefore, clearance of the vegetation would lead to the loss of these benefits. The project designs have incorporated use of overhead pipelines (Figure 17) to minimize vegetation clearance at the project area.

Figure 17: One of the GDC's overhead pipeline within the project area (Source: Reconnaissance survey, June 2024)

Recommended mitigation measure

1. Landscaping after completion of the project

4.3.2 Impacts of obtaining raw materials from the environment

The installation of power and drying plants, cooling towers as well as laying of steam pipes will require raw materials mainly steel, sand, ballast and cement among others. Extraction of such materials requires mining and industrial process which alter the natural landscape and contribute to pollution leading to environmental degradation and social impacts at the point of origin.

Recommended mitigation measures

1. Source raw materials from sites and industrial establishments that are licensed as per the Environmental Management and Coordination Act Cap. 387 of the Laws of Kenya
2. Procure quantities of construction materials in line with the Bill of Quantities prepared by a Licensed Quantity Surveyor
3. Re-use construction materials such steel cuttings which can be recovered

4.3.3 Health and safety risks

Machinery operations, use of construction tools and the actual installation activities are likely to expose the workforce, neighbors and visitors to health and safety risks such as accidental falls, air and noise pollution which could lead to injuries, impairment and death.

Furthermore, poorly disposed wastes may act as breeding sites for disease causing vectors leading to outbreaks of waterborne illnesses such as cholera, typhoid, and malaria. Moreover, the influx of construction workers may put pressure on existing local resources, cause social conflicts, promiscuity and sexually transmitted diseases.

Recommended mitigation measures

1. Ensure civil and structural designs of the geothermal power plant are prepared by a registered engineer and approved by the County and National Construction Authority (NCA)

2. Installation works should only be carried out by a contractor who is registered with the NCA at the appropriate class and supervised by a registered engineer/architect
3. Enforcing adherence to safety procedures and preparing contingency plan for accident and incident responses
4. Registration of the site as a workplace with the Directorate of Occupational Safety and Health Services (DOSHS)
5. Procure and provide adequate and appropriate Personnel Protective Equipment (PPE) to workers and visitors to the site and enforce their use
6. Erect safety signage and boards at all construction zones
7. Provide workers with correct tools for jobs assigned and train on their use
8. The contractor should obtain insurance cover for the workers and visitors
9. New employees and visitors should always be inducted on safety at the workplace
10. Sensitize workers, neighbors and other stakeholders on risks associated with installation works for enhanced self-responsibility on personal safety
11. Ensure moving parts of machines and sharp surfaces are securely protected with guards to avoid unnecessary contacts and injuries
12. Provide a fully equipped first aid kit and trained personnel at the project site
13. Comply with provisions of the Occupational Safety and Health Act (OSHA), 2007
14. Comply with guidelines provided under the National Construction Authority Act, 2014

4.3.4 Harmful radiation exposure

Excavation and rock blasting may expose the workers to radioactive elements such as radon, uranium, and thorium. While the levels of radioactivity are typically low, prolonged exposure can pose health risks to workers.

Recommended mitigation measures

1. Implement strict radiation safety protocols and monitoring systems, adhering to the Radiation Protection Act Cap. 243 of 2012 and Energy Act, 2019
2. Prepare and implement a comprehensive Radiation Management and Monitoring Plan

4.3.5 Air pollution

During the installation process, various activities such as offloading of construction materials and civil works will result to generation of particulate matter. Additionally, fugitive dust from unpaved access roads and emissions from equipment, machinery, and Heavy Commercial Vehicles (HCVs) transporting materials to the site will contribute to air pollution. This may lead to air quality degradation which poses health risks such as respiratory diseases and visual disturbances for workers, neighbors and visitors to the project site if it exceeds 100 $\mu g/Nm^3$ as per the First Schedule of the Environmental Management and Coordination (Air Quality) Regulations, 2014.

Recommended mitigation measures

1. Install appropriate and adequate dust screens around the project site
2. Watering the unpaved access roads to minimize fugitive dust emissions
3. Cover stockpiles of construction materials (aggregates, sand and fill material) to reduce dust emissions especially during windy conditions
4. Procure, provide and enforce the use of dust masks to workers and visitors to the project site
5. Use serviceable machinery/equipment and trucks
6. Comply with provisions of the Environmental Management and Coordination (Air Quality) Regulations, 2014

4.3.6 Noise pollution

Noise pollution will emanate from installation of power and drying plants, cooling towers, laying of steam pipes, machinery and equipment operations, and heavy trucks accessing the site. The exposure to noise levels exceeding 60dB, as specified in the Second Schedule of the Environmental and Management Co-ordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009, poses a risk of hearing impairments and disturbances to workers, neighbors and visitors to the site.

Recommended mitigation measures

1. Provide adequate PPE such as ear muffs to workers and visitors to the site and enforce their use
2. Delivery of raw materials, installation and fabrication works should be limited to day time hours only between 8am to 5pm
3. Comply with the provisions of the Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009

4.3.7 Solid waste management

The installation activities and civil works will generate solid waste such as biomass, overburden, metal and steel cuttings, plastics, wrappings, oil and fuel containers and tyres among others. Workers at the site will also generate domestic waste such as food leftovers. Poor disposal of solid wastes has negative environmental impacts and can create breeding grounds for disease carrying vectors like mosquitoes and flies, posing potential health risks to workers. Hence the proponent should implement measures to ensure proper management of solid wastes.

Recommended mitigation measures

1. Use of overburden in backfilling and landscaping post installation activities
2. Procure appropriate infrastructure for solid waste management including receptacles with segregation capacity
3. Designate a central waste collection area for construction debris and commercial wastes
4. Sensitize construction workers on the process of solid waste collection, segregation and proper disposal.
5. Contract a NEMA licensed waste handler to dispose-off the solid wastes
6. Comply with provisions of the Environmental Management and Coordination (Waste Management) Regulations, 2006 and Sustainable Solid Waste Management Act, 2022

4.3.8 Water use and effluent management

Water will be required for drinking, concrete mixing, curing, dust management and sanitation purposes and sourced from water bowsers. Based on the projected workforce of 100 people at installation, water demand will be at most 20m^3 per day. Out of these, 10% (2m^3) will be used for domestic purposes and will generate 1.4m^3 of effluent which will need to be disposed of. The rest of the water soaks into ground areas within the project site. Poor disposal of the effluent generated has the potential to pollute the environment.

Recommended mitigation measures

1. Sensitize the workforce on water conservation and management
2. Procure and deliver to the site mobile toilets from a NEMA licensed waste contractor
3. Comply with provisions of the Environmental Management and Coordination (Water Quality) Regulations, 2006

4.3.9 Storm water management

Storm water from the site is likely to affect the installation works especially during the rainy season. There will be increased surface runoff due to the impervious areas created during the installation of the power and drying plants as well as cooling towers. The impervious areas are more likely to have runoff coefficients as compared to natural areas and this leads to an increase in potential floods and collapse of civil works.

Recommended mitigation measures

1. Design a storm water management plan that minimizes impervious area runoff by use of recharge areas and detention and/or retention with graduated outlet control structures
2. Limit access road gradients to reduce run-off induced erosion
3. Provide adequate drainage systems to minimize and control run-off

4.3.10 Oil spills

Potential oil spills may occur during servicing and maintenance of vehicles and machinery. A release of petroleum products may lead to soil contamination hence degrading the environment.

Recommended mitigation measures

1. Develop and implement an oil spill containment plan for the site
2. Procure and train workers on the use of oil spill response kits
3. Avoid servicing of HCVs at the site

4.4 Operational phase impacts

4.4.1 Air pollution

Geothermal power production in high-temperature geothermal fields releases Non-Condensable Gases (NCG) such as carbon dioxide, hydrogen sulphide, ammonia, methane, hydrogen, nitrogen and argon which constitutes 5.9% by weight on average of the steam. Carbon dioxide and hydrogen sulphide are the dominant components in the NCG accounting for 98% and 1.59% by weight on average respectively. The most relevant pollutant considered is hydrogen sulphide because of its potentially significant increase during the operational phase. Hydrogen sulphide presents an unpleasant odour at relatively low concentrations and toxic if it's in excess of 150 g/m^3 as per the First Schedule of the Environmental Management and Coordination (Air Quality) Regulations, 2014. Other sources of air pollution will include water vapor plumes from the cooling towers and exhaust fumes from equipment, machinery and vehicles accessing the facility.

Recommended mitigation measures

1. Procure and provide adequate gas masks to workers and visitors to the plant and enforce their use
2. Install hydrogen sulphide abatement systems such as Stretford, LO-CAT or Sulferox processes
3. Develop and implement hydrogen sulphide monitoring plan to facilitate early detection and warning
4. Conduct quarterly air quality monitoring
5. Comply with the provisions of the Environmental Management and Coordination (Air Quality) Regulations, 2014

4.4.2 Noise pollution

The operations of the plant will lead to noise being produced from steam flushing and venting, turbines, generators, fans and water flow in cooling towers as well as movement of trucks in and

out of the facility. The noise levels produced may be above the stipulated maximum permissible noise levels as per the First Schedule of the Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 and may have auditory effects to the workers, visitors to the site and the neighbors.

Recommended mitigation measures

1. Procure and provide adequate earplugs to workers at peak noise producing areas
2. Regularly service machinery and equipment to ensure that they are in good condition
3. Sensitize truck drivers to avoid unnecessary hooting and running of vehicle engines
4. Comply with the provisions of the Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009

4.4.3 Decline in well productivity

Geothermal well productivity typically declines over time as the reservoir is exploited, with production rates dropping by 2-5% per year. This will significantly reduce the energy output and cost-effectiveness of the plant. As part of the design plan, the proponent will utilize alternative Well No. 35 for steam production in case of decline of productivity of Main Well 18A to unsustainable levels.

Recommended mitigation measures

1. Reinjection of brine into Main Well 18A to maintain pressure and enhance longevity of the geothermal resource
2. Conduct hydraulic stimulation to enhance permeability of geothermal reservoirs and increase productivity from Main Well 18A
3. Monitoring the amount of geothermal fluid extracted to optimize productivity and prevent depletion

4.4.4 Brine management

Brine is produced through extraction of high temperature and pressure fluids from underground geothermal reservoirs. The brine is rich in dissolved minerals, salts, and gases such as hydrogen sulfide and carbon dioxide. This hot fluid is brought to the surface through production wells, where its thermal energy is harnessed to generate electricity. After heat extraction, the cooled brine will need to be disposed off. Improper disposal of brine may lead to soil salinization, contamination of surface and groundwater, and emission of Non-Condensable Gases (NCGs) such as hydrogen sulfide and carbon dioxide.

Recommended mitigation measures

1. Rehabilitation of the existing evaporation ponds prior to brine disposal
2. Reinjection of brine into the geothermal reservoir (Well No. 34)

4.4.5 Health and safety risks

Potential health and safety risks associated with operations of the plant include musculoskeletal injuries from use of machinery and equipment, exposure to geothermal gases, fluids and heat, noise pollution, hydrothermal eruptions, well blowout, pipeline failures and fire outbreaks among others. A notable incident occurred in July 2019 at the Olkaria V Geothermal power plant under construction by KenGen where a burst steam pipe left 10 workers injured during commissioning of a newly installed unit. Other impacts include permanent disability or even death and hence the management should be committed to ensuring health and safety of workers and visitors to the facility.

Recommended mitigation measures

1. Registration of the site as a workplace with DOSHS
2. Obtain insurance cover for the workers as per Work Injury Benefits Act
3. Provide adequate and appropriate PPE to workers and enforce their use
4. Develop and implement an emergency response plan including measures for containment of geothermal fluid spills
5. Display signage warning of potential hazards at various sections of the plant
6. Access to the plant should be controlled to limit exposure to hazards
7. Procure and provide well-stocked first aid kits
8. Conduct first aid training among the workers
9. Provide a standby or easy to access ambulance service
10. Provide and keep an accident/incident register
11. Use of automated systems to minimize human exposure to geothermal gases and fluids
12. Monitoring of seismic activity and land stability to address any issues that may compromise the plant's structural integrity
13. Regular maintenance of wellheads and geothermal fluid pipelines including corrosion control and inspection, pressure monitoring and use of blowout prevention equipment such as shutoff valves
14. Reducing the time required for work in high heat areas and ensuring access to drinking water
15. Shielding surfaces where workers come in close contact with hot equipment including generating equipment, pipes etc.
16. Comply with the provisions of the Occupational Safety and Health Act (OSHA), 2007

4.4.6 Fire hazards and emergencies

Fire risks and emergencies at the plant may occur due to operational negligence, electrical faults and spillage/leakage of flammable and ignitable chemicals. Fire occurrence may lead to death, financial losses and loss of livelihoods for the workers and neighbors.

Recommended mitigation measures

1. Develop and implement a fire and emergency evacuation plan
2. Procure and provide adequate firefighting equipment and place them strategically within the plant
3. Ensure firefighting equipment are serviced quarterly by accredited fire service providers
4. Train employees on the use of fire-fighting equipment
5. Designate a fire assembly point and clearly display emergency exits
6. Display fire safety and warning signage at appropriate sections of the plant
7. Ensure proper handling and storage of flammable materials
8. Plant operations should be undertaken by authorized personnel only
9. Regular inspection and maintenance of electrical appliances
10. Conduct annual fire safety audit and fire drills
11. Comply with the provisions of the Occupational Safety and Health Act (OSHA), 2007

4.4.7 Solid waste management

Solid waste will include of paper, plastic, glass, organic wastes, scrap metal, plastics among others. Poor disposal of solid wastes has negative environmental impacts and can create breeding grounds for disease carrying vectors like mosquitoes and flies, posing potential health risks to workers. Hence the proponent should implement measures to ensure proper management of solid wastes.

Recommended mitigation measures

1. Procure and provide waste collection bins with capacity for segregation
2. Contract a NEMA licensed waste handler for disposal of the solid waste
3. Comply with the provisions of the Environmental Management and Coordination (Waste Management) Regulations, 2006 and Sustainable Solid Waste Management Act, 2022

4.4.8 Water use and sanitation

At the operation phase, water will be required for general cleaning, drinking, sanitation, cooling machinery and firefighting purposes and will be sourced from water bowsers. Water consumption rate will be based on number of workers at the plant. Approximately 70% of water used for sanitation will be released as wastewater and managed through septic tank and soak pit system. Poor wastewater management has the potential to pollute surface and ground water, harbor pathogens and vectors.

Recommended mitigation measures

1. Scheduled maintenance of water supply infrastructure to prevent losses through leakages
2. Monitor the quality of wastewater discharged from the facility in compliance with the Third Schedule of Environmental Management and Coordination (Water Quality) Regulations, 2006
3. Apply and ensure timely renewal of Effluent Discharge License (EDL) from NEMA
4. Comply with the provisions of the Environmental Management and Coordination (Water Quality) Regulations, 2006

4.4.9 Storm water management

During heavy rainfall, storm water is likely to affect the operations of the plant due to increased surface runoff from the impervious areas created at the installation phase. The impervious areas are more likely to have runoff coefficients as compared to natural areas and this might lead to an increase of flood peaks in such a developed area.

Recommended mitigation measures

1. Provide adequate drainage systems to minimize and control run-off
2. Harvest rainwater by use of gutters

4.5 Decommissioning phase impacts

A decommissioning phase is possible in the event of permanent decline (Unsustainable levels) in well productivity, closure of the plant by government agencies due to non-compliance with environmental regulations as well as natural calamities such as earthquakes, volcanic eruptions. The following environmental and social concerns will manifest at this phase;

1. Economic decline
2. Health and safety risks
3. Waste generation

To address these, the proponent will prepare and submit a due diligence decommissioning audit report to NEMA for approval at least three (3) months in advance.

4.5.1 Economic decline

In the event of decommissioning of the plant, economic benefits of the project including loss of a power plant, employment opportunities, local community empowerment and revenue generation to the government will be lost. This will lead to economic decline.

Recommended mitigation measures

1. Consider alternative well to tap steam for power generation
2. Train employees on alternative livelihoods prior to decommissioning
3. Prepare and issue recommendation letters to employees to seek alternative employment opportunities
4. Comply with labor laws by paying the employees their terminal dues

4.5.2 Health and safety risks

Health and safety risks during demolition are likely to emanate from accidental falls and cuts, injuries from demolition tools and machinery use. Additionally, noise and air pollution from demolition works could pose safety and health risks to workers, neighbors and visitors to the site.

Recommended mitigation measures

1. Erect signage to forewarn people on ongoing demolition activities
2. Provide and enforce the use of PPE throughout the demolition works
3. Avail first aid kits on site throughout the entire period
4. Ensure the process of demolition is supervised by competent personnel
5. Comply with the Occupational Safety and Health Act (OSHA), 2007

4.5.3 Waste management

Demolition works and dismantling of equipment and fixtures including power and drying plants, cooling towers, steam pipes, electrical installations among others will result in generation of significant quantities of solid waste. If not properly managed, the waste will pose health and safety risks as well as environmental pollution. Effluent will also need to be disposed off appropriately as it has potential to pollute the environment.

Recommended mitigation measures

1. Obtain demolition permits from the County Government of Nakuru
2. Recover re-usable materials such as power and drying plants, cooling towers as well as steam pipes for sale or use in other project sites
3. Contract a NEMA licensed handler to dispose off waste from the demolition activities
4. Comply with the provisions of the Environmental Management and Coordination (Waste Management) Regulations, 2006 and the Environmental Management and Coordination (Water Quality) Regulations, 2006

4.6 Public and stakeholder consultations and findings

4.6.1 Introduction

Public and stakeholders' participation in the ESIA study process is important and a legislative requirement under Regulation 17 of the Environmental Management and Co-ordination (Impact Assessment and Audit) Regulations, 2003. For the proposed project, public and stakeholders' consultations were undertaken as follows;

1. Courtesy meeting with the relevant government agencies
2. Community and stakeholder consultative meetings i.e. kick-off, meeting to review and validate draft ESIA Study Report (Table 11)
3. Administration of questionnaires to the local community and stakeholders

The objective of the public and stakeholder consultation was to obtain and document comments, views, and concerns that the local community and stakeholders have regarding the proposed project.

Table 11: Stakeholder engagement schedule

Date	Level of SHM	Nature of SHM	Venue	No. of participants
27th June 2024	Courtesy kick off meeting with relevant government agencies	Sensitization on the proposed geothermal power plant	At their respective offices	9
28th June 2024	Kick-off stakeholder meeting	Sensitization on proposed geothermal power plant	Maili Saba Police post-Kabatini	61
5th November 2024	Second Stakeholder meeting	Review of draft ESIA Study report for the proposed geothermal power plant	Dhanji Vocational Training Centre	23
15th November 2024	Third Stakeholder meeting	Review and validate draft final ESIA Study report for the proposed geothermal power plant	NG-CDF Social Hall	151
			Total	**244**

A total of 244 participants attended the three meetings comprising of stakeholders from Government agencies and the local community among others.

4.6.2 Stakeholders' consultative meetings

1. Courtesy meeting with the relevant government agencies

The consultant paid a courtesy meeting to relevant government agencies i.e. Deputy County Commissioner-Nakuru North Sub-County, Assistant County Commissioner-Kiamaina Division and Ecosystem Conservator-KFS, Nakuru County on 27th June 2024 to inform them on the proposed project activities (Annexure 8). All the stakeholders were optimistic that the project will boost economic development of the area.

2. Community and stakeholder engagement meetings

1. Kick-off stakeholder meetings

The consultant held a kick-off meeting on 28th June 2024 at Maili Saba Police Post in Kabatini Location and was attended by 61 participants drawn from Ministry of Interior and National Administration, Maili Saba community, GDC and the consultants (Figure 18).

The objective of the kick-off meeting was to sensitize stakeholders on the proposed project, document their views and opinions. During the meeting, GDC provided an overview of the project activities while the consultant made presentations on the ESIA study process including scope of the ESIA, the approach and methodology, the timeframe and the stakeholders' roles in the ESIA. Several key issues raised were discussed during the plenary session based on the presentations by the consultant and other matters arising from the project (Table 12 & Annexure 9).

Figure 18: Participants during the kick-off meeting at Maili Saba Police Post at Kabatini Location in Nakuru County (Source: First stakeholder engagement meeting, June 2024)

Table 12: Summary of issues raised during the first stakeholder meeting and response provided by the GDC and the consultant on 28th June 2024

Issue No.	Description	Response provided
1.	Prioritizing the local community for employment opportunities	- Recommendation will be forwarded to GDC and KRSL management for considerations
2.	Impacts from drilling of steam wells to the neighboring communities and mitigation measures in place	- The proposed project will not involve drilling of steam wells since they are in existence - Brine will be managed by re-injecting to the unproductive wells to minimize pollution
3.	Corporate Social Responsibility (CSR) by GDC and KRSL	- Recommendation will be forwarded to KSRL for considerations - GDC will continue to engage with the local community to implement ongoing CSR activities

2. Second stakeholder meeting to review and validate draft ESIA Study Report

The second meeting was held on 5th November 2024 at Dhanji Vocational Training Centre in Kagoto Area and was attended by 24 participants drawn from the local community, Ministry of Interior and National Administration, Office of Bahati Sub-County Member of Parliament, Members of County Assembly (Kabatini and Kiamaina), County Government of Nakuru, KFS, GDC, proponent and consultant (Figure 19).

The purpose of the meeting was to review the draft ESIA study report and summary of issues raised are provided in Table 13 & Annexure 10.

Figure 19: Participants following deliberations during the meeting to review the draft ESIA study report (Source: Second stakeholder engagement meeting, November 2024)

Table 13: Summary of issues raised during a second stakeholder meeting and response provided by the proponent and the consultant on 5th November 2024

Issue No.	Description	Response provided
1.	Number of employment opportunities available for local community	- The proposed project will create approximately 60 direct jobs for local residents. In addition, transportation services will be reserved exclusively for community members
2.	Size of land the project will utilize within the caldera	- The proposed project will occupy approximately 10-15 acres of land
3.	Establishment of a framework for implementation of Corporate Social Responsibility (CSR) activities by Karsan Ramji and Sons Limited	- Karsan Ramji and Sons Limited is open to suggestions and committed to carrying out CSR activities in partnership with local administration
4.	Route that will be used to access the proposed project site as well as noise pollution at the installation and operational phases of the proposed project	- The project will use the existing routes which is yet to be determined. In respect to noise pollution, delivery of raw materials will be conducted during day time only i.e. between 8 am and 5 pm, machinery and equipment will be serviced and maintained and noise monitoring will be undertaken to ensure compliance with the Environmental Management and Co-ordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009

Issue No.	Description	Response provided
5.	Source of pozzolana	- Pozzolana occurs naturally within the area and the locals can supply
6.	Presence of endangered tree species such as sandalwood (*Osyris lanceolata*) within menengai caldera	- There are no endangered tree species within the project site

3. Third stakeholder meeting to review and validate final draft ESIA Study Report

The third meeting was held on 15th November 2024 at NG-CDF Social Hall in Kiamaina area and was attended by 151 participants drawn from the local community, Ministry of Interior National Administration, Office of Bahati Sub-County Member of Parliament, Members of County Assembly (Kabatini, Kiamaina and Bahati Wards), County Government of Nakuru, KFS, proponent and the consultants (Figure 20).

The purpose of the meeting was to review and validate the final draft ESIA study report and summary of issues raised are provided in Table 14 & Annexure 11.

Figure 20: Participants following deliberations during the meeting to review and validate the draft final ESIA study report (Source: Third stakeholder engagement meeting, November 2024)

Table 14: Summary of issues raised during a third stakeholder meeting and response provided by the proponent and the consultant on 15th November 2024

Issue No.	Description	Response provided
1.	Establishment of a framework for implementation of Corporate	- The comment was well noted

Issue No.	Description	Response provided
	Social Responsibility (CSR) activities by Karsan Ramji and Sons Limited	
2.	Transportation services should be reserved exclusively for community members and not handled by Karsan Ramji and Sons Limited	- The comment was well noted
3.	Criteria that will be used to ensure employment opportunities will be equally distributed across all wards	- Karsan Ramji and Sons Limited will work closely with the office of the Member of Parliament and local administration to ensure opportunities are equitably distributed among all communities in Bahati Sub-county - In addition, minority groups will be given priority, and that all positions suitable for locals will be reserved for them
4.	Compensation of employees in the event of workplace injuries or accidents	- The company will adhere to the provisions of the Work Injury Benefits Act (WIBA), ensuring that employees injured during their duties would be compensated - In addition, an on-site medical facility at Karsan Ramji and Sons Limited Quarry in Kagoto area will provide emergency medical services to employees in case of injury
5.	Timeline for the implementation of CSR projects and whether sports initiatives for the youth will be included	- Karsan Ramji and Sons Limited will coordinate with the Member of Parliament office and the local administration to address the needs of the community. - The local community members should propose sports initiatives, which the company will support in collaboration with the Member of Parliament office
6.	Wastewater disposal and whether the power generation process will use any chemicals	- Wastewater will be managed through a treatment plant and that the power production process will not use any chemicals
7.	Noise pollution at installation and operational phases of the project	- The wellhead that will be installed is equipped with a muffler system to mitigate noise pollution. The only source of noise pollution will be from vehicular movement during delivery of raw materials. To mitigate noise pollution from vehicular movement, the delivery of raw materials will be conducted during day time only i.e. between 8 am and 5 pm
8.	Air pollution at installation and operational phases of the project	- The project is designed to utilize 100% of the steam for power production, meaning no steam will be released into the atmosphere

4.6.3 Summary of comments obtained during questionnaires administration

Questionnaires were administered to the local community as a supplementary method of stakeholder engagement to enrich the ESIA process besides the meetings (Annexure 12). A total of 17 questionnaires were administered where 41% were male and 59% females (Table 15 & Figure 21). In terms of period of residency within the area, 35% and 65% of the respondents had resided for >5years and <5years respectively (Figure 21). Furthermore, 65% of the respondents supported implementation of the project citing positive impacts as creation of employment opportunities as well as enhancing infrastructure within the area. Nevertheless, 35% of the respondents objected the project because of environmental pollution.

Air and noise pollution (76%) were the dominant environmental concerns raised by the respondents. Other issues include health and safety risks (8%), occurrences of landslides (8%) and earthquakes (8%) (Figure 22).

Table 15: Summary of comments obtained from the local community

No.	Name	Tel Contact	ID No.	Comments
1.	Stephen Mwangi Muriithi	0718205971	28588809	• No environmental and social concerns • Creation of employment opportunities
2.	Lucas Kihoro Mwangi	0724111241	0729422	• No environmental and social concerns
3.	Ann Wakonyo	0720773203	0471613	• No environmental and social concerns
4.	Thuo Kimathi	0729955138	-	• Conduct tree planting activities as part of CSR • Dust emissions
5.	Susan Ng'ang'a	0725228644/ 0790740680	-	• Creation of employment opportunities • Provision of affordable cement • Health and safety risks
6.	Ruth Wanjiku	0113124759	37812387	• Creation of employment opportunities • Air pollution from hydrogen sulphide odour
7.	Mary Njeri	0719692416	82880128	• Creation of employment opportunities • Generation of revenue to the government
8.	Hannah Njeri	0718466675	4265829	• Promotion of business • Creation of employment opportunities • Provision of affordable cement • Air pollution
9.	Moses Ng'ang'a	0720251075	-	• Creation of employment opportunities
10.	Stephen Mworia	0740442962	42366700	• Development of the area • Air pollution leading to respiratory diseases
11.	Veronica Njoki	0794398419	38131569	• Creation of employment opportunities
12.	Lewis Waweru	0712299604	39479837	• Noise pollution • Air pollution from hydrogen sulphide odour
13.	Irine Mwangi	0716435822	22945743	• Smoke emissions
14.	-	0792832959	-	• Air pollution from hydrogen sulphide which has a distinctive rotten egg smell • Increased frequency of earthquakes
15.	Jecinta Wambui	0702511955	35560700	• Creation of employment opportunities • Development of the area/urbanization • Generation of revenue to the government • Air pollution • Landslides
16.	Rahab Wanjiku	0715928184	22390821	• Creation of employment opportunities
17.	-	0795726024	20938797	• Creation of employment opportunities • Provision of affordable cement • Noise pollution • Air pollution from hydrogen sulphide odour

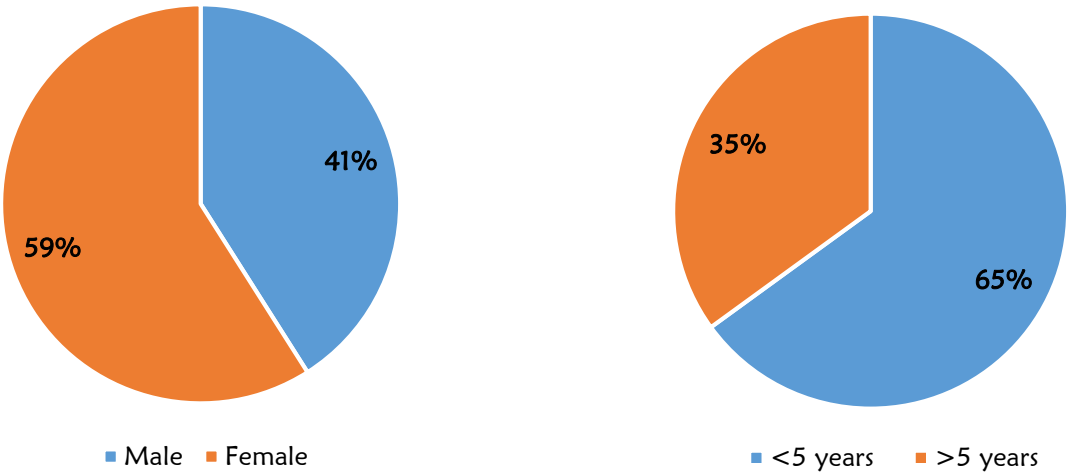


Figure 21: Categories of respondents (Left) and period of residency within the area (Right) (Source: Public consultations, July 2024)

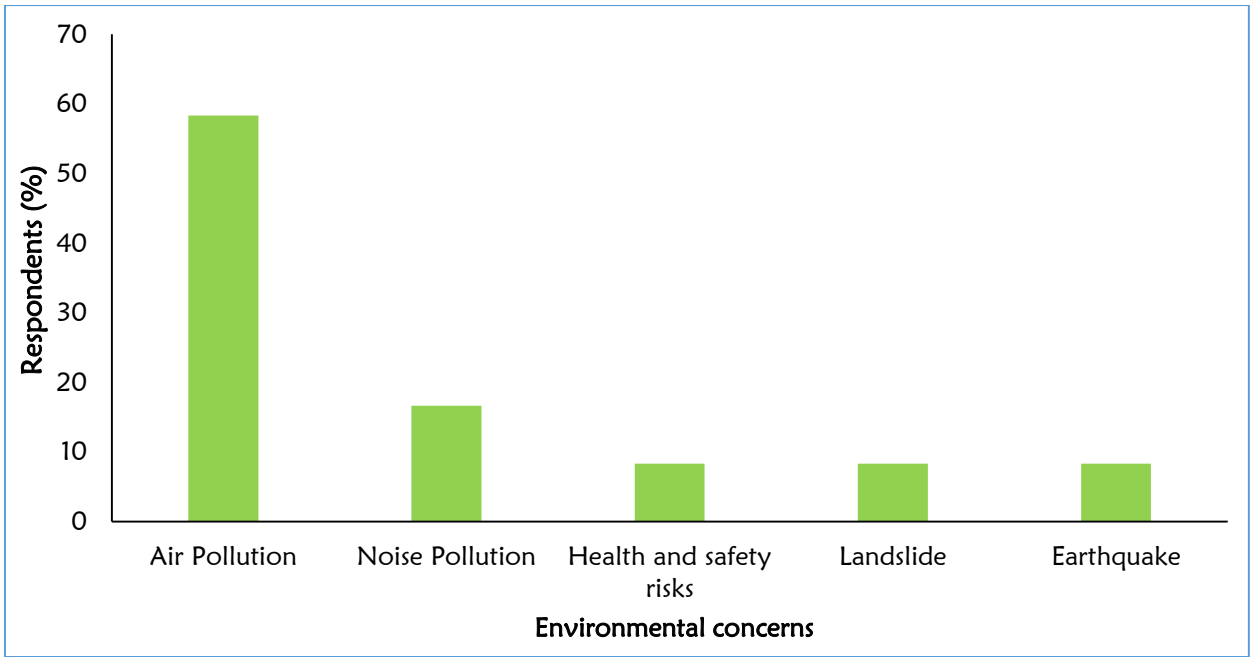


Figure 22: Environmental concerns identified by the respondents (Source: Public consultations, 2024)

5 ANALYSIS OF PROJECT ALTERNATIVES

Identifying and assessing alternatives to the proposed project is key since it allows the proponent to evaluate possible options that could mitigate the identified environmental and social concerns during the ESIA process. The pre-installation design alternatives will also assist NEMA and relevant lead agencies in decision making process.

5.1 The 'No' project alternative

The 'No' Project option in respect to the proposed project implies that the status quo is maintained. From an extreme environmental perspective, this option is the most suitable alternative as it ensures non-interference with the prevailing conditions. The 'No Project Option' is the least preferred from the environmental and partly socio-economic perspective due to increased carbon emissions from cement production and loss of job opportunities. Therefore, the 'No project' alternative is not considered viable in the light of the benefits and deprivations of the project.

5.2 The 'Yes Project' alternative

Under the 'Yes Project alternative' it's considered as the most viable option and the proposed project would be issued with an EIA License. In issuing the license, NEMA would approve the proponent's proposed project provided all environmental measures and conditions of the license are complied with during the installation and operational phases. This alternative consists of the applicant's final proposal with incorporation of NEMA regulations and procedures as stipulated in the environmental impacts to the maximum extent practicable.

5.3 Alternative geothermal field

The proponent did not consider any alternative geothermal field outside Menengai for power generation since Main Well 18A is considered productive for direct use purposes and the existing potential of 1,600 MW has not been fully harnessed. This implies that the cost of power generation at the site will be lower compared to an alternative geothermal field.

5.4 Alternative construction materials and technology

The proposed project will be constructed using modern, locally and internationally accepted standards of materials to achieve public health, safety, security and environmental aesthetic requirements. Equipment that saves energy and water should be given first priority without compromising on cost or availability factors.

To enhance use of road networks within Menengai caldera and reinjection of brine to Well No. 34 as well as minimize clearance of vegetation at the project area, the project designs have incorporated use of overhead pipeline installation to meet requirements for durability, safety and thermal performance.

Heavy use of timber during construction is discouraged because of destruction of forests. The exotic species would be preferred to indigenous species in the construction where need arises.

5.5 Alternative energy sources

Apart from geothermal, the proponent considered other energy sources including hydropower, thermal, coal, solar and wind. Geothermal energy source was considered the best option because of its availability (capacity factor) at over 95 %, reliability, sustainability and with no adverse effects on the environment. Further, the alternative energy sources were rejected for reasons summarized in Table 16. This alternative is therefore not viable.

Table 16: An analysis of alternative energy sources and reasons for rejection

No.	Energy source	Challenges and issues
1.	Hydropower	• Construction of new hydropower projects are capital intensive • Vulnerable to large variations in rainfall and climate change • Potential negative environmental and social impacts • Limited potential for scale-up
2.	Thermal sources (Diesel engines)	• High operation costs • Highly dependent on international oil price fluctuations • Potential negative environmental and social impacts
3.	Coal	• Potential negative environmental and social impacts • Limited potential for scale-up
4.	Wind	• Low availability factor (<35%); intermittent supply
5.	Solar	• Low availability factor (<35%); intermittent supply

6 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

In the preceding section, the ESIA has identified/predicted the potential environmental and social impacts that are likely to emanate from the proposed geothermal power plant and recommended mitigation measures. The Environmental and Social Management Plan (ESMP) provides a framework for implementing the mitigation measures during the three phases of the project cycle, i.e., installation, operational and possible decommissioning phases (Table 17). The EMP has five areas of focus as follows;

1. Environmental/social impact
2. Recommended mitigation measures
3. Implementation responsibility
4. Timeframe
5. Estimated cost (KES)

6.1 Environmental and Social Management Plan for installation phase

During the installation phase, the anticipated environmental concerns include loss of vegetation cover, impacts of obtaining raw materials from the environment, health and safety risks, harmful radiation exposure, air and noise pollution, water use and waste management.

6.2 Environmental and Social Management Plan for operational Phase

During the operation phase, the anticipated environmental and social concerns will include air and noise pollution, decline in well productivity, brine, waste and storm water management, health and safety risks as well as fire hazards and emergencies.

6.3 Environmental and Social Management Plan for possible decommissioning phase

A decommissioning phase is possible in the event of permanent decline (Unsustainable levels) in well productivity, closure of the plant by government agencies due to non-compliance with environmental regulations as well as natural calamities such as earthquakes, volcanic eruptions. The key issues of concern at this phase will be economic decline, health and safety risks and waste management.

Table 17: Environmental Management Plan for the proposed geothermal power plant

Environmental impacts	Recommended mitigation measures	Implementing agency	Timeframe	Estimated Cost (KES)
Installation phase				
Loss of vegetation cover	Landscaping after completion of the project	Proponent/ Contractor	Upon completion	Nil
Impacts of obtaining raw materials from the environment	Source raw materials from sites and industrial establishments that are licensed as per the EMCA Cap. 387 of the Laws of Kenya	Proponent/ Contractor	Throughout installation	In project costs
	Procure quantities of construction materials in line with the Bill of Quantities	Proponent/ Contractor	Throughout installation	In project costs
	Re-use construction materials such steel cuttings which can be recovered	Proponent/ Contractor	Throughout installation	Nil
Health and safety risks	Ensure civil and structural designs of the geothermal power plant are prepared by a registered engineer and approved by the County and NCA	Proponent/ Contractor	Prior to commencement	In project costs
	Installation works should only be carried out by a contractor who is registered with NCA	Proponent	Prior to commencement	In project costs
	Enforce adherence to safety procedures and prepare contingency plan for accident and incident responses	Proponent/ Contractor	Throughout installation	Nil
	Register the site as a workplace with the DOSHS	Proponent/ Contractor	Throughout installation	5,000
	Procure and provide adequate and appropriate PPE to workers and visitors to the site and enforce their use	Proponent/ Contractor	Throughout installation	500,000
	Erect safety signage and boards at all construction zones	Proponent/ Contractor	Throughout installation	In project costs
	Provide workers with correct tools for jobs assigned and train on their use	Proponent/ Contractor	Throughout installation	Nil
	Obtain insurance cover for the workers and visitors	Contractor	Prior to commencement	1,000,000
	New employees and visitors should always be inducted on safety at the workplace	Proponent/ Contractor	Upon Deployment	Nil

Environmental impacts	Recommended mitigation measures	Implementing agency	Timeframe	Estimated Cost (KES)
	Sensitize workers, neighbors and other stakeholders on risks associated with installation works for enhanced self-responsibility on personal safety	Proponent/ Contractor	Throughout installation	Nil
	Ensure moving parts of machines and sharp surfaces are securely protected with guards to avoid unnecessary contacts and injuries	Proponent/ Contractor	Throughout installation	Nil
	Provide a fully equipped first aid kit and trained personnel at the project site	Proponent/ Contractor	Throughout installation	20,000
	Comply with OSHA, 2007	Proponent/ Contractor	Throughout installation	Nil
	Comply with the NCA Act, 2014	Proponent/ Contractor	Throughout installation	Nil
Harmful radiation exposure	Implement strict radiation safety protocols and monitoring systems	Proponent	Throughout installation	Nil
	Prepare and implement a comprehensive Radiation Management and Monitoring Plan	Proponent	Throughout installation	Internal costs
Air pollution	Install appropriate and adequate dust screens around the project site	Proponent/ Contractor	Throughout installation	In project costs
	Watering the unpaved access roads to minimize fugitive dust emissions	Proponent/ Contractor	Daily	20,000
	Cover stockpiles of construction materials (aggregates, sand and fill material) to reduce dust emissions especially during windy conditions	Proponent/ Contractor	Throughout installation	Nil
	Procure, provide and enforce the use of dust masks to workers and visitors to the project site	Proponent/ Contractor	Throughout installation	100,000
	Use serviceable machinery/equipment and trucks	Proponent/ Contractor	Throughout installation	Nil
	Comply with the Air Quality Regulations, 2014	Proponent/ Contractor	Throughout installation	Nil
Noise pollution	Provide adequate PPE such as ear muffs to workers and visitors to the site and enforce their use	Proponent/ Contractor	Throughout installation	100,000

Environmental impacts	Recommended mitigation measures	Implementing agency	Timeframe	Estimated Cost (KES)
	Delivery of raw materials, installation, fabrication and construction works should be limited to day time hours only	Proponent/ Contractor	Throughout installation	Nil
	Comply with the Noise Regulations, 2009	Proponent/ Contractor	Throughout installation	Nil
Solid waste management	Use of overburden in backfilling and landscaping post installation activities	Proponent/ Contractor	Upon completion	Nil
	Procure appropriate infrastructure for solid waste management including receptacles with segregation capacity	Proponent/ Contractor	Prior to commencement	100,000
	Designate a central waste collection area for construction debris and commercial wastes	Proponent/ Contractor	Prior to commencement	100,000
	Sensitize construction workers on the process of solid waste collection, segregation and proper disposal	Proponent/ Contractor	Throughout installation	Nil
	Contract a NEMA licensed waste handler to dispose-off the solid wastes	Proponent/ Contractor	Prior to commencement	Tender
	Comply with Waste Management Regulations, 2006 and Sustainable Solid Waste Management Act, 2022	Proponent/ Contractor	Throughout installation	Nil
Water use and effluent management	Sensitize the workforce on water conservation and management	Proponent/ Contractor	Throughout installation	Nil
	Procure and deliver to the site mobile toilets from a NEMA licensed waste contractor	Proponent/ Contractor	Prior to commencement	Tender
	Comply with the Water Quality Regulations, 2006	Proponent/ Contractor	Throughout installation	Nil
Storm water management	Design an effective storm water management plan	Proponent/ Contractor	During installation	In project costs
	Limit access road gradients to reduce run-off induced erosion	Proponent/ Contractor	Throughout installation	Nil
	Provide adequate drainage systems to minimize and control run-off	Proponent/ Contractor	During installation	In project costs
Oil spills	Develop and implement an oil spill containment plan for the site	Proponent/ Contractor	Prior to commencement	30,000
	Procure and train workers on the use of oil spill response kits	Proponent/	During installation	30,000

Environmental impacts	Recommended mitigation measures	Implementing agency	Timeframe	Estimated Cost (KES)
		Contractor		
	Avoid servicing of HCVs at the site	Proponent/ Contractor	Throughout installation	Nil
Operational phase				
Air pollution	Procure and provide adequate gas masks to workers and visitors to the plant and enforce their use	Proponent	During operations	20,000
	Install hydrogen sulphide abatement systems such as Stretford, LO-CAT or Sulferox processes	Proponent/ GDC	Throughout operations	In project costs
	Develop and implement hydrogen sulphide monitoring plan to facilitate early detection and warning	Proponent/ GDC	Throughout operations	TBD
	Conduct air quality monitoring	Proponent/ GDC	Quarterly	50,000
	Comply with the Air Quality Regulations, 2014	Proponent	Throughout operations	Nil
Noise pollution	Procure and provide adequate earplugs to workers at peak noise producing areas	Proponent	Throughout operations	20,000
	Regularly service machinery and equipment to ensure that they are in good condition	Proponent	Throughout operations	Internal costs
	Sensitize truck drivers to avoid unnecessary hooting and running of vehicle engines	Proponent	Throughout operations	Nil
	Comply with the Noise Regulations, 2009	Proponent	Throughout operations	Nil
Decline in well productivity	Reinjection of brine into Main Well 18A to maintain pressure and enhance longevity of the geothermal resource	Proponent/ GDC	Throughout operations	Nil
	Conduct hydraulic stimulation to enhance permeability of geothermal reservoirs and increase productivity from Main Well 18A	Proponent/ GDC	Throughout operations	TBD
	Monitoring the amount of geothermal fluid extracted	Proponent/ GDC	Monthly	Nil
Brine management	Rehabilitation of the existing evaporation ponds prior to brine disposal	GDC	Six months	TBD

Environmental impacts	Recommended mitigation measures	Implementing agency	Timeframe	Estimated Cost (KES)
	Reinjection of brine into the geothermal reservoir (Well No. 34)	Proponent/ GDC	Throughout operations	Nil
Health and safety risks	Registration of the site as a workplace with DOSHS	Proponent	Annually	5,000
	Obtain insurance cover for the workers as per Work Injury Benefits Act	Proponent	Throughout operations	1,000,000
	Provide adequate and appropriate PPE to workers and enforce their use	Proponent	Throughout operations	100,000
	Develop and implement an emergency response plan	Proponent	Throughout operations	Internal costs
	Display signage warning of potential hazards at various sections of the plant	Proponent	Throughout operations	Internal costs
	Access to the plant should be controlled to limit exposure to hazards	Proponent	Throughout operations	Nil
	Procure and provide well-stocked first aid kits	Proponent	Throughout operations	25,000
	Conduct first aid training among the workers	Proponent	Throughout operations	Internal costs
	Provide a standby or easy to access ambulance service	Proponent	Throughout operations	Internal costs
	Provide and keep an accident/incident register	Proponent	Throughout operations	Nil
	Use of automated systems to minimize human exposure to geothermal gases and fluids	Proponent	Throughout operations	Nil
	Monitoring of seismic activity and land stability	Proponent	Bi-annually	Internal costs
	Regular maintenance of wellheads and geothermal fluid pipelines	Proponent	Throughout operations	Internal costs
	Reducing the time required for work in high heat areas and ensuring access to drinking water	Proponent	Throughout operations	Nil
	Shielding surfaces where workers come in close contact with hot equipment	Proponent	Throughout operations	Internal costs

Environmental impacts	Recommended mitigation measures	Implementing agency	Timeframe	Estimated Cost (KES)
	Comply with OSHA, 2007	Proponent	Throughout operations	Nil
Fire hazards and emergencies	Develop and implement a fire and emergency evacuation plan	Proponent	Throughout operations	Internal Costs
	Procure and provide adequate firefighting equipment and place them strategically within the plant	Proponent	Throughout operations	Internal Costs
	Ensure firefighting equipment are serviced by accredited fire service providers	Proponent	Quarterly	Tender
	Train employees on the use of fire-fighting equipment	Proponent	Annually	Internal Costs
	Designate a fire assembly point and clearly display emergency exits	Proponent	Throughout operations	Internal Costs
	Display fire safety and warning signage at appropriate sections of the plant	Proponent	Throughout operations	Internal Costs
	Ensure proper handling and storage of flammable materials	Proponent	Throughout operations	Nil
	Plant operations should be undertaken by authorized personnel only	Proponent	Throughout operations	Nil
	Regular inspection and maintenance of electrical appliances	Proponent	Monthly	Internal Costs
	Conduct annual fire safety audit and fire drills	Proponent	Annually	Tender
	Comply with OSHA, 2007	Proponent	Throughout operations	Nil
Solid waste management	Procure and provide waste collection bins with capacity for segregation	Proponent	Prior to operations	50,000
	Contract a NEMA licensed waste handler for disposal of the solid waste	Proponent	Prior to operations	Tender
	Comply with the Waste Management Regulations, 2006 and Sustainable Solid Waste Management Act, 2022	Proponent	Throughout operations	Nil
Water use and sanitation	Scheduled maintenance of water supply infrastructure	Proponent	Monthly	Internal Costs

Environmental impacts	Recommended mitigation measures	Implementing agency	Timeframe	Estimated Cost (KES)
	Monitor the quality of wastewater discharged from the facility	Proponent	Quarterly	TBD
	Apply and ensure timely renewal of EDL from NEMA	Proponent	Annually	Invoice from NEMA
	Comply with the Water Quality Regulations, 2006	Proponent	Throughout operations	Nil
Storm water management	Provide adequate drainage systems to minimize and control run-off	Proponent	During installation	In project costs
	Harvest rainwater by use of gutters	Proponent	During operation	Internal costs
Decommissioning phase				
Economic decline	Consider alternative well to tap steam for power generation	Proponent	Prior decommissioning	Nil
	Train employees on alternative livelihoods prior to decommissioning	Proponent/ Contractor	Prior decommissioning	Nil
	Prepare and issue recommendation letters to employees to seek alternative employment opportunities	Proponent/ Contractor	Prior decommissioning	Nil
	Comply with labor laws by paying the employees their terminal dues	Proponent/ Contractor	Throughout decommissioning	Nil
Health and safety risks	Erect signage to forewarn people on ongoing demolition activities	Proponent/ Contractor	Throughout decommissioning	30,000
	Provide and enforce the use of PPE throughout the demolition works	Proponent/ Contractor	Throughout decommissioning	100,000
	Avail first aid kits on site throughout the entire period	Proponent/ Contractor	Throughout decommissioning	15,000
	Ensure the process of demolition is supervised by competent personnel	Proponent/ Contractor	Prior decommissioning	Nil
	Comply with the OSHA 2007	Proponent/ Contractor	Throughout decommissioning	Nil
Waste management	Obtain demolition permits from the County Government of Nakuru	Proponent/ Contractor	Prior decommissioning	TBD
	Recover re-usable materials for sale or use in other project sites	Proponent/ Contractor	Throughout decommissioning	Nil

Environmental impacts	Recommended mitigation measures	Implementing agency	Timeframe	Estimated Cost (KES)
	Contract NEMA licensed waste handler to dispose demolition wastes	Proponent/ Contractor	Throughout decommissioning	Tender
	Comply with the Waste Management Regulations, 2006 and Water Quality Regulations, 2006	Proponent/ Contractor	Throughout decommissioning	Nil

7 ENVIRONMENTAL AND SOCIAL MONITORING PLANS

7.1 Introduction

Environmental and Social Monitoring Plans entails assessment of environmental performance of the proposed project by documenting, tracking and reporting any changes in environmental parameters in space and time. The objective of the monitoring plans is to enhance environmental performance of the project by providing data and information on compliance with legislative standards and determining levels of deviation from values obtained during baseline monitoring. This in turn informs the corrective measures if any that need to be implemented to comply with the legislative standards. Based on the baseline monitoring results, the ESIA Study proposes six Environmental and Social Management Plans. They are;

1. Air quality monitoring plan
2. Noise monitoring plan
3. Brine monitoring plan
4. Health and safety monitoring plan
5. Solid waste monitoring plan
6. Social monitoring plan (Grievances Redress Mechanism)

7.2 Air quality monitoring plan

7.2.1 Introduction

Air pollution will emanate at installation and operational phases of the proposed project. The purpose of the air quality monitoring plan is to ensure the concentrations of air emissions from the installation and subsequent operations are within the prescribed standards under the Environmental Management and Coordination (Air Quality) Regulations, 2014. In addition, the results will be used to evaluate if the adopted air pollution controls and management are effective.

7.2.2 Monitoring parameters

The parameters to be monitored and specified targets for geothermal power plants are listed under the Third Schedule of Air Quality Regulations, 2014 (Table 18). The proponent will also monitor fugitive emissions whose standard specified target values are stipulated in the First Schedule of the Air Quality Regulations, 2014 (Table 19).

7.2.3 Monitoring location

Air quality monitoring should be carried out within the project site and geothermal power plant at installation and operational phases respectively.

7.2.4 Monitoring frequency

Air quality monitoring should be done on a quarterly basis in collaboration with a NEMA designated laboratory.

Table 18: Ambient air quality tolerance limits for geothermal power plants as per the Third Schedule of the Environmental Management and Coordination (Air Quality) Regulations, 2014

Industry	Opacity	PM_{10}	SO_x	NO_x	CO	CO_2	Hydrocarbon	H_2S	Dioxins /Furans
Geothermal power plants	-	-	*	*	-	-	*	*	-

Table 19: Ambient air quality tolerance limits as per the First Schedule of the Environmental Management and Coordination (Air Quality) Regulations, 2014

Pollutant	Time weighted average	Industrial area
Sulphur oxides	Annual Average*	80 $\mu g/m^3$
	24 hours**	125 $\mu g/m^3$
Oxides of Nitrogen	Annual Average*	80 $\mu g/m^3$
	24 hours	150 $\mu g/m^3$
Nitrogen Dioxide	Annual Average	150 $\mu g/m^3$
	24 hours	100 $\mu g/m^3$
Suspended Particulate Matter	Annual Average	360 $\mu g/m^3$
	24 hours	500 $\mu g/m^3$
Respirable particulate matter (< 10μm)	Annual Average*	70 $\mu g/m^3$
	24 Hours**	150 $\mu g/Nm^3$
$PM_{2.5}$	Annual Average	35 $\mu g/m^3$
	24 Hours	75 $\mu g/m^3$
Lead	Annual Average*	1.0 $\mu g/Nm^3$
	24 hours**	1.5 $\mu g/m^3$
Carbon monoxide/ Carbon dioxide	8 hours	5.0 mg/m^3
	One hour	10 mg/m^3
Hydrogen Sulphide	24 hours**	150 $\mu g/m^3$
Non methane hydrocarbons	Instant Peak	700ppb
Total Volatile Organic Compounds	24 Hours**	600 $\mu g/m^3$
Ozone	One hour	200 $\mu g/m^3$
	8 hour (Instant Peak)	120 $\mu g/m^3$

7.3 Noise level monitoring plan

7.3.1 Introduction

Potential sources of noise pollution will emanate during installation activities, machinery use during power production and vehicular movement in and out of the facility. Noise may cause nuisance to the neighbours, visitors and workmanship at the site. The purpose of noise monitoring plan is to therefore ascertain the extent of the impact due to the installation and subsequent operation of the geothermal power plant in compliance with the Environmental Management and Coordination (Noise and Excessive Vibrations Pollution) (Control) Regulations, 2009. Noise levels will be measured in dB (A) as stipulated in the Noise Exposure Standards (Schedules) as shown in Tables 20 – 23.

Table 20: Maximum permissible levels for construction sites as stipulated under the Second Schedule of Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009

Zone		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

Table 21: The Maximum permissible intrusive noise levels as stipulated under the First Schedule of Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009

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

Day: 6.01 a.m. – 8.00 p.m. (Leq, 14 h) Night: 8.01 p.m. – 6.00 a.m. (Leq, 10h)

Table 22: The guidelines for International Ambient Noise Levels (World Bank and World Health Organization Noise Permissible Levels)

Receptor	Maximum allowable Leq (hourly) in dB(A)			
	World Bank		World Health Organization	
	Day time 0700-2200 Hrs	Night time 2200-0700 Hrs	Day time 0700-2200 Hrs	Night time 2200-0700 Hrs
Residential, Institutional and Educational	55	45	50	45
Industrial and Commercial	70	70	85	85

Table 23: The Occupational Health and Safety Exposure Limits for Noise Emissions

Sound Level dB(A)	Maximum Permitted Duration (hours/day)
80	16
85	8
90	2
100	1
105	0.5
110	0.25
115	1/8
>115	0
Hearing Protectors (Ear Mufflers)	
Sound Level dB(A)	Maximum Class of Hearing Protectors
85-95	C
96-105	B
106 and over	A

7.3.2 Monitoring location

Noise monitoring should be carried out within the project site and geothermal power plant at installation and operational phases respectively.

7.3.3 Monitoring frequency

Noise monitoring should be done on a quarterly basis in collaboration with a NEMA designated laboratory. Noise levels will be measured in dB (A).

7.4 Brine monitoring plan

7.4.1 Introduction

Geothermal power plants generate significant amounts of brine, a byproduct of the electricity generation process. Proper monitoring of brine is important to ensure operational efficiency, manage environmental impact, and comply with regulatory requirements.

7.4.2 Monitoring frequency and strategy

The frequency of brine monitoring is influenced by regulatory compliance, operational best practices, environmental monitoring reports as well as maintenance schedules. Environmental regulations typically require regular monitoring of brine composition to meet occupational health and environmental standards. Best practices will involve checking chemical composition and thermal properties of brine conducted weekly based on operational conditions. Additionally, semi-annual environmental monitoring reports will be prepared to assess brine management practices and their environmental impact, while maintenance schedules will include bi-annual evaluations by equipment suppliers to ensure the integrity and safety of brine management systems.

7.5 Health and safety monitoring plan

7.5.1 Introduction

During installation and subsequent operation of the geothermal power plant, health and safety risks will emanate from musculoskeletal injuries from use of machinery, exposure to geothermal fluids and gases, fire outbreaks among others. All these risks have potential to cause death, permanent disability and financial losses. The purpose of the health and safety monitoring plan is to assess existing controls alongside the potential risks in order to develop an effective action plan and ensure compliance with the provisions of OSHA, 2007.

7.5.2 Monitoring strategy

Karsan Ramji and Sons Limited (KRSL) should be committed to ensuring, as far as is reasonably practicable, the health and safety of the workers, visitors to the site and neighbors is not put at risk during the installation and operational phase of the geothermal power plant. This will be achieved by;

- Routine inspections of the facility and equipment.
- Visual inspection as well as interviewing key personnel to identify areas of improvement.
- Conducting occupational safety and health reviews and reports.
- Administration of safety awareness and motivation scheme.
- Undertaking and reviewing of fire, energy and risk assessment reports.
- Review of safety awareness, fire drills and fire safety training requirements.
- Evaluation of the effectiveness of health and safety training to the workforce.
- Action plans related to significant findings of the risk assessment.
- Having emergency evacuation plans and emergency routes and safety signage among others.
- Assessment of risks involving hazardous substances i.e. receipt, storage & handling.
- Hazard identification by analyzing activities that can be an immediate threat or cause harm over a period of time.
- Ensuring that all accidents and incidents occurring at the site are promptly reported and investigated.

The responsibility for implementing this monitoring plan will be vested in the Department of Occupational Safety and Health Services and overall the management.

7.5.3 Indicator of success
The ideal indicators of success will include zero accidents and fatalities and reduction in the number of incidents and accidents at the site.

7.6 Solid waste monitoring plan
7.6.1 Introduction
During installation and operation phases of the proposed project, solid waste management might pose health risks to the general public and environment. The purpose of this monitoring plan is to therefore ensure solid waste is managed in such a way that it protects both the public health and the environment.

7.6.2 Monitoring frequency
The frequency of solid waste monitoring will differ from the collection to the disposal stage in order to ensure reduced accumulation of heaps of waste. Table 24 describes the outline for which the activity will be monitored but can be adjusted depending on the amount generated.

Table 24: Sample outline for solid waste monitoring plan

Activity	Frequency	Critical levels (Tons)	Target	Responsibility
Collection	Daily			
Storage	Daily			
Management	Daily			
Disposal	Weekly			

7.6.3 Monitoring strategy
The solid waste monitoring plan will document the collection, storage and disposal of solid waste from the geothermal power plant. There is need to code each of the collection points, note the capacity and critical levels, frequency of disposal and the personnel and contractor responsible.

7.6.4 Indicator of success
Indicators of success will include timely collection and disposal of waste by the licensed waste handlers.

7.7 Grievances Redress Mechanism
The affected persons by the proposed project may raise their grievances and dissatisfactions about actual or perceived impacts in order to find a satisfactory solution. These grievances, influenced by their physical, situational and/or social losses, can emerge at the different stages of the project cycle. Not only should the affected persons be able to raise their grievances and be given an adequate hearing, but also satisfactory solutions should be found that mutually benefit both the affected persons and the project. It is equally important that the affected persons have access to legitimate, reliable, transparent and efficient institutional mechanisms that are responsive to their complaints.

7.7.1 Grievances prevention
Grievances cannot be avoided entirely, but much can be done to reduce them to manageable numbers and reduce their impacts. This will be achieved by;

1. Providing sufficient and timely information to communities. Many grievances arise because of misunderstandings; lack of information; or delayed, inconsistent or insufficient information. Accurate and adequate information about a project and its activities, plus an approximate implementation schedule, should be communicated to the communities, especially affected parties, regularly.

2. Conduct meaningful community consultations. The project proponent should continue the process of consultation and dialogue throughout the implementation of the project. Sharing information, reporting on project progress, providing community members with an opportunity to express their concerns, clarifying and responding to their issues, eliciting communities' views, and receiving feedback on interventions will benefit the communities and the project management.
3. Overall good management of the facility will ensure a reduction in potential conflicts with the local community and other stakeholders.

7.7.2 Grievances Redress Mechanism Tool

The project should have a prompter and efficient resolution on individual and collective complaint and provision of feedback on any grievances and dissatisfaction from stakeholders during operations. The flow chart below (Figure 23) shows a proposal consideration for the Grievances Redress Mechanism (GRM) for the geothermal power plant project that provides an accessible channel for submission of complaints and feedback to stakeholders.

Figure 23: Schematic representation of a proposed Grievances Redress Mechanism Tool

8 POLICY, LEGAL AND INSTITUTIONAL FRAMEWORKS

8.1 Introduction

The Third Schedule of the Environmental Management and Coordination (Impact Assessment and Audit) Regulations, 2003 stipulates the inclusion of environmental guidelines, standards, government policies, national legislation, and institutional arrangements in the ESIA study report. These frameworks are safeguards for protecting fragile environments and vulnerable communities while supporting the implementation of the Environmental and Social Management Plan (ESMP) for the proposed project. This section discusses the applicable policy, legal and institutional framework which KRSL and other project stakeholders must comply with for sustainable installation and operation of the geothermal power plant.

8.2 Policy Frameworks

8.2.1 National Environment Policy, 2013

Kenya has a National Environment Policy prepared and approved in 2013 by the Ministry of Environment, Water and Natural Resources. Its overall goal is to provide better quality of life in Kenya for present and future generations through sustainable management of resources and environmentally- friendly development. Chapter 6 of the policy elaborates on environmental quality and health and the need to ensure a clean and health environment for all.

The relevant policy statements for the proposed project are;

- Develop and promote an integrated national strategy for generation and sustainable utilization of renewable energy.
- Promote adaptation of the cleaner production concept in all energy production and consumption activities.

8.2.2 National Energy Policy, 2018

The overall objective of this Policy is to ensure affordable, competitive, sustainable and reliable supply of energy at the least cost in order to achieve the national and county development needs, while protecting and conserving the environment for inter-generational benefits. To enhance exploitation of the vast geothermal resources in the Country, the Government will continue to fund GDC so as to manage the exploration risk and attract investors. In the first quarter of 2023, geothermal power output increased by 46%, reaching 1,506.33 GWh, playing a crucial role in compensating for a 47% decline in hydropower due to drought conditions. Further, the Government will encourage investment in the geothermal subsector so as to achieve at least 2,056 MW of geothermal electric power generation by 2024 and enhance direct use of the resource.

8.2.3 National Industrialization Policy, 2012

Under Kenya Vision 2030, the manufacturing sector has been identified as a key driver for economic growth and development due to its immense potential in job and wealth creation, and realization of Sustainable Development Goals (SDGs). This policy framework focuses on value addition for both primary and high valued goods; and linkages between industrial and other productive sectors to drive the industrialization process and aims at providing strategic direction for the sector growth and development.

8.2.4 National Climate Change Framework Policy, 2016

The policy was developed to facilitate a coordinated, coherent and effective response to the local, national and global challenges and opportunities presented by climate change. An overarching mainstreaming approach has been adopted and applicable to the proposed project; is to ensure the integration of climate change considerations into the planning, budgeting, and implementation

of the proposed project. The climate change considerations will enhance adaptive capacity and build resilience of the project to climate variability and change, while promoting a low carbon development pathway.

8.2.5 Kenya National Climate Change Response Strategy, 2010

The Government of Kenya has strategies it's taking to address issues related to the impact of climate change on various sectors of the economy. Effects of climate change and mitigation and adaptation measures in relation to the proposed project will be taken into consideration during ESIA process.

8.2.6 National Sustainable Waste Management Policy, 2020

The overall objective of the policy is to advance Kenya towards a more sustainable and circular, green economy. Additionally, the policy aims to ensure that waste is collected, separated at source, reused and recycled, and that the remaining waste stream is destined to a secure, sanitary landfill. The proposed project will be required to comply with this policy by planning and implementing effective waste management strategies throughout the project cycle.

8.2.7 United Nations Sustainable Development Goals, 2015

The Sustainable Development Goals (SDGs) offer a comprehensive framework for addressing global challenges, including those related to sustainable development, environmental protection, and social progress. The relevant SDGs are presented in Table 25.

Table 25: Relevant SDGs to the proposed project

Sustainable Development Goal	Description
SDG 6: Clean Water and Sanitation	Ensure availability and sustainable management of water and sanitation for all
SDG 7: Affordable and Clean Energy	Ensure access to affordable, reliable, sustainable, and modern energy for all
SDG 8: Decent Work and Economic Growth	Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all
SDG 9: Industry, Innovation, and Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation
SDG 12: Responsible Consumption and Production	To ensure sustainable consumption and production patterns
SDG 13: Climate Action	Take urgent action to combat climate change and its impacts
SDG 15: Life on land	Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

8.3 Legal Frameworks

8.3.1 Constitution of Kenya 2010

The Constitution of Kenya 2010 is the supreme law of the land. Under Chapter IV, Article 42 provides for the right to a clean and healthy environment for all. Further, Chapter V of the Constitution deals with Land and Environment. Specifically, Part 2 elaborates on the obligations of the proponent in respect to protection of the environment and enforcement of environmental rights.

Relevance to the proposed project

- The proponent should ensure that the proposed project do not infringe on the right to a clean and healthy environment for all.

- The proponent should ensure project implementation activities are carried out in an ecologically, economically, and socially sustainable manner through a sustained stakeholder engagement process. The stakeholder engagement should build on the foundation set by the ESIA study during the three meetings as well development and implementation of a Grievances Redress Mechanism (GRM).
- The proponent is entitled to a fair administrative decision-making process from NEMA and other State Agencies.

8.3.2 Energy Act, 2019

It's an Act of Parliament to consolidate the laws relating to energy, to provide for National and County Government functions in relation to energy, to provide for the establishment, powers and functions of the energy sector entities; promotion of renewable energy; exploration, recovery and commercial utilization of geothermal energy; regulation of midstream and downstream petroleum and coal activities; regulation, production, supply and use of electricity and other energy forms; and for connected purposes.

Relevance to the proposed project

- The Act provides that an applicant for energy generation, transmission or distribution projects including those under the Feed-in-Tariffs (FiT) with a capacity above 3 MW should undertake an environmental assessment and acquire an EIA license before obtaining an electricity generation permit from Energy & Petroleum Regulatory Authority (EPRA).
- The proponent should also comply with Sections 77 – 90 of Part IV (Renewable Energy) of the Act.

8.3.3 Energy (Electricity Licensing) Regulations, 2012

These Regulations apply to any person who intends to engage in the generation, transmission, distribution and supply of electrical energy in Kenya.

Relevance to the proposed project

- The proponent should obtain license to generate electricity from Energy and Petroleum Regulatory Authority (EPRA)

8.3.4 Climate Change Act, 2023

The Act provides a regulatory framework for the management, implementation and regulation of mechanisms to enhance climate change resilience and low carbon development for the sustainable growth of Kenya. It provides for mainstreaming of climate change responses into development planning, decision making and implementation as well as resilience and adaptation in all governance sectors.

Relevance to the proposed project

– Geothermal energy has significant potential to reduce GHG emissions in cement production compared to conventional power sources which contribute ~8% of the world's carbon footprint. Each tonne of cement produced using fossil fuels results in ~0.8 tonnes of CO_2 emissions. By utilizing geothermal energy, the proponent will reduce GHGs emissions, approximately 2,700tCO_2/MW annually, thereby lowering the carbon footprint.

8.3.5 Environmental Management and Coordination Act Cap. 387 of the Laws of Kenya

The Act is the framework environmental law in Kenya and aims to improve the legal and administrative co-ordination of the diverse sectoral initiatives in the field of environment to

enhance the national capacity for its effective management. The Act harmonizes the sector specific legislations relevant to the environment and aligned to the National Environment Policy, 2013.

Relevance to the proposed project

Sections 58 and 68 of the Act prescribe Environmental Impact Assessment (EIA) and Audit (EA) depending on whether a project is proposed or it's ongoing respectively. To operationalize the Act the Ministry of Environment, Climate Change and Forestry has gazetted Regulations to inform and enforce compliance (Table 26).

Table 26: Regulations under the Environmental Management and Coordination Act Cap. 387 of the Laws of Kenya

Regulation	Article	Relevance to the proposed project and compliance requirements
Impact Assessment and Audit Regulations, 2003	EMCA (Section 58) EMCA (Section 68)	EIA Licence required prior to installation of the plant hence the ESIA Study Annual audits will be required from one year after completion of the installation of the plant
Air Quality Regulations, 2014	EMCA (Section 78-85)	Proponent should provide and enforce the use of gas masks to workers and visitors to the site
Noise Regulations, 2009	EMCA (Section 101-103)	Undertake quarterly noise level monitoring throughout the project cycle
Water Quality Regulations, 2006	EMCA (Section 71-72)	Water quality sampling and analysis as per the Standards in Third Schedule of the Regulations
Waste Management Regulations, 2006	EMCA (Section 86-107)	Proponent should provide infrastructure for collection, segregation, and disposal of solid wastes by a NEMA licensed contractor

8.3.6 Sustainable Waste Management Act, 2022

The Act establishes the legal and institutional framework for the sustainable management of waste and ensure the realization of the constitutional provision of the right to clean and health environment. The Act is based on the following principles: precautionary principle; polluter pays principle; payment for ecosystem services; zero waste principle.

Section 13 of the Act requires every producer to bear mandatory extended producer obligations, to reduce pollution and environmental impacts of the products introduced into the Kenyan market and waste arising therefrom. Further, Section 20 of the Act makes provision for waste segregation and disposal by a licensed personnel.

Relevance to the proposed project

- The proponent should comply with the provisions of this Act throughout the project cycle.

8.3.7 Radiation Protection Act, 2012

This Act provides for the protection of the public and radiation workers from the dangers arising from the use of devices or material capable of producing ionizing radiation. Irradiating devices or radioactive material may not be imported without a license.

Relevance to the proposed project

- The proponent should comply with the provisions of this Act throughout the project cycle.

8.3.8 Forest Conservation and Management Act, 2016

This Act provides the overarching legal framework for the conservation, management, and sustainable use of forests in Kenya. It provides for collaboration between Kenya Forest Service (KFS), County Governments and other stakeholders to promote sustainable forestry practices, including reforestation and afforestation.

Relevance to the proposed project

- Upon completion of the project, the proponent should collaborate with KFS in planting trees to compensate any loss during project implementation. The proponent may also assist KFS in afforestation campaign as part of its CSR.

8.3.9 Mining Act, 2016

This Act of Parliament was established to set out frameworks, strategies and principles for exploration and exploitation of mineral resources for socio-economic development. Further, the Act gives effect to Articles 60, 62 (1) (f), 66 (2), 69, and 71 of the Constitution of Kenya as they apply to minerals. It should be noted that the proposed site has a rocky terrain and where needed blasting may be used to pave way for civil works.

Relevance to the proposed project

- The proponent is required to comply with Section 20 of the Act by applying for a blasting License from the Director of Mines.

8.3.10 Physical and Land Use Planning Act, 2019

This Act makes provision for the planning, use, regulation and development of land and for connected purposes. Article 5 of the Act under Principles and norms of physical and land use planning notes that 'every person engaged in physical and land use planning development activities shall be in a manner that integrates economic, social and environmental needs of present and future generations.' Article 4 notes that major developments should be subjected to environmental and social impact assessment.

Relevance to the proposed project

– The proponent should comply with the provisions of this Act throughout the project cycle.

8.3.11 Occupational Safety and Health Act, 2007

This Act of Parliament was established to provide for the safety, health and welfare of workers and all persons lawfully present at workplaces. Section 19 of the Act provides that an occupier of any premises likely to emit poisonous, harmful, injurious or offensive substances, into the atmosphere shall use the best practicable means to prevent such emissions and render harmless and inoffensive the substances which may be emitted. Part VII of the Act elaborately deals with machinery safety requirements to avoid accidents and injuries at work.

Relevance to the proposed project

- Under OSHA, the proponent should register the site as a workplace with DOSHS and provide the workers with adequate and appropriate PPE and enforce their use.

8.3.12 Public Health Act, 2012

The Act aims at prohibiting activities that may be injurious to the general public. It outlines the responsibilities for the County Government to maintain a safe and clean environment by controlling the operational activities of any facility.

Relevance to the proposed project

- The proponent should ensure compliance with Act by providing clean, healthy and safe environment throughout the project cycle.

8.3.13 Work Injury Beneficiary Compensation Act, 2007

This is an Act of Parliament to provide compensation to employees for work related injuries and diseases contracted in the course of their employment and for connected purposes. The Act applies to all employees, including employees employed by the Government, other than the armed forces, in the same way and to the same extent as if the Government were a private employer. It is the duty of all employers to obtain and maintain an insurance policy from an approved insurer in respect of any liability the employer may incur as provided for by the Act. The Act also stipulates that an employee who suffers an accident that leads to disablement or death is subject to the provisions of this Act and is entitled to compensation.

Relevance to the proposed project

– Proponent/contractor should ensure that all workers during the project implementation phase are provided with appropriate insurance covers.

8.3.14 County Government Act, 2012

This Act of parliament give effect to Chapter Eleven of the Kenyan Constitution; that provide for the County government's powers, functions and responsibilities to deliver services and for connected purposes. The Act lays emphasis on the need for a consultative and participatory approach where the principles of planning and development facilitation in a county serve as a basis for engagement between the county government and the citizens and other stakeholders.

Relevance to the proposed project

– The proponent will ensure compliance of the provisions of the Act during the operations phase.

8.3.15 Nakuru County Climate Change Act, 2021

This Act provides to put in place the framework and mechanisms for mobilization and facilitation of the county government, communities and other stakeholders to respond effectively to climate change through appropriate adaptation and mitigation measures and actions and for connected purposes.

Relevance to the proposed project

- The proponent should comply with Part V (Duties Relating to Climate Change), Sections 37 - 39 which outlines climate change duties of private entities operating within the County.

8.3.16 Nakuru County Waste Management Act, 2021

This Act provides for the realization of Article 42 on right to a clean and healthy environment and Article 43 on health and sanitation, and implementation of section 2 (g) of the Fourth Schedule to Constitution of Kenya in relation to waste management and for connected purposes.

Relevance to the proposed project

- The proponent will ensure compliance of the provisions of the Act during the operations phase.

8.3.17 Nakuru County Water and Sanitation Services Act, 2021

This Act provides for development, regulation and management of county public works related to water and sanitation services, storm water management systems, water conservation, water harvesting and for connected purposes.

Relevance to the proposed project

- The proponent will ensure compliance of the provisions of the Act during the operations phase.

8.4 Institutional framework

Several institutions have been established to implement the policy and legal framework discussed in the preceding section (Table 27).

Table 27: Institutions and their legislative mandate as it applies to the geothermal power plant

Institution/Departments	Key mandate
Ministry of Energy and Petroleum	To implement the Energy Act, 2019 alongside the subsidiary legislation
Geothermal Development Company (GDC)	To promote and develop direct uses of geothermal resources
Directorate of Occupational Safety and Health Services (DOSHS)	To implement the Occupational Safety and Health Act, 2007 alongside the subsidiary legislation
National Environment Management Authority (NEMA)	To implement the Environmental Management and Coordination Act and Associated Regulations
County Government of Nakuru	To implement the County Government Act, 2012 and its by-laws

8.5 World Bank Environmental and Social Framework, 2017

The World Bank Environmental and Social Framework sets out the World Bank's commitment to sustainable development, through a Bank Policy and a set of Environmental and Social Standards that are designed to support Borrowers' projects, with the aim of ending extreme poverty and promoting shared prosperity. The framework comprises of;

1. A Vision for Sustainable Development, which sets out the Bank's aspirations regarding environmental and social sustainability;
2. The World Bank Environmental and Social Policy for Investment Project Financing, which sets out the mandatory requirements that apply to the Bank; and
3. The Environmental and Social Standards, together with their Annexes, which set out the mandatory requirements that apply to the Borrower and projects.

Relevance to the proposed project

The proposed project should comply with the ten Environmental and Social Standards (ESSs) established under the framework throughout the project life cycle (Table 28).

Table 28: Summary of the ten ESSs established under the World Bank Environmental and Social Framework, 2017 and their relevance to the geothermal power plant (Source: The World Bank Group, 2017)

ESSs No.	Description	Relevance to the geothermal power plant
1.	Assessment and Management of Environmental and Social Risks and Impacts	In compliance with the ESS, the proponent has carried out the ESIA Study of the proposed project, including stakeholder engagement, developing an Environmental and Social Commitment Plan (ESCP), and will conduct monitoring and reporting on the environmental and social performance of the project against the ESSs.
2.	Labor and Working Conditions	The proponent should promote safety and health at work, fair treatment, non-discrimination and equal opportunity of project

ESSs No.	Description	Relevance to the geothermal power plant
		workers, protect project workers, including vulnerable workers such as women, persons with disabilities, children (of working age, in accordance with this ESS) and migrant workers, contracted workers, community workers and primary supply workers, as appropriate, prevent the use of all forms of forced labor and child labor, support the principles of freedom of association and collective bargaining of project workers in a manner consistent with national law and provide project workers with accessible means to raise workplace concerns.
3.	Resource Efficiency and Pollution Prevention and Management	The proponent should promote sustainable use of resources, including energy, water and raw materials and avoid or minimize pollution from project activities including short and long-lived climate pollutants and generation of hazardous and non-hazardous waste.
4.	Community Health and Safety	The proponent should mitigate adverse impacts on the health and safety of project-affected communities during the project life cycle from both routine and non-routine circumstances, promote quality and safety, and considerations relating to climate change, in the design and construction of infrastructure, avoid or minimize community exposure to project-related traffic and road safety risks, diseases and hazardous materials, put in place effective measures to address emergency events and ensure safeguarding of personnel and property is carried out in a manner that avoids or minimizes risks to the project-affected communities.
5.	Land Acquisition, Restrictions on Land Use and Involuntary Resettlement	The project site is within Menengai Geothermal Project Area hence there will be no displacement of people and in the event, appropriate social safeguards such as resettlement action plan is prepared, approved, and implemented.
6.	Biodiversity Conservation and Sustainable Management of Living Natural Resources	The proponent should protect and conserve biodiversity hot spots and habitats within the area, provide mitigation measures on potential human-wildlife conflicts, support livelihoods of local communities, including indigenous people, and inclusive economic development, through the adoption of practices that integrate conservation needs and development priorities.
7.	Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities	The proponent should ensure that the development process fosters full respect for the human rights, dignity, aspirations, identity, culture, and natural resource based livelihoods of the local community within the area, promote local support of the project by establishing and maintaining an ongoing relationship based on meaningful consultation with the local community affected by the project throughout the project's life cycle, obtain the Free, Prior, and Informed Consent (FPIC) of the affected local community, respect and preserve the culture, knowledge, and practices of the local community, and to provide them with an opportunity to adapt to changing conditions in a manner and in a timeframe acceptable to them.
8.	Cultural Heritage	The proponent should protect cultural heritage from the adverse impacts of project activities and support its preservation.
9.	Financial Intermediaries (FI)	The proponent should assess and manage environmental and social risks and impacts associated with the subprojects it finances and promote good environmental and social management practices in the subprojects the FI finances.
10.	Stakeholder Engagement and	The proponent should provide means for effective and inclusive engagement with project-affected parties throughout the project life cycle on issues that could potentially affect them, ensure that

ESSs No.	Description	Relevance to the geothermal power plant
	Information Disclosure	appropriate project information on environmental and social risks and impacts is disclosed to stakeholders in a timely, understandable, accessible and appropriate manner and format and provide project-affected parties with accessible and inclusive means to raise issues and grievances, and to respond to and manage such grievances.

9 CONCLUSION AND RECOMMENDATION

9.1 Conclusion

Despite the anticipated negative environmental and social impacts, the proposed project has significant benefits which range from reducing the cost of production and enhancing profitability of the company, providing a market for goods and services, decreasing the GHGs emissions hence lowering KRSL carbon footprint, potential scaling up the use of geothermal energy and creating awareness for its benefits among other industry players, employment creation and income to the government. However, the ESIA Study acknowledges the importance of addressing the environmental and social risks of the project to ensure its sustainability and hence proposes a suite of Environmental Management and Monitoring Plans (EMMPs) corresponding to each project phase. Implementing the EMMPs will significantly reduce or in some cases reverse the project's negative environmental and social impacts.

9.2 Recommendation

The main recommendation of the ESIA is the need for concerted implementation of the Environmental Management and Monitoring Plans (EMMPs) by the proponent. On the basis of a commitment by the proponent to the EMMPs to the latter, we recommend the issuance of an EIA License alongside its conditions as per the Environmental Management and Coordination Act Cap. 387 of the Laws of Kenya.

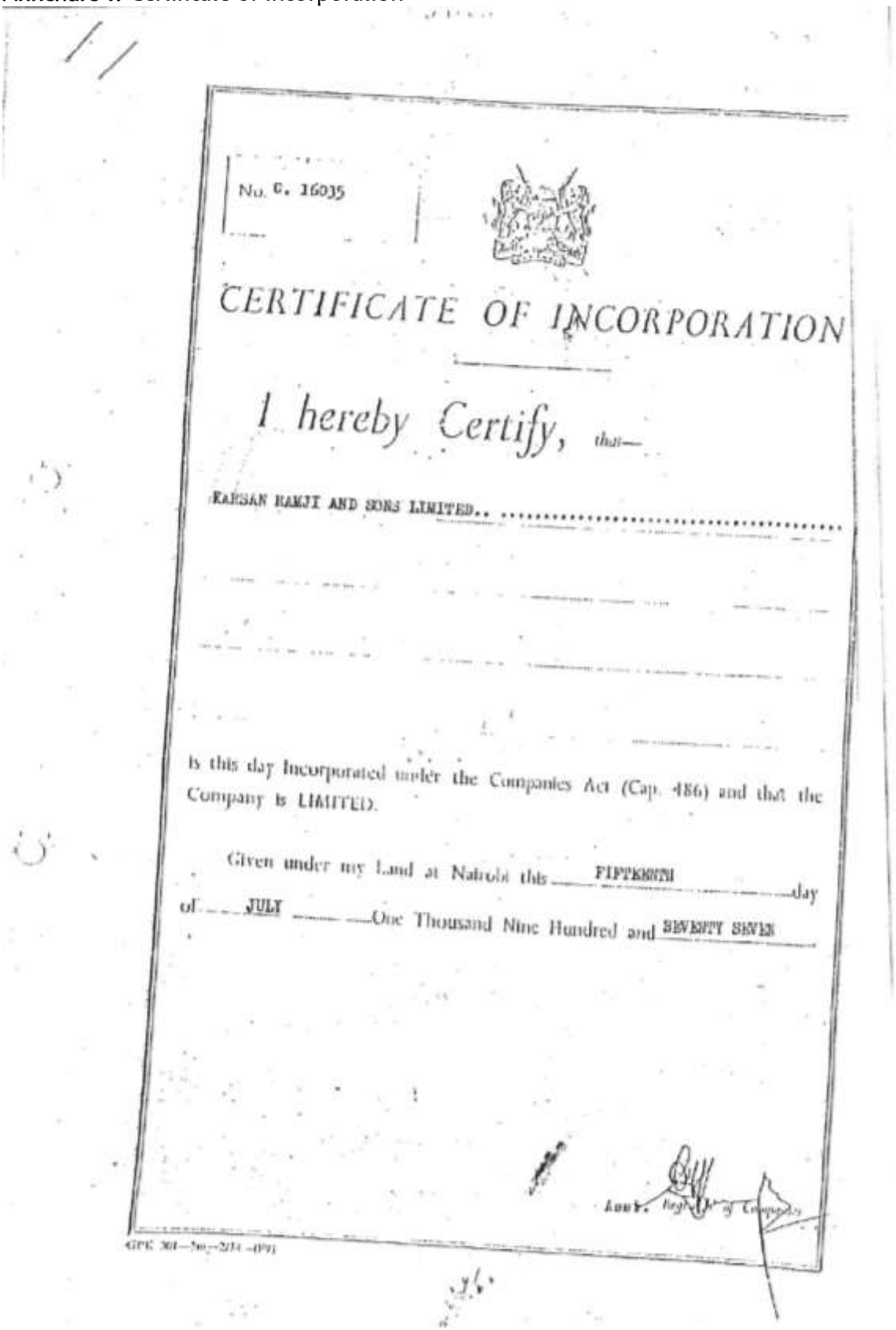
10 REFERENCES

1. Constitution of Kenya, 2010. Government Printers, Nairobi, Kenya.
2. County Government Act, 2012. Government Printers, Nairobi, Kenya.
3. Environmental Impact Assessment and Audit Regulations, 2003. Government Printers, Nairobi, Kenya.
4. Environmental Management and Coordination (Air Quality) Regulations. 2014. Government Printers, Nairobi, Kenya.
5. Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009. Government printer, Nairobi, Kenya.
6. Environmental Management and Coordination (Waste management) Regulations, 2006. Government Printers, Nairobi, Kenya.
7. Environmental Management and Coordination (Water Quality) Regulations, 2006 Government Printers, Nairobi
8. Environmental Management and Coordination Act (EMCA) Number 8 of 1999 (Amended 2015) Government Printers, Nairobi, Kenya.
9. Kenya National Bureau of Statistics, 2019
10. Kenya National Bureau of Statistics, 2021. Gross County Product Report.
11. Nakuru County Integrated Development Plan, 2023-2027
12. Occupational Safety and Health Act, 2007. Government Printers, Nairobi, Kenya
13. Public Health Act (Cap. 242), 2012. Government printer, Nairobi, Kenya.
14. Shammah Kiptanui (2015). Financial Assessment of Commercial Extraction of Sulphur and Carbon Dioxide from Geothermal Gases in Menengai, Kenya.
15. Sustainable Waste Management Act, 2022 Government Printers, Nairobi, Kenya.
16. Water Act, 2016. Government Printers, Nairobi, Kenya.

11 ANNEXURES

1. Certificate of Incorporation
2. Pin Certificate
3. License for proposed installation of 5-10MWe Modular Geothermal Power Plants at Menengai Drilling Project
4. Approval of the scoping report and Terms of Reference for the EIA study
5. 4 MW Wellhead Production Unit Conceptual Design Report
6. Geothermal Steam Supply Agreement between Geothermal Development Company and Karsan Ramji and Sons Limited
7. Bill of quantities
8. Baseline monitoring reports for ambient air and acoustic levels
9. Attendance list of the kick off meeting with key government agencies
10. Proceedings of the kick-off meeting held on 28th June 2024 at Maili Saba Police Post
11. Proceedings of the Second Stakeholder meeting to review the draft ESIA study report held on 5th November 2024 at Dhanji Vocational Training Centre at Kagoto area
12. Proceedings of the Third Stakeholder meeting to validate the draft final ESIA study report held on 15th November 2024 at NG-CDF Social Hall at Kiamaina area
13. Public consultation questionnaires
14. NEMA practicing license for the firm, Envasses Environmental Consultants Limited
15. NEMA practicing license for Team Leader, Mr. Simon Nzuki
16. NEMA practicing license for Stakeholder Engagement Expert, Ms. Jane Gitau

Annexure 1: Certificate of Incorporation



No. C. 16035

CERTIFICATE OF INCORPORATION

I hereby Certify, that—

KAPSAN RAMJI AND SONS LIMITED.. .....

is this day Incorporated under the Companies Act (Cap. 486) and that the Company is LIMITED.

Given under my Land at Nairobi this FIFTEENTH day of JULY One Thousand Nine Hundred and SEVENTY SEVEN

Asst. Registrar of Companies

GPE 301—5m—2/74—(P)

Annexure 2: Pin Certificate

KENYA REVENUE AUTHORITY

www.kra.go.ke

PIN Certificate

For General Tax Questions
Contact KRA Call Centre
Tel: +254 (020) 4999 999
Cell: +254(0711)099 999
Email: callcentre@kra.go.ke

Certificate Date : 09/04/2014

Personal Identification Number

P000610228E

This is to certify that taxpayer shown herein has been registered with Kenya Revenue Authority

Taxpayer Information

Taxpayer Name	KARSAN RAMJI AND SONS LIMITED
Email Address	krsonsltd@aggregatesafrica.com

Registered Address

L.R. Number : 209/6823/PT1	**Building :** OFF JOGOO ROAD
Street/Road : NEAR CITY STADIUM	**City/Town :** NAIROBI
County : Nairobi	**District :** Nairobi West District
Tax Area : Nairobi West	**Station :** LTO
P. O. Box : 48838	**Postal Code :** 00100

Tax Obligation(s) Registration Details

Sr. No.	Tax Obligation(s)	Effective From Date	Effective Till Date	Status
1	Value Added Tax (VAT)	08/01/1993	N.A.	Active
2	Income Tax - PAYE	01/01/1995	N.A.	Active
3	Income Tax - Company	08/01/1993	N.A.	Active

The above PIN must appear on all your tax invoices and correspondences with Kenya Revenue Authority. Your accounting end month is December unless a change has been approved by the Commissioner-Domestic Taxes Department. The status of Tax Obligation(s) with 'Dormant' status will automatically change to 'Active' on date mentioned in "Effective Till Date" or any transaction done during the period. This certificate shall remain in force till further updated.

Annexure 3: License for proposed installation of 5-10MWe Modular Geothermal Power Plants at Menengai Drilling Project

Application Reference No. EIA/827
Registration No: 0014205
For official use

nema

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY (NEMA)

THE ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION ACT
ENVIRONMENTAL IMPACT ASSESSMENT LICENSE

This is to certify that the Project Report/Environmental Impact Assessment Study Report received from ~~Geothermal Development Company~~ (Name of of individual/firm) of ~~P. O. Box 17700-20100, Nairobi~~ (Address submitted to the National Management Environment Authority (NEMA) in accordance with the nvironmental Impact Assessment and Audit Regulations regarding **Proposed Installation of 5-10 MWE Modular Geothermal Power Plants at Menengai Drilling Project** (title of project) whose objective is to carry on ..... (briefly describe purpose) located at ~~Menengai Caldera, Nakuru County~~ (locality and district) has been reviewed and a licence is hereby issued for implementation of the project, subject to attached conditions.

Dated this 28th Day of Nov 2012

Signature.....

(SEAL)

Director General
The National Environment Management Authority

CONDITIONS OF LICENSE

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

P.T.O.

GEOTHERMAL DEVELOPMENT COMPANY LTD. AREA MANAGER CENTRAL RIFT 12 AUG 2013 P.O Box 17700-20100 NAKURU

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY(NEMA)

THE ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION ACT

CERTIFICATE OF VARIATION OF ENVIRONMENTAL IMPACT ASSESSMENT LICENSE

Certificate No: **NEMA/EIA/VC/508**

Application Reference No: **NEMA/EIA/VEIA/861**

This is to certify that the Environmental Impact Assessment License No
0014205 issued on 11/28/2012

to **QPEA GT Menengai Limited.**

of

P.O. Box 896 - 00502, Nairobi.

regarding

Proposed Installation of 5-10MWe Modular Geothermal Power Plant.

whose objective is

Construction of a modular geothermal power plant with a capacity of [illegible]

located at

Menengai Caldera, Nakuru County.

has been varied to

Extension of EIA License validity period by an additional twenty four (24) months.

with effect from **31 January, 2017** in accordance with the provisions of the Act.

Date: **31 January, 2017**

Signature

(Seal)

Director-General

The National Environment Management Authority.

P. T. O.

ISO 9001 : 2008 Certified

Annexure 4: Approval of the scoping report and Terms of Reference for the EIA study

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY

Mobile Lines: 0724-253 398, 0723-363 010, 0735-013 046
Telkom Wireless: 020-2101370, 020-2183718
Incident Lines: 0786-101100, 0741-101100

P.O. Box 67839, 00200
Popo Road, Nairobi, Kenya
E-mail: dgnema@nema.go.ke
Website: www.nema.go.ke

REF: NEMA/TOR/5/2/748 **DATE: 1st July, 2024**

The Director
Karsan Ramji and Sons Limited
P.O Box 48838-00100
NAIROBI

RE: TERMS OF REFERENCE (TOR) FOR ENVIROMENTAL IMPACT ASSESSMENT STUDY REPORT FOR THE PROPOSED 4.5MW GEOTHERMAL POWER PLANT IN NAKURU COUNTY.

We acknowledge the receipt of your TOR for the above proposed project.

Pursuant to the Environmental Management and Coordination Act, 1999, the Environmental (Impact Assessment and Audit) Regulations 2003 and Legal notice 31 & 32 of 2019, your terms of reference for the Environmental Impact Assessment (EIA) for the **PROPOSED 4.5MW GEOTHERMAL POWER PLANT IN NAKURU COUNTY** has been approved with the following requirements:

You shall submit ten (10) copies of the study report, upon payment of the applicable EIA processing and monitoring fees being 0.1% of the total project cost, a soft copy of the summarised ESMP in **WORD** format for preparation of public notice and one electronic copy of the report prepared by the team of experts to the Authority.

You are advised to comply accordingly.

JOSEPH MAKAU
FOR: DIRECTOR GENERAL

Our Environment, Our Life, Our Responsibility

Annexure 5: 4 MW Wellhead Production Unit Conceptual Design Report

steam

4 MW WELLHEAD PRODUCTION UNIT
CONCEPTUAL DESIGN REPORT

Project No. P23_KRS_046

Doc. No. P23046-P-RL-00

REV.	DATE	PREPARED BY	CHECKED BY	APPROVED BY
0	15-March-2024	Beatrice Righi	Luca Xodo	Stefano Orlando

Prepared for: Karsan Ramji and Sons Ltd

STEAM srl
Via Ponte a Piglieri 8
Pisa 56121
ITALY
VAT no. IT01028420501

1 INTRODUCTION AND SCOPE OF THE DOCUMENT

Karsan Ramji and Sons Ltr (KRSL) is a family-owned company founded in 1977 focused on civil engineering, aggregate mining and cement manufacturing. KRSL is in a steam supply agreement with Geothermal Development Company (GDC) and intends to source steam and brine from the identified geothermal production well MW-18A to power a 4 MW wellhead generation unit and to dry pozzolanic through heat exchange. The plant will power KRSL cement factory located approximately 6 km from the production well, on the periphery of the Menengai Caldera in Nakuru County. The heat needed for drying the pozzolanic is given by the brine coming from the separator, that will exchange heat with air in the dryer system.

The scope of this document is to provide a conceptual report of the wellhead production unit design, according to the data and the conditions supplied by GDC. A production well pad and gathering system solution is proposed in this document. Two different solutions were considered for the design of the production unit: a direct steam turbine plant and an Organic Rankine Cycle (ORC) plant.

The next foreseen step is to make a market scouting for both ORC and steam turbine options, and carry out the analysis on the technical economic competitiveness of the solutions before deciding the preferred technology.

2 DESIGN DATA

The geothermal production well MW-18A data including the brine and condensate chemical compositions were supplied by GDC while the ambient conditions were fairly assumed considering the nearby project of the three (3) Independent Power Producers (IPP).
Based on these, we proceeded with the analysis of the data and the design of the gathering system and of the wellhead production unit.

2.1 GEOTHERMAL FLUID DATA

As illustrated in the document "P23046-X-RL-00-2 – Assessment of well data", given the significant silica concentration, that is, as reported in the last data sets (as per document "MW-18A Fluid Chemisty Data_Feb 2024"), in a range from 1,047 ppm to 1,507 ppm and also given the need to harness 40 t/h of steam considering the discharge history of MW-18A well (as per document "KRSL steam supply wells data-GDC February 2024"), it is better to operate at a higher pressure, to ensure the desired steam flow rate for the plant design and to avoid silica deposition. A wellhead pressure of 17.88 bar is the chosen target of the design for this project and the enthalpy has been estimated based on the wellhead pressure and steam and total flow rates recorded by GDC.

Table 2.1a outlines the design parameters.

Parameter	Value
Steam + NCG flow, t/h	51
NCG content, %wt (Steam + NCG flow)	1.6
Brine flow, t/h	50
Total Mass Flow, t/h	101
Wellhead pressure, bar	17.88
Total calculated enthalpy, kJ/kg	1,853

Table 2.1a ***MW-18A design paramete***

2.2 AMBIENT CONDITIONS

Table 2.2a summarizes the ambient conditions, corresponding to those reported in document "P23046-P-DT-00-0 – Project design basis".

Parameter	Unit	Value
Max ambient temperature	°C	40
Max relative humidity	%	100
Max wet bulb temperature	°C	28
Average wet bulb temperature	°C	16.5
Nominal wet bulb temperature	°C	17
Min wet bulb temperature	°C	5
Barometric pressure	mbar	810

Table 2.2a ***Ambient design parameters***

3 PRODUCTION WELL PAD AND FLUID COLLECTION AND REINJECTION SYSTEM

The proposed production well pad layout, including the power production facilities, is show in *Figure 3a*. As an example, a typical binary plant layout is outlined. The gathering system scheme is represented in Figure 3a.

Figure 3a ***General arrangement of the production well pad***

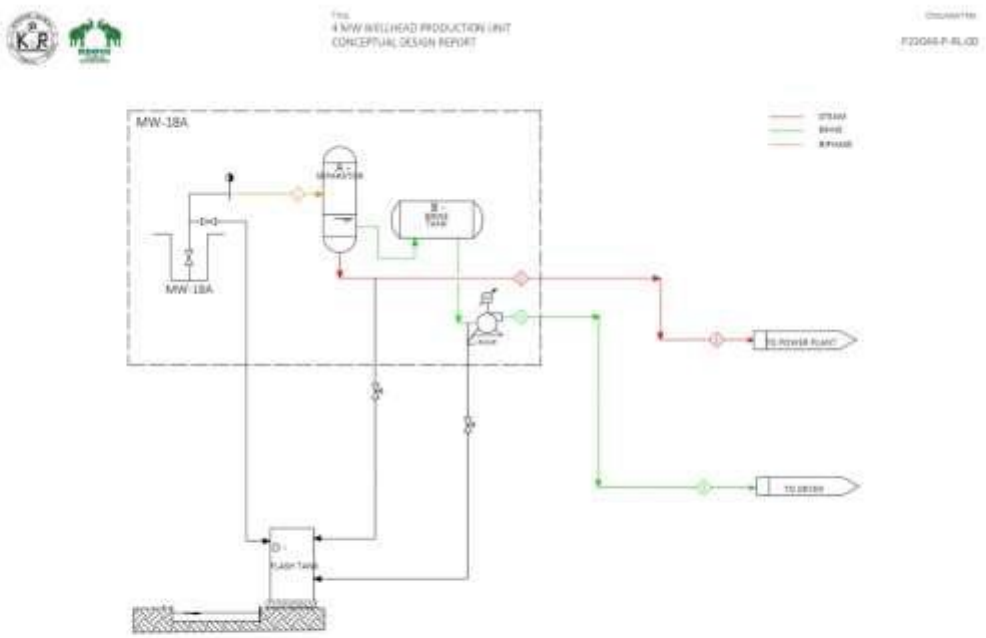


Figure 3b ***Gathering system scheme. Streams are identified with numbers and equipment with capital letters.***

4 PLANT DESIGN

We evaluated two options for the wellhead production unit design to assess the best option for exploiting the available resource. We have two commercially available options for this enthalpy and capacity range: direct steam expansion and binary system. The first technology can be designed in two configurations: counterpressure (atmospheric discharge) and condensing. The former grants the minimum cost but features low efficiencies and complete discharge of the geothermal fluid into the atmosphere, causing possible reservoir depletion. The latter features a higher complexity due to the presence of the condenser, cooling system, and non-condensable gas extraction system but grants good efficiency and partial reinjection of the fluid. As for the binary system, two configurations are available on the cooling side: air and water. Air cooling grants maximum reinjection rates, but it suffers lower efficiencies and higher costs in warm climates. Thus, for this case, we take advantage of the possibility of proceeding with water cooling thanks to the make-up possibilities given by the presence of condensate, as shown in the following. A technical-economic comparison will provide indications of the preferred solution.

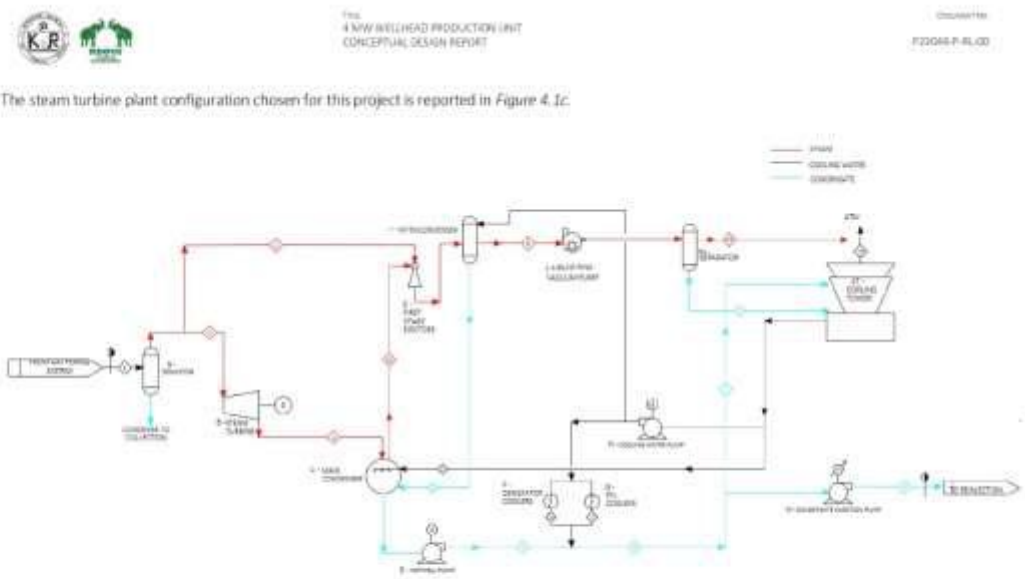
In both ORC and steam turbine configurations, we have seen from the calculations that to produce 4 MW net, the steam flow can be less than the available according to the data provided and than the contractual value. Most likely, the target of 4 MW net will need to be increased to include the electrical needs of the dryer plant.

4.1 OPTION 1: STEAM TURBINE PLANT

Figure 4.1a and *Figure 4.1b* provide a visual example of two typical geothermal wellhead power plants based on steam turbine technology.

Figure 4.1a ***Example of a wellhead production unit (2.5 MW) in Eburru, Kenya.***

Figure 4.1b ***Example of a wellhead production unit (2.5 MW) in Olkaria, Kenya.***



The steam turbine plant configuration chosen for this project is reported in *Figure 4.1c*.

***Figure 4.1c** : Steam turbine plant scheme. Streams are identified with numbers and equipment with capital letters.*

- cooling water pumps (H).

4.1.4 GAS REMOVAL SYSTEM

Non condensable gases (NCG) are extracted from the main condenser through a hybrid system composed of a first stage ejectors and liquid ring vacuum pumps as the second stage; an inter-condenser is foreseen between the two stages to cool down the NCGs and remove the water coming from the motive fluid and the one associated with the NCGs at the condenser outlet. A portion of the main steam is diverted to supply motive steam to the ejectors.
NCGs after the separator are directed to the cooling tower fan stacks where they are mixed and distributed to atmosphere with the volume of air driven by the tower fans.

The components are the following:

- first stage ejectors (E)
- inter-condenser (I)
- liquid ring vacuum pumps (L)
- separator (M).

4.2 OPTION 2: BINARY PLANT

A binary plant is a plant where the fluid expanding in the turbine is not the geothermal fluid but a working fluid operating in a closed cycle. In this case, we chose the most common binary cycle, that is the organic Rankine cycle (ORC).
The assumed conditions at the power plant inlet are the same as the steam turbine power plant and reported in *Table 4.2a*.

Plant steam inlet conditions	
Pressure, bar	16.8
Temperature, °C	202.5
Flow rate, t/h	32.7
NCG, %wt (Flow rate)	1.6
Enthalpy, kJ/kg	2,751.9

Table 4.2a ***Plant steam inlet conditions***

The calculations were carried out considering commercially available equipment efficiency to deliver 4 MW net power. Considering the inlet flow rate of 32.7 t/h and the net power produced of 4 MW net, a steam specific consumption of 8.175 t/MWh is calculated. Using this figure, it is possible to roughly estimate the maximum power that can be produced using the contractual value of 40 t/h of steam, that is 4.9 MW net.

The ORC is composed of:

- a set of primary heat exchangers (A, B, C)
- one or more turbine (T)

- one or more feed pumps
- one condenser
- one recuperator (if any)
- one or more knock-out drums.

Additionally, the cooling water system completes the power plant.

Figure 4.2a and *Figure 4.2b* provide a visual example of two typical air-cooled and water-cooled geothermal binary power plants based on ORC technology.

Figure 4.2a ***Example of an air-cooled ORC binary plant (4 MW) in Pico Alto, Azores (Portugal), operating since 2015. The tall equipment in the back is the air-cooled condenser, while in front, there is the last part of the gathering system, primary heat exchangers, turbine, and electric generator (in green).***

Figure 4.2b ***Example of a water-cooled ORC binary plant (3.5 MW) in Denizli, Turkey, operating since 2014. The ORC module is in front, with white condensers and grey primary heat exchangers, while the cooling tower is the blue equipment in the back.***

The binary plant configuration chosen for this project is reported in *Figure 4.2c*.

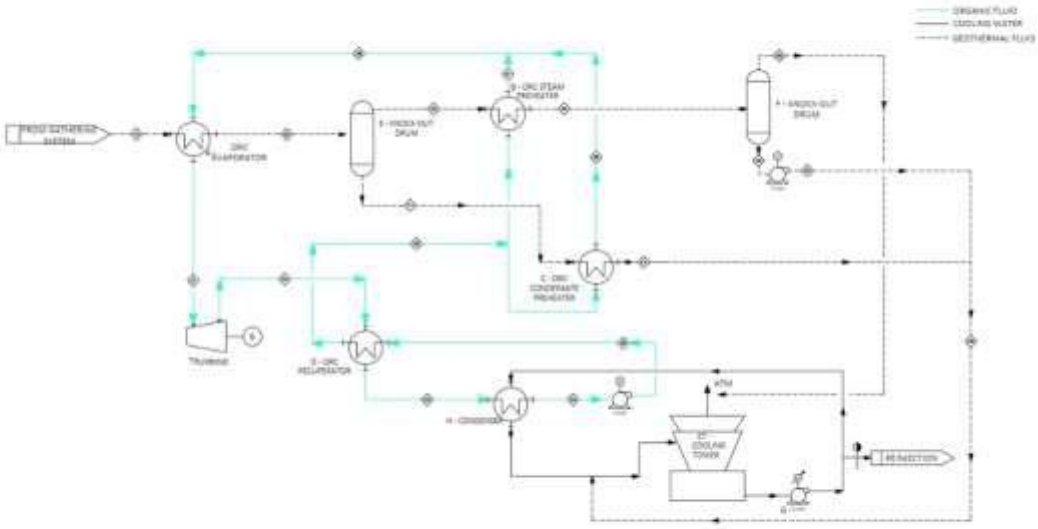


Figure 4.2c ***Binary plant scheme. Streams are identified with numbers and equipment with capital letters.***

Annexure 6: Geothermal Steam Supply Agreement between Geothermal Development Company and Karsan Ramji and Sons Limited

GDC/LS/CONTRACT/446-CZ/2023

Geothermal Development Company
Green Energy for Kenya

CONTRACT

BETWEEN

GEOTHERMAL DEVELOPMENT COMPANY LIMITED

AND

KARSAN RAMJI AND SONS LIMITED

ESTABLISHMENT OF GEOTHERMAL DIRECT – USE POWERED INVESTMENT AT MENENGAI GEOTHERMAL PROJECT AREA

TENDER NO: GDC/DU/RFP/067/2022-2023

NOVEMBER 2023

SECTION I: FORM OF CONTRACT

This **CONTRACT** (hereinafter called the "Contract") is dated on the 6th day of November 2023, (the "**Signing Date**") by and between

GEOTHERMAL DEVELOPMENT COMPANY LIMITED a limited liability company registered under the Companies Act (No.17 of 2015) and a State corporation pursuant to the State Corporations Act (Chapter 446 Laws of Kenya) of P.O. **Box 100746 – 00101 Nairobi, Kenya** with its registered offices in Kawi House, South C Bellevue, Off Red Cross Road, Mombasa Road (hereinafter called **"GDC"** which expression shall where context so allows include its successors, permitted assigns and its legal representatives) on one part,

AND

KARSAN RAMJI AND SONS LIMITED a limited company of P.O. Box 48838-00100 Nairobi, Kenya with its registered office at Ndovu Cement, Old Mombasa Road, Athi River, Machakos County (herein after referred to as the "**Investor**" which expression shall where the context so admits include its successors in title and permitted assigns), on the other part, who will be liable to GDC for all the Investor's obligations under this Contract.

(GDC and the Investor are hereinafter referred to individually as a "Party" and collectively as "Parties").

WHEREAS:

a) GDC is desirous of establishing a Geothermal Direct Use Powered Investment as further detailed under this Contract.

b) GDC invited proposals for the **Establishment of Geothermal Direct–Use Powered Investment** and has accepted the Proposal submitted by the Investor as specified in the Investor's request for proposal; **and**

c) The Investor, having represented to GDC that it has the required capacity, technical skills, expertise and resources, has agreed to set up the investment on the terms and conditions set forth in this Contract.

NOW THEREFORE the Parties hereto hereby agree as follows:

1. In this Contract, words and expressions shall have the same meanings as are respectively assigned to them in the General provisions of Contract. Headings in this Contract are included for ease of reference only and shall not affect the interpretation or construction of this Contract.

2. The following documents attached hereto shall be deemed to form an integral part of this Contract;

   (a) The Form of Contract;

   (b) General Provisions;

   (c) GDC's Request For Proposal (RFP);

   (d) Investor's Proposal;

   (e) Copies of Negotiation Minutes; and

   (f) Copy of the Letter of Notification of Award and Acceptance.

   In the event of any ambiguity or conflict between the Contract documents listed above, the order of precedence shall be; the Form of Contract, General Provisions of the Contract, Negotiation Minutes, GDC's RFP and Investor's Proposal consecutively.

3. The mutual rights and obligations of the Investor and GDC shall be as set forth in the Contract, in particular:

   (a) The Investor shall receive and utilize all the steam and brine supplied by GDC in accordance with clause 12 of the General provisions of Contract; and

   (b) GDC shall provide steam and brine at the agreed tariff, quantity and quality and ensure continuous supply in accordance with clause 13 of the general provisions of this Contract.

4. In consideration of the payments to be made by the Investor to GDC as hereinafter mentioned, the Investor hereby covenants with GDC to utilize the steam supplied by GDC as per their schedule of steam uptake while brine quantity shall be as per Investor's requirements as tabulated under clause 10 of the form of Contract.

5. GDC hereby covenants to provide all possible requirements and support as per the terms of this Contract and to allocate the Investor land to set up its plants in accordance with the RFP requirements and in accordance with all the applicable laws.

6. GDC further covenants to provide the required steam and brine at the required parameters, as provided in clause 10 in the Contract, in accordance with internationally accepted standards and at the Tariff acceptable to both Parties.

7. In consideration of the performance of its obligations herein, the Investor agrees to make payments to GDC in accordance with the applicable Tariff and payment rates or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract such sums not including the costs of remedying of defects (if any).

8. This Contract shall come into effect on the date the last condition precedent is attained or waived by the benefiting party or as may be extended by mutual agreement of Parties but not later than six (6) months from the signing date or any further reasonable extension thereof as may be agreed upon by both Parties.

9. **Project Timelines**

No	Activity	Duration
1.	Commencement of Project	On the date the Investor will receive Grant of Access from GDC
2.	Design and Construction Period	730 days from the date the Investor shall receive grant of access to the project Area
3.	Testing and Commissioning	70 days from completion of Construction Period
4.	Project Life Cycle/Term	20 years from commissioning

Project timelines may be negotiated and agreed upon during the design and construction period. Any amendment of the applicable timelines shall only be allowed upon written approval of the Authorized representatives of Parties.

Contract for Establishment of Geothermal Direct Use powered Investments-KARSAN RAMJI *Page 5*

AS WITNESSED by the hands of the duly authorized representatives of the Parties the day and year first above written

For and on behalf of **GEOTHERMAL DEVELOPMENT COMPANY LIMITED**

Paul Ngugi _____ Date 6th November 2023

Managing Director & CEO

In the presence of:-

Agnes Muthengi _____ Date 6th November 2023

Ag. General Manager, Legal Services

For and on behalf of **KARSAN RAMJI & SONS LIMITED**

Name: MR. KISORKUMAR VARSANI Signature: _____

Designation: DIRECTOR DATE: 2 November 2023

KARSAN RAMJI & SONS LTD. P.O. Box 48538 - 00100, NAIROBI PIN: P000610C28E

Witnessed by:

Name: HITESH D PINDORIA Signature: _____

Designation: C.F.O.

Annexure 7: Bill of quantities

Annexure 8: Baseline monitoring reports for ambient air and acoustic levels

AMBIENT ATMOSPHERIC QUALITY MONITORING REPORT

ENVIRONMENTAL BASELINE STUDY REPORT FOR AMBIENT ATMOSPHERIC QUALITY MONITORING OF THE PROPOSED 4 MEGAWATT (MW) GEOTHERMAL DIRECT USE POWER PLANT WITHIN MENENGAI GEOTHERMAL FIELD IN NAKURU COUNTY.

PROJECT INFORMATION:

PREPARED FOR:
KARSAN RAMJI AND SONS LIMITED,
P.O. BOX 48838-00100,
NAIROBI, KENYA.

CLIENT ADDRESS:

PREPARED BY:
LAHVENS LIMITED
P.O BOX 34153, 80118.
DESIGNATION LAB REF. NO. NEMA/21/2/LAB77/LLL
EMAIL: lahvens@lahvens.com

TESTING CONSULTANTS:

DOCUMENT ID: 50124-0057 A
TEST DATES: JUNE 06TH 2024
(FINAL) REPORT ISSUED: JULY 03RD, 2024

DOCUMENT INFORMATION:

KRSL	ENVIRONMENTAL BASELINE STUDY REPORT FOR AMBIENT ATMOSPHERIC QUALITY MONITORING OF THE PROPOSED 4 MEGAWATT (MW) GEOTHERMAL DIRECT USE POWER PLANT WITHIN MENENGAI GEOTHERMAL FIELD IN NAKURU COUNTY.	REPORT REF NO. : 50124-0057A REPORT TITTLE: EBSAAQMR-56A DOI: 06TH JUNE 2024 PAGE NUMBER PAGE | 1

DOCUMENT REVIEW PAGE

This Technical report titled ENVIRONMENTAL BASELINE STUDY REPORT FOR AMBIENT ATMOSPHERIC QUALITY MONITORING OF THE PROPOSED 4 MEGAWATT (MW) GEOTHERMAL DIRECT USE POWER PLANT WITHIN MENENGAI GEOTHERMAL FIELD IN NAKURU COUNTY was authored by Lahvens Limited in accordance to the EMC (Air Quality) Regulation 2014, Legal Notice 34.

REVISION HISTORY

03	03.07.2024	Issuance of Final Report
02	26-06-2024	Re-submission to close the given comments and approvals
01	21-06-2024	1st draft issue of the soft copy submitted for review
REV	DATE	DESCRIPTION

Accepted by			
Reviewed & Approved by	LOVANS ROBERT SPOO (LABORATORY DIRECTOR) N.E.R. NO.: 7165		03.07.2024
Prepared by	VINCENT AGIN - FIELD ATTENDANT		03.07.2024
	VALENTINE AGUTU - FIELD ATTENDANT		03.07.2024
PROJECT	Name	Signature	Date

DOCUMENT & PROJECT PARTICULARS

DOCUMENT REF: 50124-0057A	CLASSIFICATION: A - UNCLASSIFIED (OPEN REPORT)	CONTRACT NO. AS PER EECL TOR.	REVISION: 00 FINAL

TEST FIRM CONTACT PERSON: LOVANS SPOO: (254 - 728716948)	PROJECT: 4 MEGAWATT (MW) GEOTHERMAL DIRECT USE POWER PLANT	NUMBER OF PAGES: 40

AUTHOR(S): VINCENT OKUMU, VALENTINE AGUTU	QUALITY CONTROLLER: LOVANS ROBERT SPOO

ABSTRACT (ENGLISH TITTLE):
Karsan Ramji and Sons Limited through Envasses Environmental Consultants contracted Lahvens Limited to form part of the Project's Environmental Team (ET). LAHVENS Limited was commissioned to provide consulting services of environmental baseline atmospheric quality concentrations assessment before implementation of the proposed 4 MW geothermal direct use power plant within Menengai geothermal field in Nakuru County.

KEY WORDS:
EBS Air Quality Monitoring and Consultant Reporting.

ABSTRACT (in ENGLISH) | PUBLICATION TYPE: Digital document (pdf)

KRSL: ESIA Study Report for proposed 4 MW geothermal power plant Page 88

REVIEW AND CERTIFICATION FROM THE TESTING CONSULTANTS

All work, calculations, other activities, and tasks performed and documented in this report were carried out under my direction and supervision. This test project conforms to the requirements of Lahvens Limited's quality manual and ENC (Air Quality) Regulation 2014, Legal Notice 34.

Team Leader: VALENTINE ODUOR

Signature:

Date: 03.07.2024

I have reviewed all testing details, calculations, results, conclusions and other appropriate written material contained herein, and hereby certify that the presented material is authentic and accurate.

Reviewer: LOVANS ROBERT SPOO

Title: LABORATORY DIRECTOR

Signature:

Date: 03.07.2024

CERTIFICATION FROM THE LEGAL ENTITY OF THE TESTING FACILITY:

I have reviewed the information being submitted in its entirety. Based on the information and belief formed after reasonable inquiry, I certify that the statements and information contained in this submittal are true, accurate and complete.

Signature

3/07/2024
Date

Omar Said
Name Printed

Tittle

Kansan Ramji & Sons Limited.
Company Name

Company stamp

Prepared by: Envasses Environmental Consultants Limited July 2024

EXECUTIVE SUMMARY

environment survey at the proposed 4MW Geothermal Direct Use Power Plant within Menengai Geothermal Field in Nakuru County on the 06th June 2024. Atmospheric Environment survey was conducted to determine the EXISTING (Do minimum) air pollution around the proposed project for Environmental, Health, Safety and compliance purposes. Air quality remains a valued component in this environmental assessment because of their fundamental significance to the well-being of humans, wildlife and vegetation. The proposed 4MW Geothermal Direct Use Power Plant within Menengai Geothermal Field in Nakuru County will be situated at Latitude 0°12'16.21"S and Longitude 36°05'43.40"E. The proposed site neighbors' Menengai Power Plant West and Sosian Power plant to the East. There are also large chunks of land to the North and South of the project. The project will involve construction, installation, operation and possible decommissioning of a 4 Megawatt well head generation unit, drying plant and cooling towers. The well pad is composed of two wells with a production well (MW-18A), separator, water tank, and an atmospheric flash tank. The two-phase main pipeline will be approximately 100 m long connected to a Webre separator, a cyclone-type separator based on centrifugal force induced by tangential inlet, where the water droplets are forced to the outside of the spiral path and steam stream exits from the bottom of the separator.

The environmental effects of geothermal energy depend on how geothermal energy is used or how it is converted to useful energy. Direct-use applications and geothermal heat pumps have almost no negative effects on the environment. In fact, they can have a positive effect by reducing the use of energy sources that can have negative effects on the environment.

During their operations, Geothermal power plants do not burn fuel to generate electricity, but they may release small amounts of sulfur dioxide and carbon dioxide. Geothermal power plants emit 97% less acid rain-causing sulfur compounds and about 99% less carbon dioxide than fossil fuel power plants of similar size. Geothermal power plants use scrubbers to remove the hydrogen sulfide naturally found in geothermal reservoirs. Most geothermal power plants inject the geothermal steam and water that they use back into the earth. This recycling helps to renew the geothermal resource and to reduce emissions from the geothermal power plants.

There is also some likelihood of atmospheric quality deterioration during the construction or demolition works of the proposed geothermal direct use power plant in three main ways:

i. Dust nuisance. The circulation of machinery, demolition operations or the loading and unloading of materials release suspended particles (PM10, PM2.5 and PM1) that can cause health risks when inhaled, especially among the most vulnerable groups of people.
ii. Atmospheric emissions from machinery. Machinery on a construction site generates noise, dust and gases such as NOx or CO or SO2.
iii. Transport of construction materials. The handling of construction materials also contributes to higher pollution levels, especially in the case of particulate matter.

The objectives of environmental atmospheric baseline monitoring will be as follows;

To monitor the existing state of atmospheric air quality environment at predetermined survey locations of the proposed Geothermal direct use power plant site before any construction and implementation of related works

The results of these tests shall be used to demonstrate compliance with a set of emission concentration limit values for prescribed pollutants as specified in the EMC (Air quality) regulations 2014 during licensing and continuous assessments.

Report the findings of the survey in a report.

One of the most significant benefits of geothermal energy, besides a high capacity factor, is low air emissions. While variations in geothermal plant technology and cooling systems can influence emission levels, geothermal often comply with all regulatory standards set for air quality, including the more stringent of International standards. One of the main chemicals found in the released gas is carbon dioxide. While research has found that the CO2 released would have been released into the atmosphere naturally, it is still a result of geothermal power plant exhaust.

This Environmental Baseline Study is designed to characterize the atmospheric resources at the proposed site prior to establishment of the Proposed 4MW Geothermal Direct Use Power Plant within Menengai Geothermal Field in Nakuru County. EBS will provide a benchmark and reference against which to compare the environmental conditions influenced by the construction, operation and closure phases of the geothermal plant. The information will be used to assess the effectiveness of any proposed mitigation measures and to implement adaptive management, if need be.

The environmental baseline study will collect, assess, and interpret enough physical and chemical atmospheric information to: support the characterization of the atmospheric resource; enable determination of possible impacts; help predict the significance of impacts and the effectiveness of any proposed mitigation; establish thresholds for indicators of ecosystem health; and facilitate the design of monitoring programs.

Well-developed EBS often alleviate heightened perceived concerns within the community during the initial phases of any proposed development, before issues become a serious risk to the project. EBS also creates reassurance in the minds of the public and jurisdictional decision makers that key environmental issues have been identified and will be monitored and mitigated, during and after the project is approved. EBS monitoring can be looked at as an early warning system of impacts that could potentially affect the environment during the project operation phase and long after the project is decommissioned.

Atmospheric environment has been selected as a valued component because of their fundamental significance to the well-being of human health, flora and fauna health. Environmental Baseline Study is a significant component of monitoring programs for some successful development activities. This Baseline Report forms part of a Comprehensive Baseline Study (CBS) of the proposed Project. The CBS is being prepared as part of an environmental Social Impact assessment (ESIA) and approval process.

It is important to accurately determine prevailing air quality conditions against which predicted effects can be gauged and assessed for any environmental effects' assessment.
Ambient air quality survey for this study consists of **THREE** representative monitoring locations. Information for the report is presented based on air monitoring completed for 3-hour weighted average per locale. For the purpose of the baseline investigation, monitoring of air pollutants was achieved on the 06th day of June 2024 and thereafter the results were compared against the guidelines and standards while attention given to relevant referencing sites of similar nature.
Ambient air quality data were obtained from a validated and approved air quality monitoring program.

Ambient air quality data were obtained from a validated and approved air quality monitoring program.
Mobile and active monitoring was done by use of real time equipment AQM-09 which integrates the main ambient gases and meteorological parameters and particulate counter meter. Temperature is measured by way of a highly accurate Air Chip 3000 while humidity is measured using a capacitive humidity sensor (accuracy < 0.8 % / 0.1 K). The gas detector and particulate matter meters were mounted at about 1 - 2 M above the ground surface. The duration information was used to calculate the gas / pm concentrations.

FIELD NOTES AND OBSERVATIONS:

Ambient air quality measurements were taken for short term exposure levels. It should however be noted that this exercise is only applicable to the time period when sampling took place and does not take into account seasonal and other local various that might occur during other months and times. However, it is still a good general overview of the existing air quality environment.

Sensitive receptors:

The proposed site neighbors' Menengai Power Plant West and Sosian Power plant to the East. There are also large chunks of land to the North and South of the project. There are no areas considered to be sensitive receptors within close proximity to the proposed project site.

Potential Pollution causes;

From the site visits and background site description, the following sources have been identified as potential pollution causes at the proposed site;

Exhaust gases:

The survey location is accessible to motor vehicles that utilize diesel and petrol. Vehicle and motorcycle exhausts contain a number of pollutants including carbon dioxide (CO_2), carbon monoxide (CO), hydrocarbons, oxides of nitrogen (NOx), sulphur and PM_{10}. The quantity of each pollutant emitted depends upon the type and quantity of fuel used, engine size, speed of the vehicle and abatement equipment fitted. Once emitted, the pollutants are diluted and dispersed in the ambient air.

Vehicular movement;

Re-suspension of roadside dust from movement of vehicles resulted in generation of relatively higher fraction of finer dust ($PM_{2.5}$). Significant atmospheric dust arose from the mechanical disturbance of granular soils materials exposed to the air from motor vehicle / cycle movement. Pulverization and abrasion of surface materials by application of vehicular mechanical forces generate substantial amount of dust.

Air Quality Survey Conclusions and Recommendations:

Baseline Atmospheric Environment Monitoring was conducted to characterize the existing environment before implementation (DO MINIMUM) of the proposed Geothermal direct use power plant. The conclusions below were drawn from the exercise conducted on the 06th June 2024.

Gaseous Parameters:

All gaseous parameters (carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone and total volatile organic compounds) were measured and quantified at all the three survey locations.

Before the project implementation of the proposed Geothermal direct use power plant, all measured gaseous parameters COMPLIED with the EMC (Air quality) regulations 2014 limits.

The ambient air quality data (gaseous) measured around the monitoring locations are considered to be within a typical range of emissions for such neighborhood.

The findings of the gaseous monitoring program indicate that the air quality at the proposed Geothermal direct use power plant is generally good before commissioning of the project. All pollutants measured are at levels that do not pose Environmental, Health, Safety and compliance concern.

The practices in place to control and manage gaseous pollutants should be maintained.

Meteorological Parameters:

The monitoring locations in general showed Standard atmospheric environment before project implementation due to the combination of good climate and ambient conditions. Weather and Climatic conditions of the proposed Geothermal direct use power plant provided good dispersion of air contaminants.

Particulate Matter (PM_{10} and $PM_{2.5}$):

Particulate parameters concentrations (PM_{10} and $PM_{2.5}$) were measured and quantified across the survey stations.

Before the project implementation of the proposed Geothermal direct use power plant, all measured particulate parameters COMPLIED with the EMC (Air quality) regulations 2014 limits.

$PM_{2.5}$ and PM_{10} concentration levels recorded were within the typical range of emissions for similar neighborhood.

The findings of the monitoring program indicate that the particulate matter atmospheric environment is generally good before the proposed Geothermal direct use power plant implementation. Particulate pollutants measured are at levels that do not pose Environmental, Health, Safety and compliance concern.

Once construction and operations begin, the client is expected to maintain the background / baseline levels.

Recommendation:

When operations / commissioning take effect, greenhouse gas measurements and sampling should be frequently done in order to build up a robust dust and gaseous management plan.

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DEFINITIONS.

Table 1: List of acronyms

µg/m³	Microgram per cubic meter
AAQTL	Ambient Air Quality Threshold Limits
AQG	Air Quality Guidelines
CBS	Comprehensive Baseline Study
CO	Carbon monoxide
CO_2	Carbon dioxide
EA	Environmental Audits
EIA	Environmental Impact Assessment
EMC	Environmental Management and Coordination
EPA	Environmental Protection Authority
GPS	Geographic Positioning System
hpa	Hectopascal
KRSL	Karsan Ramji & Sons Limited
Km/hr	Kilometer per hour
mg/m3	Milligram per cubic meter
NEMA	National Environment Management Authority
NO_x	Oxides of Nitrogen
NO_2	Nitrogen dioxide
PM_{10}	Particulate matter (<10 microns)
$PM_{2.5}$	Particulate matter (<2.5 microns)
SO_2	Sulfur dioxide
QAQC	Quality Assurance / Quality Control
TVOC	Total volatile Organic compounds
TWA	Time Weighted Average
WB	World bank
WHO	World Health Organization
µg/m³	Micro gram per cubic meter
VOCs	Volatile organic compounds

1. INTRODUCTION

1.1. Project Summary and Objectives

Lahvens Limited, a NEMA designated laboratory, carried out the baseline ambient atmospheric environment survey at the proposed 4MW Geothermal Direct Use Power Plant within Menengai Geothermal Field in Nakuru County on the 06th June 2024. Atmospheric Environment survey was conducted to determine the EXISTING (Do minimum) air pollution around the proposed project for Environmental, Health, Safety and compliance purposes. Air quality remains a valued component in this environmental assessment because of their fundamental significance to the well-being of humans, wildlife and vegetation.

The environmental effects of geothermal energy depend on how geothermal energy is used or how it is converted to useful energy. Direct-use applications and geothermal heat pumps have almost no negative effects on the environment. In fact, they can have a positive effect by reducing the use of energy sources that can have negative effects on the environment.

During their operations, Geothermal power plants do not burn fuel to generate electricity, but they may release small amounts of sulfur dioxide and carbon dioxide. Geothermal power plants emit 97% less acid rain-causing sulfur compounds and about 99% less carbon dioxide than fossil fuel power plants of similar size. Geothermal power plants use scrubbers to remove the hydrogen sulfide naturally found in geothermal reservoirs. Most geothermal power plants inject the geothermal steam and water that they use back into the earth. This recycling helps to renew the geothermal resource and to reduce emissions from the geothermal power plants.

There is also some likelihood of atmospheric quality deterioration during the construction or demolition works of the proposed geothermal direct use power plant in three main ways:
Dust nuisance. The circulation of machinery, demolition operations or the loading and unloading of materials release suspended particles (PM_{10}, $PM_{2.5}$ and PM_1) that can cause health risks when inhaled, especially among the most vulnerable groups of people.

Atmospheric emissions from machinery. Machinery on a construction site generates noise, dust and gases such as NOx or CO or SO_2.

Transport of construction materials. The handling of construction materials also contributes to higher pollution levels, especially in the case of particulate matter.

The objectives of environmental atmospheric baseline monitoring will be as follows;

- To monitor the existing state of atmospheric air quality environment at predetermined survey locations of the proposed site before any construction and implementation of related works.
- The results of these tests shall be used to demonstrate compliance with a set of emission concentration limit values for prescribed pollutants as specified in the EMC (Air quality) regulations 2014 during licensing and continuous assessments.
- Report the findings of the survey in a report.

One of the most significant benefits of geothermal energy, besides a high capacity factor, is low air emissions. While variations in geothermal plant technology and cooling systems can influence emission levels, geothermal often comply with all regulatory standards set for air quality, including the more stringent of International standards. One of the main chemicals found in the released gas is carbon dioxide. While research has found that the CO2 released would have been released into the atmosphere naturally, it is still a result of geothermal power plant exhaust.

1.2. Facility Description;

The proposed 4MW Geothermal Direct Use Power Plant within Menengai Geothermal Field in Nakuru County will be situated at Latitude 0°12'16.21"S and Longitude 36°05'43.40"E. The proposed site neighbors' Menengai Power Plant West and Sosian Power plant to the East. There are also large chunks of land to the North and South of the project.

The project will involve construction, installation, operation and possible decommissioning of a 4 Megawatt well head generation unit, drying plant and cooling towers. The power plant will be connected to MW-18A to tap steam and brine to generate electricity for use in proponents' cement manufacturing factory and dry pozzalana respectively.

The well pad is composed of two wells with a production well (MW-18A), separator, water tank, and an atmospheric flash tank. The two-phase main pipeline will be approximately 100 m long connected to a Webre separator, a cyclone-type separator based on centrifugal force induced by tangential inlet, where the water droplets are forced to the outside of the spiral path and steam stream exits from the bottom of the separator.

From the separator, steam will be sent to the power plant through a 70 m long steam pipeline and brine to a horizontal tank to accumulate without increasing the size of the separator. A flash tank will be utilized for the geothermal fluid discharge during the commissioning and start-up phases and emergency. The tank is provided with rocks on top to work as a muffler in case of only steam venting.

The steam separator/demister will separate liquid, droplets or mist from the steam up to a certain dryness factor before it enters the turbine. The steam will expand through the turbine resulting in rotation of the turbine and generator. A crossover carries the steam from the turbine to the condenser where the steam is mixed with cooling water. The condensed steam/cooling water mixture is then pumped into the drying plant for heating pozzalana (700 tonnes per day) prior to reinjection in Well No. 34 (Figure 5) at Latitude 0°11'59.04"S, Longitude 36° 5'43.12"E. The reinjection is undertaken to prevent environmental pollution as well as maintain the geothermal reservoir's integrity. In order to avoid silica deposition and achieve the desired steam flow rate for the plant design a higher well head pressure is required. Table 1 shows the design parameters for the project.

In times of decline or MW-18A being offline, make-up well (well No. 35) which is at Latitude 0°12'30.06"S, Longitude 36° 5'23.59"E on the eastern side of Menengai discontinuity and about 675metres from MW-18A will be utilized.

1.3. Appraisal Framework Requirements

Under the Second Schedule of the Environmental Management and Coordination Act (EMCA), Cap 387 of the Laws of Kenya, the project is categorized as a High Risk and thus should undergo Environmental and Social Impact Assessment (ESIA) Study process.

Air quality monitoring is enshrined in the environmental Management Coordination (Air quality) regulations 2014 framework legal notice 34. According to EMC (Air quality) regulations 2014 framework legal notice 34 under preliminary, the interpretation of *"monitoring" means any periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements or pollutant levels in various media or in humans, animal, and other living things.*

The Constitution of Kenya provides that *"every person has a right to a clean and healthy environment and this includes the right to have the environment protected for the benefit of present and future generations."* The prevention of atmospheric pollution is recognized as a component of a clean and healthy environment. All development therefore that are proposed to be established should comply with

this provisions when their operational phase commences. It is essential therefore to take note through measurement the current / existing air quality conditions before implementation of the proposed project to justify during operations that the environmental media / parameter was not deteriorated as a consequence of the project implementation. Once the baseline values are determined, the industries are then allowed to operate in a manner that does not cause pollution, that might not lead to injury of the body and disruption of peace and comfort enjoyed by the employees and workers in the industrial areas. It is for this reason that there is a need to regulate the levels of air emissions. These regulations are set out by the National Environmental Management Authority (NEMA) to protect people from air pollution and odor.

Environmental Management Coordination (Air quality) regulations 2014 framework legal notice 34, PART XIII-MISCELLANEOUS - section 75 states that *"The Authority may in consultation with the relevant lead agencies establish **baseline levels of priority air pollutants set out in the Second Schedule**.*

In addition, Environmental Audit is required for all existing projects in compliance with Section 54 (A)(2) of the Environmental Impact Assessment (EIA) regulations, 2014 (as amended), promulgated under the National Environmental Management Act, 1998 (act No. 107 of 1998; NEMA). Air quality monitoring is captured as an environmental aspect that needs to be monitored under the Environmental Monitoring and Management plan (EMMP).

According to the EMC (IMPACT ASSESSMENT AND AUDIT) regulations 2003 framework legal notice 101 PART IV, THE ENVIRONMENTAL IMPACT ASSESSMENT STUDY REPORT section 18 which states that *(1) A proponent shall submit to the Authority, an environmental contents of impact assessment study report incorporating but not limited to the environmental following information; - (b) a concise description of the national environmental legislative and regulatory framework, **baseline information**.* PART VI - MISCELLANEOUS PROVISIONS section 43 (2) states that *the proposed policy, programme or plan specified in this regulation shall state - (d) an environmental analysis covering: **(i) baseline information focusing on areas potentially affected**.*

The client in adhering to the above extracts and as part of this authorization process contracted Envasses Environmental Consultants Limited to carry out the ESIA study in June 2024. Envasses commissioned LAHVENS Ltd to form the Project's Environmental Team (ET). Lahvens Limited were responsible to provide consulting services of existing atmospheric concentrations / environment before implementation of the proposed project.

1.4. Scope of Baseline Air Quality Assessment;

The baseline air quality report includes the National and local assessments. At the National scale the assessment considers the total mass emission of general pollutants associated with construction activities. These are sulfur dioxide (SO_2), Nitrogen oxide (NO_x), Ozone (O_3), Particulate Matter (PM_{10} and $PM_{2.5}$) - particles with aerodynamic diameters of less than 10 and 2.5 microns respectively. Background information on these pollutants and why they are of concern is summarized in section 2 'CONTEXT OF THE AIR QUALITY & MONITORING NETWORK'. The current concentrations of these pollutants are at risk of exceeding their respective Air Quality Limit Values during construction, commissioning and decommissioning phases. The estimates of the existing concentrations will be measured and compared to any relevant existing information and when the project commences, will be used as the background data. Relevant available information related to the pre-development ambient air concentration in the environment was looked into while identifying the major existing air emission sources in the environment and the existing sensitive pollution areas in the environment.

1.5. Terms of Reference

As part of the Terms of Reference (ToR), ambient air quality measurements were undertaken in compliance with the EMC (Air quality) regulations 2014 framework legal notice 34.
The following forms the TOR of the air quality survey:

- Review of the legal context relating to air pollutants;
- Evaluation of site meteorology;
- Monitoring of background air quality:

  Particulate Matter (PM) - particulate matter with aerodynamic diameter less than 10 microns and 2.5 microns (PM_{10} and $PM_{2.5}$).

  Gases - sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon dioxide (CO_2) Total Volatile Organic Compounds (TVOC) and Ozone (O_3).

1.6. Justification of EBS

This Environmental Baseline Study is designed to characterize the atmospheric resources at the proposed site prior to establishment of the Proposed 4MW Geothermal Direct Use Power Plant within Menengai Geothermal Field in Nakuru County. EBS will provide a benchmark and reference against which to compare the environmental conditions influenced by the construction, operation and closure phases of the geothermal plant. The information will be used to assess the effectiveness of any proposed mitigation measures and to implement adaptive management, if need be.

The environmental baseline study will collect, assess, and interpret enough physical and chemical atmospheric information to: support the characterization of the atmospheric resource; enable determination of possible impacts; help predict the significance of impacts and the effectiveness of any proposed mitigation; establish thresholds for indicators of ecosystem health; and facilitate the design of monitoring programs.

Well-developed EBS often alleviate heightened perceived concerns within the community during the initial phases of any proposed development, before issues become a serious risk to the project. EBS also creates reassurance in the minds of the public and jurisdictional decision makers that key environmental issues have been identified and will be monitored and mitigated, during and after the project is approved. EBS monitoring can be looked at as an early warning system of impacts that could potentially affect the environment during the project operation phase and long after the project is decommissioned.

Atmospheric environment has been selected as a valued component because of their fundamental significance to the well-being of human health, flora and fauna health. Environmental Baseline Study is a significant component of monitoring programs for some successful development activities. This Baseline Report forms part of a Comprehensive Baseline Study (CBS) of the proposed Project.

The CBS is being prepared as part of an environmental Social Impact assessment (ESIA) and approval process.

2. CONTEXT OF THE AIR QUALITY & MONITORING NETWORKS

Clean air is essential to human health and ecosystems. Five categories of general pollutants were measured at the monitoring networks at the proposed site in Nakuru county. The monitored categories of pollutants were sulphur dioxide (SO_2); oxides of nitrogen (NO_x) (which includes nitric oxide (NO) and nitrogen dioxide (NO_2)); carbon monoxide (CO); Total Volatile Organic Compounds (TVOC); ozone (O_3); particulate matter (PM) (which includes particles less or equal to than 2.5 microns ($PM_{2.5}$), particles less than or equal to 10 microns (PM_{10}). The EB study includes monitoring over a 3-hour period for the above pollutants.

Construction or demolition works deteriorate air quality in three main ways: **Dust nuisance**. The circulation of machinery, demolition operations or the loading and unloading of materials release suspended particles (PM10, PM2.5 and PM1) that can cause health risks when inhaled, especially among the most vulnerable groups of people; **Atmospheric emissions** from machinery. Machinery on a construction site generates noise, dust and gases such as NOx or CO; **Transport of construction materials** - the handling of construction materials also contributes to higher pollution levels, especially in the case of particulate matter.

Air pollution from construction is a real challenge due to the various sources and emanation of different pollutants. In this respect, particulate matter is one of the most harmful emissions. Their hazardous nature derives from their size, for example, particles ranging from 10 microns (PM_{10}) to 1 micron (PM_1). In addition to this characteristic, sometimes the nature of the particle must also be taken into account, since, in the case of asbestos, silica or wood, it can represent an added risk factor. However, detailed analyses are necessary to ascertain this.

The environmental impact of a construction site is wide-ranging. In this sense, air quality may be relegated to the background. It is, after all, a temporary condition, generally limited to the period during which the works are being carried out. But this is no excuse for not adopting measures to help reconcile environmental protection and construction or demolition activities. Thus, it should be noted that the environmental impact of construction on the atmosphere can manifest itself in different ways:

- Ecological impacts: pollutants from construction activities can alter the quality of water resources. But they can also affect the vegetation and animal species that make up ecosystems and upset the ecological balance.
- Impact on public health: the emissions mentioned in the previous section may have a significant impact on local communities and inhabited areas in the vicinity of the construction site.
- Climate connection: the soot or black carbon which is part of fine particulate matter (PM2.5) absorbs sunlight, thus contributing to global warming.

Having clean air to breathe is necessary for good health. Poor air quality reduces quality of life. Some air pollutants are irritants. Some have odor. Some air pollutants can cause respiratory disease or even cancer. Air quality is important both indoors and outdoors. Ground level ozone, particulate matter and allergens are common outdoor air pollutants. Air in its purest state is best suited for the essential task sustaining life. Air pollution is a major environmental risk to health. Air pollution can trigger heart attacks or strokes. In fact, one in three persons who have heart disease can be potentially worsened by air pollution. Breathing clean air can lessen the possibility of disease from stroke, heart disease, lung cancer

as well as chronic and acute respiratory illnesses such as asthma. Lower levels of air pollution are better for heart and respiratory health both long- and short-term.

2.1. Oxides of Nitrogen (NOx)

In a combustion process, NOx is produced through three mechanisms, namely thermal NOx, fuel NOx and prompt NOx. Thermal NOx is the primary source of NOx and is formed as a high temperature dissociation and subsequent reaction of nitrogen (N2) and oxygen (O2). It is produced in the hottest part of the flame and its formation increases exponentially with the flame temperature. The control of thermal NOx is generally achieved through reducing the flame temperature, reducing the residence time, or by operating under fuel rich conditions. Fuel NOx is formed by the reaction of nitrogen compounds chemically bound in liquid or solid fuels with oxygen in the combustion air. In the combustion of such fuels, fuel NOx can account for up to 50% of the total NOx emissions. Prompt NOx is formed from the rapid reaction of atmospheric nitrogen with hydrocarbon radicals, and typically under partially fuel-rich conditions. It can be reduced through combustion staging or by operating under highly oxidizing combustion conditions. NO2 is the primary component of concern in NOx emissions. Generally, up to 10% of the NOx emitted from the combustion of fuel is emitted as NO2. The remainder is emitted as NO, which is subsequently converted to NO2 in reactions with various oxidants and ozone as the plume is transported downwind from the source. The rate of NO2 formation varies with time of day, season, temperature, wind speed, solar radiation and the availability of oxidants to help drive the chemical reactions.

NO2 is a reddish-brown gas with a pungent odour, which upon reaction with other atmospheric compounds, becomes a major contributor to smog, acid rain, inhalable particulates and reduced visibility. At significant levels and exposure, inhalation may result in irritation and burning to the skin and eyes, nose and throat. Prolonged exposure may result in permanent lung damage.

2.2. Carbon dioxide (CO_2) & Carbon Monoxide (CO)

Geothermal energy is a renewable source that can be used to produce power or heat. Even though it produces lower pollution emissions than its nonrenewable counterparts, its expansion is beginning to raise some issues (Fridriksson et al., 2017). Three of the biggest issues from these plants are carbon dioxide, methane, and hydrogen sulfide. Power plants, however, generate little to no methane, so the focus would be on Carbon Dioxide and Hydrogen Sulfide. Emissions of the greenhouse gas CO_2 to the atmosphere is one of the top negative environmental effects of geothermal power production (Armannsson, 2017). The reason why CO_2 is considered so detrimental to the environment is because of its ability to absorb energy at a variety of wavelengths. When the surface of the earth absorbs sunlight, it radiates the sunlight back as infrared waves (heat). These waves would be able to return to the atmosphere if it was uninterrupted. Molecules such as oxygen do not interfere with these waves because they only interact with waves 200 nanometers or lower. However, carbon dioxide absorbs energy at a wavelength of 2,000 and 15,000 nanometers which interferes with infrared energy (Sadatshojaie & Rahimpour, 2020). This causes CO_2 to absorb and does not allow infrared radiation to exit the atmosphere. This is what creates the greenhouse effect. CO_2 absorbing radiation in the winter may be beneficial, high amounts of CO_2 would allow for too much radiation to be kept in the atmosphere (Fecht, 2021).

2.3. Hydrogen sulfide (H_2S) & Sulphur Dioxide (SO2)

Another one of the pollutants of greater concern that is expelled from geothermal power plants is hydrogen sulfide. Hydrogen sulfide is dangerous to humans as well as the environment as it is slightly soluble in water and can form sulfuric acid. This can add to the effects of acid deposition in soil and water while being corrosive to metals. Individuals suffering from respiratory illnesses, such as asthma, are affected most by hydrogen sulfide released into the environment (Hydrogen Sulfide & Health | California Air Resources Board, n.d., 2022).

However, hydrogen sulfide is not a greenhouse contributor, so it oxidizes to form sulfur dioxide (Kristmannsdóttir & Ármannsson, 2003). Sulfur dioxide is a water-soluble compound that can react with water to form sulfurous acid. It can also react with air or ozone to form sulfuric acid (Dean, 2001). Sulfuric acid is the main contributor to acid rain, which can acidify lakes and soils. However, ammonia can neutralize the effects of sulfuric acid and spread it throughout the atmosphere (Spiro et al.,2012).

The two main ways that are currently used focus on removing the hydrogen sulfide before it reaches the turbine and after it reaches the turbine. The first method is to allow the hot water steam and hydrogen sulfide to come in contact with copper sulfate which results in a reaction producing elemental sulfur. The second method is to use an alkaline solution like sodium hydroxide. There are many ways that the hydrogen sulfide can be removed after the steam reaches the turbine. The three categories are off-gas methods, condensate water methods, and hybrid systems. Off-gas methods use a non-condensable gas removal system to remove hydrogen sulfide from the gas, while condensate water methods use either a hydrogen peroxide treatment or waste steam treatment to remove the hydrogen sulfide. Lastly, hybrid systems can treat either the steam that exits the condenser or the condensate steam to remove the hydrogen sulfide. All these methods are highly advanced and based on each situation, one is chosen to remove the pollutant. For example, the use of a waste stream to remove the hydrogen peroxide after it has reached the turbine is cheap which makes it optimal for larger power plants.

Another issue with using and converting to geothermal energy as a renewable source is scarcity. While it has been, in the past, difficult to identify areas where geothermal energy can be harnessed, new research has found an innovative way to find areas that are less environmentally sensitive.

2.4. Ozone (O_3)

Ground-level ozone is not directly emitted into the air, but rather is formed by chemical reactions between NOx and volatile organic compounds (VOCs) in the presence of ultraviolet (UV) radiation. Ozone is a primary component of smog.

Breathing ozone can trigger a variety of health problems including chest pain, coughing, throat irritation, and congestion. It can also worsen bronchitis, emphysema, and asthma as well as reduce lung function and inflame the linings of the lungs, permanently scarring lung tissue under repeated exposure.

2.5. Particulate Matter (PM)

Particulate matter is the term for particles and aerosols found in the air, including dust, dirt, soot, smoke, and liquid droplets, and can be large and dark enough to be seen with the naked eye or so small that they can only be detected with an electron microscope. Particulate matter is one of the most harmful emissions. Their hazardous nature derives from their size, for example, particles ranging from 10 microns (PM_{10}) to 1 micron (PM_1). In addition to this characteristic, sometimes the nature of the

particle must also be taken into account, since, in the case of asbestos, silica or wood, it can represent an added risk factor. However, many manmade and natural sources emit particulate matter directly while others emit gaseous pollutants that react in the atmosphere to form particulate matter. The size of the particulate has important health considerations. Particulate matter less than or equal to 10 microns in diameter (PM_{10}) poses a health concern because it can be inhaled into and accumulate in the respiratory system. Particulate matter less than or equal to 2.5 microns in diameter (PM2.5) is believed to pose the greatest health risks as it can lodge deeply into the lungs; a $PM_{2.5}$ particles is approximately $1/30^{th}$ the average width of a human hair. Typically, these smaller particles are suspended in the air for long periods of time. Total Particulate Matter (TPM) is the term applied to any particle suspended in the atmosphere, but depending on the monitoring method, is typically limited to particulate matter less than 44 microns. Particulate larger than 10 microns is typically associated with a nuisance issue rather than a health issue.

3. LEGISLATIVE AND ENVIRONMENTAL POLICY FRAMEWORK

3.1. Environmental Management Coordination (Air Quality) regulations 2014

The Kenya Air Quality Regulations 2014 impose limit values as detailed in the SPECIAL ISSUE Kenya Gazette Supplement No.41, Legislative Supplement No.15, Legal Notice No. 34, compliance with the objectives (prevention, control and abatement of air pollution to ensure clean and healthy ambient air) is a legal requirement in Kenya.

Part 65 and 66 details the requirements on monitoring and assessment of ambient air quality, part 85 shows the need for establishment of baseline levels of priority air pollutants listed in the first schedule of the guideline and included PM_{10}, $PM_{2.5}$, SO_2, NO_2, O_3 and CO. Statutory requirements relevant to this study FIRST SCHEDULE are detailed in Table 2 below:

Table 2: Ambient Air Quality Tolerance Limits

	Pollutant	Time weighted Average	Industrial area	Residential, Rural & Other area	Controlled areas***
1.	Respirable particulate matter (<10 µg/m³) (RPM)	24 hours**	150µg/Nm³	100µg/Nm³	75µg/Nm³
2.	$PM_{2.5}$	24 hours	75 µg/m³	-	-
3.	Sulphur dioxide	Instant Peak		500 µg/m³	-
4.		Instant peak (10min)		0.191 ppm	-
5.	Non-methane hydrocarbons	instant Peak	700ppb	-	-
6.	Total VOC	24 hours**	600 µg/m³	-	-
7.	Oxides of Nitrogen	24 hours	100 µg/m³	0.1 PPM	-
8.		Instant peak		0.5 PPM	-
9.	Nitrogen dioxide	One hour		0.2 ppm	-
		Instant peak		0.5 ppm	-
10.	Carbon monoxide / carbon dioxide	One Hour	10 mg/m³	4.0 mg/m³	10 mg/m³
11.	Ozone	24-hour	200 µg/m3	0.12 PPM	-

Extract from the Ambient EMC Air Quality regulations, 2014 (Tolerance Limits)

4. MONITORING METHODOLOGY

It is important to accurately determine prevailing air quality conditions against which predicted effects can be gauged and assessed for any environmental effects' assessment.
Ambient air quality survey for this study consists of **THREE** representative monitoring locations. Information for the report is presented based on air monitoring completed for 3-hour weighted average per locale. For the purpose of the baseline investigation, monitoring of air pollutants was achieved on the 06th day of June 2024 and thereafter the results were compared against the guidelines and standards while attention given to relevant referencing sites of similar nature.
Ambient air quality data were obtained from a validated and approved air quality monitoring program.

4.1. Baseline Study Area;

4.1.1. Sensitive Receptors

The geographical scope of the baseline assessment is currently defined as the proposed 4MW Geothermal Direct Use Power Plant within Menengai Geothermal Field boundaries and environs, including potentially high risk zones along the routes of any existing surface access. High risk zones include locations with the potential for exceedance of regulatory standards for the protection of human health and/or **sensitive habitats**, in the initial and / or mature operations years.

The issue of pollutants is particularly pertinent in areas sensitive to change, often referred to as **'sensitive receptors'**. Locations for the protection of human health are areas of long term exposure which are more susceptible and shall be considered to include residential properties, hospitals and schools; whereas locations for the protection of sensitive habitats / ecosystems shall be considered to include statutory designated sites (such as sites of special scientific interest (SSSIs), special areas of conservation (SACs) and special protection areas (SPAs) which contain habitat types that are also sensitive to atmospheric quality changes.

The proposed site neighbors' Menengai Power Plant West and Sosian Power plant to the East. There are also large chunks of land to the North and South of the project. There are no areas considered to be sensitive receptors within close proximity to the proposed project site.

Close proximity of the emission source to the 'sensitive receptor' causes poor air quality because there is less opportunity for dispersion of emissions between the source and receptor resulting in greater concentrations of pollutants. Air quality is evaluated by comparing concentrations of pollutants against the EMC (Air Quality) regulations 2014 Legal Notice 34 first schedule of the Ambient Air Quality Tolerance Limits set at locations where exposure harm to human health and ecosystems is thought to occur.

4.1.2. Existing Atmospheric Environment

The neighborhood depicts mixed land use including industrial power generation and farmlands. The main source of existing air pollution is diffuse and fugitive emissions of dust particles and gaseous emissions from the industrial power generation and mobile sources. The anthropogenic emission sources directly associated with the proposed project will be the main concern of the appraisal framework and will be emitted from various sources including; mobile sources (cars and heavy goods vehicles that will be accessing the site to offload materials during construction, source emissions (generator), other related source, fugitive and diffuse sources.

The emissions concentrations reported herein, will be a combination of the total emissions from the sources and the distance to the receptor which influences the concentrations of pollutants in the air and impacts air quality. As such, the most common ambient atmospheric emission source causing poor air quality within close proximity to sensitive receptors and the site in general will be source / stack diffuse and fugitive emissions as the dominant emission sources.

4.1.3. Monitoring Locations

Baseline atmospheric quality monitoring locations were selected based on the existing facility that could or have the potential to influence the proposed project atmospheric environment. The monitoring locations at the proposed project site were determined at three project boundaries to the East (PB-1), West (PB-2), and Geothermal Development Company (GDC), Well 18A Site.

Table 3: Description of the measurement locations

Measurement Sites	Receivers	Description of monitoring Locations	Dates of sampling
East Project Boundary 1 (EPB-1) N: -0° 12' 18.072"; E: 36° 05' 43.152"	Sosian Power plant	The proposed site neighbors' Menengai Power Plant West and Sosian Power plant to the East. There are also large chunks of land to the North and South of the project. There are no areas considered to be sensitive receptors within close proximity to the proposed project site	06TH June 2024.
West Project Boundary 2 (WPB-2) N: -0° 12' 16.4664"; E: 36° 05' 41.640"	Menengai Power Plant		06TH June 2024.
Geothermal Development Company (GDC), Well 18A Site (GDCW18) N: -0° 12' 19.332"; E: 36° 05' 41.28"	Farmlands		06TH June 2024.

4.2. Baseline Air Quality Assessment process

The National and Local baseline assessments have been undertaken following the processes shown in Figure 1 and Figure 2 below.

Figure 1: National Baseline Assessment Process

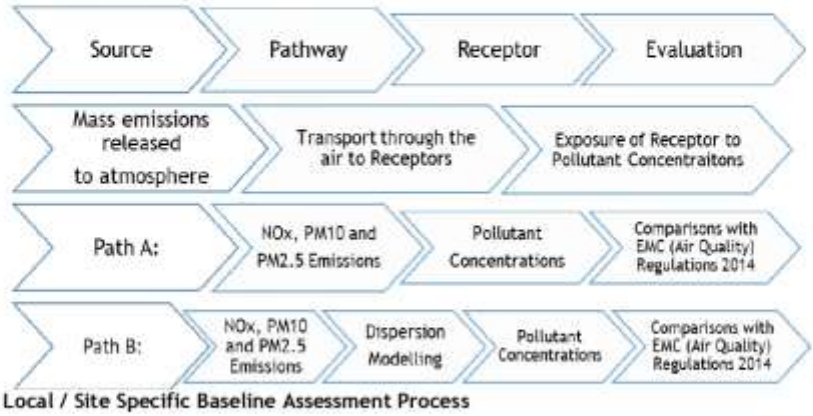


Figure 2: Local / Site Specific Baseline Assessment Process

The local baseline assessment has been undertaken following Process Path A for the first stage assessment.

4.3. Assessment Criteria for gaseous and particulate parameters

Sampling of gases was done using a 24-hour AQM-09 is a device which can monitor the air quality via the value of O_3, SO_2, NO_2, CO, $PM_{2.5}$, PM_{10}, etc. The target value is converted into voltage signal by operational amplifier circuit, and then filtered through high-precision AD data acquisition system. Finally, the gas concentration is calculated by CPU. Particulates mainly use laser scattering method to produce different scattering light according to different particle diameters under laser scattering conditions. The scattered light intensity is collected by a response device, and the particle 4 concentration is obtained after amplification, filtering and AD acquisition. The obtained gas concentration and particulate matter concentration can be displayed on LCD screen in real time, and can also be transmitted to cloud platform or environmental protection platform through GPRS, 4G LTE and other network signals, so as to realize the monitoring of regional environmental quality. The gas meters were mounted at about 1 - 2 M above the ground surface. The results and sampling duration information were used to calculate the gaseous concentrations.

Ongoing atmospheric assessment

Ongoing Atmospheric measurements

4.3.1. Carbon monoxide (CO)

CO monitoring instruments were predominantly gas filter correlation infrared (GFC-IR) absorption analyzers and the electrochemical sensor systems.

Ambient air was continuously sampled using a pump unit and the CO concentration in the sample air was measured by the absorption of infrared radiation at 4.5 to 4.9 nanometers (nm) wavelength. A reference detection system was used to alternately measure absorption due to CO in the ambient air stream and absorption by interfering species. An infrared detector and amplification system produced output voltages proportional to the CO concentration. The concentration was derived from the Beer-Lambert relation:

$$I1 = I0\ e\text{-}alc$$

where the sample was passed through a cell tube of length 'l'. The analyzer alternately measured the absorption I_0 of the air path with no CO present and the absorption I_1 of the ambient sample, with 'a' being the absorption coefficient, to provide the CO concentration, 'c'.

4.3.2. Nitrogen dioxide (NO2)

Nitric oxide (NO) in the sample air stream was reacted with ozone (O_3) in an evacuated chamber to produce activated NO_2:

$$NO + O_3 \rightarrow NO_2 + O_2 \rightarrow NO_2 + O_2 + h\nu$$

The intensity of the chemiluminescent radiation (hν) produced is measured using a photomultiplier tube (PMT) or photodiode detector. The detector output voltage is proportional to the NO concentration. The ambient air sample is divided into two streams; in one, ambient NO_2 is reduced to NO using a molybdenum catalyst before reaction. The molybdenum converter should be at least 95 per cent efficient at converting NO_2 to NO. This gas stream gives total NOx. The second stream measures NO directly by not passing through the molybdenum converter.

Separate measurements are made of total oxides of nitrogen NOx (= NO + NO_2) and NO. The ambient NO_2 concentration is calculated from the difference (NO_2= NOx - NO). This is an important point to remember because the contaminant of interest (NO_2), is actually measured by inference rather than directly, and the efficiency of the molybdenum converter should be checked on a regular basis.

In a chemiluminescent analyzer, ambient air is drawn through the system via a pump and permapure drier unit. NOx analyzers are equipped with either a single or a double reaction chamber and PMT system. A solenoid valve is used to alternately switch between NO and NOx measurements, typically at 15-second intervals.

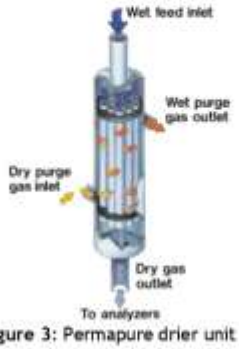


Figure 3: Permapure drier unit

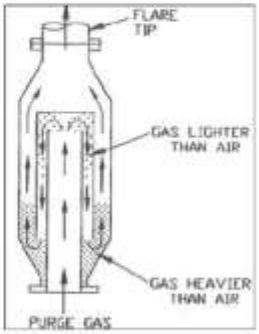


Figure 4: Air purge gas

4.3.3. Sulphur dioxide (SO2)

SO_2 monitoring instruments are predominantly molecular UV fluorescence analyzers. This is the recommended SO_2 monitoring method. UV fluorescence systems operate on the principle that an ambient air sample stream exposed to UV light excites SO_2 molecules in the sample to higher, but unstable, excited states. These excited states decay, giving rise to the emission of secondary (fluorescent) radiation:

$$SO_2 + hv \rightarrow SO_2 \rightarrow SO_2 + hv \text{ (fluorescence)}.$$

The fluorescent radiation is detected by a PMT, causing an output voltage proportional to the SO_2 concentration. A permeable membrane 'kicker' is used to remove interfering hydrocarbons (aromatic hydrocarbons also fluoresce) before reaction. Ambient air is drawn through the system via a pump unit, and the analyzer continuously displays current SO_2 concentrations.

4.3.4. Ozone (O_3)

Ozone was measured using a direct reading using the flame-ionisation detector (FID). In the FID, an organic compound is burned in a hydrogen flame giving rise to ions which are attracted to a collector electrode. The resulting electric current is amplified and recorded. The intensity of the signal depends primarily on the number of carbon atoms of the molecule, but to some extent it is also influenced by the character or structure of the chemical. Therefore, the same number of molecules of two different ozone with the same number of carbon atoms can give rise to two different signals. The FID is very stable.

4.3.5. Total Volatile Organic Compounds (TVOC)

Optical gas detection using absorption spectroscopy is based on the Lambert-Beer law (1,2):

$$I(\lambda)=I_0(\lambda)\exp[-a(\lambda C)\cdot L] \qquad a[\text{cm}^{-1}]$$

$$I(\lambda)=I_0(\lambda)\exp[-\alpha(\lambda)\cdot C\cdot L] \qquad \alpha[\text{ppm}\cdot\text{cm}^{-1}]$$

where: I—light intensity transmitted by the medium with the gas, I_0—intensity of light incident on the medium, C—concentration, a, α—absorption coefficients, and L—optical path length, gas concentration.

The optical methods for volatile organic compounds detection use its absorption characteristics in the infrared range. The strongest bands occur in the area of deformation vibrations and then valence; they are weaker in the range of overtones.

4.4. Tools Equipment and materials used

Below is the equipment used during air monitoring survey:

- Air quality multiparameter meter.
- Geographic Positioning System (GPS)
- Digital camera
- Calibration certificates
- Standard Reference materials & Standard operating procedures
- Equipment manuals.
- Terms of Reference & Maps of the project area

4.5. Monitoring Frequency

Monitoring of air quality test parameters was done for 3 hours in the study location. Once operations are underway, monitoring of air quality parameters should be tested at 3 months' interval.

4.6. Assumptions

The 3-hour exposure levels of data collection for PM_{10}, $PM_{2.5}$, SO_2, NO_x, CO_2, O_3 and H2S data collected is considered sufficient to understand the state of atmospheric air quality environment before implementation of the Geothermal direct use power plant.

4.7. Data Validity and Acceptability

All data monitored in the study was taken through data replications and quality assurance procedure to ensure that any anomalous readings or questionable data is not incorporated in the final results.

Elements of this procedure account for:

- Routine calibration and auditing of the analyzers
- Statistical rendering of outliers

5. PRESENTATION, DISCUSSION & CONCLUSION OF THE AIR QUALITY SURVEY RESULTS

5.1. Presentation of Results

5.1.1. Summary of singular Air quality measurements

Table 4: Summary results for air quality and environmental measurements

Monitoring Locations	$PM_{2.5}$ µg/m³	PM_{10} µg/m³	CO mg/m³	SO_2 ppm	NO_2 ppm	O_3 ppm	H_2S µg/m³	HUMIDITY %	TEMPS °C
East Project Boundary 1 (EPB-1)	2.50	11.80	<0.001	0.0005	0.0011	0.0184	<0.01	45	25.9
West Project Boundary 2 (WPB-2)	4.80	13.67	<0.001	0.0012	0.0018	0.0189	<0.001	47	26.8
North Project Boundary 3 (GDCW-18)	1.60	5.20	<0.001	0.00011	0.0012	0.0164	<0.01	47	27.2

(Source: Site monitoring in June 2024).

5.1.2. Gaseous parameters

Table 5: Average results for gaseous parameters

Monitoring Locations	*NO_2*		*SO_2*		*CO*		*Ozone*		*H_2S*		*REMARKS*
	Conc. (ppm)	EMC AQR guide 2014 (ppm)	Conc. (ppm)	EMC AQR guide 2014 (ppm)	Conc. (mg/m³)	EMC AQR guide 2014 (mg/m³)	Conc. (ppm)	EMC AQR guide 2014 (ppm)	Conc. (µg/m³)	EMC AQR guide 2014 (µg/m³)	
EPB-1	0.0011	0.2	0.0005	0.191	<0.001	4.0	0.0184	0.12	1	150	Complies
WPB-2	0.0018	0.2	0.0012	0.191	<0.001	4.0	0.0189	0.12	1	150	Complies
GDCW-18	0.0012	0.2	0.00011	0.191	<0.001	4.0	0.0164	0.12	1	150	Complies

5.1.3. Particulate matter (PM_{10})

Table 6: Results for Particulate matter (<10 microns)

Monitoring Locations	*PARTICULATE MATTER ≤10 (PM_{10})*			
	Sampling time	Concentration ($\mu g/m^3$)	Guideline ($\mu g/m^3$)	Remarks
EPB-1	1 hour	11.80	-	No 1-Hr guideline for residential, rural and other areas
WPB-2	1 hour	13.67	-	No 1-Hr guideline for residential, rural and other areas
GDCW-18	1 hour	5.20	-	No 1-Hr guideline for residential, rural and other areas

5.1.4. Particulate matter ($PM_{2.5}$)

Table 7: Results for Particulate matter (<2.5 microns)

Monitoring Locations	*PARTICULATE MATTER ≤2.5 ($PM_{2.5}$)*			
	Sampling time	Concentration ($\mu g/m^3$)	Guideline ($\mu g/m^3$)	Remarks
EPB-1	1 hour	2.50	-	No 1-Hr guideline for residential, rural and other areas
WPB-2	1 hour	4.80	-	No 1-Hr guideline for residential, rural and other areas
GDCW-18	1 hour	1.60	-	No 1-Hr guideline for residential, rural and other areas

5.1.5. Environmental parameters

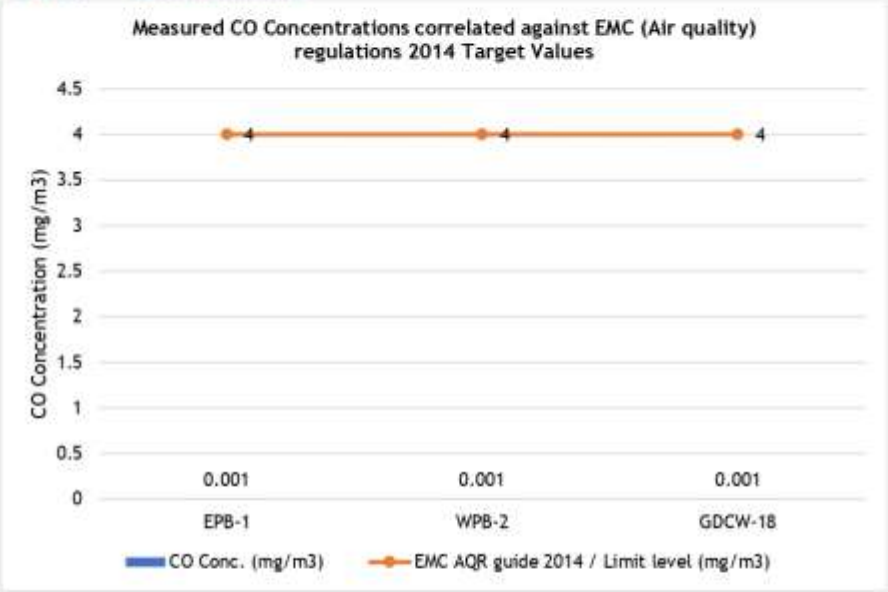
Table 8: Results for Environmental parameters

Monitoring Locations	Environmental parameters				*Remarks*
	Air temps °C	Pressure hPa	Humidity %	Wind Speed km/hr	
EPB-1	25.9	998.7	45	15 km/hr North east wind	Ambient conditions present
WPB-2	26.8	998.7	47	15 km/hr North east wind	Ambient conditions present
GDCW-18	27.2	998.7	47	15 km/hr North east wind	Ambient conditions present
AVERAGES	26.6	998.7	46.3	15 km/hr North east wind	Ambient conditions present

5.2. Discussions of air quality survey results

Air quality survey was completed for 3-hr exposure levels as the preferred time weighted averages in order to measure and quantify the air pollutant levels so as to determine the current existing conditions. Results of the gaseous concentrations and particulate parameters were thereafter correlated against the Environmental Management Coordination (Air quality) regulations of 2014 as follows:

5.2.1. Carbon Monoxide



The above combined graph was drawn from statistical analysis for 1-hr monitoring per location of atmospheric Carbon monoxide environment as per the requirement of TOR.

CO average concentration across the monitoring locations for the time weighted average of 3-hour were below the detection limit (0.001 mg/m^3) of the testing equipment. There was no 1-hour peak exceedance of the AAQTL of 4.0 mg/m^3 thus the frequency of exceedance was zero.

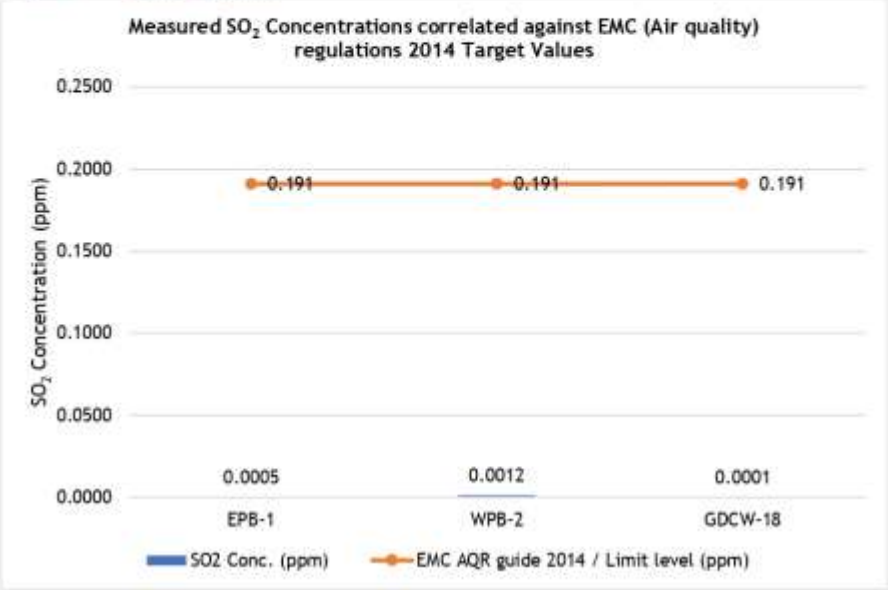
All CO concentrations recorded in the sites before implementation of the Geothermal direct use power plant COMPLIED with the EMC (Air quality) regulations 2014 of 4.0 mg/m^3.

The very low carbon monoxide concentration levels do not pose a health concern. Carbon monoxide is a gas formed by the incomplete combustion of fuels containing carbon.

The main outdoor source of carbon monoxide are motor vehicles, in particular petrol-engine vehicles.

From the above combined graph results, the levels of CO emitted from the proposed site operations does not negatively influence the Environment, health and safety of the recipients / receivers.

5.2.2. Sulfur dioxide



The above combined graph was drawn from statistical analysis for 1-hr monitoring per location of atmospheric sulfur dioxide environment as per the requirement of TOR.

From the above graph, the maximum 1-hour SO_2 average concentration extended to levels 0.0012 ppm at WPB-2 while the minimum 1-hour SO_2 average concentration extended to levels of 0.00011 ppm at GDCW-18. The average SO_2 concentration at the study area extended to levels of 0.0006 ppm. There was no peak exceedance of the AAQTL of 0.191 ppm thus the frequency of exceedance was zero.

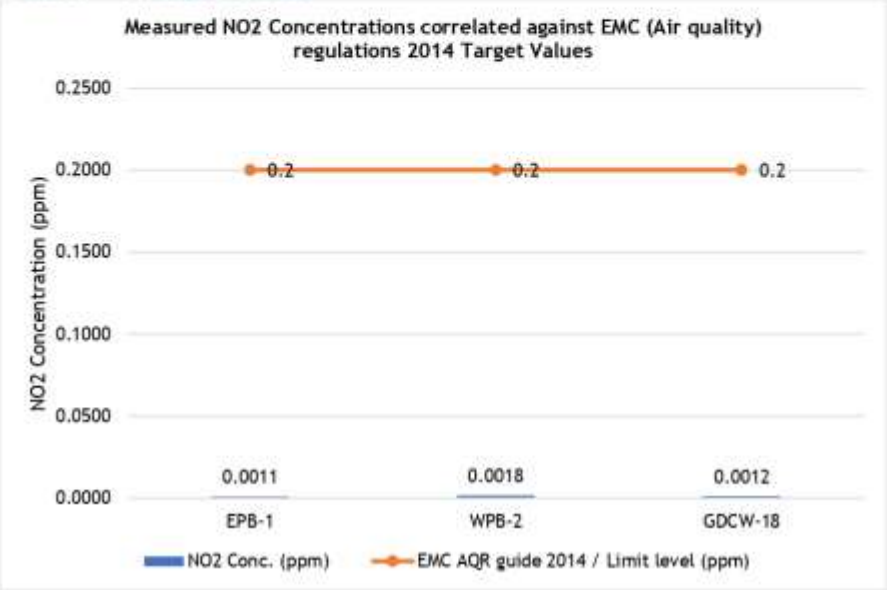
The sulfur dioxide concentrations recorded across all survey locations had concentrations levels within the ambient sulfur dioxide levels of 0.02ppm.

The resultant sulfur dioxide concentrations were correlated with the limit value EMC (Air quality) regulations 2014 maximum limits) for short term exposures. Results showed 100% COMPLIANCE with the limit values.

Low concentration levels of sulfur dioxide recorded before implementation of the proposed Geothermal direct use power plant did not pose any Environmental, Health, Safety and compliance concerns.

Fugitive and diffuse sources i.e. motor vehicles / cycles fuel combustion around the project area contribute about 90% of sulfur dioxide at the proposed site.

5.2.3. Nitrogen dioxides



The above combined graph was drawn from statistical analysis for 1-hr monitoring per location of atmospheric nitrogen dioxides environment as per the requirement of TOR.

From the above graph, the maximum 1-hour NO_2 concentration extended to levels of 0.0018 ppm at WPB-2 while the minimum 1-hour NO_2 concentration extended to levels of 0.0011 ppm at EPB-1 area. The average NO_2 concentration at the study area extended to levels of 0.0014 ppm. There was no peak exceedance of the AAQTL of 0.2 ppm thus the frequency of exceedance was zero.

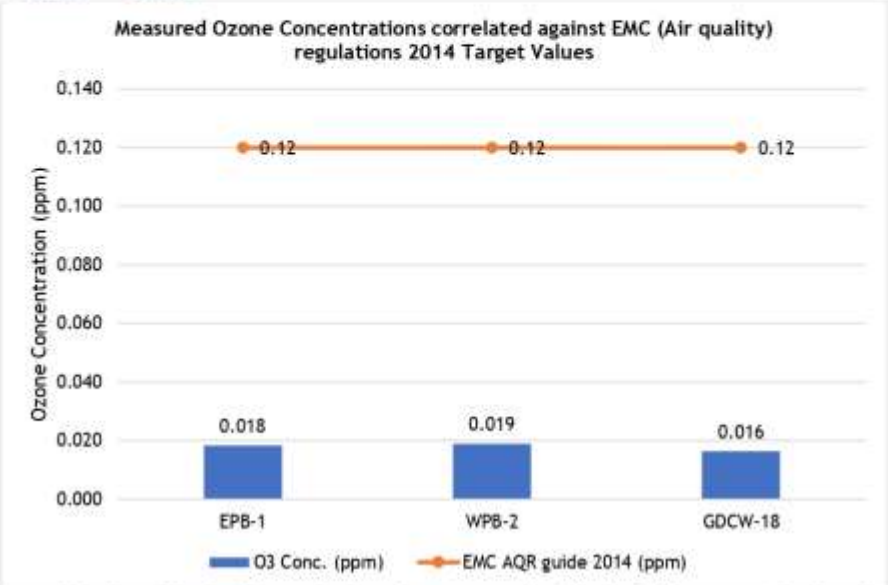
The concentration levels of all recorded nitrogen dioxide gas within the 1-hour survey were all WITHIN the ambient levels (0.05ppm). The uniform distribution of the Nitrogen dioxide concentration reveals that no outlier source influenced the NO_X concentration.

The results for the nitrogen oxide (NO_2) concentrations measured below the air quality guidelines limits. The concentration of NO_2 at the survey locations were 100.00% in COMPLIANCE with the EMC (Air quality) regulations 2014 maximum limits.

The very low NO_2 concentration levels did not pose any Environmental, Health, Safety and compliance concerns to the receiving recipients.

NO_2 is generated due to the oxidation of N2 in the atmosphere at high temperature and due to oxidation of nitrogen compounds in used fuel or due to the reaction of nitrogen radical with hydrocarbons. 90% of the NOx at the proposed project site is attributed to fugitive and diffuse motor vehicles combustion of fuel.

5.2.4. Ozone



The statistical analysis for 3-hr monitoring of ozone as outlined in the TOR was completed at three boundary monitoring locations.

From the above graph, the maximum 1-hour ozone concentration extended to levels of 0.019 ppm at WPB-2 while the minimum 1-hour ozone concentration extended to levels of 0.016 ppm at the GDCW-18. The average O_3 concentration at the study area extended to levels of 0.0175 ppm. There was no exceedance of the 1-hour AAQTL of 0.12 ppm thus the frequency of exceedance was zero.

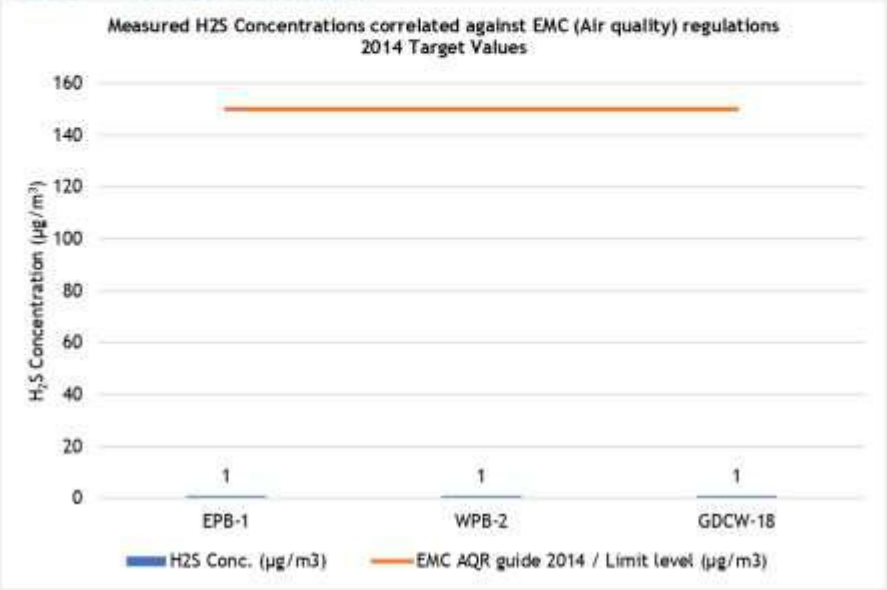
All ozone concentrations recorded in the project sites COMPLIED with the EMC (Air quality) regulations.

The primary natural source of surface O_3 is the subsidence of stratospheric O_3 from the upper atmosphere. In contrast, the primary anthropogenic source of surface O_3 is photochemical reactions involving the atmospheric pollutant carbon monoxide (CO). Ozone at ground level is primarily formed by a complicated series of chemical reactions initiated by sunlight. NO_X and volatile organic compounds (VOCs), derived mainly from man-made sources, react to form ozone. These substances are produced by combustion, industrial processes and activities such as solvent use and petrol distribution and handling. NO_X and VOCs are the most important precursors of elevated levels of O_3.

Motor vehicles account for 40% of the ground level ozone at site. These chemical reactions do not take place instantaneously, but over several hours or even days depending on the VOCs, and once ozone has been produced it may persist for several days. Ozone measured at a particular location may therefore have arisen from VOC and NOx emissions many kilometres away, and may then travel further. Maximum concentrations, therefore, generally occur downwind of the source areas of the precursor pollutant emissions.

Low concentration levels of Ozone recorded before implementation of the proposed Geothermal direct use power plant did not pose any health, safety, environment and compliance concerns to the recipients.

5.2.5. Hydrogen Sulfide (H_2S)



The statistical analysis for 1-hr monitoring of H_2S as outlined in the TOR was completed at each of the three monitoring locations.

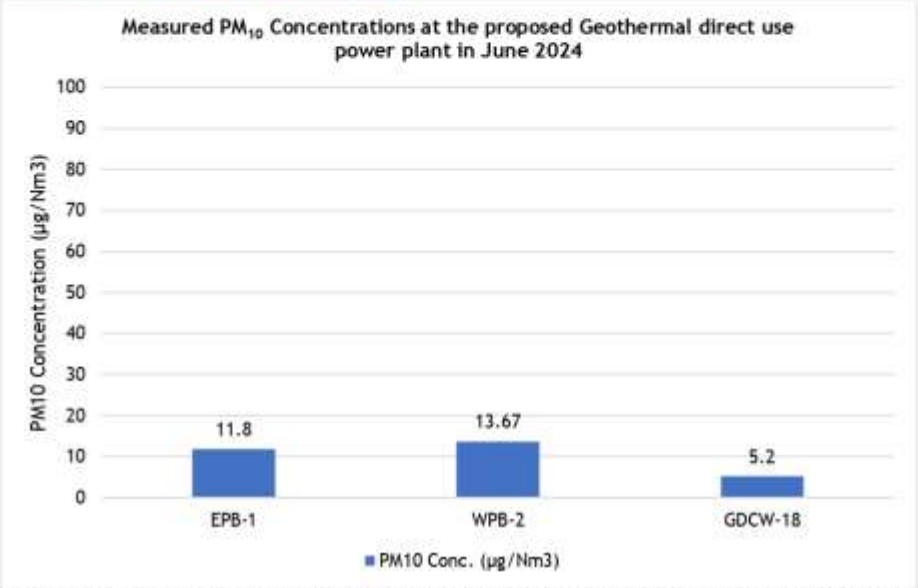
The average H2S concentration across the monitoring locations for the time weighted average of 1-hour were below the detection limit (0.001 mg/m^3) of the testing equipment. There was no 1-hour peak exceedance of the AAQTL of 150 $\mu g/m^3$ thus the frequency of exceedance was zero.

All H_2S concentrations recorded in the proposed project site before implementation of the Geothermal direct use power plant COMPLIED with the EMC (Air quality) regulations 2014 of 150 $\mu g/m^3$.

The concentration values of hydrogen sulfide recorded were considered to be within the typical range of emissions for such neighborhood.

The very low hydrogen sulfide concentration levels do not pose any notable Environmental, Health, Safety and compliance concerns to the sensitive receptors.

5.2.6. Particulate matter (PM_{10})



The statistical analysis for the combined 3-hr monitoring of Particulate matter <10 ug/m^3 as outlined in the TOR was completed.

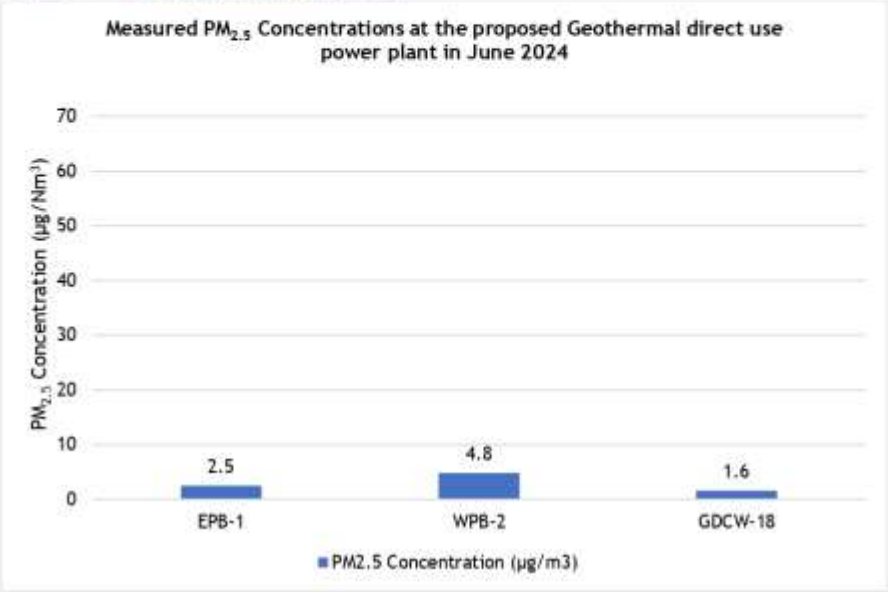
From the above graph, the maximum 1-hour PM_{10} concentration across WPB-2 section extended to levels of 13.67 ug/m^3 while the minimum 1-hour PM_{10} concentration along the GDCW-18 section extended to levels of 5.20 ug/m^3. The overall average PM_{10} concentrations of the project area over the 3-hour assessment extended to levels of 10.22 ug/m^3.

The concentration of PM_{10} across all the survey locations were within the normal and acceptable levels of such neighborhood.

Unlike the individual gaseous pollutants, which are single, well-defined substances, particles (PM_{10}) in the atmosphere are composed of a wide range of materials arising from a variety of sources. Concentrations of PM_{10} comprise: primary particles, arising from combustion sources (mainly motor vehicles emissions, which in the proposed site contribute -70%); secondary particles, mainly sulphate and nitrate formed by chemical reactions in the atmosphere; and coarse particles, suspended soils and dusts, biological particles and particles from construction work and marram roads. The relative contribution of each source type varies from day to day, depending on meteorological conditions and quantities of emissions from mobile and static sources.

From the above combined graph results, the levels of PM_{10} released through existing operations on the proposed site operations does not pose Environment, health, safety and compliance concerns before implementation of the proposed Geothermal direct use power plant.

5.2.7. Particulate matter ($PM_{2.5}$)



The statistical analysis for the 3-hr monitoring of particulate matter $PM_{2.5}$ as outlined in the TOR was completed at three survey locations.

From the above graph, the peak 1-hour $PM_{2.5}$ concentration extended to levels of 4.8 µg/Nm^3 at WPB-2. Similarly, the minimum 1-hour $PM_{2.5}$ concentration extended to levels of 1.6 µg/Nm^3 at GDCW-18.

There are No 1-Hour guideline for residential, rural and other areas given under the EMC (Air quality) regulations 2014 for comparison of results. No comparisons were made against the regulation. However, the concentration values of $PM_{2.5}$ recorded seems to be within the typical range of emissions for such neighborhood.

The main sources of atmospheric particulate matter were primarily the burning of fuel from automobiles.

The fine particle fraction ($PM_{2.5}$) is composed predominantly of primary and secondary particles. Particles in the range from $PM_{2.5}$ - PM_{10} generally consist of coarse particles.

From the above combined graph results, the levels of $PM_{2.5}$ released through existing proposed site operations does not pose any Environment, health, safety and compliance concerns to the recipients / receivers before implementation of the proposed Geothermal direct use power plant.

5.3. FIELD NOTES AND OBSERVATIONS:

Ambient air quality measurements were taken for short term exposure levels. It should however be noted that this exercise is only applicable to the time period when sampling took place and does not take into account seasonal and other local various that might occur during other months and times. However, it is still a good general overview of the existing air quality environment.

5.3.1. Sensitive receptors

The proposed site neighbors' Menengai Power Plant West and Sosian Power plant to the East. There are also large chunks of land to the North and South of the project. There are no areas considered to be sensitive receptors within close proximity to the proposed project site

5.3.2. Potential Pollution causes;

From the site visits and background site description, the following sources have been identified as potential pollution causes at the proposed site;

Exhaust gases:

The survey location is accessible to motor vehicles that utilize diesel and petrol. Vehicle and motorcycle exhausts contain a number of pollutants including carbon dioxide (CO_2), carbon monoxide (CO), hydrocarbons, oxides of nitrogen (NOx), sulphur and PM_{10}. The quantity of each pollutant emitted depends upon the type and quantity of fuel used, engine size, speed of the vehicle and abatement equipment fitted. Once emitted, the pollutants are diluted and dispersed in the ambient air.

Vehicular movement;

Re-suspension of roadside dust from movement of vehicles resulted in generation of relatively higher fraction of finer dust ($PM_{2.5}$). Significant atmospheric dust arose from the mechanical disturbance of granular soils materials exposed to the air from motor vehicle / cycle movement. Pulverization and abrasion of surface materials by application of vehicular mechanical forces generate substantial amount of dust.

5.4. Air Quality Survey Conclusions

Baseline Atmospheric Environment Monitoring was conducted to characterize the existing environment before implementation (DO MINIMUM) of the proposed Geothermal direct use power plant. The conclusions below were drawn from the exercise conducted on the 06th June 2024.

Gaseous Parameters:

All gaseous parameters (carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone and total volatile organic compounds) were measured and quantified at all the three survey locations.

Before the project implementation of the proposed Geothermal direct use power plant, all measured gaseous parameters COMPLIED with the EMC (Air quality) regulations 2014 limits.

The ambient air quality data (gaseous) measured around the monitoring locations are considered to be within a typical range of emissions for such neighborhood.

The findings of the gaseous monitoring program indicate that the air quality at the proposed Geothermal direct use power plant is generally good before commissioning of the project. All pollutants measured are at levels that do not pose Environmental, Health, Safety and compliance concern.

The practices in place to control and manage gaseous pollutants should be maintained.

Meteorological Parameters:

The monitoring locations in general showed Standard atmospheric environment before project implementation due to the combination of good climate and ambient conditions. Weather and Climatic conditions of the proposed Geothermal direct use power plant provided good dispersion of air contaminants.

Particulate Matter (PM_{10} and $PM_{2.5}$):

Particulate parameters concentrations (PM_{10} and $PM_{2.5}$) were measured and quantified across the survey stations.

Before the project implementation of the proposed Geothermal direct use power plant, all measured particulate parameters COMPLIED with the EMC (Air quality) regulations 2014 limits.

$PM_{2.5}$ and PM_{10} concentration levels recorded were within the typical range of emissions for similar neighborhood.

The findings of the monitoring program indicate that the particulate matter atmospheric environment is generally good before the proposed Geothermal direct use power plant implementation. Particulate pollutants measured are at levels that do not pose Environmental, Health, Safety and compliance concern.

Once construction and operations begin, the client is expected to maintain the background / baseline levels.

5.5. Recommendations

When operations / commissioning take effect, greenhouse gas measurements and sampling should be frequently done in order to build up a robust dust and gaseous management plan.

6. REFERENCES

1) Environmental Management and Coordination Act (EMCA) 1999 (amended 2015).
2) Environmental Management Coordination (Air Quality) Regulations 2014 (Legal Notice No.34).
3) Environmental Protection Agency. (1976) Quality Assurance Handbook for Air Pollution Measurement Systems - Volume 1 Principles. EPA-600/9-76-005, Research Triangle Park, NC.
4) Quality Assurance and Quality Control (QA/QC) Procedures for UK Air Quality Monitoring under 2008/50/EC and 2004/107/EC
5) U.S. Environmental Protection Agency (2000) Guidance for Data Quality Assessment - Practical Methods for Data Analysis, EPA Report QA G-9 QA00 Update, Washington DC, July 2000. This document can be downloaded from website: http://www.epa.gov/quality/qs-docs/g9-final.pdf
6) U.S. Environmental Protection Agency. (1998) EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, Report EPA/600/R-98/018, EPA Project Boundary 2 (PB-2) or Research and Development, Washington DC. This document can be downloaded from website: http://www.epa.gov/swerust1/cat/epaqag5.pdf.

APPENDIX A:
EQUIPMENT CALIBRATION CERTIFICATES

Calibrate report

Product	Air Quality Monitor System	Model	AQM-09
Quantity	1pcs	Cali date	October, 19, 2023
Product No.	OC202205074030080		
Appearance	☑Clean ☑Non corrosive ☑No damage		
Gas type	NO2: ppb SO2:ppb TVOC:ppm O3:ppb H2S:ppm PM2.5:ug/m³ PM10:ug/m³ TSP:ug/m³ Wind veloci: m/s Wind direct: Atmospheric : hpa Noise:dB Temperature and humidity: ℃/%RH		
Accuracy	± 3%F.S		
resolution	0.1ppm 1ppb 1ug/m³		
Response time	≤ 30S		
Survey range	NO2:0-2000ppb SO2:0-2000ppb H2S:0-100ppm O3:0-2000ppb TVOC:0-50ppm PM2.5:0-1000ug/m³ PM10:0-1000ug/m³ TSP:0-1000ug/m³ Windveloci:0-60m/s Winddirect:0-360 Atmospheric :600-1100 hpa Temperature: -20-50℃ Humidity:0%-100%RH Noise:30-130dB		
Signal output mode	4G LTE		
Power supply voltage	AC 240V/50Hz		
Power dissipation	≤ 30W		
[illegible]	-20℃-50℃ / 0%RH-100%RH		
Testing condition indoor	Temperature: 25℃ Humidity: 60%RH		
Calibration gas	SO2 O3 NO2 TVOC H2S		
Cali gas test	1.H2S: Cali gas concentration: 50 ppm Inspect concentration: 41.8 ppm 2.SO2: Cali gas concentration: 1000 ppb Inspect concentration: 1.09 ppb 3.O3: Cali gas concentration: 1000 ppb Inspect concentration: 979 ppb 4.NO2: Cali gas concentration: 1000ppb Inspect concentration: 999 ppb 5.TVOC: Cali gas concentration: 50 ppm Inspect concentration: 4.37 ppm 6.PM2.5:Measured value: 14 ug/m³ PM10:Measured value: 26 ug/m³ 7.TSP:Measured value: 21 ug/m³ Atmospheric:Measured value: 1663 hpa 8.Wind veloci:Measured value: 1-3 m/s Wind direct:Measured value: 217 9.Noise:Measured value: 72 dB 10.Temperature: Measured value: 24.3℃ Humidity:Measured value: 58 %RH		
Test result	Qualified		
Remark			

Check: QC PASS 01 Approval: QC PASS 02 Tester: QC PASS

Company: Henan Oceanus Import & Export Co., Ltd.

Date: October, 19, 2023

APPENDIX B:
LABORATORY DESIGNATION CERTIFICATES

nema

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY

Mobile Lines: 0724-253 398, 0723-363 010, 0735-013 046
Telkom Wireless: 020-2101370, 020-2183718
Incident Lines: 0786-101100, 0741-101100

P.O. Box 67839, 00200
Popo Road, Nairobi, Kenya
E-mail: dgnema@nema.go.ke
Website: www.nema.go.ke

NEMA/21/2/LAB 77/LLL **20th April, 2023**

Lahvens Limited Laboratory
Lahvens House,
P.O. Box 34153-80118
MOMBASA.

RE: LABORATORY DESIGNATION BY NEMA.

Pursuant to your application for designation, your laboratory was inspected and evaluated based on ISO 17025 for laboratory competence to carry out tests and samplings.

The Lahvens Limited Laboratory qualified and has in principle been designated to undertake **Air Quality Analysis (Stack Emission and Ambient Air) and Noise Level Measurements** subject to the attached terms and conditions.

However, pursuant to section 119 of EMCA 1999 the Gazettement will take effect once the Authority places a notice in the Kenya Gazette.

DAVID ONGARE
For: DIRECTOR GENERAL

Our Environment, Our Life, Our Responsibility

ISO 9001:2015 Certified

AMBIENT ACOUSTIC LEVELS TEST REPORT.

ENVIRONMENTAL BASELINE STUDY REPORT FOR AMBIENT ACOUSTIC EMISSIONS LEVELS MONITORING OF PROPOSED 4 MEGAWATT (MW) GEOTHERMAL DIRECT USE POWER PLANT WITHIN MENENGAI GEOTHERMAL FIELD IN NAKURU COUNTY.

PROJECT INFORMATION:

PREPARED FOR:
KARSAN RAMJI AND SONS LIMITED,
P.O. BOX 48838-00100,
NAIROBI, KENYA.

CLIENT ADDRESS:

PREPARED BY:
LAHVENS LIMITED
P.O BOX 34153, 80118.
DESIGNATION LAB REF. NO. NEMA/21/2/LAB77/LLL
EMAIL: lahvens@lahvens.com

TESTING CONSULTANTS:

DOCUMENT ID: 50124-0057 B
TEST DATES: JUNE 06TH 2024
(FINAL) REPORT ISSUED: JULY 04TH, 2024

DOCUMENT INFORMATION:

KRSL	ENVIRONMENTAL BASELINE STUDY REPORT FOR AMBIENT ACOUSTIC EMISSIONS LEVELS MONITORING OF THE PROPOSED 4 MEGAWATT (MW) GEOTHERMAL DIRECT USE POWER PLANT WITHIN MENENGAI GEOTHERMAL FIELD IN NAKURU COUNTY	REPORT REF NO.: 50124-0057B REPORT TITTLE: EBSAAQMR-57B DOI: 06TH JUNE 2024 PAGE NUMBER PAGE | 2

DOCUMENT REVIEW PAGE

This Technical report titled ENVIRONMENTAL BASELINE STUDY REPORT FOR AMBIENT ACOUSTIC EMISSIONS LEVELS MONITORING OF THE PROPOSED 4 MEGAWATT (MW) GEOTHERMAL DIRECT USE POWER PLANT WITHIN MENENGAI GEOTHERMAL FIELD IN NAKURU COUNTY, was authored by Lahvens Limited in accordance to the EMC (Excessive Noise and Vibration Regulations) (control) 2009, Legal Notice 61.

REVISION HISTORY

03	04.07.2024	Issuance of Final Report		
02	26-06-2024	Re-submission to close the given comments and approvals		
01	21-06-2024	1st draft issue of the soft copy submitted for review		
REV	DATE	DESCRIPTION		
Accepted by				
Reviewed & Approved by		LOVANS ROBERT SPOO - LABORATORY DIRECTOR. N.E.R. NO.: 7165		04-07-2024
Prepared by		VINCENT AGIN - FIELD ATTENDANT		04-07-2024
		VALENTINE AGUTU - FIELD ATTENDANT		04-07-2024
PROJECT:		Name:		Date:

DOCUMENT & PROJECT PARTICULARS

DOCUMENT REF: 50124-0057 B	CLASSIFICATION: A - UNCLASSIFIED (OPEN REPORT)	CONTRACT NO. AS PER EECL TOR.	REVISION: 00 FINAL
TEST FIRM CONTACT PERSON: LOVANS SPOO: (254 - 728716948)	PROJECT: 4 MEGAWATT (MW) GEOTHERMAL DIRECT USE POWER PLANT		NUMBER OF PAGES: 31
AUTHOR(S): VINCENT OKUMU, VALENTINE AGUTU		QUALITY CONTROLLER: LOVANS ROBERT SPOO	

ABSTRACT (ENGLISH TITTLE):
Karsan Ramji and Sons Limited through Envasses Environmental Consultants contracted Lahvens Limited to form part of the Project's Environmental Team (ET). LAHVENS Limited was commissioned to provide consulting services of environmental baseline acoustic emissions levels monitoring before implementation of the proposed 4MW Geothermal direct use power plant within Menengai Geothermal field in Nakuru County.

KEY WORDS:
EBS Acoustic Emissions Level Monitoring and Consultant Reporting.

ABSTRACT (in ENGLISH) | PUBLICATION TYPE: Digital document (pdf)

KRSL: ESIA Study Report for proposed 4 MW geothermal power plant Page 128

REVIEW AND CERTIFICATION FROM THE TESTING CONSULTANTS:

All work, calculations, other activities, and tasks performed and documented in this report were carried out under my direction and supervision. This test project conforms to the requirements of Lahvens Limited's quality manual and EMC (Excessive Noise and Vibration Regulations) (control) 2009, Legal Notice 61.

Team Leader: VALENTINE ODUOR

Signature:

Date: 04-07-2024

I have reviewed all testing details, calculations, results, conclusions and other appropriate written material contained herein, and hereby certify that the presented material is authentic and accurate.

Reviewer: LOVANS ROBERT SPOO

Title: LABORATORY DIRECTOR

Signature:

Date: 04-07-2024

CERTIFICATION FROM THE LEGAL ENTITY OF THE TESTING FACILITY:

I have reviewed the information being submitted in its entirety. Based on the information and belief formed after reasonable inquiry, I certify that the statements and information contained in this submittal are true, accurate and complete.

Signature

4/07/2024
Date

Omar Said
Name Printed

MD
Tittle

Kawsan Ramji & Shs Limited
Company Name

Company stamp

EXECUTIVE SUMMARY

Lahvens Limited, a NEMA designated laboratory, carried out the baseline ambient Acoustic environment survey at the proposed 4MW Geothermal Direct Use Power Plant within Menengai Geothermal Field in Nakuru County on the 06th June 2024. Acoustic Environment survey was conducted to determine the EXISTING (Do minimum) noise emissions around the proposed project for Environmental, Health, Safety and compliance purposes. The proposed 4MW Geothermal Direct Use Power Plant within Menengai Geothermal Field in Nakuru County will be situated at Latitude 0°12'16.21"S and Longitude 36°05'43.40"E. The proposed site neighbors' Menengai Power Plant West and Sosian Power plant to the East. There are also large chunks of land to the North and South of the project. The project will involve construction, installation, operation and possible decommissioning of a 4 Megawatt well head generation unit, drying plant and cooling towers. The power plant will be connected to MW-18A to tap steam and brine to generate electricity for use in proponents' cement manufacturing factory and dry pozzalana respectively. The well pad is composed of two wells with a production well (MW-18A), separator, water tank, and an atmospheric flash tank. The two-phase main pipeline will be approximately 100 m long connected to a Webre separator, a cyclone-type separator based on centrifugal force induced by tangential inlet, where the water droplets are forced to the outside of the spiral path and steam stream exits from the bottom of the separator.

Construction of any new facilities can lead to significant noise pollution. These emissions are the result of possible demolition work, the movement of machinery or the transport of construction materials. According to the World Health Organization (WHO), excessive noise from construction seriously harms human health and interferes with people's daily. It can disturb sleep, cause cardiovascular and psychophysiological effects, cause heart attacks, reduce performance and provoke annoyance responses and changes in social behavior. The overlooked threat of noise pollution can cause a number of short and long-term health problems, such as sleep disturbance, cardiovascular effects, poorer work and school performance, hearing impairment and more. According to OSHA, Exposure to loud noise kills the nerve endings in our inner ear. More exposure will result in more dead nerve endings.

After construction and the geothermal plants are operational, Noise geothermal activity arises a number of sources. The release of geothermal fluids and gases from underground reservoirs whether purposefully extracted as a resource for energy supply, or as a natural surface expression involves the release of energy and will generate noise.

The development of a steam field by drilling geothermal wells itself is a noise source. Drilling involves the use of large sized mud pumps, compressors, hydraulic pumps and generators. The drilling operation is usually carried out on a 24-hour basis and noise impact during night time (when existing ambient sound levels are at their lowest) can be significant. For typical drilling rigs, noise from 24-hour activity is unlikely to be an environmental issue beyond 500 700 metres.

Once the well has been drilled there are two important phases in terms of noise emissions. Purging of the well via vertical discharge is a short term activity (a few hours in duration) that is required to remove drilling debris. The geothermal fluid is directly vented vertically from the wellhead and can generate sound power levels at source of 140dBA.

Acoustic Environment Monitoring was conducted to determine the extent of pollution around the site existing economic and industrial operations for Environmental, Health, Safety and compliance purposes

before the implementation of the proposed 4MW GEOTHERMAL DIRECT USE POWER PLANT. The results will thereafter be used to assess compliance through comparisons against the Environmental Management Coordination (excessive noise and vibration controls) regulations 2009. A report on the findings will then be prepared and published.

Noise environment remains a valued component in this environmental assessment because of their fundamental significance to the well-being of humans and wildlife.

This report identifies baseline information relating to acoustic emissions levels within study area in Menengai geothermal field in Nakuru county. The baseline provides the 'do minimum' (without the proposed 4MW geothermal direct use power plant) scenario taking account of the proposed changes to the land use.

The baseline acoustic emissions report considers the total emission of key acoustic parameters associated with 4MW geothermal direct use power plant activities. These are Noise equivalent levels (LAeq), maximum noise levels recorded (Lmax) and minimum noise recorded (Lmin). The current concentrations of these pollutants are at risk of exceeding their respective Limit Values when the project commissions. The estimates of the existing concentrations will be measured and compared to any relevant existing information and when the project commences, will be used as the background data. Relevant available information related to the pre-development ambient acoustic emissions level in the environment was looked into while identifying the major existing acoustic emission sources in the environment and the existing sensitive pollution areas in the environment.

Reference is made to the EMCA Legal Notice 61 First Schedule Extract, Acoustics – Determination of noise exposure and estimation of noise-induced hearing impairment recognizing the fact that any person emitting noise in excess of noise emission standards commits an offence therefore legalizing the process of compliance with the set emission goals, permissible standards, control strategies and technologies for noise emission as mandatory.
Acoustic Environmental Baseline Study is a significant component of monitoring programs for successful development activities. This Environmental Baseline Study is designed to characterize the acoustic environment at the proposed project site prior to commencement of construction of the proposed 4MW geothermal direct use power plant. EBS will provide a benchmark and reference against which to compare the acoustic conditions influenced by the construction and operation of the 4MW geothermal direct use power plant. The information will be used to assess the effectiveness of any proposed mitigation measures and to implement adaptive management, if needed.

A baseline noise survey consisting of an operator attended noise measurements (OANM) was performed on the proposed site in Menengai geothermal field in Nakuru County. Lahvens Limited operated three mobile stations across the project boundary locations (3) as part of its noise levels monitoring networks on the 06th June 2024.

Acoustic / Noise emission survey was achieved via initial examination of existing noise sources of significance. Noise levels was evaluated using a Sound Level Meter Model UT - 351, C150107874. SLM was mounted on at 2.0m above ground level and at least 3.5m away from any sound reflecting surfaces at a boundary position and measurements taken at timed intervals of 15 minutes every one-hour period and stored in SLM's memory. The sound level meter was placed on the microphone to reduce any wind interference during measurements. The sound level meters, were within their calibration period, at the

time of monitoring. In addition, the equivalent noise level (Leq), the maximum sound pressure level (Lmax) and the minimum sound pressure level (Lmin) during that measurement period were recorded.

Factors such as time, duration and predictability of the noise emission, amplitude and frequency of the noise emission, nature of the source, location of noise sensitive receptors, ambient and background noise level, nature and character of the locality, presence of special acoustic characteristics and the incongruity or familiarity of the noise during noise survey and site placement were put into consideration.

Field Observations:

Sensitive Receptors;

The proposed site neighbors' Menengai Power Plant West and Sosian Power plant to the East. There are also large chunks of land to the North and South of the project. There are no areas considered to be sensitive receptors within close proximity to the proposed project site.

Existing Acoustic Environment;

The neighborhood depicts mixed land use including industrial power generation and farmlands. The main source of existing noise pollution are the mobile sources such as visiting motor vehicles, fugitive acoustic emissions and environmental noise. The acoustic emission sources directly associated with the proposed project will be the main concern of the appraisal framework and will be emitted from various sources including; construction equipment, mobile sources, source emissions (generators) and environmental noise. The emissions concentrations reported herein, will be a combination of the emissions from the sources and the distance to the receptors which influence the levels of noise emissions and quality of life. As such, the most common ambient acoustic emission source within close proximity to sensitive receptors and the site in general will be fugitive emissions as the dominant emission sources.

RESULTS AND CONCLUSIONS:

Noise measurements was initiated to obtain and quantify the prevailing and existing ambient acoustic levels before implementation of the proposed geothermal direct use power plant. The obtained acoustic results were thereafter correlated against the Environmental Management Coordination (Excessive noise and vibration regulations) 2009 to ascertain compliance.

The highest diurnal noise emissions recorded at the West Project Boundary 2 (WPB-2) of the site extended to levels of 49.30 dBA while the lowest diurnal noise emission recorded at the Geothermal Development Company (GDC), Well 18A Site extended to levels of 44.0 dBA. The average Leq noise levels in the proposed geothermal direct use power plant averaged 46.3 dBA. The average noise levels across all the survey locations complied with the EMC noise and vibrations regulations of 2009.

The average diurnal noise equivalent levels (Leq) along all the three survey locations complied with the EMC noise and vibration regulations 2009 before commencement of the proposed 4MW geothermal direct use power plant.

This ambient noise measurement report documented the current noise levels and meteorological conditions for the proposed 4MW geothermal direct use power plant as follows:

The quantity of noise measured and recorded along the project boundaries complied with the EMC noise and vibration regulations 2009 maximum Noise Level Permitted (Leq) during the day before implementation of the proposed 4MW geothermal direct use power plant development.

Baseline results obtained along the project boundaries show that the survey location was a noise insignificant area hence the levels do not pose threat to the sensitive receptors before implementation of the proposed 4MW geothermal direct use power plant development.

Ambient conditions existed at the time of the diurnal survey.

Environmental noise (Wind breeze) and noise emissions from motor vehicles were the main sources of noise emissions.

The proposed site was marked with no project related activities during the measurements.

The levels of noise recorded from existing operations does not pose any Environmental, Health and Safety concerns before implementation of the 4MW geothermal direct use power plant project.

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DEFINITIONS.

Table 1: List of acronyms

dBA	Decibels (A) weighted
CBS	Comprehensive Baseline Study
EMC	Environmental Management and Coordination
EBS	Environmental Baseline Study
GPS	Geographic Positioning System
hpa	Hectopascal
KRSL	Karsan Ramji & Sons Limited
km/hr	Kilometer per hour
Leq	Noise equivalent noise
Lmax	Maximum Sound Level
Lmin	Minimum Sound Level
MW	Megawatt
NEMA	National Environment Management Authority
OSHA	Occupational Safety and Health Administration's
SLM	Sound Level Meter
TWA	Time Weighted Average
WB	World bank
WHO	World Health Organization

1. INTRODUCTION

1.1. Project Summary and objectives:

Lahvens Limited, a NEMA designated laboratory, carried out the baseline ambient Acoustic environment survey at the proposed 4MW Geothermal Direct Use Power Plant within Menengai Geothermal Field in Nakuru County on the 06th June 2024. Acoustic Environment survey was conducted to determine the EXISTING (Do minimum) noise emissions around the proposed project for Environmental, Health, Safety and compliance purposes. The proposed 4MW Geothermal Direct Use Power Plant within Menengai Geothermal Field in Nakuru County will be situated at Latitude 0°12'16.21"S and Longitude 36°05'43.40"E. The proposed site neighbors' Menengai Power Plant West and Sosian Power plant to the East. There are also large chunks of land to the North and South of the project. The project will involve construction, installation, operation and possible decommissioning of a 4 Megawatt well head generation unit, drying plant and cooling towers. The power plant will be connected to MW-18A to tap steam and brine to generate electricity for use in proponents' cement manufacturing factory and dry pozzalana respectively. The well pad is composed of two wells with a production well (MW-18A), separator, water tank, and an atmospheric flash tank. The two-phase main pipeline will be approximately 100 m long connected to a Webre separator, a cyclone-type separator based on centrifugal force induced by tangential inlet, where the water droplets are forced to the outside of the spiral path and steam stream exits from the bottom of the separator.

Construction of any new facilities can lead to significant noise pollution. These emissions are the result of possible demolition work, the movement of machinery or the transport of construction materials. According to the World Health Organization (WHO), excessive noise from construction seriously harms human health and interferes with people's daily activities at school, at work, at home and during leisure time. It can disturb sleep, cause cardiovascular and psychophysiological effects, cause heart attacks, reduce performance and provoke annoyance responses and changes in social behavior. The overlooked threat of noise pollution can cause a number of short and long-term health problems, such as sleep disturbance, cardiovascular effects, poorer work and school performance, hearing impairment and more. According to OSHA, Exposure to loud noise kills the nerve endings in our inner ear. More exposure will result in more dead nerve endings.

After construction and the geothermal plants are operational, Noise geothermal activity arises a number of sources. The release of geothermal fluids and gases from underground reservoirs whether purposefully extracted as a resource for energy supply, or as a natural surface expression involves the release of energy and will generate noise.

The development of a steam field by drilling geothermal wells itself is a noise source. Drilling involves the use of large sized mud pumps, compressors, hydraulic pumps and generators. The drilling operation is usually carried out on a 24-hour basis and noise impact during night time (when existing ambient sound levels are at their lowest) can be significant. For typical drilling rigs, noise from 24-hour activity is unlikely to be an environmental issue beyond 500 700 metres.

Once the well has been drilled there are two important phases in terms of noise emissions. Purging of the well via vertical discharge is a short term activity (a few hours in duration) that is required to remove drilling debris. The geothermal fluid is directly vented vertically from the wellhead and can generate sound power levels at source of 140dBA.

Acoustic Environment Monitoring was conducted to determine the extent of pollution around the site existing economic and industrial operations for Environmental, Health, Safety and compliance purposes before the implementation of the proposed 4MW GEOTHERMAL DIRECT USE POWER PLANT. The results will thereafter be used to assess compliance through comparisons against the Environmental Management Coordination (excessive noise and vibration controls) regulations 2009. A report on the findings will then be prepared and published.

Noise environment remains a valued component in this environmental assessment because of their fundamental significance to the well-being of humans and wildlife.

1.2. Project Description

The proposed 4MW Geothermal Direct Use Power Plant within Menengai Geothermal Field in Nakuru County will be situated at Latitude 0°12'16.21"S and Longitude 36°05'43.40"E. The proposed site neighbors' Menengai Power Plant West and Sosian Power plant to the East. There are also large chunks of land to the North and South of the project.

The project will involve construction, installation, operation and possible decommissioning of a 4 Megawatt well head generation unit, drying plant and cooling towers. The power plant will be connected to MW-18A to tap steam and brine to generate electricity for use in proponents' cement manufacturing factory and dry pozzalana respectively.

The well pad is composed of two wells with a production well (MW-18A), separator, water tank, and an atmospheric flash tank. The two-phase main pipeline will be approximately 100 m long connected to a Webre separator, a cyclone-type separator based on centrifugal force induced by tangential inlet, where the water droplets are forced to the outside of the spiral path and steam stream exits from the bottom of the separator.

From the separator, steam will be sent to the power plant through a 70 m long steam pipeline and brine to a horizontal tank to accumulate without increasing the size of the separator. A flash tank will be utilized for the geothermal fluid discharge during the commissioning and start-up phases and emergency. The tank is provided with rocks on top to work as a muffler in case of only steam venting.

The steam separator/demister will separate liquid, droplets or mist from the steam up to a certain dryness factor before it enters the turbine. The steam will expand through the turbine resulting in rotation of the turbine and generator. A crossover carries the steam from the turbine to the condenser where the steam is mixed with cooling water. The condensed steam/cooling water mixture is then pumped into the drying plant for heating pozzalana (700 tonnes per day) prior to reinjection in Well No. 34 (Figure 5) at Latitude 0°11'59.04"S, Longitude 36° 5'43.12"E. The reinjection is undertaken to prevent environmental pollution as well as maintain the geothermal reservoir's integrity. In order to avoid silica deposition and achieve the desired steam flow rate for the plant design a higher well head pressure is required. Table 1 shows the design parameters for the project.

In times of decline or MW-18A being offline, make-up well (well No. 35) which is at Latitude 0°12'30.06"S, Longitude 36° 5'23.59"E on the eastern side of Menengai discontinuity and about 675metres from MW-18A will be utilized.

1.3. Purpose of this report

This report identifies baseline information relating to acoustic emissions levels within study area in Menegai geothermal field in Nakuru county. The baseline provides the 'do minimum' (without the proposed 4 MEGAWATT (MW) GEOTHERMAL DIRECT USE POWER PLANT scenario taking account of the proposed changes to the land use.

1.4. Appraisal Framework Requirements

Under the Second Schedule of the Environmental Management and Coordination Act (EMCA), Cap 387 of the Laws of Kenya, the project is categorized as a High Risk and thus should undergo Environmental and Social Impact Assessment (ESIA) Study process.

According to the EMC (IMPACT ASSESSMENT AND AUDIT) regulations 2003 framework legal notice 101 PART IV, THE ENVIRONMENTAL IMPACT ASSESSMENT STUDY REPORT section 18 which states that *(1) A proponent shall submit to the Authority, an environmental contents of impact assessment study report incorporating but not limited to the environmental following information; - (b) a concise description of the national environmental legislative and regulatory framework,* ***baseline information.*** PART VI - MISCELLANEOUS PROVISIONS section 43 (2) states that *the proposed policy, programme or plan specified in this regulation shall state - (d) an environmental analysis covering:* ***(i) baseline information focusing on areas potentially affected.*** Noise / Acoustic emissions levels was earmarked as one of the baseline parameter to be assessed and monitored.

Section 3 of the Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009, General Prohibitions states as follows;
(1) Except as otherwise provided in these Regulations, 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.
(2). In determining whether noise is loud, unreasonable, unnecessary or unusual, the following factors may be considered; (a) time of the day; (b) proximity to residential area; (c) whether the noise is recurrent, intermittent or constant; (d) the level and intensity of the noise; (e) whether the noise has been enhanced in level or range by any type of electronic or mechanical means; and,
(f) whether the noise can be controlled without much effort or expense to the person making the noise.
(3). Any person who contravenes the provisions of this Regulation commits an offence.

Section 5 of the Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009, on Permissible noise levels states as follows;
"No person shall 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.

In order to comply with the above extracts, Lahvens Limited was commissioned by the client through the firm of experts (Envasses Environmental Consultants Limited) to form the Project's Environmental Team (ET) to monitor a field baseline study of acoustic emissions prior to project implementation, to gain insight into construction-related emissions (of Lmax, Lmin and LAeq), the existing acoustic emissions impacts that result from current ongoing activities, and opportunities to mitigate potential impacts. The findings from this assessment will also support public and stakeholder communication. It will also determine the baseline acoustic environment before implementation of the proposed project.

This Baseline Report forms part of a Comprehensive Baseline Study (CBS) of the proposed Project. The CBS is being prepared as part of an environmental Social Impact assessment (ESIA) and approval process.

1.5. Scope of work

The baseline acoustic emissions report considers the total emission of key acoustic parameters associated with the proposed 4 MW GEOTHERMAL DIRECT USE POWER PLANT activities. These are Noise equivalent levels (LAeq), maximum noise levels recorded (Lmax) and minimum noise recorded (Lmin). The current concentrations of these pollutants are at risk of exceeding their respective Limit Values when the project commissions. The estimates of the existing concentrations will be measured and compared to any relevant existing information and when the project commences, will be used as the background data. Relevant available information related to the pre-development ambient acoustic emissions level in the environment was looked into while identifying the major existing acoustic emission sources in the environment and the existing sensitive pollution areas in the environment.

1.6. Terms of Reference

Reference is made to the EMCA Legal Notice 61 First Schedule Extract, Acoustics – Determination of noise exposure and estimation of noise-induced hearing impairment recognizing the fact that any person emitting noise in excess of noise emission standards commits an offence therefore legalizing the process of compliance with the set emission goals, permissible standards, control strategies and technologies for noise emission as mandatory.

The scope of work was outlined as follows:

- Review of the legal context as it relates to noise emissions.;
- Evaluation of site meteorology;
- Monitoring of background noise including the noise equivalent levels Leq.

1.7. EBS Justification

Acoustic Environmental Baseline Study is a significant component of monitoring programs for successful development activities. This Environmental Baseline Study is designed to characterize the acoustic environment at the proposed project site prior to commencement of construction of the proposed 4 MEGAWATT (MW) GEOTHERMAL DIRECT USE POWER PLANT. EBS will provide a benchmark and reference against which to compare the acoustic conditions influenced by the construction and operation of the geothermal plant. The information will be used to assess the effectiveness of any proposed mitigation measures and to implement adaptive management, if needed.

Well-developed EBS often alleviate heightened perceived concerns within the community during the initial phases of any proposed development, before issues become a serious risk to the project. EBS also creates reassurance in the minds of the public and jurisdictional decision makers that key environmental issues have been identified and will be monitored and mitigated, during and after the project is approved. EBS monitoring can be looked at as an early warning system of impacts that could potentially affect the environment during the project operation phase and long after the project is decommissioned.

2. ACOUSTIC EMISSIONS OVERVIEW AND NETWORKS

Utilization of geothermal resources for energy developments such as conventional condensing steam turbine or geothermal binary plants for electricity generation have the propensity to produce significant levels of noise in the local environment. Depending upon where this noise is received, its level, character and duration, this noise can be a significant environmental effect.

According to the National Environment Management Authority (NEMA), "construction" includes erection, alteration, repair, dismantling, demolition, structural maintenance, painting, mowing, land-clearing, earth-moving, landscaping, grading, excavating, laying of pipes and conduits whether above or below ground level, road, railway and highway building, concreting, installation and alteration of equipment, and the structural installation of construction components and materials in any form or for any purpose that includes any work in connection with the construction". The proposed project falls under the construction sector.

As per Oxford Definition, noise is a sound, especially one that is loud or unpleasant or that causes disturbance. Noise is generally considered as undesirable sound and sound can be considered undesirable due to amplitude or volume of loudness, category of noise, occurrence time of the day and resonance created. Noise is regarded as a pollutant under the EMC (Excessive Noise and Vibration Regulations) (control) 2009.

It is therefore fundamental to note that ambient noise levels are essential to human health and ecosystems. The repercussions of construction noise are extensive and encompass both the workers and the surrounding environment. Construction noise can disrupt the peace of residential neighborhoods, affecting the quality of life for residents. This disruption can lead to complaints and strained relationships between the construction project and the community.
Acoustic environment has been selected as a valued component because of their fundamental significance to the well-being of human health and fauna health.

Construction site generates noise with activities like demolition, excavation, building works, machinery involved, material unloading etc. The noise generated from such activities is found loud and irritant at times. Such activities generate noise exceeding the Occupational Safety and Health Administration's (OSHA) limit given of 90dB. Continuous exposure to such loud noise can cause various physical, psychological, and mental illnesses. This hassle can affect the workers, as well as the residences, commercial complexes or school colleges surrounding the ongoing construction sites.

Construction Related Noise Generators could include the following: -

a. Various Machineries / Equipment are involved at various stages of construction. Right from the Excavation until Finishes, various machineries are involved which help to carry out the work with lesser labors and at a faster speed by also achieving the required quality.
b. Labors Talks / yelling: - Some of the activities like Plastering, curtain wall installation, fixing trusses at sites involve laborers working at different heights. In such cases, the talk happens by yelling, shouting for the instructions.

Noise Pollution due to Construction Machineries is a major hazard observed on Modern Construction sites where extensive machineries are used for the Speed and Quality. Noise generated from the heavy machineries and the power tools varies between 80dB to 120dB. OSHA states permissible noise exposure

limit is 90 dBA (29 CFR 1926.52), whereas the American Conference of Industrial Hygienists has a noise threshold limit value of 85 dBA. NEMA through the EMC (Excessive Noise and Vibration Regulations) (control) 2009 states the permissible levels to be 60 dBA.

The level of ambient sound usually varies continuously with time. A human's subjective response to varying sounds is primarily governed by the total sound energy received. The total sound energy is the average level of the fluctuating sound, occurring over a period of time, multiplied by the total time period. In order to compare the effects of different fluctuating sounds, one compares the average sound level over the time period with the constant level of a steady, non-varying sound that will produce the same energy during the same time period. The average of the fluctuating noise levels over the time period is termed Leq, and it represents the constant noise level that would produce the same sound energy over the time period as the fluctuating noise level.

In order to compare the effects of different fluctuating sounds, one compares the average sound level over the time period with the constant level of a steady, non-varying sound that will produce the same energy during the same time period. The average of the fluctuating noise levels over the time period is termed Leq, and it represents the constant noise level that would produce the same sound energy over the time period as the fluctuating noise level.

The atmospheric conditions, interference from other objects and ground effects also play an important role in the resulting noise levels. For example, "hard" ground, such as asphalt or cement transmits sound differently than "soft" ground, such as grass. The first ground type promotes transmission of sound, thus producing louder sound levels farther from the source. In general terms, the above effects increase with distance, and the magnitude of the effect depends upon the frequency of the sound. The effects tend to be greater at high frequencies and less at low frequencies. For example, "hard" ground, such as asphalt or cement transmits sound differently than "soft" ground, such as grass. The first ground type promotes transmission of sound, thus producing louder sound levels farther from the source. In general terms, the above effects increase with distance, and the magnitude of the effect depends upon the frequency of the sound. The effects tend to be greater at high frequencies and less at low frequencies

Section 3 of the Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations requires determination as to whether the noise is recurrent, intermittent or constant.

Continuous noise in construction persists for an extended period of time. Unlike impulsive noise which comes in bursts, continuous noise is steady and unvarying, similar to a drone or a hum that stays constant over time. Machinery or processes that operate without interruption often produce this noise. Some examples of continuous noise in construction include the humming of generators, the constant whir of an operating excavator, the steady drone of ventilation systems, or the ongoing rumble of cement mixers. This persistent background noise exposure can be harmful to workers over a long period of time.

Impulsive noise, on the other hand, is characterized by sudden, loud bursts of sound that are often of high intensity but short duration. These noises are typically more jarring and noticeable than continuous noise due to their abrupt and disruptive nature. Impulsive noise adds to the overall noise level at a construction site, and its spread can significantly impact people at varying distances.

In construction settings, impulsive noise can come from a variety of sources. The loud bang of a pile driver pounding into the ground, the explosive bursts from powder-actuated tools, or the pounding of jackhammers are all examples of impulsive noise.

It is assumed that the measurement location represents other dwellings in the area (similar environment and sensitive receptors). Some numerous factors that could impact on ambient sound levels at the time of monitoring could include; the distance to closest trees, number and type of trees as well as the height of trees; available habitat and food for birds and other animals; distance to residential dwelling, locomotive sources (motorbikes, trucks & personal vehicles) and type of equipment used at dwelling (compressors, aircons, generators) was considered.

The units of sound measurement are A weighted level of sound in decibels. The A weighted level in decibels is widely used to environmental sound as this weighting best replicates the sensitivity of the human ear across the audible frequency range. The key measurement units used to quantify the temporal variation in sound levels are;
Lmax The single highest sample sound during the measurement interval. Used in night time emission limits as a means of ensuring sleep protection. Controls short duration, high level sounds such as audible warning devices, pressure relief valves, etc.
Lmin: Minimum Sound Level: during a measurement period or a noise event.
Leq is the preferred method to describe sound levels that vary over time, resulting in a single decibel value, which considers the total sound energy over the period of time of interest.
Leq noise levels often fluctuate over a wide range with time. For example, in the middle of the night the level might go down as low as 30 dB (A) with occasional passing vehicles of 70dB (A) or more. Later comes the dawn chorus followed by the general noises of the day before relative peace returns in the late evening. Alternatively, it may be an activity with different noise emissions throughout the day or week, with deliveries, intermittent compressors, and lots of varying noisy processes on top of the routine production noise levels. This is where the Leq noise or equivalent continuous noise level meter comes in. The meter follows all the fluctuations, stores them in its memory and at the end of the measurement calculates an 'average energy' or Leq value. When we say average, this is not a simple arithmetic average because we are measuring in decibels which are logarithmic values. The SLM converts the dB values to sound pressure levels, adds them all up then divides by the number of samples and finally converts this equivalent level back to decibels - dBs.

LAeq - It is common practice to measure noise levels using the A-weighting setting built into all sound level meters. In which case the term is properly known as LAeq and the results should say so - for example LAeq = 73 dB or Leq = 73 dB.
Leq noise levels are logarithmic (dB) values and cannot be added directly. A doubling of sound level results in a measured increase of 3 dB, four identical sources in a room would increase the noise level by 6 dB and so on. This works both ways, say 10 similar machines in a room produce 100 dBA then removing one machine completely will only reduce the overall noise level to 0.5 dBA, you would need to silence or remove 50% of the machines to achieve a 3 dB reduction.

3. ACOUSTIC LEGISLATIVE AND POLICY FRAMEWORK

3.1. EMC (Excessive Noise and Vibration Regulations) (control) 2009

The legislative controls relevant to noise emissions associated with any development is outlined in the EMCA Legal Notice 61 First Schedule Extract, Acoustics – Determination of occupational noise exposure and estimation of noise-induced hearing impairment. The standard recognizes that any person emitting noise in excess of noise emission standards commits an offence. It legalizes the process of Environmental Impact Assessment and compliance with the set emission goals, permissible standards, and control strategies and technologies for noise emission as mandatory. With establishment of noise emission standards, it will be a requirement to obtain temporary permits from the National Environmental Management Authorities allowing for emissions of noise in excess of established standards for a period not exceeding three months.

Noise Exposure Standards (First Schedule)

Table 2: EMC (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009.

ZONE		*Sound Level Limits dB (A)* L_{eq}, *14 h*		*Noise Rating Level (NR)* L_{eq}, *14 h*	
		DAY	NIGHT	DAY	NIGHT
A	Silent Zone	40	35	30	25
B	Place of worship	40	35	30	25
C	Residential: Indoor	45	35	35	25
	Outdoor	50	35	40	25
D	Mixed Residential (with some commercial and places of entertainment)	55	35	50	25
E	Commercial	60	35	55	25

Source: EMC (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 Legal Notice 61

The survey location falls under Zone D; mixed residential with some commercial and places of entertainment.

4. ACOUSTIC SURVEY METHODOLOGY

A baseline noise survey consisting of an operator attended noise measurements (OANM) was performed on the proposed site in Menengai geothermal fields in Nakuru county. Lahvens Limited operated three mobile stations along the project boundary walls (3) as part of its noise levels monitoring networks on the 06th June 2024.

4.1. Baseline Study Area;

4.1.1. Sensitive Receptors

The geographical scope of the baseline assessment is currently defined as the proposed 4MW Geothermal Direct Use Power Plant within Menengai Geothermal Field boundaries and environs, including potentially high risk zones along the routes of any existing surface access. High risk zones include locations with the potential for exceedance of regulatory standards for the protection of human health and/or **sensitive habitats**, in the initial and / or mature operations years. The issue of noise / acoustic pollution is particularly pertinent in areas sensitive to change, often referred to as **'sensitive receptors'**. Locations for the protection of human health are areas of long term exposure which are more susceptible and shall be considered to include residential properties, hospitals and schools; whereas locations for the protection of sensitive habitats / ecosystems shall be considered to include statutory designated sites (such as sites of special scientific interest (SSSIs), special areas of conservation (SACs) and special protection areas (SPAs) which contain habitat types that are also sensitive to acoustic changes.

The proposed site neighbors' Menengai Power Plant West and Sosian Power plant to the East. There are also large chunks of land to the North and South of the project. There are no areas considered to be sensitive receptors within close proximity to the proposed project site.

Close proximity of the emission source to the 'sensitive receptor' causes acoustic pollution because there is less opportunity for dispersion of emissions between the source and receptor resulting in greater noise emissions. Noise / Acoustic levels is evaluated by comparing emissions against the EMC (Excessive Noise and Vibration Regulations) (control) 2009 Legal Notice 61, first schedule of the Noise Exposure Standards Limit values set at locations where exposure harm to human health and ecosystems is thought to occur.

4.1.2. Existing Acoustic Environment

The neighborhood depicts mixed land use including industrial power generation and farmlands. The main source of existing noise pollution are the mobile sources such as visiting motor vehicles, fugitive acoustic emissions and environmental noise. The acoustic emission sources directly associated with the proposed project will be the main concern of the appraisal framework and will be emitted from various sources including; construction equipment, mobile sources, source emissions (generators) and environmental noise.

The emissions concentrations reported herein, will be a combination of the emissions from the sources and the distance to the receptors which influence the levels of noise emissions and quality of life. As such, the most common ambient acoustic emission source within close proximity to sensitive receptors and the site in general will be fugitive emissions as the dominant emission sources.

4.1.3. Monitoring Locations

Baseline acoustic emissions levels monitoring locations were selected based on the existing facility that could or have the potential to influence the proposed project acoustic environment. The monitoring locations at the proposed project site were determined at three project boundaries to the East (PB-1), West (PB-2), and Geothermal Development Company (GDC), Well 18A Site.

Table 3: Description of the acoustic measurement locations

Measurement Sites	Receivers	Description of monitoring Locations	Dates of sampling
East Project Boundary 1 (EPB-1) N: -0° 12' 18.072"; E: 36° 05' 43.152"	Sosian Power plant	The proposed site neighbors' Menengai Power Plant West and Sosian Power plant to the East. There are also large chunks of land to the North and South of the project. There are no areas considered to be sensitive receptors within close proximity to the proposed project site	06TH June 2024.
West Project Boundary 2 (WPB-2) N: -0° 12' 16.4664"; E: 36° 05' 41.640"	Menengai Power Plant		06TH June 2024.
Geothermal Development Company (GDC), Well 18A Site (GDCW18) N: -0° 12' 19.332"; E: 36° 05' 41.28"	Farmlands		06TH June 2024.

4.2. Equipment Placement

Acoustic / Noise emission survey was achieved via initial examination of existing noise sources of significance. Noise levels was evaluated using a Sound Level Meter Model UT - 351, C150107874. SLM was mounted on at 2.0m above ground level and at least 3.5m away from any sound reflecting surfaces at a boundary position and measurements taken at timed intervals of 15 minutes every one-hour period and stored in SLM's memory. The sound level meter was placed on the microphone to reduce any wind interference during measurements. The sound level meters, were within their calibration period, at the time of monitoring. In addition, the equivalent noise level (Leq), the maximum sound pressure level (Lmax) and the minimum sound pressure level (Lmin) during that measurement period were recorded.

Factors such as time, duration and predictability of the noise emission, amplitude and frequency of the noise emission, nature of the source, location of noise sensitive receptors, ambient and background noise level, nature and character of the locality, presence of special acoustic characteristics and the incongruity or familiarity of the noise during noise survey and site placement were put into consideration.

Furthermore, as each individual measurement was being taken, the nature of the noise climate in the area was assessed and recorded. This comprised an auditory observation by the surveyor, as well as identifying those noise incidents which influenced the sound level meter readings during the measurement period.

Ongoing diurnal acoustic level measurements at the proposed boundaries (source: Fieldwork June, 2024)

4.3. Acoustic analysis

4.3.1. Parameters and score criteria

After finding various activities, aspects and impacts, identification of the significant aspects was done. It entirely depended on the management of the system or industry to give a scaling factor. The table 4 below shows six factors naming as A to F (top row) and column 1 to 6 shows rating scheme with minimum as 1 and maximum marks as 10 depending upon their severity.

4.3.2. Procedure of significance evaluation

For evaluation processes, the various activities of the measurement sites are rated based on parameters and score criteria and a benchmark of 75 units is taken as a deciding factor. If the total unit of any aspect for an activity comes out to be more than 75, then the aspect can be considered as significant otherwise insignificant.

Table 4: Parameters and score criteria

A-Quantity 1-5	B-Occurrence 1-6	C-Impact 1-6	D-Detection 1-5	E-Controls 1-5	F-Legislation 1and10
5-High	6-Continuous	6-Fatal to human life	5-More than 24 hours	5-Absence or no effective controls	10-Not meeting legislation/ control limits
3-Moderate	5-Several times a day	5-Health effects	4-Within 24 hours	4-Mechanism in place but not reliable	1-In Compliance
1-Low	4-Once a day	4-Affects flora and fauna	3-Within 8 hours	3-Control needs human intervention	---
---	3-Once a week	3-Resource consumption	2-Within 1 hour	2-Has in-built secondary control	---
---	2-Once a month or less frequent	2-Discomfort, Acid rain, nuisance	1-Immediately	1-Available and effective at source.	---
---	1-Very Rare	1-Negligible visual impacts.	---	---	---

4.4. Tools and Equipment

- Sound Level Meter Model meter UT-351 IEC 61672 - 1:2013.
- Geographic Positioning System (GPS)
- Digital camera

4.5. Assumptions

The short term (1-hr per site) noise emissions survey and data collection for L_{eq}, L_{max} and L_{min} is considered sufficient to understand background acoustic conditions at each location.

4.6. Data Validity and Acceptability

All data recorded in the study was taken through data replications and quality assurance procedure to ensure that any anomalous readings or questionable data is not incorporated in the final results.
Elements of this procedure account for:

- Routine calibration and auditing of the analyzers and Statistical rendering of outliers.

4.7. Monitoring Frequency

Monitoring of acoustic emissions levels was done with a frequency of 1 hr / survey location. Once Geothermal power plant operations will be underway, monitoring of acoustic emissions parameters should be done at 3 months' interval.

5. RESULTS PRESENTATION, DISCUSSIONS AND CONCLUSION.

5.1. PRESENTATION OF RESULTS

5.1.1. Summary of singular noise measurements

Table 5: Results for Diurnal singular noise measurements

Measured Sound Pressure Level (Noise) (dBA)				EMC Noise Regulation 2009	Site Notes / Remarks
06th June 2024.				Day time	
Locations	Leq	Lmax	Lmin	Leq	
East Project Boundary 1 (EPB-1) N: -0° 12' 18.072" E: 36° 05' 43.152"	45.6	58.7	41.9	55	The prevailing weather was sunny at the time of acoustic survey. Wind speed averaged about 15 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Leq noise levels complied with the EMC 2009 noise permissible levels. No proposed related activities were ongoing during measurements at the proposed site. Environmental noise including Wind breeze and fugitive noise from motor vehicles were the likely sources of noise emissions. Ambient conditions were extant at the time of the survey.
West Project Boundary 2 (WPB-2) N: -0° 12' 16.4664" E: 36° 05' 41.640"	49.3	66.0	39.2	55	The prevailing weather was sunny at the time of acoustic survey. Wind speed averaged about 15 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Leq noise levels complied with the EMC 2009 noise permissible levels. No proposed related activities were ongoing during measurements at the proposed site. Environmental noise including Wind breeze and fugitive noise from motor vehicles were the likely sources of noise emissions. Ambient conditions were extant at the time of the survey.
Geothermal Development Company (GDC), Well 18A Site (GDCW18) N: -0° 12' 19.332" E: 36° 05' 41.28"	44.0	60.2	38.6	55	The prevailing weather was sunny at the time of acoustic survey. Wind speed averaged about 15 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Leq noise levels complied with the EMC 2009 noise permissible levels. No proposed related activities were ongoing during measurements at the proposed site. Environmental noise including Wind breeze and fugitive noise from motor vehicles were the likely sources of noise emissions. Ambient conditions were extant at the time of the survey.

5.2. Summary of average diurnal noise equivalents (Leq)

5.2.1. Tabular presentation of test of L_{eq} noise equivalents.

Table 6: Summary results for diurnal noise equivalents

Monitoring locations	Diurnal LAeq average results	Maximum noise level permitted (Leq) in dB (A) Day (0601-2000) hrs	Comments
EPB-1	45.60	55	Complies
WPB-2	49.30	55	Complies
GDCW18	44.00	55	Complies

5.2.2. Tabular presentation of test of significance

Table 7:Determination of diurnal noise significance of results

MEASUREMENT SITE	ASPECT	CONDITION/A	IMPACT	QUANTITY A	OCCURRENCE	IMPACTS	DETECTION	CONTROL	LEGISLATION	TOTAL A*B*C*D	REMARKS SIG / INSIG
EPB-1	NOISE	N/A	Hearing impairment	3	6	1	1	3	1	54	INSIG
WPB-2	NOISE	N/A	Hearing impairment	3	6	1	1	3	1	54	INSIG
GDCW18	NOISE	N/A	Hearing impairment	3	6	1	1	3	1	54	INSIG

5.3. DISCUSSIONS OF RESULTS

Noise measurements was initiated to obtain and quantify the prevailing and existing ambient acoustic levels before implementation of the proposed geothermal direct use power plant. The obtained acoustic results were thereafter correlated against the Environmental Management Coordination (Excessive noise and vibration regulations) 2009 to ascertain compliance.

5.3.1. Presentation of singular noise results

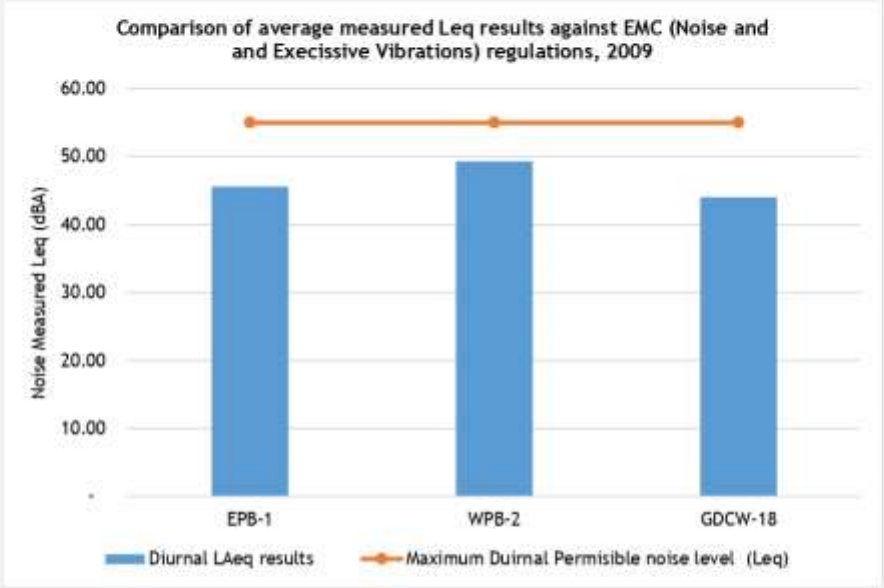
Diurnal noise results

The highest diurnal noise emissions recorded at the West Project Boundary 2 (WPB-2) of the site extended to levels of 49.30 dBA while the lowest diurnal noise emission recorded at the Geothermal Development Company (GDC), Well 18A Site extended to levels of 44.0 dBA. The average Leq noise levels in the proposed geothermal direct use power plant averaged 46.3 dBA. The average noise levels across all the survey locations complied with the EMC noise and vibrations regulations of 2009.

5.3.2. Correlation of average noise monitoring results against the noise regulations

Correlation of results against the Environmental Management Coordination (Excessive noise and vibration control regulations) 2009 to ensure compliance was done and presentation of the combined charts are as follows:

a. **Diurnal noise results**



- The average diurnal noise equivalent levels (Leq) along all the three survey locations complied with the EMC noise and vibration regulations 2009 before commencement of the proposed 4MW geothermal direct use power plant.

5.3.3. Determination of significance

Determination of noise significance of results was done vide correlation against the EMC (Excessive noise and vibration regulations) 2009 to ensure compliance amongst other aspects.

- Diurnal noise Leq averages were rated as insignificant having scored <75 units based on parameters and score criteria; therefore, the proposed 4MW geothermal direct use power plant located in Menengai geothermal field was characterized as noise insignificant area before its implementation.
- From the results of determination of significance, there is no threat to the noise receivers (farmlands and other industrial developments) of the noise emissions before implementation of the 4MW geothermal direct use power plant.

5.4. CONCLUSION.

This ambient noise measurement report documented the current noise levels and meteorological conditions for the proposed 4MW geothermal direct use power plant as follows:

- The quantity of noise measured and recorded along the project boundaries complied with the EMC noise and vibration regulations 2009 maximum Noise Level Permitted (Leq) during the day before implementation of the proposed 4MW geothermal direct use power plant development.
- Baseline results obtained along the project boundaries show that the survey location was a noise insignificant area hence the levels do not pose threat to the sensitive receptors before implementation of the proposed 4MW geothermal direct use power plant development.
- Ambient conditions existed at the time of the diurnal survey.
- Environmental noise (Wind breeze) and noise emissions from motor vehicles were the main sources of noise emissions.
- The proposed site was marked with no project related activities during the measurements.
- The levels of noise recorded from existing operations does not pose any Environmental, Health and Safety concerns before implementation of the 4MW geothermal direct use power plant project.

6. REFERENCES

1) Environmental Management and Coordination Act (EMCA) 1999 (amended 2015).
2) Environmental Management and Coordination (Noise and Excessive Vibration Pollution Control) Regulations, 2009 (Legal Notice No.61).

LIST OF APPENDICES:

APPENDIX A:
EQUIPMENT CALIBRATION CERTIFICATES

APPENDIX B:
LABORATORY DESIGNATION CERTIFICATES

APPENDIX A: EQUIPMENT CALIBRATION CERTIFICATES

SONIC QUALITY INSPECTORS LTD

P.O BOX 6063-00200,Nairobi-Kenya,Tel:+254-20-6007509/+254 722-732142
E-Mail:sonicinspections@yahoo.com or mail@sonicinspections.com
website:www.sonicinspections.com

CALIBRATION CERTIFICATE (CENTRE NO. KENAS/CL/002)

Page 1 of 2 pages

REQUESTED BY	**: LAHVENS LIMITED.**
ADDRESS	**: P.O. BOX 34153 - 80118 MOMBASA, KENYA.**
EQUIPMENT	**: SOUND LEVEL METER**
TYPE/MODEL	**: UT351**
SERIAL No.	**: 00000627**
STICKER No.	**: 10909**
MANUFACTURER	**: UNI-T**
DATE CALIBRATED	**: 06-01-2024**
CERTIFICATE No.	**: SQI/LAHVENS/24/001**

1.0 REFERENCE STANDARD AND EQUIPMENT USED

The sound level meter was calibrated according to Kenya Standard KS OIML 58: 1998 Fluke SM-70 sound level meter standard s/no. **54564D4** was used in the calibration of the Sound Level Meter.

2.0 CALIBRATION PROCEDURE

Procedure number SQI/TCP/023 (measurement procedure for the calibration of Sound Level Meters] was followed in the calibration of the Sound Level Meter.

3.0 TRACEABILITY

This calibration certificate documents traceability of calibration standards used which are traceable to the National Standard Institute KEBS, to realize units of measurement according to the International System of Units (SI).

4.0 This certificate is valid until **6th January, 2025.**

Calibrated by: **K.Otto** *Date:* **06-01-2024**

Checked by: *Date:* 6/1/2024

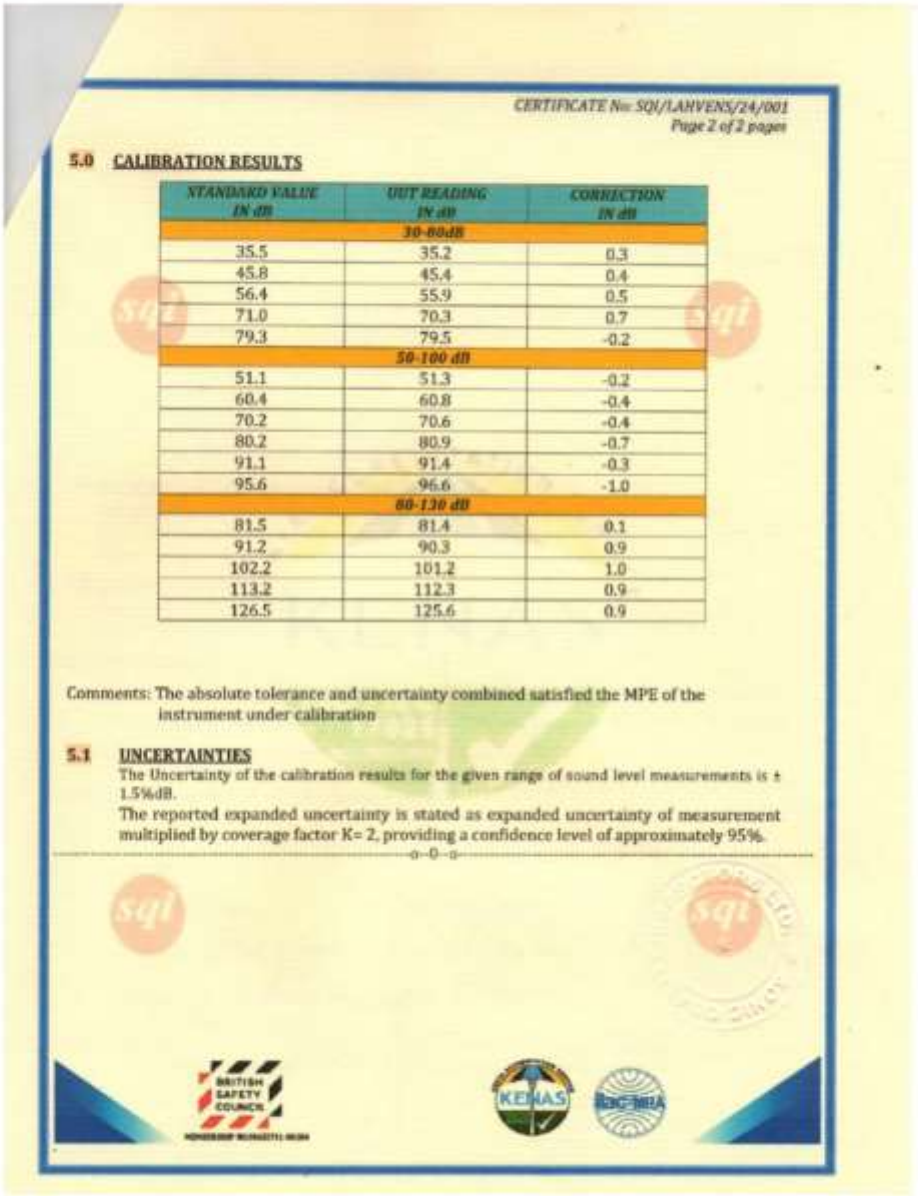
Signed: *Date:* 6/1/2024

TECHNICAL MANAGER

Calibration certificate without signature and official rubber stamp is invalid. This certificate has been issued without any alterations. This Certificate is only valid for the instrument calibrated/tested and for the period indicated there in.

BRITISH SAFETY COUNCIL

KENAS



CERTIFICATE No: SQI/LANVENS/24/001
Page 2 of 2 pages

5.0 CALIBRATION RESULTS

STANDARD VALUE IN dB	OUT READING IN dB	CORRECTION IN dB
30-80dB		
35.5	35.2	0.3
45.8	45.4	0.4
56.4	55.9	0.5
71.0	70.3	0.7
79.3	79.5	-0.2
50-100 dB		
51.1	51.3	-0.2
60.4	60.8	-0.4
70.2	70.6	-0.4
80.2	80.9	-0.7
91.1	91.4	-0.3
95.6	96.6	-1.0
80-130 dB		
81.5	81.4	0.1
91.2	90.3	0.9
102.2	101.2	1.0
113.2	112.3	0.9
126.5	125.6	0.9

Comments: The absolute tolerance and uncertainty combined satisfied the MPE of the instrument under calibration

5.1 UNCERTAINTIES

The Uncertainty of the calibration results for the given range of sound level measurements is ± 1.5%dB.

The reported expanded uncertainty is stated as expanded uncertainty of measurement multiplied by coverage factor K= 2, providing a confidence level of approximately 95%.

o-O-o

APPENDIX B: LABORATORY DESIGNATION CERTIFICATES

nema

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY

Mobile Lines: 0728-253 398, 0723-363 018, 0735-013 046
Telkom Wireless: 020-2101370, 020-2183718
Incident Lines: 0786-101100, 0741-101100

P.O. Box 67839, 00200
Popo Road, Nairobi, Kenya
E-mail: dgnema@nema.go.ke
Website: www.nema.go.ke

NEMA/21/2/LAB 77/LLL **20th April, 2023**

Lahvens Limited Laboratory
Lahvens House,
P.O. Box 34153-80118
MOMBASA.

RE: LABORATORY DESIGNATION BY NEMA.

Pursuant to your application for designation, your laboratory was inspected and evaluated based on ISO 17025 for laboratory competence to carry out tests and samplings.

The Lahvens Limited Laboratory qualified and has in principle been designated to undertake **Air Quality Analysis (Stack Emission and Ambient Air) and Noise Level Measurements** subject to the attached terms and conditions.

However, pursuant to section 119 of EMCA 1999 the Gazettement will take effect once the Authority places a notice in the Kenya Gazette.

DAVID ONGARE
For: DIRECTOR GENERAL

Our Environment, Our Life, Our Responsibility

ISO 9001:2015 Certified

Annexure 9: Attendance list of the kick off meeting with key government agencies

ENVASSES ENVIRONMENTAL CONSULTANTS LIMITED

Environmental and Social Impact Assessment Study for the Proposed 4MW Geothermal Direct-Use Power Plant at Menengai Geothermal Project Area, Nakuru County.

Task: Courtesy Meeting with relevant government agencies

Date: 27th June 2024

Venue: Nakuru North Sub-County

Attendance list

NO.	NAME	AFFILIATION	TELEPHONE NO./EMAIL	SIGNATURE
1.	Cyrus N. Gichaga	DCC Nakuru N.	0711 179 136	
2.	Kennedy Kijang	BIA Expert Envasses Environmental	0720964 333	
3.	MBOGUE HIRINE	Association Environmentalist Envasses Ltd	0795 398 746	
4.	PETER MADING	GDC	0723 160 982	
5.	Faidah Khamalisha	Envasses Consultants	0704063064	

NO.	NAME	AFFILLIATION	TELEPHONE NO. /EMAIL	SIGNATURE
6.	LEENUS ROTUK	ACC KIAMAINA	0722 126167	
7.	PETER M. KIOKO	RFC- OFFICE	0710313577	
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Annexure 10: Proceedings of the kick-off meeting held on 28th June 2024 at Maili Saba Police Post

ENVASSES ENVIRONMENTAL CONSULTANTS LIMITED

Environmental and Social Impact Assessment Study for the Proposed 4MW Geothermal Direct-Use Power Plant at Menengai Geothermal Field in Nakuru County.

Proceedings of the Kick-Off Meeting held at Maili Saba Police post in Kabatini, Nakuru-North Sub County, Nakuru County.

28th June 2024

Proponent	Firm of Experts
Karsan Ramji and Sons Limited, P.O. Box 48838-00100 Nairobi, Kenya.	Envasses Environmental Consultants Limited, P.O. Box 2013-80100, Mombasa, Kenya. Tel: 0722347155 Email: info@envasses.org

1. Meeting Agenda

Envasses Environmental Consultants Limited in collaboration with Karsan Ramji and Sons Limited (KRSL) and the area administration organized and held a kick-off meeting on 28th June 2024 at Maili Saba Police Post in Kabatini, Nakuru County. The meeting was convened to sensitize stakeholders on the Proposed 4 MW Geothermal Captive Power Plant at Menengai Geothermal Field in Nakuru County. The agenda was as follows;

1. Prayer and Introductions
2. Opening remarks
3. Overview of the proposed project
4. Presentation on ESIA Study Process
5. Plenary discussions
6. Way forward

2. Prayers and introductions

The meeting started at 10:10 a.m. with a word of prayer from Mr. Charles, a resident of Maili Saba area, Kabatini. After prayers, Mr. John Thuo, the Area Chief-Kabatini welcomed the participants and proceeded to introductions. The meeting was attended by 61 participants drawn from Maili Saba community, NGAO, GDC and Envasses Environmental Consultants Limited. (Appendix 1).

Figure 1: Participants following deliberations during the kick-off meeting at Maili Saba Police Post, Nakuru County (Source: Kick-off Meeting, June 2024)

3. Opening Remarks

a) Ministry of Interior and National Administration- Kabatini, Nakuru County

Mr. Thuo, the Area Chief Kabatini Sub-location welcomed participants to the meeting and informed them that the proposal by KRSL will be beneficial to them directly through job opportunities and general development of their area. He emphasized on the statutory requirement under the Constitution of Kenya, 2010 to carry out public participation. He urged members to provide their views and concerns on the project so that they are considered and incorporated during project

implementation. He then invited Mr. Peter Echapan from GDC to provide his remarks about the proposed project.

b) Geothermal Development Company (GDC)

Mr. Peter Echapan from GDC thanked the participants for attending the kick-off meeting and informed them that Karsan Ramji and Sons Limited has entered into a steam supply agreement with the Geothermal Development Company (GDC). Mr. Echapan highlighted that the steam will be used to power to their planned cement plant and pozzolana drying operations.

4. Overview of the proposed project

Ms. Fridah Khamalishi from Envasses Environmental Consultants Limited, provided a brief overview of the proposed project. He explained that Karsan Ramji and Sons Limited has entered into a steam supply agreement with the Geothermal Development Company (GDC) to establish a 4-Megawatt (MW) captive power generation unit at Main Well 18A within the Menengai Geothermal Field. This unit will supply power to their planned cement plant and pozzolana drying operations.

5. Presentation on ESIA Study Process

Mr. Kennedy Kijana from Envasses Environmental Consultants Limited gave an overview of the ESIA Study process for the proposed project and cited the legal basis of the meeting as per Regulation 17 (2b) of the Environmental Management and Coordination (Impact Assessment and Audit) Regulations, 2003 where public participation in the ESIA process is a mandatory requirement. He added that the ESIA Study process was guided by the requirements of Sec. 58 of the Environmental Management and Coordination Act Cap 387 of the Laws of Kenya. In this regard, he noted that the ESIA study will among other elements, provide a description of the proposed project, baseline environmental and social conditions of the project area, environmental and social risk assessments during construction, operation and possible decommissioning phase of the project, relevant policy, legal and institutional frameworks and development of Environmental and Social Management and Monitoring Plans (ESMMP) for implementation of the project.

Mr. Kijana informed the participants that three stakeholder consultation meetings will be undertaken, and their views and concerns will be incorporated in the final report prior to submission at NEMA for decision making. He added that publication of the ESIA Study Report will be done on Kenya Gazette, (2) newspapers with wider nation-wide circulation and local radio pursuant to Regulation 17 (2a) of Legal Notice 101 of 2003. This he noted would still provide stakeholders with an avenue to enrich their contribution to the ESIA study process.

He further emphasized and informed the participants that the meeting held was specifically meant for views concerning the proposed geothermal power plant and should not include the cement factory, since the proposed cement factory will come later after the power plant has been established.

6. Plenary Discussions

Mr. John Thuo, the Area Chief, emphasized that incorporating participants' views and concerns into the project would greatly enhance its sustainability. He acknowledged that every project brings benefits but may also pose potential environmental and social challenges during its installation and operational phases. He then invited the participants to share their opinions, concerns, and suggestions regarding the proposed project.

Mr. Charles Gichini was concerned about the potential negative impacts of steam well drilling on neighboring communities. Additionally, he inquired about employment opportunities for local youth, should the project gain approval from NEMA. In response, Mr. Peter Echapan clarified that GDC had already completed the drilling of steam wells, assuring the community that no further drilling would occur during the project's implementation. On employment issue, Mr. Echapan stated that it will be forwarded to GDC and KSRL for further consideration.

Mr. Charles Gichini welcomed the project and thanked the consultant for holding the meeting. He mentioned that he understood that the meeting was about the proposed power plant and that the cement factory will come later on after the implementation of the power plant, were it to be approved by NEMA. However, he had concerns on the negative impacts from drilling of steam wells to the neighboring communities. He also made an enquiry on employment possibilities for the area youths on accounts that the proposed project was approved by NEMA. In response, Mr. Peter Echapan stated that GDC has already drilled steam wells and the residents should have no concerns since there will be no drilling operations during project implementation. He added that issue on job opportunities will be forwarded to GDC and KSRL for consideration.

Mr. Peter Kimani Macharia highlighted that GDC had previously promised to provide local residents with tree seedlings and household water storage tanks. However, no action has been taken so far. He sought clarification on whether these programs were still ongoing to benefit the community and also inquired whether KSRL would engage in similar CSR activities. In response, Mr. Echapan explained that residents could visit GDC's tree nursery to obtain tree seedlings. He further stated that the concerns regarding water tanks and electricity would be forwarded to GDC management for a definitive response.

Mr. Romanus urged the proponent to allocate 30% of employment opportunities to local residents during the project implementation. In response, Ms. Fridah stated that the recommendation will be forwarded to KRSL for consideration.

7. Way forward

Ms. Khamalishi stated that the views and issues raised by the stakeholders will be incorporated in the ESIA Study Report. Additionally, she mentioned that a second stakeholder meeting will be held to review the draft ESIA Study Report and the time and venue will be communicated to the stakeholders well in advance. Mr. Thuo, the area Chief thanked everyone for attending the meeting and encouraged them to attend the following subsequent meetings.

8. Closure of the meeting

There being no other business, the meeting ended at 11.10am with a word of prayer from a resident of Maili Saba area.

Signed: _____ Date: **28th June 2024**

Ms. Hyrine Masese,
Envasses Environmental Consultants Limited,
Meeting Secretary.

Appendix 1:Attendance List

Environmental and Social Impact Assessment Study for the Proposed 4MW Geothermal Direct-Use Power Plant at Menengai Geothermal Field in Nakuru County.

Task: Community Engagement Meeting

Date: 28th June 2024

Venue: Maili Sabo Police Post, Nakuru

Attendance list

NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
1.	JOHN THUO CHIEF	CHIEF	0725129756	
2.	JECINTA G. NJOROGE	VILLAGE ELDER	0720118636	
3.	JOSEPHINE WANJIGI	YOUTH LEADER	0724 466488	
4.	Peter Kimani	YARGD Group	0725412316	
5.	JANE NJERI	Community Policy.	0724218085	

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NO.	NAME	AFFILLIATION	TELEPHONE NO. /EMAIL	SIGNATURE
6.	CHARLES N. GICHINI	TEACHER	0722699877	[signature]
7.	NORMAN K. KARIUKI	CASUAL	0717 866 586	[signature]
8.	Daniel Gitonga	MCA office	0716 042 180	[signature]
9.	John NJENGA	Farmer	07588659700	[signature]
10.	CATHERINE NJERI	CASUAL	0726 214544	[signature]
11.	George Kimathi	Bodaboda	0796957127	[signature]
12.	Arthur Ngigi	Bodaboda	0724936261	[signature]
13.	ROBI MAINA		0706 632382	
14.	Francis K.	Boda boda	0727788814	[signature]
15.	James Njogu	Boda Boda	0742089267	[signature]
16.	WILSON NMBUU	security	0713141634	[signature]
17.	Samuel Mwangi	Boda Boda	0724356692	[signature]
18.	GILBERT ISYI	Security	0725 002898	[signature]

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NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
19.	LUCY WANJIRU	FARMER	0701 494600	[signature]
20.	CATHERINE WANGUI	FARMER	0726 323420	[signature]
21.	ISHMAEL MWANGI	YOUTH	0704 473846	[signature]
22.	John Thige	Community policy	0725 910853	[signature]
23.	JUDITH MWENZI	CASUAL	0716 610708	[signature]
24.	Millicent Anyango	Casual	0799620923	[signature]
25.	Neddy Jumah	Casual	0745900825	[signature]
26.	MARGARET WANJIRU	CASUAL	0748955737	[signature]
27.	ROSE ANYONILO	CASUAL	0116707705	[signature]
28.	Gitau Kamau	Youth	0796127273	[signature]
29.	Peter Njoroge	Boda Boda operator	0795210870	[signature]
30.	Martin Mugiru	Boda boda	0729793350	[signature]
31.	SIMON MWANGI	Boda Boda	0723 687 343	[signature]

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NO.	NAME	AFFILIATION	TELEPHONE NO./EMAIL	SIGNATURE
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NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
45.	James Mbugua	Casul	0768 989 233	
46.	Veronicah Wangari	Casul	0712561722	
47.	Jane Wambui	casul	0790433576	
48.	Mary Kamau	Casual	0111381060	
49.	MARY WANGARI	Business Woman	0724733078	
50.	PETER NJOROGE	POLICE SABA OFFICER	0725294901	
51.	Pauline Waweru	SABA POLICE OFFICER	0700 504399	
52.	Kennedy Kijana	Envasses	0720 964 333	
53.	Maureen Hrine	Envasses	0795 792 946	
54.	JOSEPH NDUNGU	FARMER	0725 420 661	
55.	JACKLINE MIDEVA	—	0795769896	
56.	SIMON TANUI	QUARRY	0720 439704	
57.	MBAGO	KRP POLICE OFFICER	0725 705 708	

NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
58.	John NJENGA		0758659700	
59.	DANIEL MBUGUA WAINAINA	NEIGHBOUR MAILI SABA BODA BODA	0743882219	
60.	John Irungu		0725910233	
61.	JACKLINE MIDEVA		0795 769894	
62.	MAHLON HINGA	YOUTH	0798 418848	
63.	ARISTIDES MUGI	ASSISTANT CHIEF MAIRO MOG	0722261927	
64.	PETER ECHAPAN	GDG REP	0710357726	
65.	Faridah Khamalishi	Envasses Consultants	0704063064	
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Annexure 11: Proceedings of the Second Stakeholder meeting to review the draft ESIA study report held on 5th November 2024 at Dhanji Vocational Training Centre at Kagoto area

ENVASSES ENVIRONMENTAL CONSULTANTS LIMITED

Environmental and Social Impact Assessment (ESIA) Study Report for the Proposed 4 MW Geothermal Captive Power Plant at Menengai Geothermal Field in Nakuru County

Proceedings of the Stakeholder Engagement Meeting to Review the Draft ESIA Study Report held at the Dhanji Vocational Training Centre in Kagoto Area

5th November 2024

Proponent	Firm of Experts
Karsan Ramji and Sons Limited, P.O. Box 48838-00100 Nairobi, Kenya.	Envasses Environmental Consultants Limited, P.O. Box 2013-80100, Mombasa, Kenya.

1 Meeting Agenda

Envasses Environmental Consultants Limited in collaboration with Karsan Ramji and Sons Limited and the area administration organized and held a stakeholder engagement meeting on 5th November 2024 at the Dhanji Vocational Training Centre in Kagoto Area. The meeting was convened to review the Draft ESIA Study Report on the Proposed 4 MW Geothermal Captive Power Plant at Menengai Geothermal Field in Nakuru County. The agenda was as follows:

1. Prayer and Introductions
2. Opening remarks
3. Overview of the proposed project
4. Presentation on the draft ESIA Study Report
5. Plenary discussions
6. Way forward

2 Prayers and introductions

The meeting began at 11.45 am with a word of prayer from Rev. George Mugambi, a religious Leader of the area and thereafter introductions.The meeting was attended by 24 participants drawn from the local community, Ministry of Interior and Coordination of National Government, Office of Bahati sub-County Member of Parliament, Members of County Assembly (kabatini and KiaMaina), County Government of Nakuru, Kenya Forest Service (KFS), Geothermal Development Corporation (GDC), Karsan Ramji and Sons Limited (KRSL) and Envasses Environmental Consultants Limited (Figure 1 and Annexure 1).

Figure 1: Participants following deliberations during the meeting to review the Draft ESIA Study Report (Source: Stakeholder Engagement Meeting, November 2024)

3 Opening Remarks

Mr. George Muia, the Project Manager, Karsan Ramji and Sons Limited, thanked the participants for attending the meeting. He requested the participants to be attentive and seek clarification where necessary.

4 Overview of the proposed project

Mr. Kishor Varsani, the Managing Director, Karsan Ramji and Sons Limited, provided a brief overview of the proposed project. He explained that Karsan Ramji and Sons Limited has entered into a steam supply agreement with the Geothermal Development Company (GDC) to establish a 4-Megawatt (MW) captive power generation unit at Main Well 18A within the Menengai Geothermal Field. This unit will supply power to their planned cement plant and pozzolana drying operations.

5 Presentation on ESIA Study Process

Ms. Rhoda Mutua from Envasses Environmental Consultants Limited thanked the participants for attending the meeting and informed them that it was held pursuant to Regulation 17 of the Environmental Management and Coordination Act Cap. 387 of the Laws of Kenya. She proceeded to give a detailed presentation of the draft ESIA Study Report for the proposed project as follows;

- Background information
- Project description
- Project site status
- Approach and Methodology
- Policy and Legal Framework
- Baseline monitoring results
- Impact analysis
- Stakeholder engagement
- Analysis of alternatives
- Environmental and Social Management Plans
- Environmental Monitoring Plan
- Way forward

Ms. Mutua informed the participants that the key issues raised by the stakeholders during the Kick-off meeting held on 28th June 2024 were already incorporated in the Draft ESIA study report.

6 Plenary Discussions

Mr. Samwel Wangunyu, a representative from the Office of the Bahati Sub-County Member of Parliement was keen to know the approximate number of employment opportunities available for local community should the proposed project gain approval from NEMA. In response, Mr. Kishor Varsani, the Managing Director, Karsan Ramji and Sons Limited, stated that the proposed project will create approximately 60 direct jobs for local residents. In addition, he highlighted that the company will not engage in transportation services and therefore will be reserved exclusively for community members.

Mr. Erastus Gakono from the Kenya Forest Service (KFS), Menengai station wanted to know the size of land Karsan Ramji and Sons Limited will utilize within the caldera. Mr. Kishor Varsani responded and stated that the proposed project will occupy approximately 10-15 acres of land.

Ms. Leah Ng'ang'a, the Member of the County Assembly (MCA) for Kabatini Ward, proposed the establishment of a framework for implementation of Corporate Social Responsibility (CSR) activities by Karsan Ramji and Sons Limited in the area. Ms. Ng'ang'a highlighted that the framework will promote accountability and ensure the effective implementation of CSR activities in the area. In response, Mr. Kishor Varsani informed the meeting that Karsan Ramji and Sons Limited is open to suggestions and committed to carrying out CSR activities in partnership with local administration. To enhance communication and address concerns efficiently, Mr. Varsani shared his contact details with

the stakeholders.

Rev. George Mugambi wanted to know the route that will be used to access the proposed project site. In addition, Mr. Mugambi was concerned about noise pollution at the installation and operational phases of the proposed project. In response, Mr. Kishor Varsani stated that the project will use the existing routes which is yet to be determined. In respect to noise pollution, Ms. Rhoda Mutua from Envasses Environmental Consultants Limited stated that delivery of raw materials will be conducted during day time only i.e. between 8 am and 5 pm, machinery and equipment will be serviced and maintained and noise level monitoring will be undertaken to ensure compliance with the Environmental Management and Co-ordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009.

Mr. John Warigi, the KiaMaina Location Chief, was keen to know where pozzolana will be sourced from. Mr. Kishor Varsani responded and stated that pozzolana occurs naturally within the area and the locals can supply.

Mr. Stephen Gakono informed the meeting that there are endangered tree species including sandalwood (*Osyris lanceolata*) within menengai caldera which should be considered. In response, Ms. Rhoda Mutua stated that within the project site there are no endangered tree species.

7 Way forward

Mr. Rhoda Mutua thanked the participants for their participation during the meeting and informed them that their comments on the draft ESIA study report will be taken into account.

It was agreed that the third stakeholder engagement meeting to review and validate the draft ESIA Study Report will be held on 15th November 2024 at the National Government Constituency Development Fund (NG-CDF) social hall in KiaMaina area.

Signed: _____ Date:

Ms. Hyrine Masese,
Envasses Environmental Consultants Limited,
Meeting Secretary.

05 NOV 2024

Appendix 1: Stakeholder Attendance List

ENVASSES ENVIRONMENTAL CONSULTANTS LIMITED

Environmental and Social Impact Assessment (ESIA) Study Report for the Proposed 4 MW Geothermal Direct-Use Power Plant at Menengai Geothermal Field in Nakuru County

Task: Stakeholder Engagement Meeting to review the draft ESIA Study Report

Date: 5/11/2024

Venue: Dhanji Vocational Training Centre, Kagoto Area.

Attendance list

NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
1.	Ian Maithai	Bahati Mpr Office	0799142029	
2.	Elena Amole	G.D.C.	0716328951	
3.	Linet [illegible]	GDC	0710185989	
4.	Samuel Waugungu	Office of MP	0724988560	
5.	Pascal Mauau	GDC	0720754770	
6.	George Muia	KRSL	0722337277	

NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
7.	Erastus Gakoro	KFS Menengai	0722365731	
8.	Stephen Kirimire	County Government	0720843764	
9.	Aristides Kariuki Kougi	Ag Chief Kabatini	0722261927	
10.	Mary Kamau	Snr Chief Ruri Loc	0721224380	
11.	Esther Milgo	Snr A/Chief Kiamunga Loc	0720818591	
12.	Rev. George Mugandi	Religious Leader	0720233004	
13.	John Kiarahu Waroi	Chief Kiamaina	0723420881	
14.	Muthoni Ngubiria J	A.C.C. - Kiamaina Division	0711137370	
15.	Grace Change	Snr Ass/Chief Kiwamanio Loc	0726372885	
16.	Peter N. Mburu	Manager M.P. Office	0720695377	
17.	Festus Mungai	DCC	0728468188	
18.	Malachi O. Manasseh	Principal Yaboro VTC	0721413746	
19.	Leah Nganga	MCA Kabatini	0728830644	

NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
20.	Paul Kigwem Wanyie	MCA Kisanana Ward	[illegible]	[illegible]
21.	Kishor Vaesan	KRSL	0722788886	[illegible]
22.	Kennedy Kisang	Envasses Consultants	0720964333	[illegible]
23.	Macese Mirine	Envasses Consultants	0796 798 946	[illegible]
24.	Rhoda Ndunus	Envasses Consultants	0726721393	[illegible]
25.				
26.				
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31.				
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Stakeholder engagement meeting to review and validate draft ESIA Study Report for the proposed Geothermal Power Plant at Menengai Geothermal Field November 2024

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Annexure 12: Proceedings of the Third Stakeholder meeting to review and validate the draft final ESIA study report held on 15th November 2024 at NG-CDF Social Hall at Kiamaina area

Environmental and Social Impact Assessment (ESIA) Study Report for the Proposed 4 MW Geothermal Captive Power Plant at Menengai Geothermal Field in Nakuru County

Proceedings of the Stakeholder Engagement Meeting to Review and Validate the Draft ESIA Study Report held at the National Government Constituency Development Fund (NG-CDF) Social Hall in Kiamaina Area

15th November 2024

Proponent	Firm of Experts
Karsan Ramji and Sons Limited, P.O. Box 48838-00100 Nairobi, Kenya.	Envasses Environmental Consultants Limited, P.O. Box 2013-80100, Mombasa, Kenya.

1 Meeting Agenda

Envasses Environmental Consultants Limited in collaboration with Karsan Ramji and Sons Limited and the area administration organized and held a stakeholder engagement meeting on 15th November 2024 at the National Government Constituency Development Fund (NG-CDF) Social Hall in Kiamaina area. The meeting was convened to review and validate the Draft ESIA Study Report on the Proposed 4 MW Geothermal Captive Power Plant at Menengai Geothermal Field in Nakuru County. The agenda was as follows;

1. Prayer and Introductions
2. Opening remarks
3. Overview of the proposed project
4. Presentation on the draft ESIA Study Report
5. Validation of the draft ESIA Study Report
6. Plenary discussions
7. Way forward

2 Prayers and introductions

The meeting began at 9.10 am with a word of prayer from Mr. Peter Kamuyu, a resident of Gituamba area and thereafter introductions. The meeting was attended by 151 participants drawn from the local community, Ministry of Interior and Coordination of National Government, Office of Bahati sub-County Member of Parliament, Members of County Assembly (kabatini, KiaMaina and Bahati), County Government of Nakuru, Kenya Forest Service (KFS), Karsan Ramji and Sons Limited (KRSL) and Envasses Environmental Consultants Limited (Figure 1 and Annexure 1).

Figure 1: Participants following deliberations during the meeting to review and validate the Draft ESIA Study Report (Source: Stakeholder Engagement Meeting, November 2024)

3 Opening Remarks

3.1 Office of the Bahati Sub-County Member of Parliement

Mr. John Njoroge, a representative from the Office of the Bahati Sub-County Member of Parliement thanked the participants for attending the meeting. Mr. Njoroge noted that two stakeholder engagement meetings i.e. Kick-off and review of the draft ESIA study report have been previously held with the key stakeholders on 28th June 2024 and 5th November 2024 respectively. In addition, he highlighted the purpose of the meeting, which was to review and validate the draft ESIA Study Report.

3.2 Office of the members of County Assembly (MCAs)

Ms. Leah Ng'ang'a, the Member of the County Assembly (MCA) for Kabatini Ward, extended her appreciation to Karsan Ramji and Sons Limited for adhering to the legal requirement of conducting public participation. She commended their efforts to engage the local community in gathering views in respect to the proposed project. In addition, Ms. Ng'ang'a urged the company to partner with the local administration in implementing corporate social responsibility (CSR) initiatives that would directly benefit the community. Further, she emphasized the importance of prioritizing local residents for employment opportunities arising from the proposed project, reinforcing the need for inclusive and community-driven development.

4 Overview of the proposed project

Mr. George Muia, the Project Manager, Karsan Ramji and Sons Limited, provided a brief overview of the proposed project. He explained that Karsan Ramji and Sons Limited has entered into a steam supply agreement with the Geothermal Development Company (GDC) to establish a 4-Megawatt (MW) captive power generation unit at Main Well 18A within the Menengai Geothermal Field. This unit will supply power to their planned cement plant and pozzolana drying operations.

5 Presentation on ESIA Study Process

Ms. Rhoda Mutua from Envasses Environmental Consultants Limited thanked the participants for attending the meeting and informed them that it was held pursuant to Regulation 17 of the Environmental Management and Coordination Act Cap. 387 of the Laws of Kenya. She proceeded to give a detailed presentation of the draft ESIA Study Report for the proposed project as follows:

- Background information
- Project description
- Project site status
- Approach and Methodology
- Policy and Legal Framework
- Baseline monitoring results
- Impact analysis
- Stakeholder engagement
- Analysis of alternatives
- Environmental and Social Management Plans
- Environmental Monitoring Plan
- Way forward

Ms. Mutua informed the participants that the key issues raised by the stakeholders during the Kick-off and review of the draft ESIA study report meetings held on 28th June 2024 and 5th November 2024 respectively were already incorporated in the Draft ESIA study report.

6 Plenary Discussions

Mr. Peter Ndung'u, a resident of the Gituamba area, proposed the establishment of a framework for implementation of Corporate Social Responsibility (CSR) activities by Karsan Ramji and Sons Limited in the area. Mr. Ndung'u highlighted that the framework will promote accountability to ensure the

effective implementation of CSR activities in the area. In addition, Mr. Ndung'u highlighted that transportation services should be reserved exclusively for community members and not handled by Karsan Ramji and Sons Limited. Further, he expressed his satisfaction with the proposed project, noting that it would significantly reduce the cost of purchasing and transporting cement while ensuring its local availability.

Mr. Rodgers Osoro, representing resident workers, was keen to know the criteria that will be used to ensure employment opportunities will be equally distributed across all wards in Bahati Sub-county. These sentiments were echoed by Mr. John mwangi, a resident of Rurii area who emphasized the need for employment based on skills rather than personal connections. In response, Mr. George Muia assured the stakeholders that Karsan Ramji and Sons Limited will work closely with the office of the Member of Parliament and local administration to ensure opportunities are equitably distributed among all communities in Bahati Sub-county. He further emphasized that minority groups will be given priority, and that all positions suitable for locals will be reserved for them.

Ms. Margaret Gathoni, a representative of the resident workers, was concerned about compensation of employees in the event of workplace injuries or accidents. Mr. George Muia responded and stated that the company will adhere to the provisions of the Work Injury Benefits Act (WIBA), ensuring that employees injured during their duties would be compensated. In addition, Mr. Muia informed the meeting that there is an on-site medical facility at Karsan Ramji Quarry in Kagoto area that will provide emergency medical services to employees in case of injury.

Mr. Daniel Githinji, a resident of Kiamaina area was keen to know about the timeline for the implementation of corporate social responsibility (CSR) projects and whether sports initiatives for the youth will be included. Mr. George Muia responded and highlighted that Karsan Ramji and Sons Limited will coordinate with the MP's office and the local administration to address the needs of the community. Regarding sports, he confirmed that local community members should propose sports initiatives, which the company will support in collaboration with the MP's office.

Ms. Miriam Maina, a resident of Ahero area, was concerned about wastewater disposal and whether the power generation process will use any chemicals. In response, Mr. George Muia stated that waste water will be managed through a bio-digester and that the power production process will not use any chemicals.

Mr. Samuel Kuria, a resident of Mwaki-Mugi area, expressed concerns about noise pollution at installation and operational phases of the project. Mr. George Muia responded and explained that the wellhead that will be installed is equipped with a muffler system to mitigate noise pollution. Mr. Muia noted that the only source of noise pollution will be from vehicular movement during delivery of raw materials. To mitigate noise pollution from vehicular movement, Mr. Muia stated that delivery of raw materials will be conducted during day time only i.e. between 8 am and 5 pm.

Mr. Moses Mwathi, a resident of Bahati area, was concerned about air pollution at installation and operational phases of the project. In response, Mr. George Muia emphasized that the project is designed to utilize 100% of the steam for power production, meaning that no steam will be released into the atmosphere.

Mr. Sammy Kiio from Kenya Forest Service, Menengai Station encouraged community members to take initiative when job opportunities arise, urging them to believe in their capabilities and apply without hesitation.

7 Validation of the draft ESIA Study Report

The stakeholders agreed to the findings of the draft ESIA Study Report which was in turn validated.

8 Way forward

Mr. Rhoda Mutua thanked the participants for attending the meeting and their invaluable input in enriching the draft ESIA Study report. She further noted that the final report will be submitted to the National Environment Management Authority (NEMA) for decision making.

There being no other business, the workshop ended at 12.29 pm with a word of prayer from Mr. John Mbugua of P.C.E.A Church.

Signed: _____ Date:

Ms. Hyrine Masese,
Envasses Environmental Consultants Limited,
Meeting Secretary.

Appendix 1: Stakeholder Attendance List

ENVASSES ENVIRONMENTAL CONSULTANTS LIMITED

Environmental and Social Impact Assessment (ESIA) Study Report for the Proposed 4 MW Geothermal Power Plant at Menengai Geothermal Field in Nakuru County

Task: Stakeholder Engagement Meeting to review and validate the draft ESIA Study Report

Date: 15/11/2024

Venue: National Government Constituencies Development Fund (NG-CDF) Social Hall

Attendance list

NO.	NAME	AFFILLIATION	TELEPHONE NO. /EMAIL	SIGNATURE
1.	PETER NJOROGE KAMAU	GITUAMBA	0720558448	[signature]
2.	JOHN MACHARIA NDERITU	GITUAMBA	0707561176	[signature]
3.	Rodgers Nahashon Obero	Workers	0726365974	[signature]
4.	SAMMY KIIO	MENENGAI STATION	0718660984	[signature]
5.	EUNICE W. RAMAN	LANDMAWE SILOC.	0724775306	[signature]
6.	JOSEPH M. KIMANI	GITUAMBA	0728408929	[signature]

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NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
7.	MARGARET GATHONI	WORKERS	0726256073	
8.	MUTHONI NKUBIRIA	KIAMAINA DIVISION	0711373373	
9.	Duncan Muiruri	Rurii Sub-Location	0722361658	
10.	MOSES OPATI	WORKERS	0723120514	
11.	Mary Kagai	Makao	0723374974	
12.	Peter Obungu	MAKAO	0727978316	
13.	IRENE NJERI	RURII-SUB LOCATION	0725884726	
14.	John Mwangi	Rurii Sub-location	0723064381	
15.	SAMUEL KIHARA	GITUAMBA	0700341976	
16.	David Nichege	Mawonge	0724822493	
17.	DANIEL KAHARE	MENENGAI SUB-L	0720697747	
18.	JOSEPH Kajwanjo	KIAMAINA	0726366191	
19.	ROBERT MUTHURAH	MENENGAI SUB-L	A10548727	

Stakeholder engagement meeting to review and validate draft ESIA Study Report for the proposed Geothermal Power Plant at Menengai Geothermal Field November 2024

NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
20.	Peter Muchiri	Kiamaina	0725386207	
21.	MICHAEL MUHIA	Giwamba	0726947518	
22.	CECILIA NJUGUNA	ASST CHIEF KIAMAINA	0725678769	
23.	CHARLES MACHARIA WAKAHIU	SNR CHIEF, KIRIMA	0722460658	
24.	LIVINGSTONE WAFULA BONIRE	INDRICCAS SUB LOC	0707153892	
25.	JOHN KARIUKI KANYUA	ASS. CHIEF - RURII	0722592261	
26.	TITUS N. MWEGO	SNR ASS. CHIEF MENENGAI	0720254273	
27.	Bosco M. Wagacho	Kiamaina	0720531925	
28.	ARISTIDES NGUGI	ASST CHIEF MWAUI MUGI	0722261927	
29.	PAUL MBUTHIA KARIUKI	SNR CHIEF MUTUKWA	0723839341	
30.	JOHN KIARAHA WARUGI	CHIEF KIAMAINA	0723420881	
31.	SIMON N. KAMOTITO	ASST. CHIEF GITHIOBA	0728222366	
32.	Peter Wangombe	Menengai	0710258804	

NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
33.	Elizabeth Gathwari	Menengai slope	0722692115	
34.	John Mbugua	WORKERS P.C.E.A	0722633252	
35.	Annie Githinji	KIAMAINA	0726219130	
36.	TABITHA WAWERU	KIAMAINA	0713926772	
37.	JOYCE NJOROGE	KIAMAINA	0720507254	
38.	Ednah Nyaseto	Kiamaina	0791366599	
39.	JOSEPH KIHARA	Kabatini	0720330277	
40.	HILTON MUHIKI	BAHATI	0724501490	
41.	Ann Nduhoni	Kiamaina	0720074381	
42.	Jane wambui Muhuhu	Lower workers	0790934591	
43.	Rebecca Mbure	Nairobi area	0718231640	
44.	David Macharia Ndegwa	Githumbe	0723345680	
45.	Catharine Murimi	Kabatini	0716239556	

NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
46.	MONICAH WANYIKU	MWAKI MUGI	0712928975	[signature]
47.	SERAH WAWERU	MWAKI MUGI	0701581786	[signature]
48.	Francis Kiragu	RURII	0723796442	[signature]
49.	HARUN THIONGO	KIAMAMBA WARD MCAS OFFICE	0725793583	[signature]
50.	John Maina	AHOHE	0727038793	[signature]
51.	MONICAH WAMBUI	LAND MAWE	0723973445	[signature]
52.	Samuel Kuria	Mwaki - mugi	0725681054	[signature]
53.	Ann Ndirangu	Rurii	0720570311	[signature]
54.	ESTHER WANGARE	KIAMARA	0715228461	[signature]
55.	TABITHA KIGOTHERU	BAHATI	0700707667	[signature]
56.	Daniel Ndungu	Bahati	0722 981 874	[signature]
57.	Isaac Mutai	BAHATI	0113620497	[signature]
58.	MOHAMMED NJENGA	BAHATI	0704363291	[signature]

Stakeholder engagement meeting to review and validate draft ESIA Study Report for the proposed Geothermal Power Plant at Menengai Geothermal Field November 2024

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NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
59.	PATRICK NJOGU	BAHATI	0729983929	
60.	SAMWEL WATUNU	Menengai Sub Loc.	0722675897	
61.	Constance Njoroge	NGCDF Bahati	0783576634	
62.	Mary Wanjeri	M.p office (Secretary)	0725964138	
63.	DAVID KIIRU	Menengai	0700839515	
64.	KELVIN GICHERU.	BAHATI	0708544287	
65.	DANIEL GORMINGIN	Kagoto	0727906364	
66.	PHILIP MATHAI	Kiamaina	0728083228	
67.	JOSEPH NDUNGU	WANYORORO B	072383116	
68.	SHADRACK KAMAU	BAHATI	0721656920	
69.	Monica Mathu	Muleleki Mugi	0728998184	
70.	MARTHA MUGURE	MENENGAI	0724827349	
71.	MARY WACERA	RURII	0712856423	

Stakeholder engagement meeting to review and validate draft ESIA Study Report for the proposed Geothermal Power Plant at Menengai Geothermal Field November 2024

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NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
72.	SAMWEL NDIGA	Maili Saba	0708917783	
73.	Samuel MATIRU	MAKAO	0726488234	
74.	MICHAEL KIOJANJU	RUDII	0722691685	
75.	SAMWEL NJENGA	KABATINI	0722226645	
76.	JOHN THUO	KABATIN	0725129006	
77.	ALICE MUTHONI	BAHATI	0725464599	
78.	JAMES MWANGI	KIAMAINA	0714 107423	
79.	JOHN MWANGI	KIAMAINA	0726029916	
80.	GIDEON N. MAINA	KIAMAINA	0720827516	
81.	Gladys mbaire	J.C	0706015775	
82.	Hanna Njeri	Kembutini	0798514312	
83.	Samuel Nduati	Bahati	0722591221	
84.	Bobby Kinyanjui	Kumura	0708000224	

NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
85.	James Ndungu	Ujima Foundation	0721-512846	
86.	Anthony Kingangui	Kiamaina	0729866594	
87.	Faymary Ndungu	Mwaki muiji	0707822601	
88.	Arthur Kago Nyugi	Ahero	0790436522	
89.	Joseph Gachu Kamau	Mizpah	0722 385 953	
90.	John [illegible] Ng'ang'a	Maili kumi	0790727817	
91.	Sarah Ntambura Geita	Heshima	0718886410	
92.	Oscbert Kilanya	MPs Afee	0720444968	
93.	Miriam Maina	AHERO	0768422539	
94.	Mwangi Mbogo	Kamurari	0722480229	
95.	Paul M Gathiki	Moti TiSa	0720179151	
96.	Mohammed Matu Wachira	Mali Tiss Ahero	0727022762	
97.	Kennedy Adem Nderitu	AHERO	0710278221	

NO.	NAME	AFFILLIATION	TELEPHONE NO. /EMAIL	SIGNATURE
98.	Margaret Nganga	KABATINI	0703999275	
99.	Margret Mugre	WARDS	0720754401	
100.	LEAH NGANGA	MCA KABATINI	0724830614	
101.	GRACE MWATHI	M-C-A BAHATI	0724817341	
102.	BERNARD N. MURIURI	TUINUANE (WORKERS)	0724 363575	
103.	JOHN KAMOTHO	MENENGAI	0729146180	
104.	Isaac Gitau	Kahuhini	0728613583	
105.	Wilberforce Barasa	Mailisaba	0725831957	
106.	Moses Mwathi	Bahati	0723703351	
107.	JOSEPH MUNENE	BAHATI	0721538527	
108.	SAMUEL KAHUHGU	KABILI SITA	0720547936	
109.	David Githonga	KABATINI	0716042180	
110.	Stephen Kamau	KABATINI	0717727125	

NO.	NAME	AFFILLIATION	TELEPHONE NO. /EMAIL	SIGNATURE
111.	James Mutahi	BAHATI	0795752530	[signature]
112.	MARIANNE WAKORI	BAHATI	0726 874421	[signature]
113.	Edwin Cheje	Bahati	0758287065	[signature]
114.	MARY W. KAMAU	KIAMAINA - CHIEF KURII	0721224380	Mary
115.	LEAH MBARIRE	KABATINI	0795618698	[signature]
116.	Josephine Wambui	Kabatini	0726952804	[signature]
117.	Catherine Wamuyu Kihiu	Kiongoi	0740201028	[signature]
118.	CHEGE WAGURA	KIAMAINA	0721587709	[signature]
119.	Rebecca W. Mbugua	Kabatini	0724200199	[signature]
120.	Ann Mugwe	Kabatini	0742887747	Kmugwe.
121.	Margaret Njambi	Bahati	0722221753	[signature]
122.	ANNE GATHONI	Mwaki muugi	070511192	[signature]
123.	TILDA MUGATHI	KABATINI	0720761261	[signature]

NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
124.	STEPHEN GITAU NJOGU	RURII	0722407616	[signature]
125.	MONICA A. OBENBO	CGN- ENVIRONMENT OFFICER	0716678324	[signature]
126.	Peter mama Mgugi	MCA office	0704[illegible]1164	[signature]
127.	David Kamau	SCPHO Blu	0720532889	[signature]
128.	Samuel Wangungu	MP's Office	0724988560	[signature]
129.	PETER KARANJA	KABATINI	0723230525	[signature]
130.	PETER Kimani	Kiamaina	0708459645	[signature]
131.	PATRICK Muigai	Kiongo.ng	0721900269	[signature]
132.	DUNCAN KONES	KIAMAINA	0724 123 127	[signature]
133.	JOHN NJURE	KABATINI	0720052740	[signature]
134.	ISAAC KIMANI, NGANGA	KABATI, Kiamaina	0722986293	[signature]
135.	JOHN Kimani Kamau	Kabatini	0728059049	[signature]
136.	JOHN HIGOGE	MPS office Com	0793679248	[signature]

NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
137.	VIRGINIA WAIRO	NG-CDF OFFICE	0724505058	[signature]
138.	KEZIAH KANGETHE	NG-CDF OFFICE	0718216003	[signature]
139.	CHARLES KAMAU	NG-CDF OFFICE	0118709764	[signature]
140.	SALIM MOHAMMED	PRSC	0745387593	[signature]
141.	Bernard Kimani	NG-CDF OFFICE	0722100374	[signature]
142.	RUTH WANJIKU	NG-CDF OFFICE	0791666362	[signature]
143.	SHEM MUSUYA	NG-CDF OFFICE	0797564387	[signature]
144.	EVERLINE LIKAFWA	NG-CDF OFFICE	0702817712	[signature]
145.	BEATRICE BOWEN	NG-CDF OFFICE	0724240609	[signature]
146.	Peter Wawer	Kamirungi	0722-239061	[signature]
147.	John mkona	Kabatini	0725211592	[signature]
148.	Peter Marazi	Kabatini	0727765443	[signature]
149.	Mercy Njenga	NG-CDF	0726062430	[signature]

NO.	NAME	AFFILIATION	TELEPHONE NO. /EMAIL	SIGNATURE
150.	MACE.CE ITHRIE	ENVASSES CONSULTANTS	0795 798 746	[signature]
151.	Rhoda Muma	Envasses Consultants	0726721393	[signature]
152.	George Muia	KRSL	0722337277	[signature]
153.				
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Annexure 13: Public consultation questionnaires

ENVASSES ENVIRONMENTAL CONSULTANTS LIMITED

Ralli House Building, Nyerere Avenue, P.O. Box 2013-80100, Mombasa
Tel: +254722347155; Email: info@envasses.org; website www.envasses.org

Our REF: Envasses/KRSL/06/2024

24th June 2024

PUBLIC CONSULTATIONS QUESTIONNAIRE

Dear Neighbor,

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY FOR THE PROPOSED GEOTHERMAL DIRECT-USE POWER PLANT WITHIN MENENGAI GEOTHERMAL FIELD IN NAKURU COUNTY.

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Yours sincerely,

24 JUN 2024

Mr. Simon Nzuki
Chief Executive Officer and Lead Consultant

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About the questionnaire

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Part I: Interviewer Profile	
Name of interviewer	MASESE HTRIKE
Position/Title	ENVIRONMENTAL ASSISTANT
Date	7th/07/2024
Signature	

Part II: Respondent's Profile	
Name	Mary Njeri Wanjiru
Gender (Male, Female, N/A for companies)	Female
Position of respondent for business	
Occupation/type of business	
Approximate distance from site	4km
Period of residency in the area (<5, >5years)	10years
Telephone contact	0719692416
ID No. or Registration No. for businesses	828980128
Signature	

Firm of Experts: Envasses Environmental Consultants Limited June, 2024

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☑ NO ☐ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any specific environmental and social concerns regarding the project site historically?	(List them) N/A

Part IV: Objections and impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☐ NO ☑ If Yes, give reason(s)
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project? Creation of employment opportunities to youth Revenue generation for the government	YES ☑ NO ☐ If Yes, list them

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☐ NO ☑ If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**

ENVASSES ENVIRONMENTAL CONSULTANTS LIMITED

Ralli House Building, Nyerere Avenue, P.O. Box 2013-80100, Mombasa
Tel: +254722347155; Email: info@envasses.org; website www.envasses.org

Our REF: Envasses/KRSL/06/2024

24th June 2024

PUBLIC CONSULTATIONS QUESTIONNAIRE

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ENVASSES ENVIRONMENTAL CONSULTANTS LTD Tel:0722 347 155 24 JUN 2024 P.O. Box 2013-80100, MOMBASA

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Part I: Interviewer Profile	
Name of interviewer	MASEGE HIRINE
Position/Title	ENVIRONMENTAL ASSISTANT
Date	9th/07/2024
Signature	

Part II: Respondent's Profile	
Name	Stephen Mwangi
Gender (Male, Female, N/A for companies)	Male
Position of respondent for business	Slaughter house employee
Occupation/type of business	Employee
Approximate distance from site	6KM
Period of residency in the area (<5, >5years)	<5yrs (27yrs)
Telephone contact	0740442962
ID No. or Registration No. for businesses	42366702
Signature	

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☑ NO ☐ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any specific environmental and social concerns regarding the project site historically?	(List them)
Part IV: Objections and Impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☐ NO ☑ If Yes, give reason(s)
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☑ NO ☐ If Yes, list them - Area development

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☑ NO ☐ If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**
	- Air Pollution - Respiratory diseases

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Part I: Interviewer Profile	
Name of interviewer	MASESE NYAMWE
Position/Title	ENVIRONMENTAL ASSISTANT
Date	09/07/2024
Signature	

Part II: Respondent's Profile	
Name	
Gender (Male, Female, N/A for companies)	ANNE WAKONYO
Position of respondent for business	N/A
Occupation/type of business	N/A
Approximate distance from site	3KM
Period of residency in the area (<5, >5years)	< 5
Telephone contact	0720773203
ID No. or Registration No. for businesses	0471613
Signature	Anne

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☑ NO ☐ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any specific environmental and social concerns regarding the project site historically?	(List them) N/A
Part IV: Objections and impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☐ NO ☑ If Yes, give reason(s)
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☐ NO ☑ If Yes, list them

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☐ NO ☑ If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**

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Part I: Interviewer Profile	
Name of Interviewer	MASESE NYRINE
Position/Title	ENVIRONMENTAL ASSISTANT
Date	09/07/2024
Signature	

Part II: Respondent's Profile	
Name	LUCAS KHORO MWANGI
Gender (Male, Female, N/A for companies)	MALE
Position of respondent for business	N/A
Occupation/type of business	RETIRED 3/S
Approximate distance from site	3KM
Period of residency in the area (<5, >5years)	75 years
Telephone contact	0724111241
ID No. or Registration No. for businesses	0729422
Signature	

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☑ NO ☐ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any specific environmental and social concerns regarding the project site historically?	(List them) NO
Part IV: Objections and impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☐ NO ☑ If Yes, give reason(s)
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☐ NO ☑ If Yes, list them

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☐ NO ☑ If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**

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Our REF: Envasses/KRSL/06/2024

24th June 2024

PUBLIC CONSULTATIONS QUESTIONNAIRE

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Part I: Interviewer Profile	
Name of interviewer	MASESE HIRINE
Position/Title	ENVIRONMENTAL ASSISTANT
Date	09 | 07 | 2024
Signature	[signature]

Part II: Respondent's Profile	
Name	Stephen Mwangi Mwaathi
Gender (Male, Female, N/A for companies)	
Position of respondent for business	Resident
Occupation/type of business	Business Man
Approximate distance from site	
Period of residency in the area (<5, >5years)	10 years
Telephone contact	0718205971
ID No. or Registration No. for businesses	26588809
Signature	[signature]

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☑ NO ☐ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any spedfic environmental and social concerns regarding the project site historically?	(List them) NO
Part IV: Objections and Impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☐ NO ☑ If Yes, give reason(s)
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☑ NO ☐ If Yes, list them Bring up development in employment for youths

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☐ NO ☑ If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**

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Part I: Interviewer Profile	
Name of interviewer	Faidah Khamalisha
Position/Title	Environmental Assistant
Date	01/07/2024
Signature	

Part II: Respondent's Profile	
Name	
Gender (Male, Female. N/A for companies)	FEMALE
Position of respondent for business	N/A
Occupation/type of business	N/A
Approximate distance from site	7KM
Period of residency in the area (<5, >5years)	2-4YEARS
Telephone contact	0795726024
ID No. or Registration No. for businesses	N/A
Signature	

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☑ NO ☐ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any specific environmental and social concerns regarding the project site historically?	(List them) NOISE
Part IV: Objections and impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☒ NO ☑ If Yes, give reason(s)
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☑ NO ☐ If Yes, list them Creation of employment Cheaper cement

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES [✓] NO [ ] If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**
NOISE SMELL	

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CONSULTANTS
LIMITED

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24 JUN 2024
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Part I: Interviewer Profile	
Name of interviewer	Faidah Khamisi
Position/Title	Environmental Assistant
Date	09/07/2024
Signature	

Part II: Respondent's Profile	
Name	Jacinta Wambui
Gender (Male, Female, N/A for companies)	Female
Position of respondent for business	Not Applicable
Occupation/type of business	-
Approximate distance from site	7km
Period of residency in the area (<5, >5years)	4 Yrs
Telephone contact	0702511955
ID No. or Registration No. for businesses	35560700
Signature	

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☑ NO ☐ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any specific environmental and social concerns regarding the project site historically?	(List them) N/A
Part IV: Objections and impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☐ NO ☑ If Yes, give reason(s)
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☑ NO ☐ If Yes, list them - It will create job opportunities for the youth available in the area - It will be an income generating for the county - It will create growth of urban area to the nearest village.

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☑ NO ☐ If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**
- Air pollution. - It may cause land slidding.	

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Part I: Interviewer Profile	
Name of interviewer	Faidah Khamalishi
Position/Title	Environmental Assistant
Date	09/07/2024
Signature	

Part II: Respondent's Profile	
Name	Irine Muangi
Gender (Male, Female, N/A for companies)	Female
Position of respondent for business	Owner
Occupation/type of business	Shop vendor
Approximate distance from site	7km
Period of residency in the area (<5, >5years)	4years
Telephone contact	0716435822
ID No. or Registration No. for businesses	22945743
Signature	

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☑ NO ☐ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any specific environmental and social concerns regarding the project site historically?	(List them) N/A
Part IV: Objections and impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☐ NO ☑ If Yes, give reason(s)
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project? Creation of employment to locals	YES ☑ NO ☐ If Yes, list them

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☑ NO ☐ If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**
Not sure if smoke emitted from the production well affects people	Put in place effective measures to mitigate the impacts

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About the questionnaire

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Part I: Interviewer Profile	
Name of interviewer	MACFCE HIRWE.
Position/Title	ENVIRONMENTAL ASSISTANT
Date	9th/07/2024
Signature	

Part II: Respondent's Profile	
Name	Ruth Wanjiku
Gender (Male, Female, N/A for companies)	Female
Position of respondent for business	Hair Saloon
Occupation/type of business	Owner.
Approximate distance from site	5km.
Period of residency in the area (<5, >5years)	<5 (3Yrs)
Telephone contact	0113124759
ID No. or Registration No. for businesses	37813287
Signature	

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☑ NO ☐ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any specific environmental and social concerns regarding the project site historically?	(List them) - Air Pollution - Emmissions from site.
Part IV: Objections and impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☑ NO ☐ If Yes, give reason(s)
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☐ NO ☐ If Yes, list them - It will help community members through job opportunities

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☑ NO ☐ If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**
	- Air Pollution

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Tel: +254722347155; Email: info@envasses.org; website www.envasses.org

Our REF: Envasses/KRSL/06/2024

24th June 2024

PUBLIC CONSULTATIONS QUESTIONNAIRE

Dear Neighbor,

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY FOR THE PROPOSED GEOTHERMAL DIRECT-USE POWER PLANT WITHIN MENENGAI GEOTHERMAL FIELD IN NAKURU COUNTY.

Karsan Ramji and Sons Limited (KRSL) has a steam supply agreement with Geothermal Development Company (GDC) and intends to set up a geothermal power plant in Menengai Geothermal Field to tap steam and brine from Well No. 18A to generate electricity for use in its cement factory located approximately 6km from the production well and drying pozzalana through heat exchange respectively. Pursuant to Section 58 of the Environmental Management and Coordination Act Cap. 387 of Laws of Kenya, KRSL has contracted Envasses Environmental Consultants Limited to carry out Environmental and Social Impact Assessment study for the proposed project. The assessment will propose measures to reduce potential environmental, safety and health risks to neighbors and the general public.

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Yours sincerely,

24 JUN 2024

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Part I: Interviewer Profile	
Name of interviewer	Faida Khamalichi
Position/Title	Environmental Assistant
Date	09/07/2024
Signature	

Part II: Respondent's Profile	
Name	THUO KIMATHI
Gender (Male, Female, N/A for companies)	
Position of respondent for business	M
Occupation/type of business	Farmer
Approximate distance from site	4 Km
Period of residency in the area (<5, >5years)	20
Telephone contact	0729955137
ID No. or Registration No. for businesses	—
Signature	

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☐ NO ☑ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any specific environmental and social concerns regarding the project site historically?	(List them)
Part IV: Objections and Impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☑ NO ☐ If Yes, give reason(s) Cause am not sure if the community will benefit
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☑ NO ☐ If Yes, list them Planting trees cleaning environment

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☑ NO ☐ If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**
We are not sure if the creator can cause any harm to the community due to the dust	

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24th June 2024

PUBLIC CONSULTATIONS QUESTIONNAIRE

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ENVIRONMENTAL CONSULTANTS LTD Tel:0722 347 155 24 JUN 2024 P.O. Box 2013-80100, MOMBASA

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Chief Executive Officer and Lead Consultant

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Part I: Interviewer Profile	
Name of interviewer	Faidah Khamalisha
Position/Title	Environmental Assistant
Date	09/July/2024
Signature	

Part II: Respondent's Profile	
Name	Susan Ngaira
Gender (Male, Female, N/A for companies)	Female
Position of respondent for business	N/A
Occupation/type of business	Farmer
Approximate distance from site	6km
Period of residency in the area (<5, >5years)	>5yrs (born)
Telephone contact	0790 74[illegible]60 / 0725 228 644
ID No. or Registration No. for businesses	—
Signature	

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☑ NO ☐ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any specific environmental and social concerns regarding the project site historically?	(List them) - Respiratory diseases. - Kite diseases.
Part IV: Objections and Impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☑ NO ☐ If Yes, give reason(s)
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☑ NO ☐ If Yes, list them - Job opportunities. - Affordable Cement

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☑ NO ☐ If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**
	- Avoid using chemicals that may affect neighbours - Provide protective gears to those who will be Hooking there.

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24th June 2024

PUBLIC CONSULTATIONS QUESTIONNAIRE

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24 JUN 2024

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Part I: Interviewer Profile	
Name of interviewer	MAGEGE HIRINE
Position/Title	ENVIRONMENTAL ASSISTANT
Date	09/07/2024
Signature	

Part II: Respondent's Profile	
Name	Rahab Wanjiku
Gender (Male, Female, N/A for companies)	Female
Position of respondent for business	Business
Occupation/type of business	Owner
Approximate distance from site	5 km
Period of residency in the area (<5, >5years)	10 years
Telephone contact	0715928184
ID No. or Registration No. for businesses	22390821
Signature	

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☑ NO ☐ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any specific environmental and social concerns regarding the project site historically?	(List them) Noise and bad smell
Part IV: Objections and impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☑ NO ☐ If Yes, give reason(s)
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☐ NO ☐ If Yes, list them Give employment to the youths

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☐ NO ☑ If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**

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24th June 2024

PUBLIC CONSULTATIONS QUESTIONNAIRE

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ENVASSES ENVIRONMENTAL CONSULTANTS LTD
Tel:0722 347 155
24 JUN 2024
P.O. Box 2013-80100, Mombasa

Mr. Simon Nzuki
Chief Executive Officer and Lead Consultant

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0704063064- Faidah

ESIA Study for proposed Geothermal Direct-Use Power Plant in Menengai Field, Nakuru Page 2

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Part I: Interviewer Profile	
Name of interviewer	Faidah Khamalisha
Position/Title	Environmental Assistant
Date	09/07/2024
Signature	

Part II: Respondent's Profile	
Name	
Gender (Male, Female, N/A for companies)	
Position of respondent for business	
Occupation/type of business	
Approximate distance from site	1 mile
Period of residency in the area (<5, >5years)	20 years
Telephone contact	0792 832 959
ID No. or Registration No. for businesses	
Signature	

Firm of Experts: Envasses Environmental Consultants Limited June, 2024

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☐ NO ☑ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any specific environmental and social concerns regarding the project site historically?	(List them)
Part IV: Objections and impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☑ NO ☐ If Yes, give reason(s) impacts on both water quality and consumption. (contains high levels of sulphur, salt and other minerals.
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☐ NO ☑ If Yes, list them

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ✓ NO ☐ If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**
Water quality ~~and~~ →Geothermal power plants can have impacts on both water quality and consumption. Hot water pumped from underground reservoirs often contains high levels of sulfur, salt Air emissions. →Emition of hydrogen sulfide, carbon dioxide, ammonia, methane and boron. Hydrogen sulfide which has a distinctive "rotten egg" Land ~~There is eviden~~ It is clearly evident that geothermal plants can lead to an even greater earthquake frequency.	

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Part I: Interviewer Profile	
Name of interviewer	Lewis Mbesse Atrine
Position/Title	Environmental Assistant
Date	07/07/2024
Signature	

Part II: Respondent's Profile	
Name	Lewis Waweru
Gender (Male, Female, N/A for companies)	Male
Position of respondent for business	Posho Mill Business
Occupation/type of business	Owner
Approximate distance from site	5 KM
Period of residency in the area (<5, >5years)	7 Yrs (7 Yrs)
Telephone contact	0712 299 604
ID No. or Registration No. for businesses	39479237
Signature	

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☑ NO ☐ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any specific environmental and social concerns regarding the project site historically?	(List them)
Part IV: Objections and impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☑ NO ☐ If Yes, give reason(s) Noise pollution.
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☐ NO ☑ If Yes, list them

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☑ NO ☐ If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**
	-Noise Pollution -Air Pollution - smell from steam

ENVASSES ENVIRONMENTAL CONSULTANTS LIMITED

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24th June 2024

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Part I: Interviewer Profile	
Name of interviewer	MASEEE HIRINE
Position/Title	ENVIRONMENTAL ASSISTANT
Date	7TH / 07 / 2024
Signature	

Part II: Respondent's Profile	
Name	Hannah Njeri
Gender (Male, Female, N/A for companies)	Female
Position of respondent for business	
Occupation/type of business	Farmer
Approximate distance from site	3km
Period of residency in the area (<5, >5years)	10years
Telephone contact	0718466675
ID No. or Registration No. for businesses	4265829
Signature	Hannah

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☑ NO ☐ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any specific environmental and social concerns regarding the project site historically?	(List them) N/A
Part IV: Objections and impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☐ NO ☑ If Yes, give reason(s)
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project? Promotion of business Creation of employment Affordable cement for use in construction	YES ☑ NO ☐ If Yes, list them

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☑ NO ☐ If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**
Air pollution (little odor) Any corrosion effect from the operational stage	

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Part I: Interviewer Profile	
Name of interviewer	MASEEF HIRINE
Position/Title	ENVIRONMENTAL ASSISTANT
Date	9th/07/2024
Signature	

Part II: Respondent's Profile	
Name	Moses Ng'ang'a
Gender (Male, Female, N/A for companies)	Male
Position of respondent for business	Owner
Occupation/type of business	Farmer
Approximate distance from site	App. 1Km
Period of residency in the area (<5, >5years)	16years
Telephone contact	0720251075
ID No. or Registration No. for businesses	
Signature	

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☑ NO ☐ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any specific environmental and social concerns regarding the project site historically?	(List them) N/A
Part IV: Objections and Impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☐ NO ☑ If Yes, give reason(s)
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project? Creation of employment	YES ☐ NO ☐ If Yes, list them

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☑ NO ☐ If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**
Not sure if any negative effective will be felt during operation phase	

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Part I: Interviewer Profile	
Name of interviewer	MACEEF HIRINE
Position/Title	ENVIRONMENTAL ASSISTANT
Date	9th/10/2024
Signature	

Part II: Respondent's Profile	
Name	Veronicah Njoki
Gender (Male, Female, N/A for companies)	Female
Position of respondent for business	N/A
Occupation/type of business	
Approximate distance from site	Approx. 1km
Period of residency in the area (<5, >5years)	2years
Telephone contact	0794398419
ID No. or Registration No. for businesses	38181569
Signature	

Part III: Knowledge of the proposed site and existing environmental concerns	
a) Do you know the proposed project site (near GDC Well No. 18A)?	Yes ☑ NO ☐ (If No, the interviewer to show the respondent the proposed project site)
b) If yes, do you have any specific environmental and social concerns regarding the project site historically?	(List them)
Part IV: Objections and impact of the proposed project on the stakeholder	
a) Do you have any objection to the proposed geothermal direct use power plant project?	YES ☐ NO ☑ If Yes, give reason(s)
b) Are there any positive environmental and social impacts that you anticipate from the proposed geothermal power project? Creation of employment	YES ☑ NO ☐ If Yes, list them

c) Are there negative environmental and social impacts that you anticipate from the proposed geothermal power project?	YES ☐ NO ☑ If Yes, list them and the corresponding mitigation measures in the column below
List of negative environmental and social impacts of the proposed project?	**Proposed mitigation measures**

Annexure 14: NEMA practicing license for the firm, Envasses Environmental Consultants Limited

EAE 23060347

FORM 7 (r.15(2))

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/20222

Application Reference No: NEMA/EIA/EL/26823

M/S **Envasses Environmental Consultants Ltd**
(individual or firm) of address
P.O. Box 2013 - 80100 Mombasa

is licensed to practice in the capacity of a (Lead Expert/Associate Expert/Firm of Experts) **Firm of Experts** registration number **6175**

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

Issued Date: 12/18/2023 Expiry Date: 12/31/2024

Signature.....

(Seal)
Director General
The National Environment Management Authority

P.T.O.

ISO 9001 : 2015 Certified

Annexure 15: NEMA practicing license for Team Leader, Mr. Simon Nzuki

FORM 7 (r.16(2))

EAE 23060245

nema

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY(NEMA)

THE ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION ACT

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

License No : NEMA/EIA/EXPL/20271

Application Reference No: NEMA/EIA/EL/26824

M/S **Simon Kioko Nzuki**
(individual or firm) of address
Po Box 2013 - 80100 Nairobi

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

registration number **1350**

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

Issued Date: **1/5/2024** Expiry Date: **12/31/2024**

Signature.....

(Seal)
Director General
The National Environment Management Authority

P.T.O.

ISO 9001 : 2015 Certified

Annexure 16: NEMA practicing license for Stakeholder Engagement Expert, Ms. Jane Gitau

EAE 23060348

FORM 7 (r.15(2))

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/20221

Application Reference No: NEMA/EIA/EL/26825

M/S **Jane Mukami Gitau**
(individual or firm) of address
P.O. Box 2013 - 80100 Mombasa

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

registration number **2015**

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

Issued Date: 12/18/2023 Expiry Date: 12/31/2024

Signature.....

(Seal)
Director General
The National Environment Management Authority

P.T.O.

ISO 9001 : 2015 Certified