



UPDATED SUSWA GEOTHERMAL DRILLING PROJECT ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT REPORT



FINAL ESIA ADDENDUM REPORT



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CERTIFICATION

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EXECUTIVE SUMMARY

E.1 INTRODUCTION

This section provides a concise, high-level overview of the entire report providing the objective, key findings and recommendations.

The Geothermal Development Company (GDC) is mandated to develop 5,000MW of geothermal power by 2030. Kenya's geothermal resources are distributed across more than 14 geothermal areas along the Kenyan Rift, including Menengai, Olkaria, Suswa, Longonot, Eburru, Arus-Bogoria, Lake Baringo, Korosi, Paka, Lake Magadi, Badlands, Silali, Emuruaogolok, Namarunu, and Barrier. Among these, the proposed Suswa Geothermal Project is a key initiative aimed at harnessing geothermal energy for sustainable power generation.

The Suswa Geothermal Prospect spans an estimated 750 km², extending westward into Narok County, southward into Kajiado County, and northward towards Nakuru County. It is geographically located between Northings (986000–9885000) and Eastings (195000–225000) within UTM Zone 36°S, Arc 1960 Datum. The prospect lies approximately 20 km southwest of Mt. Longonot, within the southern sector of the Kenyan Rift.

An initial Environmental and Social Impact Assessment (ESIA) was conducted in 2013, resulting in the issuance of license by the National Environment Management Authority (NEMA). However, due to subsequent environmental, social, legal, and policy changes, an updated ESIA is needed to ensure compliance with current Kenyan legislation, including the Environmental Management and Coordination Act (EMCA) 1999 (Revised in 2015), its regulations, and IFC Performance Standards.

To this end, GDC commissioned Ecoscience and Engineering Ltd to prepare associated Environmental and Social documentation that included preparation of a new ESIA study/ update the 2013 ESIA report including Stakeholder Engagement report (SEP), Land Acquisition and Compensation Framework/ Plan, Indigenous Peoples Plan (IPP) and Community Development Framework (CDF).

E1.1 Project Location

Location of the proposed wells sites are Exploration well site 1 (SW-01) Northings 9868534 Eastings 204196; Exploration well site 2 (SW-02) Northings 9874476 Eastings 208591; Exploration well site 3 (SW-03) Northings 9873804 Eastings 201954 and Exploration well site 4 (SW-04) Northings 9877644 N Eastings 204168.

If these first exploration wells are successful, step-out/appraisal wells will be drilled to demarcate the extent of the geothermal resources before engaging into production drilling in case the field proves viable.

E1.2 ESIA Study Methodology

The ESIA methodology followed a systematic process that predicted and evaluated the impacts the project could have on the physical, biological, social/ socio-economic and cultural environment, and identified measures that Geothermal Development Company (GDC) will take in consideration to avoid, reduce, mitigate, offset or compensate for adverse impacts; and to enhance positive impacts where practicable. The study methodology comprised of the following activities:

- Preliminary Meetings;
- Desktop Review;
- Environmental Screening;
- Environmental Scoping;
- Stakeholder Engagement
 - ✓ Initial Stakeholder / Sensitization Meetings;
 - ✓ Public Consultation Meeting;
 - ✓ Public Disclosure Meeting.
- Environmental Baseline Data collection;
 - ✓ Site Evaluation and Collection of Biophysical Data
 - ✓ Soil Analysis;
 - ✓ Ambient Air Quality Assessment;
 - ✓ Ambient Noise Assessment.
 - ✓ Ecological/Archaeological Assessment;
 - ✓ Baseline Socio-Economic Studies;
 - ✓ Data Evaluation, Analysis and Reporting

E2 PROJECT DESCRIPTION

The project site is located in Mount Suswa and its calderas, which traverse Narok East and Kajiado West sub counties of Narok and Kajiado Counties respectively. Mount Suswa is made up of two calderas; the inner (younger or smaller) caldera and the outer (older or major) caldera. The outer caldera measures about 10 km in diameter and has a general ENE-WSW orientation. The inner caldera has a diameter of about 4 km and a central resurgent block that measures about 3 km in diameter. Hydrological recharge for the Suswa geothermal reservoir is from the rift flanks of Mau and Aberdares ranges. The recharge occurs through detachments and rift faults.

The proposed Suswa geothermal drilling project will comprise of the following components:

- Access roads;
- Well pads;
- Laydown area;
- Water supply network;
- A Drillers campsite and
- Geothermal wells.

The consumables that will be required for drilling of the proposed geothermal wells are provided below:

- Drilling detergent;
- Bentonite (Drilling mud);
- Drilling polymer;
- Blended cement;
- Cement additives including mica flakes;
- Diesel fuel and engine oil for the generators to power the rig;

- Water for drilling and
- Corrosion inhibitors.

An approximate volume of 140,000 cubic metres of water, 350,000 litres of diesel fuel, 400 tonnes of cement and 1 tonne Bentonite (drilling mud) will be required to drill a single well.

E3 LEGAL FRAMEWORK

The applicable frameworks that have been used in this study are:

a) National Environmental Regulatory Framework :

The applicable environmental regulations and policies in Kenya that have been utilized include the Environmental Management and Coordination Act (EMCA) 1999(Revised 2015) and the associated regulations.

The proposed geothermal drilling project is listed under the second schedule of section 58(4) of the Environmental Management and Coordination Act, 1999 (Rev, 2015) and Legal Notice No. 101 of June 2003 (Environmental Impact Assessment and Audit Regulations (Rev. 2019) categorizes this project as high-risk project.

b) International Standards

Under the IFC Performance Standards (2012), the proposed project has varied environmental and social impacts that cuts across the entire spectrum of the Performance Standards;

The applicable IFC Performance Standards relevant to the proposed Suswa geothermal drilling project are summarized in **Table 1** below.

Table 1: IFC Performance Standards and their relevancy to Suswa geothermal projects

PS	Performance Standard	Relevance to Geothermal	Remarks
PS1	Assessment and Management of Environmental and Social Risks and Impacts.	Ensures that geothermal drilling projects conduct thorough Environmental and Social Impact Assessments (ESIA), identify potential risks, and develop appropriate mitigation measures.	<i>Applicable</i> There are Environmental and Social risks that will arise during drilling of wells and associated infrastructures.
PS 2	Labour and Working Conditions	Focuses on workers' health and safety, ensuring proper labor conditions, and addressing concerns related to working	<i>Applicable</i> The proposed project shall engage both skilled and unskilled workers to offer services in the project and their welfare will need to be taken care of. The project will have to comply with best labour practices/

PS	Performance Standard	Relevance to Geothermal	Remarks
PS 3	Resource Efficiency and Pollution Prevention	Ensures resource efficiency (e.g., water, energy) and proper waste management (e.g., drilling mud, chemical disposal), and pollution prevention from geothermal effluents and emissions.	<i>Applicable</i> There are project activities like maintenance of vehicles and machines, fugitive dust and exhaust emissions that have the potential to cause pollution.
PS 4	Community Health, Safety, and Security	Focuses on community health and safety, including managing emissions (e.g., H ₂ S), ensuring local safety protocols, and establishing emergency response plans for potential accidents.	<i>Applicable</i> Community members will be employed in the project. Project vehicles will also be transporting drilling equipment, materials and waste outside the site exposing community members to safety risks. The Community will be involved in the security management of the project.
PS 5	Land Acquisition and Involuntary resettlement	Ensures that land acquisition processes are fair and transparent, and that communities are not involuntarily displaced due to geothermal drilling operations. Measures for livelihood restoration are included.	<i>Applicable</i> PS5 recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land. Proper land acquisition protocols will be followed and livelihood restoration measures implemented/
PS 6	Biodiversity Conservation and Sustainable Management of Living Natural Resources	Addresses impact on local biodiversity and ecosystems, especially in sensitive areas, and ensures sustainable management of natural resources (e.g., water bodies, local habitats).	<i>Applicable</i> PS6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. For this project, Mt. Suswa conservancy becomes of key biodiversity interest.
PS 7	Indigenous Peoples	Ensures that Indigenous Peoples' rights and cultures are respected during geothermal drilling projects. Free, Prior, and Informed Consent (FPIC) is required for projects that	<i>Applicable</i> The Maasai community, who reside within the proposed project area are regarded indigenous peoples and FPIC

PS	Performance Standard	Relevance to Geothermal	Remarks
		affect indigenous territories or practices.	protocols will be adopted during the study and implementation of the project.
PS 8	Cultural Heritage	Ensures that any cultural or archaeological sites near the drilling area are identified and preserved, respecting the cultural heritage of local communities during operations.	Applicable Before drilling, survey to ascertain the presence of any archaeological or cultural sites to avoid disturbance will be conducted. The cultural rights of the local community will be respected.

The Relevant World Bank (WB) Group's Environmental and Social Standards (ESS) relevant to Suswa projects are shown in the **Table 2** below.:

Table 2: World Bank Group Environmental and Social Standards (ESS)

Standard	What It Means for Geothermal
ESS1 - Assessment and Management of Environmental and Social Risks and Impacts	Conduct a full Environmental and Social Impact Assessment (ESIA) for the drilling phase.
ESS2 - Labor and Working Conditions	Recognizes the importance of employment creation and income generation in the pursuit of poverty reduction and inclusive economic growth.
ESS3 - Resource Efficiency and Pollution Prevention	Sets out the requirements to address resource efficiency and pollution prevention and management throughout the project life-cycle. This includes handling drilling fluids, managing emissions (like H ₂ S gas), proper waste management, and water use efficiency.
ESS4 - Community Health and Safety	Addresses the health, safety, and security risks and impacts on project-affected communities and the corresponding responsibility of the project proponent to avoid or minimize such risks and impacts, this should address risks like seismicity, chemical leaks, and accidents. Emergency response plans are required.
ESS5 - Land Acquisition, Restrictions on Land Use and Involuntary Resettlement	Involuntary resettlement should be avoided. Where involuntary resettlement is unavoidable, it will be minimized and appropriate measures to mitigate adverse impacts on displaced persons/ host communities will be carefully planned and implemented. This includes Land access for wells, access roads, and pipelines must respect people's

	rights and livelihoods.
ESS6 - Biodiversity Conservation	Recognizes that protecting and conserving biodiversity and sustainably managing living natural resources are fundamental to sustainable development and it recognizes the importance of maintaining core ecological functions of habitats, including forests, and the biodiversity they support. The proposed project is drilling near sensitive Mt Suswa ecosystems and hence strong biodiversity management measures are needed.
ESS7- Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities	Ensures that the development process fosters full respect for the human rights, dignity, aspirations, identity, culture, and natural resource-based livelihoods of Indigenous Peoples
ESS8 - Cultural Heritage	Sets out measures designed to protect cultural heritage throughout the project life-cycle. Before drilling, survey for any archaeological or cultural sites to avoid disturbance.
ESS10 - Stakeholder Engagement and Information Disclosure	Effective stakeholder engagement can improve the environmental and social sustainability of projects, enhance project acceptance, and make a significant contribution to successful project design and implementation.

E.4 BASELINE ENVIRONMENTAL AND SOCIAL CONDITIONS

E4.1 The Physical Environment

The project area lies in two administrative sub counties – Kajiado West and Narok East. The proposed project site predominantly exhibits Arid and Semi-Arid Land (ASAL) -like conditions in the better part of the year except during the long rains (March, April and May). Its short rains (October to December) have been suppressed in the recent past.

E4.2 Climate

The counties experiences long rains between March to May every year with short rains being between October to December. The average annual rainfall ranges from 300 mm to 1,250 mm in Kajiado County and from 500 mm to 2,500 mm in Narok County, while the mean annual temperature is 38.2°C.

Rainfall in the area ranges from 1200 mm-1800 mm in highlands and about 1400 mm in lowlands. Mean temperatures range from 5°C in July to 28°C in December to February. In the project area, days are sunny but temperatures significantly cool down during the nights.

E4.3 Topography

The topography on the side of Narok East is broadly divided into two: the highlands and the lowlands, which are approximately 3,000 and 1000- 1400m a.s.l respectively.

On the side of Kajiado West the topography is characterized by plains and occasional volcanic hills and valleys ranging in altitude from about 500m around Lake Magadi to about 2,500 m in the Ngong Hills.

E4.4 Geology and Soil

Suswa volcano is part of the Kenya Dome, an elevated area about 2000 m above sea level. The Kenya Dome is located in the axial graben of the Kenya Rift, formed during the Late Miocene, and continued to be active in Early Pliocene. Volcanoes in the area are associated with fissure eruptions of mafic lavas and caldera products of felsic rocks. Volcanism is prominent along the rift axis but also in the flanks.

E4.5 Baseline Data Collection and Analysis

In order to have baseline data for future monitoring purposes, on site measurements were carried out and additional samples collected for laboratory analysis.

a) Soil

This report details baseline soil quality within the proposed Suswa geothermal drilling project. Soil sampling was undertaken between 2nd and 3rd December, 2024.

The objective of the assessment was to establish baseline soil quality in the proposed project area for the purpose of future monitoring.

The scope of the assessment included collection of five soil samples from the proposed Suswa well pad 1, Suswa well site 2, Suswa well site 3, Suswa well site 4 and drillers campsite. Parameters analyzed were limited to pH, salinity (EC), Arsenic (As), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Molybdenum (Mo), Nickel (Ni) and Lead (Pb). The result of soil baseline is provided in the annexes of this report.

b) Water

Water sampling was undertaken between 2nd and 3rd December, 2024. The objective of the sampling was to detail baseline water quality within the proposed Suswa geothermal drilling project area.

The scope involved water sampling within Kikuyian Dam which is the proposed water source for the project, proposed Well Pad Site 1, Well Pad Site 2, Well Pad Site 3 and Well Pad Site 4 from Water pans, Seasonal Rivers, Rain Water and Fumaroles within the project area. The parameters analyzed included pH, Electrical Conductivity, Aluminum, Ammonium, Calcium, Magnesium, Potassium, Sodium, Nitrates, Sulphate, Chloride, Phosphate, Fluoride, Nitrite, Boron, Copper, Iron, Manganese, Zinc, Hardness, Turbidity, Total Suspended Solids, Total Dissolved Solids, Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Nickel, Molybdenum, Selenium and Residual Free Chlorine Cl(residual) and E. Coli.

All the measured parameters were within the recommended EMCA Water Quality Regulations, 2006 for domestic water standards apart from E. coli, Al, NH₃, F, Fe, Mn, Turbidity and TSS.

The proposed development is anticipated to result to an increase in concentration of the analyzed parameters if proper mitigation measures are not put in place. In case of accidental spill during drilling operations, the brine discharge may lead to surface and underground water pollution. Protection works including installation and maintenance of impervious liners to avoid percolation. Reinjection of brine should be adopted for reservoir maintenance and pollution control. In addition, all wastewater from the proposed project should be effectively managed through provision of septic tanks or mobile toilets where applicable. Similarly, the

proponent should ensure that quarterly effluent analysis and annual water quality analysis are undertaken as appropriate.

c) Ambient Air Quality

Ambient Air was sampled and analyzed for Particulate Matter (PM₁₀ and PM_{2.5}) and Hydrogen Sulphide (H₂S). These were conducted to establish environmental baseline by ascertaining the existing air quality conditions before commencement of project activities. The measurements will also provide baseline for future air quality monitoring. Parameters analyzed were found to be within the limits contained in the Environmental Management and Coordination Act (Air Quality) Regulations 2024, United States Environmental Protection Agency (EPA), World Health Organization (WHO), European Union (EU), Kenya's occupational exposure limits and IFC tolerable limits except SP22 which recorded a H₂S reading of 140.8 µg/m³ which is attributed to natural geothermal emissions.

Thirty-five sampling locations were identified whereby measurement was carried out to assess for Hydrogen Sulphide; Inhalable Particulate Matter (PM₁₀), and Respirable Particulate Matter (PM_{2.5}) concentration in air. Based on the monitoring, the results can be summarized as shown below;

- Inhalable particulate matter from all assessed areas ranged between 7.8-35.5 µg/m³.
- Respirable particulate matter concentration ranged between 2.3-11.3 µg/m³.
- Hydrogen sulphide concentration ranged between 3.3-140.8 µg/m³.

A summary of ambient baseline air quality is attached to the report for further reference.

d) Ambient Noise Levels

Measurement was carried out with the use of a duly calibrated SVAN 971 Type 1 (Serial Number 82474) sound level meter whereby equivalent noise (Leq), L10, L50 and L90 were recorded.

Ambient noise equivalent noise results from all the sampling locations ranged between 41.0-72.2 dB(A) with SP27 (Proposed Campsite Receptor 1 (Residential) and SP1 (Well Pad 1 Location 1) having the lowest and highest noise levels respectively.

Peak Particle Velocity (PPV) (ground vibration) results from all sampling locations ranged between 0.106-2.114 mm/s with SP3 (Well Pad 1 Tank Site) and SP2 (Well Pad 1 Location 2) had the lowest and highest vibration levels respectively. High vibration levels at Well Pad 1 Location 1 and Well Pad 1 Location 2, though within recommended limits can mainly be attributed to earth moving operations at the well pad at the time of this assessment.

e) Ecological Resources

Using standard methodology, a detailed field survey of different species of flora and fauna occurring in the project area was conducted. This included Plants, Mammals (bats, small & large mammals) Avifauna (birds), Herpetofauna (reptiles and amphibians) and Invertebrates.

The project Area of Influence (AOI) on Suswa Mountain supports at least 42 plant species across multiple families. Many of these species have recognized medicinal value; however, none trigger Critical Habitat status under IFC or IUCN criteria.

The primary conservation concern relates to the potential increase in wild harvesting by project personnel or non-local workers. This risk can be mitigated through close collaboration with local elders, the Suswa Conservancy management, and community scouts to enhance monitoring and regulate plant use.

According to the WRTI (2024) inventory, the recorded species span several families, including Amaranthaceae, Acanthaceae, Boraginaceae, Apocynaceae, Asparagaceae, Asteraceae, among others. One species, *Aloe kedongensis*, does not appear in the IUCN Red List under this specific name.

Findings from the biodiversity baseline survey further indicate that Mount Suswa hosts a rich diversity of fauna, comprising 82 bird species, 35 mammal species, 17 reptile and amphibian species, and 71 invertebrate species. These species play vital ecological roles, including pollination, pest control, seed dispersal, and nutrient cycling. However, human-induced disturbances, including geothermal infrastructure expansion, land clearing, and water resource depletion, pose significant threats to the region's biodiversity.

The geothermal development project in Mount Suswa presents both opportunities and challenges. While renewable energy expansion is essential for climate change mitigation, the project must be carefully managed to avoid irreversible biodiversity loss, habitat degradation, and resource depletion. By implementing sustainable mitigation strategies, such as wildlife conservation, climate adaptation, and ecosystem restoration, the project can balance infrastructure growth with environmental stewardship. Moreover, community engagement and alternative livelihoods will be critical in ensuring long-term ecological and socioeconomic sustainability. With scientifically backed conservation efforts and policy interventions, Mount Suswa's Biodiversity can be conserved while supporting Kenya's clean energy transition.

f) Socio-Economic Environment

The project is located in Narok East and Kajiado West sub – counties. The Kajiado county has a population of 1,117,840 people with 557,098 (49.8%) males and 560,704 (50.2%) females, according to the 2019 National Census. The county has a population density of 51 person's per km². According to Kajiado County Integrated Development Plan 2023-2027, urban areas have relatively high densities compared to rural areas.

The projected population composition and distribution for Kajiado West Sub-County in 2025 is 108,699 males and 108,515 females. By 2027, the male population is expected to increase to 113,628, while the female population will grow to 113,216.

Kajiado West, where much of the project lies has the lowest density of 26 persons km² due to its vast area. It's also sparsely populated due to harsh climatic conditions unfavorable for livestock keeping and settlement.

Population density in the Narok county varies across the six sub-counties. The density for the county as at 2023 stands at 63 persons per square kilometer, an increase from 47 persons per square kilometer recorded during the 2019 housing and population census. Densities are influenced by among other things climatic condition, availability of social amenities and altitude.

The projected population composition and distribution for Narok East Sub-County in 2025 is 67,767 males and 67,171 females. By 2027, the male population is expected to increase to 71,515, while the female population will grow to 71,022. g) Demographic and Household Information.

A sample population of 376 was interviewed within the project area in Kajiado and Narok counties, providing responses on key parameters such as sex, gender, age, education level, land ownership, land use, security

concerns, and access to social amenities, including water, energy, and sanitation. The data was analyzed and presented in the subsequent sections of this report.

The community faces significant challenges due to poor infrastructure, including deteriorated roads, unreliable electricity, and inadequate public utilities. Poor road conditions hinder transportation, especially during the rainy season, leading to high transport costs and limited access to essential services. The absence of public transport further complicates mobility.

Unstable electricity supply affects households, businesses, and schools, restricting economic growth. The lack of essential facilities such as dispensaries, schools, and markets forces residents to travel long distances for basic services. Wildlife attacks pose safety risks, while health concerns, including respiratory diseases and malaria, are exacerbated by environmental issues and limited healthcare access.

Unemployment remains high, necessitating sustainable economic development. Security is also a concern due to poor lighting and infrastructure. Overall, the lack of proper roads, drainage, and bridges severely impacts daily life and economic progress.

g) Resource Management

The management of natural resources is distributed among various entities, including local communities, government bodies, private owners, and, in some cases, remains unregulated.

Local communities play a crucial role in managing conservancies, forests, and water sources. Leadership structures, such as Lesetian and Lolngojine, actively participate in conservation and oversight. Certain water resources (Community water pans) and conservancies e.g. Suswa conservancy are explicitly under community management, reflecting a strong tradition of communal stewardship.

Communities, administrative bodies, and experts play a vital role in protecting natural resources through various conservation efforts. Respondents highlighted the importance of administrative measures, conservancies, and experts from the Geothermal Development Company (GDC) in promoting environmental conservation and protection.

Key strategies highlighted include afforestation and reforestation, with a strong emphasis on planting trees near dams to prevent erosion, and fencing around sensitive areas to reduce human-wildlife conflicts and restricting unauthorized access. While most responses provided valuable insights, some lacked specificity, indicating a need for greater awareness of conservation strategies. Overall, the feedback highlights a mix of community-driven efforts, administrative policies, and expert-led interventions to ensure sustainable resource management.

E5 ANALYSIS OF PROJECT ALTERNATIVES

An analysis of “With” and “Without” Project scenario reveals that the positive impacts outnumbered the adverse impacts due to the proposed Suswa Geothermal drilling project. The adverse impacts are envisaged only during the well drilling and testing phases of the project which will be temporary in nature and of a short duration. Appropriate mitigation measures will be adopted to limit these adverse impacts during the drilling and well discharge/ testing phase.

E6 PUBLIC AND STAKEHOLDER CONSULTATIONS

Public consultations were carried out as an integral part of the social and environmental assessment process of the project with an objective to inform and educate stakeholders about the proposed mitigation measures for any potential impacts and to receive public concerns about the project. It assisted in identification of the likely issues and impacts associated with the project as well as the needs, fears and concerns of the population likely to be impacted.

This participatory process helped in reducing the public concerns/ fears and enabling participation of the local community in this proposed development.

The following key institutional stakeholders were consulted;

- National Environment Management Authority (NEMA) – Narok/ Kajiado Counties
- Kenya Wildlife Service (KWS),
- Kenya Forestry Service (KFS),
- Water Resources Authority (WRA),
- Directorate of Occupational Safety and Health Services (DOSH) – Narok county
- Kenya Rural Roads Authority (KeRRA) – Narok East
- Mt. Suswa Conservancy
- National Government officers – DCC Narok East and DCC Kajiado West

E6.1 Key Informants Interviews

Initial engagement with Key Stakeholders was done in November 2024. Further consultations were carried out in late November - December 2024. Each Key Stakeholder was visited, briefed on the proposed project, before their views were sought through an interactive interview session and questionnaires.

The negative impacts of the proposed project raised during Key Informant Interviews include air and noise pollution, displacement of people, and disruption of wildlife and human corridors. It poses health risks through the potential release of toxic gases and may lead to soil and water contamination, land degradation, and increased pressure on local resources. The loss of vegetation could result in soil erosion, and tree species may be lost at the geothermal production site. Vulnerable communities, particularly women and children, may be displaced, disrupting traditional livelihoods such as livestock grazing and causing economic hardship. Cultural tensions could arise due to the loss of ancestral land and way of life, potentially leading to resistance. The project also poses risks of destabilizing local settlements, reducing land available for conservation, and disrupting tourism. Additional concerns include the potential for earthquakes or land instability, increased population, and pressure on water resources.

Outcome of the interviews are summarized and the minutes and attendance registers are annexed to the report.

E6.2 Public Consultation Meeting

The Public discussion meetings were held between 25th November to 6th December, 2024 within the two Sub counties (Narok East and Kajiado West). The local community and relevant stakeholders both government and private sector representatives participated in community and stakeholder engagement meetings.

The meeting attendance was as shown in **Table 3** below;

Table 3: Public Consultation Meetings – venue and attendance

Venue	Duka Moja	Karuka Primary School	Kikuyian Primary School	Kisharu Primary School	ACC's Office – Ewaso Kedong	Oludong'oro Primary School	Full Gospel Church Suswa	Olgumi Primary School
Male	120	78	61	46	84	85	120	76
Female	6	21	1	20	11	9	8	14
Total	126	99	62	66	95	94	128	90

E7 PROJECT IMPACTS AND MITIGATION MEASURES

The project has both positive and potential negative impacts. Detailed evaluation of the impacts and mitigation measures are provided in this Report. A summary of these impacts including enhancement measures for the positive impacts and mitigation measures for the negative impact

E7.1 Anticipated Positive Impacts

Environmental Impacts of Geothermal Drilling Projects

- i. Promotion of Green Energy: Geothermal energy is a renewable energy source with minimal carbon dioxide and other greenhouse gas emissions compared to fossil fuels. Utilizing it helps combat climate change.
- ii. Creation of employment opportunities: Direct job opportunities will result from employment of the skilled and unskilled workforce whereas indirect job opportunities will involve creation of business opportunities to the manufacturers and suppliers of materials during the construction and operation phase of the proposed project.
- iii. Enhancement of business opportunities: Business opportunities will comprise of various consultancy jobs, supply of equipment, spare parts, food and materials, cleaning services, rig camp services and contracted jobs
- iv. Improved Road Infrastructure: Implementation of the proposed project will require a road network to facilitate ferrying of materials and equipment to the construction sites. Rehabilitation of existing roads and excavation of new access roads will benefit the residents
- v. Corporate Social Responsibility (CSR) Benefits: During planning and construction of the project, the proponent will conduct community social responsibility initiatives for the project affected communities.
- vi. Increased tourism: The drivers of tourism within the project area include; Mt. Suswa Conservancy and the Mt. Suswa which harbors Baboons among others. The proposed project is likely to enhance tourism in the area.

E7.2 Negative Impacts and Mitigation Measures

a) Loss of Land

Land will be required for construction of access roads, well pads, circulation ponds and water supply infrastructure (piping, water tanks & pump stations).

Documentation of the land acquisition/transfer agreements for the identified land. Any new land requirements for the project as well as arising grievances shall be handled in line with the adopted Land Acquisition and Compensation Frameworks (LACF).

b) Vegetation Clearance

The construction of the access roads, water infrastructure, drill sites (well pads) and circulation ponds will involve clearance of terrestrial vegetation. Surface excavation will cause alteration of ground cover, due to trampling that interrupt and fragment habitats and most likely lead to introduction and spread of invasive species.

Preservation of indigenous species shall be prioritized where feasible. Selective bush clearing to ensure saplings regrowth; Restrict vegetation clearing to project sites by clear demarcation and progressive rehabilitate among others. In addition, equipment and tools brought in for reuse from other project sites shall be screened and cleaned of alien / invasive propagules to avoid introduction in the project area.

c) Air pollution

Sources of dust emission during construction phase of the proposed project will include excavation works, transportation of drilling of materials, movement of vehicles on earth roads. Atmospheric emission of particulate matter, carbon monoxide, hydro carbons from compressors and diesel gensets powering the rig beyond the recommended limits is likely to cause public nuisance, negative health effects, soiling of property and vegetation and emissions of H₂S during drilling of geothermal wells and well discharge.

The proponent shall ensure that all the vehicles, Rig gensets and Compressors are maintained in proper working condition in line with the manufacturer's recommendations. This will ensure that gaseous emissions do not increase over time. Burning of solid waste will not be undertaken to prevent gaseous emissions to the atmosphere. Monitoring of air quality will be done to mitigate any potential impacts arising for H₂S emissions and other non-condensable gases from the project.

d) Wastes generation

During the Pre-drilling, drilling and decommissioning phases of the proposed project, different waste streams (liquid & solid) will be generated as a result of the various development activities. These include spoil, papers used for packing cement, plastics and timber, food waste remains among others. Dumping around the site will interfere with the aesthetic status of the area.

Waste products from the drilling process shall include drilling cuttings and spent geothermal fluids (brine). This wastewater shall be held temporarily in sump ponds before reinjection. These sump ponds shall be lined with high density polyethylene (HDPE) to prevent percolation and surface flow that can cause contamination of soils, water and vegetation.

GDC shall adopt the 5Rs (Refuse, Reduce, Reuse, Repurpose and Recycle) approach in waste management. Appropriate waste bins shall be provided within the project site to allow waste segregation at source. A NEMA registered firm shall be engaged to collect the various streams of waste for appropriate disposal.

f) Noise and Vibrations

Noise levels of high frequencies could lead to disturbance of animals and humans and impaired hearing under extreme cases of prolonged exposure. Drilling and construction equipment will be the primary source of noise and vibrations during the drilling and construction phase of the proposed Suswa geothermal drilling project. Noisy operations shall include movements of heavy graders, trailers, bulldozers, vibrating roller or tipper trucks (making delivery of borrow material) during grading, levelling, and compaction of access roads within the project area

During well discharge and flow testing, noise levels shall also be elevated.

GDC shall consider several strategies including installing noise barriers or enclosures around equipment, using well-maintained machinery, and selecting vibration-reducing technologies. During well discharge and testing, GDC shall install high-capacity steam silencers to reduce the high noise levels generated from flowing wells, thereby minimizing noise impacts on personnel and nearby communities.

Compliance with noise and vibration regulations, and by implementing suggested measures, the project can effectively reduce noise and vibration-related disturbances to both people and animals.

f) Occupational Health and Safety

Geothermal drilling involve exposure to hazardous gases, high-pressure systems, heat, noise, chemical substances, confined space hazards and electrical risks. These hazards predispose involved personnel to risks of injury and illness.

GDC shall develop and implement the Occupational Safety and Health Management Plan (OSHMP) by adhering to safety protocols and train staff on safe work practices. Ergonomic issues from repetitive tasks shall be mitigated through training and proper equipment use. All workers shall be provided with appropriate personal protective equipment (PPE) to safeguard them against occupational hazards.. In addition, GDC shall strictly enforce the proper use of PPE. Through proactive measures, proper safety equipment, and continuous training, the risks associated with geothermal drilling shall be effectively reduced.

g) Community Health and Safety

Community safety and health impacts may arise from physical hazards associated with well drilling and related infrastructure. Accidents along the project access roads, and active operational sites. Potential exposure to both air and noise pollution is another concern. Noise silencers will be installed to reduce noise and continuous monitoring of emissions (both noise and air) will assist in establishing the zone of impact. Emission simulation will assist in establishing the cumulative impacts of geothermal development activities within the project area. This will be done upon confirmation of productive wells and prior to power plant construction.

h) Increased Traffic during rig mobilization and demobilization.

Rig mobilization and demobilization activities can increase traffic particularly heavy and oversized vehicles, leading to traffic congestions, delayed local transportation and disruptions of other local daily activities. The

movement of heavy vehicles may lead to increased road accident risks, particularly on narrow roads with limited infrastructure. Traffic related activities can generate dust/air emission, noise pollution affecting the environment and nearby community.

GDC shall develop and implement Traffic Management Plan that shall include designated transport routes, clear signage, traffic control measures and coordination with Local authorities. Heavy equipment transportation shall be scheduled to off peak hours to minimize road congestion. Road assessments and reinforcement shall be conducted to prevent damage from heavy machinery.

i) Illegal Harvesting of wild products:

Illegal harvesting of wild products within the project area may result in biodiversity loss by depleting local species, disrupting ecosystems and food chains. Unsustainable harvesting increases competition for resources, escalating human-wildlife conflict. Socioeconomically, it undermines legitimate livelihoods, particularly for local communities, and fosters illegal trade and exploitation.

Mitigation measures to address illegal harvesting during project implementation include raising awareness through education campaigns for workers and local communities about the environmental and livelihood impacts of unsustainable resource use. Active community engagement in resource management and decision-making shall help in offering alternative livelihoods and incentives.

j) Geological and seismic risks

Drilling activities, fluid injection, and extraction may trigger induced seismicity, leading to small/micro earthquakes that can damage infrastructure and alarm nearby communities. Unexpected geological conditions may cause well blowouts, releasing geothermal fluids, gases, and debris, posing serious safety risks.

Mitigating geological and seismic risks in geothermal drilling involves conducting detailed geological surveys, installing seismic monitoring systems, and carefully controlling drilling and fluid injection activities. Emergency preparedness and strict regulatory compliance help ensure safe and responsible operations.

k) Visual intrusion arising from lighting at night

Lighting at night during geothermal drilling can cause visual intrusion, which can disturb local communities, wildlife, and sensitive ecosystems by altering natural light patterns, potentially leading to disorientation in nocturnal animals and sleep disturbances for nearby residents.

Use of downward-facing, shielded lighting to minimize light spill and glare. Choose low-intensity, warm-colored lights to reduce visual impact. Position lights strategically to minimize exposure to nearby communities and natural habitats. Conduct regular assessments to ensure lighting remains appropriate and causes minimal disturbance. Installation of motion-sensor or timer-controlled lights to limit usage to when necessary.

m) Water usage impacts

Geothermal drilling requires significant amounts of water for drilling, cooling, and well quenching during testing and domestic use. High water usage can strain local water supplies, especially in arid regions, affecting availability for communities, livestock, and agriculture. Over-abstraction may also lower groundwater levels, impact surface water bodies, and harm aquatic ecosystems.

GDC shall use water-efficient drilling technologies and recycling systems to reduce total consumption. Water sustainability shall be assessed so as to evaluate local supply capacity before abstraction. Develop alternative water sources (like rainwater harvesting or treated wastewater) where possible. Monitor water use continuously and coordinate with local communities and authorities to ensure equitable and responsible water management.

n) Impacts on bats and other animals.

The proposed project may impact bats and other animals if not carefully managed when integration of wildlife protection into project planning and operation is not considered. Some of the impacts include habitat loss and fragmentation, disruption from high levels of noise and ground vibrations, air, artificial lighting, water contamination and increased human activities.

Establishment of site surveys and monitoring systems to identify wildlife crossings areas, selective vegetation clearance, enforcement of speed limits, artificial lighting should be pointed away or faced downwards to minimize disturbance to wildlife by light spill and bulbs emitting wavelengths that attract insects and that irritate bats should not be used.

E8. CONCLUSIONS AND RECOMMENDATIONS

E.8.1 Conclusions

The proposed geothermal drilling project is expected to deliver significant benefits through enhanced geothermal resource development and energy generation. However, project activities may result in temporary environmental and social impacts, including occupational health and safety risks, increased traffic during rig mobilization and demobilization, noise and air emissions, and disturbances to wildlife, particularly bats and other animals.

The assessment concludes that these impacts are generally localized, temporary, and manageable through the implementation of appropriate mitigation measures. Key interventions include strict adherence to occupational health and safety requirements, implementation of traffic management plans, protection of biodiversity and wildlife habitats, stakeholder engagement, and continuous environmental monitoring.

With effective implementation of the Environmental and Social Management Plan (ESMP), Occupational Safety and Health Management Plan (OSHMP), and applicable regulatory requirements, the project is considered environmentally and socially acceptable. The anticipated residual impacts are expected to be minor to moderate and can be reduced to acceptable levels, while the project's long-term socio-economic and energy benefits are expected to outweigh the potential adverse impacts.

The ESIA team concludes that the proposed project will contribute significantly to local and national socio-economic development through job creation, improved livelihoods, increased energy security, and support for Kenya's industrialization agenda. The project will also contribute to the country's long-term development goals, including Vision 2030 and the Bottom-Up Economic Transformation Agenda, through the generation of clean and sustainable geothermal energy.

E8.2 Recommendations

Based on the ESIA findings, the proposed Suswa Geothermal Drilling Project is considered environmentally and socially viable and is recommended for approval, subject to the implementation of the proposed Environmental and Social Management Plan (ESMP). The project proponent should ensure compliance with

all applicable Kenyan environmental regulations and international standards, undertake continuous monitoring of hydrogen sulphide (H₂S), noise, and other environmental parameters, and conduct regular environmental audits to verify the effectiveness of mitigation measures.

Meaningful stakeholder engagement should be maintained throughout the project lifecycle through regular information sharing, implementation of the Stakeholder Engagement Plan, and effective grievance management mechanisms. Any land acquisition or displacement should be managed in accordance with the Land Acquisition and Compensation Plan, ensuring fair and transparent compensation and livelihood restoration for affected persons. Capacity building, health awareness programmes, biodiversity conservation measures, and community development initiatives should also be prioritized to enhance project benefits and promote sustainable development

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LIST OF ABBREVIATIONS

AoI	Area Of Influence
ACC	Assistant County Commissioner
CAP	Corrective Action Plan
CBOs	Community Based Organizations
CDF	Community Development Framework
CEC	County Environment Coordinator
CEMP	Construction Environmental Management Plan
CESMPs	Construction Environmental and Social Management Plan
CSO	Civil Society Organizations
DCC	Deputy County Commissioner
DFI	Development Finance Institution
DPR	Detailed Project Report
EHS	Environment Health and Safety
EMCA	Environmental Management and Coordination Act
EMP	Environment Management Plan
ESCA	Environmental and Social Compliance Audit
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
FGD	Focus Group Discussion
FPIC	Free Prior and Informed Consent
g	Grams
GBV	Gender Based Violence
GDC	Geothermal Development Company
GPS	Geographic Positioning System
GRC	Grievance Redress Committee
HSE	Health Safety and Environment

IFC	International Finance Corporation
IIBP	International Industrial Best Practices
ILO	International Labour Organization
IPP	Indigenous People Plan
ISO	International Organization for Standardization
KWS	Kenya Wildlife Services
LACF	Land Acquisition and Compensation Framework
LACLRF	Land Acquisition Compensation and Livelihood Framework
LACLRP	Land Acquisition Compensation and Livelihood Plan
NEMA	National Environment Management Authority
NGO	Non-Governmental Organizations
NORM	Naturally Occurring Radioactive Materials
OHS	Occupational Health and Safety
OSHA	Occupational Safety and Health Act
PAPs	Project Affected Persons
PM	Particulate Matter
PPE	Personal Protective Equipment
PS	Performance Standards
RAP	Resettlement Action Plan
SEP	Stakeholder Engagement Plan
TOR	Terms of Reference
VECs	Valued Environmental and Social Components
VOC	Volatile Organic Compounds
WBG	World Bank Guidelines
WRA	Water Resources Authority

CHAPTER 1. INTRODUCTION

This chapter provides an overview of the project, its background, objectives of the ESIA, and the consultancy team composition and the overall ESIA report structure.

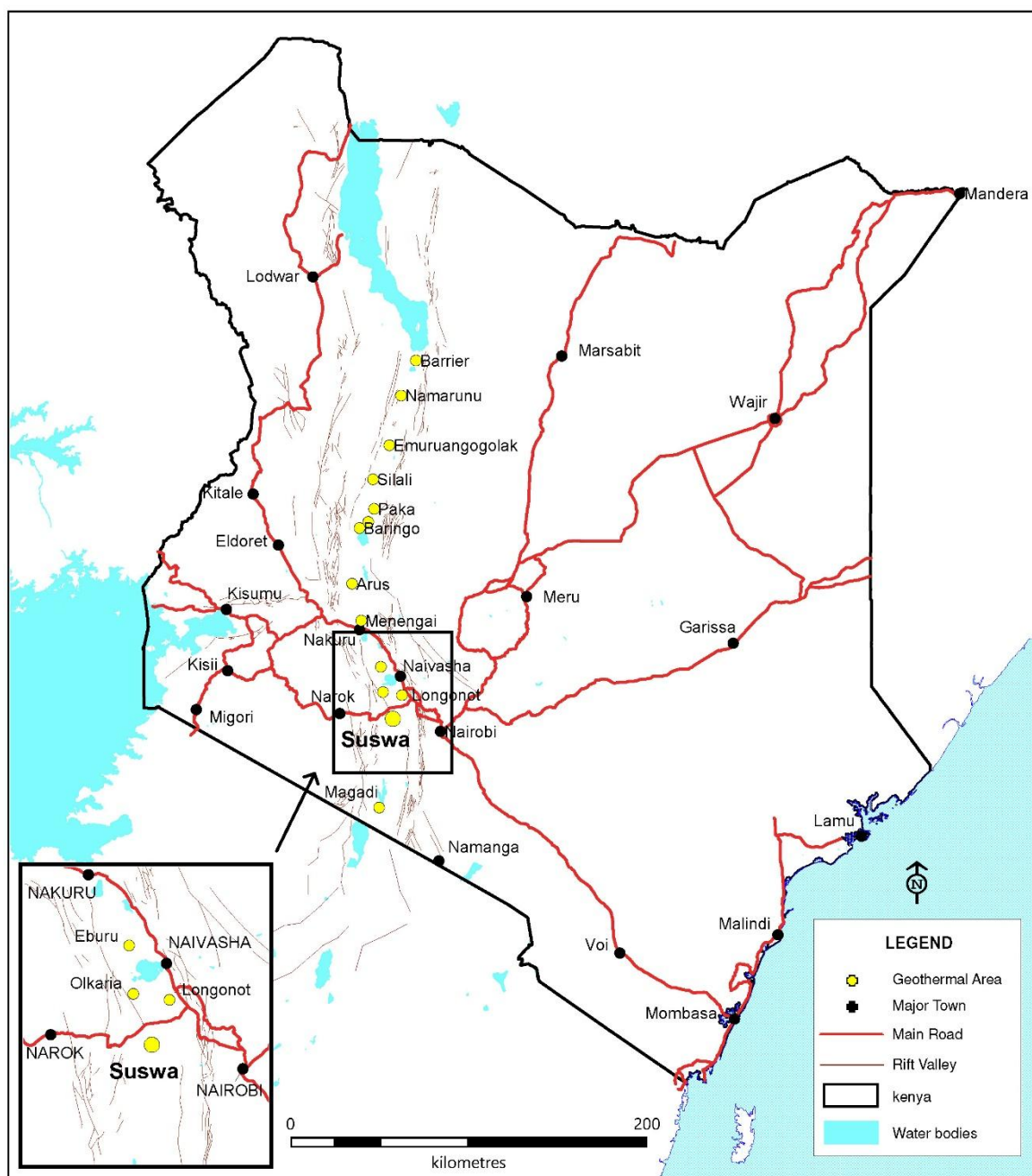
1.1 Project Background

The Suswa Geothermal Prospect resource area covers approximately 750 km², extending between Northings (986000-9885000) and Eastings (195000-225000) in UTM Zone 36°S, based on the Arc 1960 Datum. It stretches west to Narok County, south to Kajiado County, and north towards Nakuru County. The prospect is located about 20 km southwest of the Longonot volcano in the southern Kenya Rift as indicated in **Figure 1** below.

The project is supported by various Development Finance Institutions (DFIs) and the Government of Kenya. Given its potential to cause significant environmental and social impacts, Section 58 of the Environmental Management and Coordination Act (EMCA), 1999(Revised 2015), mandates the preparation of Environmental and Social Impact Assessments (ESIA) and Environmental and Social Management Plans (ESMP). The original ESIA, completed in 2013, requires an update due to fundamental shortcomings and changes in baseline data over time. The current update of the ESIA and ESMP have been reviewed against the environmental and social safeguard requirements of IFC Performance Standards. This review confirmed the need for a comprehensive update to ensure full compliance with Kenyan legislation, including EMCA 1999(Revised 2015) (Cap 387) and its subsidiary regulations, as well as IFC Performance Standards.

Geothermal Development Company (GDC) is a fully government-owned entity in Kenya's energy sector. Established in 2008 as a Special Purpose Vehicle (SPV) under the Energy Act No. 12 of 2006, GDC was formed following the adoption of Sessional Paper No. 4 on Energy in 2004, which restructured the energy sector into five sub-sectors: generation, transmission, distribution, regulation, and policy. GDC is responsible for developing steam fields and supplying geothermal steam for electricity generation to Kenya Electricity Generating Company PLC (KenGen) and Independent Power Producers (IPPs)/ private investors.

Geothermal resources is an environmentally friendly and abundant energy resource used for electricity generation. Once harnessed geothermal steam can power turbines to produce electricity. The Government of Kenya and international development partners have continued to finance geothermal exploration and drilling to expand the country's renewable energy sources and capacity.



Map of Kenya showing the location of Suswa Geothermal Prospect

Figure 1: Map of Rift Valley showing the location of Suswa Geothermal Prospect

Geothermal Development falls under category 10 of high-risk projects as per legal notice No. 31, Kenya Gazette Supplement No. 62 Amendment of Second Schedule of EMCA 1999.

An initial ESIA was conducted in 2013, resulting in the issuance of license by the National Environment Management Authority (NEMA). However, due to subsequent environmental, social, legal, and policy changes, an updated ESIA is needed to ensure compliance with current Kenyan legislation, including the Environmental Management and Coordination Act (EMCA) 1999 (Revised in 2015), its regulations, and IFC Performance Standards.

To this end, GDC has commissioned Ecoscience and Engineering Ltd, a firm of experts, to conduct a site-specific study and update the 2013 ESIA report. The study commenced with a kick-off meeting

on 12th September 2024 between the consultant and the proponent, during which the objectives, the methodology for executing the assignment and expected deliverables were presented. The consultant provided a detailed overview of the scope of work, the implementation team, timelines, and anticipated results.

1.2 ESIA Objectives

The broad objectives of this ESIA study are as follows:

- 1) To conduct a site-specific ESIA study and update the 2013 ESIA for the Suswa Geothermal drilling project that adheres to all applicable standards
- 2) To develop updated Environmental Social Management Plans (ESMPs) specifically for the Suswa project. These plans will outline the measures and strategies to mitigate any adverse environmental and social impacts identified in the ESIA study.
- 3) To develop the necessary Environmental and Social Safeguard (ESS) documents, including a Community Development Framework (CDF), Stakeholder Engagement Plan (SEP), Indigenous Peoples Plan (IPP) and Land Acquisition Compensation and Livelihood Restoration Plan (LACLRP), to ensure the project meets the International Finance Corporation (IFC) Performance Standards.

1.2.1 The specific objectives from ESMPs include:

- i. Water Management Plan (including results of Cumulative Impact Assessment)
- ii. Noise Management and Monitoring Plan
- iii. Air Quality and Dust Management Plan
- iv. Training Plan for implementation of ESMP
- v. Occupational Health and Safety Plan
- vi. Worker Management Plan including provisions for worker camps
- vii. Community Health, Safety and Security Plan including provisions for HIV/ AIDS and other communicable diseases as well as emergency response and management/ training of security personal
- viii. Chance Find Procedure for cultural heritage
- ix. Any other plan as identified in ESIA Addendum

1.3 Environmental and Social Study Team

The Key Environmental and Social Consultants that conducted the ESIA Study are presented in **Table 4** below:

Table 4: Environmental and Social Consultants for the project

Name	Role	Organization	Academic Qualification	Years' Experience	Tasks
Philip ABUOR	Team Leader ESIA Expert	Ecoscience & Engineering	BSc, MSc	15	Technical Review and input to ESIA
Joy WASIRIMBA	Sociologist	Ecoscience & Engineering	MA	10	Technical review and input to social safeguards /Facilitation of PC
Dan ADINO	SIA Consultant	Ecoscience & Engineering	PhD	16	Preparation of IPP
Dickens ODENY	Biodiversity Expert	Ecoscience & Engineering	PhD	10	Ecology and Biodiversity Ecosystems Services

Evans TOTONA	OSH Advisor	Ecoscience & Engineering	MSc	8	Preparation of OSH Plan
Philip BARAZA	Geothermal Expert	EIA Consultant	BSc	10	Project Description and Analysis of Alternatives
Prof. G. ONTTA	SIA Consultant	University of Nairobi	PhD	20	Review of Social Safeguard Documents
Calvince ARUM	Project Manager	Ecoscience & Engineering	BSc	8	Support to the ESIA Study Team

1.4 Project Proponent

The proponent of the Geothermal drilling Environmental and Social Impact Assessment Study is the Geothermal Development Company (GDC). The Geothermal Development Company is a government-owned entity in Kenya's energy sector, established in 2008. Its primary mission is to harness geothermal energy for sustainable development and green energy solutions. GDC is tasked with developing steam fields and providing geothermal steam for electricity generation to both public and private sectors. With a vision to be a global leader in geothermal resource development, GDC plays a pivotal role in advancing Kenya's energy transition and achieving 100% green energy. The contact details of the Geothermal Development Company ESIA Project are provided below.

Name of Contact Person: Mr. Gabriel Wetangula

Address: P.O. Box 100746-00101, Nairobi Kenya

Phone: +254 719 037 000, Email: info@gdc.co.ke; gwetangula@gdc.co.ke

1.5 ESIA Report Structure

The remainder of this ESIA Report is structured as shown in **Table 5** below:

Table 5: ESIA Project structure

	Chapter	Contents
1	Introduction	Provides the description of the project background, location, purpose, objectives, NEMA reporting requirements, study methodology and the overall report structure
2	Project description	Presents the project design and implementation strategies
3	Analyses of Project alternatives	Gives an analysis of project alternatives including the no-project option.
4	Policy, Legal and Regulatory framework	Outlines the overview of relevant legislative regulatory and framework, international guidelines and conventions relevant to this project.
5	Methodology	Provides the framework and process for how impacts are identified, analyzed, and evaluated.
6	Baseline environmental and socioeconomic conditions	Provides description of the baseline environmental and social setting of proposed project and surrounding areas, e.g. climate, soils, geology, vegetation, fauna, land use, socio-economic profile and cultural heritage
7	Climate Change Risk Assessment and Vulnerability	Identifies Climate-related risks to the project and provides mitigation measures.

	Assessment	
8	Public Participation and Stakeholder Engagement	Gives description of the objectives, methods used and summary of results of the public consultation activities undertaken during the project report stage.
9	Project impacts and mitigation measures	Provides description of the objectives, methods used and summary of results of the public consultation activities undertaken during the project report stage.
10	Environmental and social management plan	Presents the proposed Environmental and Social Management Plan (ESMP) and site-specific sub-plans
11	Environmental and Social Monitoring Plan	Provides the proposed Environmental and Social Monitoring Plan (ESMP)
12	Conclusions and recommendations	Briefly presents the environmental and social acceptability of the project, considering the impacts and mitigation measures identified during the assessment process
13	References	Lists all the reference material used in the course of the study.

CHAPTER 2. PROJECT DESCRIPTION AND ITS COMPONENTS

Chapter 2.1 Introduction

This chapter highlights the proposed project design, location, components, inputs required for construction, products, byproducts, anticipated waste to be generated and waste management practices.

2.2 Site description

The project area is located in Mount Suswa and its calderas, within the Narok East and Kajiado West sub counties of Narok and Kajiado Counties respectively. Mount Suswa is made up of two calderas; the inner (younger or smaller) caldera and the outer (older or major) caldera. The outer caldera measures about 10 km in diameter and has a general ENE-WSW orientation. The inner caldera has a diameter of about 4 km and a central resurgent block that measures about 3 km in diameter as shown in **Figure 2** below. Hydrological recharge for the Suswa geothermal reservoir is from the rift flanks of Mau and Aberdares ranges. The recharge occurs through detachments and rift faults.

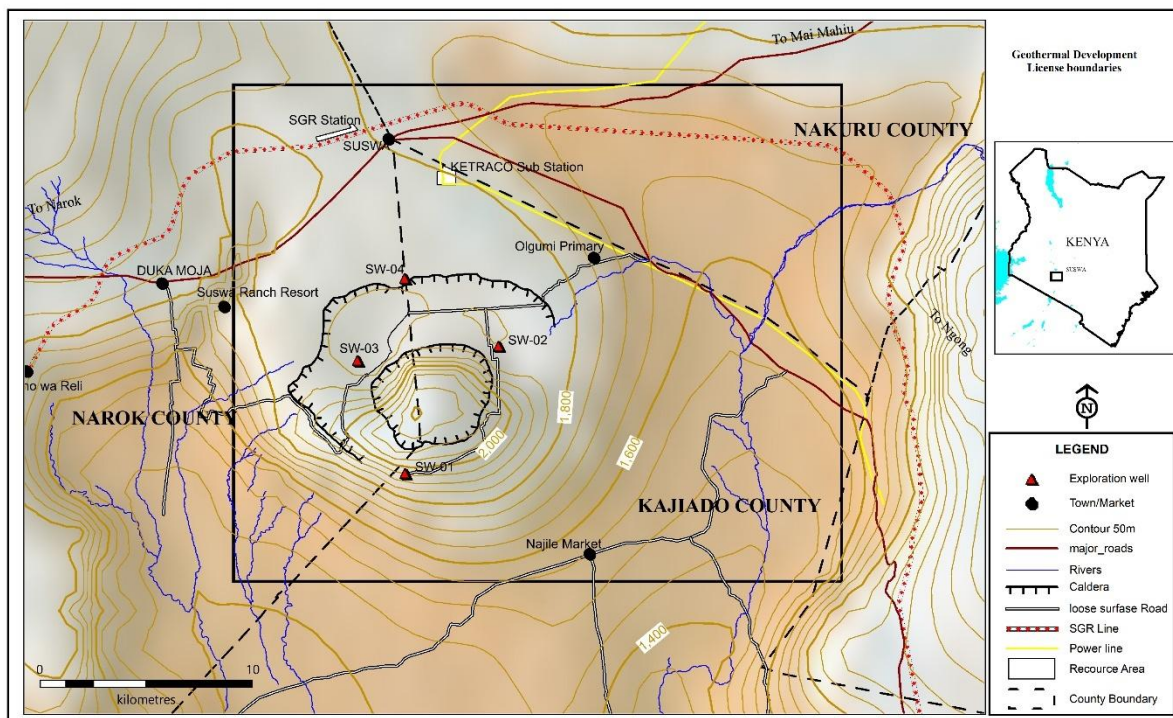


Figure 2: Geothermal Development License boundaries of the Suswa Area

2.3 Site Location

Location of the proposed wells are Suswa Exploration well 1 (SW-01) Northings 9868534 Eastings 204196; Suswa Exploration well 2 (SW-02) Northings 9874476 Eastings 208591; Suswa Exploration well 3 (SW-03) Northings 9873804 Eastings 201954 and Suswa Exploration well 4 (SW-04) Northings 9877644 N Eastings 204168. See figure 3 below.

If these first exploration wells are successful, step-out/appraisal wells will be drilled to target fractures and other geological structures and to expand the productive area of the geothermal reservoir.

For the purposes of the ESIA, the exploration phase can be split into three

- Site establishment (construction phase)
- Exploratory and appraisal drilling (operations phase)
- Site closure (decommissioning phase)

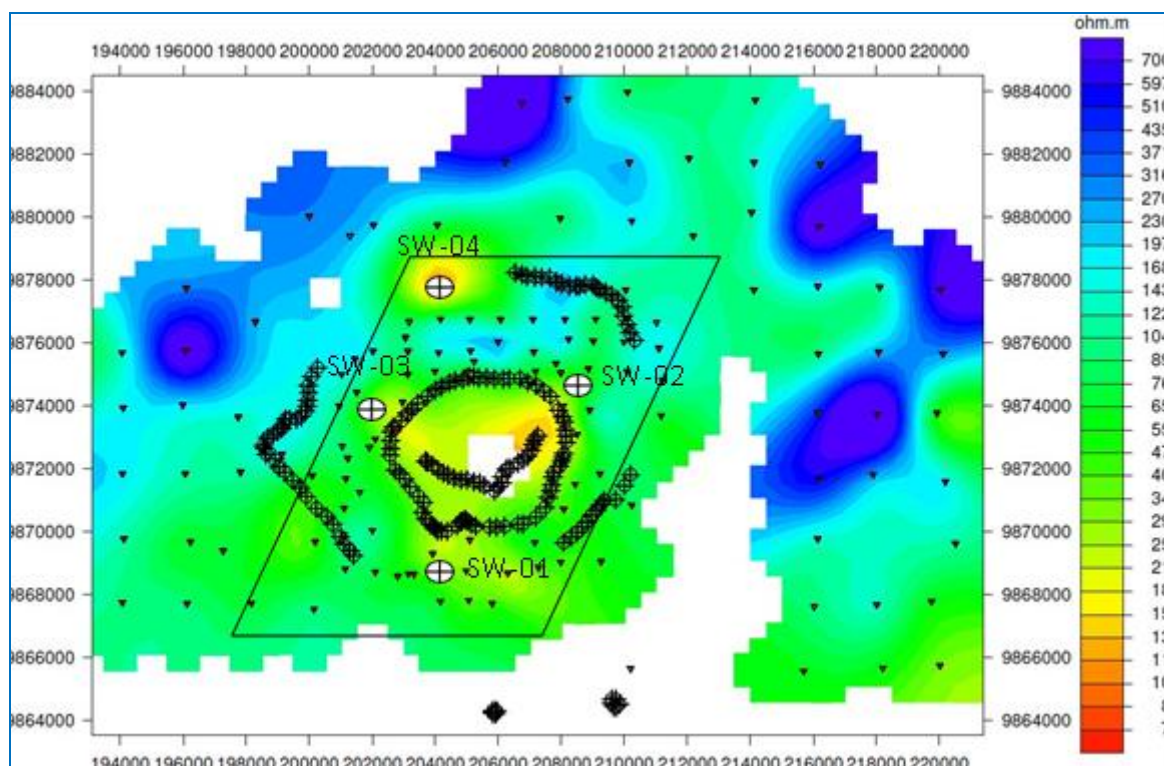


Figure 3: Location of the proposed exploratory well sites (Source: ESIA Study Report by REDDPLAN, 2013)

Table 6 and **Figure 4** below shows the current attributes and receptors respectively. The receptors have remained the same as was in 2013 during the ESIA exercise undertaken by RedPlan consultants except for population and changes in land use.

Table 6: GPS Points positions and Coordinates of Potential Receptors

Key Project Attributes	Easting (m)	Northing (m)	UTM Zone
Mt. Suswa Conservancy entrance gate	214,504.47	9,878,729.97	37S
New watering troughs (old Ol Gumi tanks)	213,079.25	9,878,394.61	37S
Starting point outer crater (Kisharu)	210,691.70	9,876,891.08	37S
Kisharu dam (water pan)	210,785.00	9,875,919.70	37S
Entrance to Cave No. 18	211,166.93	9,874,741.67	37S
Conservancy entrance (Mai Mahiu–Suswa Rd)	214,918.32	9,877,942.34	37S
Suswa Police Post	210,151.75	9,885,834.08	37S
Suswa Market / Shopping Centre	203,404.98	9,884,081.31	37S
Suswa Livestock Market	203,454.77	9,883,158.53	37S
Duka Moja (Suswa–Narok Rd)	194,550.35	9,877,679.83	37S
Suswa Conservancy West Gate	199,865.36	9,870,620.56	37S
Karuka Primary School	200,818.57	9,869,633.34	37S
New Kisharu Dispensary	205,302.19	9,875,924.74	37S
Kisharu AOG Church	206,226.31	9,876,228.75	37S
Ponds along Mai Mahiu–Suswa Rd	204,767.72	9,884,693.25	37S
Ewuaso Kedong Market	221,839.54	9,872,793.89	37S
Ewuaso Kedong D.O. Offices	221,586.03	9,872,355.55	37S

Key Project Attributes	Easting (m)	Northing (m)	UTM Zone
Ewuaso Kedong Dispensary	221,759.68	9,872,438.68	37S

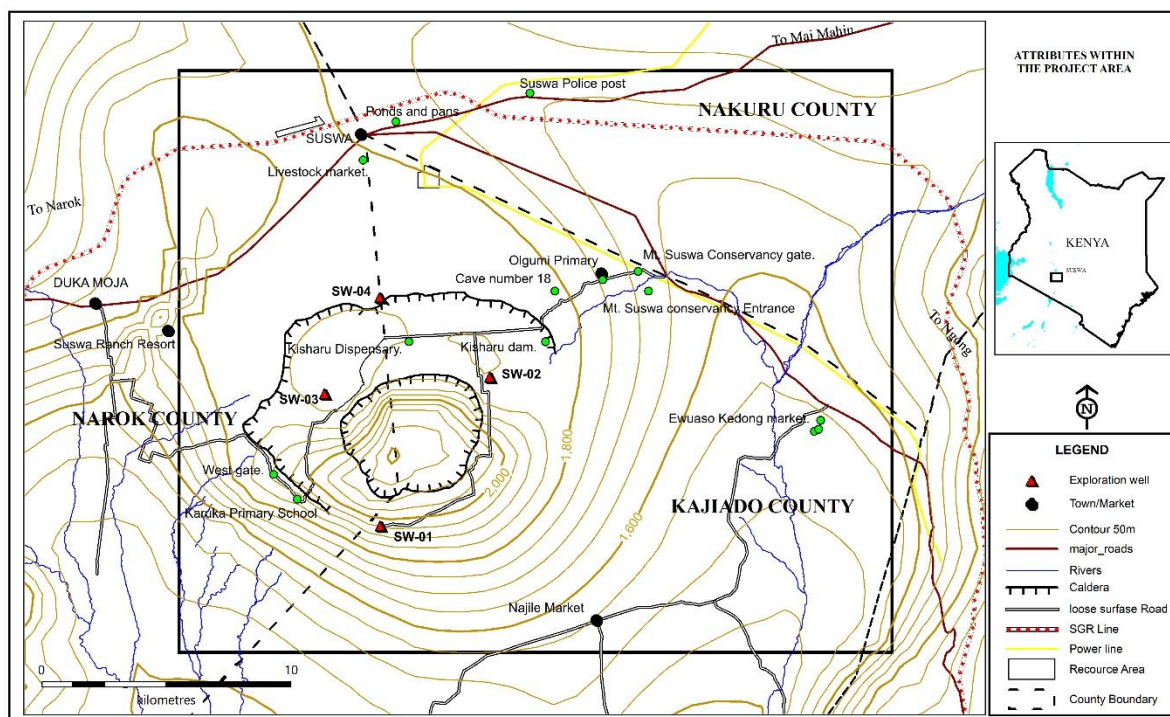


Figure 4: Project location and other attributes on the project area

2.4 Project Components

2.4.1 Land Take for the Project Components

The proposed Suswa geothermal drilling project comprises of the following components, road networks and well pads are indicated in **Table 7** below.

Table 7: Land take for the project components

Component	Purpose	Land take	Type
Access roads	Provide access to drilling sites for equipment, vehicles, and personnel	Width of 6–10 meters, length varies depending on terrain. At least 25 km long earth road off Maai Mahiu-Suswa highway, plus feeder roads that will interconnect the well pads	Permanent
Well pads	Leveled sites for drilling rig to operate on a stable platform. Each well pad will be provided with a pond that will act as a collection point for the water that	Four well-pads, each measuring 80 m by 120 m.	Permanent/ Temporary

	shall be recirculated during drilling, as well as any geothermal drilling fluids from the wells.		
Lay down area	A temporary space for storing equipment, tools, drilling materials, and pipes to be used for different purposes in the project.	To be determined based on volume of materials and equipment	Temporary
Water supply network	Water for drilling of geothermal wells as well as for domestic use.	Water will be pumped from Kikuyian dam using a submersible pump to a metallic water storage tank (32.0 m in diameter, 5.4 m high and 4,400 cubic meters capacity) which will be installed at a high elevation within the project site. Water from the storage tank will be supplied to the drilling sites through gravity.	Permanent
A campsite	Temporary structures for housing drilling and other teams working on the project.	Fabricated containers to facilitate provision of accommodation, recreation, catering, laundry and mobile clinic for about 60 workers.	Temporary
Geothermal wells.	Used for extracting geothermal fluids (production) and return cooled fluids (injection).	Drilling of the 4 exploration wells, six (6) appraisal wells and subsequent production wells. The wells will be drilled to a target depth of between 2,500 to 3,000metres.	Permanent

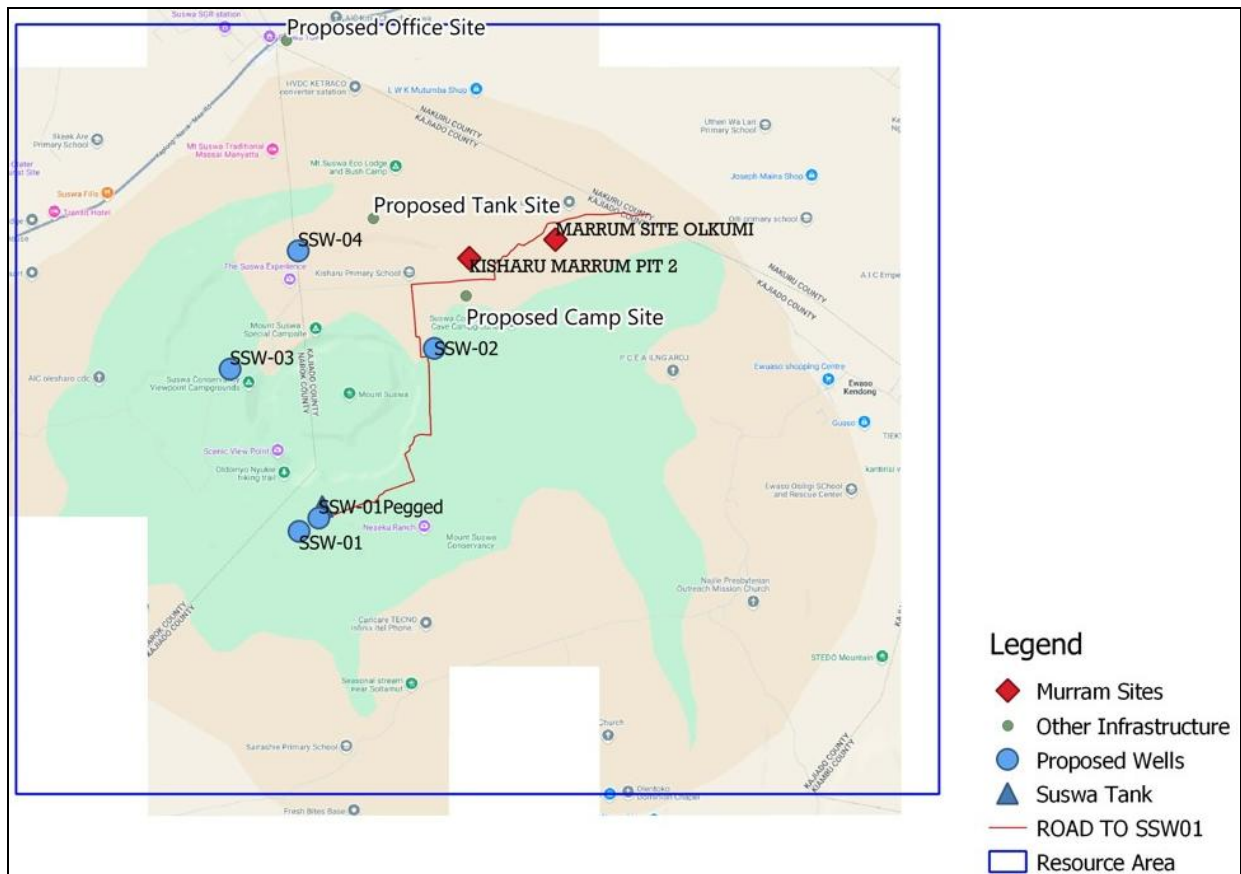


Figure 5: Proposed Road Networks and Well Pads

2.5 The Proposed Geothermal Wells

The use of geothermal resources is strongly influenced by the nature of the system that produces them. The resources of hot volcanic systems are utilized primarily for electric power generation, whereas the resources of lower temperature systems are utilized mostly for space heating and other direct uses e.g. power generation through binary technology. Based on geoscientific surface studies, Suswa geothermal prospect is a high temperature greenfield. For this reason, the proponent intends to develop the field in phases. This will involve drilling of four (4) exploration wells to determine existence of the resource. Once this has been proven, drilling of six (6) appraisal wells will follow to demarcate the extent of the field. The downhole data collected from the ten (10) wells will be used to update the geothermal reservoir conceptual model to facilitate the siting of additional production wells drilling targets with a view of designing a power plant based on the findings of a feasibility study.

The scope of this ESIA covers drilling of the 4 exploration wells, six (6) appraisal wells and subsequent production wells after feasibility study. The wells will be drilled using a rig owned by GDC. Drilling of each well will be undertaken continuously i.e. 24/7 for 45 to 60 days. A total of sixty (60) staff will be deployed to the project site. A normal drilling work shift system of four teams working on two shifts of 8 hours per day will be adopted. The wells will be drilled to a target depth of between 2,500 to 3,000 metres.

2.5.1 Geothermal Well Design

Design of a geothermal well is a “bottom-up” process. Location of the production zone determines the well’s overall depth, and the required flow rate determines diameter at the bottom of the hole – the well’s profile above the production zone is then set by iteration of the successively larger casing strings required by drilling or geological considerations as shown in **Figure 6** below (Finger and Blankenship, 2010).

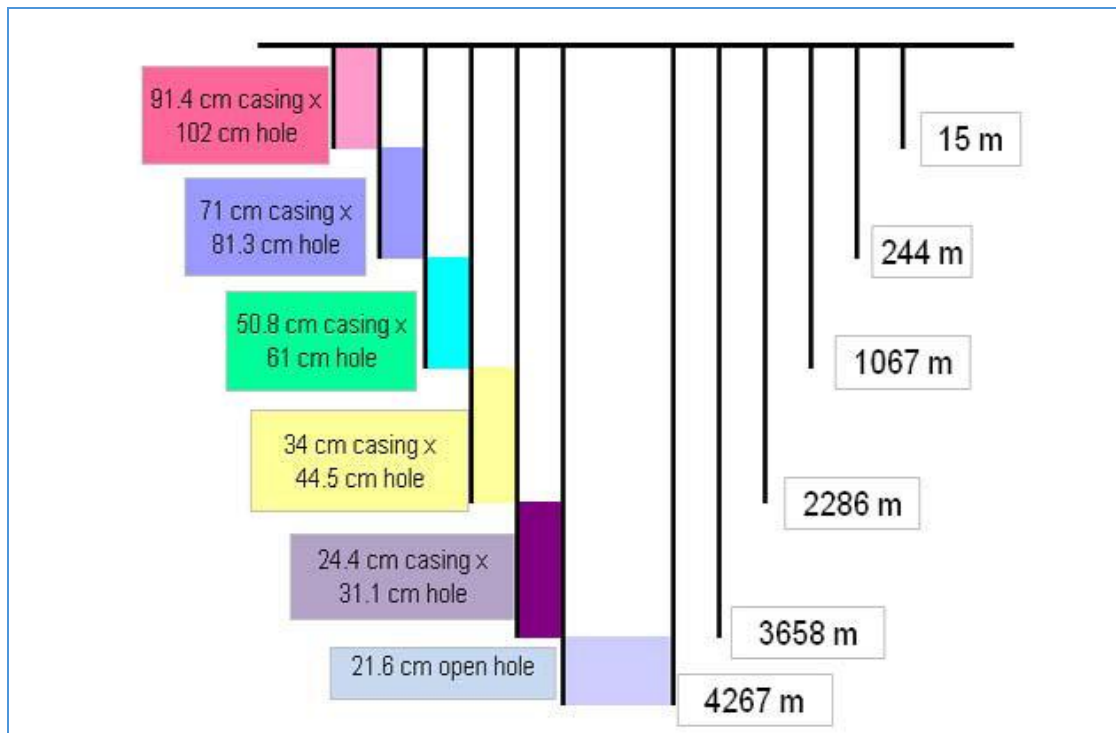


Figure 6: A Typical Geothermal well design

2.5.2 Geothermal Well Drilling Process

A rotary drilling rig rated 2000 Horsepower and owned by GDC will be used to drill the geothermal wells. The power of the rotary drilling rig will be generated by 3512 model diesel driven internal combustion engines. The rig is equipped with 4 diesel generators, 2 of which will be running while 2 will be on standby. Each of the generator sets is rated 1200 kva. In addition, the rig will be complete with 3 primary compressors, 2 booster compressors and an auxiliary generator rated at 315kVA. The fuel for the generator sets will be stored at the rig site in 3 tanks each having a capacity of 50,000 litres. Preventive maintenance of the generator sets will be undertaken at 500, 1000 and 2000 running hours.

The drilling rig uses a drill 'bit' to drill into the ground to reach the desired geothermal reservoir depth. The proposal is to drill between 2.5 km to 3 km below the earth's surface as dictated by the integrated geothermal reservoir conceptual model. The well is drilled in sections using different-sized drill bits, each section narrower than the one before. The depths and the sizes of each section are determined by the final size and depth required for the production hole, and the expected geological conditions in the reservoir.

The drill bit is rotated by the hollow drill collar and drill pipe. Torque is applied through the rotary table and Kelly. Drilling fluid is circulated down the drill pipe and out openings in the bit where it cleans cuttings from beneath the bit, cools the bit and carries cuttings to the surface where they are separated from the fluid. Weight on the bit is applied by the heavy drill collar assembly. The drill pipe is held in tension by the traveling block.

Modern well drilling techniques allows for the drill bit to change direction underground to target specific areas with a high degree of accuracy. This is done to improve the success rate and productivity of the wells. As each section of the well is drilled, it is cased with a protective metal pipe that stabilises the hole and contains the pressure from the fluid. The metal pipe is cemented in place. Casing has traditionally been cemented in place by pumping a calculated amount of cement into the casing, placing a movable plug on top of the cement, and then displacing the plug downward by pumping drilling fluid on top of it. This forces the cement to flow out the bottom of the casing and up the annulus between the casing and

wellbore. The cement has two important functions: to give the casing mechanical support under its sometimes-intense thermal cycling between production and shut-in, and to protect the outside of the casing from corrosion by in-situ fluids.

The final section that is drilled is called the ‘production hole’ and inside this section is a perforated pipe called the ‘liner’. The reasons for including casing strings and liners include (Hole, 2008): -

- i. Prevention of loose formation material from collapsing into and blocking the hole;
- ii. Provision of anchorage or support for drilling and the final wellhead;
- iii. Containment of well fluids and pressures;
- iv. Prevention of ingress or loss of fluid into or from the well, and “communication” or leakage of fluids between different aquifers;
- v. To counter losses of drilling fluid circulation during drilling;
- vi. Protection of the well and formation against erosion, corrosion, fracturing and breakdown.

In general, the shallower and outer casing strings are necessary for the drilling operations, while the inner strings are required for production purposes.

2.5.3 Well Control

Well control entails preventing the flow of formation fluids into the wellbore and safely removing them if they get into the wellbore. If the hole advances into a fractured or permeable stratum where the pore pressure is higher than the static head of the drilling fluid, the formation fluid will flow into the wellbore—this is called a “kick”—and that flow must be controlled (Finger and Blankenship, 2010). If control of that flow is lost, then the resulting disaster is a “blowout” which, at the least will be very expensive and, at worst, can result in loss of life, equipment, and the drill rig, as well as damage to the environment. Blowout Prevention Equipment (BOPE) will be installed during well drilling to control potential kicks and outflows at the wellhead.

2.5.4 Installation of the Permanent Wellhead

Once drilling has been finalized, a permanent wellhead is installed at the surface of the exploratory/ appraisal/ production well. It holds the equipment needed to control the operation of the well and pipes. A ‘wellhead flow control valve’ controls what is let out of the well; it can be closed completely in times of emergencies. As the wellheads can be very hot, they are securely fenced for safety and to protect them from vandalism. The wellhead should be designed to comply with codes of practice for pressure vessels or boilers, and in accordance with American Petroleum Institute (API) Spec. 6A – and most importantly, rated for the maximum pressure / temperature exposure possible at the surface under static or flowing conditions. The fluid at the wellhead may be water, saturated steam, superheated steam, cold gas, or mixtures of some of these fluids. Due to the column of fluid in the well, surface conditions cannot equate to downhole values, but in some circumstances can approach downhole conditions closely (Hole, 2008). The pressure ratings are de-rated as temperature increases in accordance with American National Standards Institute (ANSI) B16.5 and API 6A. A typical wellhead assembly for a ‘Standard’ well completed with an 8½” diameter production hole section, 95/8” production casing and 133/8” anchor casing is illustrated in **Figure 7** below.

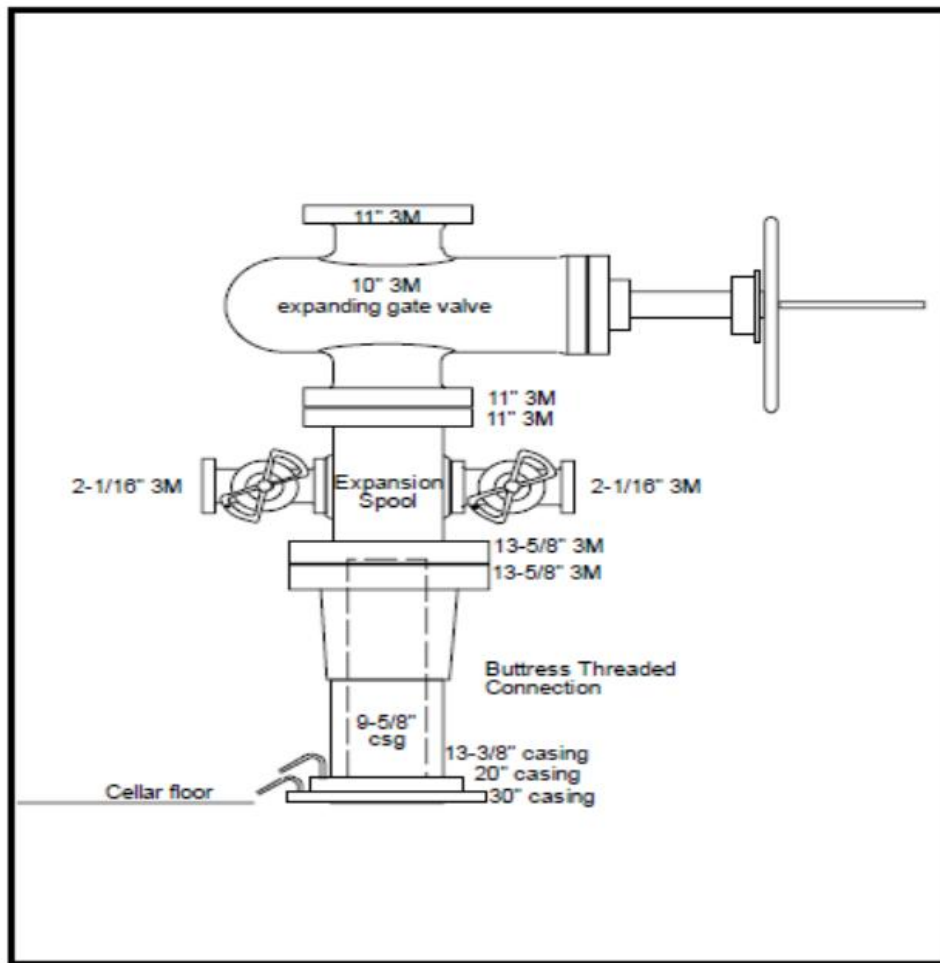


Figure 7: Typical Completion Wellhead (Hole, 2008)

2.6 Geothermal Well Testing

Normally well tests range from short step injection or discharge tests, pressure build-up and interference tests to long-term tests, sometimes involving several wells (Biru, 2020). Downhole tools allow measurements of temperature and pressure in the wells at different depths to estimate the formation temperature and the initial reservoir pressure during stages of drilling, injection, and warm-up and during discharge testing. When the production well is completed, and while the drilling rig is still in place, tests are carried out on the new well to show the temperature and pressure variation down the hole.

Upon rigging down and demobilization, the drilled well is given a certain period of time to warm up and recover its temperature as a result of cooling during drilling. As the temperature of the fluid increases during the warmup period, the water level in the well rises and if boiling occurs below the water level, a wellhead pressure builds up. In many cases, the wells build up sufficient pressure at the wellhead to start well flowing to the surface and sustain the flow. After the well has started to flow continuously, a discharge test is carried out with the main aim of getting information on the well's productivity and flow characteristics. Downhole measurements are also done by lowering the temperature and pressure logging tools down to the bottom of the well and retrieved back to the surface. Equipment selection in terms of size and type is based on availability, accuracy and expected production rate, pressure and fluid type (steam/water ratio). A short time vertical discharge together with the James lip pressure method (horizontal discharge) are used to determine the suitable equipment for long time testing as well as to estimate the production rate (Biru, 2020).

The lip pressure method is commonly used to measure the flow from geothermal wells. The two-phase fluid is discharged through an orifice, flow line and a James tube into a silencer to separate the steam and water phases at atmospheric pressure as shown in **Figure 7** above.

The lip pressure is measured at the extreme end of the James tube using a liquid-filled gauge to damp out pressure fluctuations. Water flow from the silencer is measured using weir box near the silencer outlet as shown in **Figure 8** below.

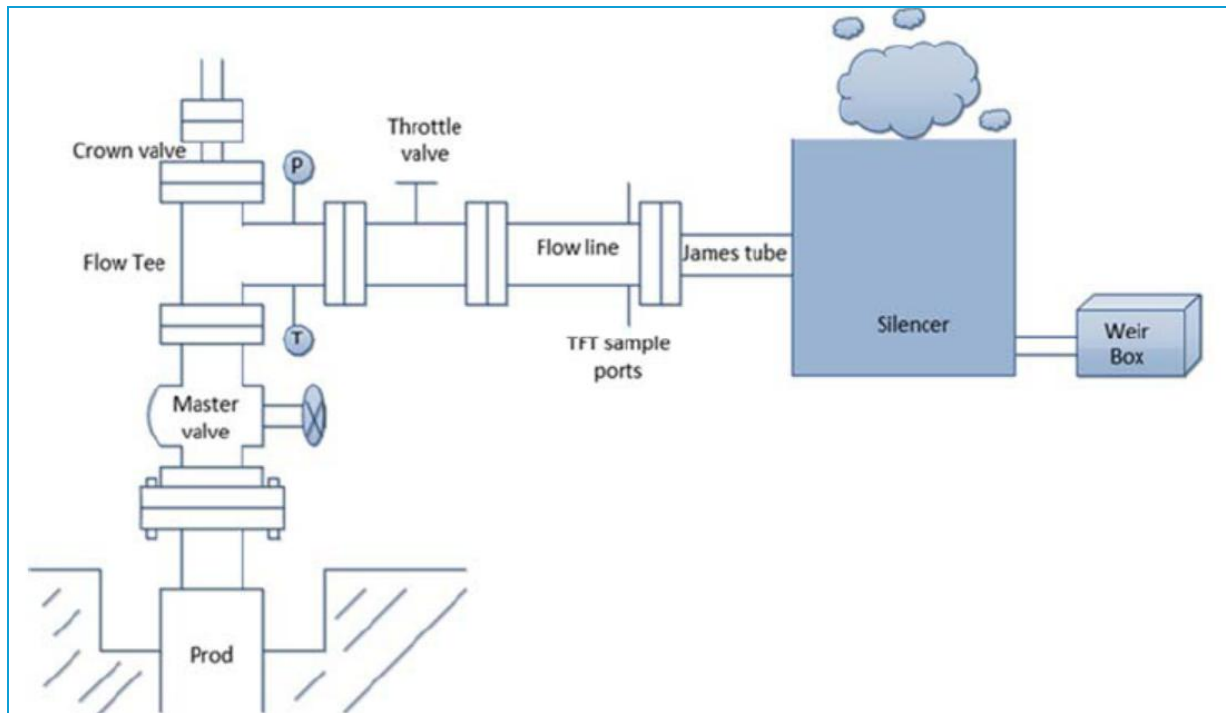


Figure 8: Schematic representation of the Russel-James lip pressure method (Biru, 2020)

Vertical discharge tests will be carried out for a duration of between 0.5 to 1 hour whereas horizontal discharge tests will be done for a minimum of a month and maximum of 3 months subject to the well attaining stable output.

2.7 Project Inputs

The consumables that will be required for drilling of the proposed geothermal wells are provided below:

- i. Drilling detergent;
- ii. Bentonite (Drilling mud);
- iii. Drilling polymer;
- iv. Blended cement;
- v. Cement additives including mica flakes;
- vi. Diesel fuel and engine oil for the generators to power the rig;
- vii. Water for drilling and

An approximate volume of 20,000 cubic metres of water 350,000 litres of diesel fuel, 400 tonnes of cement and 1 tonne of mica flakes will be required to drill a single well.

2.8 Waste Generation

The waste that will be generated by the proposed geothermal project will include the following:

- i. Solid, liquid or gaseous matter that is deposited, discharged, emitted or disposed of into the environment in a manner that can impact the environment;

- ii. A greenhouse gas substance emitted or discharged into the environment;
- iii. Matter that is discarded, rejected, abandoned, unwanted or surplus, irrespective of the potential use or value;
- iv. Matter prescribed to be waste.

2.8.1 Types of Waste that will be Generated

The possible wastes that will be generated by the proposed drilling project are shown in **Table 8** below.

Table 8: Possible Waste that will be Generated by the Proposed project

Index	Activity/Source	Type of Waste that will be Generated
1.	Road and well pad construction	Spoil materials (excavation spoils, soil piles, stock piles, or storage piles);
2.	Servicing of the generators	Used oil
		Fuel filters
3.	Drilling of the geothermal wells	Drilling fluid
		Empty containers – for hazardous and non-hazardous materials.
		Drill cuttings
		Greenhouse gas emissions from the diesel generators.
4.	Drilling of geothermal wells and servicing of the generators.	Scrap materials
5.	Medical services (Mobile clinic)	Biomedical waste
6.	Geothermal well testing	Brine
7.	Leaking oils/oil spills and fuel from generators and/or air compressors.	Contaminated soil
8.	Maintenance of the lighting system	Blown light bulbs
9.	Office work	Trade effluent/ office wastewater
10.	Laundry, Kitchen & Washrooms	Domestic/sanitary sewage
		Empty containers – for non-hazardous materials.
11.	Catering services	Fat, Oil, and Grease (FOG) and other food waste.
12.	Fumigation	Empty containers – for hazardous chemicals.

2.8.2 Waste Handling Procedure

The wastes that will be generated would be categorized as critical and noncritical based on the degree of hazard and volumes generated as shown in **Figure 9** and **Table 9** below.

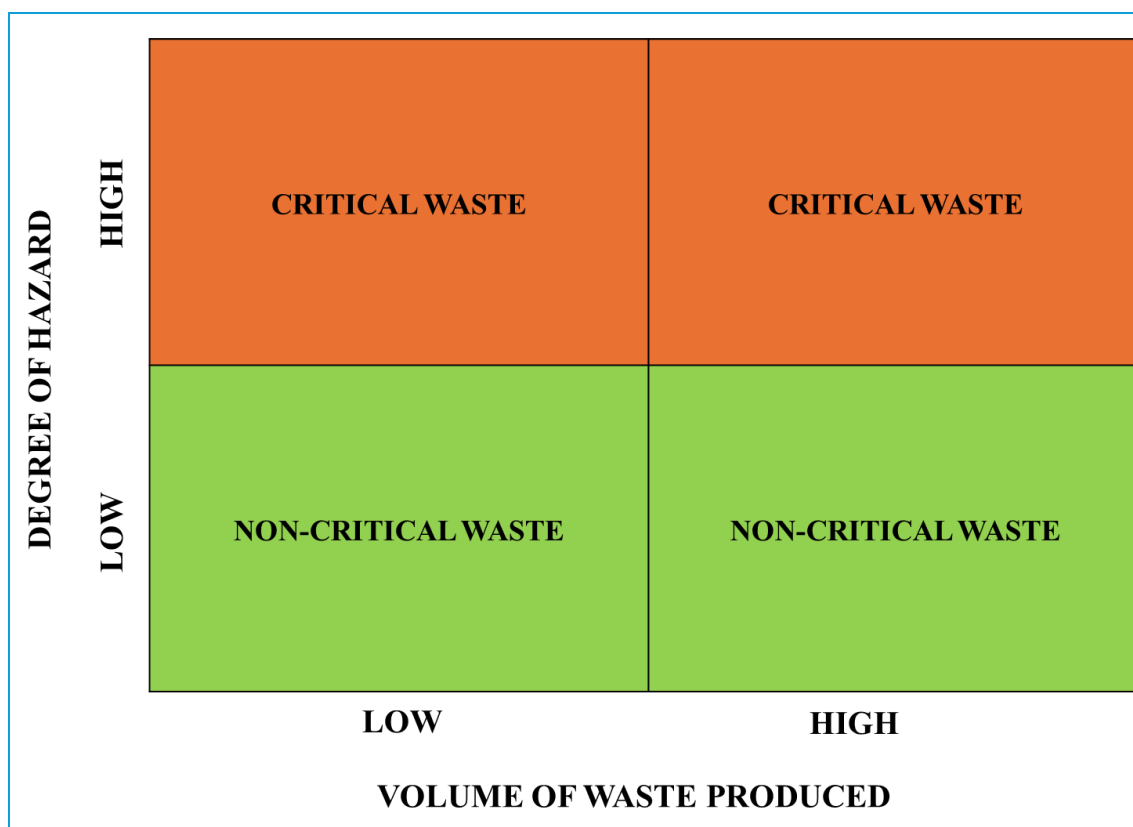


Figure 9: Waste Categorization Criteria

Table 9: Waste Categorization based on the Evaluation Criteria

Type of Waste	Degree of Hazard	Volume of Waste that will be Generated	Waste Category
Spoil materials	Low	High	Non-critical
Used oil	High	Low	Critical
Used oil and fuel filters	High	Low	Critical
Drilling fluid	High	High	Critical
Biomedical	High	Low	Critical
Empty containers for hazardous materials.	High	Low	Critical
Empty containers for non-hazardous materials.	High	Low	Critical
Drill cuttings	Low	High	Non-critical
Greenhouse gas emissions from the diesel generators.	High	Low	Critical
Scrap materials	Low	Low	Non-critical
Brine	High	High	Critical
Blown light bulbs	High	Low	Critical
Domestic waste	Low	High	Non-critical
Domestic/sanitary sewage	High	High	Critical
Fat, Oil, and Grease	High	Low	Critical

Type of Waste	Degree of Hazard	Volume of Waste that will be Generated	Waste Category
(FOG) and other food waste from the kitchen.			

Critical wastes should be handled with utmost care thus requires substantial amount of resources as opposed to noncritical waste **Figure 10** below shows how the various wastes generated by the proposed project will be handled from the point of generation to the final disposal site.

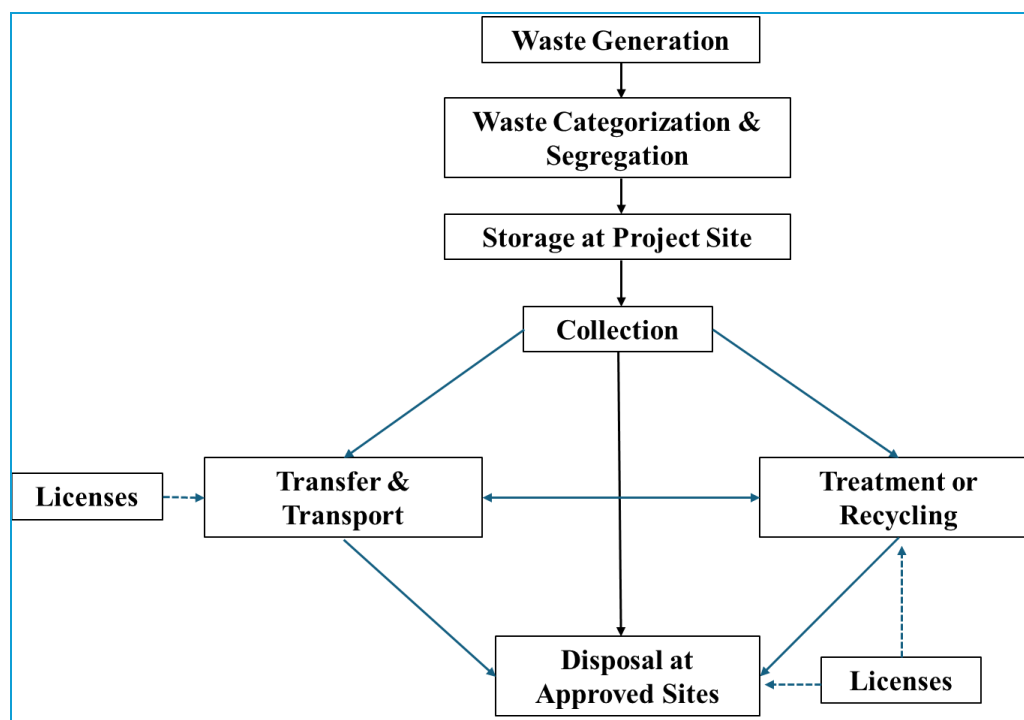


Figure 10: Waste Handling Procedure at the Project Site

2.9 Status of Works as of the time of the study

The Geothermal development program is comprised of key phases comprising of:

- Surface exploration & conceptualization for presence of a geothermal source based on surface exploration studies
- Exploration drilling- exploration programme proposed to be undertaken for the four exploratory wells
- Appraisal drilling where appraisal wells are drilled to confirm whether the project is technically and commercially feasible
- Production drilling and geothermal power plant construction. This include Building, commissioning, testing and putting in to service the power plant and associated power transmission lines
- Operation which involves development, operation and maintenance of the geothermal reservoir, steam field, power plant and transmission lines and export of electricity to the off takers.

The phased approach is typical for a small-scale geothermal development project. If initial drilling is successful, the next phase of the process would-be full-size appraisal drilling, which would aim to expand understanding of the geothermal reservoir size, well chemistry and productivity, and also understand how

the system would behave under production. This ESIA only covers the test exploratory drilling phase of the project.

For the purposes of the ESIA, the exploration phase is split into three key sub-phases; Site establishment (construction phase), Exploratory and Appraisal drilling (operations phase and Site closure (decommissioning phase). The activities associated with the site clearance phase will involve the following:

- Upgrade of access roads and widening of pinch points at existing roads where required;
- Site clearance;
- Construction of well pads including water and mud sumps;
- Construction of water intake and pump stations;
- Construction of temporary water pipeline to supply well pads and temporary materials storage yard
- Transportation of drilling rig and associated equipment and installation on site.

Activities associated with the drilling phase will involve:

- Exploratory drilling works
- Pumping of water / drilling muds
- Materials and waste handling during operations
- Drilling rig and ancillary equipment maintenance
- Geological sampling and analysis
- Well testing

2.10 Products

Geothermal drilling operations will primarily yield products related to energy generation and resource extraction. These will include:

- Geothermal Steam for use of driving turbines for electricity generation;
- Hot Water that would be utilized for direct heating applications or further energy conversion;

2.11 By-Products

Geothermal drilling operations will primarily yield by-products which include:

- Minerals extracted from geothermal fluids, such as silica and lithium;
- Drilling fluids used during the drilling process, which may be recycled or disposed of after use.
- Non-condensable gases including carbon dioxide, hydrogen sulfide, and methane, which are released during the drilling process;
- Drilling mud and cuttings that will be generated during the drilling process, which will need proper disposal or recycling.
- Brine (Salty water) extracted from geothermal reservoirs, will be contained in lined ponds.

2.12 Project Decommissioning Phase Activities

The project site closure (the decommissioning phase) will involve the following activities:

- Plugging and abandoning the wells including sealing the wells to prevent leaks or contamination including cementing and installing barriers;
- Dismantling and removal of drilling equipment including dismantling and removal of drilling rigs, pipelines, and associated infrastructure;

- Site Cleanup including removal of any waste materials, chemicals, or debris from the site;
- Environmental restoration and rehabilitation the land to its original state or as per regulatory requirements;
- Monitoring and reporting i.e conducting post-decommissioning audits and submit reports to regulatory bodies including NEMA;
- Stakeholder Engagement including communication with local communities and authorities to address post-closure concerns

CHAPTER 3. ANALYSIS OF PROJECT ALTERNATIVES

3.1 Introduction

This section provides a brief overview of the alternatives considered and details of the proposed activities to be conducted within Suswa Drilling Project area.

Alternatives to the proposed Project were considered in the early stages of Project design which included different options available that may avoid or reduce any adverse environmental and/or social impacts. The different options considered are presented in the following sections.

3.2 No Project Alternative

The ‘No Project’ alternative would result in no further exploratory drilling activity in the project area (Suswa) and, in turn, no further geothermal resources development.

The No Project Alternative option in respect to the proposed project implies that the status quo is maintained. This option is the most suitable alternative from an extreme environmental perspective as it ensures non-interference with the existing conditions. Under the No Project Alternative, the proponent’s proposal would not need to receive the necessary approval from NEMA. The proposed geothermal development project would not take place. This option will, however, involve several losses both to the proponent, the community and the Country as a whole.

The ‘No Project Option’ is the least preferred from the socio-economic and partly environmental perspective due to the following factors:

- The Kenya Government requires energy resources to spur its Vision 2030 and ‘No Project Option’ will impact that negatively;
- The local skills would remain underutilized;
- Reduced business opportunities due to lack of infrastructure in the proposed project area;
- Reduced interaction both at local, national and international levels by the community, hence education and general awareness is a major loser;
- No employment opportunities will be created for the local community in project area and for Kenyans in general who would have worked in the proposed project area;
- Increased urban poverty and crime in Kenya;
- Discouragement for investors;
- Development of infrastructural facilities (roads, schools, health facilities, water facilities, electrical etc.) will not be undertaken;
- Lack of development, research and innovation in the Country.

In addition, the anticipated environmental impacts resulting from pre-construction and construction phases of the proposed project are insignificant. From the analysis above, it becomes apparent that the ‘No Project’ alternative is not the best alternative to the local community and the entire country.

3.3 Alternative Site

The location of the well pads is normally determined by the geothermal well siting committee which comprises of geologists, geophysicists, geochemists, environmental scientists, drilling engineers, reservoir scientists/engineers, GIS experts and social safeguard specialists. The chosen location of the well pads for drilling the proposed exploration wells was informed by the available geoscientific surface exploration data for the Suswa Prospect. The areas with the highest probability of exhibiting high temperature and permeability (up flow zone), as supported by the integrated conceptual model and direct data, were considered as very good candidates for the four exploration wells to be drilled. This will be followed

conservatively by step out towards the outflow zone based on the emerging risks during the assessment. The well siting committee also considered operational and environmental aspects such as existing access roads, water source location, land acquisition issues, soil and rock properties, landslide hazard, terrain characteristic, distance to sensitive receptors like settlements, cultural sites and wildlife habitat, distance to thermal manifestations, the type and size of the rig to be used and geothermal well design (vertical or directional).

3.4 Geothermal Well Design

In the exploration phase, the drilling objectives are not mainly to exploit the geothermal resource but rather on defining the resource by its key system characteristic, such as heat source existence near surface, hydrological system, geological setting and areal extent of the prospect. In order to achieve these objectives, geothermal developer may select any of the three types of wells based on their sizes. The wells are:

- Big/large hole: – wells with 13-3/8” production casing size.
- Regular/standard hole: – wells with 9-5/8” production casing size.
- Slim hole: – wells with smaller diameter than standard hole.

Table 10 below provides a comparison of the three types of geothermal wells (Purba et al, 2019).

Table 10: A comparison of the three types of geothermal wells

Parameter for Comparison	Big/Large Hole	Standard Hole	Slim Hole
Typical Drilling Depth	Total drilling depth may range from 1500 to 3000 m	Total drilling depth may range from 1500 to 3000 m	Total drilling depth may range from 1200 to 2330 m
Rig Capacity	May require a rig with capacity of 1000 – 2000 HP depending on total well depth and inclination.	May require a rig with capacity of 550 – 1500 HP depending on total well depth and inclination.	Could be drilled using a rig with capacity less than 550 HP.
Rig Footprint/Well Pad	The well pad may require land area of about 10,000 – 15,000 M ² depending on rig size.	The well pad may require land area of about 7,500 – 12,000 M ² depending on rig size.	Since the rig is more compact and simpler, the well pad requires much smaller land area of about 2,000 – 4,000 M ² .
Drilling Preparation Time	Requires longer time to prepare access road, laydown area and well pad.	Requires longer time to prepare access road, laydown area and well pad.	Requires shorter preparation time due to compact size of the rig and less number of rig equipment.
Water Supply Requirements	May range from 60-95 litres/second depending on	May range from 60-95 litres/second depending on	May range from 5-30 litres/second.

Parameter for Comparison	Big/Large Hole	Standard Hole	Slim Hole
	hole size.	hole size.	
Lithology Definition	Uses drill cuttings as the media to determine lithology, alteration mineralogy and fracture characteristics.	Uses drill cuttings as the media to determine lithology, alteration mineralogy and fracture characteristics.	Uses core sample as the media to determine lithology, alteration mineralogy and fracture characteristics (core sample give better definition than cuttings).
Casing and Cement Requirements	About 200 tons of casing and ≥ 84 M ³ of cement is required.	About 135 tons of casing and ≥ 55 M ³ of cement is required.	About 80 tons of casing and ≥ 26 M ³ of cement is required.
Directional Drilling Capability	Able to accommodate directional drilling technology.	Able to accommodate directional drilling technology.	Commonly drilled vertically. More difficult to be drilled directionally.
Production/Injection/Monitoring Capability	Able to serve as production or injection well when reservoir characteristic allows. May also serve as monitoring well.	Able to serve as production or injection well when reservoir characteristic allows. May also serve as monitoring well.	May be difficult to induce flow and it may be too low to serve later as production wells. May serve as monitoring well.
Estimated drilling days	Ranging from 30 – 45 days (from spud to rig release with 2,000 metres total depth).	Ranging from 30 – 45 days (from spud to rig release with 2,000 metres total depth).	Ranging from 60 – 120 days (from spud to rig release with 2,000 metres total depth).
Discharge Capability	Representative to possible actual discharge capacity. Might give greater output than standard well due to its large diameter casing.	Representative to possible actual discharge capacity.	Requires further study to assess its discharge characteristics to actual production well size.
Estimated Total Cost	USD 3,000 – 4,500/Metre	USD 2,000 – 4,000/Metre	USD 4,000 – 1,000/Metre (Including

Parameter for Comparison	Big/Large Hole	Standard Hole	Slim Hole
	(Including rig and drilling support cost).	(Including rig and drilling support cost).	rig and drilling support cost).

The Chosen Design of the Geothermal Well

The project proponent has considered conducting exploration drilling using standard hole with the objective of obtaining production well after the desired temperature is proven. The Standard hole option is used when the conceptual model clearly defines hydrology of the geothermal system with sufficient amount of direct data that supports the presence of high temperature as well as permeability. Given a bottom-hole depth and diameter, determination of the casing intervals depends on several factors, including rock properties, formation fluids, surface casing setting depth, well control requirements or regulatory requirements. Each of the standard geothermal well will have a distinct well design that will specify the drilling depth and intervals of setting the casings based on the following considerations (Finger and Blankenship, 2010):

- Protection of an aquifer - Aquifers encountered will be sealed off to prevent their contamination by wellbore or drilling fluids.
- Provision of well control in case of a kick incident. The kick must be able to be removed safely without exceeding the fracturing pressure at the shoe of the last cemented casing.
- Isolation of troublesome formations - these can be unstable (sloughing, swelling, or unconsolidated) formations, zones with high or incurable lost circulation, or a depleted pressure zone above the production horizon.
- Fluid pressure control - although more common in oil and gas than in geothermal,
- drilling fluids often contain additives that bring the specific gravity of the fluid well
- above that of water, so that the weight of the fluid column will control the downhole pore pressure in the formation. This often causes the higher pressure of the drilling fluid to exceed the fracture gradient of the formation, leading to lost circulation or even loss of well control. Many geothermal systems are located in tectonically active regions, which have very low fracture gradients, complicating this part of the casing design.
- Defining the production zone - geothermal reservoirs can have more than one productive zone and casing is sometimes set to preferentially allow production from the selected zone.

3.5 Geothermal Well Pad Design

Geothermal well pads can be designed to accommodate one well or up to six wells on the same well pad by employing the directional drilling technology. An example of a multi-well pad in Mokai, New Zealand where six wells were drilled directionally, with 9 5/8" production casing and 8½" diameter production hole sections.

The well pad layout is generally dictated by the drilling rig being utilised to drill the wells and by the rule of thumb whereby a minimum spacing of at least 5 m is observed such that the chance of collision in the initial vertical sections of the wells is minimised. Wellhead spacing must be such that when a well is completed, the rig can be 'skidded' or 'walked' off the well to the next wellhead, leaving the completed well accessible for completion tests, and even vertical discharge testing without significant interruption of drilling activities on the new well. After completion of drilling all the wells on the well pad, there is always the possibility that workover activities may be required on any of the wells. The steam gathering pipework must be designed in such a manner that access to each wellhead is available without disconnection of adjacent wells.

The economic savings from multi-well pads accrue from: -

- Reduced drilling pad civil construction costs – one drilling pad with a slightly increased area can accommodate up to six wells. Only one access road and geothermal fluid containment pond need to be constructed.
- Reduced project footprint – drilling of multiple wells on a single well pad reduces the area of land to be cleared thus reduced impact on biodiversity.
- Reduced rig move costs – typically, the cost of moving a drilling rig from one location to another is in the order of USD 500,000, taking a period of around two weeks; while a rig ‘skid’ from one well to the next on the same pad is generally carried out at the rig operating rate and can usually be achieved in a period of two days, at a cost of USD 120,000.
- Reduced water supply system installation costs since the wells are located centrally on the same well pad.

Significantly reduced steam gathering pipework costs.

The disadvantages of multiple-well pads can be accommodated or easily mitigated as discussed below.

- Live wellheads close to a drilling operation – an element of danger exists due to the fact that having completed a successful geothermal well, the rig is skidded only a distance of 5 to 10 metres from the ‘live’ wellhead. There is the potential for damaging the live wellhead. This concern can be mitigated with the placement of a temporary protective cover over the ‘live’ wellhead.
- The drilling fluid containment ponds need to accommodate much greater quantities of cuttings and therefore need to be larger, and should be designed such that they can be emptied or at least partially emptied while in operation.

The project proponent considered constructing multi-well pads as opposed to Single-well pad for the reasons mentioned above.

3.5 Alternative Uses of Geothermal Resources

Geothermal resource use is defined based on temperature. High-temperature resources ($>150^{\circ}\text{C}$) are often prioritized for electricity production, whereby the heat energy of the geothermal fluid is converted to electrical energy. Low (~ 20 to 80°C)- to medium (80 to 150°C)-temperature resources are less suitable for electricity generation but are much more widespread and lend themselves to direct-use applications as shown in **Figure 11** below.

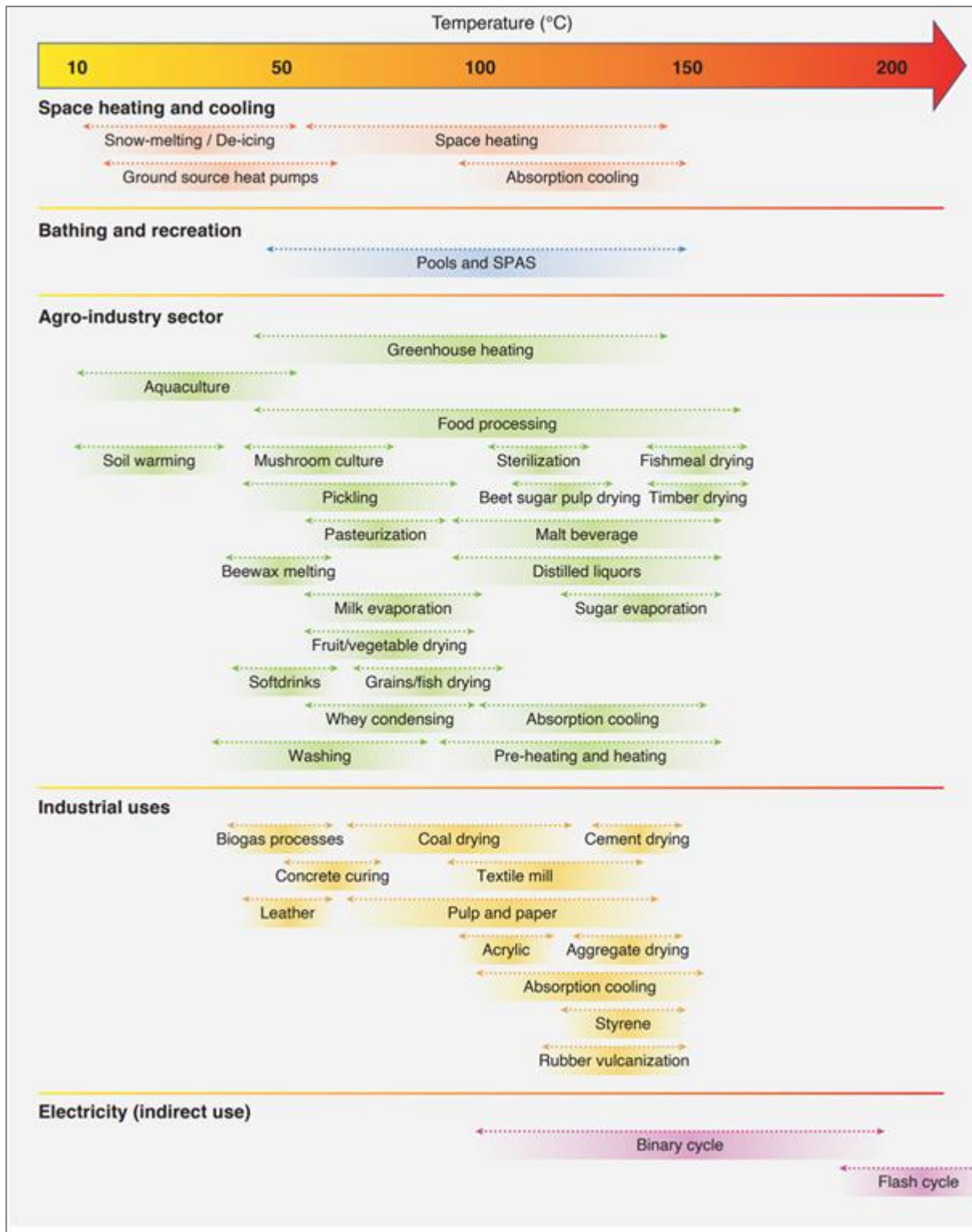


Figure 11: Potential uses of Geothermal Resource (ESMAP, 2022)

Geothermal Direct Use is the use of geothermal resources to create valuable commodities from heat, minerals and gases. The geothermal industry has been developing for over a century. Geothermal utilization has evolved into schemes combining various types of direct use and electricity production. While high-temperature resources can be harnessed solely for direct applications, their preferred use has been for electricity production to supplement the nationwide grid. The design conditions of wells drilled for utilizing low- to medium-temperature geothermal fluid are usually less demanding than wells drilled for high-temperature fluid. The temperature is lower, and usually the pressure is lower as well; the flow is

in liquid form (no steam), the volume flow is lower, and the fluid chemistry is usually less aggressive. The hot water may contain gas, which may involve additional requirements for the pump installation in operation and, in some geothermal resources, wells must be designed for gas kicks that might occur during drilling (ESMAP, 2022).

Kenya has prioritized harnessing of geothermal resource for electricity production since geothermal energy provides reliable base load power and has comparatively low electricity production costs. It is also not affected by vagaries of weather and contributes to climate change mitigation. According to the Least Cost Power Development Plan 2021 – 2041, Suswa Geothermal Prospect has been earmarked by the government of Kenya to generate 300 MW of electricity by the year 2040.

Kenya's total interconnected effective capacity was anticipated to grow from 2,919 MW in 2021 to 3,895 MW in the medium term (2026) and 8,920 MW by the end of the planning horizon (2041) as shown in figure 12 below. From the results, geothermal capacity is expected to contribute the highest to the total firm capacity at an annual average of 32% over the planning period. For this reason, the project proponent has prioritized developing the geothermal resource at Suswa Geothermal Prospect for electricity generation. Medium temperature geothermal fluid can be harnesses for electricity generation using binary technology.

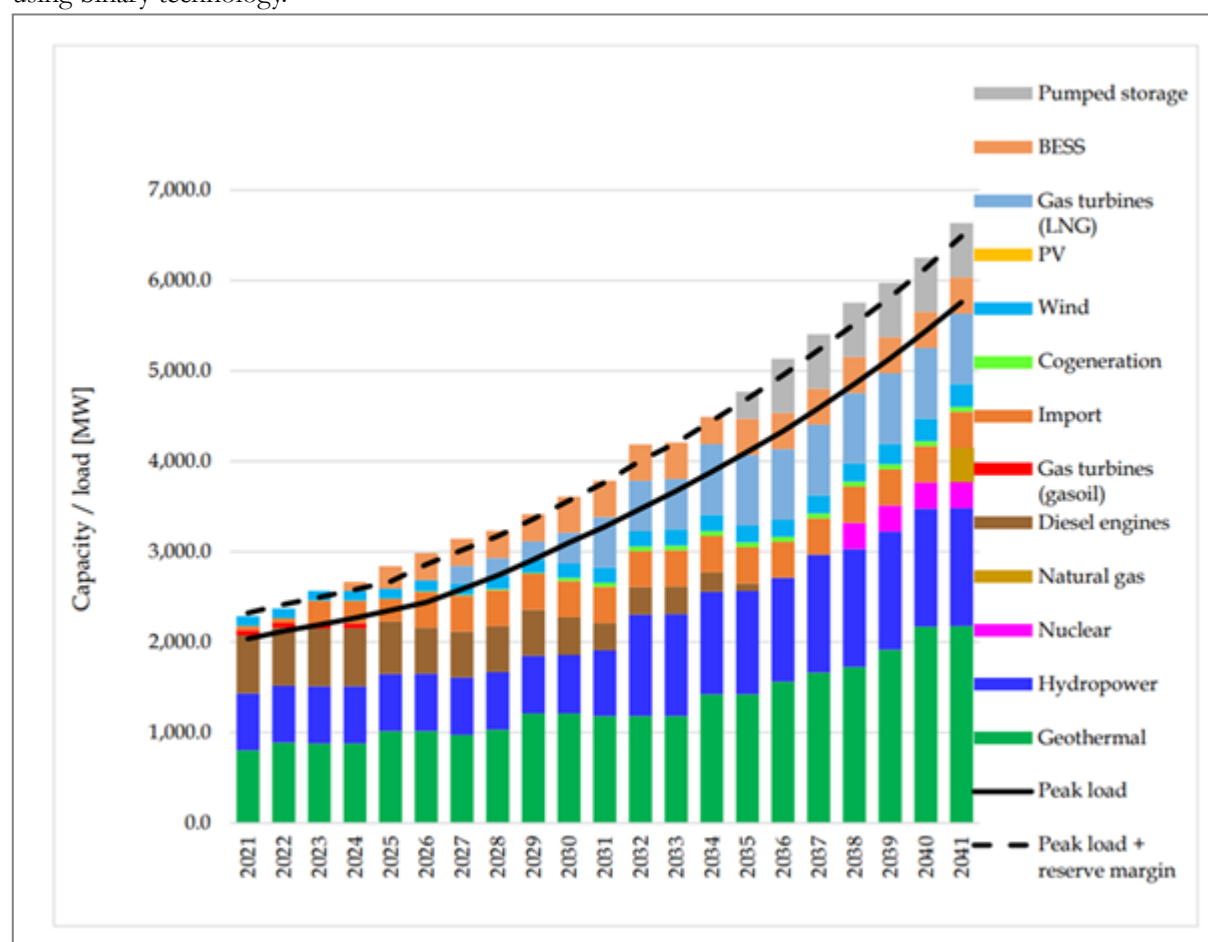


Figure 12: Firm capacity vs peak load – Reference demand scenario (Republic of Kenya, 2022)

3.6 Alternative Geothermal Resource Development Approaches

Geothermal resource can be developed in one/single or more/multiple phases. With a single-phase approach, a geothermal project is developed to the maximum size that the geothermal field is believed to be able to support, which is generally greater than 50 percent of the estimated capability. With a

multiphase approach, a geothermal resource is utilized in several relatively small phases. The resource risk is minimized by sizing the first phase significantly below half the estimated capability of the resource, essentially holding the rest in reserve. The project then proceeds to the next phase based on the experience of the previous phase. Each of the two approaches has its own benefits, as summarized in table 11 below (ESMAP, 2022):

Table 11: Approaches and its own benefits

Index	Benefits of Single-Phase Development	Benefits of Multi-phase Development
i.	Requires lower capital expenditure (CAPEX) per megawatt thermal (MW_{th}) due to economies of scale as a result of lower cost of: drilling each well, equipment and common infrastructure.	Takes shorter timeline as each phase is smaller in scale.
ii.	Lower operating expenditure (OPEX) per MW_{th} .	Full utilization is reached in shorter time.
iii.	Requires fewer employees per MW_{th} .	Results from the previous operation are used to decide on: additional applications and scale-up.
iv.	High output of energy	Easy to determine resource capability e.g. chemistry, reinjection, production.
v.	Financing is often easier due to scale.	Lower risk of failure.

3.7 Alternative Water Sources

Reliable water supply for exploration drilling will be required to complete the drilling programme. The actual water requirements is strongly influenced by the drilling conditions encountered and will vary depending on the stage of drilling.

The main source of water for the proposed project is Kikuyian Dam. However, the following are the proposed alternative sources of water for the project as outlined below;

Option 1: Abstraction from Kijabe boreholes

The borehole areas in Kijabe are situated on the western side of Kijabe escarpment, North of Mai Mahiu town and North East of Suswa prospect. Three possible borehole areas were picked based on the previous siting that was done. Two of the possible areas fall under Kenya Forest Service Land while one is on a private land. Distances from these borehole areas were tracked to Suswa tank site. Total distance to the prospect area from these boreholes will be approximately 48KM as indicated in **Figure 13** below.

The major components for this system will be: -

- Acquire access rights agreement with Kenya Forest Service to drill boreholes
- Drill boreholes (minimum 9 No.)
- Installation of 1 No. collection tank
- Installation of 2 No. booster pumps (Pump Station 2)
- 48 km 10" victaulic water pipeline
- Power supply
- 2 No. collection tanks (4 million litres each) at pumping and breaking stations
- 3 No. storage tanks (4 million litres each) at tank site

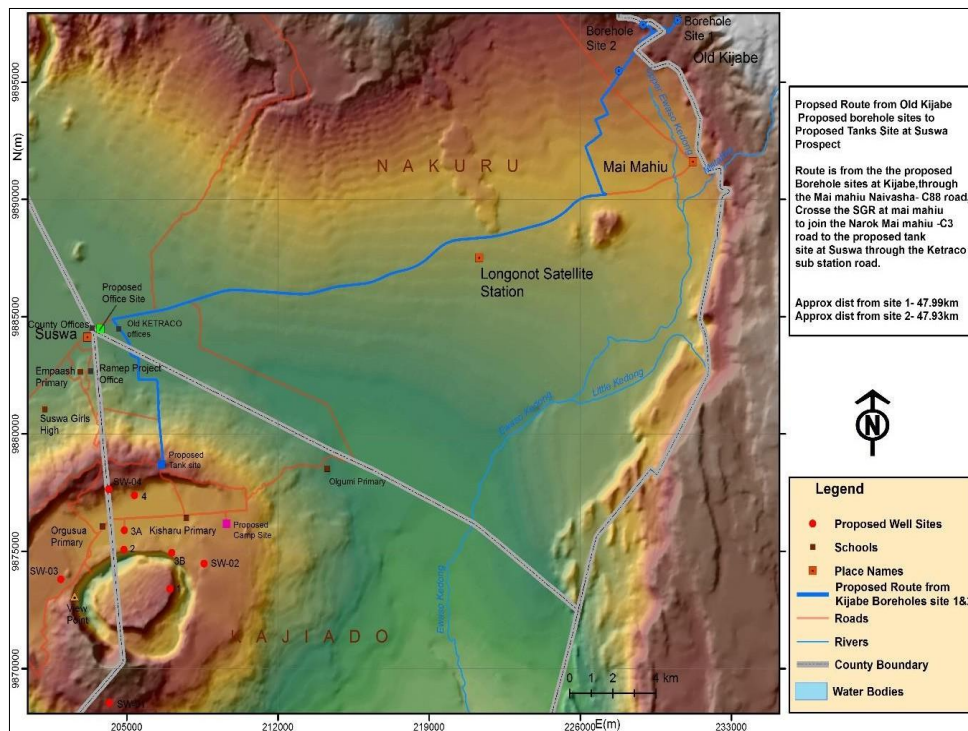


Figure 13: Kijabe water abstraction points (Source-Suswa water supply system)

Option 2: Water pan/Dam and boreholes from Kikuyian

Kikuyian Dam, also referred to in some reports as Kekuyian Dam, is a small water body located in Narok County, Kenya, within the Nairagie Enkare area of Keekonyokie Ward. The dam is an important water resource for the surrounding community, supporting livestock watering, small-scale farming, and domestic water use.

Despite its significance to the local community, Kikuyian Dam presents notable safety and environmental concerns, particularly due to frequent overflows during heavy rainfall events, such as those experienced in May 2024. These events have increased flood risks in the surrounding areas, with over 400 households identified as potentially vulnerable to evacuation due to rising water levels. The dam occupies approximately 100 acres of private land and forms part of broader local water management challenges, with community leaders expressing concern over its current management and its capacity to safely accommodate extreme rainfall events.

Water abstraction for the proposed project will be undertaken from the existing water pans/dams in this area. The abstracted water will be pumped to reservoir tanks located at Suswa, with the total distance from the source to the prospect area being approximately 38 km. The major components of the proposed water supply system will include:

- An intake structure at the water pan (including acquisition of land rights);
- Installation of one (1) collection tank;
- Pump Station 1;
- Power supply infrastructure;
- A 38 km, 10-inch Victaulic water pipeline; and
- The storage tanks.

This option is considered the most viable and practical water supply alternative available for the proposed geothermal drilling project..

Option 3: Abstraction from Lake Naivasha

Lake Naivasha presently provides water for drilling for the nearby Olkaria geothermal field under KENGEN and water for various flower farms around the lake as shown in **Figure 14** below. The lake is to the North of the Suswa prospect. The abstraction point has been established. It is anticipated that the water from this source will be pumped through the expansive Kedong ranch. Total distance to the prospect area from this source will be approximately 42KM.

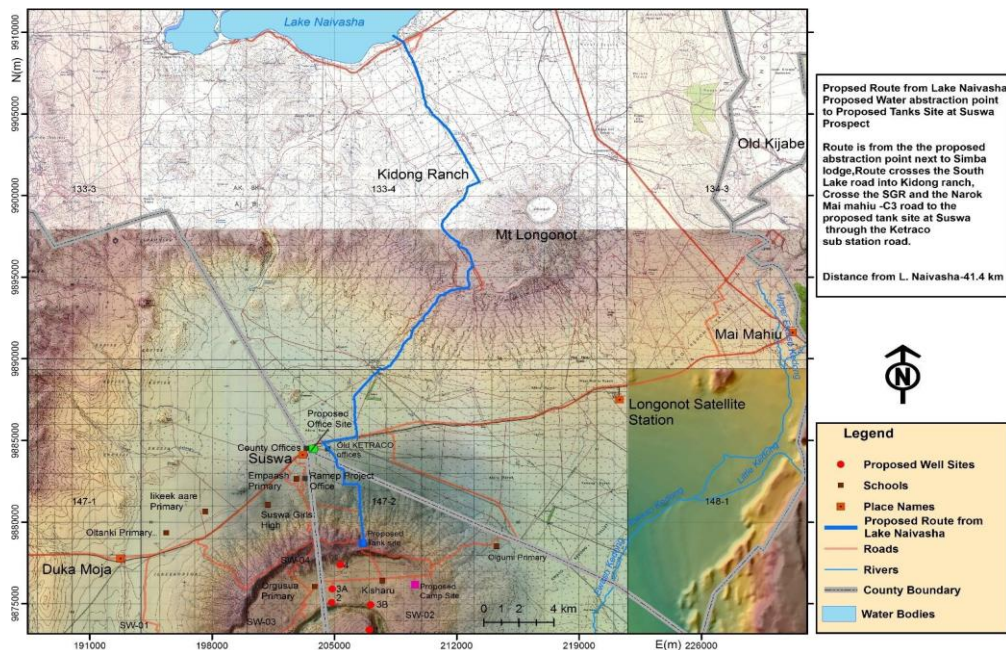


Figure 14: Lake Naivasha Abstraction Point (Source-Suswa water supply system report)

Option 4: Water delivery by tankers

This involves water delivery by tankers at a cost of US\$4,960,000. This assumes that tankers are used to bring the water required for the drilling of the first three wells. Subsequently, these wells are used to produce water for the drilling of all other wells.

If water trucking is used to supply water for the drilling of the first few wells, water could be tankered to the site initially, then for subsequent drilling, if productive, the wells which have already been drilled could be converted into water supply wells. There will be need for a large water reservoir at within the concession area. Water tanker trucks are readily available in Naivasha, as are the required water vendors. The large capacity water tanker truck will carry from 13 m³ to 20 m³ of water. The trucks are equipped with a mounted ecliptical water tank, rust proof, with capacity indicator, interior baffles drain fittings, water pump, 60 to 100 m hose and accompanying hose reels and hose storage compartment. There are several tankers both in Naivasha and Nairobi that may be used at short notice. Although it will be possible to contract a firm to bid for this contract so that there will be value for money. The average daily consumption for a conventional well bore is about 1,100 m³/day, and as such as total requirement of 61 truckloads of water per day will be required thus generating considerable traffic.

The average journey time between Naivasha and Suswa, including loading and offloading is 2 hours. That means each tanker can make four round trips in a single day. It is reasonable to calculate that a maximum of 15 tanker trucks will therefore be required to deliver 1,100m³ per day and support drilling of the first exploration well.

It should be noted that any geothermal fluids produced during the drilling of the first exploration well may reduce the water requirement for the second and third exploration wells.

Table 12 below indicates the estimated average yield for the different options highlighted above.

Table 12: Anticipated Water Estimates

Source	Unit	Estimated Yield(m ³ /h)	Av. Quantity	Total(m ³ /h)	Remarks
Ground water,	Kijabe Boreholes	30	9	270 m	To be drilled and analyzed
Surface water,	Lake Naivasha	270	1	270	Available
Surface water-	Water Pan	30	5	270	Available
Ground water	Nairagie Enkare Borehole/Kikuyian	120	1	270	To be drilled

Source-Groundwater & Surface Water Supply Options assessment report

Among the water supply options considered for the proposed project, Kikuyian Dam has been identified as the most suitable and reliable source. The project will therefore primarily source its water from Kikuyian Dam, subject to compliance with relevant regulatory approvals and sustainable abstraction requirements.

3.7 Drilling Technology

There are two drilling technologies that are available for the project, vertical and directional drilling approaches which can be used in geothermal well design. Vertical Design involve wells being drilled straight down into the geothermal reservoir. This design has the advantage in that it's simpler and less expensive; ideal for reservoirs directly beneath the drilling site. However, it has the disadvantage of limited flexibility in accessing geothermal resources spread across a wider area.

Directional drilling involves wells being drilled at an angle or curved to reach geothermal reservoirs located away from the drilling site. It has Advantages of having greater flexibility in targeting resources; allows multiple wells to be drilled from a single pad, reducing costs and least environmental impact. Directional drilling is generally considered to have a lower environmental footprint due to its efficiency and reduced surface impacts. It also has minimal surface disruption by allowing multiple wells to be drilled from a single pad hence less impact on ecosystem as it reduces the need for extensive land clearing, making it more environmentally friendly in sensitive areas.

However, the main limitations is that it is more complex and expensive; requires advanced technology and expertise. It has higher initial costs due to advanced technology and expertise required.

Rotary drilling with mud circulation supported by directional drilling and air drilling where appropriate is the established and preferred technology due to the volcanic geology and high reservoir temperatures.

3.8 Alternative Materials

The environmental impact assessment of alternative materials for geothermal drilling were focused on their sustainability and ability to minimize ecological harm. Some of the alternative materials considered were:

- High-Entropy Alloys (HEAs): These materials are highly durable and resistant to corrosion, reducing the need for frequent replacements and minimizing waste.
- Ceramic-Metal Mixtures (Cermets): Their heat resistance and longevity lower the environmental footprint by reducing material consumption.
- Advanced Coatings: Technologies like thermal spray coatings enhance equipment lifespan, reducing the need for new materials and waste generation.
- Hybrid Drilling Techniques: Combining methods like rotary drilling with water jet cutting can reduce energy consumption and wear on equipment, leading to lower environmental impact.
- Thermal Spallation Technology: This innovative approach reduces the need for mechanical drilling, minimizing wear and tear on equipment and associated waste.

CHAPTER 4. POLICY, LEGISLATIVE AND REGULATORY FRAMEWORK

4.1 Introduction

This Chapter outlines the overview of relevant County, National and international legislative regulatory and framework, guidelines and conventions relevant to this project and suggest activities to ensure compliance is achieved. It gives guidance on to ensure that project planning, execution, and decommissioning are conducted in accordance with the laws, standards and sectoral policies.

The Republic of Kenya has a policy, legal and administrative framework for environmental management. The Government's policy on energy is to provide efficient and reliable energy. Under the administrative framework, the National Environment Management Authority (NEMA) is responsible for ensuring that ESIA's are carried out for new projects and environmental audits on existing facilities as per the requirements of the Environmental Management and Coordination Act (EMCA) Cap 387. Projects subject to this requirement are specified in the Second Schedule of the Act.

Development Finance Institutions (DFIs) have also developed policies on social and environmental sustainability that calls for positive development outcomes in the public and private sector. To achieve this, they have established safeguards on environmental and social sustainability as well as general and industry specific environmental, health and safety guidelines against which projects are evaluated.

Environmental and Social Impact Assessments (ESIAs) are carried out to identify potential positive and negative impacts associated with a proposed project. The aim is to amplify the positive impacts and develop mitigation measures for the negative ones. The ESIA also ensures that baseline environmental and socio-economic data for the proposed project is collected and used in the design of projects financed by DFIs. Also, this data is used for monitoring and evaluating project impacts during the project cycle. It is a requirement by both NEMA and the DFIs that a clear management plan and action plan that describe and prioritize the actions required implementing mitigation measures are put in place.

Environmental Management and Coordination Act, 1999(Revised 2015) Second schedule, 4(d) lists drilling for the purposes of utilizing Ground water resources, including Geothermal Energy among projects which must under ESIA studies. Environmental (Impact Assessment and Audit) Regulations 2003 Legal Notice No.101 provides ESIA guidelines.

4.2 National Policy Framework

The Republic of Kenya has a policy, legal and administrative framework for environmental management. The broad objectives of the national environmental policy in Kenya are: -

- To ensure optimal use of natural resources while improving environmental quality;
- To conserve natural resources such that the resources meet the needs of the present without jeopardizing future generations in enjoying the same;
- To develop awareness that inculcates environmental stewardship among the citizenship of the country;
- To integrate environmental conservation and socio-economic aspects in the development process;
- To ensure that national environmental goals contribute to international obligations on environmental management and social integrity.

To achieve the above policy objectives, it is a policy directive that appropriate reviews and evaluations of all forms of developmental project plans and operations are carried out to ensure compliance with the environmental policy and legal frameworks. The following section provides details on the relevant policies to this proposed project.

4.2.1 Environment and Development (Sessional Paper No. 6 of 1999)

The Kenya's policy paper on the Environment and Development was formulated in 1999. The policy defined approaches that will be pursued by the Government in mainstreaming environment into development. The policy harmonized environmental and developmental objectives with the broad goal of achieving sustainable development. The policy paper also provided guidelines and strategies for government action regarding environment and development. About wildlife, the policy reemphasized government's commitment towards involving local communities and other stakeholders in wildlife conservation and management, as well as developing mechanisms that allow them to benefit from the natural resources occurring in their areas. The policy also advocated for the establishment of zones that allow for the multiple use and management of wildlife.

This policy is relevant to the proposed project in view of the potential impacts on the environment and involvement of the public in project planning.

4.2.2 National Environmental Policy, 2014

The National Environmental Policy is an outcome of the Sessional Paper No. 10 of 2014. The overall goal of the policy is better quality of life for present and future generations through sustainable management and use of the environment and natural resources. One of the objectives of the policy is to promote and support research and capacity development as well as use of innovative environmental management tools such as Environmental Impact Assessments (EIAs) and Environmental Audits that is necessary to ensure environmental quality and resource productivity on long term basis.

The policy among other important objectives calls for promotion of domestication, coordination and maximization of benefits from Strategic Multilateral Environmental Agreements (MEAs). The policy further calls for integration of environmental concerns into development policies, plans and activities.

The National Environmental Policy proposes a broad range of measures and actions responding to key environmental issues and challenges. It seeks to provide the framework for an integrated approach to planning and sustainable management of natural resources in the country. It recognizes the various vulnerable ecosystems and proposes various policy measures not only to mainstream sound environmental management practices in all sectors of society throughout the country but also recommends strong institutional and governance measures to support the achievement of the desired objectives and goal.

Relevance

The policy requires that projects such as this one, which are likely to have significant environmental and social impacts should be undertaken with sound environmental management plan.

4.2.3 The Kenya National Biodiversity Strategy and Action Plan 2019-2030

The National Biodiversity Strategy and Action Plan (NBSAP) was formulated to enable Kenya address national and international commitments defined in Article 6 of the Convention on Biological Diversity (CBD). The strategy is a national framework of action for ensuring that the present rate of biodiversity loss is reversed, and present levels of biological resources are maintained at sustainable levels for posterity. The general objectives of the strategy are to conserve Kenya's biodiversity; to sustainably use its components; to share the benefits arising fairly and equitably from the utilization of biological resources among the stakeholders; and to enhance technical and scientific cooperation nationally and internationally, including the exchange of information in support of biological conservation.

Relevance:

The proposed project shall comply with the requirements of this strategy since the project may lead to minimal loss of biodiversity in some of alternative sites identified for location of the proposed geothermal drilling project.

4.2.4 Kenya Vision 2030

The Vision 2030 is based on 3 key pillars; Economic Pillar, Social Pillar, and Political Pillar. The economic, social and political pillars of Kenya Vision 2030 are anchored on the following foundations: macroeconomic stability; continuity in governance reforms; enhanced equity and wealth creation opportunities for the poor; infrastructure; energy; science, technology and innovation, land reform; human resources development; security and public-sector reforms. According to the vision, the country aims at enhancing and diversifying national power generation and supply by identifying new generation and supply sources through exploitation of geothermal power, coal, renewable energy sources, and connecting Kenya to energy-surplus countries in the region.

In terms of environment, one of the aims is to make Kenya to be a nation that has a clean, secure and sustainable environment by 2030. This will be achieved through promoting environmental conservation for better support the economic pillar flagship projects.

Relevance

Geothermal energy has been identified as one of the sources of energy that would substantially address the prevailing energy deficit. The proposed development is thus in line with sector specific objectives in vision 2030. This ESIA study report is one of the tools geared towards ensuring the project is undertaken in a sustainable manner with proper management of any resultant wastes.

4.2.5 National Land Policy 2023

The Land Policy in Kenya is guided by the environmental management principles which are aimed at restoring the environmental integrity through introduction of incentives and encouragement of use of technology and scientific methods for soil conservation, among others. The policy further requires fragile ecosystems to be managed and protected by developing a comprehensive land use policy bearing in mind the needs of the surrounding communities. The policy also requires zoning of catchment areas to protect them from degradation and establishment of participatory mechanisms for sustainable management of fragile ecosystems.

The policy also called for development of procedures for co-management and rehabilitation of forest resources while recognizing traditional management systems and sharing of benefits with contiguous communities and individuals. Lastly, all national parks, game reserves, islands, front row beaches and all areas hosting fragile biodiversity are declared as fragile ecosystems under the policy.

The policy recognizes that sustainable management of land based natural resources depends largely on the governance system that defines the relationships between people, and between people and resources. To achieve an integrated approach to management of land-based natural resources, all policies, regulations, and laws dealing with these resources need to be harmonized with the framework established by the Environmental Management and Coordination Act (EMCA), 1999

The policy also addresses land management on ecosystem protection (including wetlands). Measures for protection are required for fragile ecosystems. The policy also calls for the protection of watersheds, lakes, drainage basins and wetlands. The policy prohibits settlement and agricultural activities in water catchment areas and calls for identification, delineation and gazettement of all water courses and wetlands.

In compliance with this, the proponent shall ensure sustainable management of land based natural resources at the proposed site.

4.2.6 Physical Planning Policy

The current policy governs the development and approval all building plans as provided for in the Physical Planning Act (Cap 286) of 2009. The proposed project will be subjected to the provisions of this policy and legislation.

4.2.7 HIV/AIDS Policy of 2009

The policy identifies HIV/AIDS as a global crisis that constitutes one of the most formidable challenges to development and social progress. The Pandemic heavily affects the Kenyan economy through loss of skilled and experienced manpower due to deaths, loss of man hours due to prolonged illnesses, absenteeism, reduced performance, increased stress, stigma, discrimination, and loss of institutional memories, among others.

Relevance:

The proposed project shall involve a mobile and concentrated workforce, often working for extended periods. Workers may be at higher risk of engaging in risky behaviors due to isolation, limited recreation, or separation from families.

The proponent shall create HIV/AIDS awareness among staff, provide condoms in dispensers and discourage against any form of discrimination against any would be HIV/AIDS patient.

4.2.8 Gender Policy of 2011

The purpose of the Gender Policy is to institutionalize The Kenya National Policy on Gender and Development (NPGD), within Gender, Children and Social Development. It articulates the policy approach of gender mainstreaming and empowerment of women at the ministry level.

Relevance:

The proponent shall provide equal employment opportunities to both gender and discourage any form of discrimination based on gender.

4.2.9 The Kenya National Climate Change Response Strategy of 2010

This strategy provides measures that the Government of Kenya is taking to address issues related to the impact of climate change on various sectors of the economy. The proposed geothermal drilling project has taken into consideration the effects of changing climate in the country and apply climate change mitigation measures.

Relevance:

The ESIA study includes climate risk assessment and mitigate against climate change.

4.3 National Environmental Legal and Regulatory Framework

The Republic of Kenya has numerous statutes that guides environmental management and conservation. Most of these statutes are sector specific and cover a wide range of issues including public health, soil conservation, protected areas conservation, endangered species, public participation, water rights, water quality, air quality, excessive noise control, vibration control, land use, among others.

The relevant legislations are described in Table 13: Relevant National Environmental Legislations and Regulations below.

4.3.1 Relevant National Environmental Legislations and Regulations

Table 13: Relevant National Environmental Legislations and Regulations

No.	Legislation / Regulations	Provisions	Relevance	Compliance
1.	The Constitution of Kenya 2010	The Constitution of Kenya has taken on-board various issues that are related to environmental management. Article 42 of the Bill of Rights contained in the Constitution provides that <i>‘every Kenyan has the right to a clean and healthy environment, which includes the right to have the environment protected for the benefit of present and future generations through legislative and other measures.</i> Chapter 5 of the Constitution is dedicated to land and the environment. The constitution requires that land be used and managed in a manner that is equitable, efficient, productive and sustainable. Part 2 of Chapter 5 of the constitution is dedicated to Environment and Natural Resources. Article 69 in Part 2 provides that the state shall provide encourages efforts towards sustainable of natural resources, increasing of the national forest cover public participation in the management, protection and conservation of the environment, protection of genetic resources and biodiversity, environmental impact assessment, environmental audit and monitoring of the environment, etc.	<i>The proposed project should ensure compliance with the constitutional requirements in as far as equitable sharing of the resources between various stakeholders is concerned on matters of sustainability of livelihoods and biological resources, public participation, Resettlement Action Plan among others.</i>	This Study is aimed at ensuring compliance to the Kenyan Constitution.
2.	The Environment Management and Coordination (EMCA), 1999(Revised 2015)	• The legislation advocates for environmental protection during project implementation and restoration of impacted environment. • Section 58, subsection 1 – Requires that before a project is executed, an EIA Report must be prepared and submitted to the Authority (NEMA) in a prescribed form. ▪ Subsection (7); EIA shall be conducted in accordance with the EIA regulations, guidelines and procedures issued under the EMCA. ▪ EMCA Part V Section 50 - The Authority shall, in consultation with the relevant lead agencies (including Ministry of Wildlife & Tourism KWS) prescribe measures necessary to ensure the conservation of biological diversity in Kenya.	This project has been included in schedule of Projects requiring submission of an Environmental Impact Assessment Study report in the Environmental Management and Coordination (Amendment) Act,	The execution of an ESIA Study in compliance with regulations has been commissioned. The ESIA Report has provided an Environmental and Social

No.	Legislation / Regulations	Provisions	Relevance	Compliance
		• EMCA, Section 72, 74,75, and 76 deals with water pollution, and prohibition and license to discharge effluent • EMCA, Section 91 and 94 deals with the classification of wastes, handling and their management • EMCA, Section 107 provides standards for the control of noxious smell • EMCA, Part XIII, Section 142 (1) says that any Person who– ▪ Discharges any dangerous materials, substances, oil, oil mixtures into land, water, air or aquatic environment. ▪ Pollutes the environment. ▪ Discharges any pollutant into the environment Commits an offence and shall on conviction, be liable to a fine not less than two million shillings.	2015; this Project fits under category 4 (e) (Drilling for the purpose of utilizing ground water resources including geothermal energy). Moreover, the project falls under High Risk category 10 (b) (geothermal development) in the Second Schedule of the Environment (Impact Assessment and Audit) (Amendment) Regulations, 2016, which requires for the project to be subjected to an ESIA Study prior to its implementation.	Management Plan (ESMP) that will be followed by GDC to mitigate identified project impacts and implement monitoring activities.

No.	Legislation / Regulations	Provisions	Relevance	Compliance
	(a)The Environment (Impact Assessment and Audit) Regulations, 2003	• The Regulation provides the guidelines that have been established to govern the conduct of environmental assessments and environmental audits in Kenya. • The legislation provides guidance on project impact categorization into low, medium and high risks and implementation of appropriate environmental and social impact assessments. • Section 4 (1) says no proponent shall implement a project that (a) is likely to have a negative environmental impact; or (b) for which an environmental impact assessment is required under the Act or these Regulations unless an environmental impact assessment has been concluded and approved in accordance with these Regulations, • Part III describes the ESIA Study Process, Part IV describes the contents of an ESIA Study Report and Part V elaborates on environmental audit and monitoring. • The regulations provide guidelines on preparation of EIA Project Report • The EMCA, Cap 387 requires that during the EIA process a proponent shall in consultation with the Authority seek views of persons who may be affected by the project or activity through posters, newspaper, radio and public meetings with the affected parties and communities.	GDC had already obtained EIA licenses or the geothermal drilling and has made an application for water abstraction licence in line with these local regulations. • Once commissioned , GDC will also be expected to carry out Environmental audit of the project annually and submit the environmental audit report to NEMA.	This Study is aimed at ensuring compliance of these regulations and is an update of ESIA study report of 2013 the study has collected information on project design, the relevant baseline data, conducted an elaborate public consultation process and created an Environmental and Social Management Plan (ESMP) and a monitoring plan (ESMMP) that if implemented will ensure conservation and

No.	Legislation / Regulations	Provisions	Relevance	Compliance
				protection of environment and improved livelihoods. The study envisages annual environmental audits by the proponent.
	(b) Environmental Management and Co-ordination (Water Quality) Regulations, 2024	- The Regulations observe that, every person shall refrain from any act which directly or indirectly causes, or may cause immediate or subsequent water pollution, and it shall be immaterial whether the water resource was polluted before the enactment of the Act. It further observes that, no person shall throw or cause to flow into or near a water resource any liquid, solid or gaseous substance or deposit any such substance in or near it, as to cause pollution. It goes on to state that, no person shall: - Discharge, any effluent from sewage treatment works, industry or other point sources into the aquatic environment without a valid effluent discharge license issued in accordance with the provisions of the Act. - Abstract ground water or carry out any activity near any lakes, rivers, streams, springs and wells that is likely to have any adverse impact on the quantity and quality of the water, without an Environmental Impact Assessment license issued in accordance with the provisions of the Act; or - Cultivate or undertake any development activity within a minimum of six meters and a maximum of thirty meters from the highest ever recorded flood level, on either side of a river or stream, and as may be determined by the Authority from time to time.	Strict adherence to these Regulations during the project implementation will ensure compliance to the standards for effluent discharge and sources.	GDC shall obtain water abstraction permit from Water Resources Authority. -Contractor vehicles shall be serviced in authorised motor vehicle garages to avoid oil spills in the project area which might be washed away by water runoff to nearby streams. -The contractor shall avoid motor vehicles crossing

No.	Legislation / Regulations	Provisions	Relevance	Compliance
				rivers and streams from undesignated points to only use existing bridges or designated crossing points.
	(c) Environmental Management and Co-ordination (Waste management) Regulations, 2024	- This Regulation define rules for the management of waste in general and for the management of solid waste, industrial waste, hazardous waste, pesticides and toxic substances, biomedical waste and radioactive substances in particular. - The regulation observes that; - No person shall dispose of any waste on a public highway, street, road, recreational area or in any public place except in a designated waste receptacle. - Any person whose activities generate waste shall collect, segregate and dispose or cause to be disposed of such waste in the manner provided for under these Regulations. - Without prejudice to the foregoing, any person whose activities generates waste has an obligation to ensure that such waste is transferred to a person who is licensed to transport and dispose of such waste in a designated waste disposal facility. - Any person whose activities generate waste, shall segregate such waste by separating hazardous waste from non-hazardous waste and shall dispose of such wastes in such facility as is provided for by the relevant Local Authority. - Any person who owns or controls a facility or premises which generates waste shall minimize the waste generated by adopting the cleaner production principles.	The proposed project activities have the potential of generating effluent, and solid wastes. The wastes generated from the activities have the potential of contaminating the immediate ground surfaces and atmosphere; thus, need for strict adherence to these Regulations in dealing with all the wastes and handling of waste streams.	The contractor shall: -Provide waste receptacles for collecting waste and shall ensure waste is segregated. -Contract a NEMA registered waste transporter to collect and dispose of waste at designated sites -Ensure updated waste tracking documents are

No.	Legislation / Regulations	Provisions	Relevance	Compliance
				maintained for collected waste. -Implement sustainable waste management principles of reduction, reuse and recycling. -Provide mobile toilets for construction workers to manage human waste. -Sensitize construction workers on best waste management practices
	(d) Environmental Management and Co-ordination (Noise and Excessive	- The regulations observe that, except as otherwise provided in the 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. - In determining whether noise is loud, unreasonable, unnecessary, or unusual, the following factors may be considered: - Time of the day.	The noise permissible limits shall guide noise management at the project site and related activities.	GDC shall they: - -Provide ear protection (earmuffs and ear plug) to employees working in areas with high noise

No.	Legislation / Regulations	Provisions	Relevance	Compliance
	Vibration Pollution Control) Regulations, 2009	▪ Proximity to residential area. ▪ Whether the noise is recurrent, intermittent or constant. ▪ The level and intensity of the noise. ▪ Whether the noise has been enhanced in level or range by any type of electronic or mechanical means; and, ▪ Whether the noise is subject to be controlled without unreasonable effort or expense to the person making the noise. • These regulations also relate noise to its vibration effects and seek to ensure that the level of noise causes no harmful vibrations. Any person(s) intending to undertake activities in which noise is suspected to be injurious or endangers the comfort, repose, health or safety of others and the environment, must make an application to NEMA and acquire a license		levels. -Ensure machines and equipment are dully serviced and inspected to reduce noise emission. -Sensitizes drivers against unnecessary hooting and vehicle idling. -Conduct periodic noise and vibration measurements to ensure they are within the require threshold.
	(e) Environmental Management and Co-ordination (Air Quality) Regulations,	• The objective of these Regulations is to provide for the prevention, control and abatement of air pollution to ensure clean and healthy ambient air. The regulations observe that. 1. No person shall- a. Act in a way that directly or indirectly causes, or is likely to cause immediate or subsequent air pollution; or b. Emit any liquid, solid or gaseous substance or deposit any such substance in levels exceeding those set out in the First Schedule.	The emissions generated from geothermal drilling have the potential of polluting the immediate atmospheric environment; thus,	GDC shall: -Regularly service vehicles, gensets and other equipment to reduce gaseous emissions. -Regularly

No.	Legislation / Regulations	Provisions	Relevance	Compliance
	2024	c. No person shall cause emission of the priority air pollutants prescribed in the Second Schedule to exceed the ambient air quality limits prescribed in the First Schedule. 2. No person shall cause emission of the priority air pollutants prescribed in the Second Schedule to exceed the ambient air quality limits prescribed in the First Schedule. 3. No person shall cause the Ambient Air Quality levels specified in the First Schedule of these Regulations to be exceeded. 4. No person shall cause or allow particulate emissions into the atmosphere from any facility listed under the Fourth Schedule to these Regulations in excess of those limits stipulated under the Third Schedule. 5. Any person, being an owner of premises, who causes or allows the generation, from any source, of any odour which unreasonably interferes, or is likely to unreasonably interfere, with any other person's lawful use or enjoyment of his property shall use recognized good practices and procedures to reduce such odours to a level determined by the odour panel, including any guidelines published by the Authority for reducing odours.	need for strict adherence to these Regulations and standards therein in dealing with all the pollutants and handling of sources. Analysis of gaseous releases from the project area indicates dominant composition of H₂S. The Ambient Air Quality tolerance limit set by the regulations for H₂S is 150µg/m³ (0.1ppm) based on 24hrs average period. At the property boundary, the limit is set at 50µg/m³ (0.03ppm).	sprinkle water in dusty sections to suppress dust emission. -Provides dust masks to workers working in dust prone sections.
	(f) Environmental Management and Coordination	The regulations states that: 1. A person shall not engage in any activity that may- a. have an adverse impact on any ecosystem. b. lead to the introduction of any exotic species. c. lead to unsustainable use of natural resources, Without an Environmental Impact Assessment License issued by NEMA.	The project will lead to cutting down of vegetation to pave way for drilling activities Hells Gate – Longonot National	GDC commissioned this ESIA study for the proposed project that has identified the baseline

No.	Legislation / Regulations	Provisions	Relevance	Compliance
	(Conservation of Biological Diversity and Resources, Access to Genetic Resources, and Benefit Sharing) Regulations, 2006.		Park and Lake Naivasha plus the surrounding natural habitats are gazetted as a National Parks and as a Ramsar Site (that is a wetland of international importance) declared on 10 April 1995.	conditions of the ecosystems and formulated a plan for their protection and conservation.
3.	The Occupational Safety and Health Act, No. 15 of 2007	• This is an Act of Parliament to provide for the safety, health and welfare of workers and all persons lawfully present at workplaces, to provide for the establishment of the National Council for Occupational Safety and Health and for connected purposes. Of importance to the proposed project are: • Registration of workplaces • Health General Provisions (including cleanliness, overcrowding, ventilation, lighting, drainage of floors, and sanitary conveniences) • Safety General Provisions (including ladders, ergonomics at the workplace, Fire prevention, safety provisions in case of fire, evacuation procedures) • Welfare General Provisions (including supply of drinking water, washing facilities, accommodation for clothing, facilities for sitting, and first aid) • Prevents employment of children in workplaces where their safety and health is at risk. • Encourages entrepreneurs to set achievable safety targets for their enterprises.	-Now that preparatory activities for drilling are ongoing, the proponent should ensure that a certificate of registration as a workplace is obtained from Narok/ Kajiado County DOSHS offices and subsequent safety and health audits are conducted accordingly.	GDC shall ensure that: -The site (s) are dully registered with DOSH as workplaces -Health and safety committees are constituted and dully trained - Statutory inspection of all equipment is done

No.	Legislation / Regulations	Provisions	Relevance	Compliance
		- Promotes reporting of work-place accidents, dangerous occurrences and ill health with a view to finding out their causes and preventing of similar occurrences in future. - Promotes creation of a safety culture at workplaces through education and training in occupational safety and health. - Provision of safety gear (PPE) where hazards are anticipated.	-Various drilling and construction plant/equipment requiring inspection by the authority in line with this Act shall also be expected to undergo regular inspection toward ensuring workers safety. The drilling sites for the proposed project will be places of work with workers. The workplaces will have occupational hazards and risks that could result to injuries to workers.	-Statutory trainings are conducted -All workers/visitors are provided with appropriate PPE -Workers are covered by an insurance in case of work-related injuries/illness -Fully equipped first aid kit and trained first aider are available on site always -Firefighting equipment have been provided -Material Safety Data Sheets are maintained on site -Accidents, incidents and near misses are

No.	Legislation / Regulations	Provisions	Relevance	Compliance
				documented -Accident investigations are conducted -Tool box talks are held daily
4.	The Work Injury Benefits Act, 2007	This Act provides for compensation to employees for work related injuries and disease contracted in the course of their employment and for connected purposes. Key sections of the Act include the obligations of employers; right to compensation; reporting of accidents; compensation; occupational diseases; medical aid etc.	-The workers face several risks to their health, safety and security from the equipment they use daily. The WIBA offers the legal assistance on these incidents or accidents at the workplace while on duty involving compensation. The proposed activities should therefore integrate the relevant provisions while the project takes place. GDC shall require appointed contractors to undertake relevant insurance covers	GDC and the Contractor shall ensure that; -Workers are covered by an insurance policy for work related injuries -Accidents, incidents and near misses are documented Accident investigations are conducted -Workers undergo induction before employment and medical examination

No.	Legislation / Regulations	Provisions	Relevance	Compliance
			against work related risks to cover all the employees engaged.	
5.	The Energy Act 2019	- This is 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. - Section 7-8 of this Act states that it the obligation of the government to provide energy in all areas of the country and promote energy investments. - Section 117 states “any person who wishes to carry out generation, exportation, importation, transmission, distribution and retail supply of electricity, must apply for a license from the Authority” - The Act also established the Energy and Petroleum Regulatory Authority (EPRA) whose mandate is to regulate all functions and players in the Energy sector. One of the duties of the EPRA is to ensure compliance with Environmental, Health and Safety Standards in the Energy Sector, as empowered by Section 98 of the Energy Act, 2006. In this respect, the following environmental issues will be considered before approval is granted: - The need to protect and manage the environment, and conserve natural resources. - The ability to operate in a manner designated to protect the health and safety of the project employees, the local and other potentially affected communities. - Section 27 and 28 under this Act requires that an application be made before the transmission and supply of bulk energy. Licensing and authorization to generate	-Drilling activities by GDC shall be subject to regulation by EPRA and may be subject to the proceedings and judgements / orders by the Energy and Petroleum Tribunal as per the requirements of the Act. -GDC and appointed contractors shall also be expected to seek a permit for bulk fuel storage on site from EPRA. The proposed project is an energy investment project that aims to drill geothermal. GDC is a player in the energy sector and	-The proponent has an operation licence from EPRA; -The proponent has commissioned an ESIA study for the proposed project; -The proponent will be required to implement the ESMP and ESMMP developed and any other conditions that may be issued by NEMA.

No.	Legislation / Regulations	Provisions	Relevance	Compliance
		and transmit electrical power must be supported by an Environmental Impact Assessment (EIA) Report approved by NEMA. - Article 177 gives obligation to the transmission licensee to make compensation to the owner or occupier of any land or the agents, workmen or servants of the owner or occupier of any land which is the subject of the provisions of the Act, for damage or loss caused by the exercise or use of any power or authority conferred by this Act or by any irregularity, trespass or other wrongful proceeding in the execution of this Act or by the loss or damage or breaking of any energy infrastructure or by reason of any defect in such infrastructure. - Article 179, gives the Cabinet Secretary for Energy Authority for compulsory acquisition of land for purposes of constructing, modifying or operating any energy infrastructure or for incidental purposes where reasonable attempts to acquire the land had failed	regulated by EPRA	
6	The Wildlife Conservation and Management Act No. 47 of 2013 (Revised 2014)	This is an Act of Parliament to provide for the protection, conservation, sustainable use and management of wildlife in Kenya. Section 19 elaborates on the functions of the County Wildlife Conservation and Compensation Committees that includes undertaking education, extension services and public awareness. Section 26(1) stipulates that the provisions of this Act with respect to conservation, protection and management of the environment shall be in conformity with the provisions of the Environmental Management and Coordination Act, CAP 387. Section 28 says that Water Act shall apply without exception. Section 29 emphasizes requirement for Sustainable use of land. Section 30 prohibits any activity which is likely to have adverse effects on the environment, including the seepage of toxic waste into streams, rivers, lakes and wetlands. Section 31 provides for declaration of protected areas by the Cabinet Secretary. Section 46 provides for Protection of endangered and threatened ecosystems. Section 47 provides for listing of endangered and threatened species and amendment of the list from time to time. Section 89 provides offences	- Any critically endangered, vulnerable, nearly threatened or protected species found within the project area will have to be managed in line with this Act -The geothermal drilling project is not located in a designated National Park or National Reserve. The project is located	In as much the project is not close or within a protected zone, the contractor shall: -Prohibit his workers from poaching/hunting of wildlife and shall charge violators in a court of law. -Ensure no invasive species

No.	Legislation / Regulations	Provisions	Relevance	Compliance
		relating to pollution of designated wildlife areas and section 92 provides offences relating to endangered and threatened species. • Subject to section 45 (1) No person shall mine or quarry in a national park without the approval and consent of Kenya Wildlife Service (KWS). Where this is approved an EIA license shall be mandatory. Section 89 (1) provides that any person who: - • discharges any hazardous substances or waste or oil into a designated wildlife area contrary to the provisions of this Act and any other written law; • pollutes wildlife habitats and ecosystems; • discharges any pollutant detrimental to wildlife into a designated wildlife conservation area contrary to the provisions of this Act or any other written law, commits an offence and shall be liable upon conviction to a fine of not less than two million shillings or to imprisonment of not less than five years or to both such fine and imprisonment. Section 93 stipulates that any person who: - • knowingly introduces an invasive species into a wildlife conservation area; or • Fails to comply with the measures prescribed by the Cabinet Secretary set out under this Act, commits an offence and shall be liable upon conviction to a fine of not less than three hundred thousand shillings or to imprisonment of not less than one year or to both such fine and imprisonment.	within the Mt. Suswa Conservancy area and in neighbourhood of Hells gate – Longonot –Akiira plains ecosystem. The Proponent shall therefore implement the proposed measures in this document towards protection and conservation of wildlife in the area.	is introduced into the wildlife habitats -Avoid discharging any waste, oil, or any other pollutant into the wildlife habitats -Schedule drilling activities to avoid breeding and nesting seasons for any critically endangered or endangered wildlife species. -Impose speed limits in the wildlife areas and on highways where wildlife concentration is high -Liaise with KWS while working in wildlife habitats.

No.	Legislation / Regulations	Provisions	Relevance	Compliance
7	Forest Conservation and Management Act No. 34 of 2016	- An Act of Parliament to give effect to Article 69 of the Constitution with regard to forest resources; to provide for the development and sustainable management, including conservation and rational utilization of all forest resources for the socioeconomic development of the country and for connected purposes. The Act applies to all forests on public, community and private lands. - According to section 3, the Act shall apply to all forests on public, community and private lands. Section 4 give the principles of this Act as: - good governance in accordance with Article 10 of the Constitution. - public participation and community involvement in the management of forests. - consultation and co-operation between the national and county governments. - Section 21 outlines the forestry functions of County Governments. Each County Government: - shall manage all forests on public land defined under Article 62(2) of the Constitution. - shall promote afforestation activities in the county. - shall advice and assist communities and individuals in the management of community forests or private forests. - may enter into joint management agreements with communities or individuals for the management of community forests or private forests. As per section 42all indigenous forests and woodlands shall be managed on a sustainable basis for purposes of: - conservation of water, soil and biodiversity. - riparian and shoreline protection. - cultural use and heritage. Section 44 avers that - Where the Service is satisfied that utilization of a public forest can be done through	The project will not be located within a gazetted forest; this act is therefore not triggered by the proposed project.	Act is not triggered But the contractor shall avoid sourcing material or dumping waste in forests

No.	Legislation / Regulations	Provisions	Relevance	Compliance
		the granting of a concession, the Service shall grant the concession subject to the provisions of the Constitution, this Act and any other relevant written law. - The Service shall not recommend any such proposal unless: the proposal has been subjected to an independent environmental impact assessment; and public consultation in accordance with the Second Schedule has been undertaken and completed. - According to section 64 (1), except under a license or permit or a management agreement issued or entered into under this Act, no person shall, in a public or provisional forest fell, cut, take, burn, injure or remove any forest produce. - Section 75. No. 9 of 1999 to apply (1) where a provision of this Act requires a person to conserve or protect the environment, the relevant provisions of the Environmental Management and Co-ordination Act, 1999, shall also apply with respect to the manner in which the conservation or protection shall proceed.(3) A user or other related right shall not be granted under this Act where the requirement for a strategic environmental, cultural, economic and social impact assessment license under the Environmental Management and Co-ordination Act, Cap 387, has not been complied with.		
8	National Land Commission Act, 2012	- An Act of Parliament to make further provision as to the functions and powers of the National Land Commission, qualifications and procedures for appointments to the Commission; to give effect to the objects and principles of devolved government in land management and administration, and for connected purposes. Sections 5 outlines the functions of the Commission while section 6 gives the powers of the commission. - The Commission can initiate investigations into present or historical land injustices, recommend appropriate redress, monitor and have oversight responsibilities over land use planning throughout the country.	The Commission will be key in ensuring that the geothermal drilling site is acquired/leased in accordance with the law.	GDC will comply with Act's provisions.
9	Land Act	An Act of Parliament to give effect to Article 68 of the Constitution, to revise,	The act guides the	The GDC have

No.	Legislation / Regulations	Provisions	Relevance	Compliance
	2012(Revised 2019)	consolidate and rationalize land laws; to provide for the sustainable administration and management of land and land-based resources, and for connected purposes 19. (1) The Commission shall make rules and regulations for the sustainable conservation of land based natural resources. - Section 107 (7) Says for the purposes of sections 110 to 143, interested, persons shall include any person whose interests appear in the land registry and the spouse or spouses of any such person, as well as any person actually occupying the land and the spouse or spouses of such person. - Section 126. Says if the Commission is satisfied that any land of which the occupation or use has been secured under this Part is needed solely as a means of access to other land, then— (b) the compensation to be paid under section 120 shall be limited to the damage done to trees, plants, growing crops and permanent improvements on the land, together with a periodical sum for diminution in the profits of the land and of adjoining land by reason of that use.	land acquisition and compensation process.	commissioned LACLRP to guide on this process of Land acquisition and compensation.
10	Water Act No. 43 of 2016	- An Act of Parliament to provide for the regulation, management and development of water resources, water and sewerage service, and for other connected purposes. This Act provides for the regulation, management and development of water resources and water and sewerage services in line with the Constitution. Authorities shall, in administering or applying this Act, be guided by the principles and values set out in Articles 10, 43, 60, and 232 of the Constitution. It establishes the Water Resources Authority ("Authority"), the National Water Harvesting and Storage Authority, the Water Services Regulatory Board, the Water Sector Trust Fund and the Water Tribunal. Section 36 provides that a permit is required for any of the following purposes. Any use of water from a water resource, except as provided by section 37. - The drainage of any swamp or other land.	WRA will have to issue an authorization for water abstraction from Kikuyian dam. In the installation and operation of geothermal drilling project these regulations and their provision on water pollution management shall be taken into consideration and	-The contractor shall be prohibited to abstract water from water resources without a permit abstraction permit from Water Resources Authority. -The Contractor shall create

No.	Legislation / Regulations	Provisions	Relevance	Compliance
		- The discharge of a pollutant into any water resource; and - Any other purpose, to be carried out in or in relation to a water resource, which is prescribed by Regulations made under this Act. - Section 143. A person shall not, without authority conferred under this Act (a) wilfully obstruct, interfere with, divert or obstruct water from any watercourse or any water resource, or negligently allow any such obstruction, interference, diversion or abstraction; or (b) throw, convey, cause or permit to be thrown or conveyed, any rubbish, dirt, refuse, effluent, trade waste or other offensive matter or thing into or near to any water resource in such manner as to cause, or be likely to cause, pollution of the water resource. - Section 144. (1) Without prejudice to any other remedy or course of action, if a person contravenes any provision under this Act, then, the Authority, the Regulatory Board, the county government executive concerned or the licensee concerned may, by order served on the person concerned, require that person within a reasonable time specified in the order to remedy the contravention and in particular (a) to clean up any pollution or make good any other harm identified in the order which was caused to any water resource by reason of the contravention	closely monitored.	awareness among workers on water resource conservation.
11	The Physical Planning and Land Use Act 2019	An Act of Parliament to provide for the preparation and implementation of physical development plans and for connected purposes. The Act provides for implementation of regulated development through preparation of physical development plans while considering potential environmental impacts. Section 30 states that any person who carries out development without development permission will be required to restore the land to its original condition. Section 31 states,” (1) Any person requiring a development permission shall make an application in the form prescribed in the Fourth Schedule, to the clerk of the local authority responsible for the area in which the land concerned is situated”. Section 36 states “If in connection with a development application a local	The project proponent will be required to discuss its development plans with the Kajiado/ Narok County Physical Planning Officers and seek the requisite approvals. For control of future	GDC shall apply for development permission and share project designs with Kajiado/ Narok physical planning departments to ensure it does not affect

No.	Legislation / Regulations	Provisions	Relevance	Compliance
		authority is of the opinion that proposals for industrial location, dumping sites, sewerage treatment, quarries or any other development activity will have injurious impact on the environment, the applicant shall be required to submit together with the application an environmental impact assessment report”.	development around the site, the County government shall enforce this law to ensure compatible land uses only. The Proponent shall secure all mandatory approvals and permits as required by the law.	physical planning designs in the proposed project areas.
12	Employment Act No 11 of 2007 (Amendment 2022)	• An Act of Parliament to repeal the Employment Act, declare and define the fundamental rights of employees, to provide basic conditions of employment of employees, to regulate employment of children, and to provide for matters connected with the foregoing. • 4(1) No person shall use or assist any other person in recruiting, trafficking or using forced labour. • • 5(3) No employer shall discriminate directly or indirectly, against an employee or prospective employee or harass an employee or prospective employee— (a) on grounds of race, colour, sex, language, religion, political or other opinion, nationality, ethnic or social origin, disability, pregnancy, mental status or HIV status; (b) in respect of recruitment, training, promotion, terms and conditions of employment, termination of employment or other matters arising out of the employment.	Proponent and any Contractor will need to understand all the requirements of the Act during employment such as ensuring that employees are of the right age, they have entitlement to leave, protection from discrimination and sexual harassment among others. There will be employment	-The proponent shall not use forced labour during project implementation. -The proponent shall ensure there is no form of discrimination against any worker during construction phase of the project. -Sexual

No.	Legislation / Regulations	Provisions	Relevance	Compliance
		- Section 6 of the act prohibits any form of sexual harassment at the workplace. 53 (1) Notwithstanding any provision of any written law, no person shall employ a child in any activity which constitutes worst form of child labour.	opportunities for skilled, unskilled and semiskilled people during construction and operation phases of the proposed project.	harassment will be strongly prohibited and will be chargeable in a court of law. -The contractor shall not use child labour (workers below 18 years).
13	HIV and AIDS Prevention and Control Act No. 14 of 2006 Revised in 2012	- The Act provides for measures for the prevention, management and control of HIV and AIDS, to provide for the protection and promotion of public health and for the appropriate treatment, counselling, support and care of persons infected or at risk of HIV and AIDS infection. 7 (1) The Government shall ensure the provision of basic information and instruction on HIV and AIDS prevention and control to— (a) employees of all Government Ministries, Departments, authorities and other agencies; and (b) employees of private and informal sectors. 31 (1) Subject to subsection (2), no person shall be— (a) denied access to any employment for which he is qualified; or (b) transferred, denied promotion or have his employment terminated, on the grounds only of his actual, perceived or suspected HIV status.	GDC will be required to institute awareness and prevention plan through service providers approved by the local public health departments. -Risk of spread of HIV/AIDS and other STIs will be high during drilling because of an influx of people from different areas.	-GDC shall ensure that the contractor conducts HIV/AIDS awareness campaigns and provides condoms for workers. -The contractor shall be directed not to discriminate any worker at the workplace based on their HIV

No.	Legislation / Regulations	Provisions	Relevance	Compliance
				status.
14	Public Health Act, Cap 242	- This Act aims to protect public health in Kenya and outlines guidelines in regard to food hygiene and protection of foodstuffs, animal keeping, public water supply, prevention and destruction of mosquitos, and the abatement of nuisances including nuisances arising from sewerage - Section 115 states that no person shall cause a nuisance or shall suffer to exist on any land or premises owned or occupied by him or of which he is in charge any nuisance or other condition liable to be injurious or dangerous to health	GDC and its service providers for the drilling works will be required to construct toilets for use by workers and visitors to the site of the project. Sufficient latrines will also be required should there be any staff quarters within the site. The Proponent shall observe its provisions and implement measures to safeguard public health and safety.	The contractor shall: Provide waste receptacles for collecting waste; --Contract a NEMA licensed waste handler to collect and dispose of waste; - -Provide mobile toilets for workers. -Not discharge any form of pollutant into water resources.
15	The Climate Change Act, 2016	This is an Act to provide for a regulatory framework for enhanced response to climate change; to provide for mechanism and measures to achieve low carbon climate development. Section 3 stipulates in part, that the national and county governments shall promote low carbon technologies, improve efficiency and reduce emissions intensity by facilitating approaches and uptake of technologies that support low carbon, and climate resilient development. According to section 15 of the Act, each state department and national government public entity shall	During drilling, the vehicles and machines to be used may contribute to additional GHG emissions.	The contractor shall: - -Service machines and equipment to reduce emission of gases

No.	Legislation / Regulations	Provisions	Relevance	Compliance
		among others; integrate the climate change action plan into sectoral strategies, action plans and other implementation projections for the assigned legislative and policy functions and report on sectoral greenhouse gas emissions for the national inventory.	However, the overall aim of the project is to facilitate exploration and generation of geothermal energy which is considered environmentally friendly. Operation of equipment, vehicles and use of certain materials during construction and operation phases of the project has potential to emit greenhouse gases that contribute towards climate change. Burning of waste on site may contribute towards greenhouse gas emission. logging or cutting down of trees will reducing the existing carbon sink	-Create awareness on reducing idling of vehicles and equipment. -Avoid burning of materials on site. -Ensure selective vegetation clearing

No.	Legislation / Regulations	Provisions	Relevance	Compliance
16	National Gender and Equality Commission Act, 2011	An Act of Parliament to establish the National Gender and Equality Commission as a successor to the Kenya National Human Rights and Equality Commission pursuant to Article 59(4) of the Constitution; to provide for the membership, powers and functions of the Commission, and for connected purposes. Key to this act is the affirmative action, popularly known as the Two-thirds gender rule, which requires not more than two-thirds of people who hold public office be from the same gender.	GDC will need to employ people of different gender.	GDC shall ensure it complies with the a third (1/3) rule of either gender in employment of staff.
17	The Valuers Act cap 532	- The Act Cap makes provisions for the relevant charges and conducts of valuers in relation to valuation of assets. - The Act also provides the relevant regulations and guidelines in the undertaking of the valuation works.	The project requires land valuation for due compensation to project effected persons	The GDC have commissioned LACLRP alongside to guide on this process of Land acquisition and compensation. Valuation shall be carried out to meet the actual compensation measures and the market rates and reduce any acts of malice in the exercise.
18	County Government Act No. 17	The County Government Act is intended to provide powers, functions and responsibilities to deliver services to the Counties under the devolved	The County governments are	Project plans will be taken to

No.	Legislation / Regulations	Provisions	Relevance	Compliance
	of 2012 Revised 2017	government. - As per section 3 the object and purpose of this Act is to (h) prescribe mechanisms to protect minorities within counties pursuant to Article 197 of the Constitution. - Section 34 says that, the county executive committee shall exercise the executive authority (e) while ensuring the protection and promotion of the interests and rights of minorities and marginalized communities. - Section 94 observes that, a County government shall use the media to (c) undertake advocacy on core development issues such as agriculture, education, health, security, economics, sustainable environment among others. - Section 104 (2) avers that, the county planning framework shall integrate economic, physical, social, environmental and spatial planning. - As per section 110. (2), the spatial plan, which shall be spatial development framework for the county, shall (c) contain strategies and policies regarding the manner in which the strategies and policies shall (vi) contain a strategic assessment of the environmental impact of the spatial development framework. - Section 115. (1) observes that, Public participation in the county planning processes shall be mandatory and be facilitated through (b) provision to the public of clear and unambiguous information on any matter under consideration in the planning process, including— ➤ clear strategic environmental assessments. ➤ clear environmental impact assessment reports;	mandated to manage some environmental and health matters in their jurisdiction including control of air, noise and other public nuisances and through various licensing activities. The Project is within the County Governs of Kajiado and Narok	county governments of Kajiado/ Narok for approval. Project shall comply with all County Government of Kajiado's and Narok's by-laws.
19	Agriculture and Food Authority Act, No. 13 of 2013	- The Act provides for governance on land classification, land use and preservation. - Section 21. Land Development Guidelines (1) The Cabinet Secretary shall, on the advice of the Authority, and in consultation with the National Land Commission, provide general guidelines, in this Act referred to as land development guidelines,	The land is used for grazing hence directly affected.	Project proponent undertakes to abide by the requirements of

No.	Legislation / Regulations	Provisions	Relevance	Compliance
	Revised 2015	applicable in respect of any category of agricultural land to the owners or the occupiers thereof. • Section 23. Land preservation guidelines • (1) The Cabinet Secretary, on the advice of the Authority, and in consultation with the National Land Commission, for the purposes of the conservation of the soil, or the prevention of the adverse effects of soil erosion on, any land, may, prescribe national guidelines for any or all of the following matters: (a) prohibiting, regulating or controlling the undertaking of any agricultural activity including the firing, clearing or destruction of vegetation when such prohibiting, regulating or controlling is deemed by the Cabinet Secretary to be necessary for the protection of land against degradation, the protection of water catchment areas or otherwise, for the preservation of the soil and its fertility; (b) requiring, regulating or controlling: ➤ the afforestation or re-afforestation of land. ➤ the drainage of land, including the construction, maintenance or repair of drains, gullies, contour banks, terraces and diversion ditches. ➤ salination, acidification and saltification of soil. (c) requiring the uprooting or destruction, without payment of any compensation therefore, of any vegetation which has been planted in contravention of a land preservation order. • Section 32. Land preservation orders A county government may make a land preservation order against the owner or occupier of land, or against both the owner and occupier either at the same time or at different times.		the developed guidelines touching on type of development, prevention of adverse effects and following preservation orders issued by County Government.
20	The Sexual Offences Act, 2006 and its amendment	• The Act of Parliament makes provision about sexual offences, their definition, prevention and the protection of all persons from harm from unlawful sexual acts, and for connected purposes. • The Act gives prominence on observing a standard work ethic to ensure all	GDC and its service providers will have a workforce that need to observe the provisions of this Act.	GDC and its service providers shall develop and enforce a sexual harassment

No.	Legislation / Regulations	Provisions	Relevance	Compliance
	2012	genders are not subjected to sexual offences. The Act lists a number of sexual offences for compliance		policy
21	The Environment and Land Court Act, 2012	- The Environment and Land Court Act, 2012 (Kenya) plays a crucial role in providing legal and institutional framework for resolving disputes and enforcing environmental and land laws. - PART III – JURISDICTION OF THE COURT 13. Jurisdiction of the Court (1) The Court shall have original and appellate jurisdiction to hear and determine all disputes in accordance with Article 162(2)(b) of the Constitution and with the provisions of this Act or any other law applicable in Kenya relating to environment and land. (2) In exercise of its jurisdiction under Article 162(2)(b) of the Constitution, the Court shall have power to hear and determine disputes— (a) relating to environmental planning and protection, climate issues, and use planning, title, tenure, boundaries, rates, rents, valuations, mining, minerals and other natural resources; (b) relating to compulsory acquisition of land; (c) relating to land administration and management; (d) relating to public, private and community land and contracts, choses in action or other instruments granting any enforceable interests in land; and (e) any other dispute relating to environment and land.	Proposed project activities may lead to rise to disputes over land ownership, compensation for compulsory land acquisition, or environmental degradation, which falls under the ELC's authority	GDC shall; - Ensure due process in any land acquisition, especially in community or trust lands. -Engage in consultations with landowners and communities, and obtain written consents or compensation agreements. -Submit a comprehensive EIA report as required by the EMCA, which the Environment and Land Court may refer to in case of dispute.

No.	Legislation / Regulations	Provisions	Relevance	Compliance
				-Address any concerns raised by stakeholders during public participation. -Implement mitigation measures for noise, emissions, land degradation, and water use. -Respect community rights, especially for indigenous or marginalized groups.
22	Traffic Act	Traffic Act (Cap 403) supports the safe and lawful transport and logistics operations which is also essential to the proposed project since it will involve transport of machinery and construction materials. The Act regulates the use of public roads by construction vehicles to prevent obstruction, road damage and hazards to other road users. It ensures proper signage and traffic management during construction related disruptions.	The proposed project activities shall involve the transportation and use of vehicles/heavy machinery and different materials	GDC shall ensure; -All vehicles used in the project have valid logbooks, insurance, and road licenses. -Any heavy

No.	Legislation / Regulations	Provisions	Relevance	Compliance
				machinery transported by road must have special transport permits if they exceed normal size or weight limits. -Employ only qualified and licensed drivers for all project vehicles, including for specialized equipment. -Obtain special transit permits from the relevant road authorities for any abnormal loads. -Enforce speed limits and safe parking practices on public and internal roads. -Implement

No.	Legislation / Regulations	Provisions	Relevance	Compliance
				internal traffic management plans at project sites to avoid accidents and congestion.
23	The Penal Code, Cap 63	This is crucial to preventing and addressing any criminal offenses that may arise during project planning, construction, and operation. The Penal Code covers a wide range of offenses including corruption, property damage, public safety, and environmental harm. Section 191 indicates that any person who unlawfully or negligently does any act which is, and which he knows or has reason to believe to be, likely to spread the infection of any disease dangerous to life, is guilty of a misdemeanour.	The project will produce waste both solid, liquid and gaseous which if not well mitigated or disposed off can pollute water sources which may trigger criminal liability for responsible individuals.	GDC shall; -Implement measures to minimize noise, emissions, and discharge through environmental controls. -Engage communities early to reduce complaints or unrest during operations.
24	The National Museums and Heritage Act (2006)	This is crucial in protecting cultural, historical, and archaeological heritage. The Act governs the conservation of sites and objects of historical or cultural significance and is enforced by the National Museums of Kenya (NMK).	The proposed project is located in areas occupied by indigenous Maa community which may have cultural, historical and	GDC shall; -Engage local communities to understand and protect sacred sites, burial

No.	Legislation / Regulations	Provisions	Relevance	Compliance
			archeological sites.	grounds, or cultural practices. - Obtain necessary permits before any intrusive or development activity. -Incorporate cultural values in the social impact assessment component of the project.
25	National Construction Authority Act, 2011	The Act provides that civil works such as drilling pad construction, power plant foundations, pipelines, and access roads must be undertaken by NCA-registered contractors. It further provides that Infrastructure such as control buildings, worker camps, water storage tanks, and access roads must meet NCA-regulated design, quality, and safety standards.	The proposed project shall involve significant construction activities—including site preparation, civil works, infrastructure development, and installation of heavy equipment. The Act regulates the construction industry to ensure safety, quality, and	GDC shall; -Submit a Project Registration Form to the NCA. -Verify any contractors, subcontractors, engineers, and architects to ensure valid NCA registration.

No.	Legislation / Regulations	Provisions	Relevance	Compliance
			compliance with national standards.	-Follow approved structural designs and building codes. -Ensure construction quality is maintained throughout the project lifecycle -Maintain records of materials used, construction progress, safety audits, and incident logs. -Address any compliance issues or corrective actions as directed by NCA.
26	Community Land Act, 2016	The Act provides a legal framework governing how community land is managed, accessed, and utilized. It provides for the recognition, protection and registration of community land rights; management and administration of community land; to provide for the role of county governments in relation to unregistered community land and for connected purposes	The proposed project will be located in a pastoralist or rural areas where land is held communally. The project requires a	GDC shall; -Confirm land status (public, private, community)

No.	Legislation / Regulations	Provisions	Relevance	Compliance
			long-term access to land for exploration, drilling pads, pipelines, and other power generation infrastructure, making proper compliance with this law crucial. The Act directly affects land access, acquisition, and benefit-sharing processes.	through official records. -Negotiate access or lease through willing-seller agreements or community consent -Draft a land lease agreement specifying the purpose, size, duration, compensation, and conditions and register the lease with the Registrar of Lands. -Negotiate and pay any compensation (monetary or in-kind) to affected persons or communities before project commencement.

No.	Legislation / Regulations	Provisions	Relevance	Compliance
				-Obtain relevant land use approvals or change-of-user permits.
27	The Labour Relations Act 2007	• The Act governs the rights, duties, and mechanisms for resolving disputes between employers and employees. It is a foundational law ensuring fair labor practices, collective bargaining, and industrial harmony. • PART IX on Adjudication of Disputes • Section 73. (1) If a trade dispute is not resolved after conciliation, a party to the dispute may refer it to the Industrial Court in accordance with the rules of the Industrial Court.	The project shall employ both skilled and unskilled labour force during different phases of the project.	GDC shall; -Avoid unfair labor practices such as intimidation or discrimination of any form. -Ensure non-discriminatory hiring, fair wages, safe working conditions, and lawful termination procedures. -Ensure labour policies reflects equality and equity, especially for marginalized groups such as women and persons with

No.	Legislation / Regulations	Provisions	Relevance	Compliance
				disabilities - Put in place grievance redress mechanisms.
28	Building Code	- The Building Code provides a set of regulations governing the design, construction, alteration, and maintenance of buildings across the country. - It ensures structural safety, functional use, and environmental sustainability in building practices.	The project shall involve construction of buildings and civil structures e.g. drill pads, control rooms, storage facilities, access roads, worker camps, and power plants. These components must comply with Kenya's Building Code, which outlines minimum standards for construction safety, design, materials, and occupancy.	GDC shall ensure that: -All constructions are designed by registered professionals (architects and engineers). -All building plans are submitted to and get approved by the relevant County Government or National Construction Authority (NCA). -Construction are supervised by certified engineers and architects, ensuring

No.	Legislation / Regulations	Provisions	Relevance	Compliance
				compliance with structural integrity standards. -All materials used are in compliance with KEBS. -The project maintains high workmanship standards for durability and safety

4.4 Institutional and Administrative Framework

The EMCA Act, 1999(Revised 2015) established several institutions for the management of the Environment in Kenya. The Apex is the parent ministry which is currently the ministry of Environment, Water and Natural Resources. Below the ministry is the National Environment Council. These key institutions and government departments are responsible for the environmental protection and natural resource management in Kenya; they are the key stakeholders in the project implementation.

4.4.1 Ministry of Environment, Climate Change and Forestry.

The mandate of the ministry is to monitor, protect, conserve, and manage the environment and natural resources through sustainable exploitation for socio-economic development aimed at eradication of poverty, improving living standards and ensuring that a clean environment is sustained now and in the future. The ministry comprises of various divisions at the headquarters and the following parastatals and departments.

- National Environment Management Authority
- Kenya Meteorological Department
- Mines and Geology Department
- Department of Resource Surveys and Remote Sensing (DRSRS)

The functions of the ministry include but not limited to the following:

- Environment and Natural Resources Policy formulation, analysis and review
- Sustainable management of Mineral resources and conservation of environment
- Continuous development of geo-database for integrated natural resources and environmental management systems
- Promote, monitor and coordinate environmental activities and enforce compliance of environmental regulations and guidelines.

4.4.2 National Environment Management Authority (NEMA)

National Environment Management Authority (NEMA) is the institution with the legal authority to exercise general supervision and coordination over all matters relating to the environment. It is the principal instrument of the government charged with the implementation of all policies relating to the environment. NEMA's functions are more particularly set out in section 9(2) of the EMCA Cap 387.

According to section 68 of the environmental management and coordination Act (EMCA) 1999(Revised 2015), The Authority shall be responsible for carrying out environmental audits on all activities that are likely to have a significant effect on the environment.

Environmental Auditing (EA) is a tool for environmental conservation and has been identified as a key requirement for existing facilities to ensure sustainable operations with respect to environmental resources and socio-economic activities in the neighborhood of the facilities.

The government has established regulations to facilitate the process on Environmental Impact Assessments and Audits. The regulations are contained in the Kenya Gazette Supplement No. 56, legislative supplement No. 31; legal notice No. 101 of 13th June 2003.

The authority core functions are:

- Coordinating the various environmental management activities being undertaken by the lead agencies

- Promote the integration of environmental considerations into development policies, plans, programs, and projects, with a view to ensuring the proper management and rational utilization of environmental resources, on sustainable yield basis, for the improvement of the quality of human life in Kenya.
- To take stock of the natural resources in Kenya and their utilization and conservation.
- Carry out surveys, which will assist in the proper management and conservation of the environment.
- Advise the Government on legislative and other measures for the management of the environment or the implementation of relevant international conventions, treaties and agreements.
- Undertake and coordinate research, investigation and surveys, collect, collate and disseminate information on the findings of such research, investigations or surveys.
- Mobilize and monitor the use of financial and human resources for environmental management.
- Identify projects and programs for which environmental audit or environmental monitoring must be conducted under this Act.
- Initiate and evolve procedures and safeguards for the prevention of accidents, which may cause environmental degradation and evolve remedial measures where accidents occur e.g. floods, landslides and oil spills.
- Monitor and assess activities, including activities being carried out by relevant lead agencies, to ensure that the environment is not degraded by such activities. Management objectives must be adhered to and adequate early warning on impending environmental emergencies is given.

4.4.3 The National Environmental Complaints Committee

The Act (EMCA) has also established a National Environmental Complaints Committee, which provides the administrative mechanism for addressing environmental harm. The Committee has the mandate to investigate complaints relating to environmental damage and degradation. Its members include representatives from the Law Society of Kenya, NGOs and the business community.

4.5 Environmental Related Permits and Licenses

Table 14 below lists the environment-related permits required in the Project.

Table 14: Licenses, Permits and Approvals for Exploration Drilling

Index	Regulatory Body	Applicable Statute	Requirement	Responsibility
1.	The State Department for Energy	Energy Act, 2019	Geothermal Resources License	GDC
2.	Water Resources Authority (WRA)	Water Act, 2016	Water Abstraction Permit	GDC
3.	National Environment Management Authority (NEMA)	EMCA, 1999	EIA License	GDC
4.	County Government	The Narok County Finance Act, 2023	Single Business Permit	GDC & Contracted 3 rd Parties
5.	Directorate of Occupational safety and Health Services (DOSHS)	Occupational Safety and Health Act, 2007	Certificate of Workplace Registration for the rig site and camp site	GDC & Contracted 3 rd Parties
6.	Kenya National Highways Authority (KeNHA)	The Kenya Roads (Kenya National Highways Authority) Regulations -Legal Notice No. 86 of 2013.	Permit for transportation of abnormal loads	GDC or 3 rd party contracted to transport the rig from Menengai to Mt. Suswa and back.
7.	Communications Authority of Kenya (CAK)	The Kenya Information and Communications Act CAP. 411A	Radio communication licence (Walkie talkies for the rig sites)	GDC and contracted 3 rd party security service provider.
8.	County Government of Narok/Kajiado and NEMA	The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009	Noise Permit for heavy industry (well discharge tests)	GDC
9.	The National Transport and Safety Authority (NTSA)	The Traffic Act CAP. 403	Driving licenses for the company vehicles.	GDC and contracted 3 rd Parties
10.	NEMA	The Environmental Management and Coordination (Water Quality)	Effluent discharge license for the case of biodigester.	GDC

Index	Regulatory Body	Applicable Statute	Requirement	Responsibility
		Regulations, 2024		
11.	Narok/Kajiado County Government	OSHA, 2007	Fire Safety Compliance Certificate for the staff camp and rig site.	GDC
12.	Narok/Kajiado County Government	Public Health Act, Cap 242	Health Clearance Certificate for the staff camp.	GDC
13.	NEMA	Environmental Management and Coordination (Air Quality) Regulations, 2024	Air Emission License for power generators rated 80 kVA and above.	GDC
14.	EPRA	Energy Act, 2019	License to Import, Export and Wholesale of Petroleum Products (Except LPG)	3 rd Party Fuel Supplier for the rig power generators.
15.	EPRA	Energy Act, 2019	License to transport petroleum products (except LPG) by road.	3 rd party fuel transporter or GDC if the company has mobile fuel tankers.
16.	NEMA	Environmental Management and Coordination (Waste Management) Regulations, 2024	License to own and operate incinerator	3 rd party contracted to collect hazardous waste from the rig sites for offsite incineration.
17.	NEMA	Environmental Management and Coordination (Waste Management) Regulations, 2024	License to own and operate waste oil recycling facility.	3 rd party contracted to collect waste oil from the rig sites for recycling.
18.	NEMA	Environmental Management and Coordination (Waste Management) Regulations, 2024	License to transport non-hazardous waste.	3 rd party contracted to transport non-hazardous waste from the rig sites for offsite disposal at approved county government dump sites.
19.	NEMA	Environmental Management and Coordination (Waste Management) Regulations, 2024	License to transport hazardous waste	3 rd party contracted to transport hazardous waste from the rig sites for offsite incineration.
20.	Scrap Metal Council	Scrap Metal Act, 2015	Scrap Metal License	3 rd party contracted to dispose scrap materials from the rig sites.
21.	County Government of Narok/ Kajiado	The Food, Drugs and Chemical Substances Act	License to prepare food, pack and store at the camp site.	Contracted 3 rd Party Camp Service Provider

Index	Regulatory Body	Applicable Statute	Requirement	Responsibility
		(Food Hygiene Regulations) 1978 (cap 254)		
22.	County Government of Narok/ Kajiado	Public Health Act, Cap 242	Certificate of good health for food handlers	Contracted 3rd Party Camp Service Provider
23.	NCA	National Construction Authority Act, No.41 of 2011	Licenses for contractors undertaking building works, civil engineering, electrical engineering services and mechanical engineering services.	3 rd party contracted to undertake building works, civil engineering, electrical engineering services or mechanical engineering services.
24.	EPRA	Energy Act, 2019	License for electrical installations	GDC employees undertaking electrical installations or 3 rd party electrical contractors.
25.	Pest Control Products Board	The Pest Control Products (Licensing of Premises) (Amendment) Regulations, 2006	License to operate any business in pest control	3 rd party contracted to undertake fumigation of the rig and camp sites.

4.6 World Bank's Environmental and Social Standards (ESS)

The World Bank Environmental and Social Framework sets out the global benchmark on international best practise on environmental and social safeguard policies.

Table 15 below are some of the key standards of consideration for the proposed project.

Table 15: WB Environmental and Social Standards

Standard	Provisions	Trigger Mechanism
ESS1: Assessment and Management of Environmental and Social Risks and Impacts	The ESS outlines the need to undertake Environmental and Social Assessments for such a project proportionate to its level environmental and Social risks It sets out Environmental and Social Impact Assessment as one the key tools in undertaking Environmental and Social Assessment to identify potential projects impacts and develop enhancement and mitigation measures for the positive and negative impacts, respectively.	With the magnitude of the proposed project, it is prudent to undertake an Environmental and Social Impact Assessment.
ESS2: Labour and Working Conditions	ESS recognizes the importance of employment creation and income generation in the pursuit of poverty reduction and inclusive economic growth. The ESS's prime objective is promote safe and healthy working environment while promoting equity at workplace through, while preventing any form of forced labour. Promotes Occupational Health and Safety as a key precursor to a sustainable project implementation.	The project will employ staff and workers useful for its implementation and will be receiving visitors. All these stakeholders are bound to a safe and healthy environment.
ESS3: Resource Efficiency and Pollution Prevention and Management;	The ESS sets out the requirements to address resource efficiency and pollution prevention and management throughout the project life cycle. The ESS is vital in undertaking for environmental and social assessment sine natural resources are finite and form an important part of any project. Pollution has a direct bearing on sustainable performance of any project hence prevention / minimization of pollution (through generation of hazardous and non-hazardous waste) is key.	The project will make use of natural resources that are finite in nature in its implementation hence the essence for compliance with the provisions of the ESS.
ESS4: Community	The ESS recognizes that project activities, equipment, and infrastructure can increase	The project set-up is within a community and

Standard	Provisions	Trigger Mechanism
Health and Safety	community exposure to risks and impacts. In addition, communities that are already subjected to impacts from climate change may also experience an acceleration or intensification of impacts due to project activities. Key to this ESS is to avoid or minimize adverse health and safety project impacts to the communities, while having in place effective measures to address emergency events. The ESS requires that proponents identify risks and impacts of the project on the health and safety of the affected communities during the project life cycle, including those who, because of their circumstances, may be vulnerable.	there will obvious interaction between the project and community on matters transport, material sourcing, etc.
ESS5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement	The ESS recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons. Project-related land acquisition or restrictions on land use may cause physical displacement (relocation, loss of residential land or loss of shelter), economic displacement (loss of land, assets or access to assets, leading to loss of income sources or other means of livelihood), or both. The ESS indicates that “involuntary resettlement” refers to these impacts. Resettlement is considered involuntary when affected persons or communities do not have the right to refuse land acquisition or restrictions on land use that result in displacement.	The geothermal drilling project land has been leased by GDC from the original owner.
ESS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	The ESS recognizes that protecting and conserving biodiversity and sustainably managing living natural resources are fundamental to sustainable development. Among its primary objectives, the ESS seeks to conserve biodiversity and habitats while mitigation hierarchy and the precautionary	The site has a number of indigenous trees which shall not be cut unless it is a must. The ones cut will be compensated and measures put in place to replace the cut ones

Standard	Provisions	Trigger Mechanism
	approach in the design and implementation of projects that could have an impact on biodiversity. The ESS applies to projects that involve primary production and/or harvesting of living natural resources.	through an afforestation programme.
ESS10: Stakeholder Engagement and Information Disclosure	ESS recognizes Effective (open and transparent) stakeholder engagement can improve the environmental and social sustainability of projects, enhance project acceptance, and make a significant contribution to successful project design and implementation.	In achieving the objectives of ESS 1, ESS10 is integral in the engagement and creating partnerships with the project stakeholders.

4.7 IFC Performance Standards on Environmental and Social Sustainability

The International Finance Corporation's (IFC) Environmental and Social Performance Standards define IFC clients' responsibilities for managing their environmental and social risks. The 2012 edition of IFC's Sustainability Framework includes Performance Standards (PSs).

The PSs that may be relevant to the project are described in **Table 16** below.

Table 16: IFC Performance standards

PS	Performance Standard	Relevance to Geothermal	Remarks
PS1	Assessment and Management of Environmental and Social Risks and Impacts.	Ensures that geothermal drilling projects conduct thorough Environmental and Social Impact Assessments (ESIA), identify potential risks, and develop appropriate mitigation measures.	<i>Applicable</i> There are Environmental and Social risks that will arise during drilling of wells
PS 2	Labour and Working Conditions	Focuses on worker health and safety, ensuring proper labor conditions, and addressing concerns related to working with hazardous materials like hydrogen sulphide.	<i>Applicable</i> The project is going to employ skilled and unskilled workers to offer services in the project and their welfare will need to be taken care of.
PS 3	Resource Efficiency and Pollution Prevention	Ensures resource efficiency (e.g., water, energy) and proper waste management (e.g., drilling mud, chemical disposal), and air pollution prevention from geothermal emissions.	<i>Applicable</i> There are project activities like maintenance of vehicles and machines, fugitive dust and exhaust emissions that have the potential to cause pollution.

PS	Performance Standard	Relevance to Geothermal	Remarks
PS 4	Community Health, Safety, and Security	Focuses on community health and safety, including managing emissions (e.g., H ₂ S), ensuring local safety protocols, and establishing emergency response plans for potential accidents.	<i>Applicable</i> Community members will be employed in the project. Project vehicles will also be transporting drilling equipment, materials and waste outside the site exposing community members to safety risks
PS 5	Land Acquisition and Involuntary Resettlement	Ensures that land acquisition processes are fair and transparent, and that communities are not involuntarily displaced due to geothermal drilling operations. Measures for livelihood restoration are included.	<i>Applicable</i> PS5 recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land.
PS 6	Biodiversity Conservation and Sustainable Management of Living Natural Resources	Addresses impact on local biodiversity and ecosystems, especially in sensitive areas, and ensures sustainable management of natural resources (e.g., water bodies, local habitats).	<i>Applicable</i> PS6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development.
PS 7	Indigenous Peoples	Ensures that Indigenous Peoples' rights and cultures are respected during geothermal drilling projects. Free, Prior, and Informed Consent (FPIC) is required for projects that affect indigenous territories or practices.	<i>Applicable</i> Maasai are regarded indigenous peoples
PS 8	Cultural Heritage	Ensures that any cultural or archaeological sites near the drilling area are identified and preserved, respecting the cultural heritage of local communities during operations.	<i>Applicable</i> Before drilling, survey for any archaeological or cultural sites to avoid disturbance.

4.7.1 Environmental, Health, and Safety Guidelines

1. General Guidelines

The World Bank's General Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project based on the results of the environmental assessment. The General EHS Guidelines cover the following topics: Environmental, Occupational Health and Safety, Community Health and Safety, and Construction and Decommissioning.

2. Geothermal Power Generation Guidelines

The World Bank's Environmental, Health, and Safety Guidelines for Geothermal Power Generation provides specific recommendations for management of EHS issues associated with geothermal power generation (IFC and World Bank Group 2007b). The guidelines were designed to be used in tandem with Environmental, Health, and Safety General Guidelines, which provides guidance on common EHS issues for all industry sectors. Although this project does not include power generation, the guidelines provide recommendations for management of drillings fluids and cuttings, air emissions (i.e., H₂S), solid waste, well blowouts and pipeline failures, and water consumption and extraction. The guidelines also specify worker protection requirements for confined spaces, heat, noise, and infrastructure safety.

4.8 Multilateral Environmental Agreements

4.8.1 The KfW Development Bank Sustainability Guidelines/Standards 2014

The KfW Development Bank provides a set of sustainability guidelines/standards to be adhered to in development projects, including geothermal drilling projects. These guidelines ensure that projects are aligned with international environmental and social standards. **Table 17** below shows the KfW Development Bank Sustainability Guidelines/Standards (2014) as they apply to a geothermal drilling project.

Table 17: KfW Development Bank Guidelines

Area of Concern	Sustainability Guidelines/Standards	Applicable to Geothermal Drilling Project
Environmental Impact	Environmental Impact Assessment (EIA): Projects must be preceded by a comprehensive EIA, which includes the identification of potential environmental impacts and the development of mitigation measures.	An EIA must be conducted for geothermal drilling to assess impacts on local ecosystems, water, and air quality. Mitigation measures should be implemented to address identified environmental risks such as soil erosion, water contamination, and seismic risks.
Biodiversity Protection	Biodiversity and Ecosystem Protection: Projects should avoid adverse impacts on biodiversity, particularly in sensitive or protected areas.	The geothermal drilling project must assess and protect local biodiversity. Special measures may be needed to prevent the degradation of habitats or disruption of sensitive ecosystems in the area.
Land and Resource Use	Sustainable Land Use and Resource Management: Land acquisition must follow sustainable practices and proper compensation for any displaced communities.	The project must adhere to land acquisition protocols and compensation plans for any displaced communities. Land use should avoid unnecessary deforestation or resource depletion.
Water Management	Water Use and Conservation: Efficient water use and management are crucial, especially in water-scarce areas. Potential impacts on local water bodies must be minimized.	The geothermal drilling project must monitor water use for cooling and steam production, ensuring it does not deplete local water resources or affect water quality. Water treatment plans should be implemented to minimize contamination.

Area of Concern	Sustainability Guidelines/Standards	Applicable to Geothermal Drilling Project
Health and Safety	Health, Safety, and Labour Conditions: The project must adhere to international labour standards, including health and safety regulations for workers and local communities.	Geothermal drilling must adhere to strict health and safety standards for workers, including handling hazardous materials and maintaining proper safety protocols during drilling activities.
Climate Change	Climate Impact Mitigation: Projects should contribute to climate change mitigation through reduced greenhouse gas emissions.	Geothermal drilling is considered a renewable energy source that contributes to climate change mitigation by producing clean energy and reducing dependence on fossil fuels.
Waste Management	Waste Management and Pollution Prevention: Ensure that waste from the project (e.g., drilling mud, chemicals) is properly managed to prevent contamination of soil and water.	Proper disposal or treatment of waste generated during drilling activities, including hazardous waste, must be in place to avoid pollution.
Community Engagement	Community Consultation and Stakeholder Engagement: Ensure affected communities are consulted and engaged in the decision-making process.	Engage local communities and stakeholders in discussions about the geothermal drilling project's impacts and benefits. Transparent communication and active involvement can mitigate social unrest and opposition.
Cultural Heritage	Cultural Heritage Protection: Avoid or mitigate adverse impacts on cultural heritage sites, traditions, and local communities' way of life.	The drilling project must consider and respect any local cultural heritage sites, ensuring that these are protected from damage or disturbance.
Monitoring and Compliance	Monitoring, Reporting, and Compliance: Regular monitoring and reporting must be conducted to ensure compliance with environmental, social, and safety standards.	Continuous monitoring of environmental and social impacts during and after drilling operations must be done to ensure adherence to agreed standards and mitigation measures. Reports should be submitted to relevant authorities.

4.8.2 International Conventions

Table 18 below is a list of key international conventions that are applicable to geothermal drilling projects:

Table 18: International Conventions

Convention	Description	Relevance to Geothermal Drilling Projects
Paris Agreement (2015)	An international treaty on climate change aiming to limit global warming to well below 2°C above pre-industrial levels.	Geothermal energy is a low-carbon alternative to fossil fuels, and drilling projects must align with

Convention	Description	Relevance to Geothermal Drilling Projects
		global climate change mitigation efforts, including carbon footprint reduction.
Convention on Biological Diversity (CBD)	A treaty aimed at conserving biodiversity and promoting sustainable use of natural resources.	Geothermal drilling projects must assess and minimize impacts on local ecosystems and biodiversity, especially when drilling in ecologically sensitive areas.
United Nations Framework Convention on Climate Change (UNFCCC)	International treaty focusing on stabilizing greenhouse gas concentrations to prevent dangerous human interference with the climate system.	Geothermal drilling contributes to renewable energy generation and must align with efforts to reduce emissions, contributing to the UNFCCC goals of climate action.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Regulates international trade in endangered species and their products.	Geothermal projects must consider impacts on endangered species in the area and ensure that drilling operations do not affect habitats of such species or violate trade regulations.
International Labour Organization (ILO) Conventions	A set of conventions aimed at improving labor standards globally.	Geothermal drilling projects must ensure workers' rights and safety are protected, including fair wages, safe working conditions, and adherence to international labor standards.
Stockholm Convention on Persistent Organic Pollutants (POPs)	A treaty aiming to eliminate or restrict the production and use of persistent organic pollutants.	Geothermal drilling operations must ensure that no harmful pollutants are released into the environment, especially during fluid injection or waste disposal.
World Heritage Convention (1972)	Protects the cultural and natural heritage of global significance.	Geothermal drilling projects must consider potential impacts on UNESCO World Heritage Sites or culturally significant areas and ensure they are not adversely affected.
Minamata Convention on Mercury (2013)	A global treaty aiming to protect human health and the environment from mercury exposure.	Geothermal drilling projects that involve the use of or exposure to mercury (in some geothermal systems) must manage mercury pollution and ensure it does not affect local populations.
Convention on Conservation of	This convention was signed in Bonn in June 1979 and entered into force on November 1,	The project area is situated close to Mt. Suswa Conservancy. This

Convention	Description	Relevance to Geothermal Drilling Projects
Migratory Species of Wild Animals	1983. It covers the protection of migratory species and their habitats and is the only global convention established exclusively for the conservation and management of migratory species. It is also concerned with wild animals that migrate across or outside national jurisdictional boundaries.	Convention should therefore be considered in the course of the project, and where applicable, best practices should be followed on the safe and appropriate handling of migratory species of wild animals.

4.8.3 Sustainable Development Goals (SDGs)

The Sustainable Development Goals (SDGs) set by the United Nations aim to address global challenges such as poverty, inequality, climate change, environmental degradation, and peace. Geothermal drilling projects align with several of these goals, as they contribute to sustainable energy production, environmental protection, and socioeconomic development. **Table 19** below shows a list of SDGs that are particularly relevant to geothermal drilling projects:

Table 19: Sustainable Development Goals

SDG	Relevant Goal	Relevance to Geothermal Drilling Projects
SDG 3	Good Health and Well-being	Geothermal energy can reduce air pollution from traditional fossil fuels, leading to improved air quality and public health, especially in local communities.
SDG 6	Clean Water and Sanitation	Proper management of water resources is crucial in geothermal projects, as they often require water for cooling or steam generation. Geothermal projects should ensure water conservation and quality protection.
SDG 7	Affordable and Clean Energy	Geothermal energy is a renewable, low-carbon energy source, contributing to affordable, reliable, and sustainable energy for communities and industries.
SDG 8	Decent Work and Economic Growth	Geothermal projects create jobs, stimulate local economies, and enhance the manufacturing and energy sectors, contributing to sustainable economic growth.
SDG 12	Responsible Consumption and Production	Geothermal projects promote the sustainable use of natural resources and encourage the efficient, low-impact extraction of energy resources.
SDG 13	Climate Action	Geothermal energy plays a role in mitigating climate change by reducing reliance on fossil fuels, decreasing greenhouse gas emissions, and supporting low-carbon development.
SDG 14	Life Below Water	In coastal or offshore geothermal projects,

SDG	Relevant Goal	Relevance to Geothermal Drilling Projects
		ensuring that geothermal activities do not harm marine ecosystems and water quality is essential to maintaining biodiversity and ecosystem health.
SDG 15	Life on Land	Geothermal drilling projects must take measures to protect ecosystems and biodiversity, particularly when drilling in sensitive or protected areas.
SDG 17	Partnerships for the Goals	Collaboration with local communities, government agencies, international bodies, and private sectors is key to ensuring the success of geothermal projects, fostering sustainable development.

4.9 International Environmental Guidelines.

In addition, Kenya is a signatory to several international treaties and conventions and is therefore bound by international guidelines governing the development of geothermal resources. These frameworks are intended to promote environmental sustainability, social responsibility, and regulatory compliance.

The Suswa Geothermal Drilling Project demonstrates compliance with the requirements of the International Geothermal Association (IGA) through the adoption of internationally recognized best practices in geothermal exploration, drilling, and sustainability. National standards, including KS:2365:2012, are integrated into the project's design and implementation, ensuring alignment with Kenya's regulatory framework. Furthermore, drilling equipment and wellhead systems conform to ISO 10423:2022 (KS ISO 10423:2025) and applicable American Petroleum Institute (API) standards, thereby ensuring operational performance, safety, and interoperability consistent with globally accepted practices in both the oil and gas and geothermal sectors.

Those that are relevant to the proposed Suswa geothermal drilling project include:

4.9.1 IFC Environmental, Health, and Safety Guidelines for Geothermal Power Generation

These guidelines are designed to be used together with the relevant Industry Sector EHS Guidelines which provide guidance to users on EHS issues. The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs.

Applicable provisions of the IFC's General Environmental, Health and Safety Guidelines, including the following:

1. Environment

- Section 1.1 Air Emissions and Ambient Air Quality
- Section 1.3 Wastewater and Ambient Water Quality
- Section 1.6 Waste Management
- Section 1.7 Noise

2. Occupational Health and Safety

- Section 2.1 General Facility Design and Operation

- Section 2.2 Communication and Training
- Section 2.3 Physical Hazards
- Section 2.4 Chemical Hazards
- Section 2.7 Personal Protective Equipment
- Section 2.9 Monitoring

3. Community Health and Safety

- Section 3.1 Water Quality and Availability
- Section 3.2 Structural Safety of Project Infrastructure
- Section 3.4 Traffic Safety
- Section 3.7 Emergency Preparedness and Response

4. Construction and Decommissioning

- Section 4.1 Environment
- Section 4.2 Occupational Health and Safety
- Section 4.3 Community Health and Safety

4.9.2 IFC-IGA Geothermal Exploration Best Practices

The practices cover the preliminary survey, as well as the geological, geophysical, and geochemical surveys and provide guidance on the survey tools to use for different types of geothermal systems. By following such best practices, developers can reduce early-stage project risk by more accurately locating and characterizing geothermal resources prior to drilling.

4.9.3 IFC's Environmental, Health and Safety Guidelines for Hazardous Materials

These guidelines are designed to be used together with the relevant Sector EHS Guidelines for hazardous material. The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs.

CHAPTER 5.0 ESIA APPROACH AND METHODOLOGY

5.1 Introduction

This chapter outlines the approach and methodology adopted in conducting the ESIA in identifying, predicting, and evaluating the potential environmental and social impacts associated with the project's activities throughout its lifecycle—from site preparation, exploratory drilling and decommissioning. It also provides methodology for conducting noise/vibration, water, soil, air and biodiversity surveys.

The ESIA was undertaken at a level that was considered to be commensurate with the scale, complexity and sensitivity of the project. The Team of Experts as indicated in Table 1 above were involved in ESIA Studies. Stakeholders were involved through the following processes;

- Pre-survey visit/ Reconnaissance and desktop study on the 31st October 2024 to 1st November 2024;
- One on one meetings with key informants, Questionnaire administration to KIIs, Public barazas and Focus group discussion were done between 25th November 2024 to 6th December 2024.

The study also involved a systematic field survey traversing of the area to quantify perceived impacts of project on:

- Existing land uses;
- Land ownership and tenure in the area;
- Institutions and infrastructures in the area;
- Vegetation cover of the area;
- Existing sensitive environmental receptors including underground and surface waters; animal feeding grounds, and methods of protection from destruction, interference, contamination and extinction;
- Waste management and disposal methods;
- Socio-economic issues.

5.1.1 Environmental and Social Screening/ Scoping

The screening scoping process involved identification of significant environmental and social issues associated with the proposed project. It identified potential stakeholders in the project area and informed them of the proposed project and the ESIA process. Further, it was done to determine the anticipated impacts in the project life cycle. ESIA scoping was achieved through reviews of the secondary documents and available data provided by Geothermal Development Company with field evaluations.

5.1.2 Desktop Study

Desktop study entailed an office-based exercise during which available existing information (such as available aerial imagery, mapping and published literature) was undertaken prior to undertaking field work, to describe the existing environment. Relevant literature and available project documents were reviewed to help in describing the biophysical and social settings of the project's area of influence. The documents reviewed included the following:

- Relevant Acts of Parliament,
- Kajiado County Integrated Development Plan 2023 - 2027

- Narok County Intergrated Development Plan 2023 - 2027
- GDC - Community Relation Policy
- GDC – Environmental Policy October 2012
- ESIA Project Report for the Proposed Suswa Geothermal Drilling Project, 4th November 2012,
- GDC Community Engagement Strategy (CES), April 2022,
- GDC Corporate Social Responsibility Policy, June 2020
- GDC Land Acquisition Policy, March 2020
- ESIA Project Study Report done by REDDPLAN, July 2013
- Feasibility Report for Exploration and Appraisal Drilling in Suswa Geothermal Prospect, March 2013

5.1.3 Site Assessment

Visits to the proposed Suswa Geothermal Drilling project site were made between the 25th November 2024 to 4th December 2024, to perform physical inspection of the site and collect baseline data on the physical location, soil and geology, water resources, drainage, climate, vegetation, land use, social characteristics, infrastructure. The baseline data was useful for predicting potential impacts on the environment and human health, as well as community safety. Ecological assessment

The Biodiversity Baseline Information and Ecological Impact Assessment study was conducted in March 2025 with the following objectives;

- Assess Biodiversity and Species Distribution – Document species richness, abundance, and distribution of birds, mammals, reptiles, amphibians, and invertebrates across different habitats.
- Evaluate Habitat Conditions and Human-Induced Impacts – Analyze how geothermal development, deforestation, and land degradation affect biodiversity and ecosystem stability.
- Identify Key Conservation Priorities – Determine critical habitats, species of conservation concern, and areas requiring protection to maintain ecological balance.
- Examine Ecosystem Services and Climate Resilience – Assess biodiversity’s role in pollination, seed dispersal, carbon sequestration, and adaptation to climate change.
- Develop Sustainable Conservation and Management Strategies – Recommend habitat restoration, wildlife protection, and mitigation measures for geothermal-related environmental risks.

The different flora and fauna assessed include;

- **Invertebrates**

Pitfall traps and pan traps were placed at designated points within each site and left open for a continuous period of 24 hours to ensure the capture of a variety of invertebrates, including those that are more active at night or in the early morning. Traps were monitored and emptied after 24 hours period and collected samples were preserved in 70% ethanol.

Sweep netting and timed searches were carried out along predefined transects in each of the five sites. Two individuals equipped with a sweep net, conducted sweeping and searches for two hours along each transect. These methods ensured that a large number of invertebrates, including those in the vegetation canopy and on the ground, were captured.

Herpetofauna survey

The sampling points were dictated by the areas where different project activities shall be undertaken. These are Sites 1, 2, 3 and 4, the Campsite, Excavation Site 1 and Excavation site 2. The different species sampling

methods were employed within the general area of these sites.

Pitfall traps associated with drift fences (Corn, 1994). The drift fences were laid in an X or cross formation to trap animals moving from all directions. For each site, two sets of traps with a total of 10 buckets and 4 drift fences of 10m were laid to maximize the effort with the limited time available for the survey. Trapping enables sampling of the species that may not be detected by other methods either because of differences in timing of activities or those that successfully hide to avoid detection. For best results, the pitfall traps should be left for more than 14 days.

Time Limited Searches (Karns, 1986). This involves actively looking for the herps from their possible cover within a restricted time frame of one hour and recording the observation. Searching involves digging up soil, moving leaf litter, turning rocks, logs and inspecting tree barks for the animals. Timed searches are more productive in rapid surveys, because of the restricted time available. The following approaches were used during the survey;

1. *Acoustic surveys* for the amphibians and is targeted at their calling behavior in wetlands especially at night. This was nested within the Time Limited Searches and done from late evening into the early hours of the night as these are the hours when the amphibians and other crepuscular reptiles are active.
2. *Opportunistic encounters* during other field activities and observations recorded and reported by other members of the team. The observations from the other members of the team were only considered if accompanied by photographs that could be used to ascertain the identity of the reported species. This information serves to enrich the inventory as it takes advantage of the large team to make observations of species that may not be seen by the helping team.
3. *Interviews*. Often, the local community observes more species in the area compared to the researchers who visit an area briefly. To enrich the information, interviews were conducted with the locals where they described some of the species they have seen in the area. Based on the descriptions given and the known distribution, a species can be identified. This provides the data under the local's account.

- **Birds**

Birds are important component of biodiversity that not only influence some ecological functions, but also survival of other plants and animals. They were studied using a mix of mist netting, vantage point and spot surveys, as well as walked transects in each study area. Birds observed were identified to species level. Conservation status age and sex were also determined for each bird observed.

- **Vegetation Survey**

Plants in the project sites was studied using Point Centred Quadrat survey (PCQ) which were established in each proposed well site. Individual plants falling on the proposed area or with quadrant was identified to species level. For trees Forbes and shrubs height and Diameter at Breast Height (DBH) were determined. The resulting data will inform determination of species composition and vegetation structure.

- **Mammal survey**

The proposed Suswa geothermal drilling development project had already identified sites to develop well pads which were tagged as proposed wells sites. Site 1, 2, 3, 4 plus additional sites for borrow pit, water tank and drillers camping. Since these sites will undergo profound physical transformation, we considered them project direct impact zone (DIZ). In light of the time allocated to the survey, we prioritized these sites as study units for baseline mammal survey to understand what species are found in each.

The baseline survey was split into desktop review and field surveys. In the desktop review, reports and published articles, databases regarding mammals in central and south Rift Valley in Kenya was reviewed.

The mammal survey within these sampling units, involved use of a combination of standard techniques and tools, including:

- a) Sherman traps for live capture of rats, mice, and shrew (Hoffman et al 2010), baited with peanut mixed in oatmeal and sadine. Model LFATDG, $7.62 \times 8.89 \times 22.86$ cm; (HB Sherman Co., Tallahassee, FL), was deployed in paceline transect in each sampling site.
- b) Mist net for live capturing of bats (Wilson et al 1996)
- c) Passive acoustic monitoring for recording acoustic signals of echolocating bats (Wildlife Acoustics 2019)
- d) Tomahawk (Cage) traps for live capturing of large size rodents (e.g porcupine) and small carnivores (weasels, genets (Hoffman et al 2010), baited with a mix of fruits, meat and vegetables
- e) Camera traps for capturing images of mammals (Cheng et al 2021)

Direct observation on individuals, tracks and sign of mammals (Chris & Mathilde 2019) opportunistically and on designed walk surveys within sampling units.

5.1.4 Biophysical data collection and analysis methods

- **Air quality assessment methodology**

Air quality monitoring was carried out using Aeroqual Monitor and sensors that meets Monitoring Certification Scheme (MCERTS) standards that are compliant with ISO/IEC 17000 series of conformity assessment standards.

KS ISO 10498: Ambient air -- Determination of sulfur dioxide -- Ultraviolet fluorescence method was applied for Hydrogen Sulphide while KS ISO 8672: Air quality - Determination of the number concentration of airborne inorganic fibers by phase contrast optical microscopy - Membrane filter method was applied for inhalable and respirable particulate matter. The Aeroqual sensor heads used feature an active fan sampling, which ensures a representative sample is taken and therefore increases measurement accuracy. The sensor heads used (H_2S and PM_{10} & $PM_{2.5}$) are duly calibrated with their calibration certificates annexed in the report. The monitors were elevated at a height of approximately 1.5m using a tripod stand. The monitor was set to log the pollutant data every minute. They were then placed in an area free of any obstruction during the monitoring period to allow free air circulation. Data was logged and download in the computer for analysis and interpretation.

- **Soil quality assessment methodology**

ISO 18400-104:2018 Soil quality — Sampling Part 104: Strategies was adopted in soil sampling.

Soil samples were obtained at a depth of 15-30 cm above the surface. Composite samples were obtained from each site in duplicate with each sample weighing approximately 500g. The soil samples were stored in air-tight plastic containers in readiness for transportation and analysis. The samples were stored in a cooler pack ensuring a temperature of below 4°C was maintained.

- **Water quality assessment and analysis methodology**

ISO 5667-1:2023 Water quality — Sampling Part 1:

Guidance on the design of sampling programmes and sampling techniques was adopted in water sampling from all the sources.

The samples obtained were then transported to Crop Nutrition Laboratory Services, an ISO/ ICE 17025 Accredited Laboratory for analysis. Water quality assessment report is attached.

- **Noise assessment methodology**

ISO 1996, Acoustics – Description and Measurement of Environmental Noise was applied in the noise assessment. Measurement was carried out with the use of a duly calibrated SVAN 971 Type 1 (Serial Number 82474) sound level meter. Monitoring locations were based on prevalent wind direction south west to north east and the two sensitive receptors located in the vicinity of the facility. Four sampling locations were, however selected with their geo-location identified using a Global Positioning System (GPS).

Field calibration checks were done before and after measurement using a duly calibrated sound level calibrator (Type SV36- Serial Number 112554). Sound level meter was positioned in unobstructed location and elevated with a tripod stand during measurement.

5.1.5 Socioeconomic data collection methodology

The methodology ensured a comprehensive socioeconomic data collection through a combination of qualitative and quantitative methods.

a) Research Instruments

- Questionnaires: Structured, semi-structured, or open-ended questions were designed to collect specific data on socioeconomic aspects such as income, employment, education, health, housing, and access to services.
- Interviews: Both face-to-face and phone interviews, using both structured and unstructured formats to gather detailed qualitative information from key informants.
- Focus Group Discussions (FGDs): Groups of community members or stakeholders discussing specific socioeconomic issues, guided by a moderator to capture diverse perspectives.
- Observation: Systematic observation of community settings or practices, where applicable, to complement other data sources.

b) Sampling Methodology

The assessment adopted the use of random or stratified sampling to ensure representative coverage of the population based on key demographics (e.g., age, gender, income level). Sampling was conducted to;

- Ensure a sufficient sample size to achieve statistically reliable results.
- Identify geographic areas or communities of interest, ensuring a mix of urban and rural locations, if applicable.

Survey Objectives: Clearly outline the purpose of the survey, such as understanding income levels, health access, education, employment status, etc.

Demographic Segmentation: Target specific groups for focused insights, such as low-income households, women, or vulnerable populations.

c) Data Collection Tools

The following tools were used in collection of the required data and information;

- Digital Platforms - Use mobile surveys or tablet-based data collection tools like KOBO Collect for efficient and real-time data capture, especially in remote areas.
- GPS Technology - For mapping the geographic locations of respondents and contextualizing data with geographic features like proximity to infrastructure.

d) Questionnaire Design and Content

Socioeconomic and Demographic questions comprised of the following;

- Personal Details: Age, gender, marital status, household size.
- Economic Activity: Employment status, primary occupation, income level, source of livelihood.
- Health and Education: Access to healthcare, education level, school enrolment.
- Housing and Living Conditions: Type of housing, access to utilities (electricity, water), sanitation facilities.
- Access to Services: Transportation, communication, and infrastructure (e.g., roads, internet).

e) Training and Pre-test

Training of Enumerators - training sessions for enumerators was conducted on survey techniques and ethical considerations to ensure consistency in data collection, improve public participation and enhance data reliability.

Before rolling out the survey to the full sample, a pre-test (pilot survey) was done to validate data collection tools, improve data quality and relevance.

f) Data Capture and Analysis

For surveys administered via digital platforms, data was captured automatically and synced with central databases. The data collected was reviewed for consistency, completeness, and accuracy.

This methodology ensured comprehensive socioeconomic data collection through a combination of qualitative and quantitative methods. By using structured and well-designed instruments, training enumerators adequately, and performing rigorous data analysis, the collected data provided a valuable insight into the socioeconomic conditions of the target population.

g) Stakeholder engagement and public participation methodology

The public consultation and participation were conducted through;

- Household socio-economic survey via Kobo Collect platform.
- Key Informant Interviews
- Public Meetings
- Focused Group Discussions

The local administration and the public were notified as required. Letters were sent seven days prior to the meetings to DCC Narok East and DCC Kajiado West Sub-counties, with the meeting dates and venues clearly indicated. The stakeholder engagement plan is attached as Annex 6.

The procedures used for each of the above are outlined below:

h) Household socio-economic survey

Household socio-economic surveys were conducted during the field visits using structured questionnaires hosted on the Kobo Collect platform. Eight enumerators, trained on November 25, 2024, were engaged to carry out the survey. Approximately 480 households participated in the study, aimed at assessing the socio-economic status of the project area.

i) Key Stakeholder Consultation

Key stakeholder consultative meetings were conducted between 25th November to 6th December, 2024. The key stakeholder engagements were conducted to foster better and mutual understanding of public concerns as well as incorporate key stakeholders' opinions to this report.

The following stakeholders were consulted:

- Proponent – Geothermal Development Company (GDC),
- National Government Administration – DCC, ACC, Chiefs and Ass. Chiefs
- Kenya Wildlife Service (KWS)
- Kenya Forest Service (KFS)
- Water Resources Authority (WRA)
- Water Resource Users Associations (WRUA's)
- NEMA – Kajiado/ Narok County Offices
- Directorate of Occupational Safety and Health -DOSH Narok office
- County Public Health Office – Narok
- National Land Commission (NLC),
- Constituency and Ward levels leaders;
- Ministry of Environment, Energy and Natural Resources Narok County
- Mt. Suswa Conservancy,
- Local CBO's – Compassion.

The summary of the feedback from consulted stakeholders are provided later on this report. The questionnaires are annexed in the report.

5.2 Impact Analysis and Evaluation

This exercise is intended to give an analysis of possible impacts of the project. The analysis and evaluation of potential impacts associated with all the project phases has been undertaken the project based on site surveys, available secondary information, professional knowledge and judgment drawn from similar projects. The methodology applied in this ESIA to assess impacts is as follows:

- Each receptor is analyzed to understand how sensitive it is to a change in its external environment as indicated in **Table 20** below.
- Each potential change which will be caused by the project is analyzed to understand the extent to which it might impact the receptors in the project area as shown in **Table 21** below.
- The two factors (sensitivity of a receptor and change parameter) are combined to estimate the significance of each impact to each receptor.

5.2.1 Sensitivity of a receptor

The sensitivity of each group of receptors has been estimated based on the understanding of their potential status, using the criteria and scoring system set out in **Table 20** below.

Table 20: Criteria and scoring system for determining sensitivity of a receptor Category

Criteria	Score	Description
Negligible	1	Receptor with good capacity to absorb proposed changes or good opportunities for mitigation.

Low	2	Receptor with some capacity to absorb proposed changes or moderate opportunities for mitigation.
Medium	3	Receptor with little capacity to absorb proposed changes or limited opportunities for mitigation.
High	4	Receptor (human, physical or biological) with little or no capacity to absorb proposed changes or minimal opportunities for mitigation.

5.2.2 Change parameter

Each potential change describes various parameters of the change and considers how each change could affect each receptor applying a scoring system. To describe the change, we used the parameters set out in **Table 21** below.

Table 21: Sensitivity of receptors

Parameter	Score	Description
Nature	Positive Negative (scoring system not applicable)	The nature of the change that is being considered may be positive, neutral or negative. For example, a gain in available habitat area for a key species would be classed as positive, whereas a habitat loss would be considered negative.
Magnitude	1 Negligible 2 Minor 3 Moderate 4 Major	The magnitude of change is a measure of the degree of change that will be incurred as a result of the proposed development. The categorization of magnitude is based on a set of criteria that is specific to the discipline area being considered. For example, in the case of surface water, the magnitude may be defined as the extent to which the water quality (for example, suspended solids) exceeds the adopted national criteria.
Duration	1 Short term (0-2 weeks) 2 Medium term (2 weeks-1.5 months) 3 Longterm (1.5-3 months) 4 Permanent	The duration of change refers to the length of time over which an environmental impact may occur.
Scale	1 Local 2 Regional 3 National 4 International	The change may happen at a local, regional, national or international level
Probability	1 Low (Unlikely) 2 Medium (as likely as not) 3 High (likely) 4 Certain	How likely is it that the change will happen.

5.2.3 Significance of impact

Having assessed the sensitivity of a receptor and change parameters set out in *Table 20: Criteria and scoring system for determining sensitivity of a receptor* Category above, an estimation of the significance of the change by

combining the parameters of change with the sensitivity of the receptor was conducted using the following formulae;

$$\text{SP (Significance points)} = (\text{Magnitude} + \text{Duration} + \text{Scale} + \text{Probability}) \times \text{Sensitivity}$$

Based on the result of the calculation (the significance point), the relative significance of the impact is classified as set out in **Table 22** below.

Table 22: Guidance to significance points

Significance points	Significance	Description
Between 48- 64	Major	The degree of impact that the project may have upon the environment and/or the community(s) is unacceptably high. It is unlikely that an impact of this magnitude can be satisfactorily mitigated. If this impact cannot be avoided, the project is unlikely to be permitted for development.
Between 32-47	Moderate	The degree of impact that the project may have upon the environment and/or the community(s) is high. The project may be compromised if this impact cannot be avoided or mitigated (i.e. to reduce the significance of the impact).
Between 16-31	Minor	The degree of impact that the project may have upon the environment and/or the community(s) is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.
<16	Negligible	No noticeable impact on the environment and/or the community(s). No mitigation is required.

The methodology chosen for this ESIA aims to provide a reasoned determination of significance, which demonstrates how the impacts have been assessed whether significant effect will occur, indicating how the scores are applied to different parameters to easily understand the rationale for the assessment based on the magnitude of the change, duration, scale and probability.

5.2.4 Mitigation and enhancement measures

Mitigation measures are identified through the ESIA process in order to reduce the level of adverse impact upon a receptor.

The following hierarchy of mitigation measures is applied:

- Avoid and reduce impacts through design (embedded mitigation)
- Abate impacts at source or at receptor
- Repair, restore or reinstate to address temporary construction impacts
- Compensation for loss or damage

In addition to the above, community engagement and disclosure activities have played a key role in managing the extent of impacts and consideration has also been given to the identification of enhancement measures.

Enhancement measures are actions and processes that:

- Create new positive impacts or benefits
- Increase the reach or number of positive impacts or benefits
- Distribute positive impacts or benefits more equitably

5.2.5 Residual impacts

Residual impacts are those that remain after the application of mitigation and enhancement measures. As discussed above, once the application of mitigation and management measures has been defined, the residual significance is determined. Impacts considered 'Major' or 'Moderate' after application of mitigation and enhancement measures, are presented as significant residual impacts. These will be identified as part of this ESIA.

5.3 ESIA Study area / Area of influence

The project Area of Influence (AOI) is the area over which the impacts of the project are likely to be felt including all its related facilities such as the construction of access roads, as well as any reasonably foreseen unplanned developments induced by the project or cumulative impacts.

The project AOI is comprised of areas of direct impacts and indirect impacts which will inform the impact assessment.

- Direct area of influence: considers the physical footprint of the project such as the construction sites, work staging area and area affected during project works
- Indirect area of influence: includes the area which may experience project related changes in combination with activities not under the direct control of the project.

The project direct AOI often varies depending on the specific environmental or social aspect considered based on the extent an impact may be affected and can be influenced on a spatial and temporal level.

The temporal influence of the project has been assessed by comparing the existing baseline conditions (social, biodiversity, hydrological and other) with the change expected over time as a result of the project activities as listed below phases:

- Site establishment
- Exploratory drilling works
- Site closure (decommissioning phase)

The baseline conditions are those assumed to be prevailing immediately prior to the start of site establishment.

CHAPTER 6. ENVIRONMENTAL AND SOCIAL BASELINE CONDITION OF THE PROJECT AREA

6.1 Introduction

This section is vital to this report since it provides the baseline state of the environment covering biophysical, social, and economic prior to commencement of the project. The section is significant in undertaking the project's impact prediction and analysis. The project area lies in two administrative sub counties – Kajiado West sub-county and Narok East sub-county.

The proposed project site predominantly exhibits Arid and Semi-Arid Land (ASAL) -like conditions in the better part of the year except during the long rains. Its short rains have been suppressed in the recent past.

6.2 Biophysical Environment

6.2.1 Climate

Kajiado West Sub County experiences long rains between March and May every year with short rains falling between October and December. The average rainfall ranges from 2.3mm to 38.9mm while the mean annual temperatures is 38.2°C.

Rainfall in the area ranges from 1200 mm-1800 mm in highlands and about 1400 mm in lowlands. Mean temperatures range from 5°C in July to 28°C in December to February.

The short rains start in October- December while the long rains fall between March and May. Annual Rainfall is generally influenced by altitude. Temperatures range from a mean maximum of 34°C around Lake Magadi to a mean minimum of 22°C on the slopes of Ngong Hills. In the project area, days are sunny but temperatures significantly cool down during the nights.

Narok East Sub-County, located in southwestern Kenya, experiences a semi-arid climate influenced by its elevation of approximately 1,900 meters (6,200 feet) above sea level. This elevation contributes to a moderate temperature range and distinct wet and dry seasons.

The average annual temperature in Narok East ranges between 10°C and 28°C, with the warmest months being January through March and the coolest months from June to August. July is typically the coldest month, with average temperatures around 15.7°C.

Narok East experiences two main rainy seasons: Long rains: March to May, with April being the wettest month while Short rains: November to December.

The dry season occurs from June to October, with July and August being the driest months. Annual precipitation ranges from 600 mm to 1,600 mm, with the northwestern region receiving more than 1,500 mm annually.

6.2.2 Soils and geology of Suswa Volcano & Environs

Kajiado West Sub County consists of three geological regions; quaternary volcanic, Pleistocene and basement rock soils. The soils in the project area appear shallow, loose and a bit rocky. The soils are infertile judging by the vegetation type dominating the project area.

Suswa volcano is part of the Kenya Dome, an elevated area about 2000 m above sea level. The Kenya Dome is located in the axial graben of the Kenya Rift, formed during the Late Miocene, and continued to be active in Early Pliocene (Baker et al., 1972).

Volcanoes in the area are associated with fissure eruptions of mafic lavas and caldera products of felsic rocks (Baker, 1987; Baker et al., 1972). Volcanism is prominent along the rift axis but also in the flanks (Price et al.,

1985; Davies and Macdonald, 1987; Macdonald et al., 1987; Simonetti and Bell, 1995, Omenda, 1997; Velador et al., 2003; Macdonald and Scaillet, 2006; Ren et al., 2006; Macdonald et al., 2008). The Kenya Dome area has three caldera volcanoes – Menengai, Longonot, and Suswa. Menengai caldera volcano is a trachytic composition (Leat and Macdonald, 1984); Longonot is composed by trachyte and mixed (trachyte/basalt) lava flows (Clarke et al., 1990; Heumann and Davies, 2002; Rogers et al., 2004; Scott and Bailey, 1984), while Suswa has a composition of trachytic-phonolitic lava flows and pyroclastic rocks (Clarke et al., 1990; Johnson, 1969; Nash et al., 1969; Skilling, 1993). The Olkaria volcanic complex is also found in the Dome area but has no caldera. There is evidence of magma mixing at Olkaria complex, Menengai, Longonot and Suswa (Leat and Macdonald, 1984; Macdonald et al., 2008; Rogers et al., 2004).

Mount Suswa is a Quaternary volcano built of pre- and sync-caldera trachyte and post-caldera phonolite. This association is intriguing from a petrologic stand, as scientists try to understand the genesis of highly alkaline rocks, and is important for understanding the geodynamics of the Kenya Rift, in that the other Quaternary central volcanoes are trachyte and rhyolite, not phonolite. Other characteristics of the Suswa volcano are that it is underlain by a shallow, high density body which we interpret to be the residuum of the chamber which fed the volcano, and that high heat flow makes it one of the best targets for geothermal exploration. Previous studies included mapping, whole-rock and mineral chemistry, and documentation of magmatic carbon dioxide (CO₂) in syn-caldera trachytic ignimbrite. Pre- and syn-caldera trachyte are more silica (SiO₂)-rich, in both the whole-rock and glass, than the phonolites, and have feldspars less An-rich. Other indices correlate with these, and imply that the trachytes are more evolved than phonolites. Trace element concentrations for the pre-caldera trachyte span the entire range for the volcano and form their own separate array. The sync-caldera trachyte and the phonolite form a coherent array, and the trachyte has higher concentrations of incompatible elements. Our preferred model at this time is that the pre-caldera trachyte was an early discrete magma pulse, followed by a separate pulse in which a zoned magma chamber developed. A volatile-rich, evolved trachyte cap overlay more primitive phonolite. The cap vented to form the caldera, followed by eruption of phonolite from the main chamber. Gravity data at Mount Suswa show existence of shallow magma beneath the calderas and geothermometric temperatures exceeding 250°C. Resistivity data show evidence of a geothermal reservoir. Hot geothermal fluids probably flow through the lineaments and fractures indicating permeability. **Figure 15** below shows the geology of Suswa and its environs.

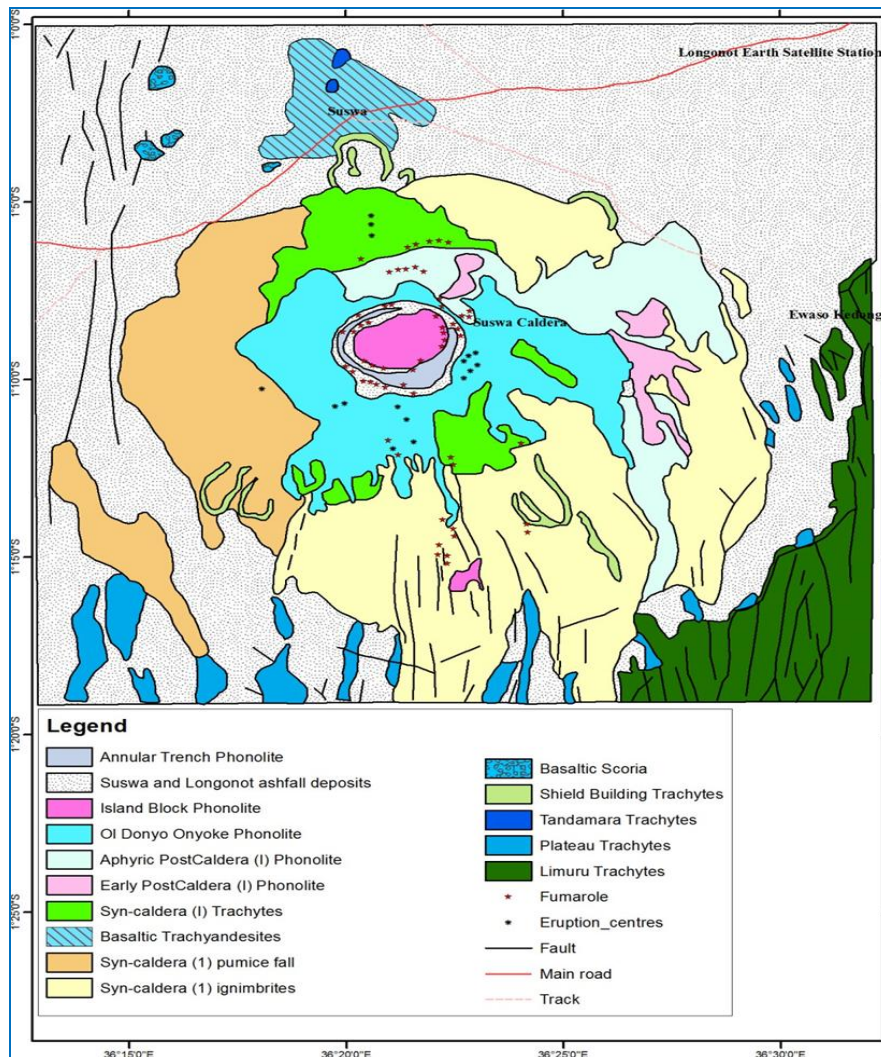


Figure 15: Geology of Suswa volcano (Previous ESIA 2013 Report)

6.2.3 Hydrogeology

The hydrogeology of Suswa is strongly controlled by the main rift faults, fractures, rift floor, and rock types. The Suswa Geothermal Prospect is recharged from the Mau and Aberdare scarps through detachment faults that go down into the crust by several kilometres. The recharge relies on rainfall on the Rift flanks of the Mau and Aberdares areas. Warm springs such as Ewaso Kedong River originate from some of the faults that cut through the N-S rift faults. Since the Mount Suswa area is extensively faulted, fractured and coupled with southward gradient in the area, fluid flow is expected to drain rapidly through the faults and fractures with the result of a likely absence of shallow perched aquifers. Groundwater table is estimated at more than 1600m and likely to be controlled and restricted by faults, fractures, and lithological boundaries (Omenda, 1993). The Tandamara fracture, Suswa fault, and Ol'Esayeti faults control the N-S water flow through the Suswa Volcano.

The floor of the Rift Valley has its highest elevation (1890m) near Lake Naivasha and then slopes southwards. The surface water divide runs from the Mau Escarpment in the west via Olkaria and Longonot to the Kinangop Plateau and finally Nyandarua mountains. The Rift Valley floor is divided into many sub- parallel ridges with a NNE trending, a physiographic expression of the recent grid faulting. Under the Akira plains, subterranean streams, N-S trending faults and E-W trending faults control the flow, which is deep.

Flow from the sides of the Rift to Suswa area is limited and it is likely that major faults act as low permeability barriers to the flow across the Rift. Limited evidence shows that there is expected flow down the topographic gradient from Suswa to Magadi. Much of the subsurface outflow from Lake Naivasha catchment is to the south via Olkaria-Longonot towards Suswa and eventually towards Lake Magadi though there is little evidence that such flow ever reaches Lake Magadi in an identifiable form (BGS, 1990). Surface recharge for Suswa is from the western and eastern flanks of the escarpments, which recharges the Suswa prospect through E-W trending faults.

6.2.4 Topography

The topography on the side of Narok East is broadly divided into two: the highlands and the lowlands, which are approximately 3,000 and 1000- 1400m a.s.l respectively. The topography may be as low as 460m.a.s.l. in Mosiro area.

On the side of Kajiado West the topography is characterized by plains and occasional volcanic hills and valleys ranging in altitude from about 500m around Lake Magadi to about 2,500 metres in the Ngong Hills.

The most prominent physical features on Mount Suswa are the caldera faults, which define the oval-shaped outer and inner calderas. The calderas long axis trend approximately NE-SW, which is interpreted to be the shape of the magma chamber that was controlled by the regional NE-SW, faults. The outer caldera has vertical walls in the western and northern sections but most of the southern and eastern wall is covered by younger lava flows originating from the Ol'Doinyo Nyoke volcano. In the northern section, fumaroles emanate from the outer caldera fault indicating that some vertical permeability exists in this zone. The outer caldera may have collapsed by 500m though the exposed wall is less than 100m.

The inner caldera consists of a 100-200m moat around a central block that is about 4km in radius. The inner caldera may have collapsed by more than 500m followed by the uplifting of the central block. The highest uplift occurred in the SE region resulting in the tilting of the central block westwards.

The Mount Suswa caldera faults are not well exposed due to a thick cover of Quaternary volcanic material. The southern area shows intense fracturing and faulting of the Rift floor lavas. The faults trend in a general NNW-SSE direction but to the west, some faults trend in a NNE-SSW direction. The Kedong-Ng'iro accommodation zone is a transform fault, is the most prominent feature in the south, trends NE-SW and is a stress-relieving structure.

The Mount Suswa area consists of four major lineaments: Suswa, Ol'Esayeti, Olorgesale, and Ewuaso Kedong. Suswa is a NE-SE lineament that extends from SE of Suswa through the Olkaria West Field joining the Mau rift faults. Other lineaments trending NW-SE or NE-SW pass the Suswa caldera and run parallel to Suswa lineament.

One lineament passes through Suswa caldera with a trend ENE-WSW, runs sub-parallel to the Kedong-Ng'iro accommodation zone and joins the Rift scarp at a locality that is also the source of Ewuaso Kedong River. Ol'Esayeti and Olorgesale lineaments are NNW-SSE trending structures that are sub-parallel to the Nguruman detachment and are interpreted as pre-rift (Tertiary) faults that have been rejuvenated during the Quaternary times.

There is only one major volcano-tectonic axis in Suswa and it passes through the Suswa caldera to the Ol'Doinyo Nyoke crater. The axis is defined by an alignment of volcanic centers in the south and Tandamara volcanic center in the north. In the Suswa caldera, the evidence of the tectonic axis is a visible micrograben

cutting through the northern outer caldera wall. Minor axes too occur within the caldera. The other major volcano-tectonic axis is the Longonot axis, which joins the crater in Lake Naivasha, Longonot Volcano, Mlima Panya and a detachment block in the eastern scarp. The south Rift stratigraphy consists of Precambrian metamorphic basement rocks that are overlain by Tertiary volcanics (i.e. basalts, trachytes, and tuffaceous intercalations) within which the magma chamber under Suswa is likely hosted. Overlaying the unit is the Kinangop Tuff Formation (consists of tuffs, welded ignimbrites and trachytes) which in turn are overlain by the Limuru and plateau trachytes which are exposed in the southern sector.

Torfason (1987) outlines a sequence of events that led to the development of Mount Suswa Volcano including the collapse of the Suswa calderas. The magma chamber may have a diameter of more than 10km, which is the same as the diameter of the outer caldera (Omenda, 1993). **Figure 16** below shows the topography of the proposed project area.

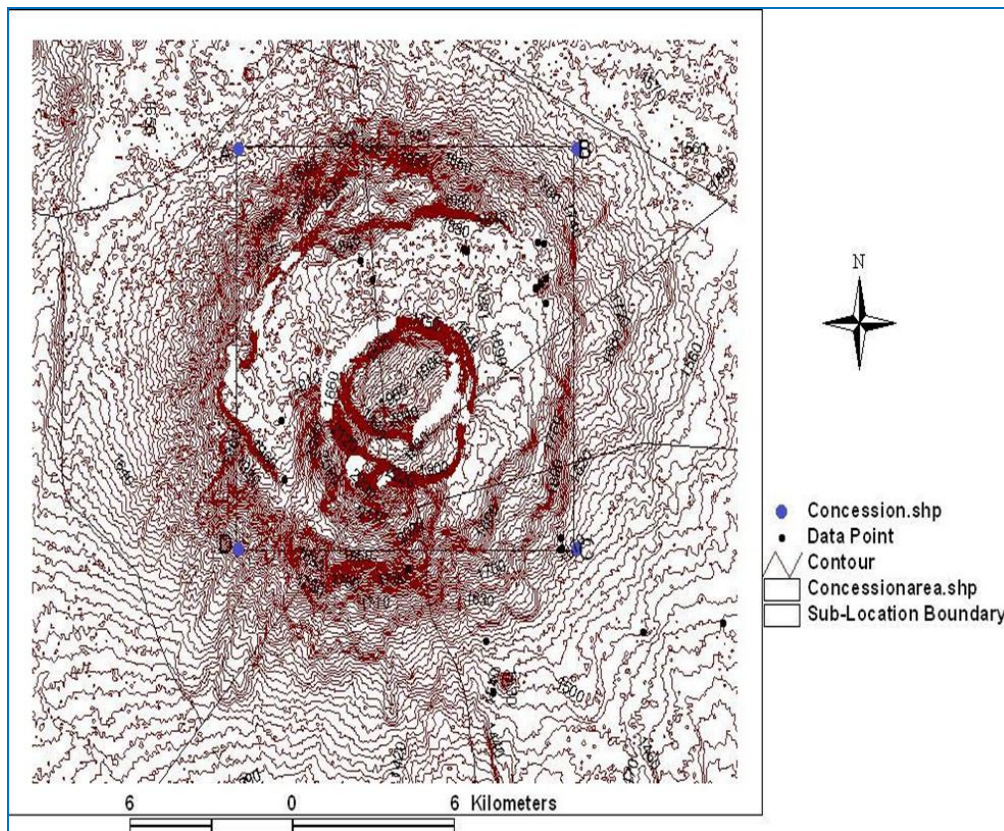


Figure 16: Topography of the Concession Area of Suswa (Previous ESIA 2013 Report by REDPLAN)

6.2.5 Geothermal Manifestations, Potential, and Accessibility

The geothermal potential of Suswa is associated with the shallow hot magma that exists under the inner caldera. The magma may be within a depth of 3-5km. Fumaroles (steam vents), steaming and hot grounds, steam jets, and altered grounds are the evidence of geothermal activity at Suswa. These geothermal manifestations occur along the ring structures of both the outer and inner calderas. Most of the high-temperature and most active fumaroles are located within the annular trench area.

Geothermal manifestations of Suswa are concentrated along the walls of the outer and inner calderas and some are found on the floor of the outer caldera, and a few on the southern slopes of the mountain. The development of the Suswa geothermal system will depend on the up flow within the calderas. The main heat

source is most likely located under the inner caldera due to high temperature fumaroles located there. According to Omenda (1993), permeability of the Suswa geothermal system is likely to be low due to abundant dykes expected in the subsurface and deep exploration wells are recommended to access the geothermal resource. Deep well drilling is likely to encounter 'roof' syenitic rocks within a few to several kilometres.

Accessibility to Suswa geothermal resource is most possible from the northern and western flat region of the outer caldera and on-site preparation and road works in this region of the caldera will be low (Omenda, 1993:31). On the other hand, the eastern and northern sectors of the outer caldera floor have poor accessibility due to rough terrain, high elevations and steepness but it is possible to drill most of the area once the geothermal resource is proven. Accessibility to the area covered by the inner caldera is only possible with a crossing on the 100-200m deep annular trench that surrounds the island block. A bridge (s) across the trench or moat may be costly to construct but may remain a possibility if the geothermal prospect in the inner caldera is too attractive to place aside. Without drilling in the Island block, wells could only be sited just outside the trench.

For geothermal prospecting to prove the resource using exploratory wells, KPC (1993) recommends drilling of deep slim wells sited within the Suswa caldera floor. The Tandamara fracture zone in the area between the outer and inner caldera was highly rated for exploratory drilling due to the existence of high temperature fumaroles on the outer caldera ring fracture and annular trench. Another highly rated zone for exploratory drilling is the Ewuaso-Kedong lineament/fracture.

6.2.6 Geochemistry

The trachy-andesites of Suswa are rich in potassium. The trachytes are undersaturated with silica content less than 62% but the plateau trachytes of Limuru and Mosiro are richer in silica than the shield building pumiceous trachytes. Recent lavas have high alum (Al_2O_3) content and low total iron content while older lavas have high total iron content but low alum content. Also, the plateau trachytes have high total iron content while the shield building pumiceous trachytes have higher alum but lower iron content. The main compounds in Suswa rocks are Silica (SiO_2), Titanium oxide (TiO_2), Aluminium (III) Oxide (Al_2O_3), Manganese (II) Oxide (MnO), Magnesium Oxide (MgO), Calcium Oxide (CaO), Sodium Oxide (Na_2O), Potassium Oxide (K_2O) and Phosphorus(V) Oxide (P_2O_5). The total oxide content in Suswa rocks ranges between 97 and 100 percent. This assertion may need confirmation by further geochemical analyzes.

Trace element data indicate that three suites of lava exist in Suswa: shield building trachytes, plateau trachytes, and trachy-andesites. The trachy-andesite suite comprises the phyric and aphyric Ol'Doimyo Nyoke lavas; Holocene Suswa annular trench lava; island block lava and the Holocene flow on the southern slopes of the Suswa volcano. The youngest of the trachy-andesites have lower niobium, zirconium, and thorium contents. All are products of a basaltic magma. Trace elements barium, niobium, cerium, zirconium, yttrium, strontium, vanadium, zinc, lead, rubidium, thorium, and cobalt may exist in significant quantities in most parts of the Mount Suswa volcano. Others like copper, chromium, and nickel may only exist in some parts of the volcano area. A more detailed study of trace elements may reveal better evidence about their quantities and distribution in the Suswa volcano area.

6.2.7 Fumaroles

Fumaroles at Suswa emit acidic gases such as hydrogen sulphide and carbon dioxide, which are air pollutants. However, natural production of these gases does not lead to serious air quality problems. It is the development of the geothermal resources that may increase the production of these gases.

Figure 17 below shows how fumaroles are utilized in the area for water harvesting.



Figure 17: A view of drinking water harvesting at Fumaroles in Suswa project area

6.2.8 Ecology

6.2.8.1 Overview

Vegetation is scarce in low altitude areas and increase with altitude as more rain is received. Ground cover throughout the county varies seasonally with rainfall and grazing intensity. Canopy cover ranges from less than 1% on heavily settled areas to about 30% on steep hills. This expanse of the area falls within a savannah range land.

This can be observed beyond the boundaries of the proposed project site where grass is predominant dotted with a few trees yellow-bark acacia trees, and shrubs. Notably, the project area neighbored is Suswa town, there has been disturbance of the natural state of the immediate environment by the town's hinterland due to prevailing socioeconomic activities.

Mount Suswa is a biodiversity-rich region within Kenya's Great Rift Valley, characterized by a mosaic of savannah grasslands, rocky outcrops, forest patches, and riparian zones. The mountain is home to a wide range of species, including birds, mammals, reptiles, amphibians, and invertebrates, each contributing to the ecological balance of the area. Notably, over 80 bird species have been recorded, including pollinators like sunbirds, insectivores like drongos, and raptors such as the Augur Buzzard. Mammals such as zebras, antelopes, hyenas, and even leopards inhabit the region, while caves within the mountain provide crucial roosting sites for various bat species, some of which are of conservation concern. Additionally, the invertebrate population, particularly pollinators, decomposers, and pest controllers, plays an essential role in maintaining ecosystem stability. However, habitat destruction, overgrazing, and deforestation threaten these species, reducing biodiversity and altering ecosystem functions.

Mount Suswa's habitats reflect a fascinating ecological gradient from dry savannah to moist crater-top vegetation shaped by both its unique volcanic geology and human influences. The inner crater, with its cooler microclimate, supports vegetation types not common elsewhere at similar elevations in the region. Lava tubes further enrich this landscape by creating niche ecosystems for bats and other specialized species. The **Table 23** shows the Summary Habitat Zones of Mount Suswa.

Table 23: Summary of Habitat zones in Mount Suswa Area

Elevation / Zone	Dominant Vegetation & Land Use	Notable Fauna or Features
1,500–1,800 m (Lower Slopes)	Semi-arid savannah grassland; Acacia woodlands; pastoralism	Grazing lands; habitat degradation from human use

1,800–2,100 m (Mid Slopes)	Mixed shrubland; scattered forests	Resilient flora on volcanic soils
>2,100 m (Inner Crater)	Dense evergreen shrubs; isolated forest patches	Cooler micro-climate; specialized alpine-like habitat
Craters & Caves	Sparse vegetation; volcanic rock terrain	Klipspringers, bats, unique cave ecosystems
Human-Impacted Zones	Degraded rangelands, farms, settlements	Restoration efforts underway

Figure 18 below shows flora within the proposed project site.



Figure 18: View of the flora at the project site

6.2.8.2 Herpetofauna

The landscape features in Mt. Suswa such as the rocky outcrops and kopjes, the open grassland, the shrubs together with the mid-altitude make it suitable for reptile habitation. The dominance of the agamids for example indicates their preference for the rocky environments which were characteristic in all the sites. The vegetation cover in these environments made for suitable additional hiding sites for the reptiles in addition to the rock crevices which are used as nesting grounds. Different species of Agamas are common by the roadside which can be differentiated by the color of the mature males. **Figure 19** below indicates two different species of herpetofauna habituating the proposed project area.



Figure 19: A male Red-headed Rock agama, *Agama lionotus* (a) and the female Tropical rock agama, *Agama armata* (b)

The Amphibians are distributed in 4 families; *Hyperoliidae*, *Pipidae*, *Ptychadenidae* and *Pyxicephalidae* each with a single species representing 25% of the community as shown in **Figure 20** below.

The Hyperoliidae is represented by the Senegal Bubbling Kassina, (*Kassina senegalensis*, Pipidae by *Xenopus borealis*, Ptychadenidae by *Ptychadena anchietae* while Pyxicephalidae has *Tomopterna monticola*.



Figure 20: Showing Senegal bubbling frog (*Kassina senegalensis*)

6.2.8.3 Invertebrates

The species recorded across the five sites reveal a dynamic and intricate web of ecological roles, with each group contributing significantly to ecosystem processes. The diversity of functional roles, from predators like

African Ponerine ant (*Platythyrea cribrinodis*) and Ground ants (*Tetramorium sp.*) in pest control to pollinators such as *Apis mellifera* and *Ceratina sp.*, highlights the importance of species richness in maintaining ecosystem stability. Sites 2 and 4, in particular, show the highest species richness and abundance, indicating a more diverse and functionally robust ecosystem. Site 1 which is rich in species diversity demonstrates lower overall abundance, suggesting a more limited functional capacity. Site 3, with fewer species and lower abundance, indicates a less diverse ecological structure but still supports key functional roles, particularly in pest control and pollination. The prevalence of scavengers, decomposers, and herbivores across all sites further supports nutrient cycling, vegetation dynamics, and biodiversity maintenance, the data highlights the crucial need for maintaining biodiversity across different sites to ensure the resilience and proper functioning of Suswa ecosystems. **Figure 21** below shows some of the invertebrates inhabiting the proposed project site.

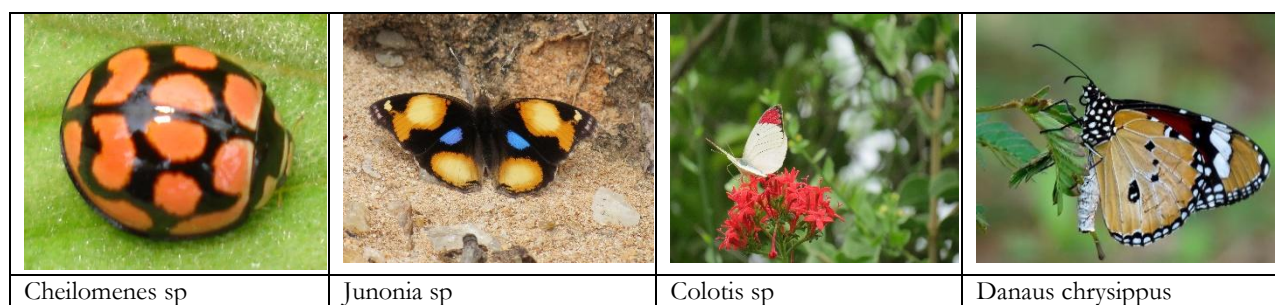


Figure 21: Images of some recorded invertebrates

6.2.8.4: Terrestrial mammals

Overall, we recorded 67 captures of individual rodents, shrews and small carnivores across all sites in 6 days. Additionally, we made 18 direct sightings of mammals and 26 tracks and signs. Furthermore, SM4 made 12,362 acoustic signals of bats across the sites. All these efforts translated to 35 mammal species representing 20 families within 10 orders, of the 15 Orders of African land mammals as indicated in **Table 24** below. This means, over 60% and over 42% of African terrestrial mammalian Orders and families respectively are represented in Suswa.

Among these mammalian orders, bats (*chiroptera*) were most systematically sampled in all the sites, albeit relying on SM4 only. Mist net sampling of bats at night was not logistically possible during the survey period.

Table 24: Mammal Species inventory in the proposed project area (Source-Biodiversity Survey)

Species	Status	Site 1	Site 2	Site 3	Site 4	Quarry
Tragelaphus oryx	LC	3	0	1	0	0
Aepyceros melanpus	LC	0	5	0	7	1
Eurodca thomsoni	LC	0	0	0	2	0
Oreotragus oreotragus	LC	8	2	0	0	0
Sylvicapra grimmia	LC	2	1	0	0	0
Pharcochoerus africanus	LC	1	0	0	0	0
Orycteropus afer	LC	3	6	2	1	4
Equus quagga	LC	0	0	1	0	0
Mastomys pernanus	DD	3	7	0	0	2
Arvicanthis niloticus	Lc	0	2	1	0	1
Aethomys kaiseri	LC	5	0	1	0	0

Species	Status	Site 1	Site 2	Site 3	Site 4	Quarry
Mus triton	LC	2	3	0	1	0
Tachyoryctes splendens naivashae	LC (endemic ssp)	3	12	0	0	0
Elephantulus brachyrhynchus	LC	3	0	0	0	0
Lepus saxatilis	LC	1	3	0	0	2
Crocuta crocuta	LC	1	0	0	0	0
Panthera pardus	Vu	1	0	0	0	0
Geneta maculata	LC	2	1	0	0	1
Civettictis civetta	LC	1	0	0	0	0
Bdeogale crassicauda	LC	0	1	0	0	0
Ichneumia albicauda	LC	0	1	0	2	1
Herpeses ichneumon	LC	1	1	0	0	0
Mellivora capensis	LC	1	3	0	2	0
Canis adustus	LC	0	1	0	0	0
Atelerix albiventris	LC	0	1	0	0	0
TOTAL		41	50	6	15	12
Bats						
Otomops harrisoni	Vu	11	28	9	17	
Rhinolophus hildebrandtii	LC	3	9	16	1	
Rhinolophus clivosus	LC	0	14	4	0	
Miniopterus africanus	LC, Mig	6	41	15	36	
Miniopterus minor	DD, Mig	0	5	3	1	
Pipistrellus aero	DD, Endemic	0	16	21	11	
Pipistrellus reupelli	LC	0	3	12	4	
Neoromicia helios	DD	2	8	12	18	
Nycticeinops schliiffeni	LC	17	6	2	1	
Nycteris hispida	LC	0	22	17	10	
Number of Individual observed		39	152	111	99	
Number of species		22	26			

6.2.8.5 Avifauna

Birds are important component of biodiversity that not only influence some ecological functions, ut also survival of other plants and animals. They were studied using a mix of mist netting, vantage point and spot surveys, as well as walked transects in each study area. Birds observed were identified to species level. Conservation status age and sex were also determined for each bird observed.

6.2.8.6: Flora of the project area

Plants in the project sites was studied using Point Centred Quadrat survey (PCQ) which were established in each proposed well site. Individual plants falling on the proposed area or with quadrant was identified to

species level. For trees Forbes and shrubs height and Diameter at Breast Height (DBH) were determined. The resulting data will inform determination of species composition and vegetation structure.

Mount Suswa's landscape is characterized by diverse vegetation, which plays a crucial role in supporting both biodiversity and local livelihoods. The dominant vegetation type is grasslands, covering approximately **70%** of the area. These grasslands are essential for livestock grazing, particularly for cattle, sheep, and goats, which many community members depend on for their livelihoods. However, overgrazing and soil erosion have led to a decline in pasture quality, making it increasingly difficult for herders to sustain their livestock. One pastoralist noted, *"The grasses here are critical for grazing cattle, sheep, and goats."*

Acacia woodlands, which make up about **50%** of the vegetation, are another important ecosystem. These trees provide multiple benefits, including shade, firewood, timber, and a habitat for wildlife. They also help prevent soil erosion, particularly in areas with fragile red soils. However, the demand for firewood and timber has led to widespread tree cutting, posing a significant threat to the ecosystem. Many households rely on Acacia trees for firewood and charcoal, with **80%** of respondents citing them as their primary source of fuel. Additionally, **20%** reported using Acacia wood for construction and fencing. One community member emphasized their importance, stating, *"Acacia trees are useful for firewood and also prevent soil erosion."*

Shrublands, which consist of drought-resistant species like *Commiphora* and *Euphorbia*, cover approximately **40%** of Mount Suswa. These plants are particularly important during dry seasons when grass becomes scarce, providing an alternative food source for livestock, especially goats. Shrublands also play a vital role in stabilizing the soil and preventing further land degradation. Additionally, **20%** of respondents acknowledged the significance of these shrubs for medicinal purposes, with a local healer explaining, *"We use these plants to treat livestock and even human illnesses."*

Although wetlands and natural springs cover only **30%** of the landscape, they serve as critical water sources for both people and animals. These areas support biodiversity, attracting wildlife and maintaining essential ecological functions. However, many respondents have reported that these wetlands and springs are drying up due to environmental changes, increasing water scarcity in the region. One concerned farmer remarked, *"The wetlands attract wildlife and provide water for both people and livestock."*

While not a vegetation type, **red soil areas** significantly influence the landscape by affecting vegetation growth and erosion patterns.

These soils, common in many parts of Mount Suswa, are highly susceptible to erosion, especially where tree cover has been lost. The continued deforestation of Acacia woodlands has exacerbated soil degradation, reducing fertility and making it difficult for grasses and shrubs to regenerate. Managing these red soil areas through reforestation and controlled grazing is essential to maintaining the balance of the ecosystem.

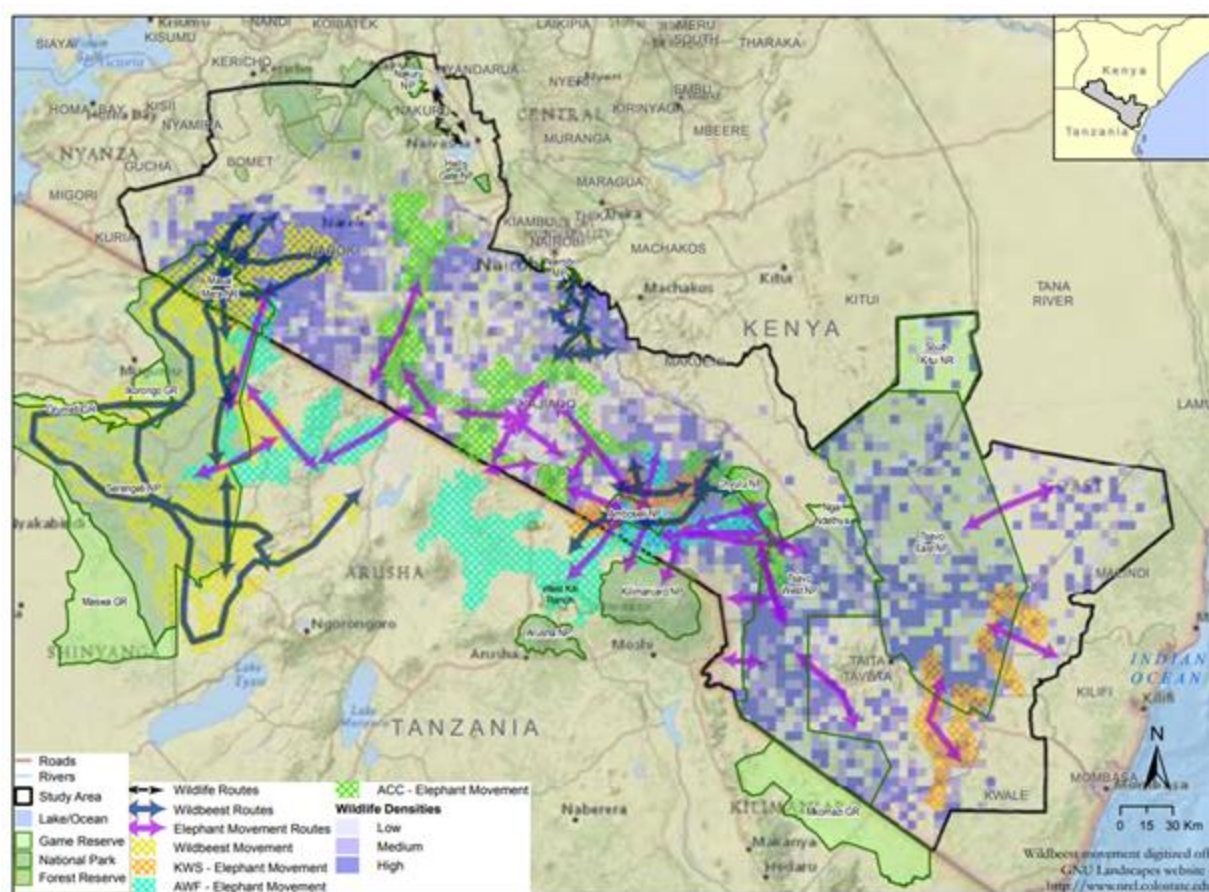
6.2.9 Profile of Mt Suswa Conservancy

Mt Suswa conservancy lies on the floor of Eastern Rift Valley and covers an area of about 8000 Ha and standing at 1,921 meter above sea level. Its summit (highest point) stands at 2,356 meters above sea level. It is located 28 km away from the Mt Suswa Duka Moja town. In 2006, the conservancy management's headcount revealed that there were 3,500 landowners in the conservancy owning about 600 acres of land in the conservancy (Odhiambo and Onjala, 2018). The conservancy lies almost equally in two counties – Narok and Kajiado counties – with the Maasai being the predominant inhabitants.

The key attractions are the caldera and the caves. The cave passage stretches 9 km long and contains 70 caves covering an area of 5 km² which are considered as the Maasai cultural shrines. The caldera, formed after an

eruptive activity, has a smaller caldera nested inside a larger one and a lava cone. The caldera is covered by an indigenous forest, which is a home to wildlife such as snakes, rock hyraxes, wild dogs, genet cats, birds, squirrels, civet cats, hyenas and baboons.

Mt. Suswa Conservancy falls within the Eburu Forest Ecosystem and Lakes Naivasha-Elementaita-Nakuru Conservation Areas. These include lands occupied by Lakes Naivasha, Elementaita and Nakuru, and their immediate riparian surroundings within the Rift Valley basin. Included are the upland landscapes of Mounts Suswa and Longonot, and the Eburu Forest, as well as the adjacent Mau Forests Complex (Ojwang et al, 2017). The greater conservation area includes several protected areas and a number of public and private sanctuaries and ranches with substantial wildlife populations. Only about 10 % of wildlife in the conservation zone is found inside protected areas. The rest of the wildlife, if its populations are to be sustained, depends on community protection. Figure 22 shows wildlife dispersal areas in Narok and Kajiado counties (Ojwang et al, 2017).



Source: DRSRS/KWS

Figure 22: Wildlife Dispersal Areas in Narok and Kajiado

Community conservancies in wildlife dispersal areas outside national parks and reserves are key to the protection of wildlife migratory routes/corridors. From the above map, Mt. Suswa conservancy is a dispersal area for the African Elephants (*Loxodonta Africana*) which are endangered mammals as per the 6th schedule of the Wildlife Management and Conservation Act, 2013. September – November is the period when elephants give birth within the project's area of influence (Narok County Warden – KWS, 2024). The elephants have GPS collaring for monitoring their movement.

In 2015, Harrison's large-eared giant mastiff bat (*Otomops harrisoni*) was described as a new species which only roosts in two locations in Kenya, Mount Suswa and Ithundu lava caves of the Rift Valley and Chyulu Hills respectively. *Otomops harrisoni* is listed in the IUCN Red List of Threatened Species as Vulnerable A2c (Richards, 2017). The globally Vulnerable Harrison's large-eared giant mastiff bat roosts in the volcanic caves of Mount Suswa Conservancy, representing crucially important maternity colonies. This bat only gives birth to one pup per year and the species has declined rapidly since its discovery in 2015. The caves are being impacted by expanding ecotourism, harvesting of guano, and blocking of cave entrances. As well, uncontrolled clearing of the area's forests for fuelwood and to create pasture impacts the bat's foraging areas.

Otomops harrisoni is listed as vulnerable because of observed extreme declines at the two major roosting locations in Kenya. The species is usually found roosting in caves and disused tunnels in colonies of 500 or more individuals (Richards, 2017). Foraging areas for bats may extend up to 30 km or even further from the day roosts, although most foraging activity takes place between 5 to 15 km from day roost (Happold and Happold, 2013). Forests are the most critical habitats for supporting local abundance and species diversity for bats at a global scale (Frick et al, 2019). Forests not only provide essential foraging habitats, but they also allow many bat species to roost in plant structures, such as hollows and cavities in standing and fallen trees, under bark, or in foliage.

6.2.10 Value of Bats in Provision of Ecosystem Services

Bats play a key role in cave ecosystems and surrounding habitats, especially when they form aggregations in the thousands to millions. Bats depositing guano in caves provide some of the only allochthonous nutrient inputs into cave environments, thus contributing substantially to cave ecosystem food webs and supporting cave-specialist organisms. In addition, bats commuting and foraging to and from a centralized cave roost provide ecosystem services as consumers of nocturnal insects especially agricultural insect pests. Nectar-feeding and fruit-eating bats perform ecosystem services by pollinating plants and dispersing seeds. Some plants including baobabs in Africa (*Adansonia digitata*), rely heavily on bats for pollination or seed dispersal (Frick et al, 2019).

6.2.11 Categorization of Mount Suswa as a Critical Habitat

The presence of *Otomops harrisoni*'s roosting caves within Mt. Suswa conservancy, qualifies the geothermal project's area of influence as a critical habitat. According to IFC Guidance Note 6 (GN72b) on criteria 1 for identifying a critical habitat, areas that support globally important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to Endangered (EN) or Critically Endangered (CR) and meet the thresholds in GN72(a) should be categorized as critical habitats (IFC, 2012). Critically Endangered species are those facing an extremely high risk of extinction in the wild. Species facing a very high risk of extinction in the wild are considered endangered. Since *Otomops harrisoni* is listed in the IUCN Red List of Threatened Species as Vulnerable A2c (Richards, 2017), it warrants special attention during implementation of the proposed geothermal project. Bats that roost in caves are particularly vulnerable to disturbance because they form large, concentrated aggregations. Large colonies of cave-roosting bats are relatively easy to locate by local communities and tourists alike resulting in documented cases of intentional disturbance (e.g., persecution, hunting, vandalism, etc.) or roost destruction (Frick et al, 2019). Climate shifts may disrupt or change migratory behavior, survival and reproduction, foraging behavior, and disrupt food availability for pollinating species through alterations in flowering phenology.

6.3 Baseline conditions

Taking of baseline conditions and measurements is essential to provide an understand existing environmental and social dynamics, predict and manage project impacts, comply with local and international legislations, enables monitoring the effectiveness of mitigation measures. Some of the baseline conditions taken include;

6.3.1: Baseline Air Quality

Baseline air quality assessment was undertaken in accordance with Environmental Management and Co-ordination (Air Quality) Regulations, 2024. Air quality measurements were undertaken between 16th November and 1st December 2024.

The objective of the monitoring was to establish baseline ambient air quality as guided by Environmental Management and Co-ordination Act (Air Quality) Regulations, 2024.

The scope of work was limited to:

1. Monitoring and sampling for ambient air quality at;
 - Proposed Well Pad 1;
 - Proposed Well Pad 2;
 - Proposed Well Pad 3;
 - Proposed Well Pad 4;
 - Proposed camp site;
 - Proposed gravel material sites; and
 - Sensitive receptors that included education facilities, health facilities, religious institution and residential establishments.
2. Undertaking Respirable Particulate Matter (PM_{2.5}), Inhalable Particulate Matter (PM₁₀), and Hydrogen Sulphide (H₂S) measurements.

The proposed geothermal resources exploration sites are situated in Suswa area in Kajiado West and Narok East Sub counties. **Table 25** below shows the summary of the sampling locations.

Table 25: Summary of the Sampling Air Quality at various Locations

Location	Description	Coordinates	Pollutants Monitored
SP1	Well Pad 1 Location 1	1°11'14.01"S, 36°20'56.99"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP2	Well Pad 1 Location 2	1°11'12.13"S, 36°20'54.49"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP3	Well Pad 1 Tank Site	1°10'56.10"S, 36°20'56.70"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP4	Well Pad 1 Receptor 1(Residential)	1°11'29.48"S, 36°20'37.40"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP5	Well Pad 1 Receptor 2 (Residential)	1°11'14.14"S, 36°20'24.15"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP6	Well Pad 2 Location 1	1° 8'9.83"S, 36°22'56.38"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP7	Well Pad 2 Location 2	1° 8'11.68"S, 36°22'57.70"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP8	Well Pad 2 Receptor 1 (Residential)	1° 8'15.10"S, 36°22'41.11"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP9	Well Pad 2 Receptor 2 (Residential)	1° 8'19.88"S, 36°22'49.03"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP10	Well Pad 2 Receptor 3 (Residential)	1° 8'4.68"S, 36°22'40.37"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP11	Well Pad 2 Receptor 4 (Kisharu Comprehensive School)	1° 7'5.62"S, 36°22'29.90"E	H ₂ S, PM ₁₀ & PM _{2.5}

Location	Description	Coordinates	Pollutants Monitored
SP12	Well Pad 4 Receptor 1 (Community Water Point)	1° 6'58.23"S, 36°20'35.59"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP13	Well Pad 4 Receptor 2 (Community Water Point)	1° 6'57.21"S, 36°20'32.16"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP14	Well Pad 4 Location 1	1° 6'30.42"S, 36°20'34.43"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP15	Well Pad 4 Location 2	1° 6'30.71"S, 36°20'33.34"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP16	Well Pad 4 Receptor 3 (Residential)	1° 6'44.16"S, 36°20'43.76"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP17	Well Pad 4 Receptor 4 (Org'osoa Primary School)	1° 7'14.04"S, 36°20'27.10"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP18	Well Pad 4 Receptor 5 (Residential)	1° 7'24.88"S, 36°20'32.56"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP19	Well Pad 4 Receptor 5 (Kisharu Dispensary)	1° 7'15.32"S, 36°21'6.95"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP20	Well Pad 3 Location 1	1° 8'37.89"S, 36°19'18.84"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP21	Well Pad 3 Location 2	1° 8'40.12"S, 36°19'19.74"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP22	Well Pad 3 Receptor 1 (Residential)	1° 8'43.41"S, 36°19'27.91"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP23	Well Pad 3 Receptor 2 (Residential)	1° 8'28.96"S, 36°19'23.53"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP24	Well Pad 3 Receptor 3 (Residential)	1° 8'59.80"S, 36°19'19.96"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP25	Well Pad 3 Receptor 4 (Residential)	1° 8'58.73", 36°19'15.97"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP26	Proposed Campsite	1° 7'8.72"S, 36°23'26.80"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP27	Proposed Campsite Receptor 1 (Residential)	1° 7'9.46"S, 36°23'20.90"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP28	Proposed Campsite Receptor 2 (Residential)	1° 7'5.49"S, 36°23'16.95"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP29	Proposed Campsite Receptor 3 (Residential)	1° 7'5.47"S, 36°23'32.99"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP30	Material Site 1 Location 1	1° 6'39.13"S, 36°23'35.30"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP31	Material Site 1 Location 2	1° 6'36.95"S, 36°23'27.91"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP32	Well Pad 4 Receptor 6 (Residential)	1° 6'39.64"S, 36°21'8.80"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP33	Well Pad 4 Receptor (Kisharu KAG)	1° 7'7.80"S, 36°21'36.76"E	H ₂ S, PM ₁₀ & PM _{2.5}

Location	Description	Coordinates	Pollutants Monitored
SP34	Material Site 2 Location 1	1° 6'18.04"S, 36°25'2.72"E	H ₂ S, PM ₁₀ & PM _{2.5}
SP35	Material Site 2 Location 2	1° 6'19.72"S, 36°25'6.47"E	H ₂ S, PM ₁₀ & PM _{2.5}

6.3.1.1 Inhalable and Respirable Particulate Matter Results

Inhalable particulate matter from all assesses areas ranged between **7.8-35.5** µg/m³ with SP33 and SP4 having the lowest and highest concentrations, respectively. Similarly, respirable particulate matter concentration ranged between **2.3-11.3** µg/m³ with SP33 and SP4 having the lowest and highest concentrations respectively. A summary of the results is shown on **Table 26** below.

Table 26: Respirable and Inhalable Particulate Matter Sampling Results

Sampling Location	PM ₁₀ Results (in µg/m ³)	PM ₁₀ Results (in µg/m ³)	PM _{2.5} Results (in µg/m ³)	PM _{2.5} Results (in µg/m ³)
SP 1	10.3	150.0	3.4	75.0
SP 2	19.1		5.5	
SP 3	10.5		3.8	
SP 4	35.5		11.3	
SP 5	11.4		4.4	
SP 6	10.0		4.0	
SP 7	9.0		3.0	
SP 8	10.3		4.0	
SP 9	11.3		4.8	
SP 10	14.3		6.2	
SP 11	13.6		5.1	
SP 12	14.5		4.7	
SP 13	11.1		3.3	
SP 14	13.3		6.0	
SP 15	11.9		5.2	
SP 16	11.6		4.3	
SP 17	12.2		4.3	
SP 18	11.1		3.9	
SP 19	8.8		3.0	
SP 20	8.9		3.0	
SP 21	9.4		3.4	
SP 22	10.9		4.3	
SP 23	11.4		4.1	
SP 24	9.6		3.4	
SP 25	8.5		2.6	
SP 26	13.3		5.6	
SP 27	13.6		5.6	
SP 28	13.3		5.7	
SP 29	14.5		6.5	
SP 30	13.6		5.7	

Sampling Location	PM ₁₀ Results (in µg/m ³)	PM ₁₀ Results (in µg/m ³)	PM _{2.5} Results (in µg/m ³)	PM _{2.5} Results (in µg/m ³)
SP 31	16.0		7.3	
SP 32	8.1		2.4	
SP 33	7.8		2.3	
SP 34	11.9		5.3	
SP 35	13.9		5.9	

6.3.1.2 Hydrogen Sulphide Results

From the monitoring, hydrogen sulphide concentration ranged between **3.3-140.8** µg/m³ with SP27 (Proposed Campsite Receptor 1 -Residential) and SP22 (Well Pad 3 Receptor 1 -Residential) having the lowest and highest concentrations respectively. A summary of the results is as presented on **Table 27** below.

Table 27: Hydrogen Sulphide Sampling Results

Location	Hydrogen Sulphide Results (in µg/m ³)	Hydrogen Sulphide Tolerance Limit (in µg/m ³)
SP 1	5.4	125.0
SP 2	20.0	
SP 3	11.1	
SP 4	8.6	
SP 5	30.9	
SP 6	6.8	
SP 7	15.4	
SP 8	24.8	
SP 9	30.0	
SP 10	45.6	
SP 11	60.8	
SP 12	60.8	
SP 13	60.8	
SP 14	24.3	
SP 15	11.5	
SP 16	84.0	
SP 17	63.3	
SP 18	44.6	
SP 19	21.7	
SP 20	6.2	
SP 21	49.1	
SP 22	140.8	
SP 23	45.6	
SP 24	84.6	
SP 25	4.6	
SP 26	17.9	
SP 27	3.3	
SP 28	22.1	

Location	Hydrogen Sulphide Results (in µg/m³)	Hydrogen Sulphide Tolerance Limit (in µg/m³)
SP 29	18.1	
SP 30	28.7	
SP 31	44.6	
SP 32	87.0	
SP 33	24.6	
SP 34	41.9	
SP 35	11.2	

Thirty-five sampling locations were identified whereby measurement was carried out to assess for hydrogen dioxide and Inhalable Particulate Matter (PM₁₀), Respirable Particulate Matter (PM_{2.5}) concentration in air. Based on the monitoring, below is a summary;

- Inhalable particulate matter from all assesses areas ranged between **7.8-35.5** µg/m³.
- respirable particulate matter concentration ranged between **2.3-11.3** µg/m³.
- hydrogen sulphide concentration ranged between **3.3-140.8** µg/m³.

6.3.2 Noise Measurements

Baseline ambient noise and ground vibration assessment was undertaken in accordance with Environmental Management and Coordination (EMC) (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 Legal Notice No. 61. Measurements were undertaken between 26th November to 1st December, 2024.

The proposed geothermal resources exploration sites are situated in Suswa area in Kajiado and Narok counties. The area main land uses include agricultural, residential and conservation. Among key areas of interest proposed in the project include;

- Proposed Well Pad 1;
- Proposed Well Pad 2;
- Proposed Well Pad 3;
- Proposed Well Pad 4;
- Proposed camp site; and
- Proposed gravel material sites.

These were the key areas of interest for this assessment whereby measurements were carried. In addition, other areas where measurements were undertaken included sensitive receptors that included education facilities, health facilities, religious institution and residential establishments.

Table 28 below presents a summary of all sampling locations.

Table 28: Noise and Ground Vibration Measurements Locations

Location	Location Description	Coordinates	Parameters Assessed
SP1	Well Pad 1 Location 1	1°11'14.01"S, 36°20'56.99"E	Noise & Ground Vibration
SP2	Well Pad 1 Location 2	1°11'12.13"S, 36°20'54.49"E	
SP3	Well Pad 1 Tank Site	1°10'56.10"S, 36°20'56.70"E	

Location	Location Description	Coordinates	Parameters Assessed
SP4	Well Pad 1 Receptor 1(Residential)	1°11'29.48"S, 36°20'37.40"E	
SP5	Well Pad 1 Receptor 2 (Residential)	1°11'14.14"S, 36°20'24.15"E	
SP6	Well Pad 2 Location 1	1°8'9.83"S, 36°22'56.38"E	
SP7	Well Pad 2 Location 2	1°8'11.68"S, 36°22'57.70"E	
SP8	Well Pad 2 Receptor 1 (Residential)	1°8'15.10"S, 36°22'41.11"E	
SP9	Well Pad 2 Receptor 2 (Residential)	1° 8'19.88"S, 36°22'49.03"E	
SP10	Well Pad 2 Receptor 3 (Residential)	1° 8'4.68"S, 36°22'40.37"E	
SP11	Well Pad 2 Receptor 4 (Kisharu Comprehensive School)	1° 7'5.62"S, 36°22'29.90"E	
SP12	Well Pad 4 Receptor 1 (Community Water Point)	1° 6'58.23"S, 36°20'35.59"E	
SP13	Well Pad 4 Receptor 2 (Community Water Point)	1° 6'57.21"S, 36°20'32.16"E	
SP14	Well Pad 4 Location 1	1° 6'30.42"S, 36°20'34.43"E	
SP15	Well Pad 4 Location 2	1° 6'30.71"S, 36°20'33.34"E	
SP16	Well Pad 4 Receptor 3 (Residential)	1° 6'44.16"S, 36°20'43.76"E	
SP17	Well Pad 4 Receptor 4 (Org'osoa Primary School)	1° 7'14.04"S, 36°20'27.10"E	
SP18	Well Pad 4 Receptor 5 (Residential)	1° 7'24.88"S, 36°20'32.56"E	
SP19	Well Pad 4 Receptor 5 (Kisharu Dispensary)	1° 7'15.32"S, 36°21'6.95"E	
SP20	Well Pad 3 Location 1	1° 8'37.89"S, 36°19'18.84"E	
SP21	Well Pad 3 Location 2	1° 8'40.12"S, 36°19'19.74"E	
SP22	Well Pad 3 Receptor 1 (Residential)	1° 8'43.41"S, 36°19'27.91"E	
SP23	Well Pad 3 Receptor 2 (Residential)	1° 8'28.96"S, 36°19'23.53"E	
SP24	Well Pad 3 Receptor 3 (Residential)	1° 8'59.80"S, 36°19'19.96"E	
SP25	Well Pad 3 Receptor 4 (Residential)	1° 8'58.73",	

Location	Location Description	Coordinates	Parameters Assessed
		36°19'15.97"E	
SP26	Proposed Campsite	1° 7'8.72"S, 36°23'26.80"E	
SP27	Proposed Campsite Receptor 1 (Residential)	1° 7'9.46"S, 36°23'20.90"E	
SP28	Proposed Campsite Receptor 2 (Residential)	1° 7'5.49"S, 36°23'16.95"E	
SP29	Proposed Campsite Receptor 3 (Residential)	1° 7'5.47"S, 36°23'32.99"E	
SP30	Material Site 1 Location 1	1° 6'39.13"S, 36°23'35.30"E	
SP31	Material Site 1 Location 2	1° 6'36.95"S, 36°23'27.91"E	
SP32	Well Pad 4 Receptor 6 (Residential)	1° 6'39.64"S, 36°21'8.80"E	
SP33	Well Pad 4 Receptor (Kisharu KAG)	1° 7'7.80"S, 36°21'36.76"E	
SP34	Material Site 2 Location 1	1° 6'18.04"S, 36°25'2.72"E	
SP35	Material Site 2 Location 2	1° 6'19.72"S, 36°25'6.47"E	

6.3.2.1 Ambient Noise Measurement Results

Ambient noise equivalent noise results from all the sampling locations ranged between 41.0-72.2 dB(A) with SP27 and SP1 having the lowest and highest noise levels respectively. Similarly, L_{90} results from all the measurement results ranged between 24.7-62.0 dB(A) with SP12 and SP1 having the lowest and highest noise levels respectively. A summary of the noise measurement results is provided on **Table 29** below.

Table 29: Summary of Noise Measurement Results

Location	Location Description	Leq (dBA)	EMCA Limit (dB)	WHO Limit (dB)	IFC Limit (dB)	L ₁₀ (dB)	L ₅₀ Leq (dB)	L ₉₀ Leq (dB)	R2 (in m)	Altitude (in m)
SP 1	Well Pad 1 Location 1	72.2	60.0	-	70.0	75.7	68.8	58.8	61.15	2131
SP 2	Well Pad 1 Location 2	70.4	60.0	-	70.0	73.6	67.4	62	43.53	2128
SP 3	Well Pad 1 Tank Site	54.5	60.0	-	70.0	53	38.4	34.3	510.96	2220
SP 4	Well Pad 1 Receptor 1(Residential)	56.5	50.0	55.0	55.0	62.4	43.6	39.2	774.46	2042
SP 5	Well Pad 1 Receptor 2 (Residential)	54.6	50.0	55.0	55.0	54.7	45.8	36.5	974.37	2096
SP 6	Well Pad 2 Location 1	46.1	60.0	-	70.0	49.7	40.3	34	33.99	1877
SP 7	Well Pad 2 Location 2	52.4	60.0	-	70.0	56.2	41.9	36	38.77	1878
SP 8	Well Pad 2 Receptor 1 (Residential)	47.8	50.0	55.0	55.0	49.2	36	31.8	509.00	1871
SP 9	Well Pad 2 Receptor 2 (Residential)	46.7	50.0	55.0	55.0	47.8	38.4	30.4	380.12	1881
SP 10	Well Pad 2 Receptor 3 (Residential)	48.9	50.0	55.0	55.0	51.4	38.4	31.6	544.56	1857
SP 11	Well Pad 2 Receptor 4 (Kisharu Comprehensive School)	62.1	40.0	35.0	55.0	56.1	42.2	32.5	2178.94	1830
SP 12	Well Pad 4 Receptor 1 (Community Water Point)	42.9	50.0	55.0	55.0	39.1	30.1	24.7	864.78	1826
SP 13	Well Pad 4 Receptor 2 (Community Water Point)	43.7	50.0	55.0	55.0	46.4	34	29.2	854.93	1830
SP 14	Well Pad 4 Location 1	48.5	60.0	-	70.0	42.5	30.3	28.6	16.2	1963
SP 15	Well Pad 4 Location 2	55.4	60.0	-	70.0	47	31.9	30.3	22.36	1953
SP 16	Well Pad 4 Receptor 3 (Residential)	48.7	50.0	55.0	55.0	54.2	37.6	30.1	529.17	1852

Location	Location Description	Leq (dBA)	EMCA Limit (dB)	WHO Limit (dB)	IFC Limit (dB)	L ₁₀ (dB)	L ₅₀ Leq (dB)	L ₉₀ Leq (dB)	R2 (in m)	Altitude (in m)
SP 17	Well Pad 4 Receptor 4 (Org'osoa Primary School)	65.2	40.0	35.0	55.0	66.2	54	37.3	1367.77	1824
SP 18	Well Pad 4 Receptor 5 (Residential)	48.5	50.0	55.0	55.0	51.7	35.3	27.3	1687.89	1815
SP 19	Well Pad 4 Receptor 5 (Kisharu Dispensary)	45.4	40.0	35.0	55.0	49	31.5	28.5	1719.16	1823
SP 20	Well Pad 3 Location 1	45.3	60.0	-	70.0	47	34.6	28	32.15	1872
SP 21	Well Pad 3 Location 2	43.3	60.0	-	70.0	46	32.5	27.4	50.28	1870
SP 22	Well Pad 3 Receptor 1 (Residential)	47.3	50.0	55.0	55.0	50.2	39.8	32	306.74	1876
SP 23	Well Pad 3 Receptor 2 (Residential)	49.6	50.0	55.0	55.0	49.7	35.4	30.5	333.56	1873
SP 24	Well Pad 3 Receptor 3 (Residential)	52.6	50.0	55.0	55.0	56.6	46.1	35.1	654.62	1876
SP 25	Well Pad 3 Receptor 4 (Residential)	47.1	50.0	55.0	55.0	50.8	39.7	31.1	624.2	1874
SP 26	Proposed Campsite	45.0	50.0	55.0	55.0	45	36	30.5	66.79	1858
SP 27	Proposed Campsite Receptor 1 (Residential)	40.1	50.0	55.0	55.0	42.8	31.8	27.4	245.61	1852
SP 28	Proposed Campsite Receptor 2 (Residential)	50.0	50.0	55.0	55.0	54.8	37.1	29	386.39	1848
SP 29	Proposed Campsite Receptor 3 (Residential)	47.1	50.0	55.0	55.0	50.3	41.4	31.4	168.22	1852
SP 30	Material Site 1 Location 1	48.4	60.0	-	70.0	48.7	39.9	29.7	103.2	1853
SP 31	Material Site 1 Location 2	54.9	60.0	-	70.0	53.4	41.8	31.1	126.82	1867

Location	Location Description	Leq (dBA)	EMCA Limit (dB)	WHO Limit (dB)	IFC Limit (dB)	L ₁₀ (dB)	L ₅₀ Leq (dB)	L ₉₀ Leq (dB)	R2 (in m)	Altitude (in m)
SP 32	Well Pad 4 Receptor 6 (Residential)	53.3	50.0	55.0	55.0	55.3	47.9	39.3	1120.76	1837
SP 33	Well Pad 4 Receptor (Kisharu KAG)	47.4	50.0	55.0	55.0	54.6	29.3	26.5	2251.01	1827
SP 34	Material Site 2 Location 1	50.8	60.0	-	70.0	53.5	40	33.5	23.32	1680
SP 35	Material Site 2 Location 2	46	60.0	-	70.0	46.8	40.1	32.2	32.95	1682

Discussions of Results

Ambient noise equivalent noise results from all the sampling locations ranged between 41.0-72.2 dB(A) with SP27 (Proposed Campsite Receptor 1 (Residential)) and SP1 (Well Pad 1 Location 1) having the lowest and highest noise levels respectively.

From **Table 29** above, it is evident that most sampling locations had their noise levels within the EMC Noise & Excessive Vibrations Regulations 2009, WHO and IFC recommended limits. However, a number of sampling locations had their noise levels above the recommended limits and are as summarized below:

- Well Pad 1 Location 1 and Well Pad 1 Location 2 had their noise levels above the EMC Noise Regulations 2009, WHO and IFC recommended limits mainly due to the earth moving operations that were taking place at the time of the assessment.
- Well Pad 1 Receptor 1(Residential) and Well Pad 1 Receptor 2 (Residential) had their noise levels above the recommended limits mainly due to noise levels from earth moving operations.
- Kisharu Comprehensive School, Org'osoa Primary School and Kisharu Dispensary had their noise levels above EMC Noise Regulations, WHO and IFC recommended limits. This can mainly be attributed to thunderstorms experienced at the time of the assessment.
- The high noise levels above EMC Noise Regulations 2009 recommended limit at Well Pad 4 Receptor 6 (Residential) can mainly be attributed to ongoing construction at the residential establishment.

6.3.3 Ground Vibration Measurement Results

Based on the assessment, ground vibration; Peak Particle Velocity (PPV) results from all sampling locations ranged between 0.106-2.114 mm/s as shown in **Table 30** below. SP3 and SP2 had the lowest and highest vibration levels respectively.

Table 30:Summary of ground vibration measurement results

Sampling Location	PPV Results (mm/s)	Threshold Limit (in mm/s)
SP 1	1.710	5.000
SP 2	2.114	
SP 3	0.106	
SP 4	0.614	
SP 5	0.491	
SP 6	0.111	
SP 7	0.175	
SP 8	0.250	
SP 9	0.435	
SP 10	0.565	
SP 11	0.541	
SP 12	0.209	
SP 13	0.437	
SP 14	0.321	
SP 15	0.669	
SP 16	0.970	
SP 17	0.311	
SP 18	0.400	

Sampling Location	PPV Results (mm/s)	Threshold Limit (in mm/s)
SP 19	0.203	
SP 20	0.123	
SP 21	0.202	
SP 22	0.995	
SP 23	0.496	
SP 24	0.392	
SP 25	0.439	
SP 26	0.718	
SP 27	0.597	
SP 28	0.818	
SP 29	0.552	
SP 30	0.677	
SP 31	0.738	
SP 32	0.339	
SP 33	0.912	
SP 34	0.114	
SP 35	0.947	

Thirty-Five sampling locations were identified whereby ambient noise and ground vibration measurements were undertaken and a comprehensive report is annexed. Based on the measurements, below is a summary;

- Ambient noise equivalent noise results from all the sampling locations ranged between 41.0-72.2 dB(A);
- L_{90} results from all the measurement results ranged between 24.7-62.0 dB(A); and
- Ground vibration results from all sampling locations ranged between 0.106-2.114 mm/s.

6.3.4 Soil measurements

Overview

Soil sampling was undertaken between 2nd and 3rd December, 2024. The report is attached as **Annex 3**. The objective of the assessment was to establish baseline soil quality in the proposed project for the purpose of future monitoring. The scope of the assessment included collection of five soil samples from the proposed well pad 1, well pad 2, well pad 3, well pad 4 and campsite. Parameters analysed were limited to pH, salinity (EC), Arsenic (As), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Molybdenum (Mo), Nickel (Ni) and Lead (Pb). This report therefore details baseline soil quality for the proposed development project area.

ISO 18400-104:2018 Soil quality — Sampling Part 104: Strategies was adopted in soil sampling. Soil samples were obtained for between 15-30 cm above the surface. Composite samples were obtained from each site in duplicate with each sample weighing approximately 500g. Soil analysis was undertaken by Crop Nutrition Laboratory Services, an ISO/ ICE 17025 Accredited Laboratory for analysis, with Potentiometric (for pH and Salts) and Aqua regia – ICP (for metals) methods adopted in the soil analysis.

Table 31 below shows the soil samples analysis results.

Table 31: Soil samples analysis results within Suswa project

Field Name	pH	EC(S) (uS/cm)	As (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	Co (mg/kg)	Mo (mg/kg)	Ni (mg/kg)	Pb (mg/kg)
Well Pad 1	6.72	42.3	< 0.20	0.67	1.11	2.26	2.50	< 0.10	12.5
Well Pad 2	6.60	33.3	< 0.20	0.26	1.62	1.75	2.46	< 0.10	11.7
Well Pad 4	6.48	46.8	< 0.20	< 0.20	0.69	1.71	2.10	< 0.10	15.1
Well Pad 3	6.67	34.2	0.43	0.38	0.88	1.98	2.29	< 0.10	9.89
Proposed Campsite	7.51	57.8	< 0.20	< 0.20	0.92	1.44	2.45	< 0.10	10.9
Limits									
Laboratory Standards	6.0 - 6.8	< 800	< 20.0	< 30.0	< 200	< 30.0	< 1.00	< 75.0	< 450
Canadian Environmental Quality Guidelines CEQGs (Upper Limit)	6.0-8.0	-	<12	<22	<87	<300	<40	<89	<600
Tanzania (Upper Limit)	-	-	<1	<1	<100	-	<5	<100	<200
Dutch (Upper Limit)	-	-	<55	<12	<380	<240	<200	<210	<530
Latvia (Upper Limit)	-	-	<40	<100	<350	-	-	<200	<500

It is therefore expected that Molybdenum and other analyzed parameters concentration in soil is anticipated from the proposed project implementation if proper measures are not put in place. This will mainly be from brine that should be efficiently managed in minimizing discharge in the environment. Continuous soil monitoring is therefore recommended in monitoring trends in soil pollution.

6.3.5 Water quality measurements

Overview

Water sampling was undertaken between 2nd and 3rd December, 2024. The water quality report is attached in Annex 4. The objective of the assignment was to detail baseline water quality within the proposed project area. The scope of the assignment involved water sampling within Kikuiyani Dam, proposed Well Pad 1, Well Pad 2, Well Pad 3 and Well Pad 4 from Water pans, Rivers, Rain Water and Fumaroles. The parameters analyzed included pH, Electrical Conductivity, Aluminum, Ammonium, Calcium, Magnesium, Potassium, Sodium, Nitrates, Sulphate, Chloride, Phosphate, Fluoride, Nitrite, Boron, Copper, Iron, Manganese, Zinc, Hardness, Turbidity, Total Suspended Solids, Total Dissolved Solids, Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Nickel, Molybdenum, Selenium, Residual Free Chlorine Cl(residual) and E. Coli.

ISO 5667-1:2023 Water quality — Sampling Part 1: Guidance on the design of sampling programmes and sampling techniques was adopted in water sampling from all the sources. The samples obtained were then

transported to Crop Nutrition Laboratory Services, an ISO/ ICE 17025 Accredited Laboratory for analysis. Respective ISO and EPA methods were applied for respective parameters analysis.

Sixteen water samples were collected from the proposed project area from water pans, rivers, rain water and fumaroles. The water samples were obtained from water sources from Kikuiyan Dam, proposed well pad 1, well pad 2, well pad 3 and well pad 4. From the analysis, below is a summary of the results. A comprehensive water quality results is annexed to the report for further reference

- E. coli results from SWS 4, SWS 5, SWS 6, SWS 7, SWS 8, SWS 1 and SWS 2 was above the guideline limit. This can mainly be attributed livestock droppings due to the fact that water pans in the areas are the main source of drinking water from livestock.
- Aluminum results from SWS 1, SWS 2, SWS 3, SWS 4, SWS 5, SWS 6 and SWS 8 were above guideline limit of below 0.20 ppm.
- Ammonia results from SWS 4, SWS 5, SWS 6, SWS 7 and SWS 1 were above guideline limit of below 0.50ppm. can mainly be attributed livestock urine due to the fact that water pans in the areas are the main source of drinking water from livestock.
- Fluoride results from SWS 1, SWS 2 and SWS 8 was above guideline limit of below 1.50ppm. All these samples were from control samples that are outside the proposed project area.
- Iron results from SWS 4, SWS 5, SWS 6, SWS 1 and SWS 8 were above guideline limit of below 0.30 ppm.
- Manganese result from SWS 6 was above guideline limit of below 0.1ppm.
- Turbidity results from SWS 1, SWS 2, SWS 3, SWS 4, SWS 5, SWS 6, SWS 7 and SWS 8 were above guideline limit of 2.5 NTU. All these samples were from surface water sources hence the high levels of turbidity with the samples collected during a rainy season.
- Total suspended solids result from all the sampled samples were above the guideline limit.

Table 32 below shows the water analysis results for various water sources in the Suswa project area.

Table 32: Water Laboratory Analysis results for various water sources in the Suswa Project area

Water Source	FWS 1	FWS 2	FWS 3	FWS 4	FWS 5	FWS 6	RWS 1	RWS 2	SWS 1	SWS 2	SWS 3	SWS 4	SWS 5	SWS 6	SWS 7	SWS 8	Guide High
pH	5.65	7.08	6.87	6.18	5.50	5.89	5.70	6.08	7.77	7.94	6.98	6.95	6.96	7.32	7.12	7.15	5.50-9.50
E. coli (mpn/100ml)	ND	ND	ND	ND	ND	ND	ND	ND	23	33	ND	5	110	8	5	23	ND
EC (mS cm -1)	0.0048	0.027	0.0063	0.0032	0.0087	0.0021	0.011	0.009	0.35	0.14	0.062	0.024	0.11	0.12	0.029	0.095	<2.5
Al (ppm)	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	9.89	0.46	0.21	2.19	0.23	15.7	0.12	0.84	<0.20
NH4 (ppm)	0.044	0.086	0.21	0.059	0.15	0.035	0.28	0.26	2.78	0.12	0.081	0.75	5.32	2.92	0.77	0.26	<0.50
Ca (ppm)	0.58	2.78	0.55	0.27	0.58	0.068	0.48	0.58	9.51	4.62	1.61	0.38	2.65	7.89	1.35	4.24	<150
Mg (ppm)	0.073	1.07	0.10	0.021	0.085	< 0.02	0.085	0.089	3.29	1.29	0.69	0.18	1.03	2.29	0.23	0.57	<100
K (ppm)	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	25.1	9.87	12.6	2.72	17.7	20.9	3.51	13.2	<50.0
Na (ppm)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	57.9	19.9	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	4.28	<200
NO3 (ppm)	0.97	< 0.01	< 0.01	0.071	1.77	< 0.01	2.61	1.59	24.2	2.12	5.22	0.66	2.26	1.77	0.66	18.7	<45.0
SO4 (ppm)	<0.047	<0.017	<0.017	<0.017	<0.017	<0.017	0.18	0.24	15.0	5.90	1.68	0.21	1.56	3.09	0.26	8.00	<400
Cl (ppm)	0.31	0.25	< 0.10	0.32	0.78	< 0.10	0.13	0.14	18.9	5.20	2.42	1.07	5.13	0.60	0.11	2.37	<250
PO4 (ppm)	<0.014	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.014	0.46	0.13	0.22	0.25	0.46	0.58	< 0.01	0.15	<2.20
Fl (ppm)	0.11	0.081	0.084	0.086	0.17	0.19	0.23	0.22	3.28	2.12	0.31	0.45	1.18	1.33	0.43	1.81	<1.50
NO2 (ppm)	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	0.037	<0.033	<0.033	0.033	0.097	0.20	0.11	0.32	<0.90
B (ppm)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.034	< 0.01	< 0.01	< 0.01	< 0.01	0.044	< 0.01	0.015	<2.40
Cu (ppm)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	<1.0
Fe (ppm)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	6.50	0.35	0.18	1.19	0.26	13.0	0.10	0.57	<0.30
Mn (ppm)	0.021	0.042	< 0.01	< 0.01	0.02	< 0.01	0.024	0.013	0.091	< 0.01	0.016	0.028	< 0.01	0.26	< 0.01	0.013	<0.10
Zn (ppm)	< 0.01	< 0.01	0.35	0.21	0.61	0.024	0.28	0.13	0.032	< 0.01	< 0.01	< 0.01	< 0.01	0.069	< 0.01	< 0.01	<5.00
CaCO3 (ppm)	1.75	11.3	1.78	0.76	1.80	0.25	1.55	1.81	37.3	16.8	6.85	1.69	10.8	29.1	4.32	12.9	<600
TUB (NTU)	0.47	0.52	0.36	1.03	1.13	0.28	1.41	1.71	333	28.1	59.1	69.7	447	158	12.1	46.6	<2.50
TSS (ppm)	1.00	1.00	1.00	2.00	3.00	3.00	2.00	7.00	692	106	72.0	172	444	124	60.0	174	ND
TDS (ppm)	3.00	17.0	4.00	2.00	5.50	1.30	6.90	5.70	218	89.0	39.0	15.0	71.0	76.0	18.0	60.0	<1500
As (ppm)	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.01
Ba (ppm)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.70
Cd (ppm)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.003
Cr (ppm)	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.05
Pb (ppm)	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.01
Hg (ppm)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ni (ppm)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.02
Mo (ppm)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.07
Se (ppm)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.01
Cl(residual) (ppm)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Water Source	FWS 1	FWS 2	FWS 3	FWS 4	FWS 5	FWS 6	RWS 1	RWS 2	SWS 1	SWS 2	SWS 3	SWS 4	SWS 5	SWS 6	SWS 7	SWS 8	Guide High
Key:		Above Guideline Limit										Within Guideline Limit					

6.4 Socio-Economic Baseline

6.4.1 Administrative units

Kajiado County is divided into five administrative sub-counties namely; Kajiado, Central, Kajiado North, Loitokitok, Isinya and Mashuuru, with a total of 19 administrative divisions as shown in **Table 33** below.

Table 33: Kajiado County administration units

Sub-County	Area (sq. km)	No. of Divisions	No. of locations.	No. of Sub-locations
Kajiado North	111	2	10	23
Kajiado West	7862	3	31	55
Kajiado East	3322	6	20	36
Kajiado South	6337	4	18	38
Kajiado Central	4240	4	31	55
Total	21,872	19	105	215

Source: Kajiado County Development Plan 2023-2027.

The proposed project is located in Kajiado West which covers a total area of 7862km². It is divided into five wards including Keekonyoike, Mosiro, Ewuaso Nkidong, Illoodokilani and Magadi. It has a total of 13 locations and 31 sub locations.

Administratively, Narok County has had six sub-counties during the devolution era until after 2019 when two new sub-counties, Transmara South and Narok Central were created. The initial sub-counties comprised of Transmara West, Transmara East, Narok North, Narok South, Narok West and Narok East. **Table 34** the area and administrative units in Narok Sub-counties.

Table 34: Area and Administrative units in Sub-counties within Narok County

Sub-County	Area (sq. km)	No. Divisions	No. Locations	No. Sub-Locations
Narok East	2123.45	4	12	29
Narok North	920.3	2	11	27
Narok Central	1239.1	2	7	14
Narok South	5452.79	4	20	39
Narok West	5452.79	3	17	35
Transmara East	311	2	6	13
Transmara West	2301	3	18	40
Transmara South	224	5	17	32
Total	18,024.43	25	108	229

Source: Narok County Development Profile 2023-27.

Narok East Sub County is divided into four wards namely Mosiro, Ildamat, Keekonyokie and Suswa. It has a total of 4 divisions, 12 locations, 29 sub locations and 172 villages.

6.4.2 Population Density and Distribution

Table 35 below indicates population distribution and density of the two sub counties where the project will be located. Kajiado West is relatively larger in terms of total area as compared to Narok East.

Table 35: Kajiado West and Narok East Sub Counties Population density and distribution

County	Area(km ²)	2019 Census		2025 Projections		2027 projections	
		Population	Density	Population	Density	Population	Density
Narok East	2,042	115,323	56	134,976	66	142,580	70
Kajiado West	7,862	182,849	23	217,214	28	226,844	29

Source: Kajiado and Narok CIDPs 2023-27.

Kajiado West, where the project lies has a lower density of 23 persons km² as compared to Narok East due to its vastness. It's also sparsely populated due to harsh climatic conditions unfavourable for farming and settlement.

6.4.3 Disease Prevalence in Narok and Kajiado Counties

The five most common diseases in Narok County in order of prevalence are upper respiratory tract infection, skin diseases, diarrhoea, malaria and pneumonia (County Government of Narok, 2018). The top five most common causes of morbidity in Kajiado County, in order of prevalence are: Disease of Respiratory System (45.1 percent), Diarrhoea (9.1 percent), Skin Disease (8.1 percent), Pneumonia (6.5 percent), and Urinary Tract Infection (5.0 percent) (County Government of Kajiado, 2018). Continued use of unclean fuels for heating coupled with climate change is likely to increase the prevalence of these top five diseases in the 2 counties.

6.4.4 HIV/AIDS Prevalence

HIV/AIDS is a major developmental and health problem affecting socio-economic and cultural aspects of life. Kenya has made significant progress in reducing the HIV epidemic. In the last 10 years, new HIV infections in Kenya declined by 83% across all populations from 101,448 in 2013 to 16,752 in 2023 (National Syndemic Diseases Control Council, 2024).

Currently, the country has an estimated 1,378,457 people living with HIV, with a prevalence rate of 3.3%. The prevalence is higher among females (4.5%) compared to males (2.2%). Among key populations, HIV prevalence is notably higher, with rates of 29.3% among sex workers, 18.2% among men who have sex with men, and 18.3% among people who inject drugs. Kajiado county ranks 19 nationally in the HIV epidemic, with an estimated 25,746 people living with HIV at 2.5% HIV prevalence rate. New HIV infections in 2023 were 538 (139 men and 296 women). Narok county ranks 26 nationally with an estimated 15,918 people living with HIV at 1.8% HIV prevalence rate. In 2023, 93 men and 216 women were infected thus translating to 399 new infections (National Syndemic Diseases Control Council, 2024). From these statistics, women are at a higher risk of contracting HIV/AIDS thus considered vulnerable.

6.4.5 Household Energy Utilization and Related Indoor Air Pollution

The percentage distribution of households using dirty cooking fuels (paraffin, firewood and charcoal) in rural areas is 94.6 and 74.5 percent in urban areas of Kajiado County. Firewood is the most used cooking fuel in rural areas with 75.3% of households while charcoal is mostly used in urban areas with 35.6 percent

households (County Government of Kajiado, 2018). Similarly, firewood and charcoal remain the most common sources of energy in Narok County accounting for 80% of total energy used (County Government of Narok, 2018). According to the World Health Organization, combustion of unclean fuels such as charcoal, wood, dung and kerosene, during the heating process, releases air emissions such as carbon monoxide and particulate matter that can result in Household Air Pollution (HAP) levels many times higher than acceptable air quality levels.

The health impacts associated with HAP include childhood pneumonia, cardiovascular diseases, chronic obstructive respiratory disease, lung cancer and cataracts (Younger et al, 2021). In addition, a range of birth outcomes are reported across studies reviewed by Younger et al, 2021. These include spontaneous abortion, low birth weight, preterm birth, small for gestational age, stillbirth, neonatal mortality and reduction in birthweight. Another review of 43 studies revealed that exposure to air pollutants such as particulate matter, carbon monoxide and cooking smoke may be associated with higher risk for stillbirth and spontaneous abortion (Grippio et al, 2020). The traditional Maasai manyattas have very poor ventilation which puts the occupants at a higher risk of exposure to air pollutants. Women are the most affected by the HAP since they are the ones who spend most of their time in the kitchen while preparing food for the larger family.

6.5 Land Use

The main land use in the in the project area is: residential, commercial, educational purposes, public utilities, small scale industries, recreation, conservation (wildlife and forestry) crop production and livestock production. Pastoralism is the predominant form of economic activity in the project area.

6.5.1 Crop Production

The population in the Narok East and Kajiado West sub-Counties are engaged in activities in the agriculture sector making it a contributor to household incomes.

Narok East Sub-County exhibits a diverse agricultural landscape characterized by both traditional and emerging farming practices. Agriculture in this semi-arid region is influenced by climatic conditions, with farmers employing various strategies to adapt to the challenges posed by climate variability.

In Narok East Sub County, farmers cultivate a mix of staple and cash crops:

- **Staple Crops:** Maize and beans are predominantly grown for household consumption and local markets as shown in the Figure 21 below of harvested maize stocks. These crops are rain-fed, making them vulnerable to climatic fluctuations.
- **Cash Crops:** Wheat, barley, French beans, onions, and tomatoes are cultivated, especially in the highland areas where irrigation is more feasible. French beans, in particular, are a significant export crop

To cope with climate change and variability, farmers in Narok East have adopted several strategies including;

- **Early Planting:** Initiating planting activities early to align with the onset of rains.
- **Use of Organic and Inorganic Fertilizers:** Enhancing soil fertility to boost crop yields.
- **Terracing:** Implementing soil conservation methods to prevent erosion.
- **Short-Season Crops:** Opting for crops that mature quickly to mitigate the effects of unpredictable rainfall patterns.

Kajiado West Sub-County, located semi-arid area, has experienced a significant transformation in its agricultural landscape. While traditionally dominated by pastoralism, the region is increasingly embracing crop production, driven by innovations in irrigation and climate-smart practices.

- **Key crops and farming practices**

Horticulture and Irrigated Farming (Source; Soko Directory)

Farmers in Kajiado West have adopted irrigation techniques, including the use of water pans and drip irrigation systems, to cultivate a variety of crops. Commonly grown crops include:

- Tomatoes: Varieties such as Bawito F1, Master F1, Mavuno F1, and Chonto F1 thrive in the region's conditions.
- Onions: Cultivated using both open field and greenhouse methods.
- Watermelon: Grown successfully, benefiting from the region's warm climate.
- Vegetables: Crops like sukuma wiki and spinach are also prevalent.

- **Irrigation and water management**

According to National Irrigation Authority (NIA), access to water has been a critical factor in the expansion of crop farming in Kajiado West. NIA has implemented projects like the Olookil water pan, which, along with other community water pans, provides irrigation potential for up to 260 acres, benefiting approximately 260 households.

- **Market access and economic Impact**

The adoption of irrigation and crop diversification has opened new markets for farmers in Kajiado West. Crops such as tomatoes, onions, and watermelon are not only sold locally but also have the potential for national and international markets. Maize is also grown locally and sold in the local and regional markets. **Figure 23** below shows stocks of maize which have already been harvested. The establishment of irrigation schemes like the Nkurumani scheme is expected to further boost agricultural productivity and incomes in the region. (Source; [Knowledge Hub](#))

The accessibility and quality of local markets remain a significant challenge for the community. Many respondents cited the absence of a slaughterhouse and a proper marketplace, which limits their ability to sell their products. Distance was repeatedly mentioned as a major barrier, with 6.4% of respondents highlighting how far the market is from their homes. Coupled with poor road infrastructure, lack of transportation means, and inadequate public facilities, market access remains a difficult task for many traders and farmers.

Poor infrastructure—such as inadequate drainage systems, lack of proper shelters, and limited space—hinders business activities. Several respondents pointed out that the market is often dirty, lacks proper waste management, and is affected by poor hygiene conditions. This discourages traders and customers alike, reducing economic activity.

Security concerns also emerged, with some respondents reporting issues like theft, insecurity, and the absence of proper fencing and lighting. The lack of essential utilities such as water, electricity, and sanitary facilities further exacerbates the situation. Many suggested that modernizing the market by improving roads, constructing new structures, and ensuring proper drainage systems would enhance trade and economic opportunities.



Figure 23: View of the field with maize stocks

6.5.2 Livestock Farming

The primary land use in the project area was livestock keeping, reported by 155 respondents (41.2). Mount Suswa provides a variety of food resources that are integral to the nutrition and well-being of the local population. Livestock products, including milk and meat, are the primary sources of sustenance for many households, supported by the grazing lands on the mountain. Additionally, wild fruits and berries, which are seasonal, serve as supplemental nutrition for 20% of respondents. Honey, harvested through traditional beekeeping or wild collection, is relied upon by 50% of households for its nutritional and medicinal value.

Game meat, though accessed by 15% of households, remains a contentious resource due to its illegal status under wildlife protection laws. Nonetheless, it serves as an alternative protein source. Edible plants and herbs are gathered by 80% of respondents, frequently used in traditional soups and teas as a substitute for commercial tea leaves.

The reliance on Mount Suswa's resources varies among households. About 60% of respondents depend on these resources daily, particularly for water, firewood, and grazing. For 30%, the reliance is occasional, tied to seasonal or cultural needs such as honey collection or herb gathering. However, 20% of respondents reported rare use, often due to alternative resource availability or restrictions on access.

Over the past 5-10 years, 75% of respondents have observed a decline in resource availability. Charcoal burning has significantly increased deforestation, reducing vegetation cover and impacting the availability of honey. While the springs have not experienced significant changes, some community and personal dams tend to dry up during prolonged dry periods. Despite these challenges, slight improvements have been noted in certain areas, attributed to community-led reforestation efforts and controlled grazing practices.

Livestock production within the project area is practiced on a high scale. Some of the animals kept include; cattle, goats, sheep, donkeys and poultry. **Figure 24** and **25** below shows goats grazing in the neighbourhood and cattle pen, an indicator of livestock keeping in the area respectively.



Figure 24: Goats observed grazing within the project area



Figure 25: A view of a Cattle pen observed within the project area

6.6 Infrastructure

6.6.1 Roads and accessibility

The Ngong –Ewuaso Kedong road is Class D and has been regraded and drainage constructed at sections, with funding from Africa Development Bank (AfDB). However, there is no classified road access from Suswa Market or Duka Moja Market Centres to the prospect geothermal drilling area around the outer caldera.

The project site is accessible through tracks that generally run in a southerly / south easterly direction to reach a crossing point with a signpost of Mt. Suswa Conservancy on the slope of the hill, from which there exists a single track up the hill.

There are four distinct sections that are apparent along the existing routes, these being:

- Section 1: Road B3 to Mt. Suswa Conservancy Signpost
- Section 2: Mt. Suswa Conservancy Signpost to prospect project Boundary
- Section 3: Concession Boundary to Crater Rim
- Section 4: Caldera Floor

Each of the above noted sections was surveyed and three separate access roads from Road B3 to the Mt. Suswa Conservancy signpost were surveyed.

The proposed project sites can be accessed through Maai Mahiu- Narok-Bomet road shown in **Figure 26** below. The road is a single carriage way, providing access to the south region of rift valley to and from Nairobi. It has high economic importance and therefore the traffic sometimes is heavy. The site location will be accessed by a Murram road as shown in **Figure 27**.



Figure 26: View of Maai Mahiu Narok Road



Figure 27: A view of the access road to the site

6.6.2 Water supply and drainage

The Rift Valley has an internal drainage system with its main rivers draining from both the Aberdares and the Mau escarpments into the various inland lakes in the floor of the rift valley. Lake Naivasha is the main significant surface water source near the project site. There are however, numerous seasonal streams with high runoff volumes during the rainy season.

Groundwater potentiality is very poor especially in Mosiro, Suswa, Nairegie Enkare and Ntulele location in Narok North. Kajiado North district is also a water- deficit area with few perennial rivers that are along the borders with other districts such as Athi, Ewuaso Nyiro and Pakase Rivers. The alternative water sources for the communities are pans/dams and boreholes.

There are occasional flash floods that appear to cause severe soil erosion. Mount Suswa has a radial drainage pattern along the outer rim of the caldera and an internal drainage towards the inner caldera. The storm runoff

flows in different directions depending on the orientation and gradient of the slopes. The slope angles are more variable but generally range from 0° to 10°.

The only sources of water from the Kijabe-Ewuaso Kedogo catchment are its two streams the main Ewuaso Kedong River (which has more than ten (10) tributaries) and the Little Ewuaso Kedong River. The main Ewuaso Kedong River is heavily harvested in the upstream Kijabe area and hardly any water flows beyond the escarpment. These water sources are not proposed for further exploitation and expansion by the project proponent as a main source of water as they are too small for drilling purposes.

The most reliable alternative sources of water would be Olkaria geothermal zone and Lake Naivasha which are likely to provide constant and reliable source of water for the initial drilling process.

Other sources of water are the local rivers, boreholes, dams/pans, shallow wells and seasonal streams. The Little Ewuaso Kedong River has a substantial flow but the water is not adequate to meet the needs of the people and certainly would not meet the drilling water requirements. Both Narok East and Kajiado West Sub Counties are a semi-Arid area, and the water availability is scarce. Most of the people depend on water pans, fumaroles and a few from available streams.

Among the Maasai community, ensuring the household's water supply falls under responsibility of the women. Considerable time and energy are spent daily on collecting water and caring for family members suffering from water related illnesses. Improving access to a safe water supply and basic sanitation would have significant positive impacts on women's living conditions by giving them more time for other productive activities.

At the same time, reducing the distance travelled to the water points will also improve the security and safety and reduce the risk of harassment and conflict among pastoralists/herders and households, and herders and farmers. Improved water, sanitation and hygiene impacts on the socio-cultural position of women and has the potential to provide them with privacy and dignity as well as increased status within the family and wider community. Female representation on water boards and user committees strengthens the role of women in society and has far-reaching positive socio-cultural impacts.

Table 36 below shows the total number of households drawing water from different water sources.

Table 36: Waters Users: Rural households by main source of water

Sub County	Pond/Dam	Well/ Borehole	Stream Spring/ Harvested	Rain/ Vendor	Water	Total
Narok East	6,945	24,717	7,744	441	1,097	62,412
Kajiado West	3,811	3,723	12,435	558	3,931	34,427

Source (Red Plan Consultants ESIA Report)

Most of the surface water will mainly be absorbed into the soil during the construction phase. Appropriate drainage system has been provided already in place at site to handle the resultant storm water.

6.6.3 Energy

Kajiado County has an average electricity connectivity of 67.4%, with 85% of the trading centers within the County connected to electricity (Kajiado County CIDP)

The propose project area does not have electricity since it is not connected to the national grid.

According to KETRACO, Narok East Sub County is experiencing a transformation in electricity connectivity, with major infrastructure projects enhancing grid access. These developments are poised to

stimulate economic growth, improve quality of life, and support sustainable development in the region. The connectivity project involves the construction of the 68km 132kV double circuit transmission line from Olkaria to Narok, a new 132/33kV substation at Narok and extension of the existing Olkaria substation.

6.6.4 Communication

The area is well covered by communication facilities by the main telephone services providers which includes Safaricom, Airtel and Telkom. These enables voice calls, Short Message Services (SMS) and internet. All these will facilitate communication during all phase of the project.

6.6.5 Health Facilities

Kajiado West Sub County has a number of health facilities spread across the sub county to provide both curative and preventive health services. **Table 37** below shows the number of available health facilities within the sub county.

Table 37: Distribution of health facilities within Kajiado West Sub County

Health facility	Kajiado West Subcounty	Narok East Subcounty
Health Centres	4	
Dispensaries	31	
Private clinics	12	
Maternity beds	20	
Youth friendly centres	2	
Health facility bed capacity	232	
ICU beds	0	
Nurse-Patient ratio	32.2	

Source (Kajiado County Integrated Development Plan 2023-2027)

Kajiado West and Narok East Sub Counties recorded different conditions and diseases as indicated in **Table 38** below. Majority of the community members suffer from diarrhoea, skin diseases, eye infections, pneumonia and other respiratory diseases.

Table 38: Dominant ailments in the project areas

Ailment/condition	Kajiado West	Narok East
	Numbers	
Accidents	347	318
Clinical malaria	2718	2586
Diarrhoea	9050	5064
Skin diseases	3005	1540

Dysentery	102	204
Ear infections	691	374
Eye infections	3323	1142
Intestinal worms	71	273
Malnutrition	109	22
Other diseases of respiratory system	20,998	14,385
Pneumonia	2967	1726
UTI	114	-

Source (KEBS Kajiado and Narok Counties Statistical abstract, 2015)

The survey data highlights various health challenges faced by the community, including inadequate healthcare facilities, poor infrastructure, limited medical supplies, and a lack of trained personnel. Key concerns raised include:

- Lack of hospitals, dispensaries, and health centers within accessible distances
- Poor road networks and lack of ambulances, hindering emergency medical response
- Insufficient medical supplies, including medicine and essential equipment
- Inadequate number of trained health personnel, including doctors and nurses
- Poor sanitation, unsafe drinking water, and unhygienic conditions contributing to disease prevalence
- The impact of cultural practices, drought, famine, and flooding on health outcomes
- The need for community-based health facilities and improved health service delivery

6.6.6 Education Facilities

Education sector is critical in providing the skills that will be required to steer the location to the economic and socio goals of vision 2030. Although the sector has faced serious challenges over the years relating to access, equity, quality, financing, and relevance, significant achievements have been made over the years. **Figure 28** and **29** below shows some primary schools within the project area.

Limited access to education due to long distances, poor road infrastructure, and lack of transportation makes it difficult for children to attend school regularly. School dropout rates remain high, driven by financial difficulties, early marriages, and teenage pregnancies. Inadequate facilities, such as a lack of classrooms, teachers, and learning materials, further compromise the quality of education. The absence of clean water in schools and the community also affects students' well-being and overall learning environment.

Economic challenges such as school fees and poverty significantly impact education accessibility. Many families struggle to afford school-related expenses, leading to high dropout rates. Additionally, inadequate government support and poor facilitation in schools hinder the provision of quality education.

Socio-cultural issues, including early marriages, teenage pregnancies, and insecurity, further disrupt learning. Many young girls drop out of school due to early pregnancies or being married off at a young age. Boda boda operators have also been linked to school dropouts, as they contribute to early pregnancies and other forms of social vulnerability. In some areas, insecurity and cultural beliefs discourage school attendance, further limiting education opportunities.

Environmental factors, such as drought and seasonal flooding, also play a role in limiting access to education. During the rainy season, rivers overflow, and the lack of bridges makes it difficult for students to reach school. Drought conditions exacerbate poverty, making it even harder for families to afford education.



Figure 28: A view of Karuka Primary School



Figure 29: A view of Kisharu Comprehensive School

6.7 Demographic and Household Information

6.7.1 Gender of the Respondents

The gender distribution of respondents indicates a nearly balanced representation of males and females. Males accounted for 51.3% of the surveyed population, while females made up 47.9%, showing a slight male majority as shown in **Figure 30** below. Additionally, 0.8% of respondents identified as "other," reflecting a small but notable presence of individuals who do not conform to traditional gender categories. This distribution suggests inclusivity in data collection and provides a comprehensive perspective on gender dynamics within the surveyed population.

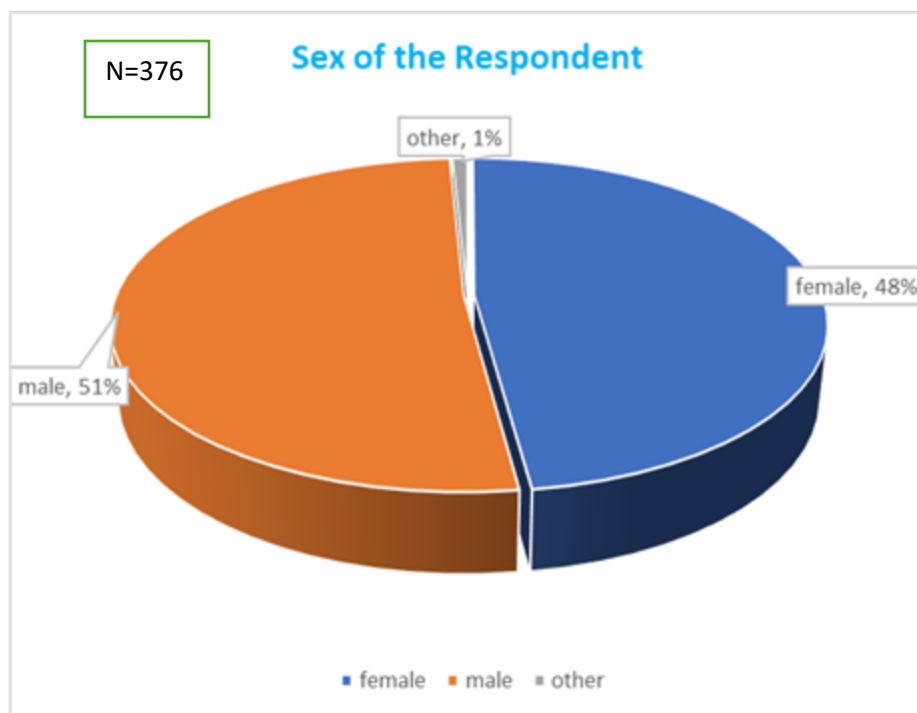


Figure 30: Showing sex of the respondent

6.7.2 Age

The age distribution of respondents reveals a diverse demographic composition. A small proportion (4.5%) of the respondents were under 18 years, while the majority fell within the economically active age groups. Specifically, 43.1% were between 18 and 35 years, and 44.4% were between 36 and 64 years, collectively accounting for 87.5% of the surveyed population as shown in **Figure 31** below. This indicates a workforce-dominated demographic, with a significant representation of young and middle-aged individuals. Meanwhile, 8.0% of respondents were 65 years and above, highlighting the presence of an aging population. The distribution suggests a balanced age structure, with a strong presence of working-age individuals who are likely to drive economic and social activities within the community.

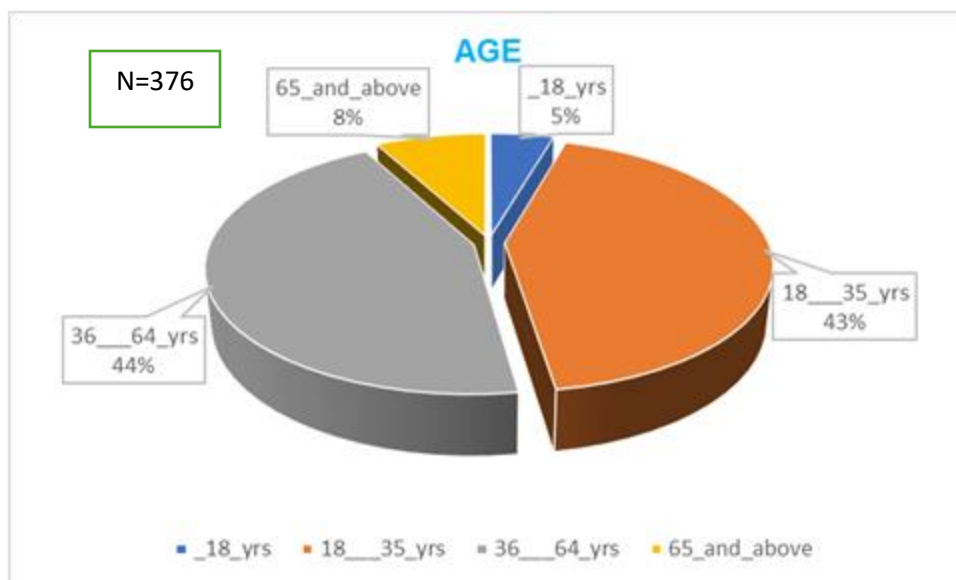


Figure 31: Showing the age of Respondent

6.7.3 Source of Income

The respondents' sources of income are illustrated in **Figure 32** below, with agriculture, business, and pastoralism leading at 14.1%, 38.6%, and 22.3%, respectively.

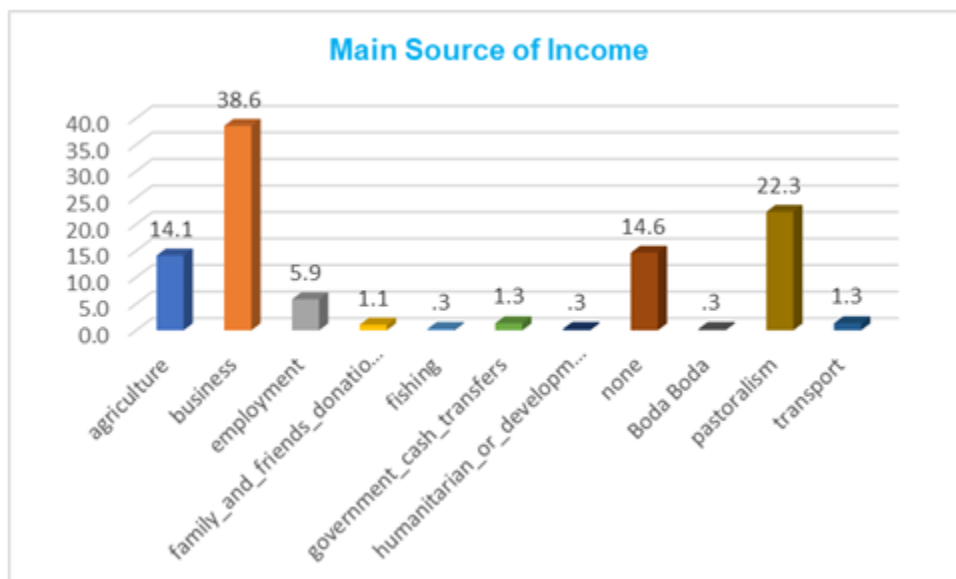


Figure 32: Showing the main source of income

6.7.4 Education

The literacy levels among respondents indicate a diverse range of educational attainment. A significant portion (35.1%) reported having no formal education, while 19.1% had completed primary education. Secondary education was the highest level attained by 29.3% of respondents, followed by 6.9% who had tertiary-level education, and 9.6% who had reached university level as shown in **Figure 33** below. This distribution highlights varying access to education within the community, with a notable proportion having limited formal schooling. Regarding children's education, 50.8% of respondents had between one and three

children enrolled in school, while 28.8% had between four and six. A smaller percentage (9.4%) had between seven and ten school-going children, and only 1.7% had more than ten. Additionally, 9% reported having no children in school. When asked if any of their children had dropped out, 20.5% confirmed this, while 56.9% stated no children had dropped out, and 2.1% were uncertain about the matter.

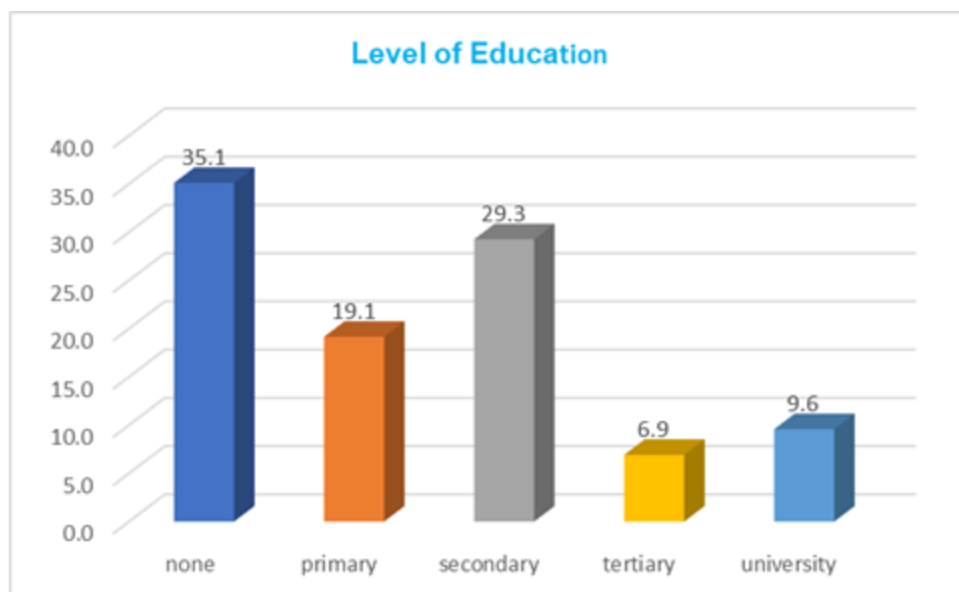


Figure 33: Level of education

6.7.5 Marital Status

Among the 376 respondents, the majority (68.4%) reported being married, indicating that marriage is the most common marital status within the surveyed population. A smaller percentage (19.7%) identified as single, while 8.5% were widowed. Additionally, 3.5% of respondents reported being divorced or separated. This distribution reflects the diversity of marital statuses within the community, with marriage being the predominant status. **Figure 34** shows the marital status of the respondents.

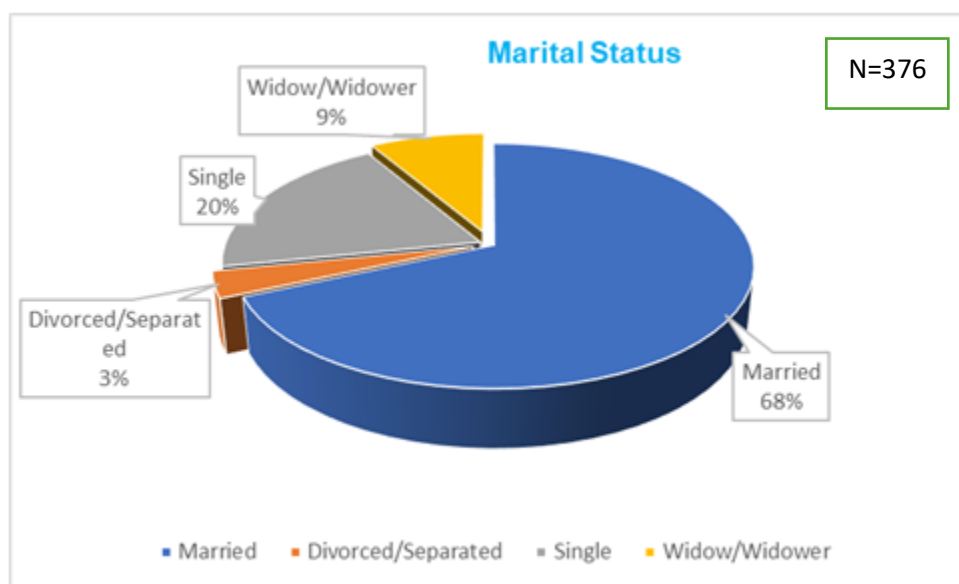


Figure 34: Showing the marital status

6.7.6 Children Per Household

Among the 376 respondents, 79.5% reported having children, while 20.5% did not as indicated in **Figure 35** below. Among those with children, the majority (36.5%) had between one and three children, followed by 32.8% with four to six children. Additionally, 23.1% had between seven and ten children, while a smaller percentage (7.7%) had more than ten children. This distribution highlights variations in family sizes within the surveyed population.

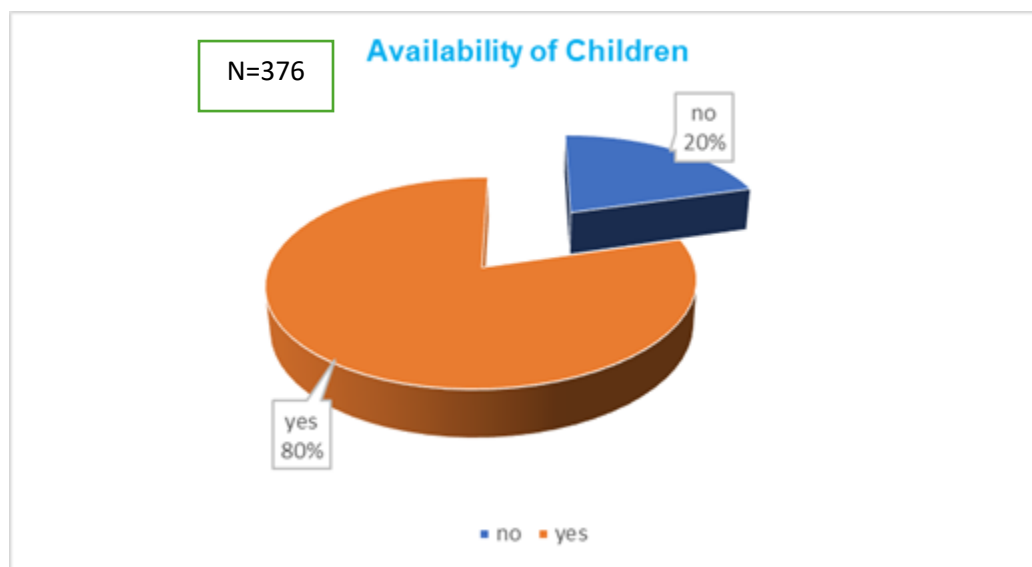


Figure 35: Showing the availability of children

6.7.7 Accessibility to Social Amenities

The distance to key social, educational, and public service facilities varies significantly across the surveyed population. Regarding education, 67.6% of respondents live within 4 km of a nursery school, while 61.2% are within the same range for primary schools. However, access to secondary schools is more challenging, with 60.4% of respondents residing more than 7 km away.

Healthcare access is also a concern, as 46.5% of respondents must travel over 7 km to reach a health center. Similarly, 39.1% live more than 40 km from a mortuary. Social amenities, including community halls and parks, are distributed unevenly, with a significant proportion traveling over 20 km to access them.

Markets and shopping facilities are relatively accessible for many, with nearly 45% living within 10 km. However, access to higher education institutions, fire stations, and police stations varies, with a notable percentage traveling over 40 km for these essential services.

6.7.8 Main Source of Water

The primary source of water for the surveyed population within the project areas varies, with the majority (47.1%) relying on dam water or water pans. Unprotected dug wells are another significant source, serving 13.8% of respondents, while 12.8% access piped water within their yard or plot as indicated in **Figure 36** below.

Other sources include water kiosks (8.0%), boreholes (4.5%), and public tap standpipes (4.5%). A smaller proportion of respondents have water piped directly into their dwelling (4.0%) or rely on a neighbor's tap (2.9%). Protected springs (1.9%) and unprotected springs (0.5%) are the least utilized sources.

These findings indicate that while some residents have access to piped or treated water, a significant portion depends on untreated surface or groundwater sources, highlighting potential concerns regarding water safety and reliability.

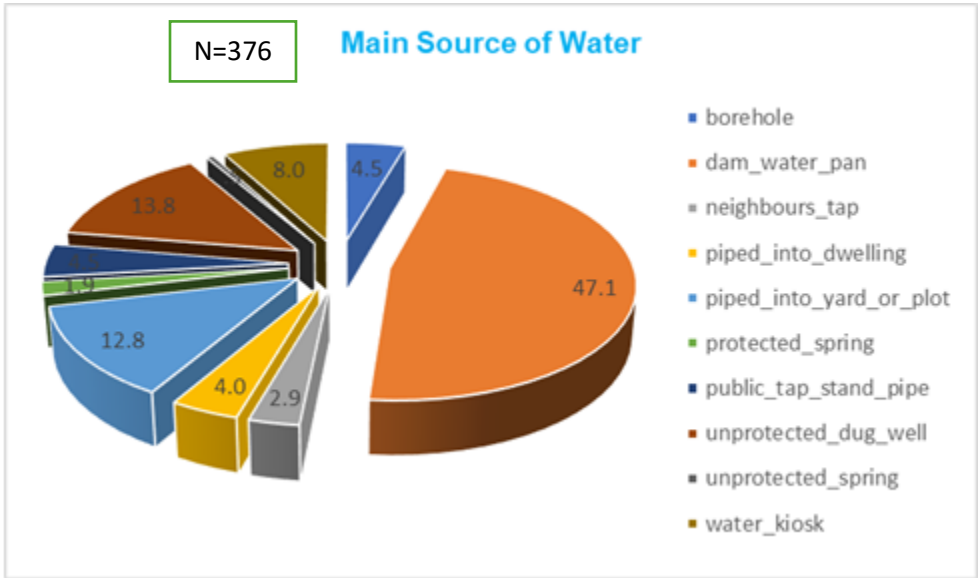


Figure 36: Showing source of water

6.7.9 Source of Energy

The primary source of energy for the surveyed population is firewood, used by a majority (54.8%) of respondents, indicating a high reliance on traditional biomass fuels. Solar energy is also widely utilized, with 26.1% of households using it, highlighting a growing shift toward renewable energy solutions.

Charcoal remains a common fuel source, used by 22.3% of respondents, while liquefied petroleum gas (LPG) is accessed by 10.1%, reflecting a smaller but notable adoption of cleaner cooking fuels as shown in **Figure 37** below. Electricity is used by 12.5% of the population, while kerosene, a less sustainable and potentially hazardous fuel, is still relied upon by 7.2% of respondents.

Biogas use is minimal, with only 0.3% of respondents indicating its usage. The data suggests that while some households are transitioning to modern energy sources like solar, electricity, and LPG, a significant proportion still depends on firewood and charcoal, raising concerns about deforestation, indoor air pollution, and environmental sustainability.

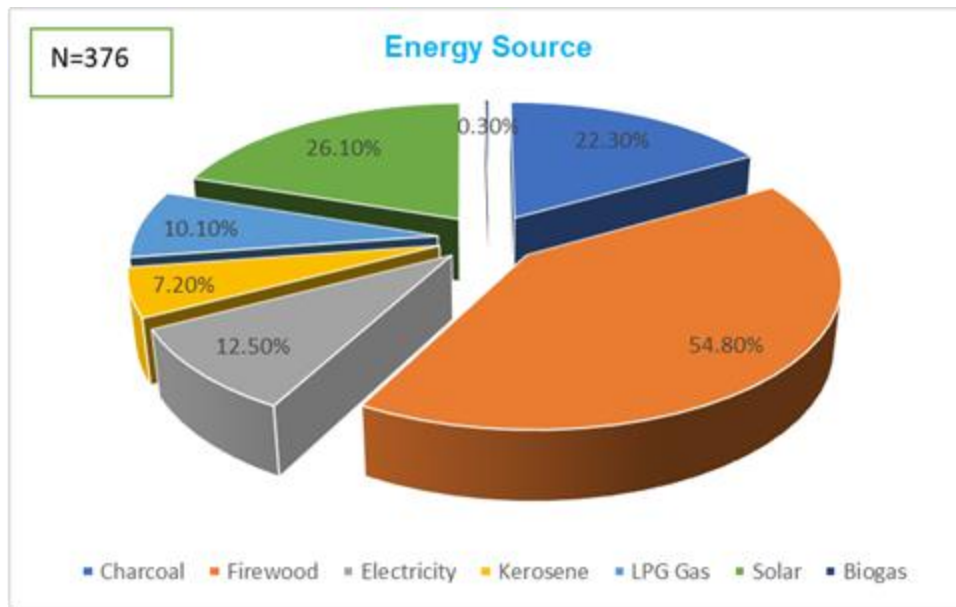


Figure 37: Showing Energy Source

6.7.10 Sanitation Facilities

The majority of households (78.7%) in the surveyed population have access to toilet facilities, while 21.3% lack any form of toilet, indicating a significant gap in sanitation access as indicated in **Figure 38** below.

Among those with toilet facilities, pit latrines are the most commonly used, with 74.2% of households relying on them. Flush toilets (WC) are available in only 6.6% of households, suggesting limited access to modern sanitation infrastructure. A small percentage (2.4%) of respondents use public latrines, while 0.8% have access to a Ventilated Improved Pit (VIP) latrine.

Alarmingly, 1.6% of households still practice open defecation, utilizing bushes due to the absence of toilet facilities. This poses serious public health risks, including the spread of waterborne diseases and environmental contamination. The findings highlight the urgent need for improved sanitation infrastructure and access to better toilet facilities, particularly in underserved areas.

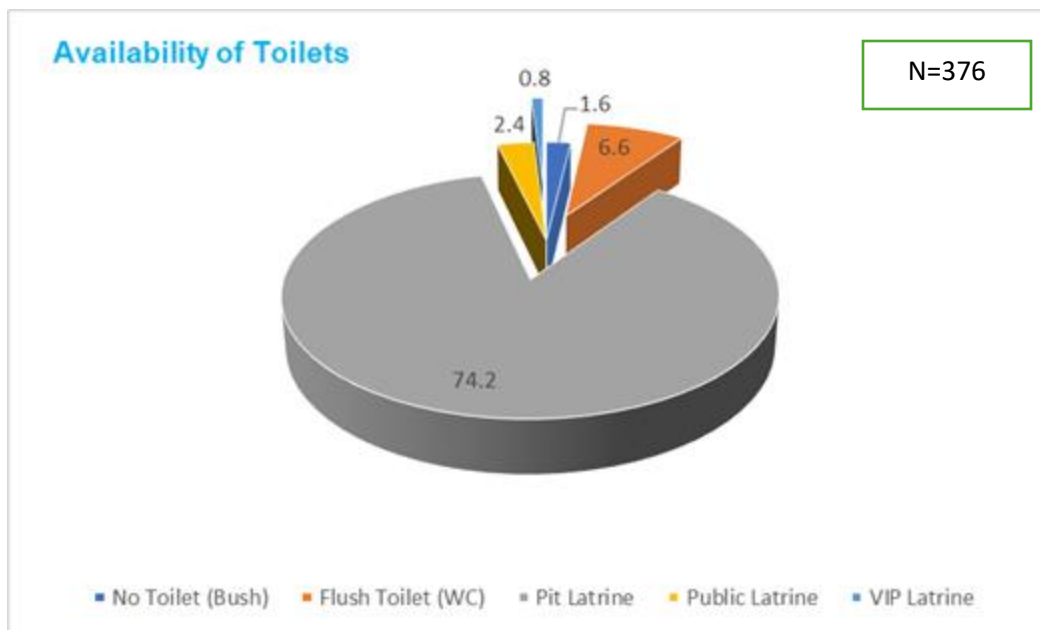


Figure 38: Showing availability of toilets

6.7.11 Waste Disposal

Satisfaction levels within the neighborhood are varied. While 39.9% of respondents expressed satisfaction with their living conditions, a significant 31.4% reported dissatisfaction. Additionally, 28.7% of respondents specifically cited the lack of refuse collection as a major concern, highlighting waste management as a key issue affecting community well-being.

The majority of households (87.2%) manage their solid waste by burning it within their compounds, a practice that may contribute to air pollution and health risks. A small percentage (4.5%) bury their waste, while 5.3% practice composting, which is a more environmentally friendly approach. However, 15.7% of households resort to indiscriminate dumping in their neighborhoods, posing environmental and sanitation challenges as indicated in **Figure 39** below.

Regarding wastewater disposal, nearly half of the respondents (49.2%) dispose of grey water by pouring it into drains, which may lead to drainage system overload or blockages. About 26.3% dispose of grey water by pouring it onto roads or pavements, potentially causing sanitation hazards and infrastructure deterioration. Meanwhile, 16.5% use pit latrines, 12% divert grey water into gardens for reuse, and 9.6% utilize alternative methods.

The findings indicate a need for improved waste management infrastructure, particularly in refuse collection and sustainable disposal methods. The high reliance on burning waste suggests the absence of structured waste collection systems, while the prevalence of indiscriminate dumping and poor grey water management calls for better drainage systems and community education on sustainable waste disposal practices. Addressing these issues can significantly enhance neighborhood satisfaction and environmental health.

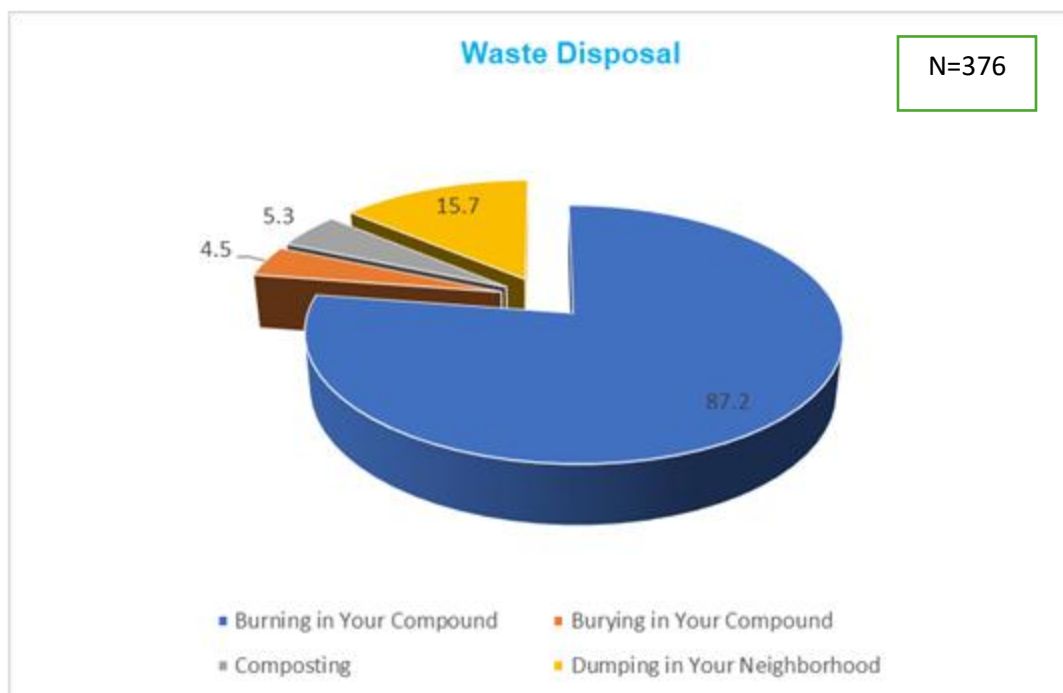


Figure 39: Showing waste disposal

6.7.12 Birthplace and Migration Patterns

Out of the 376 respondents, 317 (84.3%) were born in the project area, while 47 (12.5%) were not. A small fraction, 12 respondents (3.2%), did not specify their birthplace. Regarding migration patterns, 318 respondents (84.6%) have not migrated, while the remaining 58 respondents (15.4%) moved into the area. Among the migrants, 7 (1.9%) had lived there for 1 to 3 years, 50 (13.3%) for 4 years or more, and 1 (0.3%) had lived there for less than a year.

6.7.13 Reasons for migration

A majority of respondents (329, or 87.5%) did not specify their reason for immigration. Among those who did, marriage was the predominant reason, with 28 respondents (7.4%) citing it as their main reason. Other reasons included business (3 respondents, 0.8%), employment (2 respondents, 0.5%), and job opportunities (1 respondent, 0.3%). Some respondents cited specific professions such as electrical engineering, accounting, plumbing, and masonry. Other reasons for migration included owning land (1 respondent, 0.3%), poor sanitation (1 respondent, 0.3%), and general hustling (1 respondent, 0.3%).

6.7.14 Land Ownership

Out of the total respondents, 311 (82.7%) owned land in the project area, while 65 (17.3%) did not. Among those who owned land, ownership was spread across various villages, with the largest proportions found in Kikuyian (38 respondents, 10.1%), Olodungoro (33 respondents, 8.8%), and Olgumi (32 respondents, 8.5%). Other notable villages included Olesharo (22 respondents, 5.9%) and Kisharu (21 respondents, 5.6%) as indicated in **Figure 40** below.

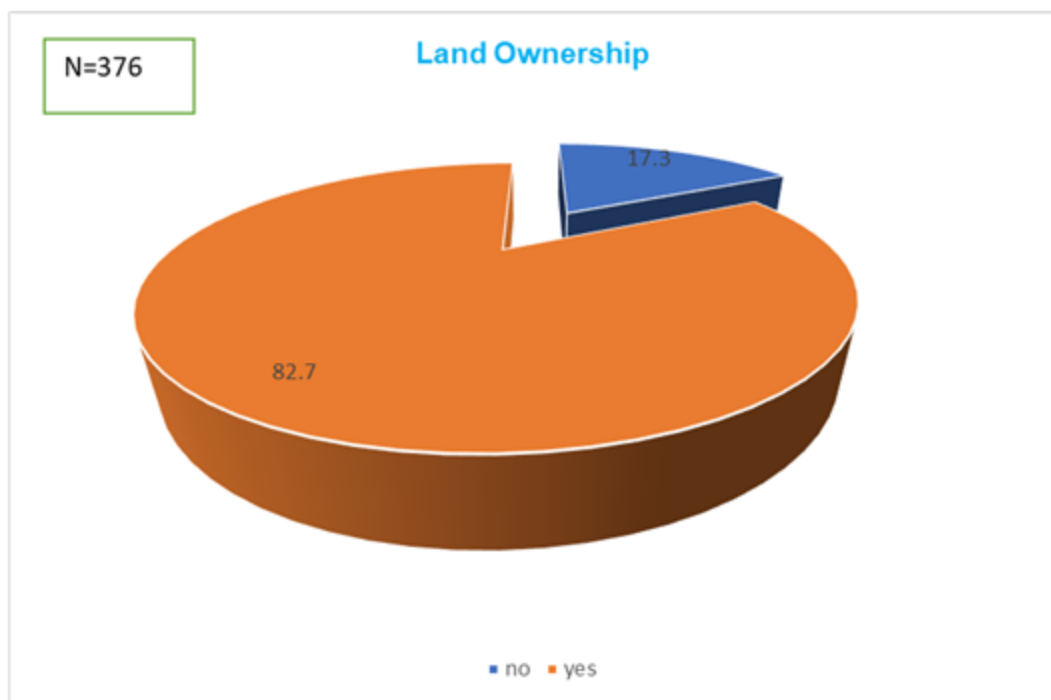


Figure 40: Showing land ownership of the respondents

6.7.15 Land Size and Ownership Nature

Regarding land sizes, the majority of respondents (201, or 53.5%) owned land larger than 10 acres. A significant number (54 respondents, 14.4%) owned land ranging from 6 to 10 acres, while 32 respondents (8.5%) had between 2 to 5 acres. A smaller proportion (24 respondents, 6.4%) owned less than an acre. Concerning land tenure, most respondents (281, or 74.7%) had freehold private land, while 5 respondents (1.3%) had leasehold land. Community trust land ownership was reported by 7 respondents (1.9%), and 18 respondents (4.8%) fell into other categories, including plots or land purchased.

6.8: Literacy level

Narok East and Kajiado West Sub Counties are located in the Rift Valley region which continues to face notable challenges in literacy, particularly among its predominantly Maasai population. Cultural traditions, geographic barriers, and socio-economic conditions have contributed to relatively low literacy rates compared to the national average.

In 2018, Narok County enrollment in ECDE was 67.4%, which increased to 69.9% in 2022 against a target of 100%, transition and retention rate also improved from 82% to 89%. Literacy level also increased from 63% to 74% these achievements can be attributed to among many factors; improvement of teacher child ratio from 1;110 to 1:53, improvement of infrastructural facilities and construction of additional ECDE and TVET centers and employment of 885 teachers up from 475. Beyond the ECDE level, there was an improvement in transition rate from primary to secondary school attributed to among other factors, the increase in number of secondary schools and bursary allocations (Narok County CIDP 2023-2027).

Access to basic and tertiary education in Kajiado County improved as a result of various interventions. The net enrolment rate in Early Childhood Education was 86 percent. This achievement is attributed to the construction, rehabilitation and equipping of 81 ECDE classrooms, recruitment of 656 ECDE teachers, training of 614 ECDE teachers and provision of learning materials to 95 percent of all ECDE centres in the

county. Transition rate from ECD to primary school level increased from 77 percent in 2018 to 90 percent at the end of the plan period. The County Literacy Rate improved from 65 percent in 2018 to 67 percent at the end of 2022(Kajiado County CIDP 2023-2027).

6.9 Unemployment situation

While Narok County exhibits a high employment-to-population ratio, the persistent unemployment rate highlights underlying issues such as market access, skill gaps, and gender disparities. Addressing these challenges through targeted interventions can unlock the county's full economic potential and provide sustainable livelihoods for its residents.

Narok County has a total of 563,430 working-age population, which is 48.66 per cent of the total county population. Most of the working-age population is youthful (18-34 years) at 53.34 per cent. **Table 39** below shows distribution of working population per age group for male and female.

Table 39: Distribution of the working age population by age categories for Narok County.

Working age population	Male	Female	Total	Percentage of total working population (%)
15-17	42,432	38,742	81,174	12.63
18 –24	69,639	74,623	144,262	22.44
25-34	74185	82072	156257	24.31
35-64	125,561	135,528	261,089	40.62
Total	311,817	330,965	642,782	100

Data Source: KNBS (2019), Kenya Population and Health Census - 2019

With a total population of 115,316, Narok East Sub County has s total work force of 55,671 distributed between the various age group as shown in the **Table 40** below;

Table 40: Workforce distribution per age group

	Total workforce per age group				
Age group	15-17	18 –24	25 –34	35-64	Total
Numbers	8,105	13,621	14,898	19,047	55,671

Data Source: KNBS (2019), Kenya Population and Health Census - KPHC 2019

Most of the socioeconomic indicators that affect the quality of labour perform lower than the national average. Intensify interventions to increase literacy rates, school enrolment rates, increase vaccination rates, reduce the percentage of stunted children and percentage of teenage pregnancies

6.10 Management of Natural Resources

The management of natural resources is distributed among various entities, including local communities, government bodies, private owners, and in some cases, remains unregulated.

6.10.1 Community-Based Management

Local communities play a significant role in managing natural resources such as conservancies, forests, and water sources. Community leadership structures, including specific groups like Lesetian and Lolngoijine, actively participate in conservation and oversight.

6.10.2 Government and Conservancy Management

The management of conservancies in the project area exemplifies a holistic approach that integrates wildlife conservation with community development. These efforts are crucial for preserving biodiversity, enhancing local livelihoods, and promoting sustainable land use in the region. Some natural resources, particularly mountains and forests, are managed by either the government or conservancies. Responses indicate government involvement in managing mountain resources, while conservancies also play a role in conservation efforts.

This dual governance model suggests a combination of state and private conservation initiatives working to protect these critical ecosystems.

6.10.3 Private Ownership and Organizational Management

Certain resources, such as quarries and private lands, fall under the control of individual landowners or specific organizations. Entities such as Kedong and Kihara are noted for their involvement in resource oversight. Additionally, resources like dams and privately-owned land are managed by their respective owners, indicating a mix of personal and corporate responsibility in environmental management.

6.10.4 Unmanaged Natural Resources

A significant portion of responses indicates that some natural resources remain unmanaged. Several respondents mentioned highlight that mountains and rivers lack any formal oversight, with some responses explicitly stating that "nobody manages them." This absence of structured management raises concerns about potential overexploitation and degradation of these resources.

6.10.4.1 Types of Natural Resources Identified

Various natural resources were cited, including dams, forests, and sand harvesting areas. Water sources and school forests were also mentioned, alongside references to multiple overlapping resources such as forests, dams, and marram deposits. Mountains, rivers, and trees were highlighted as key environmental elements in need of structured management.

6.10.4.2 Geothermal and Energy Resources

Some responses pointed to the presence of geothermal energy sources, with specific mentions of the Geothermal Development Company (GDC) and the Suswa geothermal drilling project. The inclusion of geothermal resources suggests growing awareness of energy production and its impact on natural resource conservation.

6.10.4.3 Protection Measures for Natural Resources

Communities and administrative bodies play a vital role in protecting natural resources. Some respondents highlighted the importance of administrative measures in conservation efforts, while others pointed to the role of conservancies in safeguarding these resources. Additionally, experts from the Geothermal Development Company (GDC) were mentioned as key figures in handling and controlling environmental protection efforts.

A significant number of responses emphasized the importance of preventing deforestation and encouraging reforestation. Planting trees emerged as a common strategy, with some specifically recommending planting

trees near dams to enhance soil stability and prevent erosion. Others stressed the need to stop tree cutting altogether as a way of preserving forested areas.

Fencing was identified as a crucial protective measure, with several respondents advocating for fencing around key environmental areas. This included fencing near dams, around natural houses, and as a general safety precaution. Such measures aim to prevent unauthorized access, mitigate human-wildlife conflicts, and protect fragile ecosystems from destruction.

In terms of general safety measures, wearing protective gear was suggested as an important practice, potentially referring to individuals working in environmentally sensitive areas. Drought was another key concern, with several respondents acknowledging its impact, though specific mitigation measures were not elaborated on.

While most responses provided clear insights, some were vague or lacked specific details. A few responses were unclear, with generic statements like “During” and “3.” Additionally, one respondent admitted uncertainty regarding protection measures, indicating a potential gap in awareness and knowledge on environmental conservation strategies.

Overall, these responses illustrate a range of perspectives on natural resource protection, from community-driven efforts to administrative and expert-led interventions. The emphasis on tree planting, fencing, and infrastructure improvements highlights key strategies in preserving the environment and ensuring sustainable resource management.

6.11 Ecosystem Services and Environmental Challenges in Mount Suswa

Mount Suswa is a critical natural resource for the surrounding communities, providing essential provisioning and regulating ecosystem services. The mountain supports local livelihoods by offering resources such as food, water, grazing land, fuelwood, medicinal plants, and materials for construction. These resources are vital for daily survival and serve as a fallback during times of economic or climatic challenges. However, the availability and sustainability of these resources are increasingly under threat due to human activities and climate variability.

6.11.1 Provisioning Services

Mount Suswa provides a variety of food resources that are integral to the nutrition and well-being of the local population. Livestock products, including milk and meat, are the primary sources of sustenance for many households, supported by the grazing lands on the mountain. Additionally, wild fruits and berries, which are seasonal, serve as supplemental nutrition for 20% of respondents. Honey, harvested through traditional beekeeping or wild collection, is relied upon by 50% of households for its nutritional and medicinal value.

Game meat, though accessed by 15% of households, remains a contentious resource due to its illegal status under wildlife protection laws. Nonetheless, it serves as an alternative protein source. Edible plants and herbs are gathered by 80% of respondents, frequently used in traditional soups and teas as a substitute for commercial tea leaves.

The reliance on Mount Suswa’s resources varies among households. About 60% of respondents depend on these resources daily, particularly for water, firewood, and grazing. For 30%, the reliance is occasional, tied to seasonal or cultural needs such as honey collection or herb gathering. However, 20% of respondents reported rare use, often due to alternative resource availability or restrictions on access.

Over the past 5-10 years, 75% of respondents have observed a decline in resource availability. Charcoal burning has significantly increased deforestation, reducing vegetation cover and impacting the availability of honey. While the springs have not experienced significant changes, some community and personal dams tend to dry up during prolonged dry periods. Despite these challenges, slight improvements have been noted in certain areas, attributed to community-led reforestation efforts and controlled grazing practices.

6.11.2 Regulating Services

Mount Suswa also plays a crucial role in regulating environmental conditions, but these services are increasingly compromised. Soil erosion is a major issue, reported by 60% of respondents. Deforestation and overgrazing have left the slopes bare, making them vulnerable to heavy rains that wash away fertile topsoil. This degradation has made farming difficult for some people.

Water scarcity is another pressing concern, with 85% of respondents highlighting reduced drying of dams during prolonged dry periods. In addition, 40% of respondents reported flash floods in low-lying areas, a consequence of deforestation and reduced vegetation cover.

The prevalence of pests and diseases has also decreased majorly because of the pesticides and vaccines. Climate variability further compounds these challenges, with 80% of respondents noting unpredictable rainfall patterns, prolonged droughts, and rising temperatures, which disrupt agricultural activities and planting schedules.

Wildfires, reported by 30% of respondents, occur during dry seasons. These fires are often caused by human activities such as charcoal burning and land clearing, further exacerbating vegetation loss and hindering ecosystem recovery.

6.11.3 Community Responses and Mitigation Strategies

Local communities have implemented various strategies to address these challenges. To combat soil erosion, 50% of respondents have undertaken reforestation and terracing initiatives, planting grass and digging terraces to stabilize the soil. In tackling water scarcity, 30% of households have begun harvesting rainwater using tanks, although the collected water is often insufficient.

To manage pests and diseases, 40% of farmers rely on chemical pesticides, while others use traditional remedies like ash or herbal mixtures, though these methods have varying levels of success. In adapting to climate variability, 50% of households have switched to drought-resistant crops or diversified their income through small-scale trade.

Wildfire management efforts focus on preventive measures, including creating firebreaks and exercising caution during activities such as land clearing or charcoal burning to minimize fire risks.

6.12 Cultural Significance of Mount Suswa

Mount Suswa is a vital cultural and spiritual landmark, with its natural features deeply connected to community traditions and identity. Sacred caves, lava tunnels, the summit, crater, natural springs, and red soil play a significant role in rituals, ceremonies, and cultural preservation.

6.12.1 Sacred Areas and Practices

The caves and lava tunnels serve as prayer and ritual spaces, while the summit and crater are believed to house ancestral spirits, where sacrifices are made during droughts. Natural springs are essential for cleansing rituals and ceremonies. The red soil holds symbolic value in traditional blessings, body adornment, and spiritual practices.

6.12.2 Importance of Cultural Sites

These sacred areas help preserve spiritual connections and cultural identity. However, declining engagement, especially among younger generations and newcomers, poses a threat to their significance.

6.12.3 Threats to Cultural Sites

Deforestation, land encroachment, and infrastructure development are disrupting cultural landmarks, while cultural erosion among the youth weakens traditional practices.

6.13 Supporting Services of Mount Suswa

Mount Suswa provides essential ecosystem services that sustain local livelihoods, particularly through its diverse vegetation and ecological functions. These ecosystems support livestock grazing, fuelwood collection, timber harvesting, beekeeping, and medicinal plant use, making them integral to the community's survival.

6.13.1 Ecosystem Contributions to Livelihoods

The ecosystems of Mount Suswa play an essential role in sustaining local livelihoods. Grasslands provide grazing land for **80%** of respondents who rely on livestock for their income and food security. During dry seasons, Acacia pods serve as supplementary feed for animals, ensuring their survival when pasture is scarce. Acacia woodlands are a crucial source of firewood and timber, with **60%** of households depending on them for fuel, while **40%** use the wood for construction and fencing. Additionally, certain shrubs and grasses serve medicinal purposes, benefiting **20%** of the population who use them for treating both livestock and human ailments.

6.13.2 Seasonal Importance of Mount Suswa

Mount Suswa's ecosystems play a vital role, particularly during the dry season, with the majority of respondents identifying it as a crucial time for survival. Many families migrate to the area in search of water and grazing land, as one herder explained, "During the dry season, we move our livestock to Mount Suswa because it has more grazing and water sources."

During the wet season, dependence on Mount Suswa decreases, with a significant number of respondents stating that resources become more widely available across the region. However, some still rely on the mountain's water sources, as one individual noted, "In the wet season, there's grass everywhere, but we still use Mount Suswa for water." Additionally, seasonal migration patterns were mentioned by a portion of respondents, who move their livestock to Mount Suswa's slopes when conditions elsewhere become harsh.

6.13.3 Environmental Changes and Ecosystem Degradation

The ecosystems of Mount Suswa have undergone noticeable degradation over time, with many community members expressing concern over changes that threaten both biodiversity and local livelihoods. One of the most pressing issues is the decline of grasslands due to overgrazing and soil erosion. Many herders have observed that grasses no longer grow as tall or as abundantly as before, making it increasingly difficult for livestock to find enough fodder. A local herder lamented, "The grasses don't grow as tall as they used to because of overgrazing." This reduction in grassland quality directly affects pastoralist communities that depend on these areas for their livestock.

Another major concern is deforestation and the loss of Acacia woodlands. Many community members have noted a decline in tree cover, mainly due to the demand for firewood, timber, and charcoal. The continued cutting of trees has led to increased soil erosion and a shrinking habitat for wildlife. A resident explained, "The acacia forests are shrinking because people are cutting too many trees." The loss of tree cover not only

affects biodiversity but also disrupts important ecological processes such as carbon sequestration and soil stabilization.

Water scarcity has also become a significant issue, with many people reporting that springs and wetlands are drying up at a faster rate.

These water sources are crucial for human and livestock consumption, as well as for sustaining local biodiversity. A concerned farmer shared, "The springs are drying faster now, and it's affecting everyone." As water availability decreases, competition for this essential resource grows, often leading to conflicts among different land users.

The dependence on Acacia woodlands for firewood and charcoal has further contributed to environmental degradation. Many households rely on firewood as their primary cooking fuel, and charcoal production has become a source of income for some families. A community member explained, "We collect firewood from the forest to cook and sell." However, this unsustainable harvesting of trees is accelerating deforestation and reducing the land's ability to recover naturally.

In addition to firewood, timber harvesting for construction is another driver of woodland loss. Many community members reported that Acacia and other hardwood trees are frequently used for building houses, fencing, and making poles. A local builder stated, "We harvest trees for poles, fencing, and even house construction." The continuous extraction of timber threatens the long-term availability of these resources and slows down the natural regeneration of forests.

Despite these challenges, some residents engage in beekeeping and honey production as an alternative livelihood. Acacia trees and various shrubs provide an important habitat for bees, making honey production a viable source of income. A beekeeper shared, "The bees thrive in the acacia forests, and we harvest honey to sell in the market." However, ongoing deforestation threatens this activity, highlighting the need for sustainable forestry practices.

Traditional knowledge also plays a role in the community's interaction with the environment. Many people use certain shrubs and grasses for medicinal purposes, treating both human and livestock ailments. However, as these plants become increasingly scarce, concerns are growing over the potential loss of indigenous knowledge and natural remedies.

Overall, the degradation of Mount Suswa's ecosystems is driven by a combination of human activities and environmental stressors. The declining condition of grasslands, loss of forests, water scarcity, and encroachment of invasive species pose serious challenges for both biodiversity and the livelihoods of local communities. Without urgent conservation efforts and sustainable land management strategies, the continued deterioration of these ecosystems could have lasting consequences for the region.

CHAPTER 7: CLIMATE CHANGE RISK AND VULNERABILITY ASSESSMENT

7.1 Introduction

This chapter presents the Climate Change Risk and Vulnerability Assessment (CCRVA) for the proposed project. The chapter identifies and evaluates potential climate-related risks that may affect the project over its lifecycle, as well as the project's potential contribution to climate change vulnerability in the surrounding environment and communities

The greenhouse gases of major concern are carbon dioxide (CO₂), Methane (CH₄), and Nitrous Oxide (N₂O). They also comprise of hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride, which have relatively high global warming potentials but are emitted in small volumes (Steen, 2007). Anthropogenic emission of these gasses' triggers rises in the earth's temperatures over time, a phenomenon referred to as global warming, whose outcome is climate change. The effects of climate change are manifested in severe weather patterns such as longer and hotter summers accompanied by droughts, and frequent extreme weather phenomena that includes hurricanes, monsoon, rains, and rise in sea level (Mulea, 2015).

Acute climate hazards, such as extreme precipitation, floods, landslides, and wildfires, are expected to increase in frequency and severity in Kenya due to climate change (Republic of Kenya, 2023). The prudent response to climate change is to adopt a portfolio of actions aimed at mitigation, adaptation, and research (Steen, 2007). Many adaptation and mitigation options can help in addressing climate change. However, no single option is sufficient by itself. Effective implementation depends on policies and cooperation at all scales and can be enhanced through integrated responses that link mitigation and adaptation with other societal objectives (FAO, 2022).

The Government of Kenya approved its National Long-term Low Emission Development Strategy 2022–2050 (LTLED strategy) that sets out a long-term vision for mitigation and adaptation for the country. Under this strategy, Kenya has an ambitious target of moving toward net zero emissions by 2050 and is committed to prioritizing adaptation actions that address the greatest climate risks and reduce socioeconomic losses (Republic of Kenya, 2023). The strategy was developed in the wake of realization that the Kenyan economy is dependent on climate-sensitive sectors such as rain-fed agriculture, tourism, water, energy, wildlife, and health whose vulnerability is exacerbated by climate change (FAO, 2022).

The proposed geothermal project is climate sensitive by virtue of its location in Arid and Semi-Arid Land (ASAL) coupled with the large volumes of water required for drilling of the wells. Both Narok and Kajiado Counties are vulnerable to climate change (MoALFC. 2021 and MoALF. 2017). Communities and systems in the ASALs – which constitute up to 89% of the land area and 38% of Kenya's total population –are highly vulnerable to climate change because of high levels of poverty and recurring droughts (Republic of Kenya, 2023). Droughts and changing rainfall patterns impact water availability in Narok and Kajiado Counties (County Government of Kajiado, 2023 and County Government of Narok, 2023b).

7.2 Climate Variability in Kenya

Kenya's mean annual temperature has increased by 1.0°C since 1960 at an average rate of 0.21°C per decade and is projected to continue rising by 1.7°C by the 2050s. Rainfall patterns have changed with the March–April–May (MAM) long-rain season becoming shorter and drier, and the October–November–December (OND) short-rain season becoming longer and wetter.

Overall annual rainfall remains low, with the long rains declining continuously and droughts becoming longer, more intense, and tending to continue across rainy seasons (Republic of Kenya, 2023). This trend calls for climate change mitigation and adaptation measures.

7.3 Climate Variability in Narok and Kajiado Counties

Analysis of historical temperature trends in Kajiado county over 25 years (1981 to 2005), indicate that mean first season (MAM) temperatures increased by approximately 0.5°C, while second season (OND) temperatures decreased slightly $\leq 0.1^\circ\text{C}$ (County Government of Kajiado, 2023a). Analysis of precipitation trends over a 35-year period (1981-2015) showed that average first season rainfall had decreased moderately, while that of second season had increased by more than 50 mm particularly since 2000. Because of these changes in temperature and rainfall, first season has experienced a steady increase in the number of heat stress days, while flood risk in both seasons has increased.

An analysis of total annual rainfall trends in Narok County showed a slight decrease of precipitation for the period 1985-2015 which will continue until 2040 during the long rainy season. On the contrary, the short rainy season has recorded increased precipitation levels since 1985 (County Government of Narok, 2023b). The annual mean minimum temperature trends indicate an increase of temperature for the last 30 years and the average temperatures are projected to continue rising in the future (The County Government of Narok, 2023a).

The historic trends of Narok County also show that during the long rainy season, most of the county experiences fewer than 25 consecutive dry days (CDD). CDD serve as an indicator for risk of drought. In future, the county will experience an overall increase of up to 10 CDD, suggesting a slightly greater risk of dry spells. During the short rainy season, the county has historically experienced fewer than 50 CDD. The county is projected to experience fewer than 25 CDD during the short rainy season (MoALFC. 2021).

7.4 Climate Change Risks in Narok and Kajiado Counties

7.4.1 Flooding

Suswa area and Kajiado county are prone to flash floods (Nashipay et al, 2022 and County Government of Kajiado, 2023a). This has been attributed to; overgrazing, loss of vegetation cover, deforestation, land subdivision, riparian and wetland encroachment, unsustainable sand harvesting practices, natural change of river course among others (County Government of Kajiado, 2023a). Flood risk as measured by the average level of precipitation over 5 days (P5D) shows that in Narok County, P5D has historically remained below 25 mm during the long rainy season. However, projections indicate that the P5D value will increase, principally in the northern and southern parts of the county, by 15 mm or more, suggesting higher risk of floods (County Government of Narok, 2023b).

Narok County has several areas susceptible to floods during heavy down pour due to topographical formations. The most affected areas include areas adjacent to river valleys, low lying and flat areas. In the past floods have been recorded in areas such as Narok Town and frequently in the Suswa Plains (Republic of Kenya, 2013). The flood events that occurred e.g. in 2005, 2007, 2009, 2019 and 2020 sends a signal 2 to 3 days prior to occurrence.

The onset of the floods is rapid and normally happens in April and November (County Government of Narok, 2023a). Floods have been reported to be associated with deaths, damage to property and infrastructure, cholera outbreaks and upsurges in mosquito-borne diseases, such as malaria and dengue fever (Republic of Kenya, 2023). In Narok county, malaria occurs twice a year within these months; February, March, June and July (County Government of Narok, 2023a).

7.4.2 Soil Erosion

Erosion is the movement of soil by wind or water. Although a natural process, land-use change and disturbance to soil have accelerated the rate of erosion worldwide (Baer and Birge, 2018). The major environmental issue in Narok County is soil erosion. This is common during drought when the soil surface cover dries and wind blows away the topsoil exposing the weaker sub-soil. When it rains the exposed soil is carried away by surface run-off causing erosion (Republic of Kenya, 2013). An increase in built up area, bare land and agricultural land and a decrease in grassland are likely drivers of gully erosion which is affecting Narok County (Konana et al, 2017). The massive production of charcoal, which has a ready market, coupled with overgrazing and deforestation and the conversion of natural grasslands and forests into cropland has led to severe degradation in an already highly fragile ecosystem (Gachene, 2018). Dense gully networks, which widen every time there is a downpour, dissect the areas' landscape. The gullies carry storm water runoff and soil washed from Mt. Suswa towards the Maai Mahiu-Narok road thus occasionally rendering it impassable.

Kajiado County is susceptible to desertification and land degradation due to overstocking, overgrazing, deforestation, and unsustainable land management practices. These processes exacerbate soil erosion (County Government of Kajiado, 2023). Removal of vegetation and physical disturbance to soil facilitate erosion. Eradicating perennial plants reduces surface heterogeneity created by plant stems and litter that stabilize soil, as well as a boundary layer that protects soil from wind (Baer and Birge, 2018).

7.4.3 Drought

Droughts in Narok County have been recorded in 1976, 1984, 1992, 2002, 2004, 2007 and 2021. It is a slow onset hazard with a forewarning period of two months from July to October (County Government of Narok, 2023a). Similarly, Kajiado County is prone to prolonged, recurrent droughts, which have severe consequences on water and pasture availability (County Government of Kajiado, 2023).

7.4.4 Extreme Temperatures/Heat Waves

Heat stress is measured by the total number of days during one season with a maximum temperature greater than or equal to 35°C. In the long rainy season, Narok County's levels of heat stress have been low, with no days recording temperatures above 35°C (County Government of Narok, 2023b). In Kajiado county, rising temperatures are a notable climate hazard. Heat waves and increased frequency of hot days have led to increased prevalence of skin diseases, respiratory diseases and high rate of evaporation (County Government of Kajiado, 2023). An analysis of temperature trends shows that Narok County usually varies between 10 and 28°C (MoALFC, 2021) with the driest and hottest months being January and February (County Government of Narok, 2023a).

7.4.5 Whirl Winds/Windstorms

Trees and building rooftops have been carried away, such as in Oldonyokie Secondary school in Magadi ward, due to frequent whirl winds. This has caused physical injuries to people and livestock (County Government of Kajiado, 2023). Similarly, Narok county experiences frequent strong winds/windstorms which cause serious damage to school buildings, homesteads, environment (uprooting/breaking of trees) and general risk to human health & safety. Windstorms are known to cause havoc in areas such as Olokurto, Mau and Ololulunga especially in open spaces (Republic of Kenya, 2013).

7.4.6 Lightning and Hailstorm

Lightning and hailstorms are common in Narok county. Hailstones have caused serious damage to crops and vegetation while lightning has been reported to have caused death to both animals and human beings. The most hit areas include parts of Mulot, Olokurto, Mau, Ololulunga and Olokurto (Republic of Kenya, 2013).

7.4.7 Landslides

Landslides are natural phenomenon, which normally occur when soil on higher ground fall back (slides) due to increased weight of soil as a result of water absorption. Areas prone to landslides in Narok county include steep slopes along Amala River, tributary of the Mara river, in parts of Mulot and Olokurto (Republic of Kenya, 2013). According to Riyandari et al, 2023, precipitation, seismicity, eruptions, and human activity, are external driving forces that may initiate landslides within a period of time. In geothermal areas, landslides may also be driven by additional forces from hydrothermally altered materials, magma-pressures, groundwater seepage, and hydrothermal activity (e.g. phreatic eruption and hydrothermal explosion). While surface runoff may weaken the slope's lateral support, ground water level fluctuations may affect slope instability. The pore-fluid pressure in the aquifer adjacent to magma intrusion may elevate, and thus potentially threaten mechanical stability even without magmatic eruption (Riyandari et al, 2023).

There are no widely reported discrete landslide events specifically in Kajiado West in recent, but the area does experience heavy rainfall and flood-related ground instability, including reports of severe flooding in Shompole, Pakase, and Entasopia in Kajiado West where rivers have burst their banks and homes were inundated, conditions that can contribute to slope failures and soil movement under intense rains.

7.4.8 Bushfires

Fire hazards in Narok county are frequent and normally occur during the dry spell (September –December) and around January – March. Some fires are caused intentionally to clear land / tick control or pasture improvement but eventually get out of hand creating havoc while other types of fires are caused by honey gatherers, smokers, lightening or electric faults (Republic of Kenya, 2013).

7.4.9 Assessment of Climate Change Risks

The above climate change risks were evaluated based on the risk assessment criteria provided in **Figure 41** below. The criteria used is provided in the International Finance Corporation's (IFC) Environmental and Social Management Toolkit Version 1.2 of November 2015. The resultant climate change risk categorization is provided in **Table 41** below.

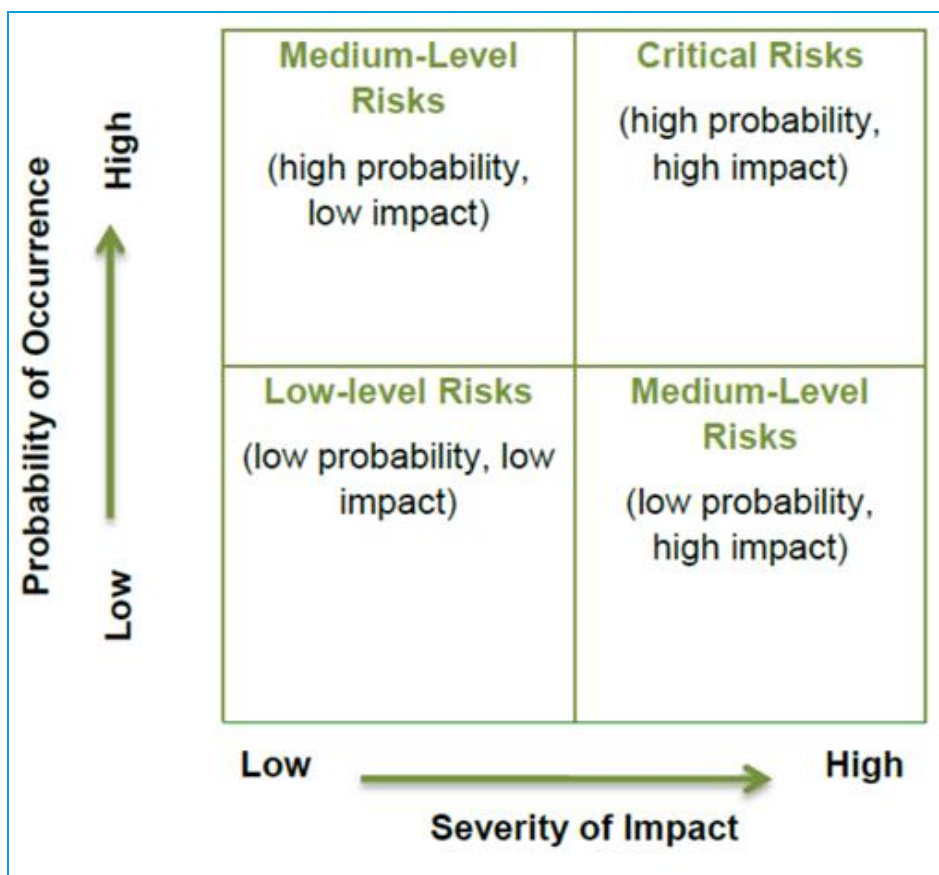


Figure 41: Climate Change Risk Assessment Criteria (IFC, 2015)

Table 41: Climate Change Risk Evaluation & Categorization

Index	Climate Change Risk	Probability of the Risk to Occur (low or high)	Severity of the Impact to the Proposed Project (low or high)	Risk Prioritization (low, medium, critical)
1.	Flooding	High	High	Critical
2.	Soil erosion	High	Low	Medium
3.	Drought	High	Low	Medium
4.	Extreme Temperatures/Heat Waves	High	Low	Medium
5.	Whirl Winds/Windstorm	High	Low	Medium
6.	Lightning and Hailstorm	High	High	Critical
7.	Land slides	Low	High	Medium
8.	Bushfires	High	High	Critical

From table above, it can be concluded that flooding, lightning and hailstorms as well as bushfires are critical climate change risks to the proposed geothermal project whereas soil erosion, drought, extreme temperatures/heat wave, whirl winds/windstorm and landslides are medium risks.

7.4.10 Climate Change Mitigation for the Proposed Project

Table 42 below shows the climate change mitigation measures for the various activities associated with the proposed project. The measures are majorly targeted at avoidance or reduction of greenhouse gas emissions.

Table 42: Climate Mitigation Plan for the Proposed Project

Index	Possible Source of Green House Gas Emissions	Proposed Mitigation Measures	When to Implement	Responsibility
i.	Electricity generation	The proposed project entails development of renewable energy which is clean.	Commercial development of the proposed project.	GDC's geothermal power plant operator.
ii.	Road transport using internal combustion engine vehicles.	Provision of pool transport e.g. using a bus where practicable.	All phases of the project	GDC and contracted 3 rd Parties.
		Use of electric vehicles.	Commercial development of the proposed project.	GDC
		Undertake preventive inspection and maintenance of the internal combustion engines as per manufacturer's recommendations.	All phases of the project	GDC and contracted 3 rd Parties.
iii.	Powering of the drilling rig and lighting using diesel generators.	Undertake preventive inspection and maintenance of the generators as per manufacturers recommendations.	Drilling phase	GDC
		Ensure that the fuel used conforms to the specifications of the relevant Kenya standard.	Drilling phase	GDC & the contracted fuel supplier.
		Carry out stack emission tests at least twice in a year and implement corrective actions where measured emissions exceed the permissible levels.	Drilling phase	GDC
		Use of solar for heating water and security lighting.	Drilling phase	GDC
iv.	Waste Management.	Open burning of solid waste should be prohibited.	All phases of the project	GDC and contracted 3 rd

Index	Possible Source of Green House Gas Emissions	Proposed Mitigation Measures	When to Implement	Responsibility
				Parties.
v.	Utilization of the Air Conditioning Systems and refrigerants/cold rooms.	The refrigerants should have zero ozone depletion potential.	Drilling and commercial development of the project.	GDC and contracted 3 rd Parties.
vi.	Land Clearing for the well pads and campsites.	Promotion of afforestation with consideration of proper choice of trees to be planted. Trees such as <i>Melia volkensii</i> (Mukau) which are Suitable for ASALs are known to have a robust carbon sink that aids in mitigating climate change.	All phases of the project.	GDC
vii.	Catering Services	Discourage use of charcoal and fuelwood for cooking. Instead, clean fuels like electricity, Liquified Petroleum Gas, biogas and solar should be used.	All phases of the project.	GDC and contracted 3 rd Parties.
viii.	Demand for charcoal created by influx of workers to the project site.	Suppress the demand for charcoal through company policy measures and procurement procedures e.g employees should not buy and transport charcoal from the project site.	All phases of the project.	GDC and contracted 3 rd Parties.

7.4.11 Climate Adaptation Measures for the Proposed Project

Table 43 shows the climate adaptation measures for the various climate change risks associated with the proposed project.

Table 43: Climate Adaptation Measures for the proposed project

Index	Climate Change Risk	Potential Impacts	Proposed Adaptation Measures	Responsibility
1.	Flooding	• Damage to infrastructure requiring replacement of components or extra maintenance activities. • Diseases like malaria, dengue fever and cholera. • Loss of life and/or property. • Pollution of existing water sources including water pans as a result of accidental breakage of brine/drilling fluid recirculation ponds.	• Proper storm water management including provision of adequate drains. • Designing and implementing climate resilient infrastructure. • Lining of the drilling fluid recirculation pond with impervious material and incorporating an overflow pond for high discharging wells. • Provision of potable water for drinking and domestic chores. • Disease prevention and control measures. • Awareness and education of employees, contractors and the local community. • Issue flood alerts to employees, contractors and neighbours to the project site. • Implement early warning system. • Inspection and maintenance program for the access roads. • Schedule delivery of the drilling rig, associated equipment and consumables during dry season. • Develop flood emergency response plan and test it at predetermined intervals. • Train employees on emergency	GDC

Index	Climate Change Risk	Potential Impacts	Proposed Adaptation Measures	Responsibility
			response.	
2.	Drought	Reduced volume of water in Kikuyian dam resulting to resource use conflicts among the pastoral communities.	- Desilting of Kikuyian Dam. - Implement water conservation measures. - Participation in the conservation of the Maasai Mau Forest which forms a catchment to the rivers in the project's area of influence. - Install large capacity water storage infrastructure to harvest water during rainy season thus ensuring uninterrupted water supply during dry period. - Recirculate drilling fluid to minimize wastage. - Promoting ongoing harvesting of condensate from fumaroles for local community usage and for animals both wild and domestic. This can be a Corporate Social Responsibility Program.	GDC
3.	Soil erosion	- Sedimentation of the existing surface water sources like water pans. - Land degradation via gully formation. - Negative health impacts of workers and/or neighbours.	- Extent of all disturbed areas shall be restricted as far as practicable. - Bulk cement should be transported and stored in enclosed containers. - Topsoil should be protected from wind erosion via application of water sprays. - Rehabilitation of existing gullies within the project site.	GDC

Index	Climate Change Risk	Potential Impacts	Proposed Adaptation Measures	Responsibility
			<i>Euphorbia tirucalli</i> (Finger euphorbia or Oloile in Maasai) fences are widely used in dry areas as erosion breaks. Project should consider this concept. Design and implement a suitable afforestation program. Choice of trees should factor in their characteristics e.g. <i>Melia volkensii</i> (Mukau) are suitable for ASALs. The extensive root system plays pivotal role in combating soil erosion.	
4.	Extreme Temperatures/Heat Waves	- Equipment overheating or failures due to extreme heat can cause operational disruptions, leading to downtime and reduced power availability. - Workers involved in outdoor operational and maintenance activities may be exposed to extreme heat events and suffer heat stress or heat exhaustion.	- Provide suitable Personal Protective Equipment to those working outdoors. - Limit outdoor activities, where practicable, during extreme heat events. - Train workers to identify the symptoms of heat stress and first aid measures to be taken. - Develop cool and shaded resting spaces (indoor or outdoor) for workers and other external personnel e.g. using air fans or conditioning systems.	GDC and contracted 3 rd Parties.
5.	Whirl Winds/ Windstorm	- Damage to property. - Injuries and/or death of animals/human beings.	- Avoid parking vehicles below trees during windstorms. - Create awareness on the risks associated with windstorms. - Retaining or planting of suitable	GDC and 3 rd party contracted Parties.

Index	Climate Change Risk	Potential Impacts	Proposed Adaptation Measures	Responsibility
			wind breaks.	
6.	Lightning and Hailstorm	• Damage to property. • Injuries and/or death of animals/human beings. • It may trigger fires, which can pose a risk to the drilling infrastructure and surrounding areas.	• Install lightning arresters and earthing rods. • Creating and updating emergency response plans that address lightning-related hazards, such as fire prevention and worker safety, on a regular basis. • Education and awareness amongst staff.	GDC and contracted 3 rd parties.
7.	Land slides	• Damage to property. • Injuries and/or death of animals/human beings.	• Avoid constructing roads, well pads or water lines near steep slopes, near drainage ways or along natural erosion valleys/gullies. • Ensure correct drainage of ground water to avoid building up pressure on the building and soil structure. • Reduce the slope of the Project site through ground movement. • Monitoring of surface deformation and topographical drift. • Conduct geotechnical surveys prior to undertaking construction of well pads or roads in areas likely to be prone to landslides. • Development of a landslide emergency preparedness and evacuation plan.	GDC
8.	Bushfires	• Damage to property. • Injuries and/or death of	• Provision of a designated smoking room as per Section 35 (2) (a) of the	GDC

Index	Climate Change Risk	Potential Impacts	Proposed Adaptation Measures	Responsibility
		animals/human beings.	Tobacco Control Act, Cap 245A. • Construction of fire breaks around the camp site and the well pads. • Provision of appropriate firefighting equipment. • Documentation of a fire emergency response plan and testing it at predetermined intervals. • Establishment of a fire fighting team which shall be well trained. • Documentation of emergency contacts and disclosure to employees and 3rd party service providers. • Open burning of solid waste should be prohibited.	

CHAPTER 8. STAKEHOLDER AND PUBLIC PARTICIPATION & CONSULTATION

8.1 Introduction

This chapter presents the approach, process, and outcomes of the Stakeholder and Community Consultation conducted as part of the ESIA process. Stakeholder engagement is a critical component of the ESIA process, ensuring that the views, concerns, and knowledge of affected and interested parties are considered in project planning and decision-making.

The IFC Performance Standards and World Bank stakeholder engagement requirements emphasize early, inclusive, and continuous engagement as a foundation for effective environmental and social risk management, with structured identification of stakeholders, transparent information disclosure, and meaningful, culturally appropriate consultation throughout the project lifecycle. Within this framework, the principle of Free, Prior, and Informed Consent (FPIC) particularly applicable to projects affecting Indigenous Peoples strengthens engagement by requiring that affected communities are adequately informed, consulted in good faith, and able to provide or withhold consent without coercion, prior to key project decisions. Together, these frameworks underscore that stakeholder engagement is an ongoing, participatory process that promotes accountability, reduces conflict, and enhances project sustainability by respecting community rights and social legitimacy.

Public participation is an essential and legislative requirement for environmental authorization. The Firm of Experts undertook the public stakeholder consultation (PSC) with regard to the proposed Suswa Geothermal Drilling project. The public consultation was undertaken between 25th November to 6th December, 2024 to obtain information from interested and affected parties (stakeholders), solicit their views and consult on sensitive issues by completing a set of questionnaires. The output is incorporated in the development of mitigation measures.

8.2 Objectives of Stakeholder Engagement

Stakeholder engagement for the proposed project was undertaken to:

- a) To uphold the principle of Free, Prior, and Informed Consent (FPIC) where applicable, particularly for Indigenous Peoples.
- b) Inform key stakeholders of the proposed Suswa Geothermal Drilling project and create public awareness on environmental and social risks associated with the project.
- c) Identify opportunities and risks from and to the project: By anticipating a project's potential problems, consultations can help reduce the risk profile (delays, legal disputes, and negative publicity), lead to cost savings, and enhance the social benefits to local communities.
- d) Explicitly address stakeholders' comments and concerns, in the project's decision-making process.
- e) Achieve a transparent decision-making process with greater input from stakeholders and their support of the decisions that are taken.
- f) To enhance the project to support the aspirations and needs of the local communities, including the vulnerable marginalized groups (VMGs) living within the project area.
- g) To build local capacities and foster ownership, which are crucial elements of project sustainability.

The consultation process enabled the establishment of a communication channel between the Public and the Consultant Firm, the Proponent (GDC) and the Government (through the National Government Administration Office), and ensured that concerns of the stakeholders were known to the decision-making bodies at an early phase of project development.

8.3 Methodology used in the CPP

The public consultation and participation were conducted through;

- Household socio-economic survey via Kobo Collect platform.
- Key stakeholder interviews
- Public Meetings
- Focused Group Discussions

The local administration and the public were notified as required. Letters were sent to DCC Narok East and DCC Kajiado West Sub-counties, with the meeting dates and venues clearly indicated. This was done seven days prior to the meetings.

The procedures used for each of the above are outlined below:

8.3.1 Household socio-economic survey

Household socio-economic surveys were conducted during the field visits using structured questionnaires hosted on the Kobo Collect platform. Eight enumerators, trained on November 25, 2024, were engaged to carry out the survey. Approximately 480 households participated in the study, aimed at assessing the socio-economic status of the project area.

8.3.2 Key Stakeholder Consultation

Key stakeholder consultative meetings were conducted between 25th November to 6th December, 2024. The key stakeholder engagements were conducted to foster better and mutual understanding of public concerns as well as incorporate key stakeholders' opinions to this report.

The following stakeholders were consulted:

- Proponent – Geothermal Development Company (GDC),
- National Government Administration – DCC, ACC, Chiefs and Ass. Chiefs
- Kenya Wildlife Service (KWS)
- Kenya Forest Service (KFS)
- Water Resources Authority (WRA)
- Water Resource Users Association (WRUA's)
- NEMA – Kajiado/ Narok County Offices
- DOSH Narok office
- County Public Health Office – Narok
- National Land Commission (NLC),
- Constituency and Ward levels leaders;
- Ministry of Environment, Energy and Natural Resources Narok County
- Mt. Suswa Conservancy,
- Local CBO's – Compassion.

The summary of the feedback from consulted stakeholders is as shown in **Table 44** and minutes are annexed to the report.

Table 44: Summaries of Key Informant Interviews

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	MITIGATION MEASURES
1.	Water Resources Authority (WRA) – Sub regional Coordinator – Ewaso Kedong	- GDC submitted hydrological report for Kikuyian Dam to WRA. - GDC to obtain abstraction permit before commencing any water works. - The dam has been in existence for more than 10 years. - The site where the dam lies used to be private farms. - The dam was created through natural processes. - The dam is recharged by storm water runoff, a spring and a seasonal stream. - Land ownership document for the dam will need to be attached to the application. Where this is not available, the local chief should write a letter to WRA.	- Source of employment - Growth and development in Suswa - Increase in Water availability sourced from Kikuyian dam to the project area - Discoveries of Ground water/ probability of striking Ground Water - Increased of Geothermal production and distribution - Source of revenue to the country.	- Air pollution - Displacement of people - Blockage of human beings and wildlife corridors - Noise pollution - Cases of diseases	- Compensation of the land owners in the project site, - Switch off machines when not in use Regularly service the machines - Work only during day time, 8:00am to 5:00pm - The community residents to be given priority in jobs, especially unskilled and semiskilled labour. - Community and stakeholder's engagement meetings. - Afforestation and reforestation/ planting of water friendly trees probably indigenous - Less gaseous emissions

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	MITIGATION MEASURES
		- During dry season, the volume of water in the dam reduces. - GDC should consider construction of water kiosks and livestock troughs close to the dam as CSR projects. - If the company has funds, it can undertake desilting of the dam as a climate adaptation measure, subject to consultation with the community.			
2.	Assistant County Ecosystem Conservator – Narok (KFS)	- Charcoal burning is one of the livelihoods in the project area of influence thus it is rampant. - GDC should promote alternative sources of energy like biogas at the household level. - KFS maintains a register of community tree nurseries. - It also offers forest extension services.	Partnership with GDC in adopting blocks within Masai Mau complex	- Clearance of vegetation which can cause soil erosion, - Tree species might be lost on Geothermal production site	- Tree planting and growing - The machines used should be thoroughly checked not to disperse invasive species from other areas

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	MITIGATION MEASURES
		• KFS can partner with GDC in the creation of awareness and education on forest management. • KFS operates tree nurseries where GDC can buy seedlings from. • KFS is willing to work in collaboration with GDC to set up community tree nurseries in the project's area of influence. • GDC to adopt rehabilitation blocks within Mau forest and help achieving 15b trees by the year 2032.			
3.	Narok County Warden - KWS	• Mt. Suswa Conservancy, run by the community, is registered by KWS in line with the Wildlife Management and Conservation Act, 2013. • Mt. Suswa area is an elephant dispersal and maternity area. • Elephants migrate from	• Community can benefit from direct use of geothermal heat for agriculture, aquaculture and heating purposes i.e. geothermal energy is used to heat and cool greenhouses; geothermal heat is also used for sterilising soils, drying crops and	• Loosing environment for conservation • Community and workers will be affected by the toxic gases from the project • Pollution of environment • High cost of drilling and uncertainty of the	• Community engagement to address social and economic concern, ensuring their support and corporation • Properly manage solid waste and waste generated during the project to minimize environment impacts

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	MITIGATION MEASURES
		Mosiro-Suswa lowlands which overlaps in Kajiado and Narok. - During migration, the elephants are prevented from moving to Mt. Longonot National Park to minimize human-wildlife conflicts. - African Elephants (<i>Loxodonta Africana</i>) are endangered mammals as per the 6th schedule of the Wildlife Management and Conservation Act, 2013. - Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) thus applies. - Mt. Suswa is considered a critical habitat. - Elephants are capable of smelling water up to a distance of 14 km. - September – November is the period where elephants give birth	pasteurising milk. Utilizing local geothermal resource can reduce dependence.	resource availability.	- Train employees and community on emergency and risk management to enhance preparedness - Improve infrastructure.

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	MITIGATION MEASURES
		within the project's area of influence. • The elephants have GPS collaring for monitoring their movement. • The Kenya Wildlife Research and Training Institute should be included in the key stakeholder's public disclosure workshop. • KWS maintains data on corridors, human-wildlife conflicts, wildlife mortalities and compensation. • Restoration of degraded ecosystems, Conservation of Natural habitats, agroforestry, water management and community engagement should be considered towards enhancing resilience to climate change.			
4.	County Director of Environment -	• Involve local administration in the	Gave no comment since they will be involved in the		

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	MITIGATION MEASURES
	NEMA (Narok) Environment Officer (NEMA Kajiado)	public meetings. • GDC should consider implementing some CSR projects at the onset of the proposed project since this forms part of the key issues during public meetings. • Free Prior and Informed Consent should be embedded in the ESIA process. • Since the project will result in displacement of persons, National Land Commission should be approached to provide awareness creation and education on land adjudication process. • Promote local development by hiring vehicles from the local community. • Ensure participation and consultation of people living with disability. • The community liaison	validation and review of final report.		

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	MITIGATION MEASURES
		officers should be engaged from project inception stage. • Develop Grievance Redress Mechanism for the project. • Public meetings may require deployment of interpreters to promote wider understanding of the ESIA findings. • The area is a biodiversity hotspot thus relevant CBOs should be consulted as early as possible through the Narok County Director of Environment's Office. • Since the initial ESIA study report was submitted to NEMA in 2013, GDC should consider submitting a fresh report to NEMA which shall undergo the due process as opposed to submitting an addendum with an application for			

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	MITIGATION MEASURES
		variation.			
5.	County Coordinator – National Land Commission (Narok)	- The Project Affected Persons should undergo capacity building on financial management prior to compensation. - The PAPs are likely to experience stress thus Psychosocial support should be provided during relocation period. - Training on adaptation to alternative income generating activities should be provided to the PAPs e.g zero grazing. - The affected PAPs need to be compensated adequately in relation to the Land Act pursuant to Section. 107	N/A	- The project will displace people, displacement from the ancestral land may affect household specifically the vulnerable members (women and children) - They will lose the number of Livestock held per family thus economically impacting their livelihoods - The compensation in kind may never be enough to compensate the loss of their land and incomes.	- Psycho Social support shall be provided - Training on handling financial aspects shall be done, - Training on other economic activities to support their livelihoods e.g. Zero grazing - Communities shall be sensitized on the emissions that may endanger their lives.
6.	County Public Health Officer Narok County	The enlisted conditions are in order of occurrence relevance to the county; Upper Respiratory Tract Infections (26.9%), Suspected Malaria	- Job creation and economic opportunities - Access to Energy – Geothermal energy can provide a clean and sustainable energy source to the region.	Displacement or disruption of livelihoods, directly due to drilling activities or through land acquisitions for infrastructure.	- Community engagement - adequately consulted and involved. - Sustainable development – shall follow environmentally

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	MITIGATION MEASURES
		(4.7%), Disease of the skin (4.4%), Urinary Tract infection (3.4%), Pneumonia (3.2%), Diarrhoea with no dehydration (2.7%), Intestinal worms (2.6%), Other Injuries (2.5%), Diarrhoea (2.3%), Other diseases of respiratory system (2.1%). The environmental factors predispose the community to the hazards such as physical, biological and chemical agents in terms of concentrations and creating favourable conditions for the hazards to thrive and thereby causing disease or ill health.	- Increased infrastructure development e.g. roads, school and medical facilities. - Skill Development and capacity building – may offer training and capacity-building programs, - Reduction in greenhouse gas emissions compared to fossil fuels - Sustainable land use – geothermal energy uses relatively small areas of land for drilling, which means the surrounding environment can remain largely intact. - Biodiversity Conservation – if carefully planned and executed can reduce the need for deforestation.	- Cultural and social tensions – loss of traditional ways of life might fuel resistance to the project. - Health and safety risks – potential for accidental releases of gases or toxic substances, could pose health risks to nearby communities; - Risks of soil and water contamination; - Land degradation; - Potential for Earthquakes or land instability; - Disruption to Wildlife and Ecosystem services	best practices to protect land, water and biodiversity. - Fair Compensation - Continuous monitoring of environmental and social impacts should be carried out, and local communities should be involved in reporting and addressing issues as they arise.
7.	Compassion International Rev. Joseph Kiranto (POMC Kisharu)	There are schools and churches in the area, the project should be able to consider so that schools and churches	- Job creations - Open up the community e.g. access roads	- Destabilized settlements - Environnent pollution i.e. air pollution - Disrupted tourism	Ensure timely compensation and a well thought out strategy on how to resettle any persons

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	MITIGATION MEASURES
	Child Development Centre)	- will not be affected. - Every project has its positive and negative impacts, the negative impacts should be mitigated to revert their negativity. - Provide beneficial services to the community through Corporate Social Responsibility (CSR).	Improving on water availability which will be good for livestock keeping.	Reduced area for livestock grazing	- who might be displaced in the process - Ensures that the caves and Volcanic crater remain open for tourist to access all the times
8.	Ewuaso Water Project Manager	The members are residence of Olgumi, Olokiringai, Ewuaso, Enkusero – Keri, Najile and Osero,		- Population increase - Pressure on water from people and animals	- Proper waste management, - Tree Planting within Mt. Suswa e.g. Red Cedar and other indigenous trees - Consider fencing the areas of drilling to protect animals & human beings.

8.3.3 Analysis of Stakeholder Responses

The stakeholder response matrix demonstrates broad, multi-sectoral engagement involving national regulatory agencies, county departments, conservation institutions, community-based organizations, and local service providers. Overall, stakeholder feedback reflects general support for the proposed geothermal project, subject to compliance with regulatory requirements, effective mitigation of environmental and social risks, and meaningful community engagement. **Table 45** below shows the analysis of stakeholder responses

Table 45: Analysis of Stakeholder Responses

Stakeholder Issue Area	Key Risks / Concerns	ESMP Actions	Performance Indicators	Responsibility
Water Resources & Abstraction	Over-abstraction; dry season water shortages;	• Obtain WRA abstraction permit prior to works • Implement water abstraction monitoring plan • Promote water efficiency and reuse • Desilting of Kikuyian Dam (CSR/climate adaptation)	• Valid abstraction permit in place • Monthly abstraction records • Dam water levels monitored seasonally • Number of water efficiency measures implemented	GDC; WRA
Forestry & Vegetation Loss	Deforestation; soil erosion; invasive species	• Vegetation clearance control • Reforestation using indigenous species • Establish community tree nurseries • Clean machinery to prevent invasive species spread	• Area replanted (ha) • Survival rate of planted trees (%) • Number of community nurseries supported	GDC; KFS;
Wildlife & Critical Habitat	Disruption of elephant corridors; loss of maternity areas; habitat degradation	• Maintain and mark wildlife corridors • Schedule drilling outside calving season (Sept–Nov) • Install wildlife warning signage and fencing • Continuous wildlife monitoring (GPS data)	• No. of wildlife incidents reported • Corridor functionality maintained • Drilling schedule compliance	GDC; KWS;
Air Quality & Toxic Gases	Exposure to geothermal gases; community health risks	• Install gas detection and alarm systems • Implement air quality monitoring program	• Gas monitoring reports • Zero fatal gas exposure incidents	GDC; HSE Team;

Stakeholder Issue Area	Key Risks / Concerns	ESMP Actions	Performance Indicators	Responsibility
		• Emergency response and evacuation plans		
Noise & Vibration	Community disturbance; worker health impacts	• Restrict work hours (8:00am–5:00pm) • Use noise suppression equipment • Maintain machinery regularly	• Noise levels within NEMA limits (dB) • Number of noise complaints received	Contractor; GDC
Livelihood Restoration	Loss of grazing land and livestock	• Training on alternative livelihoods (zero grazing) • Financial literacy training	• Adoption rate of alternative livelihoods in cases of relocation	GDC; County Agriculture
Public Health Risks	Increased disease burden; water contamination	• Health risk assessments • Water and sanitation controls • Community health awareness programs	• Disease incidence trends • Water quality results within standards	GDC; County Health Dept
Community Engagement & FPIC	Lack of informed participation; conflict	• Implement Stakeholder Engagement Plan (SEP) • Embed FPIC principles • Hold regular public meetings with interpreters	• Number of consultations held • Attendance records (gender, PWD)	GDC; CLOs
Grievance Redress Mechanism (GRM)	Unresolved community grievances	• Adopt project-level GRM provided in SEP report • Record and resolve grievances within timelines	• % grievances resolved within 30 days • GRM log maintained	GDC
CSR & Community Benefits	Expectations on visible benefits	• Early CSR interventions (water kiosks, troughs) • Local employment prioritization	• Number of CSR projects delivered • % local workforce employed	GDC

Stakeholder Issue Area	Key Risks / Concerns	ESMP Actions	Performance Indicators	Responsibility
Cultural, Religious & Tourism Sites	Disruption of schools, churches, caves	• Avoidance buffers around sensitive sites • Maintain access to caves and crater	• Zero damage to cultural sites • Continuous tourist access maintained	GDC;
Waste Management	Environmental pollution; safety hazards	• Implement waste management plan • Proper disposal of hazardous and non-hazardous waste	• Waste disposal records • No illegal dumping incidents	GDC
Occupational Health & Safety	Worker injuries; accidents	• OHS training and PPE provision • Incident reporting system	• Lost Time Injury Frequency Rate • PPE compliance rate (%)	GDC

8.3.4 Community/ Public Meetings/ Focus Group Discussions

The meetings were carried out in a language that was appropriate to the different audience i.e. English, Swahili and Masai. The public barazas were held at the locations as shown in **Table 46** below:

Table 46: Venues for the public meetings

S/N	County	Venue	Date
1.	Narok	Duka Moja Primary School	25 th November, 2024
2.		Karuka Primary School	26 th November, 2024
3.		Empash Primary School	28 th November, 2024
4.		Kikuyani Primary School	29 th November, 2024
5.	Kajiado	Kisharu Primary School	30 th November, 2024
6.		Ewuaso ACC Office	3 rd December, 2024
7.		Olodung'uro Pr. School	4 th December, 2024
8.		Olgumi Primary School	5 th December, 2024

The Photo log (Figures 42 - 49) shows images of the public baraza meetings that were held during the period.



Figure 42: Ongoing Public meeting at Duka Moja on 25th November, 2024



Figure 43: Ongoing public meeting at Karuka Primary school on 26th November, 2024



Figure 44: Ongoing public meeting at Suswa on 28th November, 2024



Figure 45: Public meeting at Kikuyian Pri. School on 29th November, 2024



Figure 46: Ongoing public meeting at Kisharu primary school on 30th November, 2024



Figure 47: Ongoing Public meeting at Ewuaso Kedong ACC's office on 3rd December, 2024



Figure 48: Ongoing Public meeting at Olodung'uro Primary School on 4th December, 2024



Figure 49: Ongoing Public meeting at Olgumi Primary School on 5th December, 2024

8.3.5 Summary of issues raised and response during community engagement sessions.

The following tables represent a summary of various issues and concerns raised during the community engagement sessions.

a) Summary of community engagement session held at Duka Moja centre on 25th November, 2024.

Table 47: Summary of issues and response at Duka Moja community engagement

Persons	Issue raised	Response
Olesuru Koima	Are there known effects from exposure to hydrogen sulphide.	Exposure to hydrogen sulphide is known to cause eye, nose or throat irritation and headache. These effects are however dependent on level of exposure/ concentration of hydrogen sulphide in the air. In view of this, baseline hydrogen sulphide measurements will be undertaken with continuous monitoring to be undertaken in monitoring the concentration of hydrogen sulphide. H ₂ S leak test will be continuously undertaken in minimizing the concentration in the air. In addition, air dispersion modelling will be undertaken once the exploration phase of the project is successful in determining H ₂ S fallout areas that will inform whether the affected persons will be relocated.
	Noise generated from the project, especially from well testing will affect those suffering from blood pressure and other diseases.	Silencers will be put in place in minimizing noise levels from well testing operations. Prior communication through notices to communities in respective areas will be provided for operations with high noise levels. In addition, noise propagation modelling will be undertaken once the exploration phase of the project is successful in

Persons	Issue raised	Response
		determining noise fallout areas that will inform whether the affected persons will be relocated.
	Clarification on whether community members will benefit from water that will be piped from Kikuiyan Dam. This is bearing in mind that water is a major challenge in the project area.	The proposed project will have community water points in place for use by community members.
	Highlighted that all PAPs to be fairly compensated and the proponent to ensure they directly deal with the PAPs.	Resettlement action plan (RAP) will be undertaken for the proposed project with all identified PAPs to be fairly compensated upon all agreements.
John Olemushiko	Emphasized that the photos taken in the meeting should be exclusively used for the purpose of the updated ESIA report.	The photos taken will only be used as evidence of the public meeting held for the purpose of updating ESIA for the proposed GDC project. GDC adheres to requirements of Data Protection Act, 2019
	Requested for clarification on the criteria to be used in employment of persons in the project.	All labour issues including recruitments in the project will be in compliance with Kenya Employment Act. In addition, all recruitments for available job opportunities will be in line with GDC HR policies and other related policies.
Professor Koisamba	Emphasised on the need to had a free, prior and informed consent (FPIC) meeting, since he felt that the meeting did not meet these criteria.	Adequate notices and communication with areas residents were provided inviting residents to the meeting. This was carried out through area administrators that were key in mobilization. The principle of Free, Prior, and Informed Consent (FPIC), shall be incorporated throughout the project
	Highlighted that the land under which the proposed sites are located is privately owned.	Resettlement action plan (RAP) will be undertaken for the proposed project and all identified PAPs will be fairly compensated upon all agreements.

Persons	Issue raised	Response
	Requested for a comprehensive meeting to be held between area residents, the government and GDC so that a written MoU can be put in place.	Memorandum of Understanding (MoU) with Kajiado and Narok Counties are in place in reference to the proposed project. It is recommended that these MoU to be shared with community members in subsequent meetings.
Elijah Koilek	Requested for 70% of job opportunities in the project to be set aside for local community members.	GDC being a government entity, is guided by the employment Act. However, it is however important to point out that a majority of unskilled and semi-skilled job in the project will be set aside for local community members.
	He stated that all land compensations to be through individual land owners and not through land companies or representatives.	Resettlement action plan (RAP) will be undertaken for the proposed project with all identified PAPs to be fairly compensated upon all agreements.
	The project to initiate CSR projects in the project such as upgrading of existing schools & roads, provision of school buses among others.	As part of updating the ESIA report, the Consultant will develop a Community Development Plan (CDP) upon consultation with residents. The CDP will detail community-based projects that GDC should consider for implementation as part of the CSR.
James Lesolol	Recommended for future public participation meetings for the purpose of the proposed project to be held in the presence of women and youths.	This meeting was free and open meeting with all in the community including men, women, youth, persons with disabilities, aged among others welcome to attend and give their views.
	Highlighted that all Community Based Organizations (CBOs) in the area to be engaged are they have a significant role to play in the community.	All CBOs will be individually engaged through key stakeholder meeting that will be held. These CBOs will also be part of the representation that will be invited for the validation workers to be held later.

Persons	Issue raised	Response
	He felt that the meeting was only for the purpose of showing that residents were engaged in the project so that necessary approvals to be obtained.	The meeting was a public participation meeting for the purpose of updating 2013 ESIA. Public participation is a requirement as provided by the Constitution of Kenya, 2010 and further highlighted by EMCA, 1999. The purpose of public participation is to inform all stakeholders about the proposed development and gather their views with a view of incorporating them into ESIA. Validation workshops will be held with representatives from various areas in the community to represent community members and other key stakeholders. This will ensure that all stakeholders concern and recommendations have been incorporated in the report.
	He further recommended for all land issues related to the proposed project to be delt with respective land owners and not brokers.	Resettlement action plan (RAP) will be undertaken for the proposed project with all identified PAPs to be fairly compensated upon all agreements. All land compensations will be facilitated by National Land Commission (NLC) in collaboration with GDC.
Daniel Loujalu	He stated that livestock deaths have been experienced in other geothermal exploration project through consumption of contaminated surface water. He was hence was concerned this will be the case in the proposed project.	Surface water contamination from the project can occur from accidental spillage of brine (that may contain heavy metals) However, brine will be contained in HDPE lined sump ponds that will be fenced to control access. In addition, appropriate signage will be in place and frequent routine checks will be conducted to identify and address possible spillages.
	He was further concerned about increased cases of miscarriages as a result of the proposed project, as experienced in other areas where geothermal explorations have taken place.	GDC will put in place measures to prevent exposure to H ₂ S missions. Incidences of Miscarriages at the workplaces where H ₂ S is expected to be high have never been reported.
	Lamented that the area has previously been	As part of updating the ESIA report, the Consultant will develop a Community Development Plan (CDP) upon

Persons	Issue raised	Response
	isolated in reference to development. He hence requested for provision of water from the project.	consultation with residents. The CDP will detail community-based projects that GDC should consider for implementation as part of the CSR.
	He requested for information of ownership of GDC for public knowledge.	GDC is fully-state owned company under the custodian is the Permanent Secretary for the National Treasury and State Department for Energy.
	He requested for community members to have a percentage share from the sale of geothermal resources in the area.	The sale of geothermal resources is governed by national laws; therefore, GDC is not in a position to comment on the matter.
Lucas Munywa	He noted that Standard Gauge Rail (SGR) ESIA project initiated in the area engaged local community representative during public participation. Based on this, he requested for confirmation on whether this project has this aspect in place.	A number of enumerators from respective areas have been engaged as part of public participation and gathering of project area socio-economic data.
	He requested for information on companies involved in the proposed project.	The proposed project will be implemented by GDC, a company that is fully-owned by the Government of Kenya.
	Highlighted that Suswa Mountain is critical in storm water management in residents residing downhill. As such, the proposed project might lead to flooding of areas located downstream of	Appropriate drainage will be put in place in management of storm water along the proposed well sites and along proposed roads. This is in addition to other flood control measures. Additionally, as part of the Government of Kenya attainment of planting 15 billion trees by the year 2032, GDC is recommended to establish tree planting programmes in the areas, as part of flood control measures.

Persons	Issue raised	Response
	the mountain.	
	He further requested for information on CSR projects and programmes proposed in the area from the project.	As part of updating the ESIA report, the Consultant will develop a Community Development Plan (CDP) upon consultation with residents. The CDP will detail community-based projects that GDC should consider for implementation as part of the CSR.
	He further requested for clarification on the criteria for compensation of the PAPs from the proposed project.	Resettlement action plan (RAP) will be undertaken for the proposed project with all identified PAPs to be fairly compensated upon all agreements. All land compensations will be facilitated by National Land Commission (NLC) in collaboration with GDC.
	He requested for information on whether GDC community liaison committee is in place.	GDC community engagement committee (CEC) was in the process of being formulated at the time of this meeting.
William Supeo	He requested for provision of a training institute and provision of community water points as part of the proposed project CSR.	As part of updating the ESIA report, the Consultant will develop a Community Development Plan (CDP) upon consultation with residents. The CDP will detail community-based projects that GDC should consider for implementation as part of the CSR.
	He requested on information on what will happen to the well pad land in case of unsuccessful explorations.	Resettlement action plan (RAP) will be undertaken for the proposed project with all identified PAPs to be fairly compensated upon all agreements. All land compensations will be facilitated by National Land Commission (NLC) in collaboration with GDC. Additionally, lease agreements are recommended at the four explorations well sites. In addition, decommissioning reports should be prepared before the land is handed over to the respective land owner with necessary rehabilitation undertaken.
	Requested for GDC to ensure that implementation of the project to only be implemented once an	A collaboration framework agreement for the proposed project with respective counties is in place. It recommended for this information to be disclosed to the community members.

Persons	Issue raised	Response
	MOU is in place.	
	Requested for correct information to be provided to community members and all stakeholders. This is bearing in mind the aftershock the residents have experienced from previous project in the area.	As part of updating the ESIA report, the Consultant will develop updated ESMP for Suswa Project, Land Acquisition and Compensation Framework (LACF) Plan, Land Acquisition Compensation and Livelihood Restoration Plan, Stakeholder Engagement Plan & Indigenous Peoples Plan and Community Development Framework (CDF). These plans and frameworks will ensure that the proposed project full benefits are accrued.
Joseph Kingoi	Requested for confirmation that the public consultative meeting was only aimed at updating of ESIA report and not as consent that for the project to go ahead. He further requested for a validation workshop to be held with community members. Additionally, he requested for consent from community members to be sort prior to implementation of the proposed project.	The public consultative meeting was aimed at informing the community members about the proposed development and gather community members views in reference to the proposed development. A validation meeting will be held and will involve key stakeholders and a representation from community members in ensuring that issues raised have been incorporated in the updated ESIA report and other deliverables under the project. In addition, implementation of various project components will be upon agreement with respective land owners as informed by RAP reports.
Peninah	Highlighted that they had done a letter to GDC to request for an ESIA to be undertaken before the proposed project is implemented.	This public meeting was part of updating the 2013 ESIA report, hence their concerns have been actioned. However, it is recommended that all communication done in writing are responded to and should be done in writing.
	She stated that women should be involved in all phases of the project.	The project will ensure inclusivity, ensuring that youth, aged, persons with disabilities, women, aged among others are engaged in all phases of the project.

Persons	Issue raised	Response
	She applauded the organizers of this meeting as previous meeting for the proposed project were held in hotels hence limiting attendance of all community members.	

b) Summary of community engagement session held at Karuka Primary School on November 26, 2024.

Table 48: Summary of issues raised during community engagement at Kuruka Primary school

Name	Issue raises	Response
Kalempe Ole Monyis (Community member)	There is a perception that cases of miscarriage will be rampant how true is this statement	The perception of miscarriages is null and void because there is no prove for the same.
	How do you intend to control noise pollution and also waste water from the wells and so that it may not affect animals?	The company will maximize the use of silencers to control noise pollution they will ensure that the waste water is well contained in lined circulation ponds and the ponds shall be fenced
Sabaya Punyua (Youth representative)	What is a safe distance from the drilling area?	The safest distance is determined by the ambient levels of noise and hydrogen sulphide gas. GDC shall conduct continuous monitoring and incase the limits exceed, appropriate actions shall be taken
	How do you intend to go about the process of negotiation is it based on individuals or public forum?	GDC is guided by the laws of the land and internal policies that guide the process of negotiation.
	How are you planning to do environmental restoration?	The company will restore and rehabilitate degraded sites by planting indigenous species i.e grass as well as trees where necessary.
	What is the minimum or the maximum time given to individuals affected for them to relocate and under whose cost?	Time will be as per the negotiations and GDC will cater for the costs of relocation.
	In case the project fails, what will happen if there	GDC will decommission, then rehabilitate and restore the sites.

	will be no geothermal?	
	How is the company planning to curb the problem of insecurity emanating from the population influx that may be caused by the Project?	The company has security management plans in place and works together with the Ministry of Interior and National administration during project implementation.
Ann Nkalo (Community member)	Does the project have effects on women?	The project has both positive and negative impacts as highlighted in this meeting. The negative impacts will be mitigated and monitoring to prevent harm to all

c) Summary of community engagement session held in Enoosupukia Location (Empash) on November 28, 2024

Table 49: Summary of community engagement at Enoosupukia

Name	Issue raised	Response given
Santai Ole Mututua (Suswa Water Community Chair)	Is there a place the company intends to resettle the locals who will be displaced?	Currently, there is no place that has been designated for resettlement. However when need be, negotiation will be done between the company and the locals to agree.
Ole Masi (Community Member)	How is the company planning to protect our livestock from consuming brine water?	Brine will be contained in lined ponds which shall be fenced to prevent access by people and animals.
	How are you planning to dispose waste water?	Storm water shall be channeled through drains and the brine will be held temporary in lined sumpponds then finally reinjected.
Ole Parkire (Community Member)	How do you intend to distribute the available employment opportunities?	GDC being a government entity, employment is guided by the employment Act. Everyone shall be considered and selected based on merit.
Nicolas Kisotu (Community Member)	1. How many wells do you intend to drill within the nuclear? 2. How are you planning to educate people on the negative impacts of the project?	1. Project will start with four (4) wells and the number will progress depending on the availability of the geothermal resource 2. Currently in this meeting we are educating people on the projects negative impacts and the mitigation measures. During project implementation, GDC shall continually do the same
Ole Meshuko (Community Member)	What tangible project do company intends to carry out in the locality before the request by the locals?	GDC will elaborate on the same, however decisions are based on priorities as agreed by locals and the company. i.e Water, Health, Education, Empowerment and Emerging

Murungaru Mututua	In case there will no geothermal, what will the company do the water project?	Various studies have been done and proved existence of the resource. In case GDC drills and finds none, the project will be decommissioned, then rehabilitated and restored. On the water, GDC shall consult with the relevant authorities on the best approach
Kapusia Ole Naadokila	1. Are you aware of a fishy scheme to acquire land illegally by individuals purporting to be government's agents? 2. What will be the longevity of the project?	1. The sale of land is based on willing -buyer- willing seller and GDC advises the community work with the Chief and other relevant authorities 2. The project time length is not definite.
Ole Supeyo (Youth Representative)	What will happen to the water fumaroles when the drilling starts?	They will not be affected by the drilling.
Vivian Saruni (Chair Women Initiative)	How do you plan to empower women?	The company will bring all people on board including; - Women, youths and people with disabilities.

d) Summary of community engagement session held at Kikuyian Primary School on 29th November 2024.

Table 50: Summary of issues raised at Kikuyian school

Name	Issue raised	Response
Simeon Kunkuru (Keek-Onyokie Ward Administrator)	How will the company safeguard the community fishing ponds around Kikuyian dam?	During the water abstraction, GDC will ensure appropriate measures are in place to prevent interference with community fishing ponds. Screens shall be placed at the abstraction point to prevent fingerlings getting to the pipe
Ole Nkamasiai (Community Member)	When will the report be out?	Information will be given in due time. Probably 3 weeks from now
Lemondoi Ole Poreka (County Officer)	How will the Company ensure that the locals get sufficient supply of Water because Kikuyian Dam acts as a source of Water for the households living around the dam?	The water that is abstracted is very minimal compared to the water in the dam. The dam will never be exhausted as per the hydrological studies undertaken so far.
Evans Naenkop (Youth Representative)	How will the residents of Kikuyian benefit from the project?	Clean water supply and other CSR projects that GDC will deem fit for them.
Sitonik Ole Naenkop (Member)	How big is the Water pump to contribute to noise pollution?	A separate EIA for the water abstraction was done and various mitigation measures detailed including enclosing all pump stations to prevent noise

e) **Summary of community engagement session held at Ewuaso Kedong on 3rd December, 2024.**

Table 51: Summary of issues raised at Ewuaso Kedong

Name	Issues raised	Response
Nkaka Ole Matura (Ewuaso Water Project Chair)	1. How do you intend to do the process of compensation? 2. Where do you intend to resettle those who will be displaced? 3. How are you planning to control leakage of brine Water?	1. Compensation shall be guided as per the Kenyan laws and due process will be followed 2. Negotiation will be done and both parties will agree 3. Brine shall be contained in well lined sumponds. Rountine checks shall be conducted to identify and corrective action taken before the spill/leakage
Grace Sekento	Is it possible to build a facility for disabled children?	Request is noted and will be forwarded to management for consideration
Ole Matura	Before the start of the Project, what measures have you put in place to control air pollution?	During this study, baseline air quality measurements will be taken thereafter GDC shall continuously monitor air quality and implement appropriate measures as required
Jeremiah Ole Tinina	Which skills are required for one to be employed by GDC?	Opportunities are available depending on one's qualifications.
Ole Kinayia(Disabled)	Do disabled people have a chance to work with GDC?	Employment in GDC is guided by employment Act and so no one shall be discriminated based on disability. Merit will determine
Timothy Tome (Teacher and a Local Football Federation Coach)	Will the Company offer support to local football federation?	The request is noted and will be forwarded to GDC management for consideration

f) **Summary of community engagement session held at Olodungoro Primary School on 4th December, 2024.**

Table 52: Summary of issues raised at Olodungoro Primary School

Name	Issues raised	Response
Samima Teeka (Teacher)	What is the approximate distance from the well to the safe resettlement place?	GDC shall strive to site wells away from the settlements to maintain the safe distance. During project implementation, disperation modelling will be done and noise propagation to exactly determine the distances
John Konana	1. Is there a possibility of	1. No. During the project implementation geohazard

	an earthquake and land sinking? 2. What is the intensity of the expected damage? 3. Will the noise pollution cause ear damage?	monitoring will be undertaken 2. The expected negative impacts will be mitigated thus no damage is anticipated 3. Silencers will be installed on all discharging wells and continuous monitoring conducted. Employees working in these sites will undertake audiometry tests on annual basis
Chris Maraitei (Youth)	1. What is the assurance that the Company will adhere to the CSR Policy? 2. What is the role of the Youth in the project?	1. GDC being a government entity, budget allocation determine implementation of the various planned activities for the financial year 2. Youth are part of the project in various ways: currently in this meeting you are part of decision making and as project progress, wherever opportunities are advertised, the youths are encouraged to apply
William Sirere (Youth)	1. How are you planning to prevent leakages? 2. How do you intend to benefit from the Maasai culture? 3. Is this a continuous conversation?	1. Brine shall be contained in well lined ponds and fenced to prevent unauthorized access. In addition, routine checks shall be conducted to identify and take corrective action to prevent the leaks 2. The culture will assist in many things including conservation of key indigenous species 3. Yes. GDC shall continuously engage its stakeholders
Nkaru Teeka (Youth)	1. How do you intend to do the process of compensation? 2. Can Communal Projects come first?	1. Compensation process shall be guided by the Kenyan laws and will follow the due process 2. GDC shall have a consultative approach where the community will rank and prioritise projects depending on availability of resources

g) Summary of community engagement session held at Olgumi Primary School on 5th December, 2024.

Table 53: Summary of issues raised at Olgumi Primary school

Name	Questions asked	Response given
Ting'a Murkuku	Do you have an approximate distance that the pollution effect will be felt?	During project implementation, dispersion modelling will be done and noise propagation to exactly determine the fallout distances
Rides Maisiodo	How sure are we that the agreement is secure and will be followed to the latter?	The agreement is based on negotiation between the Company and the owners of land and GDC shall abide as required by law

Santayian Ole Kerenke (Village Elder)	How is the well pad equipped to avoid leakages and the possibility of drowning?	The sump ponds shall be well lined and fenced to prevent unauthorized access. The well pads shall also be manned by security guards
Parsinante Kindi (Youth)	Can the air be purified to reduce its negative effects?	In geothermal areas like Suswa, the Hydrogen Sulphide gas naturally exist and so during the project implementation, GDC shall continuously monitor its levels and where the levels exceed, appropriate measures shall be taken
Julius Ntete (Ass. Chief)	How do you plan to control overflowing of the well pad?	Brine shall be contained in well lined ponds and fenced to prevent unauthorized access. In addition, routine checks shall be conducted to identify and take corrective action to prevent the leaks
Joseph Kipuri	1. Do well pads have overflows? 2. Do you have Land for resettlement?	1. Brine shall be contained in well lined ponds and fenced to prevent unauthorized access. In addition, routine checks shall be conducted to identify and take corrective action to prevent the leaks 2. Currently, there is no place that has been designated for resettlement. However when need be, negotiation will be done between the company and the locals to agree
Lesinko Tatiyia (Committee Chair)	How are you planning to control dust?	GDC shall control speed within the project sites and sprinkle water

Figure 50 below shows the graphical summary different issues raised during public participation forums.

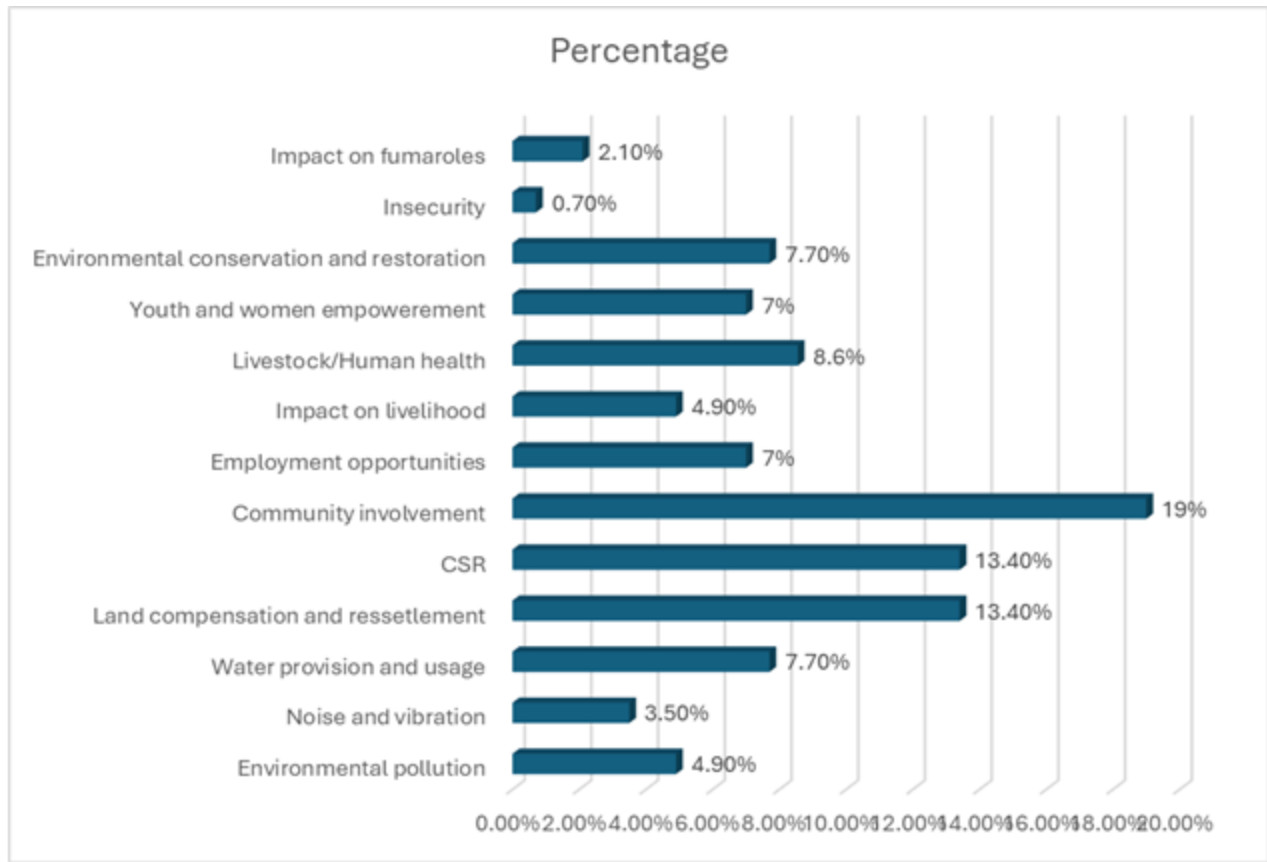


Figure 50: Summary of issues raised during community meetings

CHAPTER 9. SIGNIFICANT ENVIRONMENTAL IMPACTS IDENTIFICATION, ANALYSIS AND EVALUATION.

9.1 Introduction

This chapter presents the systematic identification, evaluation, and analysis of potential environmental and social impacts associated with the proposed project the objective is to determine the likely positive and negative effects of project activities across all phases and to assess their significance in order to inform decision-making and the design of appropriate mitigation measures.

The implementation of the Geothermal Drilling project and its associated amenities is anticipated to result in both positive and/or negative impacts on the physical, social, economic and biophysical environment of the project site area.

This environmental analysis has considered the main phases associated with geothermal energy development.

- **Reduction in Greenhouse Gas Emissions:** Geothermal energy is a renewable energy source with minimal carbon dioxide and other greenhouse gas emissions compared to fossil fuels. Utilizing it helps combat climate change.
- **Sustainable Energy Source:** Geothermal reservoirs are naturally replenished, ensuring a consistent and reliable energy supply with minimal environmental degradation over time
- **Minimal Land Use:** Geothermal power plants require relatively small amounts of land compared to other energy sources like solar or wind farms, preserving habitats and reducing ecological disruption.
- **Conservation of Water Resources:** Closed-loop geothermal systems recycle water, making them less water-intensive than fossil-fuel-based or nuclear power generation.
- **Support for local Biodiversity:** with proper planning, geothermal projects can be developed without significant harm to local ecosystems and in some cases, degraded areas can be restored during the development process

9.3 Predicted Negative Impacts

Table 53 below is a matrix showing impact categories during the different project phases.

9.3.1 Negative Environmental Impacts

9.3.1.1 Construction of Roads, Well Pad, and Sump Pit Construction

The development and or improvement of access roads to the proposed drilling sites will include:

- Clearing vegetation along the access routes and drilling sites;
- Development of pits for road borrow materials;
- Increase in labour and service transport vehicles to and from site; and,
- A potential for an increase in accidents due to the increase in frequency of vehicular traffic and pedestrian and animal traffic using the new roadways.

Since the maximum width of the road will be on average only 6.5 m wide, the impact on original vegetation will be minimal. The drilling sites have grassy patches and lava rocks and therefore do not have much vegetation to be cleared. The design of roadways has considered ditch profiles that accommodate expected rainfall accumulations as well as have runoff controls to prevent gully erosion during periods of high rainfall.

The major impact shall therefore be increased vehicular traffic due to an increase in labour and service transport vehicles to and from site, thus affecting wildlife crossings and the amount of dust and noise generated. The increase in vehicular and pedestrian movement increases the potential for accidents. The proposed mitigation measures regarding increased traffic are:

- Abide by the speed limits and by laws i.e. 30km/hr.
- Movement of heavy construction traffic should be planned appropriately.
- Prevention of soil erosion during upgrading and use of access road and regular watering should be done to avoid impact of dust.
- Rehabilitation of pits for road construction.
- Establish maintenance responsibilities and ensure that road rehabilitation takes place as soon as possible.

Table 54: Matrix showing various impact categories during the phases of development

PHASE 1: SITE PREPARATION	
Impact category	Impacts
Flora and Fauna	• Clearing and de-vegetation, levelling of land surface; excavated materials, drainage requirements. • Traffic affecting wildlife by driving them away from their natural habitat leading to increased stress and displacement.
Air quality / general site establishment works and access road	• Earthmoving, stockpiling, land clearance and excavation activities have the potential to create air quality impacts. Different activities will create different levels of dust, so the magnitude of change will vary throughout the site clearance phase.
Increase in noise and vibration from establishment works and access road upgrade	• These may cause excessive noise to the human and ecological receptors. The nearby properties could be adversely affected from a small number of movements or even the passage of a single heavy vehicle in close proximity to receptors at a sensitive time of the day • Noise generated from machinery for construction of road, water storage facilities, vehicular transport of equipment to drilling sites
Water quality	• Water required for reducing dust during site clearance and establishment • There is potential for pollution of surface water courses from fuel or chemical spillages (if poorly managed) and spoil materials generated during site clearance and construction, particularly if heavy rainfall occurs
Reduced Surface Water Quantity	• Water will be sourced from Kikuyian Dam for dust suppression, road construction, and foundation works can lead to reduction of water quantity however, the quantity is not expected to be much to cause any significant negative impacts.
Soils and geology	• Extensive bush clearing, levelling of land, construction of buildings causing soil compaction, soil exposure to wind/water erosion, and dust pollution. • Repeated movement of trucks and drilling equipment along undesignated routes may compress the soil resulting in reduced porosity and permeability, poor water infiltration and drainage.
Improved access due to upgrades to existing road	• Potential impacts on local road users and local people due to increased project traffic and upgrades

network	
Infrastructure	• Construction will increase de-vegetation, earth moving causing dust storms; • Potential for traffic accidents will increase which would have an effect on both people and livestock.
Project influx/induced in-migration	Although, the small nature of the project makes it less likely that opportunistic jobseekers will be attracted to the area looking for employment opportunities, the project may result in a temporary increase in population in the area. This increase is also not expected to result in increased pressure on local services or markets for local goods and services although it could contribute to perceptions that local people are not sufficiently benefiting from employment opportunities and create conflict between the local community and non-local workers.
Temporary employment generation	• Job opportunities to locals for unskilled labour. Unskilled jobs will include laborer's and the provision of services for workers such as food and refreshments, providing workers accommodation etc. • Provision of an income source for workers and their families contributing to their well-being and enhancing their quality of life. • The labour pool for unskilled jobs opportunities will likely come from the direct area of project influence. • Indirect employment generation will create income generating opportunities for businesses in the project supply chain and supporting industries in the wider area through providing construction materials and equipment such as gravel/sand, cement as well as services to workers (eg groceries, food, transportation among others
Visibility and emergency management	• Vegetation clearance, earthwork and heavy machinery use may stir up large amounts of dust affecting visibility. • Improper site layout planning may make it a challenge to evacuate or move people during incidents. This will require proper emergency h, health and safety plan and procedures to be put in place.
Economic Improvement	• The procurement opportunities available for businesses is expected to be limited in the Country and the respective Counties. Construction materials like gravel, sand are likely to be sources from the counties of Kajiado and Narok. Local community enterprises and start-ups are expected to benefit from the project. • Benefits to the wider economy of Kenya will not be visible but are expected to include increased income for workers and businesses from the provision of specialists' services and materials for example quarry material, cement among others

Land acquisition and economic displacement	Physical displacement is not expected as no residential structures have been identified near to the proposed drill pads locations. However, the project is expected to result in temporary loss of land and access to land for landowners and livestock farmers on the drill pads and the proposed campsite. 1.
Damage to Cultural Heritage/known and unknown archaeological sites	There are no known archaeological sites located within the site/ or footprints of the project but the presence of as yet unidentified artifacts or sites of archaeological and/or historical importance cannot be ruled out that could be accidentally damaged during construction activities.
Health, safety and security risks to workers	The key OHS risks for the site establishment phase, include: • Exposure to physical hazards from use of heavy equipment • Trip and fall hazards • Exposure to dust, noise and vibrations • Falling objects • Exposure to hazardous materials; and exposure to electrical hazards from the use of tools and machinery • Environmental hazards adverse weather conditions, such as working in extreme heat, heavy rainfall • Psychological hazards including high-stress work environments or fatigue • Risks specific to the project location include exposure to extreme heat and hazards associated with working on or near roads. Workers involved in vegetation clearance are at greater risk of snake bites.
Health, safety and security risks to the local community	• It is not predicted that the Project will result in accidents and transmission of disease among community members, however, the Project does create potential risk for their occurrence. These risks and associated hazards require management measures. • Truck and vehicle movements will increase existing traffic volumes. • Nuisance impacts from increased noise, vibration and dust related to construction activities. See Chapters. • Construction site storage and use of hazardous materials. • Potential diseases and infections passed from workers to local community, in particular HIV/AIDS and other sexually transmitted infections as a result of the influx of construction labour force population.
Vegetation removal/loss of Habitat	• Habitat loss and degradation • Disturbance and displacement of species. This change will lead to permanent and temporary habitat and flora loss
Excavation/ drilling and	Introduction of invasive species in the project area. Movements of spoils/soil through excavation activities could result

Construction	in the accidental introduction of invasive plant species
Presence of people, noise, vibrations, artificial light, and air emissions	Presence of people, noise, artificial light, vibration and air emissions will impact mammals, birds and some herpetofauna species during construction through disturbance and displacement. This change can disrupt fauna populations by interfering with their movements and/or breeding activities. Dust particles generated by vehicle movements on dusty roads may adhere to leaves, impeding photosynthesis and plant growth
Movement of vehicles and mobilization of the rig and other associated equipment	Injury and killing of species through Project activities e.g vehicle movement can cause degradation of terrestrial habitats. There is also potential for injury/ death of terrestrial fauna due to collisions with vehicles. Incidents and accidents caused by wide vehicles transporting drilling rig to and from the site. Emissions from vehicles and pollution from operational vehicles
PHASE II: EXPLORATORY APPRAISAL AND PRODUCTION DRILLING PHASE	
Flora and Fauna	• Acidic gases such as hydrogen sulphide may affect vegetation if encountered in high enough concentrations. • Well pads are 50x80 m. Installation of pipeline requires the removal of vegetation and soil. • Trace metals may affect vegetation and soils if encountered in high enough concentrations. • Traffic affecting wildlife
Drilling rig Air emissions	• Emissions of combustion-related pollutants from drilling rigs and other on-site plant have the potential to impact on air quality in the Project area. The exploration wells will be drilled using a large rig of hook load. The drilling rigs will include diesel-powered generators. The combustion of diesel emits emissions of NO_x, particulates and CO. The composition of exhaust gases will depend on the fuel used and combustion conditions (i.e. old or poorly maintained generators are likely to produce emissions with a greater percentage of harmful pollutants than newer equipment)
Well testing emissions	• Testing a geothermal well involves releasing steam, water, and other gases from the wellbore into the atmosphere. The specific emissions that may be released depend on several factors, including the temperature, pressure, and chemical composition of the geothermal fluids. • Geothermal fluids can also contain H₂S, which is a toxic gas that can pose health risks. It is expected that the separation distances between the pad locations and closest sensitive receptors are sufficiently great such that noise levels during site activity will not exceed the relevant threshold values
Increase in noise from sites	It is expected that the separation distances between the pad locations and closest sensitive receptors are sufficiently

establishment works and access road upgrade construction	great such that noise levels during site activity will not exceed the relevant threshold values.
Noise Pollution and Vibrations	Noise resulting from earth-moving equipment (related to road, well pad, and sump pit construction), vehicle traffic, and drill rig operations
Water quality	Geothermal gases such as hydrogen sulphide (if present) may escape into the air reducing pH of rainwater. Drilling mud/ mud cuttings may contaminate surface water downstream if not well managed. There is potential for pollution of surface watercourses from fuel or chemical spillages, or escaped drilling fluid, if poorly managed. Should there be an equipment failure or blowout during testing, geothermal brine could be released
Reduced Surface Water Quantity	Large volumes of water are required during drilling and well testing, which will be abstracted from a local watercourse . Water level at the Kukuyan dam may be affected.
Soils and geology	More paved surfaces causing runoff if not properly designed, loose soil may be swept by storms. Vibrations during drilling may affect caves.
Improved access due to upgrades to existing road network	. Improvements to the existing road through upgrades to existing roads and creation of new roads to the pads will improve access for local people particular local residents to their land.
Infrastructure	Construction, dust, air pollution, traffic accidents involving people, wildlife and livestock.
Project influx/induced in-migration	The small nature of the project makes it less likely that opportunistic jobseekers will be attracted to the area looking for employment opportunities during exploratory geothermal drilling, the project may result in a temporary increase in population in the area. This increase is also not expected to result in increased pressure on local services or markets for local goods and services although it could contribute to perceptions that local people are not sufficiently benefiting from employment opportunities and create conflict between the local community and non-local workers.
Temporary employment generation	The exploratory phase is expected to generate fewer direct employment opportunities with very few unskilled positions available that could be taken up by local residents.
Visibility and emergency management	Drilling activities and vehicle movement can generate relatively large amount of dust. Emergency preparedness and mitigation plans shall be put in place.
Economic Improvement	The procurement opportunities available for businesses is expected to be limited in the Country and the respective Counties. Construction materials like gravel, sand are likely to be sources from the counties of Kajiado and Narok. Local community enterprises and start-ups are expected to benefit from the project. Benefits to the wider economy of Kenya will not be visible but are expected to include increased income for workers

	and businesses from the provision of specialists' services and materials for example quarry material, cement among others
Land acquisition and economic displacement	Further impacts on land acquisition and economic displacement are not expected during exploratory drilling phase
Damage to Cultural Heritage /known and unknown archaeological sites	There are no known archaeological sites located within areas earmarked for location of the drilling pads but the presence of as yet unidentified artifacts of archaeological and/or historical importance cannot be ruled out that could be accidentally damaged during construction activities.
Health, safety and security risks to workers	The key OHS risks for the drill phase, include: • Exposure to physical hazards from use of heavy equipment • Trip and fall hazards • Exposure to dust, noise and vibrations Falling objects • Exposure to hazardous materials; and exposure to electrical hazards from the use of tools and machinery • Environmental hazards adverse weather conditions, such as working in extreme heat, heavy rainfall • Psychological hazards including high-stress work environments or fatigue • Risks specific to the project location include exposure to extreme heat and hazards associated with working on or near roads. Workers involved in vegetation clearance are at greater risk of snake bites. • In addition, risks to workers during geothermal exploratory drilling phase include blowouts, gas and vapor leakage (geothermal brine), fuel spills or leaks, sewage spills
Health, safety and security risks to the local community	Although, it is not predicted that the Project will result in accidents and transmission of disease among community members, the Project does create potential risk for their occurrence. These risks and associated hazards require management measures. During exploratory geothermal drilling, if not mitigated the following activities could cause disturbance or impact the health safety and security of land users, neighboring villages and local community members: Truck and vehicle movements will increase existing traffic volumes. • Nuisance impacts from increased noise, vibration and dust related to construction activities • Construction site storage and use of hazardous materials. • Potential diseases and infections passed from workers to local community, in particular HIV/AIDS and other sexually transmitted infections as a result of the influx of construction labour force population. In addition, risks associated with geothermal exploration drilling include blowouts, gas and vapor leakage (geothermal brine).

Vegetation removal/loss of Habitat	This change may lead to habitat degradation, disturbance and displacement of species No additional habitat is expected to be lost during the geothermal drilling phase of this Project. However, terrestrial habitat adjacent to the Project could become degraded during operational activities such as drilling rig and other equipment maintenance.
Excavation/ drilling and Construction	Injury of species through Project activities There is potential for injury/ death of fauna through individuals becoming trapped in the mud pond/ water storage areas during drilling.
Presence of people, noise, vibrations, artificial light, and air emissions	Drilling operations will be 24 hours a day and cause disturbance and displacement of fauna species due to noise and vibration
Movement of vehicles and transportation of drilling rig and associated equipment	There is potential for injury/ death of fauna through collisions with vehicle. Emissions from vehicles and pollution from operational vehicle run-offs. There may habitat degradation caused by pollution (including dust), There is also potential for injury/ death of fauna due to collisions with vehicles.
PHASE III: DECOMMISSIONING	
Flora & fauna	Clearing site, rehabilitating site and planting trees. Traffic affecting wildlife
Increase in noise from sites establishment works and access road upgrade construction	The activities of the various site restoration works are deemed to be similar to the ones from the site establishment phase
Noise Pollution and Vibrations	Localized in scale.
Water Quality	There is potential for pollution of surface watercourses from fuel or chemical spillages (if poorly managed) and spoil materials generated during site clearance and construction, particularly if heavy rainfall occurs, though the impacts could be limited.
Reduced Surface Water Quantity	Some water may be required during decommissioning but the volumes are unlikely to be large
Soils and geology	Heavy machinery used in dismantling and transportation can compact soil, reducing Infiltration, drainage and soil aeration when designated routes are not followed.
Infrastructure	Limited impact.
Project influx/induced in-migration	The small nature of the project decommissioning activities makes it less likely that opportunistic jobseekers will be attracted to the area looking for employment opportunities during site closure, the project may result in a temporary

	increase in population in the area. This increase is also not expected to result in increased pressure on local services or markets for local goods and services although it could contribute to perceptions that local people are not sufficiently benefiting from employment opportunities and create conflict between the local community and non-local workers.
Temporary employment generation	• Job opportunities to locals for unskilled labour. Unskilled jobs will include labourers and the provision of services for workers such as food and refreshments, providing workers accommodation etc. • Provision of an income source for workers and their families contributing to their well-being and enhancing their quality of life. • The labour pool for unskilled jobs opportunities will likely come from the direct area of project influence. • Indirect employment generation will create income generating opportunities for businesses in the project supply chain and supporting industries in the wider Aol through providing construction materials and equipment such as gravel/sand, cement as well as services to workers (eg groceries, food, transportation among others
Visibility and emergency management	Noise and dust as machinery shall be used to remove any materials and landscape rehabilitation.
Economic Improvement	The process of dismantling equipment and land rehabilitation shall require both skilled and unskilled labor force. Local businesses can benefit from contracts for Equipment removal and recycling, Transportation services and site restoration (e.g., landscaping, reforestation) Additionally, hotels, catering, and retail may also see increased demand from incoming work crews.
Land acquisition and economic displacement	Further impacts on land acquisition and economic displacement are not expected during decommissioning phase. Once the project has been decommissioned it is expected that most land required for the drill sites will be rehabilitated and will be returned to the existing land uses. The land required for the upgraded roads and new access roads will not be rehabilitated and so the land loss will be permanent.
Damage to Cultural Heritage/known and unknown archaeological sites	There is a possibility that during the decommissioning activities hitherto undiscovered artefacts or sites may be discovered although the likelihood of this is low given that no new areas of land take is expected.
Health, safety and security risks to workers	The key OHS risks for the site decommissioning phase, include: • Exposure to physical hazards from use of heavy equipment • Trip and fall hazards • Exposure to dust, noise and vibrations • Falling objects • Exposure to hazardous materials; and exposure to electrical hazards from the use of tools and machinery • Environmental hazards adverse weather conditions, such as working in extreme heat, heavy rainfall

	• Psychological hazards including high-stress work environments or fatigue • Risks specific to the project location include exposure to extreme heat and hazards associated with working on or near roads. Workers involved in vegetation clearance are at greater risk of snake bites.
Health, safety and security risks to the local community	During site closure/decommissioning phase, if not mitigated the following activities could cause disturbance or impact the health safety and security of land users, neighboring villages and local community members Truck and vehicle movements will increase existing traffic volumes. • Nuisance impacts from increased noise, vibration and dust related to construction activities. • Construction site storage and use of hazardous materials. • Potential diseases and infections passed from workers to local community, in particular HIV/AIDS and other sexually transmitted infections as a result of the influx of construction labour force population
Vegetation removal/loss of Habitat	No habitat should be lost during site decommissioning as this should be mainly re-vegetating the sites.
Excavation/ drilling and Construction	Movements of soil through excavation activities could result in the accidental introduction of invasive plant species
Presence of people, noise, vibrations, artificial light, and air emissions	• Presence of people, noise, artificial light, vibration and air emissions will impact mammals, birds and some herpetofauna species during decommissioning through disturbance and displacement from their natural habitat. This change can disrupt fauna populations by interfering with their movements and/or breeding activities. • Dust particles generated by vehicle movements on dusty roads may adhere to leaves, impeding photosynthesis and plant growth
Movement of vehicles and transportation of drilling rig and associated equipment	• Injury and killing of species through Project activities e.g. vehicle movement can cause degradation of terrestrial habitats. There is also potential for injury/ death of terrestrial fauna due to collisions with vehicles. • Emissions from vehicles and pollution from operational vehicles

9.4 Significance and Impact Analysis

Significance and impact analysis matrix have been used purposely to evaluate the importance and severity of predicted impacts on the environment and local communities. The matrix combines several criteria to determine which impacts are most significant and therefore require focused mitigation and monitoring. It also ensures that predicted negative impacts are evaluated objectively, forming the basis for effective mitigation planning, stakeholder engagement, and environmental management throughout the project lifecycle.

The following tables below indicate the significance of the evaluated impacts.

i. Noise and vibration pollution

Table 55: Evaluation of Noise and vibration pollution

PHASE	Site Preparation	Exploratory, Appraisal and Production drilling	Decommissioning
Magnitude	2(minor)	2(Minor)	2(minor)
Duration	2(Medium term)	3(Longterm)	2(Medium term)
Scale	1(Local)	1(Local)	1(Local)
Probability	1(Unlikely)	3(likely)	2(Medium (as likely as not)
Sensitivity	1(Negligible)	2(Low)	2(Low)
Significant points	6(negligible)	18(minor)	14(negligible)
Implication	No noticeable impact on the environment and community. Little or no mitigation is required	The degree of impact is relatively low. Opportunities to avoid or mitigate the noise impact should be considered; however, this should not compromise the viability of the project	No noticeable impact on the environment and community. Little or no mitigation is required
Discussion	Ambient noise results from all the sampling locations ranged between 41.0-72.2 dB(A) as indicated in the Annex 1 (Baseline noise and measurement report). Noise from site preparation and decommissioning phases are expected to be negligible. While the project is expected to produce minor noise during exploratory drilling phase, the impact will		

	be effectively managed through engineering controls, operational best practices, and stakeholder engagement as outlined in Chapter 10.2.7 Noise and Vibrations.
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ii. Air pollution- Gaseous emissions

Table 56: Evaluation of Gaseous emissions

PHASE	Site Preparation	Exploratory, Appraisal and Production drilling	Decommissioning
Magnitude	2(minor)	4(Major)	1(Negligible)
Duration	2(Medium term)	3(long-term)	2(medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	2 Medium (as likely as not)	3(likely)	2(Medium (as likely as not)
Sensitivity	2(Negligible)	3(Medium)	1(Negligible)
Significant points	14(negligible)	33(Moderate)	7(negligible)
Implication	No noticeable impact on the environment and/or the community(s). No mitigation is required	The degree of impact that the project may have upon the environment is high. The project may be compromised if this impact cannot be avoided or mitigated.	No noticeable impact on the environment and/or the community(s). No mitigation is required
Discussion	From the air quality measurement report, H ₂ S concentration for most sampling locations was within EMCA and other standards tolerance limits. However, only one sampling location, Well Pad 3 Receptor 1 (Residential) had a high concentration above EMCA tolerance limit of 125µg/m. Relevant mitigation measures are indicated in Air Quality Management Plan.		

iii. Air pollution- Dust generation

Table 57: Evaluation of Noise and vibration pollution

PHASE	Site Preparation	Exploratory, Appraisal and Production drilling	Decommissioning
Magnitude	4(Major)	3(Moderate)	2(Minor)
Duration	2(Medium term)	2(Medium term)	2(Medium term)
Scale	1(Local)	1(Local)	1(Local)
Probability	3(Likely)	3(likely)	2(Medium (as likely as not)
Sensitivity	3(Medium)	3(Medium)	2(Low)
Significant points	33(Moderate)	27(Minor)	14(negligible)
Implication	The degree of impact that the project may have upon the environment and community is high. The project may be compromised if this impact cannot be avoided or mitigated	The degree of impact that the project may have upon the environment and community is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.	No noticeable impact on the environment and/or the community(s). Little or no mitigation is required
Discussion	Dust generation is a key environmental concern during the construction and drilling phases. It typically arises from site preparation, earthworks, vehicle movement on unpaved roads, and material handling. If not properly managed, dust can negatively affect air quality, human health, agriculture, and nearby ecosystems.		

iv. Impact on vegetation

Table 58: Evaluation of Impact on vegetation

PHASE	Site Preparation	Exploratory, Appraisal and	Decommissioning
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		Production drilling	
Magnitude	4(Major)	2(Minor)	2(Minor)
Duration	3(Long-term)	3(long-term)	2(medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	4(Certain)	3(likely)	1(Medium (as likely as not)
Sensitivity	3(High)	2(Low)	1(Low-unlikely)
Significant points	36(Moderate)	18(minor)	7(negligible)
Implication	The degree of impact that the project may have upon the environment is high. The project may be compromised if this impact cannot be avoided or mitigated.	The degree of impact is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project	No noticeable impact on the environment and community. Little or no mitigation is required.
Discussion	Site preparation activities may result in the disturbance, degradation, or loss of vegetation within the project area. Mitigation measures are highlighted in the Soil Erosion Control and Revegetation plan.		

v. Health and safety of workers

Table 59: Evaluation of Health and safety of workers

PHASE	Site Preparation	Exploratory, Appraisal and Production drilling	Decommissioning
Magnitude	4(Major)	4(Major)	3(Moderate)
Duration	2(Medium term)	3(Long-term)	2(Medium term)
Scale	1(Local)	1(Local)	1(local)

Probability	3(High)	3(High)	3(High)
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant	30(Minor)	33(Moderate)	27(Minor)
Implication	The degree of impact that the project may have upon the workers is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project	The degree of impact that the project may have upon the workers is high. The project may be compromised if this impact cannot be avoided or mitigated.	The degree of impact that the project may have upon the workers is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.
Discussion	Worker health and safety is a critical concern throughout the lifecycle of the project. Each phase of a project presents unique risks and challenges with difference significance. Proactively managing these risks ensures compliance with regulations, prevents accidents, and fosters a productive work environment.		

vi. Community health and safety

Table 60: Evaluation of Community health and safety

PHASE	Site Preparation	Exploratory, Appraisal and Production drilling	Decommissioning
Magnitude	4(Major)	4(Major)	3(Moderate)
Duration	2(Medium term)	2(Medium term)	2(medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	3(High)	3(High)	2(Medium (as likely as not)
Sensitivity	3(medium)	3(Medium)	3(Medium)

Significant points	30(minor)	30(minor)	24(minor)
Implication	The degree of impact that the project may have upon the neighboring community is relatively low across all phases. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project. Further mitigation measures are outlined in Community OSH and Security Management Plan.		
Discussion	Community Health and Safety (CHS) focuses on identifying and managing risks that the project may pose to nearby populations. Key concerns include exposure to hazardous gases (e.g., hydrogen sulfide), increased traffic and accident risks, noise and dust.		

vii. Solid and liquid waste generation

Table 61: Evaluation of Solid and liquid waste generation

PHASE	Site Preparation	Exploratory, Appraisal & Production drilling	Decommissioning
Magnitude	4(Major)	4(Major)	4(Major)
Duration	2(Medium term)	2(Medium term)	2(Medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	4(Certain)	4(Certain)	4(Certain)
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	33(Moderate)	33(Moderate)	33(Moderate)
Implication	The degree of impact that the project may have upon the environment and community is high. The project may be compromised if this impact cannot be avoided or mitigated effectively.		
Discussion	Solid waste generated may include drill cuttings, used materials, and general construction debris, while liquid waste consists of drilling fluids, geothermal brine, and wastewater. Improper management can lead to soil and water contamination, posing environmental and health risks. The recommended mitigation measures are shown in Waste Management Plan.		

viii. **Soil erosion/vegetation disturbance**

Table 62: Evaluation of Soil erosion/ vegetation disturbance

PHASE	Site Preparation	Exploratory, Appriasal and Production drilling	Decommissioning
Magnitude	3(Moderate)	2(Minor)	2(minor)
Duration	2(Medium term)	2(Medium term)	2(Medium term)
Scale	1(Local)	1(Local)	1(Local)
Probability	3(High-Likely)	1(Unlikely)	1(Unlikely)
Sensitivity	3(Medium)	2(Low)	2(Low)
Significant points	36(Medium)	12(Negligible)	12(negligible)
Implication	The degree of impact that the project may have upon the environment is high. The project may be compromised if this impact cannot be avoided or mitigated.	No noticeable impact on the environment during drilling and decommissioning phases. Little or no mitigation may be required.	
Discussion	Project site preparation shall involve land clearing, access road construction, and site excavation, which can lead to soil erosion and disturbance of natural vegetation. Potential consequences include loss of topsoil, reduced land productivity and habitat destruction.		

ix. **Influx of workers leading to increased HIV/Aids prevalence and moral decay**

Table 63: Evaluation of Influx of workers leading to increased HIV/Aids prevalence and moral decay

PHASE	Site Preparation	Exploratory, Appraisal and Production drilling	Decommissioning
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Magnitude	4(Major)	3(Moderate)	3(Moderate)
Duration	2(Medium term)	2(Medium term)	2(Medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	3(likely)	3(likely)	3(likely)
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	30(Minor)	27(Minor)	27(Minor)
Implication	The degree of impact that the project may have upon the community is relatively low during all phases. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.		
Discussion	The influx of workers can lead to significant social impacts on nearby communities with key concern is the increased risk of HIV/AIDS transmission due to the rise in sexual relationships. This can strain local health systems and contribute to long-term public health challenges. Additionally, rapid population growth and cultural differences may lead to moral decay, including increased crime, substance abuse, and breakdown of social norms.		

x. **Pollution from oil spills**

Table 64: Evaluation of Pollution from oil spills

PHASE	Site Preparation	Exploratory, Appraisal and Production drilling	Decommissioning
Magnitude	3(Moderate)	3(Moderate)	3(Moderate)
Duration	2(Medium term)	3(Long term)	2(medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	2 Medium (as likely as not)	2Medium (as likely as not)	2(Medium (as likely as not)

Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	33(Moderate)	36(Moderate)	33(Moderate)
Implication	The degree of impact that the project may have upon the environment is high. The project may be compromised if this impact cannot be avoided or mitigated.		
Discussion	Oil spills may occur during project phases due to the use of lubricants, fuels, and hydraulic fluids for machinery and equipment. Spills pose a risk to soil, surface and groundwater quality, and local biodiversity.		

xi. **Handling, Storage and Use of Hazardous Materials**

Table 65: Evaluation of Handling, Storage and use of Hazardous Materials

PHASE	Site Preparation	Exploratory, Appraisal and Production drilling	Decommissioning
Magnitude	3(Moderate)	4(Major)	2(Minor)
Duration	2(Medium term)	3(long-term)	2(medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	2 Medium (as likely as not)	3(likely)	2 Medium (as likely as not)
Sensitivity	2(Low)	3(Medium)	2(Low)
Significant points	16(negligible)	33(Moderate)	14(negligible)
Implication	No noticeable impact on the environment and community. Less or No mitigation is required	The degree of impact that the project may have upon the environment is high. The project may be compromised if this impact cannot be avoided or mitigated.	No noticeable impact on the environment and/or the community(s). Less or no mitigation is required
Discussion	Hazardous waste that may be generated mostly during exploratory drilling includes used drilling fluids, chemical containers, oily rags, spent lubricants, and contaminated soil or water from spills. These wastes pose risks to human		

	health and the environment if not properly handled.
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xii. Visual intrusion arising from lighting at night

Table 66: Evaluation of Visual intrusion arising from lighting at night

PHASE	Site Preparation	Exploratory, Appraisal and Production drilling	Decommissioning
Magnitude	2(minor)	4(Major)	2(minor)
Duration	2(Medium term)	3(long-term)	2(medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	1(Unlikely)	4(Certain)	2(Medium (as likely as not)
Sensitivity	1(Negligible)	3(Medium)	2(Low)
Significant points	6(negligible)	36(minor)	14(negligible)
Implication	No noticeable impact on the environment and community. Little or no mitigation is required	The degree of impact that the project may have upon the environment and/or the community(s) is high. The project may be compromised if this impact cannot be avoided or mitigated.	No noticeable impact on the environment and community. Little or no mitigation is required
Discussion	Lighting at night during geothermal drilling can cause visual intrusion, disrupt the natural landscape and affecting the aesthetic value of the area. It can disturb local communities, wildlife, and sensitive ecosystems by altering natural light patterns, potentially leading to disorientation in nocturnal animals and sleep disturbances for nearby residents.		

xiii. Impacts of drilling rig mobilization and demobilization

Table 67: Evaluation of Impacts of drilling rig mobilization and demobilization

PHASE	Site Preparation	Exploratory, Appraisal and Production drilling	Decommissioning
Magnitude	1(Negligible)	4(Major)	1(Negligible)
Duration	1 Short term	1 Short term	1 Short term
Scale	1(Local)	1(Local)	1(local)
Probability	1 Low (Unlikely)	4(Certain)	1 Low (Unlikely)
Sensitivity	1(Negligible)	3(Medium)	1(Negligible)
Significant points	5(negligible)	33(Moderate)	5(Negligible)
Implication	No noticeable impact on the environment and community. No mitigation is required	The degree of impact that the project may have upon the environment and community is high. The project may be compromised if this impact cannot be avoided or mitigated.	No noticeable impact on the environment and community. No mitigation is required
Discussion	Rig mobilization and demobilization are critical phases, involving the transport, assembly, and disassembly of drilling equipment and support infrastructure. These activities can pose temporary but significant environmental and social impacts are addressed in Chapter 10.2.10: Impacts during rig mobilization and demobilization.		

xiv. Traffic accidents

Table 68: Evaluation of Traffic accidents

PHASE	Site Preparation	Exploratory, Appraisal and Production drilling	Decommissioning
Magnitude	3(Moderate)	3(Moderate)	2(Minor)

Duration	1(Short term)	1(Short term)	1(Short term)
Scale	1(Local)	1(Local)	1(local)
Probability	3(High likely)	2(Medium (as likely as not)	2(Medium (as likely as not)
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	24(Minor)	21(Minor)	18(Minor)
Implication	The degree of impact that the project may have upon the environment and/or the community is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.		
Discussion	The risks of traffic accidents may arise mainly due to heavy-truck movements including rig mobilization/demobilization and construction of access roads to the project sites. This can be mitigated through proper planning, monitoring, and safety measures indicated in Traffic Management Plan.		

xv. Cumulative Impacts of Water Abstraction from Kikuyian dam

Table 69: Evaluation of Cumulative impacts of Water Abstraction from Kikuyian dam

PHASE	Site Preparation	Exploratory, Appraisal and Production drilling	Decommissioning
Magnitude	1 (Negligible)	3(Major)	1 Negligible
Duration	1 Short term (0-2 weeks	2(Medium term)	1(Short term)
Scale	1(Local)	1(Local)	1(local)
Probability	1(Unlikely)	4(Certain)	1(Unlikely)
Sensitivity	1(Negligible)	3(Medium)	1(Negligible)
Significant points	4(negligible)	30(minor)	1(negligible)

Implication	No noticeable impact on the environment and community. Little or no mitigation is required	The degree of impact that the project may have upon the dam is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.	No noticeable impact on the environment and community. Little or no mitigation is required
Discussion	Sourcing of water from Kikuyian dam needs careful planning and management to avoid its depletion or creating social tensions between different users. The source sustainability, and mitigation measures to ensure responsible and equitable use are detailed in Chapter 10.2.13; Cumulative Impacts of Water Abstraction from Kikuyian dam.		

xvi. Impacts on Bats and other animals

Table 70: Evaluation of Impacts on Bats and other animals

PHASE	Site Preparation	Exploratory, Appraisal and Production drilling	Decommissioning
Magnitude	4(Major)	3(Moderate)	2(Minor)
Duration	4(Permanent)	4(Permanent)	2(medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	4(Certain)	4(Certain)	2(Medium (as likely as not)
Sensitivity	3(Medium)	3(Medium)	2(Low)
Significant points	39(Moderate)	36(Moderate)	14(negligible)
Implication	The degree of impact that the project may have upon fauna is high. The project may be compromised if this impact cannot be avoided or mitigated.		No noticeable impact on the environment and community. Little or no mitigation is required

Discussion	Geothermal drilling can have significant but manageable impacts on fauna, including bats and other wildlife, particularly if projects are sited near ecologically sensitive areas. Through early ecological assessments, careful planning, and targeted mitigation, these impacts can be reduced to acceptable levels, ensuring the project proceeds in line with environmental protection standards and biodiversity conservation goals.
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CHAPTER 10. ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS MITIGATIONS

This chapter highlights significant impacts which may arise due to the proposed geothermal exploration drilling works and further proposes the various mitigation measures. The focus of this chapter will be:

- To identify and analyze the extent of the environmental and social impacts from the project
- To assess the environmental impacts of the project phases and
- To propose mitigation measures

10.1 Positive Environmental Impacts Associated with Implementation of the Proposed Project

The potential positive socio-economic impacts of the proposed project will depend on project implementation schedule, manpower requirements, the available economic opportunities and the involvement of the nearby communities.

10.1.1 Promotion of Green Energy

The ultimate goal of the proposed project is geothermal power production in line with the national energy development policies. Upon successful drilling of the proposed geothermal wells, they will be connected thus increasing the power generation capacity of the Country. Provision of a stable and secure supply of power has the potential to promote growth in Gross Domestic Product (GDP), through a multiplier effect, by creating a conducive environment for establishing manufacturing industries. Reliable power supply are key elements of Vision 2030.

10.1.2 Enhancement of business opportunities

The proposed project has the potential of enhancing business opportunities. The local community operating shops, rental houses and food kiosks in the neighboring settlements will benefit greatly especially during construction phase of the proposed project. On the other hand, construction of well pads and associated infrastructure as well as drilling exercise have a capital expenditure that requires a range of inputs comprising drilling machinery/equipment, fixed installations (rig pipes) and consumables (drilling mud, oil lubricants, fuel etc.).

10.1.3 Creation of employment opportunities

The proposed project has the potential of creating direct and indirect job opportunities. Direct job opportunities will result from employment of the skilled and unskilled workforce whereas indirect job opportunities will involve creation of business opportunities to the manufacturers and suppliers of materials during the construction and operation phase of the proposed project. Skilled labour will be required especially in the supervision and execution of drilling and construction programs while unskilled labour will be mainly manual jobs that may be done during installation of site facilities (manual offloading deliveries and provision of security at active sites among others).

10.1.4 Improved Road Infrastructure

Implementation of the proposed project will require a road network to facilitate ferrying of materials and equipment to the construction sites. A favorable road network will be excavated to allow for easy movement of machinery and construction materials. The proponent will rehabilitate existing roads and create new access roads which in the long run will be used by the residents.

10.1.5 Increased tourism

Tourism has gained popularity in the proposed project area. The drivers include; Mt. Suswa Conservancy and the Mt. Suswa which harbors Baboons among others. The proposed project is likely to enhance tourism in the area.

10.1.6 Corporate Social Responsibility (CSR) Benefits

During planning and construction of the project, the proponent will conduct community social responsibility initiatives for the project affected communities. This will be done as a way of giving back to the community. Communities living in the project affected areas may benefit from water projects.

10.2 Potential Negative environmental and social Impacts, Proposed Mitigation Measures during project phases.

10.2.1 Loss of land

Land will be required for site preparation including construction of access roads, camp site for workers, well pads, circulation ponds and water supply infrastructure. From consultations with the project proponent and the surrounding community, compensation will be done in accordance with the agreements made with the identified land owners prior to acquisition of the land. All negotiations shall be done as per the laws governing the land and the adopted Land Acquisition and Compensation Frameworks.

This will also lead to loss of grazing land for both wildlife and domestic animals.

Proposed Mitigation Measures

- Documentation of the land acquisition/transfer agreements for the identified land.
- Any new land requirements for the project as well as arising grievances shall be handled in line with the adopted Land Acquisition and Compensation Frameworks (LACF).
- Designate and protect buffer zones and migration corridors to allow movement between grazing areas.
- Work with local communities and authorities to identify and support alternative grazing zones.
- Improve existing rangelands through pasture reseeding, water access, and erosion control.

10.2.2 Vegetation Clearance

The construction of the access roads, camp site, water infrastructure, drill sites (well pads) and circulation ponds will involve clearance of terrestrial vegetation. Surface excavation will cause alteration of ground cover, due to trampling that interrupt and fragment habitats and most likely lead to introduction and spread of invasive. Disturbance and establishment of invasive species will in turn make the habitats unsuitable for endemic species.

Likely impacts on vegetation include:

- Excessive de-vegetation and earthworks may set loose and expose the surface to erosion hazards and siltation run-off especially on sloppy grounds;
- Borrow material for levelling and compacting the access roads and pads may introduce invasive plant propagules that take advantage of disturbance to colonize native species.
- Tools and equipment brought from other project development sites for re-use in the proposed project area may be agents for dispersal of alien / invasive species, particularly in the disturbed areas.

Proposed Mitigation Measures

- Equipment and tools brought in for reuse from other project sites shall be screened and cleaned of alien / invasive propagules to avoid introduction in the project area.
- Employ selective bush clearing to ensure saplings regrowth.
- Restrict vegetation clearing to project sites by clear demarcation.
- Multiple wells will be drilled on one well pad. This will reduce the number drilling sites needed thus ensuring minimal vegetation clearance.
- All sites where vegetation will be cleared, replanting with the same kinds of trees, shrubs, herbs and grasses as existed before. This will work to prevent soil erosion in the long term and maintain the biodiversity of the area.
- After drilling, re-vegetation shall be done using native trees to avoid colonization of cleared well sites by opportunistic and invasive species
- Borrow sites shall be inspected for invasive and colonizer propagules

10.2.3 Air Pollution

10.2.3.1 Dust Emission

Sources of dust emission during site preparation, exploratory drilling and decommissioning phases of the proposed project will include excavation works, transportation of drilling of materials, movement of vehicles on earth roads and actual drilling. Atmospheric emission of particulate matter beyond the recommended limits is likely to cause public nuisance, negative health effects, soiling of property and vegetation. Reduced visibility from the dust emissions can also lead to road accidents.

Proposed Mitigation Measures

- Where practicable, re-vegetate disturbed areas as soon as possible to minimize ground exposure
- Traffic movement shall be limited to 40 Km/hr along the project access roads to reduce the risk of dust emission
- Regular sprinkling of water (at least twice a day) to suppress dust emission as a result of excavation works, stockpiling and movement of vehicles
- Ensure vehicles entering and leaving sites with loose materials like sand, spoil or stone aggregate are covered to prevent accidental escape of materials during transportation
- The loose materials shall be adequately wetted prior to and during the loading, unloading and handling operations
- Investigate all dust complaints and take appropriate measures to reduce emissions in a timely manner.
- Minimize drop heights from loading shovels and other loading or material handling equipment.
- All workers who are likely to be exposed to dust will be provided with suitable personal protective equipment including dust masks, eye goggles and coveralls.
- The concrete mixers shall be enclosed with suitable barriers to minimize airborne dust when being operated.
- Keep the workforce within defined site boundaries and agreed access routes where possible to avoid disturbance to wildlife.

10.2.3.2 Gaseous pollution

Use of mobile construction equipment and vehicles during exploratory drilling phase of the proposed project has the potential of generating gaseous emissions. These emissions will comprise of Sulphur dioxide (SO₂),

oxides of nitrogen (NO_x), Volatile Organic Compounds (VOCs), carbon monoxide (CO) and carbon dioxide (CO₂). The levels of these emissions from the proposed project will depend on the type of equipment, type of vehicle, maintenance status, operating hours, idling time and the quality of fuel. Emission of these air pollutants in excess of permissible ambient levels, have the potential of causing public nuisance, health risks and climate change. According to other studies, fine particulate matter in diesel exhaust easily enters lung tissue to aggravate asthma, allergies, chronic bronchitis and emphysema.

Proposed Mitigation

- The proponent shall ensure that all the vehicles are maintained in proper working condition in line with the manufacturer's recommendations. This will ensure that gaseous emissions do not increase over time.
- Burning of solid waste will not be undertaken to prevent gaseous emissions to the atmosphere.
- Provide workers with gas masks.
- Conduct baseline and ongoing ambient air quality monitoring around the site.

10.2.4 Solid Waste Generation

During the different project phases, of the proposed project, different waste streams will be generated as a result of the various development activities. These include spoil, papers used for packing cement, plastics and timber, food waste remains among others. Dumping around the site will interfere with the aesthetic status of the area. This has a direct effect to the surrounding community. Disposal of these solid wastes off-site could also be a social inconvenience if done in the wrong places.

The off-site effects could be aesthetic, pest breeding, pollution of physical environment and invasion of scavengers. In order to ensure that the various waste streams are disposed of in accordance with Environmental Management and Coordination (Waste Management) Regulations 2006, a functional waste management system will be put in place. Solid waste management approaches will include source reduction, waste segregation, temporary disposal in waste bins, transportation, reuse, recycling and final disposal at designated sites.

Proposed Mitigation Measures

- Prioritize options of waste reduction, reuse and recycling, particularly papers, plastic wrappers and containers and other materials that can possibly be recycled
- Spoil soil emanating from excavations will be reused for landscaping followed by revegetation of the landscaped areas.
- Food waste can be disposed in a composite pit as it can degrade and enrich the soil.
- No burning of waste onsite
- Contract a NEMA certified waste collection firm to collect solid waste for disposal
- Implementing procurement measures that ensure ordering the correct amount of materials when needed to reduce chances of unused materials being abandoned at the site.

10.2.5 Liquid Waste

i. Storm Water

Compaction of surface on well-sites, roads and campsite construction will create impervious surfaces (slab environment). There is a likelihood of increased storm water runoff from these sites, which result in gully

erosion overtime. In addition to creating unattractive terrain, this may cause flood incidences downhill during high rainfall times.

Proposed mitigation measures

- Identifying natural drainage paths, water bodies, and flood-prone areas.
- Scheduling drilling activities during dry periods when stormwater risks are lower.
- Installing silt fence around the perimeter to prevent sediment-laden runoff from leaving the site.
- Capturing runoff and allow sediment to settle before water is discharged.
- Slowing water flow in ditches to reduce erosion and encourage sedimentation.

ii. Oil Spills

The machines at site and project vehicles require oils during maintenance. The oils will be transported and may be stored at project site. Any major accidental oil spill would impact negatively on the environment as a whole. Cumulatively, small releases of oil would also impact negatively on the environment. Such impacts include creation of new sceneries due to destruction of biological diversity and pollution of water and soil. But these dangers are contained by maintaining the machinery in specific areas designed for this purpose.

Proposed Mitigation Measures

- Hazardous wastes (used oil) to be separately held on paved and bunded area prior to final disposal by licensed waste handler
- A spill prevention, control and response plan shall be developed and maintained on site
- Suitable spill containment measures shall be provided in areas designated for storage of the oil products.
- Sell or reuse waste oil from vehicle/machine servicing.
- Choose non-toxic, biodegradable drilling muds and additives to reduce possible environmental harm.
- Recycle, sell or reuse waste oil from machines and vehicles after servicing.
- Train all personnel on waste management protocols.

10.2.6 Handling, Storage and Use of Hazardous Materials

Some of the hazardous materials likely to be maintained at the site during drilling phase of the project include fuel for the drilling equipment. Unsafe handling of hazardous materials, leakage or spillage, in areas which are not lined with impervious material, is likely to contaminate soil and surface water through direct contact and storm water runoff respectively. In addition, direct contact with body parts can cause negative health effects.

Proposed Mitigation Measures

Measures to ensure safe handling, storage and use of hazardous materials during construction phase will include the following:

- All workers handling hazardous materials will be provided with suitable personal protective equipment including hand gloves, coveralls and respirators.
- Suitable storage areas, complete with impervious floor, will be provided to prevent exposure to harsh weather conditions which are likely to aggravate pollution incidents
- A spill prevention, control and response plan shall be developed and maintained on site

- An inventory of hazardous materials together with respective Material Safety Data Sheets will be maintained on site to act as a guide on material handling
- Suitable spill containment measures shall be provided in areas designated for storage of the hazardous materials

10.2.7 Noise and Vibrations

Noise levels of high frequencies could lead to disturbance of animals and humans and impaired hearing under extreme cases of prolonged exposure. Drilling equipment will be the primary source of noise and vibrations during the exploratory drilling phase of the proposed project. Movements of heavy graders, trailers, bulldozers, vibrating roller or tipper trucks (making delivery of borrow material) during grading, levelling, and compaction. This has potential of exposing site staff/employees to occupational noise.

Proposed Mitigation Measures

Noise and vibrations shall be mitigated as follows:

- Idling of vehicles, concrete mixers and material handling equipment shall be minimized as far as reasonably practicable.
- Placing barriers close to the main sources of noise to limit its spread.
- Display warning signs about high noise levels around the well pad site boundary.
- Workers performing noisy operations shall be provided with suitable ear protectors based on the expected noise levels
- Drivers of motor vehicles will be warned against unnecessary hooting of vehicles
- The contractor shall ensure that all the vehicles, concrete mixers and material handling equipment are maintained in proper working condition in line with the manufacturer's recommendations. This will ensure that noise emission does not increase over time.
- The proponent will consider noise emission characteristics during selection and mobilization of construction equipment with preference to low-noise geothermal technology;
- Where feasible, fit equipment with mufflers, sound insulations, silencers to lower the levels of noise emission.

10.2.8 Soil Erosion

All activities that reduce vegetation cover or disturb the land will result to soil erosion. These activities include construction of access roads, drill pads and the construction of temporary and permanent structure on the site. Exposure and loosening of soil will expose it to the agents of erosion, namely wind and water. The topography of the area which is generally uneven with gullies and the loose volcanic soils also intensifies the risk of erosion. Access roads drainages will form new water channels which will contribute to erosion in affected areas during both the construction and operation phases.

Proposed Mitigation Measures

- Restrict clearing of vegetation for the well pad and the access roads to the demarcated areas only
- Appropriate soil erosion control measures including construction of gabions and replanting of vegetation in degraded areas and along the project roads shall be carried out
- Preserve top soils for rehabilitation of degraded sites
- The area where vegetation has been cleared shall be compacted, graveled and revegetated.
- Avoiding steep slopes and erosion-prone areas during site selection for well pads, roads, and camps.

- Using contour mapping and slope analysis to guide infrastructure placement.
- Minimizing ground disturbance by confining heavy equipment movement to designated paths.
- Compact soil in high-traffic areas to reduce loosening and runoff.
- Revegetate disturbed areas using indigenous plants.

10.2.9 Road Accidents

Increased traffic during site preparation, exploratory drilling and decommissioning phases and poor road safety measures like absence of diversion (where necessary), signage during construction and road safety awareness campaigns may result into unnecessary road accidents involving vehicles, non-motorized vehicles, humans and livestock.

Proposed Mitigation Measures

- Any abnormal loads for the project must be transported in line with the traffic rules, including public notification and use of escort cars.
- Sensitize project staff on risks of over speeding while on site
- Erect warning signs for approaching drivers at the points of entry to the project site
- The proponent to have in place an effective traffic management plan
- Develop procedures for safe driving on site, establishing rights of way and speed limits.
- Employ safe traffic control measures, including road signs and flag persons to warn and guide traffic.

10.2.10: Impacts during rig mobilization and demobilization.

Impacts of drilling rig mobilization and demobilization to and from the site during site preparation and after exploratory drilling may lead to vegetation clearance and land leveling, building/upgrading roads for rig access leading to habitat fragmentation, emission of CO₂, NO_x, and particulate matter due to use of diesel-powered trucks, dust from unpaved roads and accidents/ incidences from wide vehicles used in rig transportation.

Proposed Mitigation Measures

- Any abnormal loads for the project must be transported in line with the traffic rules, including public notification and use of escort cars.
- Warning signs for approaching drivers indicating wide load.
- The proponent to have in place an effective traffic management plan
- Develop procedures for safe driving on site, establishing rights of way and speed limits.
- Conduct **pre-mobilization route assessments** to identify sensitive areas and plan for safe, low-impact transport.
- Engage safe traffic control measures, including road signs and flag persons to warn and guide traffic.
- Use existing roads and infrastructure whenever possible to avoid building new access routes.
- Schedule rig mobilization during off-peak hours to reduce traffic-related accidents and incidences.

10.2.11 Influx of Workers to the Construction Project Site leading to increased HIV/Aids prevalence and moral decay.

Influx of workers during drilling on site in search of job and business opportunities has the potential of creating social vices like spread of communicable diseases and promotion of crime incidents. Communicable

or infectious diseases that will be of major concern during drilling phase of the proposed project include HIV/AIDS and other sexually transmitted infections. Crime incidents likely to be encountered will comprise of, fraud, burglary, theft and vandalism of property. The location of the project greatly affects both the amount and type of crime that occurs. According to the Chartered Institute of Building, Crime tends to increase when working in or around cities and big towns, and the nature of crime tends to vary in different regions. The proposed project is located in a remote area thus the crime incidents are expected to be minimal.

Mitigation measures;

- Prioritize recruitment of local workers for unskilled labour through job fairs, community hiring agreements and consider partnerships with local vocational training centers for skilled labour.
- Restrict site access to only essential staff, especially during high-impact activities like drilling.
- Develop shared strategies for mitigation (e.g., zoning and curfews)
- Require incoming workers to follow a code of behavior that respects local culture and laws.
- Incorporate STD/HIV/AIDS awareness and prevention programmes into the training Programme for all project workers

10.2.12 Disputes over employment

Recruitment of labour from the local communities can result in conflicts. These would result in need for proper stakeholder engagement in line with the requirements of the standards on labour and working conditions for smooth operation of activities that rely on local labour. Protection of vulnerable and marginalized groups such as youth and women within the project's labour force may also require especial measures.

Proposed Mitigation Measures

- The proponent shall develop a grievance management system to manage grievances arising from the local labour force.
- The proponent shall implement provision on the Stakeholder Engagement and Community Development Plans.
- The proponent shall develop local labour recruitment plans, including disclosure of opportunities and partnership building with local support agencies / institutions.

10.2.13; Cumulative Impacts of Water Abstraction from Kikuyian dam

Large volumes of water are required during drilling and well testing, which will be abstracted from Kikuyian dam at approximately 10.5 l/s. This will affect water level at the dam considering the water from the dam is also used for other purposes.

Main Uses of Water in Geothermal Drilling

- Drilling Fluid (Mud) Preparation; Water is the primary base for drilling mud, used to cool and lubricate the drill bit and maintain well pressure to prevent blowouts
- Well cleaning and flushing: Large volumes of water are used to flush the well before and after drilling. This is conducted to remove debris and cuttings and also ensure clear access for logging and casing

- **Hydrostatic Pressure Maintenance:** Water-based fluids help balance formation pressures and prevent fluid influx from underground reservoirs.
- **Construction and Dust Suppression:** Water is also used for mixing concrete and construction activities, Dust suppression on access roads and drilling pads and Cleaning equipment and workspaces

The impacts may accumulate over time and space, affecting ecosystems, communities, and water resource sustainability. Some of the potential impacts include;

- Reduction in water availability for other Users
- Decreased reservoir levels and storage capacity
- Ecosystem and Biodiversity Impacts
- **Water Quality Degradation:** Lower water levels may increase concentration of pollutants, sediment, and nutrients in the dam. This can worsen eutrophication, promote algal blooms, and reduce oxygen levels in water bodies.
- **Increased Sedimentation and Erosion:** Lower water volumes slow flow rates, promoting sediment buildup in the dam. This reduces storage life and increases maintenance costs. Downstream erosion may also increase if flow patterns change significantly.
- **Social and Livelihood Impacts:** Communities dependent on the dam for fishing, agriculture, or domestic use may face economic hardship.
- Over abstraction reduces the buffering capacity of the dam against climate-related events like droughts or floods. This can threaten long-term water security for both people and nature.

Mitigation measures

- Obtaining water use permits which regulates abstraction through licensing and sustainable withdrawal limits.
- Reuse drilling fluids and process water to reduce fresh water demand.
- Scheduling abstraction by avoiding/reducing water withdrawal during critical low-flow seasons or when reservoir levels are low.
- Stakeholder Engagement by including local communities, water authorities, and environmental groups in decision-making.
- Monitoring Program: Implement a real-time hydrological monitoring system to track impacts and trigger adaptive management.

10.2.14: Illegal Harvesting of wild products

Illegal harvesting of wild products can lead to biodiversity loss by depleting local species, disrupting ecosystems and food chains. Overharvesting may also degrade natural resources, including soil and land quality, making the area more susceptible to erosion, deforestation, and desertification.

Additionally, unsustainable harvesting increases competition for resources, escalating human-wildlife conflict. Socioeconomically, it undermines legitimate livelihoods, particularly for local communities, and fosters illegal trade and exploitation. Finally, illegal harvesting often violates national or international laws, potentially creating legal issues for the project or company involved.

Mitigation measures

- Raising awareness through education campaigns for workers and local communities about the environmental and livelihood impacts of unsustainable resource use.
- Active community engagement in resource management and decision-making can help by offering alternative livelihoods and incentives.
- Regular monitoring, employing security measures, and collaborating with law enforcement are essential to detect and prevent illegal activities.
- Promoting sustainable resource management practices with local agencies, supporting conservation initiatives, and establishing protected areas also help protect ecosystems.
- Building the capacity of communities through training in sustainable land use and implementing robust monitoring and reporting systems, with strict penalties for violations, will further discourage illegal harvesting.

10.2.15. Visual intrusion arising from lighting at night

Lighting at night during geothermal drilling can cause visual intrusion, disrupting the natural landscape and affecting the aesthetic value of the area. It can disturb local communities, wildlife, and sensitive ecosystems by altering natural light patterns, potentially leading to disorientation in nocturnal animals and sleep disturbances for nearby residents.

Mitigation measures

- Use downward-facing, shielded lighting to minimize light spill and glare.
- Install motion-sensor or timer-controlled lights to limit usage to when necessary.
- Choose low-intensity, warm-colored lights to reduce visual impact.
- Position lights strategically to minimize exposure to nearby communities and natural habitats.
- Conduct regular assessments to ensure lighting remains appropriate and causes minimal disturbance.

10.3: Impacts on Indigenous people

During the ESIA process, the following are the possible negative impacts of the local Maasai community.

a) Loss of Land and Other Assets

The improvement of the access road will lead to impacts and risks associated with land use and land-based livelihoods during construction. Potential impacts include: Physical displacement and Economic displacement.

b) In-Migration Risks

- Without mitigation, the primary impact of in-migration will be an increase in population, physical expansion of towns and villages, and informal development on the outskirts and alongside roads and tracks approaching settlements. Land use intensification combined with limited land availability, is likely to increase the strain on existing physical, social and human resources as well as governance systems.
- The potential for unplanned and uncontrolled growth could lead to issues surrounding safety, sanitation, and service delivery. In terms of impacts on infrastructure, the increased population will increase demand on water, power, sewerage and waste facilities, health and education facilities, and telecommunications.

These services are already constrained and significant social, environmental and health risks will arise from a failure to adequately provide for these needs. Pressure on land could potential displace or introduce conflict with existing land owners and communities.

- Continued uncontrolled exploitation, spurred by in-migration, could be detrimental to biodiversity, as well as to the livelihoods of people who are dependent on natural flora and fauna for food and other resources.
- Impacts on biodiversity will be exacerbated by increasing access into areas that have generally been less at risk from exploitation because of their poorer accessibility. These areas are likely to have retained higher biodiversity value and will experience adverse impacts from development, and a general increase in human activity.
- Socio-economic impacts of in-migration will include an increase in prices. The categories of goods and services that may experience price increases include construction materials, food, fuel and transport. Such inflationary trends can reduce the availability and affordability of basic goods and services to the existing population.
- An influx of migrant job-seekers into the area will significantly increase local competition for employment opportunities. It is possible that some migrants will have gained skills in the geothermal explorations in previous large-scale projects in Kenya and elsewhere, which will be an advantage in seeking work positions within the Project, and may provide some uplift of skills in the local community.
- Where in-migrants compete directly against local people, especially for unskilled jobs, it may result in tension, and possible aggression, between job seekers within the affected areas, and Kenya more widely.
- In-migration can also lead to negative social change and an erosion of cultural values, as migrants bring in different cultural norms and values and attitudes to traditional leadership systems.
- An influx of in-migrants is likely to lead to an increase in communicable and vector-borne diseases such as malaria, TB, HIV/AIDS and sexually transmitted diseases, exacerbated by increased pressure on health care facilities and the possible introduction of new diseases.

c) Gender-Based Violence

The in-migration risks and associated impacts is considered to be high in significance and likely to occur but short terms in nature (construction phase). The risks especially with respect to Gender Based Violence (GBV) and Violence on Children (VAC) is likely to be higher in areas along the access roads with settlements or within close proximity to the project area.

d) Resources Use Competition

Competition over existing water resources between the IPs for livestock and work force could also exacerbate tensions and even trigger potential conflict between the IPs and the workers.

e) Cultural Risks

Cultural erosion as a result of mingling between the work force and IPs could also exacerbate tensions and even trigger potential conflict between the IPs and the workers. The construction may impact on cultural heritage of the IPs, including both tangible and intangible features. Tangible features include archaeological sites, historic sites and monuments, traditional sacred sites and other places of importance. Intangible cultural heritage includes traditional beliefs and practices such as religious rites of passage, ritual, crafts and other cultural traditions.

f) Employment Conflicts

The employment of workers during project construction is likely to lead to conflict with the IPs if contractors do not provide employment opportunities to the IPs. The IPs are likely to be disgruntled in the event that

majority of positions of work are given to external workers. There is need for the project to develop an elaborate labour management plan to ensure that employment positions are clearly bias to IPs especially with respect to casual and unskilled labor.

g) IPs Health and Safety Risks

The community health and safety risks look at ways in which the health and safety of the IPs could be impacted during the project life cycle as a result of both routine and non-routine activities of the road construction. The risks include consideration of disease transmission, access to health care and accidents and injuries.

h) Air Pollutant Emissions Risks and Impacts

The increased vehicular traffic along the access roads brings with it risks associated with increased air pollution specifically from the motorized vehicles. The quantity of pollutant emissions by vehicles, rig machine and other associated equipment will depends on a variety of factors, such as type and power of engine, time of drilling, type and composition of fuel, efficiency of combustion (e.g. age, wear), presence of emission control equipment (i.e. catalyser), actual speed of the vehicle, composition of vehicle/ machine types (e.g. abundance of trucks, average age and actual performance of engine types). Elevated hydrogen sulphide emissions observed within the project area during well drilling and testing activities.

i) Noise and Vibration Risks and Impacts

Noise and vibration will have the following risks and impacts during the drilling and testing phases of the project as a result of increased vehicular movement and drilling exercise.

- Impacts on settlements from noise from drilling rig,
- Impacts on wildlife from noise from drilling rig,

j) Community Health, Safety and Security Risks and Impacts

The presence of an increased vehicular traffic on access road has the potential to affect the safety of local communities close to the access route and also the population over a wider area due to collisions between vehicles, pedestrians and livestock at crossing points.

k) HIV/AIDS Risks

The establishment of campsite for the workers during the exploration can also lead to cultural erosion related risks and impacts including spread of sexually transmitted diseases including (HIV/AIDS).

10.3.1 Mitigation Measures against impacts on Indigenous Peoples (IPs)

Table 71 below highlights the proposed mitigation measures. A report is annexed to the report.

Table 71: Impacts and mitigation measures on IPs

Impacts	Corresponding plans to be developed to mitigate the Risks
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Loss of Land and Other Assets	The actual land to be taken and other assets along the road corridor have been identified and the owners have been engaged. The valuer has done the initial valuation and the final valuation shall be conducted by the National Land Commission (NLC). All PAPs shall sign an agreement with the NLC with details of all the affected property and the compensation amount before being compensated by the NLC. The agreement with NLC to ensure that they will take into account international standards during valuation, including also compensation of PAP using the corridor informally and also applying replacement cost principle will be discussed and agreed upon during the RAP implementation.
Gender-Based Violence	Gender Management Plan shall be prepared by the client to address the GBV related issues during project implementation
Resources Use Competition	Specific ESIA study is being undertaken. A separate study for abstraction of water at Kikuyani Dam is been undertaken by GDC.
Employment Conflicts	Labour management Plan has been prepared as part of the ESMP for this project
Noise and Vibration Risks and Impacts	Noise Management Plan has been prepared as part of the ESMP for this project
Community Health, Safety and Security Risks and Impacts	Community health, safety and security management Plan has been prepared as part of the ESMP for this project
HIV/AIDS Risks	HIV management Plan shall be prepared by the client to address the HIV related issues during project implementation
Concerns or complaints raised by affected stakeholders.	Grievances Response Mechanism has been included in the SEP
Engage with and support local communities	Community Development Framework has been developed to guide engagement with local communities

10.4 Impacts on Bats and other animals

The proposed project can cause direct and indirect impacts on local fauna, including bats and other wildlife, particularly during site preparation, drilling, and decommissioning. These impacts vary depending on the location, ecosystem sensitivity, and seasonal wildlife activity. The conservation actions have been established

with the aim of achieving ‘no net loss’ and net gain to biodiversity in accordance with IFC PS6 (IFC, 2012a, 2012b). IFC PS6 requires evidence that the mitigation hierarchy has been applied, that avoidance is prioritized, and that offsets are measurable and only applied as a last resort where residual impacts are unavoidable.

Geothermal drilling activities may affect fauna through:

- Habitat loss or fragmentation due to land clearing for well pads, access roads, and support infrastructure.
- Noise and vibration from drilling equipment, generators, and vehicles, which can disrupt wildlife behavior and communication.
- Light interference especially from night-time operations, which can disorient nocturnal animals and alter natural activity patterns.
- Increased human activity at the project site, leading to stress or displacement of animals from previously undisturbed areas.

10.4.1 Summary mitigation actions

To protect fauna during geothermal drilling projects, a range of mitigation measures shall be implemented to avoid, minimize, or offset negative impacts. These measures shall be integrated into all project phases and tailored to the local ecology and species present.

Table 72: Mitigation measures against impacts on bats and other wildlife

Aspect	Mitigation measures
To prevent accidental collision of project vehicles with wildlife on site roads	• Identification of wildlife crossing locations and higher risk crossing points along the access roads. • Speed reduction measures are to be installed on wildlife crossing locations to warn road users. • The implementation will be by the delegated site team staff. • An incident reporting mechanism will be introduced to record injured or killed wildlife including inclusion on a database
Conduct high conservation value species assessment before land clearing to avoid and minimize disturbance and mortalities among species of conservation concern	• Provide specific detailed pre-construction data on species of mammals of high conservation value in the new wellpads. • Inform changes or additions to the mitigation measures. • The target species for the surveys are faunal species.
Minimize noise, vibration and artificial lighting	Lighting • Artificial lighting should be pointed away from forest or

Aspect	Mitigation measures
	faced downwards so it will only illuminate the works areas to minimize disturbance to wildlife by light spill; • Bulbs emitting wavelengths that attract insects and that irritate bats should not be used • No night working that can disturb wildlife will be undertaken during construction or operation unless under exceptional circumstances (this does not include drilling activities at wellpads and power plant activities). Noise • Best practice noise reduction measures will be implemented during construction and operations will include: • Avoidance of unnecessary engine run and switching off of equipment when not required; • Vehicles and equipment will be properly maintained to meet the manufacturers' noise rating levels; • Limiting the use of particularly noisy plant equipment or vehicles where practicable
Reduce wildlife mortality arising from excavation/earthmoving activities	• An excavation/earth moving procedure should be developed and implemented to incorporate pre-inspection, invitation of experts and restrictions to specific sites and time • Animal handling procedure must also be developed in consultation with KWS • A monitoring a monitoring procedure on cave roosting bats (especially <i>Pipistrellus aero</i> and <i>Otomops harrisoni</i>) to be developed and strictly implemented to detect early impacts of vibration and lighting and recommend avoidance or minimization
Preventing introduction and spread of invasive species (plants and animal)	• The notorious invasive plants in construction areas include <i>Prosopis juliflora</i>, <i>Patbenium</i> spp, among the plants, and 3 species of rodents (<i>Mus musculus</i>, <i>Rattus</i> spp), all whose database and expertise are currently domiciled at NMK. These species are a few others are easily introduced and spread via use of unwashed construction equipment and vehicles, as well as un-inspected cargo.
Prepare long-term monitoring plan for endangered species in Project area	• A monitoring plan to be developed in consultation NMK (bats and plants), KWS(Wildlife), complete with data sharing framework

10.5 Cumulative Impacts Assessment (CIA)

Cumulative impacts are defined as the successive, incremental, and/or combined effects of a project or activity, accumulated with other projects or activities. A cumulative impact assessment (CIA) focuses on environmental and social components rated as “critical” by the affected communities and the scientific community (Valued Environmental and Social Components), which are cumulatively impacted by the project, other projects, and sources of external pressure (IFC, 2013).

The proposed Suswa geothermal drilling project will be phased. Drilling of exploratory wells and appraisal wells will be undertaken in phase I while drilling of production wells and construction of a power plant will be carried out under phase II. Though the individual impacts of the project are expected to be localized and temporary, cumulative effects may arise when considered alongside pastoral activities, infrastructure development, geothermal exploration, tourism activities, and natural resource utilization in the region. A rapid CIA (RCIA) was conducted for phase I of the proposed project (Table 73). The RCIA was based on the ESIA study conducted in 2013, information provided by GDC, published information, baseline data collected to update the 2013 ESIA report and the outcome of public participation. According to the RCIA, the potential impacts associated with phase I of the project are very localized and reversible except anticipated future expansion that may require resettlement of the project affected persons.

Table 73: Potential Cumulative Impact Matrix for Suswa Geothermal Drilling Project

Valued Environmental / Social Component (VEC)	Existing & anticipated Activities	Potential Cumulative Impact	Proposed Mitigation Measures
Surface water resources (Kikuyian Dam, among others)	Water abstraction for drilling, livestock watering, domestic consumption, future geothermal development	Increased cumulative abstraction may reduce Kikuyian Dam storage levels during prolonged dry seasons and increase competition among domestic, livestock, and project users.	Acquire water abstraction permits, water balance monitoring, water recycling, phased abstraction, dam desilting, have alternative water sources
Groundwater resources	Existing boreholes, future geothermal drilling and water supply from boreholes	Groundwater depletion and quality deterioration	Quarterly groundwater monitoring, Use lined ponds, spill prevention measures, regular ground water quality analysis
Water quality	Livestock use, community use, geothermal drilling activities	Increased TDS, heavy metals, turbidity and contamination due to brine leakages, drilling fluids,	Use proper HDPE-lined ponds, spillage containment, reinjection of brines, quarterly water quality monitoring
Air quality	Natural background emissions from fumaroles/steaming ground, geothermal drilling activities, vehicle emissions, future geothermal operations	Increased ambient H ₂ S and dust concentrations	Monthly air quality monitoring, install H ₂ S detection systems, implement dust suppression

Noise and vibrations	Existing background conditions, noise from drilling rigs, well testing operations, transportation activities	Increased noise levels from concurrent drilling and well discharge activities affecting communities and wildlife	Use of silencers/ noise mufflers, noise barriers, scheduling of noisy activities, continuous noise monitoring
Biodiversity and Critical habitat	Conservancy activities, livestock grazing, roads and geothermal development	Reduced habitat quality, wildlife displacement due to progressive habitat fragmentation/disturbance.	Minimize footprint, progressive rehabilitation, wildlife protection, develop and implement biodiversity management plan, vehicle speed controls, ecological monitoring
Bats and Cave ecosystems	Tourism, cave visitation, drilling activities	Disturbance of roosting colonies and migration patterns from cumulative noise, vibration and night-time lighting from drilling rigs and camp facilities Incremental ecosystem degradation from phased development	Buffer zones around caves, use of low brightness lights with optical controls and shielding to control direct and stray lighting effects, vibration controls.
Vegetation	Grazing pressure, geothermal works (well pad construction and related civil works)	Loss of vegetation cover and invasive species	Controlled vegetation clearing, progressive rehabilitation, indigenous revegetation, invasive species control
Waste generation	Existing waste and waste generated from drilling activities	Increased volumes of combined waste from drilling rigs and camp	Develop and implement waste management plan; use licensed waste contractors; maintain waste tracking records
Traffic and Road Safety	Existing road users, project vehicles, future development traffic	Increased accident risk and road deterioration	Develop and implement traffic management plan, impose speed limits, driver training/sensitization, road maintenance
Community Health & Safety	Existing community health and safety, and traffic	Health risks and nuisance impacts from combined H ₂ S exposure, noise levels, dust, traffic and construction activities	Establish emergency response plans, health awareness programmes, monitoring, implement traffic management plan
Socio-economic impacts	Population growth, project labour influx	Increased pressure on existing services i.e health, water and local infrastructure	Workforce camp management, prioritize local employment strategy, consider CSR investments

Livelihoods (Pastoralism)	Livestock grazing, geothermal development	Reduced pasture availability and livelihood impacts	Livelihood restoration, alternative grazing arrangements, community CSR programmes
Seismicity and Ground Stability	Induced micro-seismic events drilling activities	Increased risk of induced micro-seismic events due to long-term drilling and reinjection activities	Seismic monitoring network, reinjection management, annual review of seismic trends

Generally, potential cumulative impacts that would arise from Phase I and Phase II activities are:

- i. **Increased number of displaced project affected persons (PAPs):** phase II of the project will require additional land for access roads, well pads, transmission line, substation, steam and reinjection pipe network, separator stations, power plant, cooling towers, venting stations, water treatment plant, workshops, stores, clinic and administration block. It is envisaged that more people will be displaced by the proposed project due to increased and continuous emission of hydrogen sulphide gas and noise. However, the exact number of PAPs will be informed by the air dispersion and noise propagation modelling.
- ii. **Increased disruption of biodiversity due to the expansion of the project's footprint:** implementation of phase II of the project will result in increased clearing of the native vegetation, increased volumes of waste generation and continuous noise emission. All these will compound the negative impacts on biodiversity. The steam and reinjection pipe network, if not properly designed, would block animal dispersal areas. The transmission and distribution lines would lead to electrocution of birds, bats and other large mammals. Influx of workers is likely to increase poaching incidents whereas increased traffic volume may lead to high number of vehicle-wildlife collisions.

It is recommended that phase II of the project be subjected to an independent ESIA study that will take care of the cumulative impacts. The roosting cave for the Harrison's large-eared giant mastiff bat (*Otomops harrisoni*), listed in the IUCN Red List of Threatened Species as Vulnerable A2c, should be avoided at all costs. Directional drilling technique will be utilized to drill multiple wells on a single well pad thus reducing the area of land to be affected. The design of the transmission lines should be environmental friendly while the steam and reinjection pipeline network should allow for wildlife dispersal. The spent geothermal fluids like condensate and brine should be reinjected so as to prevent land subsidence, recharge the reservoir and prevent environmental pollution. A program to monitor the risk of induced micro-seismicity should be put in place during operation phase of Phase II. An updated Resettlement Action Plan shall be prepared to address displacement of the new PAPs. In addition, the stakeholder management plan shall be updated accordingly.

CHAPTER 11. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

11.1 Introduction

This chapter presents the Environmental and Social Management Plan (ESMaP) for the proposed project. The ESMP outlines the practical measures, procedures, cost, timelines and responsibilities required to manage, mitigate, and monitor the identified potential environmental and social impacts.

Environmental and Social Management Plan (ESMP) for development projects provides a logical framework within which identified negative environmental impacts can be mitigated and monitored. In addition, the ESMaP assigns responsibilities of actions to various actors and provides a timeframe within which mitigation measures and monitoring can be done. ESMP is a vital output of an ESIA as it provides a checklist for project monitoring and evaluation.

11.2 Purpose and Objectives of ESMP

The purpose of ESMP is to ensure that the environmental and social impacts identified during the ESIA process are effectively managed, mitigated, or enhanced throughout the project lifecycle.

It specifically;

- Outlines specific measures to prevent or reduce possible negative impacts on the environment.
- Ensures the project adheres to Kenyan and international environmental law
- Assigns responsibilities, timelines, and resources for environmental and social risk management.

Sets out how environmental and social impacts will be tracked, measured, and reported.

11.3 Auditing of the ESMP

Auditing the ESMP is critical in ensuring the environmental and social commitments made during project planning and licensing are actually being implemented, and that they are effective in managing impacts throughout the project's lifecycle.

ESMP audit is crucial in;

- Verifying compliance with the ESMP and regulatory conditions as indicated in the NEMA license.
- Assessing effectiveness of mitigation measures, identify any gaps, non-compliance, or new risks.

Recommending corrective and preventive actions.

11.4 Environmental Management System for GDC

GDC has a dedicated Safety, Health and Environmental department with a clear mandate to enforce safe systems of work, conduct safety surveillance and oversee environmental management in projects such as the Menengai and Baringo Silali geothermal project.

GDC is in the process implementing Environmental Management Systems (EMS) to minimize the negative impacts of their geothermal development activities on the environment. These systems are crucial for ensuring legal compliance, reducing environmental risks, and promoting sustainable practices. ISO 14001 will provide a framework for the organization to establish and maintain an EMS in accordance with the Best Environmental Practices.

Key aspects of GDC's Environmental Management Systems will be:-

- Commitment to environmental responsibility - GDC acknowledges the potential environmental impacts of geothermal development and will actively work to mitigate them.
- Framework for environmental management - The EMS will provide a structured approach to managing environmental aspects, including identifying, assessing, and controlling environmental risks.
- Compliance with regulations - GDC's EMS will ensure that the company adheres to all relevant environmental laws and regulations.
- Focus on sustainability - The goal is to minimize negative environmental impacts and promote sustainable practices in geothermal development.
- Training and capacity building - GDC will offer training programs, including those focused on Environmental Management, to enhance the expertise of its workforce.

11.5 Responsibilities of the ESMP

ESMP assigns clear responsibilities to various actors to ensure effective implementation, monitoring, and compliance with environmental and social safeguards as shown in **Table 74** below.

Table 74: Actors and tasks in ESMP implementation.

Actor	Responsibility
GDC	• Overall accountability for ESMP implementation. • Allocation of budget and resources for mitigation measures. • Ensuring all project phases (design, construction, drilling, operation) follow the outlined ESMP. • Submitting compliance reports to NEMA and other regulators.
SHE Manager	• Responsible for the implementation of the ESMP • Manages the activities of the SHE team • Oversees and coordinates all activities pertaining to the ESMP • Reports monitoring findings in line with the ESMP
Community Relations Manager	• Responsible for implementing the Stakeholder Engagement Plan (SEP) and Resettlement Action Plan (RAP) • Manages activities of the community relations team • Leading stakeholder engagement and public communication •
Drilling Operations Manager	• Responsible for the implementation of the ESMP during drilling of the exploratory wells
Infrastructure Development Manager	• Responsible for the implementation of the ESMP during construction of roads, well pads, lay down area, water lines and camp site
SHE Officer/Scientist	• Monitors and reports on ESMP performance • Inspects the project site and surrounding areas on a daily basis to

	ensure compliance with the ESMP and keeps records of these inspections • Reports any incidents of non-compliance with the ESMP
Community Relations Officer	• Leads stakeholder engagement associated with implementation of the entire project • Ensures effective communication with all stakeholders • Reports monitoring findings to stakeholders • Implements the Grievance Redress Mechanism • Monitoring and reporting on any community issues, land access, and cultural concerns
National Environment Management Authority (NEMA)	• Approving the ESIA/ESMP. • Conducting controlled environmental audits and inspections. • Enforcing compliance with environmental laws and license conditions.
County Governments of Narok and Kajiado	• Reviewing and supporting land use approvals, local compliance, and permitting. • Participating in community consultations and conflict resolution where necessary.
Independent Environmental Auditor (if engaged)	• Conducting annual Environmental audits as guided by the ESMP. • Providing objective evaluation of the environmental performance of the project and giving recommendations.
Land Commission	• Facilitates land acquisition and ensure proper valuation of affected land and property, fair and prompt compensation to landowners and occupants.
National Museums of Kenya	• Safeguarding any archaeological, historical and cultural resources within the area including any chance finds.

The ESMP outlined in **Table 75** below considers mitigation measures for impacts during construction, operation and decommissioning phases of the project respectively

Table 75: Environmental Social Management Plan (ESMP)

Site Establishment, Exploration and Appraisal Drilling Phase, ESMP					
Impacts	Proposed Mitigation Measures	Goal	Responsibility	Time Frame	Cost (KShs)
Loss of land	Documentation of the land acquisition/transfer agreements for the identified pieces of Land.	To ensure that the rightful owners are identified.	Proponent	Before acquisition of the identified land	To be implemented as per LACRAP
	Any new land requirements for the project as well as arising grievances shall be handled in line with the LACRP report.	To ensure grievances are identified and adequately addressed.	Proponent	Land take process to be completed before taking over sites	
Vegetation Clearance	- Equipment and tools brought in for reuse from other project sites should be screened and cleaned of alien / invasive propagules to avoid introduction in the project area - Borrow sites should be inspected for invasive and colonizer propagules - Employ selective bush clearing to ensure saplings regrowth. - Restrict vegetation clearing to project sites by clear demarcation - Multiple wells will be drilled on one well pad. This will reduce the	To minimize ecological disruption and biodiversity loss.	ProponentProject Manager & Contractor	Continuous	400,000

	number of drilling sites needed thus ensuring minimal vegetation clearance. • All sites where vegetation was cleared will be replanted back with the same kinds of trees, shrubs, herbs and grasses as existed before. This will work to prevent soil erosion in the long term and maintain the biodiversity of the area. • Once a well is complete (after drilling), re-vegetate around with native grass species to avoid colonization of cleared well sites by opportunistic and invasive species				
Dust Emission	• Where practicable, re-vegetate disturbed areas as soon as possible to minimize ground exposure • Traffic movement shall be limited to 40 Km/hr along the project access roads to reduce the risk of dust emission • Regular sprinkling of water (at least twice a day) to suppress dust emission as a result of excavation works, stockpiling and movement of vehicles • Ensure vehicles entering and	To protect human health, reduce environmental degradation, and ensure regulatory compliance.	Proponent, Project Manager & Contractor	Continuous	400,000

	leaving sites with loose materials like sand, spoil or stone aggregate are covered to prevent accidental escape of materials during transportation. • The loose materials shall be adequately wetted prior to and during the loading, unloading and handling operations. • Investigate all dust complaints and take appropriate measures to reduce emissions in a timely manner. • Minimize drop heights from loading shovels and other loading or material handling equipment. • All workers who are likely to be exposed to dust will be provided with suitable personal protective equipment including dust masks, eye goggles and coveralls. • The concrete mixers shall be enclosed with suitable barriers to minimize airborne dust when being operated				
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Gaseous pollution	- The proponent shall ensure that all the vehicles are maintained in proper working condition in line with the manufacturer's recommendations. This will ensure that gaseous emissions do not increase over time - Burning of solid waste will not be undertaken to prevent gaseous emissions to the atmosphere.	To minimize the release of harmful gases into the atmosphere, protect human health and environmental quality.	Proponent and Contractor	Continuous	700,000
Solid Waste Generation	- Prioritize options of waste reduction, reuse and recycling, particularly papers, polythene bags and plastic wrappers and containers and other materials that can possibly be recycled - Spoil soil emanating from excavations will be reused for landscaping followed by revegetation of the landscaped areas. - Food waste can be disposed in a compost pit as it can degrade and enrich the soil. - No burning of waste onsite - Contract a NEMA certified waste collection firm to collect solid waste for disposal	To minimize the amount of waste produced, ensure safe handling, storage, disposal, and prevent health hazards	Proponent and Contractor	Continuous	100,000

Liquid Waste	• Hazardous wastes (used oil) to be separately held on paved and bunded areas prior to final disposal by licensed waste handler • A spill prevention, control and response plan shall be developed and maintained on site • Suitable spill containment measures shall be provided in areas designated for storage of the oil products.	To prevent contamination of soil, ground/ surface water by ensuring the safe collection, treatment, and disposal of all liquid waste.	Proponent and Contractor	Continuous	300,000
Handling, Storage and Use of Hazardous Materials	• All workers handling hazardous materials will be provided with suitable personal protective equipment including hand gloves, coveralls and respirators • Suitable storage areas, complete with impervious floor, will be provided to prevent exposure to harsh weather conditions which are likely to aggravate pollution incidents • A spill prevention, control and response plan shall be developed and maintained on site • An inventory of hazardous materials together with respective Material Safety Data Sheets will be maintained on site to act as a guide	To prevent harm to human health and the environment by ensuring safe, controlled, and compliant management of hazardous substances.	Proponent and Contractor	Continuous	300,000

	- on material handling - Suitable spill containment measures shall be provided in areas designated for storage of the hazardous materials				
Noise and Vibrations	- Idling of vehicles, concrete mixers and material handling equipment shall be minimized as far as reasonably practicable. - Construction activities will be limited to the hours of operation between 8.00 am and 6.00 pm. - Workers performing noisy operations shall be provided with suitable ear protectors based on the expected noise levels - Drivers of motor vehicles will be warned against unnecessary hooting of vehicles - The contractor shall ensure that all the vehicles, concrete mixers and material handling equipment are maintained in proper working condition in line with the manufacturer's recommendations. This will ensure that noise emission does not increase over time. - Where feasible, fit equipment with mufflers, sound insulations,	To manage and reduce noise and vibration impacts, safeguard public health, ensure a safe working environment and maintain regulatory compliance.	Proponent and Contractor	Continuous	300,000

	silencers to lower the levels of noise emission. • Conduct pre-construction vibration studies to understand the natural baseline and sensitivity of the sites (both wildlife and geological). • Map the exact distance and geological connection between the proposed drilling sites and sensitive locations. • Carry out ecological assessments to determine species presence, especially any bats, primates, or cave-dwelling wildlife. • Select low-vibration drilling technology e.g. rotary drilling instead of percussive/hammer drilling where feasible. • Smaller casing/bit sizes to reduce mechanical impacts. • Limit simultaneous high-vibration activities (e.g., drilling) near sensitive sites.				
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Soil Erosion	• Restrict clearing of vegetation for the well pad and the access roads to the demarcated areas only • Appropriate soil erosion control measures including construction of gabions and replanting of vegetation in degraded areas and along the project roads shall be carried out • Preserve topsoils for rehabilitation of degraded sites • The area where vegetation has been cleared shall be compacted, graveled and revegetated.	To preserve soil stability and fertility, prevent land degradation, and protect nearby ecosystems and water bodies from sedimentation and pollution.	Proponent and Contractor	Continuous	300,000
Road Accidents	• Any abnormal loads for the project must be transported in line with the traffic rules, including public notification and use of escort cars. • Sensitize project staff on risks of over speeding while on site • Erect warning signs for approaching drivers at the points of entry to the project site	To safeguard lives and ensure safe transport operations.	Proponent and Contractor	Continuous	100,000

Disputes over employment	• Develop a grievance management system to manage grievances arising from the local labour force • Implement Stakeholder Engagement and Community Development Plans • Develop local labour recruitment plans, including disclosure of opportunities and partnership building with local support agencies / institutions.	To prevent conflicts, foster community trust, and ensure compliance with labor laws.	Proponent	One -Off	300,000
Exploratory, Appraisal and Production Drilling Phase					
Expected Negative Impacts	Recommended Mitigation Measures	Goal	Responsibility	Time Frame	Cost (Kshs)
Poor site management and control leading to accidents and incidences	• Nominate persons with defined responsibility for EHS • Through relevant training, ensure everyone on site is aware of their responsibilities and liabilities with respect to the environment. • Through site induction, make staff and visitors aware of Project environmental issues and environmental standards. • Display warning signs at key work sites prominently. • Avail GDC's environmental policy at the site • Provide adequate security at the site	To ensure the operations are safe, environmentally responsible, efficient, and compliant with regulatory standards.	Proponent	Continuous	200,000

	to protect primary work sites against vandalism, theft and breakage.				
Air Pollution – Gaseous Emissions	- To minimize the potential danger due to H₂S gas, constant monitoring within the project site should be done. This is to ensure that in case the concentration of the gas is above the threshold, timely and effective measures will be taken to minimize any ensuing damage. The results of the monitoring will be compared with the safe limit as well as the baseline data generated in the ESIA study - H₂S Measuring equipment will be regularly calibrated and sampling as well as analysis procedures enhanced to ensure results are reliable - Personnel working in close proximity to areas with a likelihood of high concentration of H₂S gas will be required to use protective gear e.g Self Contained breathing apparatus (SCBA). This is especially in regard to personnel such as those involved in well	To protect air quality, safeguard human and ecological health, and ensure regulatory compliance	Proponent and Contractor	Continuous	1,000,000

	testing/confined spaces • During and after the drilling, areas with likelihood of high concentration of H₂S will be restricted to only those personnel working there, unnecessary access will be prevented • Use of permit to work by all employees carrying out operations at the rigs and during well testing • Emergency procedures: Where gases emitted exceed safe levels and normal control measures fails, emergency procedures should be activated. This includes total shutdown of operations and evacuations of personnel. An action plan needs to be developed to deal with life threatening situations beyond the ordinary coping mechanisms. • For wells confirmed productive following tests, H₂S dispersion modelling will be undertaken prior to power plant construction to inform management of any likely long-term impacts.				
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Air pollution-Dust emissions	• Provide sufficient PPEs and ensure their correct and timely usage e.g. dust masks. • Locate activities and stockpiles away from identified receptors e.g. households • Cover stockpiles to prevent wind whipping and keep them for the shortest possible time. • Consider the prevailing wind direction when siting stockpiles to reduce the likelihood of affecting sensitive receptors. • Ensuring all vehicles carrying loose or dusty material to or from the site are fully sheeted. • Ensuring that the engines of all vehicles and drilling equipment are not left running unnecessarily. • Plan site layout – machinery and dust causing activities (e.g., access roads, stockpiles) should be located away from the site boundary and sensitive receptors where practicable. • Use water as a dust suppressant where applicable • Minimize movement of construction traffic around site and ensure they follow a predetermined	To protect human health, maintain environmental quality, ensure regulatory compliance, and support efficient operations.	Proponent	Continuous	300,000
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	- route. - Regular visual monitoring of dust episodes, soiling of vegetation, dust resuspension on the roads and dust clouds. - Maintain record any incidents that cause dust and the action taken to resolve the situation				
Over exploitation of raw materials	- Re-using materials on site wherever possible. - Implementing good housekeeping and operating practices e.g. Inventory control to reduce the amount of waste resulting from materials that are out-of-date, off-specification, contaminated, damaged, or excess - Implementing procurement measures that ensure ordering the correct amount of materials when needed.	To ensure the sustainable and responsible use of natural resources.	Proponent	Continuous	200,000
Solid Waste Generation	- Prioritize options of waste reduction, reuse and recycling, particularly papers, polythene bags and plastic wrappers and containers and other materials that can possibly be recycled - Sensitize drilling site workers and	To manage solid waste responsibly, protect health and the environment, and ensure compliance.	Proponent and Contractor	Continuous	700,000

	frequent visitors (especially those operating food catering services) to the drilling sites on proper waste management practices especially hazardous materials and risks of contaminations • Use of durable, long-lasting materials that will not need to be replaced as often, thereby reducing the amount of waste generated over time • Donate recyclable/reusable or residual materials to local community groups, institutions and individual local residents or homeowners. • Reuse packaging materials such as cartons, cement bags, empty metal and plastic containers to reduce waste at the site • Waste collection bins to be provided at designated points on site • NEMA Licensed waste handlers to be contracted to transport and dispose the solid waste from site • Sensitization campaigns amongst employees, e.g. through use of posters, to encourage reuse and				
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	proper management practices				
Impacts on hydrology	- The proponent shall ensure that water is used efficiently at the site by sensitizing staff to use water efficiently and avoid irresponsible water wastage. - The proponent will install water-conserving automatic taps and toilets - Any water leaks through damaged pipes and faulty taps shall be fixed promptly by qualified staff. - The proponent will employ water recycling and re-use, explore drilling subsequent geothermal wells after the first well by use of geothermal brine.	To protect water resources by ensuring activities do not disrupt natural water flow patterns, pollute surface/ groundwater.	Proponent and Contractor	Continuous	700,000
Geological risks (Ground Subsidence & Induced Seismicity)	- Monitoring of geological hazards which are anticipated during the development stages of the power projects in the area - Ground deformation monitoring. During power generation both vertical (subsidence) and horizontal (inflation) of ground deformation may occur. These aspects should be	To manage and minimize geological risks to ensure safe, sustainable, and technically sound operations.	Proponent	Continuous	500,000

	monitored before production stage to have baseline information • Installation of the real time data transmission system for the micro-seismic monitoring for efficiency in data processing and interpretation • Communication of any geological and seismic hazards and associated emergencies to the local communities should be incorporated in Company local Stakeholder Engagement and Emergency Response plans.				
Liquid Wastes	• Ensure brine ponds are fenced off and the fence regularly maintained • Reuse drilling fluids • During acid treatment of wells, use of leak- proof well casings to a depth appropriate to the geological formation in order to avoid leakage of acidic fluids to groundwater • Sensitize local communities on dangers of using brine/spent geothermal fluids • Use of soakage pits and contract licensed sewage exhausters • Hazardous wastes (used oil) to be separately held on paved and bunded area prior to final disposal	To manage liquid waste responsibly, prevent pollution, protect water resources, and ensure health and environmental safety.	Proponent and Contractor	Continuous	500,000

	by licensed waste handler.				
Ground water contamination	• Ensure all circulation ponds are well lined before discharge • Monitoring of the quality of the groundwater in the project area i.e. water samples should be taken for chemical analysis to establish any chemistry changes in the groundwater which could result from contamination from geothermal waste fluids. • Positioning site compounds and laydown areas away from sensitive water features. • Refuelling and maintenance of vehicles and equipment in designated bunded areas and off-site where feasible. • Use of drip trays, bunded storage, and spill kits on site, to minimise the potential for releases and spills of oils and other liquids. • Use of silt traps and other measures to control silt laden run off from sites, especially during the rainy season. • Ensure that adequate stormwater containment and settlement areas	To protect underground water resources from pollutants that may be introduced during drilling activities.	Proponent	Continuous	500,000

	are provided.				
Handling, Storage and Use of Hazardous Materials	• All workers handling hazardous materials will be provided with suitable personal protective equipment including hand gloves, coveralls and respirators • Suitable storage areas, complete with impervious floor, will be provided to prevent exposure to harsh weather conditions which are likely to aggravate pollution incidents • A spill prevention, control and response plan shall be developed and maintained on site • An inventory of hazardous materials together with respective Material Safety Data Sheets will be maintained on site to act as a guide on material handling • Suitable spill containment measures shall be provided in areas designated for storage of the hazardous materials	To minimize risks to people and the environment by ensuring hazardous materials are handled, stored, and used safely, responsibly, and in accordance with legal standards.	Proponent and Contractor	Continuous	400,000
Noise and Vibrations	• Workers performing noisy operations shall be provided with suitable ear protectors based on the expected noise levels	To limit noise and vibration to acceptable levels to protect people and	Proponent and Contractor	Continuous	700,000

	• The proponent will consider noise the environment. emission characteristics during selection and mobilization of construction equipment with preference to low-noise geothermal technology. • Where feasible, fit equipment with mufflers, sound insulations, silencers to lower the levels of noise emission. • Undertake pre-employment and periodic audiometric testing for staff exposed to occupational noise risks to monitor the sharpness and acuity of an employee's hearing over time. This will be in line with OSHA (Medical Examination) Rules, 2005; • Employees and visitors to drilling sites and wells under discharge shall be provided with ear protectors • The drilling rig and its components including the generators shall be serviced and maintained in optimal working conditions to minimize the noise that will be generated • Warning signs shall be placed at all noise hazardous areas • All wells under test will be fitted with silencers to minimize the noise			
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	generated • The duration for the vertical discharge (well testing) should be restricted to two months • Noise measurement shall be undertaken periodically both on site and at the nearest settlements and appropriate mitigation measures recommended based on the results • Monitor noise levels as per the NEMA Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009				
Visual Impacts from Nighttime Lighting	• Night lighting should be shielded or designed to prevent any adverse impacts of offsite glare. • Use low-pressure sodium lights/lighting • Minimize light trespass and over illumination by limiting lighting to only those areas necessary • Use light activation mechanism (or assign as a responsibility to project staff) to ensure that lights are on only when needed • Use shrouds, low brightness	To reduce visual impact while maintaining safety and compliance.	Proponent and Contractor	Continuous	300,000

	fixtures with optical controls and other methods of shielding to control direct and stray lighting effects.				
Energy Consumption	- The proponent shall ensure proper planning of transportation of materials will ensure that fossil fuels (diesel, petrol) are not consumed in excessive amounts. - The proponent shall ensure responsible electricity use at the project site through sensitization of staff to conserve electricity by switching off electrical equipment or appliances when they are not in use. - The proponent shall monitor energy use during construction and set targets for reduction of energy use.	To make project operations more efficient, cost-effective, and environmentally sustainable.	Proponent and Contractor	Continuous	100,000

Soil erosion	• Restrict clearing of vegetation for the well pad and the access roads to the demarcated areas only • Appropriate soil erosion control measures including construction of gabions and replanting of vegetation in degraded areas and along the project roads shall be carried out • Preserve top soils for rehabilitation of degraded sites • The area where vegetation has been cleared shall be compacted, graveled and revegetated.	To protect soil integrity, prevent sediment runoff, and avoid land degradation,	Proponent and Contractor	Continuous	500,000
Road Accidents	• Any abnormal loads for the project must be transported in line with the traffic rules, including public notification and use of escort cars. • Sensitize project staff on risks of over speeding while on site • Erect warning signs for approaching drivers at the points of entry to the project site.	To ensure the safety of workers, local communities, and road users.	Proponent and Contractor	Continuous	100,000
Occupational Health & Safety Risks e.g. Physical hazards, Chemical and Gas exposure, Thermal hazards,	• Ensure compliance with all standards and legally required health and safety regulations as per OSHA, 2007 revised in 2010 • Attach a full-time qualified safety	To protect the health, safety, and well-being of workers, prevent accidents and	Proponent and Contractor	Continuous	700,000

Noise and vibration, Fire and explosion risks, Biological hazards, Psychosocial risks and work place accidents)	and Health Officer during the project implementation period • Provision of a standard First Aid kit at the site office at all times and train first aiders • Install appropriate safety signages for the work site. • Registration of the work place • Establish Occupational Health and Safety Committee for the site • Maintain site staff and visitor safety induction • Conduct toolbox and monthly safety meetings • Undertake impromptu and statutory safety inspections and audits respectively • Ensure regular statutory inspection of lifting equipment and air receivers • Regularly monitor noise and Hydrogen sulphide emissions • Develop site specific emergency response plan and procedures • Proper servicing of the generators and other mechanical equipment • Provision of spill response kits • Provision of firefighting equipment and train staff in fire fighting • Maintain an accident register	injuries.			
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	• carry out accident and incidents investigations and implement corrective actions; • Restricting access to hazardous work areas to authorized persons only. This will include fencing and guarding such areas • Induction of new staff on safety aspects pertaining to their job description • Enforce permit to work systems as applicable to the drilling operations • Installation and maintenance of warning signage's at appropriate locations depending on the hazards e.g. no smoking signs at the diesel storage areas • Sensitizing the local community and visitors on safety aspects associated with geothermal drilling operations				
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Community Safety and Health Hazards	• Sensitize community on dangers associated with drilling operations • Restrict access to work sites. Reasons for restricted access will be explained to the community throughout the continuous engagement process • Enforce requirements for traffic safety • All brine ponds will be fenced and warning signs posted • Maintain a complaint register and redress mechanism for the community members to report • Conduct continuous risk assessment and monitoring for noise and H₂S release or adverse emissions.	To protect the well-being, health, and security of local populations by minimizing risks arising from project activities.	Proponent and Contractor	Continuous	500,000
High stakeholders' expectations	• Implement a Stakeholder Engagement Plan that is tailored to the characteristics and interests of the Affected Communities; • Deploy differentiated measures to allow the effective participation of those identified as vulnerable • Inform Local communities on the upcoming works on time and awareness on possible temporary nuisance	To manage and align stakeholder interests with realistic project outcomes.	Proponent and Contractor	Continuous	100,000

	• Allow stakeholder participation in decisions that affect them				
HIV / AIDS and Sexually Transmitted Infections	• Education and sensitization of workers and the local communities on HIV/AIDs and STIs in conjunction with community health workers • Provision of condoms to the project workers and the community. This should be kept in easily accessible places • Formation of peer groups from among the project staff to ensure continuity in training and awareness raising • Proponent will ensure that all project staff are made aware of the risks of contracting or spreading sexually transmitted diseases; and • The proponent should ensure that the project workers are sensitized on the local culture and sign a code of conduct while on the project.		Proponent and Contractor	Continuous	10,000
Decommissioning Phase EMP					
Expected Negative Impacts	Recommended Mitigation Measures		Responsibility	Time Frame	Cost (KShs)

Air Pollution	• Maintain vehicles and equipment used during the decommissioning phase • Comply with the provisions of Environmental Management and Coordination (Air Quality) Regulations, 2024	To minimize the release of harmful airborne pollutants.	Project Manager & Contractor	Continuous	500,000
Oil Spills	• Maintain vehicles and equipment outside the Project Site • Prepare plans and procedures for proper storage and handling of oil products • Comply with the provisions of Environmental Management and Coordination (Waste Management) Regulations, 2024	To prevent environmental contamination from oil spills.	Project Manager & Contractor	Continuous	200,000

Solid Waste (Demolition Waste)	• All buildings, machinery, equipment, structures and partitions that will not be used for other purposes should be removed and reused/recycled. Where reuse/recycling of the machinery, equipment, implements, structures, partitions and other demolition waste is not possible, the materials should be taken to a licensed waste disposal site • Donate reusable demolition waste to community members and institutions • Comply with the provisions of Environmental Management and Coordination (Waste Management) Regulations, 2006	To protect the environment, reduce health and safety risks, and comply with legal and environmental standards	Project Manager & Contractor	One-Off	500,000
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Noise Pollution	• Sensitize drivers and machine operators to switch off engines of vehicles or machinery not being used. • Demolition activities will be limited to the hours of operation between 8.00 am and 6.00 pm. • Drivers of motor vehicles will be warned against unnecessary hooting of vehicles • Comply with the provisions of Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 regarding noise limits at the workplace.	To reduce noise disturbances and uphold legal compliance.	Project Manager & Contractor	Continuous	500,000
Site degradation	• Implement an appropriate landscaping and re-vegetation Programme to restore the site to its original status. Consider use of indigenous plant species in re-vegetation.		Project Manager & Contractor	One -Off	600,000

11.2 Environment, Health, Safety and Social Management Plans Relevant to the Proposed Project

The plans presented in this section provides guideline for the proponent to prepare detailed applicable specific plans for the project. The plans should incorporate monitoring and audit checklists to ensure compliance with the relevant legislations. The following plans indicated in **Table 76** below.

Table 76: Summary of management plan requirements

No.	Management Plan	Summary of Reporting Requirements
1	Grievance and complaints management plan	Documents complaints received (from community and workers) in the period and redress provided. The proponent will put in place a Grievance management committee and reporting mechanisms.
2	Waste Management Plan	Presents various waste stream sources (camps and operational areas), amounts and management measures. Provided in Waste Management Plan.
3	Traffic Plan	Presents traffic safety measures in place, any accidents & incidents reported. Corrective measures taken. Provided in Traffic Management Plan.
4	Water Use Management Plan	Water requirements, consumption rates (community and drilling sites) as well as leaks and spills from supply lines- Provided in Chapter 11.2.1 Water Resource Management Plan
5	Chance find procedures for Archaeological and Cultural Heritage	Specify locations of encounter and action taken provided in Chapter 11.2.9:
6	Hazardous Substances Management Plan	Installation and maintenance / Warehousing of substances- Provided in Chapter 10.2.6 Handling, Storage and Use of Hazardous Materials
7	Biodiversity Management Plan	Ecological monitoring- Provided in Biodiversity Management plan.
8	Health and safety management Plan	General housekeeping measures in place, incidences recorded and treatment taken (records maintained daily)- Management plans provided in ESMP.
9	Air Quality Management	Ambient air quality monitoring data, emission sources, sensitive receptors and controls in place-Provided in Pollution Prevention Management Plan.
10	Noise Abatement Plan	Ambient noise monitoring data, pertinent sources, sensitive receptors and controls in place-Provided in Noise Management Plan under ESMP.
11	Environmental and Social	Outlines how environmental and social impacts will be tracked, managed, and reported, responsibility, budget and

No.	Management Plan	Summary of Reporting Requirements
	Management Plan	indicators-Summary of the plans provided in ESMP.

11.2.1 Water Resource Management Plan

The project proponent shall consider all measures necessary to ensure sustainable development by considering provision of water for drilling as well as for domestic use.

A comprehensive water resource management plan shall be developed and shall detail how water resources shall be used, managed, protected and conserved. Objectives of the plan shall include:

- Creating mechanisms for integrating energy and water resources planning and management within the proposed project
- Improving water resources assessment in order to obtain more accurate information on ground and surface water yield
- Incorporating all genders in water resource management programs within the proposed project.
- Putting in place mechanisms that provide access to water for communities surrounding the project
- Creating mechanisms for catchment conservation and management
- Putting in place measures to enhance water availability, quality and quantity (Quality monitoring and alternative sources i.e. roof catchments and use of brine)
- Creating awareness on water resource management amongst the project staff and the surrounding community.

11.2.2 Waste Management Plan

Implementation of the proposed project will result in generation of various types and quantities of wastes constituting consumables, surpluses and byproducts of the project phases. The Waste Management Plan (WMP) will be elaborated for specific wastes and implemented by all parties during the project cycle.

The following within the WMP will be elaborated for the various phases of the Project:

- Identify the types and quantities from all waste streams produced during all the phases of the project
- Identify waste management options as described in the ESMP and develop a hierarchy of waste reduction, reuse, and recycling protocols.
- Develop hazardous wastes identification and management procedures according to national requirements
- Document the quantities of wastes produced on a monthly basis, and where possible measures taken to re-use, reduce or recycle waste as appropriate
- Train project staff on the requirements of the WMP as contained in the ESMP
- Identify suitable waste management sites
- Use NEMA licensed waste disposal contractors and facilities that comply with the legal requirements at the local and national levels
- Monitor throughout the project life cycle, waste management to ensure compliance with the WMP

11.2.3 Site Rehabilitation and Restoration Plan

Rehabilitation of borrow pits excavated during construction of access roads shall be accomplished through refilling, ground leveling and planting of indigenous suitable trees, shrubs and grass. Suitable trees or other

plants that can establish in the rehabilitated areas but are not native will only be used after a thorough evaluation and profiling on their suitability, economic value and invasiveness potential. Stockpiled soil from road cuttings, borrow pits and surplus excavated materials from earth works will be used in the rehabilitation.

Prior to material extraction from the borrow areas, a site biodiversity inventory of the native species and photographic documentation of the areas will be made so that restoration replicates or approximates original conditions. Rehabilitated areas will be made to blend with their surrounding landscapes and the proponent shall ensure proper maintenance of such sites.

11.2.4 Occupational Health and Safety Plan

The project proponent shall ensure that where practicable; exposure to health and safety risks to workers and other persons arising from the proposed project are minimized. To achieve this, the risks will be identified, assessed and their occurrence probabilities mitigated. The occupational health and safety plan will have the following components:

- i. Identification of risks and hazards: identification of potential risks and hazards associated with the proposed project will be done. Potential risks include well blow outs, fire out breaks, slipping, tripping, accidental falls, injurious exposure to noise, heat, and contaminated atmosphere.
- ii. Risks assessment: An assessment of risks will be undertaken as part of the occupational health and safety plan for categorization of:
 - severity of injuries or illnesses that could result and its ranking as minor, significant with wide ranging and severe affects
 - Probability of occurrence of injury or illness relative to the number of people likely exposed to the hazards.
- iii. The risk assessment will enable appropriate control measures deployment, planning and assist in identifying of workers and categories at risk, determination of sources and processes associated with specific risks, verification of effectiveness of adopted and operational control measures.
- iv. Control and elimination of risks: Appropriate control measures and protocols will be used in the proposed project and all personnel involved in the project will be trained on health and safety aspects and their obligations in the discharge of duties.

11.2.5 Emergency Response Plan, Spills Prevention and Response Plan

Various activities and operations within the proposed geothermal drilling project will entail use of various materials with potential for accidental spill incidences leading to fires, explosions, health impacts, surface/ground water contamination and soil pollution. The hazards posed are dependent on the spilt material toxicity, chemistry, quantity, spill area, work processes and weather conditions. The formulated response plan for the proposed project elaborates on procedures for prevention and responses to spills that will involve:

i. Spill Prevention: Appropriate handling, management and storage of only limited quantities of hazardous materials will considerably minimize risks of spills and mitigate potential effects to personnel and the environment. The source and attendant mitigation of spills include:

a) Construction equipment spills risk mitigated through:

- Storage and maintenance of equipment in designated areas
- Use of secondary containment such as drain pans when removing or changing oil
- Use of right equipment such as. pumps or funnels to transfer both new and used oil
- Conduct of fueling in designated areas

- Filling of fuel tanks and containers to manufacturer indicated fill levels
- Examination of incoming vehicles to for oils and fluids leaks
- Transfer of used oil and oil filters to waste bins or recycling drums
- Routine inspection of all equipment for leaks and spills
- Immediate repair of leaking equipment
- Design and use of preventive maintenance schedules for all equipment and vehicles

b) Use and storage of regulated and hazardous wastes mitigated by:

- Retention of original product labels to avoid confusion and accidental mixing
- Completely use of contents before disposal of the various containers
- Maintenance of only needed quantities of material at specific times and disposal of excess or expired substances in compliance with NEMA regulations
- Disposal of hazardous wastes at only NEMA approved facilities
- Training of employees on safe handling of hazardous material and safe waste management

ii. Spill Kits: Spill-containment kits will be well-marked, accessible and maintained at material storage areas and operation points. The spill kits shall include oil absorbent pads/rags, heavy duty disposal bags, nitrile gloves (synthetic rubber) and all-purpose absorbents (e.g. sawdust). All personnel of the proposed project will be trained on the nature of likely spill hazards, location, content and usage of spill kits.

iii. Spill Response: Spills at fueling area during fueling operations will be contained within a spill pan for small container handling, or by use of portable secondary containment berms in the storage areas. Accidental leakage of hazardous material shall follow the below procedure

- Stop ongoing operations immediately
- Identify the product and examine the warning labels and markings
- Barricade the site to prevent personnel from accessing the site and keep them at a safe distance to avoid injury, fire ignition or explosion
- Stop substance flow at its source, reduce or terminate the motion of the product without endangering anyone
- Assess the extent of spill, fill the Spill Response Form and send copies to the HSE Manager and the Project Manager
- Contaminated soil should be scooped and stored in sealed containers for disposal according to set procedures after consultations, consensus establishment and relevant authorization

11.2.6 Traffic Management Plan

During the construction phase of the project, construction activities will increase the ambient traffic along the road due to movement of trucks and other construction equipment.

The traffic management plan aim is to facilitate traffic flow and reduce accidents occurrence potential, it is recommended that:

- The proponent provide, erects and maintain barricades, signs, markings, lights and personnel where necessary to ensure the safety of all road users throughout the entire period of construction activities
- Community to be sensitized prior to ferrying of extraordinary loads (rigs) along the road 's to the various operation sites
- Bulky materials to be transported to sites where and when required during off peak hours

- Flagmen or traffic marshals are present at all operation sites where traffic flows through road works to direct vehicles

11.2.7 Community Management plan

To manage communities and their expectations, the social aspects highlighted in the ESMP has to be implemented in addition to health and security, stakeholder engagement and management plans. In implementing the social management plan, it is recommended that the projects' social expert understands:

- Communication mechanisms that enable engagement with communities at all times during the project cycle
- Prevailing demographic and cultural trends
- The biophysical and natural resources linkages with livelihood systems
- The social context of the proposed project radius
- Social risks and vulnerabilities for different social categories
- Development and social transformation aspirations of different categories relative to the proposed project
- Multiple engagement pathways with the communities and existing leadership structures and governance arrangements
- Local governance structures and key actors
- Evolving social dynamics in the project area and their implication on project time schedules

11.2.8 Land Acquisition, Compensation and Livelihood Restoration Plan (LACRAP)

Resettlement is not envisaged at exploration stage of the project however in future, the project proponent shall implement a LACRAP in case of potential displacement. The objective of the LACRAP is to ensure that the population to be displaced are formally consulted and adequately compensated. Prior to the resettlement, compensation for the losses shall be paid in full before the actual movement, the population to be displaced/resettled shall be assisted in the movement and supported during the transition period. In addition, efforts shall be made to improve on their former living standards or at the very least maintain them.

11.2.9: Chance Find procedures for Archaeological and Cultural Heritage

Chance Find Procedures (CFP) are essential protocols designed to protect archaeological and cultural heritage that may be unexpectedly discovered during different activities within a community or given area.

The main purpose is to establish a systematic procedure for handling unexpected discoveries of cultural heritage, including artifacts, fossils, human remains, or structures, during site preparation, drilling or decommissioning activities.

Chance find may include any previously unknown:

- Human remains or burial sites
- Stone tools, pottery, or ceramics
- Fossils or bones
- Structures (e.g., foundations, walls, wells)
- Sacred or ceremonial objects

Responsibility and Training

- The GDC/ Contractor is responsible for enforcing the CFP through training of site workers on:
 - What constitutes a chance find
 - Steps to take if one is discovered
 - Reporting lines and documentation

Table 77 below indicates procedures to be undertaken in case of a chance find during project activities.

Table 77: Step-by-Step Procedure for a Chance Find

	Step	Action
1	Stop Work Immediately	All activities must cease in the immediate area of the find. Secure the area to prevent further disturbance.
2	Notify Supervisor	The discoverer must inform their immediate supervisor and the Environmental/Social Officer.
3	Record the Find	Document the location using GPS, take photographs, and describe the find (type, size, condition).
4	Report to Authorities	The Site Manager must notify the relevant national heritage authority within 24–48 hours.
5	Protect the Site	Establish a buffer zone (e.g., 10–30 m radius) with visible markers or fencing and prevent unauthorized access.
6	Assessment by Experts	Authorities or appointed archaeologists will inspect and assess the find.
7	Decision and Clearance	Based on the assessment

11.2.10: Induced Seismicity Management Plan

Geothermal drilling, well testing, production, and reinjection activities can alter subsurface pressure regimes and potentially trigger low-magnitude seismic events, commonly referred to as induced seismicity. Although induced seismic events associated with geothermal developments are typically of low magnitude and localized in nature, they may result in community concern, potential impacts on infrastructure, and changes to the geothermal reservoir if not appropriately managed. To manage this risk, the project proponent will develop and implement an Induced Seismicity Management Plan (ISMP) that includes baseline seismic assessments, continuous seismic monitoring, and adaptive operational controls throughout the project lifecycle.

11.3 Responsibility and Accountability

The Environmental and Social Management Plan (ESMP) contains the schedule for implementing the mitigation measures for impacts identified for the proposed project. It includes the identified environmental and social parameters, indicators, monitoring frequency, assigns monitoring responsibility and associated costs.

The Proponent will utilize the existing arrangements in the implementation of the ESMP during planning and design, construction, operation and decommissioning phases. The Proponent is accountable for ensuring that resources are made available to effectively implement the ESMP and necessary environmental management

measures arising from the proposed project. The Project Manager will oversee and take responsibility of the day to day running of the project while the SHE Manager will oversee the detail of implementation of the ESMP for the project phases. Environmental monitoring will be undertaken by the SHE specialists and independent audits of environmental performance will be conducted from time to time by independent NEMA approved environmental experts. **Table 78** below provides details on the functions of each staff member.

Table 78: Responsibilities of various staff Implementing the Project ESMP

Position	Responsibility
Project Manager	- Overall, in charge of the project. - Schedule preparation and resource forecasting for both technical non-technical activities relating to the project.
Project Engineer	Overseeing all engineering activities/works
SHE Manager	Overall in charge of Health, Safety and Environmental issues in regard to the project.
Environmental Specialists	- Conducting environmental monitoring, preparation of environmental monitoring reports and any permit applications (if any) - Running of day-to-day requirements for EMP implementation - Supervising monitoring and review of EMP implementation by contractors.
Health and Safety Expert	- Monitor and promote HSE work practices within all the operational sites - Monitor HSE process and equipment availability and safe operations. - Safety and Environmental awareness creation to all workers within the project.
Community Relations Officer	- Implementing community engagement strategies and overseeing all community liaison related matters - Management of emerging community matters - Liaison with the appropriate company personnel to ensure that community grievances are tracked, reported and responded to accordingly as necessary
Contractor(s)/Proponent	- Undertake development of project activities in accordance with contract signed with the Proponent - Will implement the proposed project - Ensure strict adherence to the project ESMP requirements, - HSE policies/procedures and other legal requirements in regard to the project

11.4 Training, Awareness and Capacity Building

The Proponent will ensure that project supervisors, managers, general staff, contractors and community surrounding the project are inducted on health, safety, environmental and emergency response procedures. The Proponent will use written (EHS code of conduct/newsletter/posters/toolbox talks/ brochures) and verbal (as part of routine briefings) communication methods to raise awareness on a range of health, safety and environmental issues. This will be done in both Kiswahili and English languages (as appropriate) to ensure that all members of the workforce are made aware of the aspects of the ESMP.

The training components shall include but not limited to:

- Operational legislative frameworks detailing all applicable laws, regulations, standards and technical guidelines in work aspects that will affect environmental compliance
- Policies and procedures to be followed by the proponent and contractors applicable to the project
- ESMP as the tool and key document for project environmental compliance and associated documents including EHS and ERP among others
- Environmental monitoring and surveillance for ESMP implementation
- Documentation, record keeping and reporting procedures for ESMP related aspects
- Awareness creation methods, information packaging and communication procedures for ESMP purposes
- Complaints handling and good relationship nurturing with other stakeholders' local communities
- The economic and social cultural contexts and behavior of local communities in the within the project area.

11.5: Security management and assurance

Security Management Plan outlines the framework, strategies, and measures for protecting personnel, equipment, assets, and critical infrastructure during the development and execution of the proposed project. It addresses potential security threats including vandalism, theft, community unrest, sabotage, and unauthorized access. The objectives include;

- To ensure the safety and security of all project personnel, contractors, and stakeholders.
- To protect project infrastructure from theft, vandalism, or damage.
- To maintain uninterrupted operations through effective risk prevention and response systems.
- To foster trust and cooperation with local communities and security agencies.
- To comply with national security regulations and international best practices.

Security Strategies

a) Physical Security Measures

- Install perimeter fencing and gatehouses at drilling sites.
- Construct guard towers at strategic locations.
- Ensure adequate lighting for all critical areas.

b) Personnel and Surveillance

- Employ 24/7 trained security personnel from a licensed security firm.
- Prioritize local recruitment for guards to improve intelligence and acceptance.
- Install CCTV cameras, motion detectors, and alarm systems linked to a central control room.
- Conduct daily patrols and maintain incident logs.

c) Access Control

- Implement a visitor and contractor registration system with photo ID and escort protocols.

- Enforce badge-only access for sensitive zones
- Maintain vehicle screening procedures at entry points.

d) Community Engagement and Social Safeguards

- Conduct regular stakeholder consultations to keep communities informed and involved.
- Establish a Community Grievance Redress Mechanism (GRM) to resolve conflicts amicably.
- Implement Corporate Social Responsibility (CSR) projects (e.g. water access, road repairs) to build goodwill.

e) Emergency Response and Incident Management

- Develop and train a Security Incident Response Team (SIRT).
- Maintain a detailed incident reporting and escalation protocol.
- Conduct monthly security drills and scenario simulations (e.g., protests, break-ins, fire).
- Establish a hotline for anonymous tip-offs and reporting.

CHAPTER 12. ENVIRONMENTAL AND SOCIAL MONITORING PLAN

12.1 Introduction

This chapter outlines the Environmental and Social Monitoring Plan (ESMoP) developed to verify the effectiveness of mitigation measures, assess compliance with applicable environmental and social legal requirements and project commitments, identify emerging impacts throughout the lifecycle of the proposed project.

Environmental and social monitoring is key in any project implementation for it ensures that project activities comply and adhere to environmental laws/standards provisions. Environmental and social monitoring also ensures that mitigation measures are implemented and that they are effective. New and developing issues of concern are also addressed during the Environmental and social monitoring. The activities and indicators that have been recommended for monitoring are presented in the **Table 79** below:

The environmental monitoring program will operate during all the project phases and will include visual observations, selection of environmental parameters, sampling and regular testing of environmental parameters.

12.2 Internal Monitoring

It is the responsibility of the proponent to conduct regular internal monitoring of the project to verify the results of the Contractor and to audit direct implementation of environmental mitigation measures contained in the ESMMP and construction contract clauses for the Project.

The proponent also has direct responsibility to implement and monitor land acquisition and compensation issues arising from project. The monitoring should be a systematic evaluation of the activities of the operation in relation to the specified criteria of the conditions of approval.

The objective of internal monitoring and audit will be:

- To find out any significant environmental hazards and their existing control systems in place.
- Meeting the legal requirements as stipulated in EMCA and international standards.
- To come up with corrective actions to identified non-conformities to ensure adherence to the Environmental Management Plan

12.3 External Monitoring and Evaluation

NEMA has the overall responsibility for issuing approval for the Project and ensuring that their environmental guidelines are followed during Project implementation. Its role therefore is to review environmental monitoring and environmental compliance documentation submitted by the implementing authorities and they would not normally be directly involved in monitoring the Project unless some specific major environmental issue arose.

12.4 Environmental Social Monitoring plan (ESMoP) of the Proposed Project

The planned activities and impacts predicted will be monitored against the mitigation measures proposed guided by local and international standards and pursuant to the proscribed legal and/or regulatory requirements of the intervention. The recommended measures are presented in the **Table 79** below:

Table 79: Environmental Social Monitoring plan (ESMP) of the Proposed Project

Monitoring Scope	Parameter	Indicators (KPIs)	Activity	Location	Frequency	Responsibility
Land take	Land size taken	Compensation documents	Inventory of PAPs	Entire site	Monthly	GDC
Vegetation Disturbance Visual intrusion; Insecurity and Illegal Harvesting of Wild Products	% cover Vegetation cover and wildlife habitat.	No. of Trees felled; Areas of land cleared; Identified invasive species Number of seedlings replanted.	Inventory of vegetation baseline	Entire Site	Weekly	GDC
Noise and Vibration Impacts	dB and m/s	Noise levels monitoring data dB(A) & Complaints log	Noise level measuring	Active areas	Daily	GDC
Air pollution	PM, TSP, H ₂ S, NO _x , SO ₂ , CO _x , Dust particulate	Daily water uses for dust sprinkling; Safety induction records. Air Quality records Records on issuance and use of PPEs	Measure concentrations of particulate matter and H ₂ S	Active areas; Proximate settlements	Daily	GDC
Generation of Waste	Spoils, domestic refuse, scrap metal	Disposal sites?? Waste tracking records	Site inspections / observations	Active Construction sites	Weekly	GDC
Wild animals such as birds drowning in water tanks	Water tanks will have no roofing therefore animals that can access water from that height face the risk of drowning this is a wildlife issue and O& M issue with regards to management of sludge from cleaning	Birds that will be seen at the Tanks	Observation	Storage water tanks	Once the tanks start to operate	GDC

Monitoring Scope	Parameter	Indicators (KPIs)	Activity	Location	Frequency	Responsibility
	of water tanks					
Increased Demand for Water	Rate of consumption	Consumption records(Daily abstraction volumes) Complains from other water users	Inspection of meter readings Observation of water levels	Reservoir tanks and Water Pump Stations	Daily	GDC
Occupational and Public Health and Safety Impacts	Job safety analysis	JSA Report by a qualified OSH Advisor		Inspection of records	Once contractor takes possession of the site	GDC
	Health and safety action plan	HASP as approved by the RE	Inspection of records	Contractor's Administrator/ Project Manager's office	After conduct of a JSA	GDC
		Community sensitization and participation in Community health and safety	Consultations of sample of the Project area communities	Community Baraza	Quarterly	GDC
		Health and Safety Personnel	One on One Interview with the H&S Personnel	Contractors Office	Once contractor takes possession of the site	GDC
	Emergency preparedness and response plan (EPRP)	EPRP as approved by the RE	Inspection of records	Contractor/ Project Manager's office	After conduct of a JSA	GDC

Monitoring Scope	Parameter	Indicators (KPIs)	Activity	Location	Frequency	Responsibility
		Community awareness posters/ warnings Participation of response activities by the community	Community Sensitization in their participation in community health and safety	Community Baraza	Quarterly	GDC
	Registration of the workplace	Work place registration permit	Inspection of records	Contractor/ Project Manager's office	After conduct of a JSA	GDC
	Accidents and incidents	Number of accidents and incidents register	Inspection of incident reports	Contractor/ Project Manager's office	Quarterly	GDC
		Community complaints related to road accidents and incidents	Consultations of sample of the project area communities	Community Baraza	Quarterly	GDC /DOSHS
	Safety training for workers	Training plans, Training Reports, Attendance list	Inspection of records	Contractor/ Project Manager's office	Quarterly	GDC
		Feedback Reports on Training from staff Attendance sheets	Inspection of records	Contractor/ Project Manager's office	Quarterly	GDC
		Staff awareness on health and safety issues Staff use of appropriate PPE Reduced accidents and incidents on site	Observation and interviews with a sample group of staff	Work sites where Project Staff operate	Quarterly	GDC
	Awareness posters on identified risks and	Physical posters	Observation	Work sites where Project	Quarterly	GDC /DOSHS

Monitoring Scope	Parameter	Indicators (KPIs)	Activity	Location	Frequency	Responsibility
	responses in case of emergency			Staff operate.		
		Physical posters for the community	Observation	Along potential road safety risk areas for the community	Quarterly	GDC /DOSHS
	Emergency drills	Records of drills	Inspection of record.	Contractor/ Project Manager's office	Quarterly	GDC /DOSHS
	Safety and health committee for a contractor with more than 20 staff on site	Safety and Health Committee Minutes of meetings	One on One Interview with the committee	Contractors Office	Quarterly	GDC
	Internal Audits	Internal audit reports	Inspection of record	Contractor's Administrator / Project Manager's office	Quarterly	GDC
	OSHA required Reports to DOSHS	Copies of Reports submitted to DOSHS	Inspection of record	Contractor's Administrator /Project Manager's office	Quarterly	GDC /DOSHS
			Community Baraza with sample community	Community Baraza	Quarterly	GDC

Monitoring Scope	Parameter	Indicators (KPIs)	Activity	Location	Frequency	Responsibility
	Handling, storage and use of hazardous materials	Presence of Material Safety Data Sheet (MSDS)	Inspection of Material Safety Data sheets Incidence reports resulting from improper handling of hazardous materials.	Material stores	Quarterly	Health and safety Officer
HIV/AIDs and STIs program	Education and sensitization of workers on HIV/AIDs Management Program.	Training plans, Training Reports	Inspection records	Contractor/ Project Manager's office	Quarterly	GDC
		Feedback Reports on Training from staff Attendance sheets.	Inspection of records	Contractor/ Project Manager's office	Quarterly	GDC
		Formation of counselling P groups.	Interviews with staff	Work sites where Project Staff operate	Semi-Annually	GDC
			Records of Training of trainers for peer counsellors	Contractor/ Project Manager's office	Quarterly	GDC
		Physical posters on appropriate locations within the worksite.	Observations	Work sites where Project Staff operate	Monthly	GDC

Monitoring Scope	Parameter	Indicators (KPIs)	Activity	Location	Frequency	Responsibility
		Staff awareness on HIV/AIDS and STI Causative agents, prevention, diagnosis and management.	Knowledge, Attitudes and Practices (KAP) Survey of a stratified sample group of staff, prior to Commencement Of the sensitization program and periodically every six months	Work sites where Project Staff operate	Semi-Annually	GDC
Enhancement of project benefits-employment	Equitable distribution of employment opportunities	Community complaints	Inspection of grievance logs	Contractor/ Project Managers office	Monthly	GDC
		Gender mainstreaming strategies within the HR recruitment policies.	Inspection of Relevant HR policy procedures and records.	Contractor/ Project Manager's office	Once contractor takes possession of the site and every quarter after that	GDC
		Gender balance among project staff to a minimum proportion of 2/3 of men or women	Number of employees segregated by age and gender	Contractor/ Project Manager's office	Monthly	GDC

Monitoring Scope	Parameter	Indicators (KPIs)	Activity	Location	Frequency	Responsibility
	Compliance with labor laws and labor standards	Availability of Human Resource Policy that includes a recruitment strategy (including a local staff recruitment strategy), non-discrimination procedures and practices as well as a retrenchment policy.	Inspection of records	Contractor/Project Manager's office.	Once contractor takes possession of the site	GDC
		Availability of employment record	Inspection of employment records	Contractor/ Project Managers office	Monthly	GDC
	Mechanism for managing staff grievances	Establishment grievance mechanism Of staff redress	Inspection of records established under the grievance redress mechanism	Contractor/Project Manager's office	Once contractor takes possession of the site and every quarter	GDC
		Policy and practice by the contractor that does not prohibit staff from joining workers associations.	Inspection relevant policy procedures records of HR	Contractor/ Project Manager's office	Once contractor takes possession of the site and every quarter after that	GDC
	Freedom to join workers association	Records or evidence of a worker's association	Interviews project staff	Work sites	Semi-Annually	GDC

Monitoring Scope	Parameter	Indicators (KPIs)	Activity	Location	Frequency	Responsibility
	Child protection	Compliance with child protection requirements by Kenyan law and ILO standards.	Inspection relevant policy procedures records of HR	Contractor/Project Manager's office	Once contractor takes possession of the site and every quarter after that	GDC
Vandalism	Destruction pipelines and associated infrastructure	Unaccounted for water losses	Monitoring of the water pressure and water utilization records	Distribution And storage facilities	Monthly	GDC
Stakeholder engagement during monitoring and evaluation of the implementation and efficacy of project environmental and social management plans and mitigation	Awareness on the project ESMPs and management plan that affect the various stakeholder	Increased ownership of project's ESMPs and management plans	Interviews with sample groups of stakeholders	Community Barazas and areas where interviews are held	Quarterly	GDC
	Stakeholder participation in decisions that affect them	Maintenance of social license	Interviews with sample groups of stakeholders	Community Barazas and areas where interviews are held	Quarterly	GDC
	Record of as felt benefits or negative impacts to improve the ESMP and Management Plan	Records of as felt benefits or negative impacts Revision and updates of ESMP and management plans based on recommendations from stakeholder engagements	Inspection of records	EHS Office	Quarterly	GDC

Monitoring Scope	Parameter	Indicators (KPIs)	Activity	Location	Frequency	Responsibility
Natural Resource use Conflicts	Maintenance of Project social license	Complaints by the communities	Inspection of community feedback records. Grievance logs	Community Liaison Office	Quarterly	GDC
			Consultations of sample of the project area communities	Community Baraza	Quarterly	GDC
Groundwater Depth	Depth to groundwater	WRA Guidelines	Inspection of hydrological reports; Consultations with WRA for area data	Existing boreholes and wells	Monthly	GDC
Groundwater Quality	pH, Salinity (EC), Nitrates Phosphorous, Pesticide residues	WRA Guidelines	Inspection of hydrological reports; Consultations with WRA for area data	Existing boreholes	6 months	GDC
Surface water quality – intakes and receiving waters	pH, Salinity (EC), Nitrates, Phosphorous, Pesticide residues, Coliforms BOD and COD	EMCA and WRA Guidelines	Water analysis of collected water samples	Intake points and selected points along the pipeline network	Monthly	GDC
Geological and seismic risks	Ground deformation Induced seismic activities	Operational seismic stations Seismic monitoring data; micro-gravity monitoring data	Entire exploration area	Site seismic inspection	Monthly	GDC

Monitoring Scope	Parameter	Indicators (KPIs)	Activity	Location	Frequency	Responsibility
Disputes over employment	A formal recruitment process to be adhered to Clearly explain to all job-seekers the terms and conditions of their respective employment contract.	Recruitment policy Copies of signed contracts for each employee filed	Inspection of records	Entire site	Monthly	
Interference with cultural sites	Destruction of features or areas of cultural interest.	Registered cases	Inspection of records	Entire site	Quarterly	Contractor/ GDC
Grievance Management	Resolve of grievances	Review of complaints logbook and the response and handling of the complaints. Number of grievances received and resolved	Inspection of records	Site offices	Entire duration of works	Contractor/ GDC
	Meetings held with the stakeholders	Reports shared with the community	Inspection of records	All relevant Stakeholders	Quarterly	GDC
Excessive water usage	Water meter readings Reduced water level in the dams	Complaints by other water users. Reduction of water quantity for project activities	Feedback from other water users. Grievance logs	All relevant Stakeholders	Entire duration of works	GDC
Excessive energy usage	Total energy used over time.	Energy efficiency reports	Review of energy reports	Site offices	Entire duration of works	GDC

CHAPTER 13. CONCLUSIONS AND RECOMMENDATIONS

13.1 Introduction.

This chapter presents the conclusions drawn from the Environmental and Social Impact Assessment (ESIA), along with a set of recommendations to guide responsible project implementation and long-term sustainability.

13.2 Conclusions

In order to encourage affordable, reliable, quality and sustainable electricity for manufacturing industry in Kenya, the government has recognized the need to license private firms to develop geothermal resources. The proposed drilling project will avail steam for electricity generation which is an important input in the manufacturing sector. Manufacturing is among the Bottom up Economic Transformation agenda aimed at accelerating economic growth in Kenya. The findings of the ESIA for the proposed geothermal exploration drilling at Suswa, Narok and Kajiado Counties indicates that the project has the potential for both positive and negative environmental impacts. The positive impacts envisaged include: creation of job opportunities, business opportunities for both local and international entrepreneurs and provision of reliable green energy to power the manufacturing sector. Manufacturing is among the Bottom up Economic Transformation Agenda aimed at accelerating economic growth in Kenya.

The potential negative social and environmental impacts identified are those associated with the following aspects: water demand, land take, vegetation clearance, dust, noise, air emissions, increased waste generation and general health and safety aspects. All the potential impacts can be adequately mitigated thus the project should be considered for approval by NEMA. However, upon approval, the project proponent will need to implement the Environmental and Social Management Plan during the construction and operation phases of the proposed project in order to promote environmentally sustainable development.

In view of the information collected, the ESIA Team concludes that the proposed project is desirable as it will significantly contribute positively towards improving livelihoods of the local community. The project will also go a long way in improving the country's energy needs and demands towards attainment of Vision 2030 and the Big 4 Agenda.

13.3 Recommendations

Recommendations are made based on the assessment of cumulative and potential impacts of the proposed project and are summarized as:

13.3.1 Environmental Issues

The proponent adheres to the proposed ESMP and monitoring plan suggested in this ESIA report. The Proponent should ensure project implementation is in compliance with all the relevant legal requirements of Kenya as well as the international guidelines (IFC safeguards and World Bank Safeguard Policies)

- Monitoring of hydrogen sulphide and noise emission levels be undertaken throughout the drilling process both on site and at the neighboring settlements.
- For wells confirmed productive following exploration, both H₂S and noise dispersion modelling to be undertaken prior to power plant construction. This will inform further management actions necessary for any likely long-term impacts of these emissions on the local communities.
- The proponent to conduct a separate ESIA prior to power plant construction.
- An environmental audit of the project be undertaken upon completion of the construction works to verify the implementation of the proposed mitigation measures.

- The proponent be licensed based on the environmental and social management measures contained in this ESIA Report.
- Organize a learning visit for key staff to Olkaria Geothermal project to learn some best practices in environmental management including mitigation against Hydrogen Sulphide.

13.3.2 Stakeholder and Community Issues

- The proponent to ensure disclosure of all ESIA study findings, provision of regular updates to the host communities on project progress and management of the community expectations.
- The proponent to ensure implementation of developed Stakeholder Engagement Plan and Community Development plan to enhance community ownership and amicable resolution of any conflicts arising from social and environmental concerns.

13.3.3 Socio-Economic Issues

- In cases where the proponent needs to acquire land from the community, the prepared Land Acquisition and Compensation Plan (LACP) should be fully implemented.
- In case of displacement, an accurate socio-economic census of affected people, and a transparent and fair valuation exercise should be done to derive value of property to compensate.
- Raise awareness of control of Human Immune Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS) and health risks for construction workers and service providers.

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LIST OF ANNEXES

Annex 1: Noise and vibration measurement report

Annex 2: Air quality report

Annex 3: Biodiversity assessment report

Annex 4: Soil quality report

Annex 5: Water quality report

Annex 6: Community development framework

Annex 7: Stakeholder engagement plan

Annex 8: Indigenous Peoples Plan report

Annex 9 :LACRAP Report

Annex 10: Evidence of Public Participation