SUPPLEMENTAL ENVIRONMENTAL IMPACT ASSESSMENT (SUEIA) REPORT

Project Name:

ORPOWER TWENTY-TWO LTD 35 MW GEOTHERMAL POWER PLANT IN MENENGAI

SEPTEMBER 2025

Prepared for:

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ACKNOWLEDGEMENT

Our sincere gratitude goes to the proponent, Orpower Twenty-Two Limited for their support and contribution towards undertaking this Supplemental Environmental and Social Impact Assessment (SUEIA) Report. The proponent provided all the related information of the project.

We would also like to acknowledge the effort made by GIBB Africa Limited in preparing a Supplemental Environmental and Social Impact Assessment (SUEIA) for the proposed 1x35 MW Modular Geothermal Power Plant in compliance with; NEMA requirements, Multinational Development Banks (MDBs) requirements and the International Finance Corporation (IFC) performance standards

Finally, we would like to recognize the effort made by Africa Waste and Environment Management Centre (AWEMAC) in upgrading the Supplemental Environmental and Social Impact Assessment (SUEIA) Report to meet international standards specifically International Finance Corporation (IFC) and Africa Development Bank (AfDB) Requirements.

The final report is the result of a collaborative process which drew on the effort, knowledge, expertise and patience of the experts in availing additional information. Others that have not been named here, their efforts are earnestly recognized.

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LIST OF ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
ADMS	Atmospheric Dispersion Modelling System
AfDB	African Development Bank
AIDS	Acquired Immune Deficiency Syndrome
ANSI	American National Standard Institute
AQSRs	Air Quality Sensitive Receptors
ARAP	Abbreviated Resettlement Plan
ASALs	Arid and Semiarid Lands
ASG	Atmospheric Studies Group
BOO	Build Own and Operate
BOP	Balance of Plant
CCS	Carbon Capture and Storage
CDM	Clean development Mechanism
CEDAW	Convention on the Elimination of all forms of Discrimination against Women
CEO	Chief Executive Officer
CERC	Cambridge Environmental Research Consultants
CFCs	Chlorofluorocarbons
CIA	Cumulative Impact Assessment
CITES	Convention on International Trade in Endangered Species
CLO	Community Liaison Officer
CRC	Convention on the Rights of the Child
dB	Decibels
DCS	Distributed Control System
DOSH	Directorate of Occupational Safety and Health
EA	Environmental Audit
ECD	Early Childhood Development
EIA	Environmental Impact Assessment
EIS	Environmental Impact Study
EMCA	Environmental Management and Coordination Act
EMP	Environmental Management Plan
EPFIs	Equator Principles Financial Institutions
EPRA	Energy & Petroleum Regulatory Authority
ERC	Energy Regulatory Commission
ESIA	Environmental & Social Impact Assessment

ESMS	Environment and Social Management System
FIs	Financial Intermediaries
FOMEC	Friends of Menengai Crater
GDC	Geothermal Development Company
GHGs	Green House Gases
GMGL	Globeleq Menengai Geothermal Limited
GPN	Good Practice Note
GPS	Geographical Positioning System
H_2S	Hydrogen sulphide
HSE	Health Safety and Environment
HVAC	Heating, ventilation and Air Conditioning system
IFC	International Finance Corporation
ILO	International Labour Organization
IMCE	Inter ministerial Committee on Environment
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
ISO	International Standardization Organization
ISS	Integrated Safeguard Systems
IUCN	International Union for Conservation of Nature
KEBS	Kenya Bureau of Standards
KETRACO	Kenya Electricity Transmission Company
KFS	Kenya Forest Service
KPLC	Kenya Power and Lighting Company (now Kenya Power)
KRA	Kenya Revenue Authority
KWS	Kenya Wildlife Service
LOAEL	Lowest observable adverse effect level
LPG	Liquefied petroleum gas
LRVPs	Liquid Ring Vacuum Pumps
LSA	Later Stone Age
MDAs	Ministry Department Agencies
MDBs	Multinational Development Banks
MDGs	Millennium Development Goals
MEAs	Multilateral Environmental Agreements
MoEP	Ministry of Energy and Petroleum
MSDS	Materials Safety Data Sheets
MW	Mega Watts

NACADA	National Authority for the Campaign Against Drug and Alcohol Abuse
NARUWASCO	Nakuru Rural Water and Sanitation Company
NAWASSCO	Nakuru Water Sanitation Services Company
NCGs	Non condensable Gases
NEMA	National Environment Management Authority
NET	National Environment Tribunal
NFPA	United States National Fire Protection Association
NGO	Non-Governmental Organisation
NMK	National Museum of Kenya
NSRs	Noise Sensitive Receptors
ODS	Ozone Depleting Substances
OSHA	Occupational Health and Safety Act
OTTL	Orpower Twenty-Two Limited
PAPs	Project Affected Persons
PES	Payment for Environmental Services
PISSA	Project Implementation and Steam Supply Agreement
PIT	Project Implementation Team
PPA	Power Purchase Agreement
PPE	Personal Protective Equipment
ppm	Parts per million
PPPs	Public Private Partnerships
PRG	Partial Risk Guarantee
Rev	Revised
RFP	Request for Proposal
RTI	Respiratory Tract Infections
RVWSB	Rift Valley Water Services Board
SACCOs	Savings and Credit Cooperative Societies
SDGs	Sustainable Development Goals
SEAs	Strategic Environmental Assessment
SERC	Standards and Enforcement Review Committee
SGS	Steam Gathering System
SUEIA	Supplemental Environmental Impact Assessment
TEWAC	Totally Enclosed Water-to-Air Cooled
TLV	Threshold Limit Value
TOR	Terms of Reference
UN	United Nations

UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention. on Climate Change
UNIDO	United Nations Industrial Development Organization
USGS	United States Geological Survey
VECs	Valued Environmental and Social Components
WB	World Bank
WHO	World Health Organization
WIBA	Work Injury Benefits Act
WRMA	Water Resources Management Authority
WRUA	Water Resource Users Association

EXECUTIVE SUMMARY

E1 Project background and components

OrPower Twenty-Two Limited (OTTL), the proponent, is desirous of constructing and operating 1X35MW geothermal power plant within Menengai geothermal field, Nakuru county. The geothermal field is located within the Menengai caldera, which lies north of Nakuru Town in Kenya. OTTL is one of the three independent power producers (IPPs) who have entered into an agreement with Geothermal Development Company (GDC) each to develop a power plant with a net generation of 35MW, this being the first phase of developing the Menengai resource. The concept of developing the geothermal resource by GDC is aimed at reducing or managing the high upfront costs of geothermal development to achieve a lower end user tariff for consumers in the country. GDC has already done the resource field and steam gathering system works and associated facilities.

OrPower Twenty-Two Ltd (OTTL) is the special purpose vehicle (SPV) established to develop, construct, and operate the Menengai 35 MW Geothermal Power Plant (Phase I Unit III). OTTL is owned by Kaishan Kenya Engineering Company Ltd, a subsidiary of China-based Kaishan Group Co. Ltd. (Kaishan acquired OrPower Twenty-Two in 2023). Kaishan Group is the project developer and has been contracted to perform the Engineering-Procurement-Construction (EPC) work and long-term O&M. As the operator, OTTL will ensure that the plant adheres to all health, safety, and environmental standards during its operational phase.

OTTL signed a Project Implementation and Steam Supply Agreement (PISSA) with GDC and Power Purchase Agreement (PPA) with Kenya Power and Lighting Company (KPLC) in 2014 and proceeded to negotiate and sign various related instruments relevant to the project.

OTTL will build the power plant on a plot of land measuring 140m by 180m that has a sub lease issued by GDC based on a head lease from Kenya Forest Service (KFS). The purpose of the Power Plant Project is to increase the power generation capacity of Kenya to enhance socio- economic development and diversify sources of power supply by developing the country's huge geothermal potential. The project involves finance, design, procurement, supply, installation/construction, testing, commissioning, operation and maintenance of 35MW Geothermal Modular Power Plant. The justification for the site is the availability of Steam from the Geothermal Wells; the primary fuel for the project. The Project site is one of three 35 MW plants in the Menengai Geothermal field for which the GDC simultaneously granted identical build-own-operate geothermal concessions and allocated adjacent plant sites.

Administratively, the Menengai Geothermal field lies within Rongai and Nakuru North Sub Counties of Nakuru County. The geothermal power plant will be constructed within the caldera area which falls in Mercy Njeri sub location of Kiamunyi Location within Rongai subcounty. Menengai crater is a public forest land under the management of Kenya Forest Service. GDC has a memorandum of understanding with KFS on the development of geothermal resources within the forest land.

The power plant will be driven by steam supplied by GDC to the Power Plant under the terms in the PISSA to generate a net electrical capacity of 35MW. The design of the power plant is based on five units, two being Screw Expanders and three being Organic Rankine Cycle system. The Nominal gross capacity will be 40MW and the guaranteed net plant output is 35MW. The main power plant system components include:

- Screw Expander Turbine Unit 1 and Unit 2 each designed for normal inlet steam conditions of 6.0 bar exhausting at 0.977 bar (a) and associated instrumentation with a generator rated at 10,000 kW, 3,000 rpm, 3 phase, 50 Hz, 11,000 Volts with
- Exhausted Steam Organic Rankine Cycle (ORC) Turbine Unit 3 and Unit 4 each designed for normal inlet steam conditions of 0.98 bar exhausting at 0.83 bar (a) and associated instrumentation with a generator rated at 11,000 kW, 1,500 rpm, 3 phase, 50 Hz, 11,000 Volts
- Exhausted Steam ORC Turbine Unit 5 designed for normal inlet steam conditions of 0.98 bar exhausting at 0.83 bar (a) and associated instrumentation with a generator rated at 3,600 kW, 1,500 rpm, 3 phase, 50 Hz, 11,000 Volts

The construction phase is expected to take 17 months to reach commercial operation date (CoD) and this schedule has been agreed with the Ministry of Energy and Petroleum who have included this in their projected development plan for power plants. Power generated will be supplied to KPLC under the

terms in the Power Purchase Agreement (PPA). The power will be generated at 11.0 kV, stepped up to 132kV and evacuated via a transmission line already construction by the Kenya Transmission Company (KETRACO). Apart from the power evacuation line, other project associated facilities like access roads, production wells and steam gathering system have already been constructed by GDC up to the proposed plant area boundary. GDC will also extend the existing water line in the caldera to the interface point at the plant boundary.

GIBB Africa Ltd as a Firm of Experts Registered by NEMA was commissioned by OTTL, to undertake a supplemental EIA Study for the proposed 1x35 MW Modular Geothermal Power Plant so that they could comply with NEMA requirements for extension of EIA license and comply with Multinational Development Banks (MDBs) and the International Finance Corporation (IFC) performance standards. The report was later revised and upgraded by AWEMAC to meet international standards specifically IFC and AfDB requirements. This SUEIA builds on an initial ESIA Study undertaken by the University of Eldoret on behalf of GDC covering all the three proposed 35MW Modular Geothermal Power Plants at the site. The initial ESIA study report was submitted to National Environment Management Authority (NEMA), application reference No. EIA/872 and approved in November 2012 vide NEMA license registration No. 0014205. The license for 1x35MW was transferred to OTTL by GDC.

The study was conducted through: desktop review of earlier reports and other related literature to identify gaps; baseline socio-economic survey; stakeholder engagement and previous feedback from public meetings with communities in the project area; interviews with key informants including various government agencies; and specialist impact assessment studies including air quality modelling using Atmospheric Dispersion Modelling System version 4.2 (ADMS 4) as well as noise modelling using the Calculation of Sound Propagation by the Concave method' (SANS 10357, 2004).The proposed project Owner is OTTL and Kaishan Kenya Engineering Company Ltd is the contractor. GDC is responsible for supply of steam and maintenance of access roads to the plant as well as management of EHS matters at the Caldera level. The contractor can as well engage services of sub-contractors and ensure they adhere to the contractual agreement requirements.

E2 Policy, legal and regulatory framework

The table below presents a summary of the Policy, Legal and Institutional Framework

Table 0-1: Key Policies, Laws and Institutions

Category	Key Instruments / Institutions	Relevance to the Project
International Standards	▪ IFC Performance Standards (PS) ▪ AfDB Integrated Safeguards System (ISS) ▪ Multilateral Environmental Agreements (MEAs)	Project classified as *Categories B (IFC PS) & Category 1 (AfDB ISS)* (high risk); IFC and AfDB standards guide ESIA, stakeholder engagement, pollution control, and cumulative impact assessment.
National Policies	▪ National Environment Policy (2014) ▪ National Energy Policy (2018) ▪ Vision 2030 ▪ Climate Change Policy (2016) ▪ - Forest & Wildlife Policies	Promote sustainable, clean energy (geothermal); support ESIA, biodiversity, and climate resilience.
Social Inclusion Policies	▪ Gender and Development Policy (2019) ▪ Persons with Disabilities Act (2025)	Support gender equality, anti-discrimination, and protection of

	▪ Children Act (2022) ▪ - Sexual Offences Act (2006)	vulnerable groups during project implementation.
National Legal Instruments	▪ EMCA Cap 387, and Subsidiary Regulations ▪ Energy Act (2019), Geothermal Resources Act (1982) ▪ OSHA (2007) and associated rules ▪ - Land, Forest, Wildlife, Water Acts	Provide legal basis for EIA, licensing, pollution control, workplace safety, and resource use.
County Legislation (Nakuru)	▪ Climate Change Act (2021) ▪ Waste Management Act (2020) ▪ - Public Participation Act (2016)	Guides local permits, stakeholder engagement, and environmental compliance at county level.
Institutional Roles	▪ **NEMA**: ESIA licensing and oversight ▪ -**EPRA**: Energy licensing ▪ **GDC**: Steam supply & head lease ▪ **KFS/KWS**: Forest & wildlife protection ▪ **DOSH**: OSH oversight ▪ - **County Government**: Permits, participation	Coordinated oversight and compliance across national and county levels.
Key Permits (Status)	▪ EIA license Variation Certificate (NEMA), Valid up to 29/04/2026 ▪ Geothermal License (GDC via EPRA) ▪ Generation License (OTTL) ▪ - County Approvals	Required to commence and continue project development in compliance with law.

Several institutions also play integral roles in the project.

E3 Existing Environment

The project is situated within the Menengai geothermal field, located inside the Menengai Caldera in Nakuru County, a region characterized by diverse environmental and socio-economic conditions. Physically, the area exhibits a rugged volcanic landscape with altitudes ranging from 1,800 to 2,400 meters above sea level, a semi-arid to dry sub-humid equatorial climate, and features such as geothermal vents, fractured lava flows, and intermittent watercourses. Biologically, the caldera supports a mosaic of flora including over 100 plant species such as *Tarchonanthus camphoratus*, *Protea gaguedi*, and geothermal indicator species like *Fimbristylis exilis*, The site is home to several wildlife species including 13 mammals and 237 bird species, with some — such as the leopard *(Panthera pardus)* and striped hyena *(Hyaena hyaena)* — classified as vulnerable or near threatened. Socio-economically, the surrounding areas are primarily rural and agriculturally focused, with communities engaged in crop farming and livestock keeping. Settlements within Rongai and Nakuru North sub-counties show moderate population density, constrained access to water and sanitation, and limited infrastructure, yet demonstrate high community interest in employment opportunities and local development linked to the geothermal project.

E4 Feedback from consultation

In seeking the views of the public, the project proponent through GDC undertook a total of 13No. continuous public consultation within a period of 2 years (21 March 2016 to 9th Nov 2018). Additional public and stakeholder engagement were undertaken on 8th May 2024 within the project primary zone of impact populated locations of Kiamunyi and Kirima that were within a radius of 5 – 10 Km from the project site. The stakeholder engagement was done in order to refresh the community regarding the upcoming project implementation and to seek any additional emergent potential impacts or concerns by the stakeholders. Two sessions were held with representatives from all the five surrounding distinct villages and the government administration (see 6.2.2). A Key Stakeholder Meeting was held with the Menengai Community Forest Association (MCFA) on 22 Aug 2025 at KFS MCFA office.

A summary of the expected benefits and expressed concerns are given below.

The perceived potential benefits

- Increase in land value in the area due to industrial growth;
- Employment creation for the local youth;
- Decrease in consumption of illicit alcohol due to engagement in employment opportunities;
- Decrease in crime rates among the youth
- Geothermal power plant's development will increase power available to the national grid and reduce cost of electricity;
- The project will lead to improved development of infrastructure which will improve marketing of agricultural produce.
- The project will attract more business opportunities due to the influx of people.;
- GDC has an established tree nursery in the caldera which they donate to the community.
- Water supply has been an issue in the area and its expected that as part of the CSR the developers could help the community access water.
- Acquisition of skills and knowledge from the specialist on site during construction to the local staff;
- The project will lead to improved development of infrastructure such as the access Roads

The perceived potential negative impacts

- Increase pressure on waste management systems within the caldera which are already inadequate;
  - Concern of previous unfulfilled CSR promises by IPP's in operation in the area;
  - Effects from Hydrogen sulphide (H_2S) gas that affects people and crops;
  - Human wildlife conflict due to the increased activities in the caldera;
  - Potential increase in dust pollution due to increase in vehicle traffic and over speeding project vehicles.
  - Concern of potential increase in noise pollution during project construction and operation;
- The project could result into influx of foreign labour populations which would lead to an increase in crime rates;
- Concern of deterioration of access road due increase in vehicle traffic

Project Acceptance

Regarding project acceptance, majority of the primary and secondary stakeholders consulted expressed support of the project on condition that appropriate mitigation measures proposed on potential negative impacts are adequately implemented.

E5 Key Environmental and Social Impacts and Mitigation Measures

Table 0-2: Key Environmental and Social Impacts and Mitigation Measures

Impact	Key Mitigation Measures (Summary)	Cost (KES)
Construction Phase		
Impact on flora	▪ Minimize clearing to essential areas and preserve mature or protected trees. ▪ Restore and replant disturbed areas with native vegetation; remove any invasive plants during and after construction.	500,000

Impact	Key Mitigation Measures (Summary)	Cost (KES)
Impact on macro fauna (mammals)	▪ Prevent harm to wildlife: cover or fence off excavations (with escape ramps) and backfill trenches promptly to avoid trapping animals. ▪ Minimize disturbance: restrict works to daylight hours, use shielded lighting at night, enforce strict low speed limits, and train workers to avoid disturbing wildlife and report sightings to KWS for safe handling.	100,000
Impact on Avifauna (birds)	▪ Avoid or minimize bright lighting at night to protect birds. ▪ Schedule vegetation clearing outside peak nesting seasons and enforce speed limits to reduce harm to birds and their nests.	100,000
Impact on Herpetofauna and invertebrates	▪ Safely capture and relocate any reptiles encountered during works in coordination with KWS. ▪ Limit heavy machinery movement to only what is necessary within the site to minimize habitat disturbance.	80,000
Landscape and visual intrusion	▪ Restrict vegetation clearing and earthworks to designated construction areas and quickly replant cleared areas with native species ▪ Reduce visual impacts by using neutral, non-reflective colors on structures and minimizing unnecessary lighting at night.	350,000
Soil erosion and geology	▪ Preserve and stockpile topsoil for use in later site restoration. ▪ Install erosion control measures (temporary drainage, silt fences, sediment traps) to prevent runoff and sedimentation during construction.	150,000
Impact on natural sources of construction materials (quarry/borrow)	▪ Use only authorized quarries/borrow pits (obtain NEMA and Mines & Geology permits) and locate them at least 100 m away from watercourses with proper stormwater controls. ▪ Prepare and implement rehabilitation plans for each quarry/borrow site after use, as approved by authorities.	50,000
Impact on water resources	▪ Conserve water on site: reuse water where feasible, fix leaks promptly, and only abstract water within permitted limits. ▪ Manage wastewater properly: contain and remove all grey water and sewage via licensed handlers, and collect or treat concrete wash water to prevent contamination.	100,000
Air quality and dust	▪ Control dust by regular water spraying on exposed soil and roads, covering transport trucks and material stockpiles, and enforcing low vehicle speeds on unpaved roads. ▪ Maintain construction equipment to minimize exhaust emissions, and provide dust masks or respirators to workers in high-dust areas.	400,000
Noise and vibration	▪ Use low-noise equipment and ensure all machinery has functional mufflers/silencers; confine noisy activities to daytime hours. ▪ Provide and enforce the use of hearing protection for workers, and minimize unnecessary noise from vehicles.	150,000
Solid waste	▪ Minimize waste generation and segregate wastes on-site with clearly labeled bins ▪ Reuse and recycle materials where possible, and dispose of all non-reusable waste off-site through licensed waste handlers.	350,000
Labor influx	▪ Provide ongoing HIV/STI education for workers and offer regular voluntary testing clinics.	100,000

Impact	Key Mitigation Measures (Summary)	Cost (KES)
	▪ Enforce a strict worker Code of Conduct and hold community health outreach sessions on hygiene, disease prevention, and HIV/STI awareness.	
Sexual Exploitation and Abuse (SEA), Sexual Harassment (SH), and other Gender-Based Violence (GBV)	▪ Enforce zero-tolerance for sexual misconduct: ▪ Provide safe, anonymous reporting channels for incidents, and hold regular awareness sessions for workers and nearby communities.	400,000
Traffic and road safety	▪ Implement a Traffic Management Plan ▪ Enforce road safety measures: monitor vehicle speeds with GPS and random checks, and use escort vehicles/flagmen during off-peak hours for any oversized transports.	100,000
Public safety & site security	▪ Secure the site with 24/7 security guards ▪ Strictly control hazardous materials	600,000
Occupational and public health and safety	▪ Implement a comprehensive Construction Health and Safety Management Plan (compliant with OSHA/IFC standards) with a full-time safety officer, thorough worker inductions/training, and a permit-to-work system for high-risk jobs. ▪ Provide appropriate PPE to all workers at no cost and enforce its use; maintain an Emergency Response Plan.	500,000
Contractor's site camp	▪ Establish any worker camps off-site (outside the caldera) with proper county approvals, and ensure they provide adequate sanitation and waste management facilities.Incorporate worker transportation into the traffic plan to minimize trips, and fully remove the camp after use, restoring the land to its original condition.	150,000
Risk of wild fires	▪ Maintain a cleared firebreak around the construction site ▪ Educate and train staff on wildfire risks and emergency response in coordination with KFS	200,000
Fuel and chemical spills	▪ Have spill response procedures and cleanup materials readily available; store fuels and chemicals in bunded, impermeable areas with proper containment. ▪ Keep machinery well-maintained to prevent leaks, and immediately isolate and absorb any spill with appropriate materials, following NEMA-approved cleanup methods.	300,000
Chance find of archaeological artefacts	▪ Monitor excavations for any heritage artifacts; if discovered, halt work and invoke the chance-find procedure, involving a National Museums of Kenya archaeologist for guidance.	50,000
Subtotal (Construction Phase)		**4,730,000**
Operational Phase Impacts		
Impact on Biodiversity	▪ Remove invasive weeds around the plant promptly ▪ Ensure infrastructure is safe for wildlife and continue wildlife monitoring with KWS/GDC.	250,000
Operation solid wastes	▪ Minimize and segregate waste: provide labeled bins for different waste streams (including hazardous waste) and educate staff on waste reduction (reduce, reuse, recycle). ▪ Dispose of all wastes through licensed contractors at approved sites and maintain records tracking waste from generation to final disposal.	240,000
Operation liquid wastes	▪ Dispose of all sewage and wastewater using NEMA-licensed service providers and ensure any effluent discharge complies with permit requirements.	300,000

Impact	Key Mitigation Measures (Summary)	Cost (KES)
	▪ Track and document all liquid waste disposal to ensure compliance with environmental regulations.	
Fire	▪ Integrate comprehensive fire protection systems into the plant design and maintain a cleared firebreak around the facility. ▪ Implement a fire emergency response plan (aligned with GDC's plan) and train on-site fire marshals, conducting regular fire drills (at least annually).	100,000
Accidental oil spill / hazardous pollution	▪ Use secondary containment and preventive measures ▪ Develop and regularly test a spill response plan, and store all flammable or hazardous materials securely in compliance with fire safety and SDS guidelines.	100,000
Occupational safety and health	▪ Continuously monitor H_2S levels on site and provide all at-risk personnel with appropriate PPE, including personal H_2S gas monitors. ▪ Conduct regular occupational health and safety training, ensure first aid kits and warning signage are in place, and maintain a detailed emergency response plan for the plant.	500,000
Operations-phase on-site occupancy (office compound)	▪ Provide proper facilities at the on-site office: install a lined septic tank at least 50 m from any watercourse and segregated waste bins with weekly licensed disposal; enforce daily cleaning and mosquito control ▪ Ensure compound security	500,000
Operation-phase off-site accommodation (external housing)	▪ Adopt sustainable practices at off-site housing: install water-saving fixtures and a biodigester to reuse greywater for landscaping, and provide solar power for the facility. ▪ Maintain strict controls and security premises ▪ provide segregated waste bins with regular licensed collection.	450,000
Impact on water resources	▪ Employ water-efficient systems in the plant ▪ Meter and monitor water use throughout operations to ensure consumption remains within sustainable limits.	150,000
High socio-economic interest by communities	▪ Establish a community liaison program with clear communication and feedback channels, and route all CSR/community projects through this mechanism to manage relations. ▪ Implement a transparent local hiring policy and clearly communicate the limited job opportunities and requirements during operation to manage community expectations about employment.	1,100,000
Air quality	▪ Install H_2S control systems: ▪ Collaborate with GDC and other operators on a caldera-wide air quality management plan – including additional H_2S monitoring near sensitive areas – and keep nearby communities informed about air quality or odor issues.	500,000
Cumulative noise and vibration impacts	▪ Design for low noise/vibration ▪ Monitor noise levels regularly and share data with GDC to assess noise in nearby settlements, adjusting operations if needed to minimize any cumulative noise impacts on the community.	200,000
Subtotal (Operation Phase)		**4,390,000**
Decommissioning Phase		
Occupational safety and health	▪ Prioritize safety in demolition: disconnect all power, secure or remove hazardous substances, vent and test all pipes/vessels for gases, and continuously monitor H_2S levels during decommissioning works.	1,350,000

Impact	Key Mitigation Measures (Summary)	Cost (KES)
	▪ Have emergency measures ready: keep functional firefighting equipment on site and implement a demolition-specific Emergency Response Plan with clear procedures and designated assembly points.	
Redundant plant equipment and recyclable wastes	▪ Carefully remove all usable plant equipment and materials so they can be sold or recycled rather than disposed as waste.	1,000,000
Non-recyclable demolition waste	▪ Manage demolition debris responsibly: segregate materials by type on-site and ensure all waste (including hazardous debris) is hauled away by licensed handlers to appropriate disposal facilities. ▪ Prohibit any on-site burning of waste during demolition activities.	5,700,000
Re-instatement of biophysical environment	▪ Restore the site after demolition: landscape the former plant area with a mix of indigenous plant species in consultation with KFS. ▪ Maintain the replanted vegetation until it is well established before final site closure.	1,700,000
Subtotal (Decommissioning Phase)		**9,750,000**
Total ESMP Cost		**18,870,000**

E6 ESMP Implementation Structure and Capacity

Implementation of the ESMP shall be a collaborative exercise. Whereas it is the role of the Proponent as the project owner (OTTL) to ensure implementation of the ESMP, the plan shall be either escalated to Contractor (Kaishan) for implementation in the form of construction-ESMP during construction phase and also in the form of an Operations and Maintenance- ESMP during operations phase. In addition, different individuals and stakeholder institutions shall play specified roles towards effective implementation of the ESMP. The contractor shall be required to ensure all Sub-contractors engaged in the project are conversant with the ESMP and its implementation requirements and procedures. Depending on the nature of impacts, GDC and KFS shall be involved if the effects of impacts emanating from the project site are beyond the project boundaries hence affecting the caldera ecosystem.

The total estimated cost for implementing the Stakeholder Engagement Plan and the two Grievance Mechanisms (community and worker) is approximately KES 6,381,100, (SEP ~2.83M; external/community GRM ~1.87M; workers' GRM ~1.69M). which is included in the overall ESMP implementation cost. This highlights the proponent's commitment of resources to community engagement and grievance resolution as part of the project's social risk management.

Implementation of the ESMP will require adequate capacity in the form of human resource skills and applicable equipment. The necessary human resource skills required include; EHS Monitoring, Environmental and Social risks identification, assessment, analysis and reporting, biodiversity management, Labour management, Occupational Safety and Health management including First Aid skills. EHS Monitoring skills required include Air and water quality and noise levels. ESMP implementation also necessitates establishment and implementation of a Grievance Redress Mechanism for reporting of EHS incidents occurring beyond project boundaries. Relevant equipment to compliment human resource capacity shall also be required.

E7 Conclusion and Recommendations

The proposed 35 MW power plant will support Kenya's national energy targets while delivering clean, reliable, and renewable power. The SUEIA confirms that with the recommended mitigation measures, the project's environmental and social impacts can be managed within acceptable limits.

Key recommendations:

- OTTL should fully operationalize a dedicated Environment, Health & Safety (EHS) Unit

- Establish a joint air quality monitoring committee with GDC and adjacent IPPs
- Engage stakeholders continuously and transparently, including formalizing CSR commitments
- Ensure all mitigation measures and monitoring plans are embedded in contractor contracts and construction management plans
- Comply with national legislation and AfDB/IFC safeguards throughout the project life cycle

1 INTRODUCTION

1.1 Background

This document is a Supplemental Environmental Impact Assessment (SUEIA) Study Report for the proposed 35MW Geothermal Power Plant in Menengai commissioned by Orpower Twenty-Two Limited (OTTL). The report is built on an initial ESIA Study undertaken by the University of Eldoret on behalf of Geothermal Development Corporation (GDC) for a proposed 3x35MW Modular Geothermal Power Plants at the site. GDC is a wholly government owned limited liability company and is mandated to undertake integrated development of geothermal resources through initial exploration, drilling, resource assessment and promotion of direct utilization. These projects are expected to generate an additional 105MW of electricity to be connected to the national grid. Each involves finance, design, procurement, supply, installation/construction, testing, commissioning, operation and maintenance of 35MW Geothermal Modular Power Plant. The justification for the site is the availability of Steam from the Geothermal Wells; the primary fuel for the project.
OTTL, previously referred to as Verbena Properties Limited in 2014 (See Appendix I), is a locally registered and incorporated company operating in Kenya as a developer, owner and operator of the Geothermal Power Plant. OTTL is one of the three Independent Power Producers (IPPs) each awarded a tender by GDC through competitive bidding to install a 35MW Geothermal Modular power Plant in Menengai Geothermal Field in Nakuru County for 25 years on a Build Own and Operate (BOO) basis. The two other IPPs granted identical build-own-operate geothermal concessions and allocated adjacent plant sites are Quantum Power East Africa (QPEA) now known as Globeleq Menengai Geothermal Limited (GMGL) and Sosian Energy Limited.

The purpose of the Power Plant Projects by the three IPPs is to increase the power generation capacity of Kenya to enhance socio- economic development and diversify sources of power supply by developing the country's huge geothermal potential. The three IPPs will cumulatively generate 105MW under Phase I of geothermal development in the Menengai Geothermal field.

OrPower Twenty-Two Ltd (OTTL) is the special purpose vehicle (SPV) established to develop, construct, and operate the Menengai 35 MW Geothermal Power Plant (Phase I Unit III). OTTL is owned by Kaishan Kenya Engineering Company Ltd, a subsidiary of China-based Kaishan Group Co. Ltd. (Kaishan acquired OrPower Twenty-Two in 2023). Kaishan Group is the project developer and has been contracted to perform the Engineering-Procurement-Construction (EPC) work and long-term O&M.

The proposed power plant will be driven by steam owned by the GDC and supplied to the Power Plant under the terms in a Project Implementation and Steam Supply Agreement (PISSA) to generate a net electrical capacity of 35MW. Power generated will be sold to Kenya Power Company (KPLC) under the terms in a Power Purchase Agreement (PPA) entered between OTTL and KPLC. The power is generated at 11kV and stepped up to 132kV and evacuated through a line constructed by the Kenya Electricity Transmission Company (KETRACO) who are responsible for high voltage transmission infrastructure in the country. KPLC will operate and maintain the transmission line.

The additional power is intended for enhanced commercial and industrial activities countrywide thus contributing to job creation, increased productivity, electricity connection rates and improving the quality of life. Other direct project beneficiaries include people living around the project site who will benefit from employment during project implementation and operation, contractors and consultants will supply goods and services.

1.1.1 Project Execution Structure

The proposed project Owner is OTTL. This is the company that is responsible for obtaining all relevant permits and licences from different government of Kenya institutions as well as entering into an agreement with GDC on development and operation of the power plant. OTTL is at liberty to outsource construction, operation and maintenance services from contractors with capacity to undertake the necessary tasks. In view of this, the proposed Power Plant contractor is Kaishan Kenya Engineering Company Ltd. GDC is responsible for supply of steam and maintenance of access roads to the plant as well as management of EHS matters at the Caldera level. The contractor can as well engage services of sub-contractors and ensure they adhere to the contractual agreement requirements.

1.2 Project Location and Site

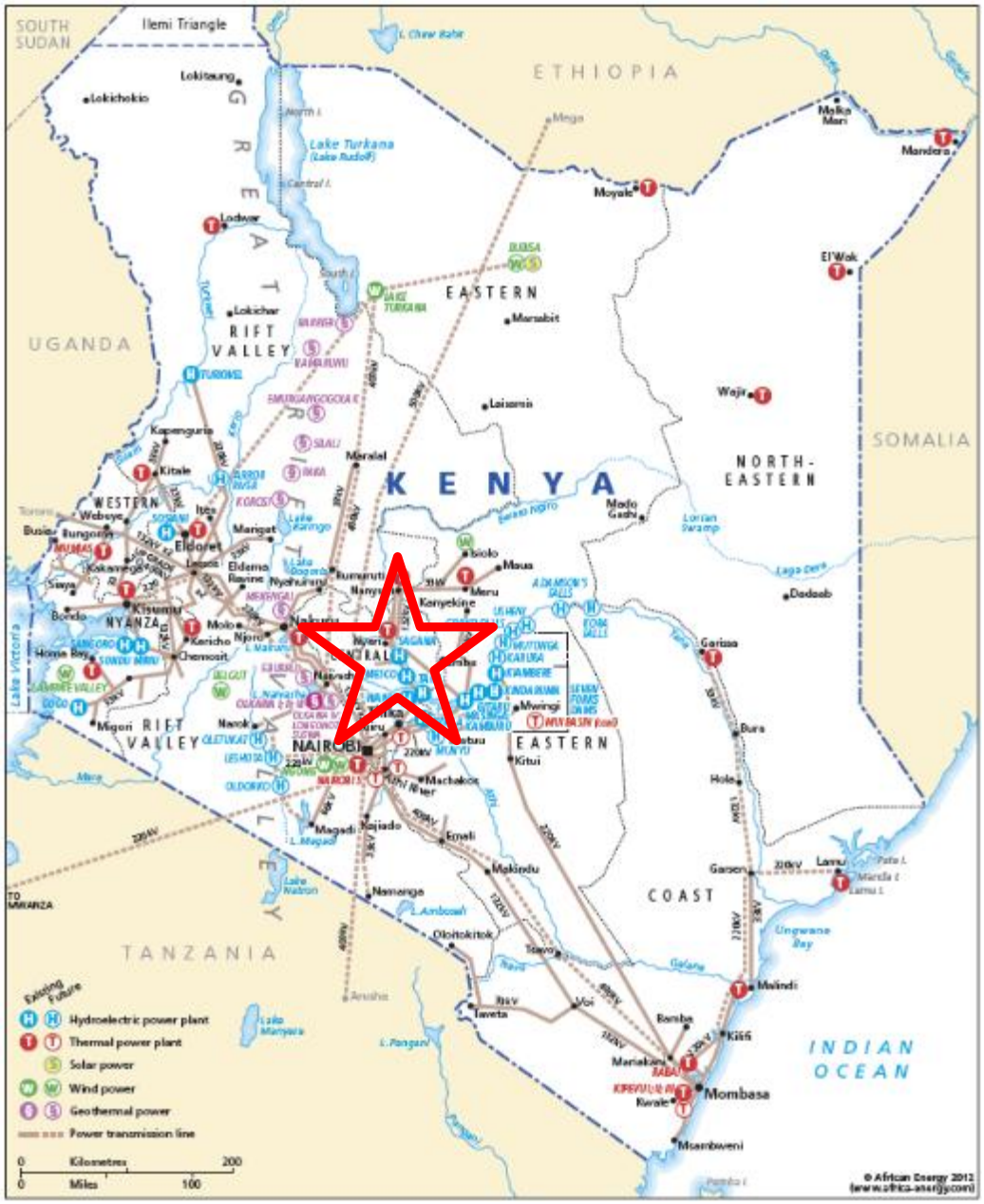
The Project is in the Menengai Geothermal Field on the outskirts of the Nakuru town in Nakuru County, Kenya and is about 180 km North-west of Nairobi. Administratively, the project area lies within Nakuru North and Rongai sub counties of Nakuru County. It borders Subukia Sub County to the North, Bahati Sub County to the East and Nakuru West Sub County to the South. The project site within the caldera area lies within Mercy Njeri sub location of Kiamunyi Location and the next nearby administrative zone of impact is Wanyororo sub location of Kirima location.

Access to the Menengai caldera is through gravel surfaced roads either off the main Nakuru - Bahati Road off A104 or off the Nakuru – Marigat road.

Figure 1-1 and

Figure 1-2 illustrate the location of Menengai Geothermal Field in Kenya and project site respectively.

Figure 1-1: Location of the Menengai Geothermal Field in Kenya

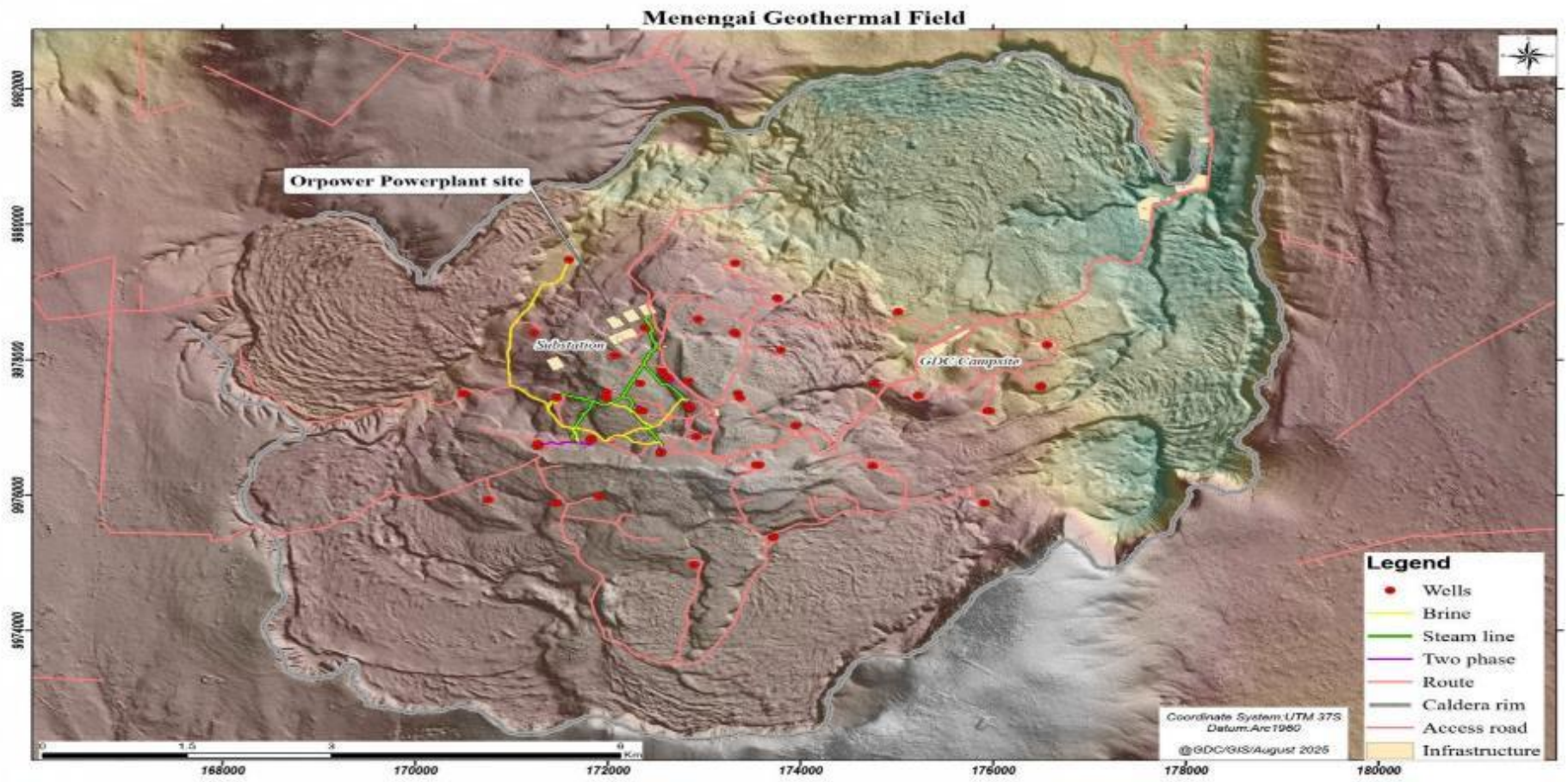


The power plant boundaries are defined by the following coordinates.

Table 1-1 GPS Coordinates for the power plant boundaries

Site boundary	Eastings (m)	Northings (m)
A	172057.880	9978444.410
B	172180.860	9978511.310
C	172094.860	9978669.430
D	171971.870	9978602.540

Figure 1-2: Project site in the Menengai Geothermal Field



The project area of influence covers the following location and villages;

Table 1-2 Locations and villages covered within the project area of influence

Locations	Sub Locations	Villages
Kiamunyi	Mercy Njeri	Kileleshwa, Valley, Maciaro
Kirima	Wanyororo	Wanyororo B

1.2.1 ***Land tenure and use***

The site is within a public forest land which is managed by the Kenya Forest Service (KFS). KFS leased the land to GDC which has then sub-leased the land to OTTL for a period of 26 years and 7 months. (Appendix I).

OTTL's power plant and associated facilities shall occupy an area that measuring 180m by 140m with a 50m buffer zone between the IPPS i.e. between OTTL and GMGL between GMGL and Sosian.

While the area is designated as a public forest land, consultations held with the local forest manager in earlier studies indicated that the main interest of putting the area under forest management was its unique landscape features. Since 2011, GDC has undertaken numerous activities related to geothermal exploration and development within the caldera culminating in the current project which is meant to complete the development cycle. Geothermal production wells have been drilled at various locations within the caldera and connected through steam gathering system as well as associated access roads. Also in place are power and water supply lines, substation and power evacuation line. While the OTTL has been cleared and levelled in readiness for site establishment, the adjacent GMGL had already kick started the construction and Sosian has already been constructed and is in operation. The common access road to all the three IPP sites had been cleared of vegetation.

1.3 Geothermal Electricity Supply Status in Kenya

Kenya's current effective installed (grid connected) electricity capacity is 3,300 MW, with peak demand of 1,202 MW, as at June 2022 (now over 2,300 MW by Feb 2025). At that time, demand was rising at a calculated rate of 3.6 percent annually, given the peak demand was 1,770 MW, at the beginning of 2018. Electricity supply is predominantly sourced from hydro and fossil fuel (thermal) sources.

Whilst about 30% is hydro power, about 40% is geothermal and emergency thermal power. Wind power plays a minor role contributing less than 11.7%. 13% Fossil fuels. Bagasse Cogeneration 1.8%. and others such as solar 7.8%. Thermal energy sources have been used to make up for these shortfalls, geothermal sources contribute to the highest amount of electricity generated in the country.

Geothermal power plants, which convert steam generated from hot rocks deep underground into electricity, have a prominent place in Kenya's overarching development plans. These include the Vision 2030, the National Climate Change Action Plan (NCCAP) and the current '5000+ MW in 40 months initiative'. Geothermal power has the potential to provide reliable, cost-competitive, baseload power with a small carbon footprint, and reduces vulnerability to climate by diversifying power supply away from hydropower, which currently provides the majority of Kenya's electricity.

Kenya set out ambitious targets for geothermal energy. It aims to expand its geothermal power production capacity to 5,000 MW by 2030. Kenya has an installed geothermal capacity of approximately 340 MW. Although there is significant political will and ambition, reaching these ambitions is a major challenge. Kenya Electricity Generating Company (KenGen) and Geothermal Development Company aimed at raising the country's geothermal output from the 891.8 MW in 2023 to 5 GW to the grid by 2030.

1.4 Project Justification

Energy is considered an essential ingredient for economic growth and social development in Kenya and anywhere in the world. The growth of energy demand is often driven by several factors namely,

population growth, economic growth, urbanization, rural energization programs, increasing penetration of energy intensive appliances and industrialization.

While Kenya is experiencing significant growth in energy demand, energy supply appears to have stagnated or dwindled. The security of energy supply especially electricity generation in Kenya seems to be threatened by climate change induced phenomenon, chief among them, drought. Inadequate electricity generation capacity and high-power bills have been perennial problems in Kenya prompting the Government to explore various ways of tackling the glitches. A shift to alternative sources of energy such as geothermal power which is environmentally friendly and more affordable to run compared to other sources of energy like fossil fuel will insulate the country against the effects of drought, which often interferes with hydroelectric power which historical has been the major source of installed power. The proposed geothermal power plants in Menengai will minimize climate drawbacks facing hydroelectric power generation and reducing the component of national energy mix that is dependent on the price of fossil fuels. It will create a reliable and stable renewable source of energy which will ensure sustainability of the Kenyan economy.

The Energy situation in Kenya dictates that there is need to develop the electricity generation capacity in the country for faster economic growth. According to Vision 2030, it is estimated that the national power requirements in the next 14 years will reach 15000MW, which is more than five times the current power generation capacity. This justifies the immediate need to more than double the power generation to 5000MW in the next 5 years to meet the rising demand and move in tandem with economic growth projections.

1.4.1 Need for the Supplemental EIA

In 2013 the Geothermal Development Company (GDC) issued an open public tender for the financing, design, procurement, construction, commissioning, and operation for 3 Independent Power Producers (IPPs) each to set up a 35MW geothermal power plant in the Menengai Geothermal Field in Nakuru County. One of the three successful submissions to set up an IPP was by an Ormat led consortium which set up Orpower Twenty-Two Ltd. (OTTL) as the special purpose vehicle (SPV). OTTL proceeded to negotiate, and sign in 2014, the project agreements that included the Project Implementation and Steam Supply Agreement (PISSA) for steam supply and the Power Purchase Agreement (PPA) for the sale of electricity to the off-taker Kenya Power KPLC). Other related project agreements included a government Letter of Support (LoS) and the Partial Risk Guarantee (PRG), a facility for commercial risk mitigation from African Development Fund (ADF). Since the geothermal resource in Menengai is located in a forest reserve the Kenya Forest Service (KFS) had to issue a special licence and sign a Head Lease to enable GDC drill wells for geothermal development. GDC would then issue sub-leases to each IPP for their power plants.

The analysis of the steam resources in Menengai by an independent consultant as per the PISSA terms revealed inadequate steam for the three IPPs. GDC embarked on an intensive drilling exercise that was completed at the end of 2018. The project was unable to take off due to delays in issuing a government LoS and having the commercial risk mitigation instrument PRG in place. Despite several round table negotiations, these delays persisted and eventually ADF pulled out of the agreement to issue the PRG to cover the commercial risk. The government's position was that PRG would decrease their liability and negatively affect their balance sheet thus increase the government's access to credit. Due to the tough economic conditions this standoff persisted till late in the year 2023 when the PRG was replaced with a risk insurance cover referred to as the Regional Liquidity Support Facility (RLSF) under African Trade and Development Insurance (ATIDI), to support the development of renewable energy in Kenya.

On 1st March 2024, the MoU was signed between ATIDI, Ministry of Energy and Petroleum (MoEP) and the National Treasury enabling the facility to be active. As part of the project agreements GDC prepared a common ESIA report and submitted to NEMA in 2012 and were issued with an EIA licence. Due to the need for each IPP entity to satisfy their lender requirements GDC applied for a separation of the EIA licence, and this was granted, and three separate licences were issued to the three IPPs with OTTL receiving their licence in 2015.

The delays since 2014 in processing and approval of the various project related documents affected the securing of financial closure for the project to commence construction. Following redress of the project related challenges, OTTL sought an approval of variation of its initial ESIA from NEMA that would result into an extension of the license for an additional 24 months. Consequently, the need for a

supplemental ESIA was triggered following direction from NEMA which would provide an update of the following issues:

- Project implementation status and detailed project description;
- Current baseline information and development trends with the project site;
- Infrastructure in place to support the development;
- The area land use changes since the initial license was issued;
- Potential environmental changes, anticipated project impacts and proposed mitigation measures;
- Evidence of current public consultation and stakeholder engagement in relation to the proposed variation.

1.4.2 Target Group for the ESIA Report

This Supplemental Environmental Impact Assessment Study Report has been prepared for use by different stakeholders to be involved in the project. The report contains useful information on policies and procedures to be adhered to, implementation modalities, analysis of potential environmental and social impacts and suggested mitigation measures at various stages of the project activities. The information will be useful in planning, implementation, management and maintenance of the plant.

In this regard, the report will be useful to the following stakeholders:

- Multinational Development Banks;
- The government Lead Agencies;
- The NEMA monitoring and compliance section;
- Planners and engineers to be involved in preparation of designs and plans for project;
- Contractors engaged in the construction works for the project;
- The potential project affected persons (PAPS) living within the project area; and
- Beneficiaries of the project both at local and regional level.

1.5 Methodology

This SUEIA Report has been prepared in accordance with the Environmental (Impact Assessment and Audit) Regulation, 2003. It is also guided by the IFC's Performance Standards on environmental and social sustainability, EHS General Guidelines and IFC's EHS Guidelines for Geothermal Projects.

The study methodology comprised the following activities:

- Preliminary meetings with the Client;
- Data collection and document review;
- Site inspection and discussions with GDC personnel;
- Public consultations
- Air and Noise Dispersion Modelling;
- Data Analysis; and
- Reporting.

The SUEIA Report has confined itself to the construction of the 1x35MW modular geothermal power station and associated infrastructure.

1.5.1 Preliminary meetings

An initial meeting was held with the Client representative virtually on 6 May 2024 to brief them on the SUEIA study work program and the various activities to be undertaken as part of the study as well as request for project information such as the project design. Another meeting was also held with GDC technical Community liaison departments representatives on 7 May 2024 at the GDC Nakuru office. On 22nd August 2025, a consultative meeting was held with Menengai Community Forest Association (M-CFA). Other consultative meetings were also held on 10th June 2025 between the consultant with the Project Owner and the Contractor,

1.5.2 Desktop study

This entailed desktop review of project related literature in order to gain background information and current status of the project and the project environment. Some of the documents reviewed include:

- PISSA with GDC;
- PPA with KPLC;

- GDC ESIA Study Report prepared by the University of Eldoret (2013);
- Water Quality Assessment Report;
- KETRACO ESIA Report by David Moindi (2013);
- OTTL Geotechnical Report prepared by Rock Link Geological Consultants limited (2015);
- OTTL Seismic Hazard Assessment Report prepared by Rock Link Geological Consultants limited (2015);
- OTTL Seismic survey Report prepared by Rock Link Geological Consultants limited (2015);
- GDC Steam Resource Report prepared by West Japan Engineering Consultants Inc. (2017);
- GDC Menengai Geothermal field Meteorological data;
- Floral (vegetation) and faunal mapping studies – Final Study Report (June 2015) prepared by Egerton University;
  - Floral and faunal studies in Menengai Caldera, Kenya - Final Field Report (2010) prepared by Friends of Menengai Crater (FOMEC).
- Menengai power plant Flora and Fauna study reports prepared by Friends of Menengai Crater (FOMEC) (2010) for GDC;
- Menengai Participatory Forest Management Plan, 2023 - 2027
- Various permits Business permits, Land lease documents, Licenses and Registration certificates for the project (see Appendix I);
- Air Quality impact Assessment Report for the proposed OrPower Twenty-Two Limited Geothermal Power Plant in Kenya by of Airshed Planning Professionals (2024);
- Noise Impact Assessment Results for the Proposed OrPower Twenty-Two Limited Geothermal Power Plant in Kenya by Airshed Planning Professionals (2024);
- National Census Report 2009; and
- Available reports on the project area on geology, soils, hydrology etc.

A detailed bibliography for literature consulted is included in section 10 of this report

1.5.3 Field visit

A visit to the project area was undertaken on 7 May 2024 to undertake a top-up exercise for the Environmental and Social Impact Assessment of 1x35 MW Geothermal Power Plant in Menengai. The specific areas visited during this visit include: Soilo sub-station and transmission line, GDC Weather station at Mlima Punda, Menengai well MW3 (Discharging), Water storage tanks area, Steam gathering system (SGS)- Separator 3, Menengai sub-station and OTTL power plant & laydown areas (SGS vent station); primary population zone of impact in Mercy Njeri & Wanyororo sub locations.

During the site visit, a rapid site appreciation of existing infrastructure as well as identification of flora species within the plant area was made. In the year 2025, a site visit was undertaken on 10th June 2025 to assess the status of the project site subject to the ongoing construction activities.

1.5.4 Specialized Studies

1.5.4.1 Air Quality Assessment

An air quality impact assessment was conducted in May 2024 by an independent consultant, Airshed Planning Professionals, for the operational phase activities planned for the proposed Menengai geothermal power plant. The main objective was to quantify the extent to which ambient pollutant levels will increase as a result of the project. The air quality impact assessment report is provided as Appendix XV in this report for more details.

1.5.4.1.1 Approach to assessment

The air quality impact assessment included a study of the receiving environment and the quantification and assessment of the impact of the proposed Menengai geothermal power plant on human health and the environment. The receiving environment was described in terms of local atmospheric dispersion potential, the location of potential Air Quality Sensitive Receptors (AQSRs) in relation to proposed activities as well as pre-development ambient pollutant levels. A comprehensive atmospheric emissions inventory was compiled for the operational phase of the project. Pollutant quantified included only hydrogen sulphide (H_2S).

1.5.4.1.2 Meteorological data

An understanding of the atmospheric dispersion potential of the area is essential to an air quality impact assessment. Physical environmental parameters that influence the dispersion of pollutants in the

atmosphere include terrain and meteorology. Existing pre-development ambient air quality in the study area was also considered.

Readily available terrain data was obtained from the Atmospheric Studies Group (ASG) via the United States Geological Survey (USGS) web site at (ASG, 2011). The MM5 (short for Fifth-Generation Penn State/NCAR Mesoscale Model) is a regional mesoscale model used for creating weather forecasts and climate projections. It is a community model maintained by Penn State University and the National Centre for Atmospheric Research.

1.5.4.1.3 Dispersion modelling

Estimated emissions along with information on the receiving environment were used as input to an atmospheric dispersion model which simulated ground level pollutant concentrations. The assessment was done for the operational phase of the project only.

In the simulation of ambient air pollutant concentrations use was made of the Atmospheric Dispersion Modelling System Version 4.2 (ADMS 4) developed by the Cambridge Environmental Research Consultants (CERC). This model simulates a wide range of buoyant and passive releases to the atmosphere either individually or in combination. A summary of the model inputs is presented in Table 1-3 below.

Table 1-3: Model inputs summary for Air Quality Impact

Parameter	**Comments**
Dispersion Model Selection	Version 4.2 of ADMS
Meteorological Requirements	hourly MM5 surface and profile data
Source Data Requirements	The ADMS model is able to model point, jet, area, line and volume sources. Stack and cooling tower fans were modelled as point sources.
Modelling Domain	The dispersion of pollutants expected to arise from proposed activities was modelled for an area covering 15 km (east-west) by 10 km (north-south). The area was divided into a grid matrix with a resolution of 200 m, with the geothermal power plants located centrally. The nearest town and farmsteads were included as AQSR. ADMS calculates ground-level (1.5 m above ground level) concentrations at each grid and discrete receptor point. Topography was included in dispersion simulations.
Results presentation	Dispersion modelling was undertaken to determine highest hourly, 8 hourly, highest daily and annual average ground level concentrations. Averaging periods were selected to facilitate the comparison of simulated pollutant concentrations to relevant ambient air quality, inhalation health criteria and odour thresholds. Results are provided in tabular form as discrete values simulated at specific AQSR receptor locations. Selective use is also made of isopleths to present areas of exceedance of assessment criteria. It should be noted that ambient air quality criteria apply to areas where the Occupational Health and Safety regulations do not apply, thus outside the property or lease area. Ambient air quality criteria are therefore not occupational health indicators but applicable to areas where the general public has access i.e. off-site.

1.5.4.1.4 Determining risks of the project on the receiving environment

The simulated ground level pollutant concentrations were screened against both local and internationally accepted reference inhalation concentrations. In the evaluation air emissions and ambient air quality impacts reference was made to:

- Screening levels for non-criteria pollutants published by various internationally recognized organizations;
  - Odour thresholds; and
  - Occupational limits.

Health risk screening was done through the comparison of simulated criteria pollutant concentrations (H_2S) to inhalation screening levels. Potential for odour impacts was done through the comparison of simulated non-criteria pollutant concentrations (H_2S) to odour thresholds. Regulatory occupational limits were used to assess the occupational impact.

1.5.4.1.5 Assumptions, Exclusions and Limitations

- The quantification of sources of emission was restricted to proposed operations at the geothermal power plants;
- Project information required to calculate emissions for proposed operations were provided by OTTL. Where necessary, assumptions were made based on the specialist's experience. Assumptions had to be made on the other two independent power producers (IPPs) located on either side of the proposed OTTL plant as details on their emissions were not available;
- Routine emissions were estimated and simulated;
- In the absence of on-site surface meteorological data, use was made of modelled MM5 data for an on-site location;
- A minimum of 1 year, and typically 3 to 5 years of meteorological data are generally recommended for use in atmospheric dispersion modelling for air quality impact assessment purposes;
- The impact assessment was limited to H_2S during the operational phase.

1.5.4.2 Noise Modelling

Noise impact assessment included a study of the legal requirements pertaining to noise impacts, a study of the physical environment of the area surrounding the project and the analyses of existing noise levels in the area. The impact assessment focused on the estimation of noise 'emissions and noise impacts associated with the operational phase of the facility.

Baseline acoustic environment was described in terms of the location of Noise Sensitive Receptors (NSRs) in relation to the proposed power plant, the ability of the environment to attenuate noise over distances and existing or pre-development noise levels.

Sound power levels for main power plant equipment including turbines, pumps and generators were determined from supplier specifications and theoretical calculations.

The propagation of noise from proposed activities was calculated according *to 'The Calculation of Sound Propagation by the Concave method'* (SANS 10357, 2004). The Concave method makes use of the International Organisation for Standardization's (ISO) air absorption parameters and equations for noise attenuation as well as the factors for barriers and ground effects. In addition to the ISO method, the concave method facilitates the calculation of sound propagation under a variety of meteorological conditions. Meteorological data obtained from the MM5 data set as used in the air quality impact assessment were applied.

The noise source inventory, local meteorological conditions and information on local land use were used to populate the noise propagation model (Concave). Noise levels were calculated over an area of 5 km east-west by 5 km north-south at intervals of 50m.

Noise impacts were calculated in terms of:

- Total day- and night time noise levels as a result of:
- The proposed OTTL plant in addition to the baseline; and
- The OTTL, GMGL, and Sosian geothermal power plants in addition to the baseline.
- The effective increase ambient day and night-time noise levels over the baseline as a result of:
- The proposed OTTL plant; and
- The Globeleq Menengai Geothermal Limited and Sosian Enegy Limited geothermal power plants.

The impacts were assessed according to guidelines published by NEMA in the Environmental Management and Coordination (Noise and excessive vibration pollution control) regulations of 2009 and IFC. To assess annoyance at nearby places of residence, reference was made to guidelines published in SANS 10103 (2008).

Assumptions, Exclusions and Limitations on noise modelling

- The mitigating effect of infrastructure acting as acoustic barriers was not taken into account, providing a conservative assessment of the noise impacts off-site;
- The quantification of sources of noise was limited to the routine operational phase of the project. Construction and closure phase activities were assessed qualitatively;
- All activities were assumed to be 24 hours per day, 7 days per week; and
- The noise sources and sound power levels for the OTTL Geothermal Power Plant was provided by OTTL. It was assumed that this information was accurate and representative of routine operations at the facility.
- Baseline data (i.e. meteorological and sampled noise baseline data) as obtained from the 2019 OTTL noise assessment were used for the current assessment and were assumed to be representative of current baseline conditions.

The noise impact assessment report is provided as Appendix XVI in this report for more details.

1.5.4.3 Ecological Survey

Baseline data on the ecological environment of the project area was compiled on the following accounts:

- Floral (vegetation) and faunal mapping studies – Final Study Report (June 2015) prepared by Egerton University;
  - Floral and faunal studies in Menengai Caldera, Kenya - Final Field Report (2010) prepared by Friends of Menengai Crater (FOMEC).
- KFS Menengai Participatory Forest Management Plan (2023-2027) – Accessed on 2nd July 2025

In addition, opportunistic observations were made by the SUEIA Study Team during a site visit on 7 May 2024. No sampling protocol applied in this case.

In this SUEIA Report, the Final Study Report (June 2015) and an Updated ESIA (2019) has been used as the main reference document since it is the most recent comprehensive ecological study undertaken in the project area. Nonetheless, the other sources were used to supplement information.

Ecological data was collected through the following approaches:

1.5.4.3.1 Vegetation

Vegetation sampling was carried out on and around the six determined sites. Visual observation and recording of all spermatophytes encountered. Plant scientific names, family names, growth forms, natural habitat and their status whether indigenous or exotic were also noted and recorded. Selected plants images were also collected and the sites geo-referenced.

1.5.4.3.2 Avifauna

Birds' investigation was based on line transect, which was designed at every site by use of binoculars. Bird species were identified and recorded. Also, bird calls or songs or any other songs were incorporated in birds' identification exercise. During observations, only birds visible within a range radius of 25 m from transects were recorded.

1.5.4.3.3 Mammals

The survey used was standard line transect methods that are practiced widely in animal census (Burnham *et al 1980*). Each site held one transect of 500 m in length and tracks, dung, footprint and other signs associated to certain species of mammals observed within the transect were recorded.

1.5.4.3.4 Herpetofauna

Field search was conducted in the study area where and at time when the reptiles were known to be active or detectable. The search for reptiles was centred on the ground and on trees. Active and barrowing reptiles encountered were recorded. Any other evidence or signs of presence of particular vertebrate were noted.

1.5.4.3.5 Entomological Survey

Field data collection was undertaken on 17 (No.) sites using different methods of invertebrate sampling:

Timed Sweep-netting

Involved trapping invertebrates (mostly insects) using a sweep net for fixed periods of time between 08:00am and 4:00 pm (the time when most flying insects become active and begin feeding) along the open paths of the selected sampling sites. Thereafter, the samples were preserved for identification.

Pan Trapping

Pan traps were set to collect pollinators (e.g. bees) some species of beetles and flies. The traps comprised mainly of small bowls of different colours including, yellow, blue, pink and white to mimic flowers. Twenty bowls were spread randomly along the open paths in every site and half-filled with water mixed with odourless detergent. The traps were inspected every evening to harvest trapped insects then preserve them for identification.

Timed Visual Searches

Involved walking along the sites in limited minute's collecting some and recording all observed invertebrates.

1.5.4.4 Public and Stakeholders' Consultation

Public participation was done through public meetings with the local on 7 & 8 May 2024 in tandem with the baseline socio-economic studies conducted as part of the ESIA studies. In addition, reference has also been made to feedback from community and stakeholders' meetings held by GDC post the initial ESIA study covering the period between March 2016 to November 2018. On 22nd August 2025, a consultative meeting was held with Menengai Community Forest Association (M-CFA).

1.6 Structure of the report

This report has been prepared under the following chapters:

Executive summary: This chapter presents a summary of the significant findings and recommended actions, with an emphasis on expected impacts.

Chapter 1: **Introduction:** This chapter gives description of the project background, location, purpose, objectives, reporting requirements, study methodology and the structure of the report.

Chapter 2: **Policy**, L**egal and regulatory framework**: This chapter outlines the overview of legislative framework, regulatory, international guidelines and conventions relevant to this project.

Chapter 3: **Description of the project environment:** This chapter gives description of the environmental setting of proposed project and surrounding areas, e.g., climate, soils, geology, vegetation, fauna, land use, human populations, socio-economics, cultural heritage.

Chapter 4: **Project description:** This chapter gives a description of the project details and design and implementation strategies.

Chapter 5: **Project Alternatives:** This chapter gives an analysis of project alternatives including the no-project option.

Chapter 6: **Public and Stakeholder Consultation:***'* This chapter gives description of the objectives, methods used and summary of results of the public consultation activities undertaken during the project report stage.

Chapter 7: **Impacts assessment and mitigation measures:** This chapter presents the analysis of beneficial and adverse impacts of the project on the biophysical and human (social, cultural and economic) environments. The analysis covers anticipated impacts during the construction, operation phases and decommissioning phases and also describes the enhancement and mitigation measures proposed to enhance benefits or prevent,

minimize, mitigate or compensate for adverse impacts as well as the estimated cost of mitigation.

Chapter 8**:** **Environmental and Social Management Plan:** This chapter gives in details summary of procedures and plans to ensure that the mitigation measures and monitoring requirements approved during the environmental compliance review will actually be carried out in subsequent stages of the project.

Chapter 9: **Conclusions and Recommendations:** This chapter summarises the consultant's conclusion and recommendations form the assessment.

2 POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

2.1 Background

In Kenya, Laws governing environmental protection and conservation are derived from constitutional statutes and ratified international conventions. These laws regulate the establishment and operation of development projects. This chapter includes a summary of the policies, laws, regulations and institutional framework for environmental and social management in Kenya relevant to the proposed project. A review of the regulations and standards governing health and safety has been included. In addition, analysis of international standards (World Bank/IFC Environmental and Social Standards, Africa Development Bank (AfDB) and Multilateral Environmental Agreements (MEAs) and their applicability to the proposed project were reviewed and presented in this chapter to guide the proponent.

2.2 Policy Framework

The Consultant analyzed relevant policies and provided relevant policy proposals to guide implementation of the proposed project. A discussion on the policies identified during the scoping process is provided in this chapter.

Table 2-1: Key relevant policies

Policy	Objective	Sections Triggered	Relevance
National Environment Policy 2014	The objectives of this Policy include: Providing a framework for an integrated approach to planning and sustainable management of Kenya's environment and natural resources; Strengthen the legal and institutional framework for good governance, effective coordination and management of the environment and natural resources; Ensure sustainable management of the environment and natural resources, such as unique terrestrial and aquatic ecosystems, for national economic growth and improved livelihoods; Promote and support research and capacity development as well as use of innovative environmental management tools such as incentives, disincentives, total economic valuation, indicators of	Chapter nine of the policy regarding the "Implementation Strategies and Actions" requires that all significant development projects are subjected to EIA and regular environmental audits conducted. ESIA is one of the environmental management tools identified and supported by the policy.	The proposed project is subjected to ESIA in reference to the requirements of the policy.

Policy	Objective	Sections Triggered	Relevance
	sustainable development, Strategic Environmental Assessments (SEAs), Environmental Impact Assessments (EIAs), Environmental Audits (EA) and Payment for Environmental Services (PES); Promote and enhance cooperation, collaboration, synergy, partnerships and participation in the protection, conservation, sustainable management of the environment and natural resources; Ensure inclusion of cross-cutting and emerging issues such as poverty reduction, gender, disability, HIV&AIDS and other diseases in the management of the environment and natural resources.		
National Energy Policy, 2018	The overall objective of the energy policy is to ensure affordable, sustainable, adequate, competitive, secure and reliable supply of energy at the least cost geared to meet national and county needs while protecting and conserving the environment.	Chapter 3 of the Policy discusses renewable energy sources available in Kenya, geothermal is listed as the first source. On geothermal energy, the policy outlines the policies and strategies to be implemented by the government under different implementation plans. Chapter 6 on Land, Environment, Health and Safety, the policy discusses policies and strategies and implementation Plan for the following issues related to the energy sector in Kenya: Land and Socio-Economic Issues; Environment, Health and Safety; Climate Change Mitigation; Renewable Energy EHS Concerns	This study addresses some of the concerns on geothermal energy as underscored in the policy including, licensing, the management of associated gases and liquids which may contribute to global warming, acid rain, noxious smells and ground water pollution if released on the surface

Policy	Objective	Sections Triggered	Relevance
		Conservation of Catchment Areas; Disaster Preparedness, Prevention and Management.	
Kenya Vision 2030	Vision 2030 aspires to transform Kenya into a newly industrialized middle-income country by 2030.	It identifies energy and electricity as a key element of Kenya's sustained economic growth and transformation. 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. It encourages more private generators of power and separating generation from distribution.	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 toward ensuring the project is undertaken in a sustainable manner with proper management of any resultant wastes. The proposed project aims to increase the total installed geothermal capacity, to enhance electricity service provision in Kenya
Forest Policy, 2014	The overall goal of this Policy is sustainable development, management, utilization and conservation of forest resources and equitable sharing of accrued benefits for the present and future generations of the people of Kenya. The policy seeks to promote investment in commercial tree growing, forest industry and trade, enhance management of forest resources for conservation of soil, water, biodiversity and environmental stability.	Section 8.2 on partnership and stakeholder involvement states that participatory forest management and sound conservation practices has the potential to improve forest protection, management and growth by involving relevant non-state actors and local communities in planning and implementation.	The proponent will ensure all forest resources are managed sustainably. Proposed project activities are restricted within a site area of about 100mx100m to avoid destruction of the forest. The proponent will be a major stakeholder in protection and management of the 'Menengai' forest.
Sessional Paper No.3 of 2016 on National Climate Change Framework Policy.	This policy was developed to facilitate a coordinated, coherent and effective response to the local, national and global challenges and opportunities	Section 2.2. on impacts of climate change in Kenya indicates that Kenya requires energy security and accessibility to become a middle -income economy by 2030.	The proponent has ensured that the infrastructure design of the proposed project is climate-proof over its lifespan. Geothermal power production will increase

Policy	Objective	Sections Triggered	Relevance
	presented by climate change. An overarching mainstreaming approach has been adopted to ensure the integration of climate change considerations into development planning, budgeting and implementation in all sectors and at all levels of government.	Energy production and utilization has a close connection with climate change hence the need for promotion of renewable energy like geothermal to lower GHGs emission.	accessibility to clean energy.
Sessional Paper No.1 of 2020 on Wildlife Policy	The specific objectives of this policy include conservation in perpetuity, Keny's a Wildlife resources, as a national heritage, increase access, incentives and sustainable use of wildlife resources, while ensuring equitable sharing of benefits, Promote management of viable wildlife populations and their habitats in Kenya.	To promote wildlife conservation, section 4.3.5 proposes that the government shall promote wildlife conservation as a land-use option, support implementation of approved management plans that incorporate multiple and compatible land -use practices and also mitigate threats to wildlife by physical developments in important wildlife areas.	The proponent will put in place measures to ensure that proposed project operations does not harm the Menengai Forest which is a habitat for few wild animals recorded to be present. The proponent shall ensure adherence to the Menengai forest Management plan throughout the proposed project lifecycle.
Least Cost Power Development Plan (LCPDP) (2024-2043)	The primary objective of the plan is to derive a long-term power generation and transmission expansion plan that considers the growing demand, new developments, and policies in the planning period at least cost.	Section 5.11 indicates that geothermal is one of the most economical electricity generation options for Kenya. Output from renewable energy plants is projected to account for 82.3% of the electricity generation mix by 2043. In the same year, geothermal energy is projected to have the highest contribution accounting for 47.3% of the total electricity generation mix.	In line with the LCPDP, the proponent intends to develop the proposed project with an estimated equivalent output of 35-40 MW which will boost geothermal electricity expansion.

Policy	Objective	Sections Triggered	Relevance
Environmental, Health & Safety (EHS) Policy Framework for the Electric Power Sub-Sector, 2005	The Policy recognizes the role of lead agencies in the power sector and the need for aligning with EMCA requirements in the ESIA process of approving EIA Reports for new power plants, transmission and distribution lines. The policy is aimed at strengthening the enforcement of environmental, health and safety regulations in the electric power sub-sector. It describes best practice on EHS principles for generation and demand sides of the energy subsectors. It also recognizes Energy and Petroleum Regulatory Authority (formerly Electricity Regulatory Commission (ERC) in respect of the electric power sub-sector. It further affirms the strategic contribution of energy services in achieving sustainable social and economic development as an integral part of environmental ad ecological sustainability.	The policy sets out performance monitoring and compliance protocols including monitoring measures as well as monitoring and reporting procedures for key environmental, health and safety aspects of the operations in the power sub-sector (geothermal power plants, hydro-power plants, thermal power plants, transmission & distribution networks). Further, the policy provides an eco-efficiency indicator formula for EPRA to keep track of ecological efficiency performance of licensed power producers. This introduces checks to ensure that business (in the energy sub sector) does not only make profit but also in an environmentally responsible manner	The Proponent should recognize the mandates of EPRA as a lead agency in EHS management, especially in Licensing and oversight EHS monitoring in the power sub-sector. The Proponent should integrate into its EHS monitoring protocols; the parameters, procedures and reporting schedules recommended by EPRA in S8.1 (Monitoring Protocols for Geothermal Power Plants) of the Policy.
National Policy on Gender and Development (NPGD) 2019	The overall objective of the Policy is to facilitate the implementation of the constitution and domesticate the international and regional obligations and commitments that promote gender equality and freedom from discrimination, provide a framework to integrate and mainstream gender into	Section 4.9 provides policy actions towards gender integration and mainstreaming in environment and natural resources management which include; ensuring women participate in and benefit equitably from investments in various natural resources development initiatives and support interventions aimed at equitable participation of	The proponent will ensure gender concerns are mainstreamed into the planning and implementation of the project to ensure that the needs and interests of men, women, youth and People Abled differently are addressed.

Policy	Objective	Sections Triggered	Relevance
	the National and County Government development planning and budgeting as well as resultant policies, programmes and plans including those on Non-state actors and define institutional framework and performance indicators for effective tracking, monitoring, evaluation and reporting implementation of gender equality and women empowerment.	women, men, girls and boys in the sustainable utilization of natural resources for economic benefits including opportunities for carbon trading.	
GDC Health, Safety and Environment Policy 2011	The policy is geared towards ensuring safety and environmental protection in all its working environment.	The policy states that "GDC shall conduct all its activities taking foremost account of health and safety of its employees, contractor and local community while paying proper regard to the environment". The policy in clause 2 stipulates responsibilities of various players involved in GDC activities including GDC itself, GDC employees; and any procured contractors. Of relevance to OTTL is clause 2.1 which requires all contractors engaged by GDC to: ▪ Abide by its policy and be responsible for management of their employees through training, mentoring etc.; • Perform all work in a manner to prevent HSE incidents; • Ensure training and proper tools/equipment; • Notify GDC immediately of any health, safety or environmental	The proponent will ensure the activities undertaken during construction and operation of the plant are executed in accordance with the requirements of this policy.

Policy	Objective	Sections Triggered	Relevance
		(HSE) incidents, even if no injury occurs; • Provide GDC with a written report on incidents within 24 hours; • Undertake Proactive HSE efforts; • Contractor shall hold a pre-job or pre-task HSE meeting on-site in which the specific hazards pertaining to the job are discussed prior to beginning all work; and • Contractor shall have their own written drug, alcohol and firearms policy in effect.	

2.3 Legal Framework

Kenya has a wealth of laws and regulations that guide environmental management and conservation. Most of these laws are sector specific and cover a wide range of environmental, social, safety and health management aspects for sustainable development. The legislations relevant to this project as identified during the scoping process are as discussed in this chapter.

Table 2-2 Key relevant laws

Legislation	Objective	Sections Triggered	Relevance
The Constitution of Kenya, 2010	The Constitution of Kenya, 2010 recognizes the role of the environment in sustaining our heritage, as a heritage of inter-generational benefit. Chapter 5 on Land and Environment is more particular on this. Part 1 of the chapter clarifies that the state may regulate the use of any land, or any interest in or right over any land, in the interest of defense, public safety, public order, public morality, public health, or	Section 69(1): Provides for the State obligations towards environmental protection and conservation. The obligations include; • Ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits;	The Proponent intends to use land for the purpose of the power plant construction and operation for the benefit of the public. The Proponent shall ensure the activities undertaken during the project lifecycle does not undermine any of these environmental protection and conservation

	land use planning. Part 2 of the chapter defines environment and natural resources, obligations in respect of the environment, enforcement of environmental rights, agreements relating to natural resources and legislation relating to the environment.	• Work to achieve and maintain a tree cover of at least ten per cent of the land area of Kenya; • Protect and enhance intellectual property in, and indigenous knowledge of, biodiversity and the genetic resources of the communities; • Encourage public participation in the management, protection and conservation of the environment; • Protect genetic resources and biological diversity; • Establish systems of environmental impact assessment, environmental audit and monitoring of the environment; • Eliminate processes and activities that are likely to endanger the environment; and • Utilize the environment and natural resources for the benefit of the people of Kenya.	obligations of the State. The project aims at promoting sustainable utilization of geothermal resources for the benefit of Kenyans. Deliberate actions shall be undertaken to enhance relevant and practicable obligations for example ensuring public participation through the project lifecycle, ensure the project processes does not harm the environment.
Environmental Management and Coordination Act (EMCA Cap, 387)	The Act provides for the establishment of an appropriate legal and institutional framework for the management of the environment	Part II of the Act vests on every person a right to a healthy environment and a responsibility to safeguard it. Section 51 and 54 deals with conservation of biological resources and protection of the significant environmental areas, Section 56 deals with the protection of ozone layer and emissions of dangerous gases to the atmosphere, the geothermal processes will lead to emission of CO2. CO, H2S and CH4 which are ozone layer depleting substances.	The Proponent shall ensure the activities of the Project within its lifecycle does not undermine this right by ensuring compliance with the legal requirements and ensuring public health and safety. The proposed development lies within a sensitive ecosystem, which should be protected. The Proponent will be required to put in place technology to control release of GHGs to adhere to

		Section 58 of the Act makes it a mandatory requirement for an EIA study to be carried out prior to implementing projects specified in the (amended) Second Schedule (L.N No. 31 of 2019) of the Act. Such projects have a potential of causing significant impacts on the environment. Section 68 of the same Act requires operators of existing projects or undertakings to carry out Environmental Audits (EA) in order to determine the level of conformity with statements made during the EIA study.	the allowable emission limits. The project falls under "High-Risk Projects" category of the 2nd schedule, as Power and Infrastructure projects specifically: "(b) geothermal development; for which an ESIA study is mandatory. In compliance, the ESIA study report will be submitted to NEMA so as to obtain an EIA License prior to the implementation of the proposed project.
Relevant EMCA Cap 387 subsidiary Regulations			
Environmental (Impact Assessment and Audit) Regulations, 2003 and (Amendment) Regulations, 2019 (L.N No. 32 of 2019)	Environmental Impact Assessment and Environmental Audits under EMCA Cap 387 is guided by these regulations. It provides that major development projects are required to be subjected to an ESIA process and the resultant ESIA report be submitted to NEMA for approval and issuance of an ESIA license, after demonstrating that the possible negative impacts of a project will be effectively mitigated.	Section 4. (1) provides that no proponent shall implement a project that is likely to have a negative environmental impact or a project for which an environmental impact assessment is required under EMCA, Cap 387 unless an environmental impact assessment has been concluded and approved. Regulation 18 (1) (b) of the Environmental (Impact Assessment and Audit) Regulations 2003 requires that the proponent provides an environmental assessment study report prior to the commencement of a project, this report should have among others; a concise description of national environmental legislative and regulatory framework.	The project has already been licensed by NEMA in accordance with these regulations. GDC has already transferred the existing licence to the Proponent as provided in these regulations.

		This chapter presents a review of the current triggered local policy, legal and regulatory framework as well as International Standards relevant to development and environmental management of the proposed geothermal power project. Regulation 26 (1) provides that a holder of an environmental impact assessment licence may, on payment of the prescribed fee, transfer the licence to another person only in respect of the project to which such licence was issued.	
Environmental Management and Coordination (Waste Management) Regulations, 2024	These Regulations apply to all categories of waste including: Industrial wastes; Hazardous and toxic wastes; Pesticides and toxic substances; Biomedical wastes; Radio-active substances. These Regulations outline requirements for handling, storing, transporting, and treatment / disposal of all waste categories as provided therein.	Regulation 1 prohibits disposal of any waste on a public highway, street, road, recreational area or in any public place except in a designated waste receptacle. It also requires any person whose activities generate waste to collect, segregate and dispose of or cause such waste to be disposed- off in an appropriate manner. This requires that, generated waste should be transferred to a person who is licensed to transport and dispose of such waste in a designated waste disposal facility.	The Proponent shall ensure adherence to these regulations in dealing with waste management throughout the project life cycles.
		Regulation (1) requires minimization of waste generated during project activities.	The Proponent shall minimize generation of waste through promotion of recycling and reuse of materials through incorporation of appropriate measures in the design and processes of the plant.

Environmental Management and Coordination (Water Quality) Regulation, 2024	The objective of the regulations is to prohibit discharge of effluent into the environment contrary to the established standards. The regulations provide guidelines and standards for the discharge of poisons, toxins, noxious, radioactive waste or other pollutants into the environment in line with the Third Schedule of the regulations. The Regulations shall apply to drinking water, water used for industrial purposes, water used for agricultural purposes, water used for recreational purposes, water used for fisheries and wildlife, and water used for any other purposes.	Regulation 4, prohibits any act which directly or indirectly causes, or may cause immediate or subsequent water pollution. The regulation requires 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.	The Proponent shall undertake continuous monitoring of any waste water generated from the power plant during construction and operation and ensure compliance with the acceptable quality standards before discharge. Also, the water supplies for domestic use either during construction or operational phase of the project as well as the resultant effluents shall be required to comply with the standards stipulated in the regulations.
Environmental Management and Coordination (Conservation of Biological Diversity and Resources, and Access to Genetic Resources and Benefits Sharing) Regulations 2006	These Regulations apply to conservation of biodiversity which includes Conservation of threatened species, Inventory and monitoring of Biological Diversity and protection of environmentally significant areas, access to genetic resources, benefit sharing and offences and penalties	Regulation 4, prohibits engagement in any activity that may have an adverse impact on any ecosystem or lead to the introduction of any exotic species or lead to unsustainable use of natural resources, without an Environmental Impact Assessment Licence issued by NEMA.	The Regulations mainly applies due to the location of the proposed project site with the 'Menengai' caldera. Proper environmental management will be required to conserve the biological diversity within the area. A detailed assessment of the likely impacts of the power plants on biodiversity in the area was conducted to ensure their conservation and sustainability. The Proponent shall adhere to the ESIA Licence conditions as prescribed by NEMA.

Environmental Management and Coordination (Air quality) Regulations,2024	The objective of these Regulations is to provide for the prevention, control and abatement of air pollution to ensure clean and healthy ambient air.	Regulation 5, requires that no person shall act in a way that directly or indirectly causes, or is likely to cause immediate or subsequent air pollution; or emit any liquid, solid or gaseous substance or deposit any such substance levels exceeding permissible levels set out in the First Schedule of the regulation or engage in open burning save for in the manner permitted by this Regulation and EMCA Cap 387. The 4th schedule of the regulation provides for air pollution parameters from stationery sources which should be monitored. Sulphur oxides, Hydrocarbon and hydrogen sulphide should be monitored from Geothermal Power Plants.	H2S will be the main emission of concern during operation and is listed as one of the general source pollutants in the second schedule of these regulations, hence necessitating continuous monitoring. The proponent will comply with the mitigation measures proposed in this ESIA report and will continue to conduct ambient air quality analysis of: the proposed and existing geothermal power plants; and infrastructure.
Environmental Management and Coordination (Noise & Excessive Vibration Pollution) Control Regulation, 2009	These regulations stipulate the maximum permissible noise levels for various zones.	Section 15 of the regulations, states that any person intending to carry out construction, demolition, mining or quarrying work shall, during the Environmental Impact Assessment studies: • identify natural resources, land uses or activities which may be affected by noise or excessive vibrations; • determine the measures which are needed in the plans and specifications to minimize or eliminate adverse noise or vibration impacts; and • incorporate the needed abatement measures in the plans and specifications. Regulation 3(1) provides that no person shall make	The Proponent shall put in place measures during construction and operation of the plant and install appropriate technologies to minimize noise emission to the lowest possible. The Proponent will be required to undertake regular monitoring of the noise levels within the proposed geothermal power plant to check for compliance and any required corrective actions. The proponent will implement the measures set out in the ESMP of this

		or cause to be made any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. Regulation 4 (1) provides that, except as otherwise provided in these Regulations, no person shall make or cause to be made excessive vibrations which annoy, disturb, injure or endanger the comfort, repose, health or safety of others and the environment; or cause to be made excessive vibrations which exceed 0.5 centimeters per second beyond any source property boundary or 30 meters from any moving source.	report and will conduct regular Noise level monitoring within the proposed geothermal power plant to check for compliance and any required corrective actions.
Other Sector Relevant Legislation			
The Energy Act, 2019	The Energy Act makes provisions that shall apply to every person or body of persons importing, exporting, generating, transmitting, distributing, supplying, using electrical energy, importing, exporting, transporting refining, storing and selling petroleum or petroleum products, producing, transporting, distributing and supplying of other forms of energy, and to all works or apparatus for any or all of these purposes	Part IV of the Act specifically makes provisions on renewable forms of energy including geothermal energy. The Minister is obligated to promote the use of renewable energy in Kenya. The Minister is charged with formulating a national strategy for coordinating research in renewable energy. The Act expressly identifies geothermal energy as a form of renewable energy whose production should be fostered in the Country. Section 73, vests ownership of all geothermal resources under any land is vested with the Government. Section 78, requires acquisition of a Licence or	The Proponent intends to increase geothermal power through the proposed project. Importantly to note that the Proponent of the Proposed power plant will rely on supply of steam by GDC hence not drilling wells to tap the resources hence not required to obtain requisite licence (GDC has the Licence to carry out Geothermal development in accordance with section 80 of the Act) The proponent shall put in place measures to ensure workplace

		grant of authority before sinking a well, tap, take, use or apply geothermal resources for any industrial or commercial purpose. Section 87, places responsibility and liability to the licensee for any loss, damage or injury to any person or property resulting from his works or operations, whether as a result of negligence or otherwise.	and public safety during construction and operation of the proposed power plant.
Geothermal Resources Act, 1982	The act provides that no person shall sink a bore, tap or take and use or apply geothermal resources for any purpose unless he is first granted an authority or license.	Section 7 of the Act provides that the cabinet secretary may on application being made to him in respect of any land, grant a license (to be known as a "geothermal resources license") over part or the whole of a geothermal resources area under such terms and conditions as he may determine.	The Geothermal Resources Licence is issued to GDC. The Proponent is a private sector Firm contracted to develop and operate geothermal plant by GDC in accordance with the exclusive rights granted through the Geothermal Resource Licence.
Geothermal Resources Regulation, 1990		Section 13 of the regulation provides that all geothermal operations shall be conducted in a workmanlike manner and should: prevent the unnecessary waste of or damage to geothermal or other energy and mineral resources; protect the quality of surface waters, air, and other natural resources, including wildlife, soil, vegetation and natural history; protect the quality of cultural resources, including archeological, historical, scenic and recreational resources; and prevent injury to life and damage to property.	The plant construction works shall be restricted to a demarcated area to avoid excessive destruction of the Menengai Crater forest through deforestation and vegetation clearance.
Forest Conservation and Management Act, 2016	The act provides for the establishment, development and sustainable management,	Section 44(1), provides that where KFS is satisfied that utilization of a public forest can be done through	The proponent will work in collaboration with KFS, to ensure that disruption of the

	including conservation and rational utilization of forest resources for the socio-economic development of the country.	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. Section 44(3) provides that, the grantee of a concession shall; comply with the guidelines or management plans prescribed by KFS, prepare environmental and social impact assessments as may be required under any other written law, prepare a concession area forest management plan that shall include inventories, reforestation or replanting programmes, annual operation plans and community user rights and benefits, protect the concession area from destruction and encroachment by any other person, ensure that the forest areas under his management are maintained for the conservation of biodiversity, cultural or recreational use, maintain the physical boundaries of the concession, take precautions to prevent the occurrence or spread of forest fires in connection with any or all operations within or outside the concession area, ensure that all structures and facilities constructed or operated by and in connection with any activities are maintained according to the conditions of the licence; and pay applicable land rent, fees and other charges for utilizing forest resources within the concession area;	environment in any forested areas is minimized and mitigation measures set out in the ESMP of this report are well implemented. The Proponent shall comply with the conditions provided by GDC in line with the Geothermal Resource Licence.
Wildlife Conservation and	The Act provides for the protection, conservation, sustainable use and	Section 26 (1) provides that the provisions of this Act with respect to conservation, protection	The proponent is putting up a geothermal power plant on a site within a

Management Act, 2013	management of wildlife in Kenya	and management of the environment shall be in conformity with the provisions of the Environmental Management and Coordination Act. Section 27 (1) provides that No user rights or other licence or permit granted under this Act shall exempt a person from complying with any other written law concerning the conservation and protection of the environment. Section 27(2) provides that 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 licence under the Environmental Management and Coordination Act, 1999 has not been complied with. Section 30 of the Act 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.	gazette forest which may require conservation of the existing wildlife notwithstanding the fact that 'Menengai' Caldera is not a gazetted National Park but is an important Eco-tourism site. The proponent will ensure full implementation of the measures set out in the ESMP to mitigate any adverse impacts on wildlife.
Land Act, 2012 and Land Laws (Amendment) Act, 2016	The Act gives effect to Article 68 of the Constitution, to revise, consolidate and rationalize land laws; to provide for the sustainable administration and management of land and land-based resources, and for connected purposes.	Part VIII of the Act provides compulsory conditions and guidelines for acquiring land.	The land on which the proposed project will be undertaken is owned by a state agency (KFS). KFS has an Agreement with GDC, allowing for exploration, exploitation and generation of electricity from the site which is within 'Menengai' forest.

Environment and Land Court Act, 2011	The Act gives effect to Article 162(2)(b) of the Constitution; to establish a superior court to hear and determine disputes relating to the environment and the use and occupation of, and title to, land. The principal objective of this Act is to enable the Court to facilitate the just, expeditious, proportionate and accessible resolution of disputes governed by this Act.	Section 13 (1) provides that 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. Section 13 (2) provides that in exercise of its jurisdiction under Article 162(2)(b) of the Constitution, the Court shall have power to hear and determine disputes relating to environmental planning and protection, climate issues, land use planning, title, tenure, boundaries, rates, rents, valuations, mining, minerals and other natural resources, compulsory acquisition of land, land administration and management; relating to public, private and community land and contracts, choses in action or other instruments granting any enforceable interests in land; and any other dispute relating to environment and land.	Any land or/and environmental cases arising from the project will be handled in accordance with the provisions of this Act.
Physical and Land Use Planning Act, 2019	This Act make provision for the planning, use, regulation and development of land.	Section 57 (1) provides that no person shall carry out development within a County jurisdiction without a development permission granted by the respective county executive committee member. Additionally, Section 58 (4) of the Act states that "Where an applicant is not the registered owner of the land for which development permission is being sought, that applicant shall obtain the written consent of the	The proponent has obtained approval of all geothermal power plant design plans from the County Government of Nakuru.

		registered owner of that land and the applicant shall provide that written consent to the respective County Executive Committee member at the time of applying for development permission"	
Climate Change (Amendment) Act, 2023	The Act provides a regulatory framework for an enhanced response to climate change; to provide for mechanism and measures to achieve low carbon climate development. Section 3 (1) provides that this Act shall be applied for the Objects and development, management, implementation and regulation of mechanisms to enhance climate change resilience and low carbon development for the sustainable development of Kenya.	Section 3 (2), this Act shall be applied in all sectors of the economy by the national and county governments to-mainstream climate change responses into development planning, decision making and implementation; build resilience and enhance adaptive capacity to the impacts of climate change; formulate programmes and plans to enhance the resilience and adaptive capacity of human and ecological systems to the impacts of climate change; mainstream and reinforce climate change disaster risk reduction into strategies and actions of public and private entities; mainstream intergenerational and gender equity in all aspects of climate change responses; provide incentives and obligations for private sector contribution in achieving low carbon climate resilient development; promote low carbon technologies, improve efficiency and reduce emissions intensity by facilitating and uptake of	The aim of the project is to generate geothermal energy, which is considered environmentally friendly. However, the vehicles and machines that will be used may contribute to additional GHG emissions. To avoid this, the proponent will implement the measures set out in the ESMP of this report.
Public Health Act Cap 242	This is an Act of Parliament to make provision for securing and maintaining health.	Section 115 of this act prohibits causing nuisance or other conditions liable to be injurious or dangerous to health. Section 118 provides a list of nuisances that includes any noxious matter, or wastewater, flowing or discharged from any premises, wherever	The project construction and operation activities are bound to expose both workers and members of the general public to situations injurious to health. All activities of the project are thus expected to abide by

		situated, into any public street, or into the gutter or side channel of any watercourse, irrigation channel or bed thereof not approved for the reception of such discharge.	this act to ensure a healthy environment. The proponent will ensure that adverse impacts of air and water pollution will be mitigated through measures set out in the ESMP of this report.
Water Act, 2016	The Act provides for the regulation, management and development of water resources, water and sewerage services	Section 143 provides that no person, without authority, will 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.	The proponent shall ensure the implementation of appropriate measures, so as to prevent potential contamination of both surface and underground water sources.
County Government Act, 2012 and (Amendment) (No. 2) Act, 2020	The Act gives effect to Chapter Eleven of the Constitution; to provide for county governments' powers, functions and responsibilities to deliver services.	It vests responsibility upon the County Governments in planning of development projects within their areas of jurisdiction, be it projects of importance to the county government or those of national importance. Section 113 of the Act makes public participation in County planning processes compulsory.	The County Government of Nakuru will be actively involved as a Key Stakeholder in all phases of the project. Additionally, relevant county licenses shall be obtained from the relevant county departmental offices.
National Museums and Heritage Act Cap 216	The Act consolidates the law relating to national museums and heritage; to provide for the establishment, control, management and development of national museums and the identification, protection, conservation and transmission of the cultural and natural heritage of Kenya;	Section 31 provides that no person shall move a monument or object of archaeological or paleontological interest from the place where it has been discovered otherwise than in such manner and to such place as may be allowed by an exploration licence, or by written permit from the Minister after consultation with the National Museums.	The proponent will ensure due diligence is practiced where historical property is encountered during construction of the proposed project and other related activities. Any Chance finds shall be managed in consultation with the National Museums.
National Construction Authority Act, 2011	This Act establishes the National Construction Authority (NCA), meant to oversee the construction industry and coordinate its development. The	In accordance with Section 5(2) of the Act, the authority is mandated to: promote and stimulate the development, improvement and	The Proponent shall ensure that construction works are implemented in adherence to the requirements

	authority is meant to promote quality assurance of the construction industry; accredit and register contractors as well as accredit and certify skilled construction workers and construction site supervisors.	expansion of the construction industry; advise and make recommendations to the Cabinet Secretary on matters affecting or connected with the construction industry; undertake or commission research into any matter relating to the construction industry; and prescribe the qualifications or other attributes required for registration as a contractor under this Act, among other duties. Section 15 (1) provides that no person shall carry on the business of a contractor unless the person is registered by the Board under this Act.	prescribed by the National Construction Authority. The proponent will demonstrate compliance by ensuring all local and foreign contractors are registered under the Authority and have appropriate licenses and permits for operating
The National Gender and Equality (NGEC) Act, 2011	Its main objective is to provide precedence for the prevention of discrimination on the basis of sex in the national development process in order to improve social, legal/civic, economic, and cultural conditions of women, men, girls and boys in Kenya.	Section 8 provides for the functions of the Commission which include; promoting gender equality and freedom from discrimination, monitoring, facilitating and advising on the integration of the principles of equality and freedom from discrimination in all national and county policies, laws, and administrative regulations in all public and private institutions;	The Proponent shall ensure fulfillment of the aspiration of the Act in terms of gender equality and Non-discrimination throughout the project life cycle. The proponent shall ensure equal job opportunities for all gender throughout the project's cycle.
Persons with Disabilities Act, 2025	The Act gives effect to Article 54 of the Constitution; to restructure the National Council for Persons with Disabilities and to provide for its functions and powers; to provide for the institutional framework for protecting, promoting and monitoring the rights of persons with disabilities; to provide for incentives and reliefs	Section 21 (1) provides that no employer shall discriminate against a person with disability in job application procedures, hiring, advancement and other terms, conditions, and privileges of employment. Section 21 (2) provides that where an employer has at least twenty employees, at least five per cent direct employment opportunities should be reserved for persons with disabilities to secure	The proponent shall provide an accommodative working environment for People with Disabilities as well as ensuring they acquire employment opportunities throughout the project life cycle.

		employment; formulate policies and programmes to promote basic human rights, improve working conditions, and enhance employment opportunities for persons with disabilities; when recruiting, not discriminate on account of disability; not conduct any test or examination to establish whether an applicant is a person with a disability or as to the nature or severity of the person's disability; be required to carry out appropriate modifications in their work premises to accommodate the employment of persons with disabilities.	
Children Act, 2022	The Act gives effect to Article 53 of the Constitution; to make provision for children rights, parental responsibility, alternative care of children including guardianship, foster care placement and adoption; to make provision for care and protection of children and children in conflict with the law; to make provision for and regulate the administration of children services.	Section 18 (1) of the Act provides that no person is allowed to subject a child-to-child labor, domestic servitude, economic exploitation or any work or employment which is hazardous, interferes with the child's education or is likely to be harmful to the child's health or physical, mental, moral or social development.	The proponent and contractors will ensure that during construction and operation of the Geothermal Power Plant, no persons under the age of 18 years will be employed. Additionally, employees will be required to provide National Identification Cards during employment.
Sexual Offences Act, 2006	Act of Parliament to make provision about sexual offences, their definition, prevention and the protection of all persons from harm from unlawful sexual acts. The act protects people and employees from any unwanted sexual attention or advances by staff members. This act ensures the safety of women, children, and men from any sexual offences, including rape, defilement, and indecent acts.	Section 23 (1) states that, any person, who being in a position of authority, or holding a public office, who persistently makes any sexual advances or requests which he or she knows, or has reasonable grounds to know, are unwelcome, is guilty of the offence of sexual harassment.	The proponent shall establish a sexual harassment policy for implementation through the project lifecycle.

HIV and AIDS Prevention and Control Act, 2006	The Act provides measures for the prevention, management and control of HIV and AIDS, protection and promotion of public health and for the appropriate treatment, counseling, support and care of persons infected or at risk of HIV and AIDS infection	Section 7 provides that the Government shall ensure the provision of basic information and instruction on HIV and AIDS prevention and control to employees of all Government Ministries, Departments, authorities and other agencies; and employees of private and informal sectors	The proponent and contractor will promote educational and informational campaigns and organize for Voluntary Counselling and Testing of workers during the construction and operation phases. Additionally, the proponent will ensure there is no discrimination against workers on the basis of their HIV status
Occupational Safety and Health Act(OSHA), 2007	This Act provides for the safety, health and welfare of workers and all persons lawfully present at workplaces. The Act also applies to the protection of persons other than persons at work against risks to safety and health arising out of, or in connection with, the activities of persons at work.	It applies to all workplaces where any person is at work, whether temporarily or permanently. The purpose of the act is to secure the safety, health and welfare of persons at work and protect persons other than the workers against risks to safety and health arising out of, or regarding, the activities of the facility. Section (3) provides that every occupier shall carry out appropriate risk assessments in relation to the safety and health of persons employed and, on the basis of these results, adopt preventive and protective measures. Section 44(1), provides for registration of any premises as a workplace before occupation or use.	A registration of workplace certificate will be secured. Annual Environmental, Health and Safety Audit will be undertaken and reports submitted to relevant Authorities. Health and safety committees will be established through the project life cycle.
Regulations under OSHA, 2007			
The Occupational Safety and Health (First Aid in the Workplace) Regulations, 2024	These regulations stipulate that there shall be provision of well-maintained and readily available and accessible first aid boxes or cupboards.	Section 6 of the regulations provide that no person shall be placed in charge of a first aid box or cupboard unless he or she has received adequate training in the application of first-aid to the injured persons and holds a certificate of	The proponent will ensure the first aid boxes/cupboards are plainly and clearly marked on the outside with the words “FIRST AID” and contact

		competence issued by: The St. John Ambulance of the St. John Council of Kenya; or The Kenya Red Cross Society; or such other body or society as may be approved from time to time, by the Labor Commissioner. The certificate of competence must be renewed annually.	information of the First Aider on-duty. The Proponent will ensure a Competent person is contracted for provision of First Aid services through the project life cycle.
Factories and Other Places of Work (Safety and Health Committees) Rules, 2004 (L.N No. 31)	These Rules apply to all factories and workplaces, which regularly employ twenty or more employees.	Rule 4(1) requires that the Occupier of every factory or other workplace to which these Rules apply shall establish a Safety and Health Committee in the manner provided in these Rules. These Rules provide guidelines on composition of the Committee, its functions and modes of operation. These committees are tasked with the responsibility of overseeing OSH implementation and performing safety audits.	The proposed project will employ more than 20 workers during all phases of the project and therefore the proponent will comply with the requirements of this regulation by: establishing a Safety and Health Committee in a manner provided by the rules and ensuring the committee meets at least four times in every year (interval of three (3) months).
Factories and Other Places of Work (Medical Examination) Rules, 2005 (L.N No. 24)	These Rules apply to medical examination of all those employees in employment or have been in employment in every workplace.	Rule 4(1) provides that It is the duty of the employer to ensure that all persons employed in any of the occupations outlined in the Eighth schedule to the OSHA, 2007, undergo both pre-employment and periodic examinations by the Designated Health Practitioner.	The proponent shall ensure that all employees undergo a pre-employment and periodic medical testing within the course of the project activities to survey on their health.
Factories and Other Places of Work (Fire Risk Reduction) Rules, 2007 (L.N No. 59)	These Rules apply to every workplace, process and operation where flammable materials are used or involved.	Rule 4 provides that a person wishing to set up or operate a facility for the use on or storage of highly flammable substances shall ensure that such facility is located in the designated area. Rule 5(1) provides that every Owner or Occupier of a workplace shall ensure that every workroom where flammable substances are used, manufactured or	The proponent and contractor will ensure proper storage and handling of flammable substances, including establishment of firefighting teams and put in place fire emergency prevention and response procedures. In addition, select staff shall be trained

		manipulated, is constructed with fire resistant materials.	on firefighting and ensure provision of fire protection systems (portable fire extinguishers, hose reels, sprinklers hydrants, smoke detectors, fire alarm and fire water tank) and regular undertaking of fire audits.
Factories and Other Places of Work (Hazardous Substances) Rules, 2007 (L.N No. 60)	Schedule 1 of the Rules prescribe exposure limits for Hazardous substances. Where exposure limits of a hazardous substance is not provided for in Schedule 1 to these Rules, it shall be the responsibility of a supplier or manufacturer of such substance to provide a provisional exposure limit.	Rule 7(1) provides that it shall be the duty of every employer to prevent his employees from being exposed to hazardous substance. Rule 7(2) provides that where it is not reasonably practical to prevent the exposure, it shall be the duty of every employee to control the exposure of employees and provides how this shall be achieved.	The proponent and contractor will maintain at the point of use Data sheets for the various materials or hazardous substances in use, carry out regular monitoring of the levels of H2S emissions, provide suitable PPEs to employee and document safe working procedures on the use, handling and storage of hazardous materials.
Factories (Building Operations and Works of Engineering Construction) Rules, 1984	The Rules cover the construction, structural alteration, repair and maintenance of buildings, including repainting, redecoration and external clearance of the structure; the demolition of a building; and preparing and laying the foundation of an intended building or work of engineering construction for the purpose of any industrial or commercial use. The Rules require the contractors and Occupiers to observe good safety standards while performing building operations in the above activities.	Section 48 (1) prohibits any timber or material from projecting nails to be placed or be allowed to remain in any place at a site where they are a source of danger to persons employed. Section 55 (C) provides that properly maintained scaffolds or; where appropriate, ladders or other means of support which shall be sufficient and suitable for the purpose shall be provided, placed and kept in position for use where work cannot be safely done on or from the ground or from part of a building or other permanent structure.	The proponent and contractor shall ensure that the relevant provisions of these Rules and provisions of OSHA 2007 are adhered to throughout the project life cycle especially of ensuring safe access and safety while working at heights.
County government of			

Nakuru relevant laws			
Nakuru County Climate Change Act, 2021	This is an Act of the Nakuru County Assembly to put in place the framework and mechanisms for mobilization and facilitation of the County government, communities and other stakeholders to respond effectively to climate change through appropriate adaptation and mitigation measures. The objective of the Act is to enhance climate resilience through development, management, implementation, regulation and monitoring of adaptation and mitigation measures and actions.	Section 3(2) (a) provides that this Act shall be applied in all sectors of the economy to mainstream climate change responses into development planning, decision making and implementation. Section 3(2) (c) provides that this Act applies to enforce duties and provide incentives for the private sector to contribute to achievement of low carbon climate resilient development.	The Proponent shall put in place measures to minimize emission of GHGs and also collaborate with County government of Nakuru in promoting climate change adaptation and mitigation initiatives.
Nakuru County Public Participation Act, 2016	An Act of Nakuru County Assembly to give effect to Article 1, 10 (2) (a), 174 (c) (d), 196,232 (1) (d) and Paragraph 14 of Part 2 of the Fourth Schedule of the Constitution and Part VIII of the County Governments Act; to encourage participation on matters of public interest and to establish modalities and platforms for public participation in the governance of the county;	Section 9 of the Act provides that a public participation notice shall be published at least twenty-one (21) days before the meeting in the County Gazette or the media in terms of this Act or shall be displayed at the sub-county, ward or village offices, provided that notice of a shorter period may be given in an emergency situation that calls for public participation or consultation. The notice shall indicate the time, date and venue of the meeting and shall be in the official languages but shall have regard to language preferences and usage of the area.	The proponent undertook comprehensive public participation during the ESIA process. Stakeholder engagement shall continue regularly during the construction and operation phase of the project.
Nakuru County Waste Management Act, 2020	The objectives of this Act include; Provide a county legal framework for solid waste management function as spelt out in part 2 of the Fourth Schedule of the	Section 11 provides that an Authorized officer may order any person to immediately cease an operation involving the generation, handling, transportation, storage, or	Additionally, the proponent shall ensure that only waste handler that has been licensed by the county Department and/or

	Constitution of Kenya; Pursuant to Article 69 (1) (d) of the Constitution provide a framework to encourage public participation in the management, protection and conservation of the environment; Provide for and regulate the participation of the various actors in the solid waste management in the country.	disposal of any waste whose such generation, storage, handling, transportation, storage or disposal presents an imminent oi substantial danger to public health or to the environment. Section 13 provides for Proof of safe disposal of refuse. It states that; It shall be sufficient proof of safe disposal of refuse if an authenticated payment receipt from a licensed private garbage collector, in case of domestic refuse or a conservancy certificate issued by the council in case of trade or commercial refuse is produced. In addition, every occupier, tenant, agent, or owner is required segregate waste and be stored in separate receptacles until collected or otherwise disposed-off in an approved manner.	NEMA, to collect, transport and dispose waste in areas designated for disposal are contracted for this service. Relevant documentation for waste tracking shall be maintained.

2.4 Administrative Framework

2.4.1 The National Environment Management Authority

The responsibility of the National Environmental Management Authority (NEMA) is to exercise general supervision and co-ordination over all matters relating to the environment and to be the principal instrument of Government in the implementation of all policies relating to the environment.

In addition to NEMA, the Act provides for the establishment and enforcement of environmental quality standards to be set by a technical committee of NEMA known as the Standards and Enforcement Review Committee (SERC) which will govern the discharge limits to the environment by the proposed project.

NEMA has offices at county levels contributing to decentralized environmental management.

Relevance

The project is licensed by NEMA as required and the NEMA county officers will have overall supervision of environmental matters during both construction and operation.

2.4.2 The National Environment Tribunal

The Tribunal performs the following functions:

- To hear and determine appeals from NEMA's decisions and other actions relating to issuance, revocation or denial of Environmental Impact Assessment (EIA) licences or amount of money to be paid under the Act and imposition of restoration orders;
- To give direction to NEMA on any matter of complex nature referred to it by the Director General; and

- In accordance with the Forest Act No. 7 of 2005, NET is mandated to review decisions of the board under sections 33 and 63.

2.4.3 National Environment Complaints Committee

The Act EMCA, 1999 as amended in 2015 established a National Environment 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.

2.4.4 Ministry of Energy and Petroleum (MoEP)

It is responsible for formulation and articulation of energy policies through which it provides an enabling environment for all stakeholders. Its tasks include national energy planning, training of manpower and mobilization of financial resources.

2.4.5 Energy & Petroleum Regulatory Authority (EPRA)

Formerly known as Energy Regulatory Commission (ERC), EPRA was established as an energy sector regulator under the Energy Act, 2019, with responsibility for economic and technical regulation of electric power, renewable energy, and downstream petroleum sub-sectors. Its functions also include tariff setting, review, licensing, enforcement, dispute settlement and approval of power purchase and network service contracts.

OTTL has an Electric power generation license and GDC has a Geothermal Resource License from ERC/EPRA and both are valid.

2.4.6 Energy and Petroleum Tribunal

With the operationalization of the Energy Act, 2019 this quasi-judicial body replaced the Energy Tribunal that was established under section 108 of the Energy Act, 2006. The Energy Tribunal came into operation in July 2007 to primarily hear appeals against the decisions of ERC. The tribunal has jurisdiction to hear and determine disputes and appeals relating to the energy sector in line with the Energy Act 2019 and any other written law.

2.4.7 Geothermal Development Company (GDC)

This is a 100% state-owned company established by the Government of Kenya as a Special Purpose Vehicle for the development of geothermal resources in Kenya.

GDC will supply/deliver steam to the plant based on parameters in the PISSA. GDC has already developed the Steam gathering facilities and will also develop the condensate re-injection systems before the testing and commissioning of the plant.

As the owner of the head lease, GDC will also play crucial role in ensuring that all environmental and safety measures within the geothermal field in general and those pertaining to the steam gathering and re-injection systems in particular are assured. This will require continuous coordination with both OTTL and the other two IPPs as necessary.

2.4.8 Kenya Electricity Transmission Company (KETRACO)

This is a Government of Kenya wholly owned company established to be responsible for the development, maintenance and operation of the national transmission grid network. It is also responsible for facilitating regional power trade through its transmission network.

KETRACO was responsible for development of power evacuation transmission line for the power generated from the plant and its connection to the existing national grid, through the Soilo substation. In this respect, KETRACO was responsible for a separate ESIA and ARAP studies for the power transmission line. The line was implemented following approval by NEMA and implementation of the ARAP.

2.4.9 Other Independent Power Producers (IPPs)

IPPs are private companies which will be responsible for the construction and operation phases of the power plants and selling the generated electricity in bulk to KPLC.

OTTL will liaise with the other two IPPs i.e. Globeleq Menengai Geothermal Limited and Sosian Energy Limited as well as GDC is managing environmental and social issues relating to their power plants' construction and operation within the Menengai caldera.

2.4.10 Kenya Forest Service

Kenya Forest Service (KFS) is mandated to manage public forests within the country and is also the owner of the land in which the project is located. Protection of the Menengai forest cover and general management of the area will require close collaboration between the proponents and KFS. GDC has a memorandum of understanding with KFS in which they have agreed in the development of geothermal resources, management and conservation of forest resources.

2.4.11 Kenya Wildlife Service

Kenya Wildlife Service (KWS) is principal institution responsible for administration of the Wildlife Management Act, 2013. KWS is responsible for protection of all wildlife within the Menengai forest and thus works jointly with KFS in the forest conservation management program.

2.4.12 Directorate of Occupational Safety and Health

Directorate of Occupational Safety and Health (DOSH) is a government agency responsible for enforcement of Occupational Safety and Health throughout the country for the protection of workers and the general public at all work places in line with OSHA, 2007.

The proponent must have its power plants registered as a work place with the Nakuru county office and also submit regular audit and any incidence reports report to the agency.

2.4.13 County Government of Nakuru

Nakuru County as the project host county will have various inputs in the project implementation in line with constitutional functions of county governments. The functions of the county government relevant to the proposed project, as outlined in the Fourth Schedule, Constitution of Kenya 2010 are as follows:

- Agriculture and husbandry;
- Provision of essential services such health services, county transport, education;
- Control pollution and disasters management;
- Monitor cultural activities, public entertainment and public amenities;
- County planning and development;
- County public works and services;
- Implementation of specific national government policies on natural resources and environmental conservation; and
- Encourage public participation in county governance and development

The county government of Nakuru is thus expected to actively be engaged in coordinating various project related activities as far as general environmental conservation and public participation are concerned. This will be better achieved through the county directorate of environment under Ministry of Environment, Natural Resources, Energy and Water.

2.4.14 Water Resources Authority (WRA)

WRA is responsible for regulation of water resources issues such as water allocation, source protection and conservation, water quality management and pollution control and international waters. Its roles and responsibilities are as follows:

- Planning, management, protection and conservation of water resources;
- Planning, allocation, apportionment, assessment and monitoring of water resources;
- Issuance of water permits;
- Water rights and enforcement of permit conditions;
- Regulation of conservation and abstraction structures;
- Catchments and water quality management;
- Regulation and control of water use; and
- Coordination of the Integrated Water Resource Management (IWRM) Plan.

2.4.15 *Land and Environment Court*

The court is mandated to hear and determine disputes relating to the environment and the use and occupation of, and title to land.

2.4.16 *Summary Statutory Permits*

Form the foregoing review, the **Error! Reference source not found.** provides a summary of associated statutory approvals required of OTTL prior to implementation of the project and their current status.

Table 2-3: List of permits/authorizations already obtained by OTTL

License/permit/Authorization	Reference Legal requirement	Issuing authority	Permit status
EIA license Variation Certificate	EMCA	NEMA	Valid up to 29/04/2026.
GDC Geothermal License	The Geothermal Resource Act 1982	EPRA	Valid
Nakuru Planning Approval	Physical Planning Act 1996	Nakuru County Government.	Valid
OTTL Business permits (for Nairobi and Nakuru offices)	National Construction Authority Regulation	Nairobi County Government and Nakuru County Government	Valid.
OTTL Generation License	Energy Act	EPRA	Valid

2.5 International Guidelines

2.5.1 *International Finance Corporation (IFC) Guidelines*

2.5.1.1 *IFC Policy and Performance Standards on Environmental and Social Sustainability 2012*

The Performance Standards (PSs) are relevant to the project, providing guidance on how to identify risks and impacts, and help avoid, mitigate, and manage risks and impacts as a way of ensuring project sustainability, including stakeholder engagement and disclosure obligations of the client in relation to project-level activities. In the case of its direct investments (including project and corporate finance provided through financial intermediaries), IFC requires project proponents to apply the Performance Standards to manage environmental and social risks and impacts so that development opportunities are enhanced.

Below are the eight Performance Standards that the project proponent is required to meet throughout the life of project cycle:

Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts;

Performance Standard 2: Labor and Working Conditions;

Performance Standard 3: Resource Efficiency and Pollution Prevention;

Performance Standard 4: Community Health, Safety, and Security;

Performance Standard 5: Land Acquisition and Involuntary Resettlement;

Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources;

Performance Standard 7: Indigenous Peoples;

Performance Standard 8: Cultural Heritage.

Under the IFC PSs, the proposed Orpower Twenty-Two Limited (OTTL) 35 MW geothermal power plant in Menengai is classified as a Category B project, as its potential environmental and social risks and impacts are limited in scale, site-specific, largely reversible, and can be effectively managed through the application of Good International Industry Practice (GIIP). OrPower/OTTL is a standalone 35 MW power plant whose scope excludes drilling, well testing, reservoir management, or brine disposal. Steam supply, wellfield infrastructure, reinjection and associated facilities are managed by GDC under the PISSA. Although OTTL's physical footprint is confined to a pre-allocated plot with no planned expansion, the project involves material environmental and social risks—especially related to cumulative impacts due to neighboring power plants and GDC's steam facilities—that remain within the project's risk boundary.

A summary of the triggered standards and the appropriate incorporation into the project throughout its life cycle is provided in Table 2-4.

Table 2-4: Summary on the expectation of each of the IFC PSs

PS Triggered	Expectation	Comment
PS1 – Assessment and Management of Environmental and Social Risks and Impacts	• Conduct an ESIA consistent with national law and IFC PSs, including assessment of cumulative risks across the Menengai caldera. • Maintain and periodically update the project's Environmental and Social Management System (ESMS). • Ensure all E&S management plans are updated for operational readiness, including risk identification, monitoring, stakeholder engagement, and emergency preparedness. • Implement continuous stakeholder engagement throughout the project lifecycle, supported by an accessible community grievance mechanism. • Maintain systematic monitoring and management review processes consistent with IFC PS1.	• The ESMS is adequate for construction but requires substantive updates for operations. • A formal process safety assessment (HAZID, HAZOP, QRA) is required to address geothermal process hazards. • The existing Emergency Preparedness and Response Plan must be strengthened with worst-case H_2S scenarios, community protocols, alarms, and periodic drills. • Ensure continuous coordinated, caldera-wide management through GDC-led mechanisms to address cumulative impacts. • Update the SEP to include joint engagement with other IPPs and SEAH-sensitive grievance mechanisms
PS2 – Labour and Working Conditions	• Develop a comprehensive HR Manual aligned with IFC PS2, covering direct workers, contractors, and supply chain. • Ensure clear employment terms, non-discrimination, equal opportunity, and special protection for vulnerable workers. • Maintain a confidential worker grievance mechanism that includes SEAH-sensitive procedures. • Implement an OHS management system consistent with GIIP, covering risk analysis, heat-stress prevention, incident reporting, and worker participation.	• Update current HR policies to ensure they thoroughly cover every essential aspect outlined in PS2. • Worker grievance mechanisms require formalization, documentation, and sexual exploitation abuse and harassment (SEAH) protocols. • Contractor and supply chain management procedures must include screening, a Supplier Code of Conduct, and compliance requirements.
PS3 – Resource Efficiency and	• Promote efficient use of energy, water, and raw materials during construction and operation.	• Concerns were raised about H_2S exposure at Rigogo and Marigo, which led to recommendations

Pollution Prevention	• Implement pollution prevention measures consistent with IFC EHS General and Geothermal Guidelines—including H_2S, noise, wastewater, waste, and hazardous material controls. • Maintain an Air Quality Management Plan that addresses routine and accidental emissions, including H_2S release scenarios. • Establish operational resource-efficiency targets and continuous monitoring systems.	that process-safety assessment results be integrated into air emissions management so these issues can be addressed more effectively. Modelling of cumulative noise impacts reveals heightened baseline levels, highlighting the necessity for more comprehensive and integrated control strategies. Operational efficiency targets and monitoring mechanisms are currently lacking and require development. • Waste, brine reinjection, and stormwater controls are largely consistent but require integration with operational monitoring. • Chemical management should include inventory tracking, emergency response, and substitution analysis to enhance process safety.
PS4 – Community Health, Safety and Security	• Identify and manage community health and safety risks arising from air emissions, noise, traffic, hazardous materials, and labour influx. • Maintain and update an Emergency Preparedness and Response Plan (EPRP) with effective community communication procedures, alarms, H_2S management, and drills. • Implement security arrangements consistent with PS4, including training on human rights, GBV/SEAH prevention, and access to grievance processes. • Establish a Traffic Management Plan covering construction and maintenance activities.	Minimal community interactions undertaken to date. Communities are primarily affected by cumulative odor, noise, and air emissions. • EPRP requires substantive updates to integrate process safety assessment findings, community alerts, and periodic drills • Security arrangements must include contractor due diligence, audit rights, Codes of Conduct, and SEAH-sensitive grievance access. • Traffic risks remain relevant even with low anticipated volumes, especially during equipment mobilization and maintenance. • Community health concerns regarding H_2S require strengthened air quality planning, SEP updates, and accessible GRMs.
PS6 – Biodiversity Conservation and Sustainable	• Assess biodiversity risks consistent with PS6, including habitat impacts within the Menengai Forest Reserve. • Implement biodiversity mitigation hierarchy (avoid–	• While project footprint is small, gaps were identified in baseline vertebrate surveys and requires BMP enhancement. • Cumulative biodiversity impacts are primarily

Management of Living Natural Resources	minimize–restore) especially for natural and modified habitat. • Maintain and update a Biodiversity Management Plan (BMP) including invasive species control, habitat restoration, and reforestation commitments in collaboration with KFS. • Ensure monitoring and adaptive management aligned with caldera-level management roles.	associated with other IPPs, GDC infrastructure, and access roads. • BMP must include reforestation and invasive species procedures, aligned with KFS requirements. • Restoration of disturbed areas at project closure must be explicitly planned and scheduled.

2.5.1.2 *IFC Environmental, Health and Safety General Guidelines*

The EHS general guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice. The guideline will be tailored for the project specific impacts on the environment and human health. The guidelines provide issues and recommendation in the following areas:

- Environmental;
- Occupational health and safety;
- Community health and safety;
- Construction and decommissioning.

2.5.1.3 *IFC Environmental, Health, and Safety Guidelines for Geothermal Power Generation*

The EHS Guidelines for Geothermal Power Generation are applicable to geothermal power generation activities such as exploration and reservoir evaluation, production field development, and power plant construction.

The guidelines provide environmental, health and safety issues that may occur during geothermal generation project such as;

- Effluent.
  - Air emission.
  - Solid waste.
  - Well blowouts and pipeline failure.
  - Water consumption and extraction.
  - Heat.
  - Noise.
  - Geothermal gases.
  - Confined spaces.
  - Infrastructure safety.

Environmental, health and safety performance and monitoring indicators are also provided to be used to measure performance and make correction where performance is not satisfactory. These guidelines have been consulted in completing this report.

2.5.1.3.1 Effluent monitoring guidelines

The guidelines recognize that spent geothermal fluids are typically re-injected to the host rock formation, resulting in minor effluent volumes involving reject waters. However, if spent geothermal fluids are not re-injected, effluents should meet site-specific discharge levels for surface water as discussed in the General EHS Guidelines.

2.5.1.3.2 Emissions monitoring guidelines

Although geothermal energy projects do not normally generate significant point source emissions during construction and operations, hydrogen sulphide emissions, or other types of emissions, should not result in ambient concentrations above nationally established air quality standards or, in their absence, internationally recognized guidelines.

2.5.1.3.3 Occupational health and safety guidelines

These IFC guidelines require occupational health and safety performance of geothermal project to be evaluated against internationally published exposure guidelines. Examples of these include: the Threshold Limit Value (TLV) occupational exposure guidelines and Biological Exposure Indices (BEIs) published by American Conference of Governmental Industrial Hygienists (ACGIH), the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Safety and Health (NIOSH), Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA), Indicative Occupational Exposure Limit Values, published by European Union member states, or other similar sources.

A review of the various international guidelines for hydrogen sulphide (H_2S), for both general community health and occupational exposure relevant to the project is summarized in table below.

Table 2-5: Summary of recommended limits by various international organizations

Effect	Concentration (µg/m^3)	Concentration (ppm)	Averaging period
Occupational	1500(ACGIH)	1	8 hours
Community Health	150(WHO)	0.1	24 hours
	50 (Iceland)	0.03	24 hours
	10 (OEHHA)	0.007	annual
Community odour	7 (WHO)	0.005	30 minutes
	70 (New Zealand)	0.05	1 hour

The WHO limits are recommended for the Menengai project's community heath and odour assessment while ACGIH guidelines are recommended as target for the occupational exposure.

2.5.1.4 IFC Cumulative Impact Assessment and Management Guidance for the Private Sector in Emerging Markets

The Guidelines are based on IFC's experience in applying its Performance Standards and are to be used in conjunction with the Performance Standards, their Guidance Notes, and the World Bank Group Environmental, Health, and Safety Guidelines, which contain basic requirements and good international practices to be followed when designing, developing, and/or implementing projects. It provides a practical guidance to companies investing in emerging markets to improve their understanding, assessment, and management of cumulative environmental and social impacts associated with their developments.

For private sector management of cumulative impacts, IFC considers good practice to be two pronged:

- Effective application of and adherence to the mitigation hierarchy in environmental and social management of the specific contributions by the project to the expected cumulative impacts; and
- Best efforts to engage in, enhance, and/or contribute to a multi stakeholder, collaborative approach to implementing management actions that are beyond the capacity of an individual project proponent.

Cumulative Impact Assessment (CIA) should focus the assessment and management strategies on Valued Environmental and Social Components (VESCs) such as

- Physical features, habitats, wildlife populations (e.g., biodiversity);
- Ecosystem services;
- Natural processes (e.g., water and nutrient cycles, microclimate);
- Social conditions (e.g., health, economics), or
- Cultural aspects (e.g., traditional spiritual ceremonies).

It should employ information from a variety of instruments including, regional and local environmental, social and resource studies, programs and/or planning documents; strategic, sectoral, and regional assessments; project impact assessments, cumulative impact assessments, and targeted studies on specific issues.

Project initiated CIA have six objectives:

1. Assess the potential impacts and risks of a proposed development over time, in the context of potential effects from other developments and natural environmental and social external drivers on a chosen VESCs;
2. Verify that the proposed development's cumulative social and environmental impacts and risks will not exceed a threshold that could compromise the sustainability or viability of selected VESCs;

3. Confirm that the proposed development's value and feasibility are not limited by cumulative social and environmental effects;
4. Support the development of governance structures for making decisions and managing cumulative impacts at the appropriate geographic scale (e.g., airshed, river catchment, town, regional landscape);
5. Ensure that the concerns of affected communities about the cumulative impacts of a proposed development are identified, documented, and addressed;
6. Manage potential reputation risks.

The proposed project is one out of three power plants within the Menengai geothermal field. This report has considered in detail the potential cumulative impacts of all the three power plants operating at the same time, with focus on cumulative noise and air quality impacts.

2.5.1.5 IFC Good Practice Note (GPN) on Managing Contractors' Environmental and Social Performance

These guidelines help project developers to provide sound, consistent, and effective approaches for managing the E&S performance of contractors to ensure compliance with IFC requirements. The GPN provides practical information for each step in the contractor selection and contractor management process, from preparing the request for proposal (RFP) to contract termination. Thus, these guidelines will provide handy information to OTTL in framing the expectations from the appointed contractor as well as monitoring the contractor during construction period.

2.5.2 Africa Development Bank Integrated Safeguard Standards (ISS)

In 2013, the African Development Bank adopted an Integrated Safeguards System (ISS) (also referred to as the "2013 ISS"), which established the Bank Group's commitment to sustainable development. This system has since been revised and approved by the AfDB Board on April 2023 and came into force on 31st May 2023. One of the key aims of the ISS was to better align Operational Safeguards (OSs) with the Bank's new policies and strategies. The Environmental and Social Operating Safeguards set out the requirements for Borrowers relating to the identification and assessment of E&S risks and impacts associated with operations supported by the Bank.

Under the African Development Bank (AfDB) Integrated Safeguards System (ISS), the project is designated as a Category 1 undertaking. This category is reserved for projects likely to result in significant adverse environmental and/or social impacts that are sensitive, diverse, or unprecedented, and which may affect a large area or population. The classification is informed by several factors, including the project's footprint within a sensitive ecosystem, the anticipated emissions and air quality implications, occupational safety hazards linked to geothermal infrastructure, and socio-economic disruptions associated with construction and operations. As a Category 1 project, AfDB requires the preparation of a full Environmental and Social Impact Assessment, along with a robust Environmental and Social Management Plan (ESMP), public disclosure, and meaningful stakeholder engagement throughout the project life cycle.

The E&S OSs establish the standards that Borrowers shall meet, as appropriate, in projects, activities, and initiatives supported through Bank financing throughout the life cycle of operations, as follows:

- E&S OS 1: Assessment and Management of Environmental and Social Risks and Impacts
- E&S OS 2: Labour and Working Conditions
- E&S OS 3: Resource Efficiency and Pollution Prevention and Management
- E&S OS 4: Community Health, Safety and Security
- E&S OS 5: Land Acquisition, Restrictions on Access to Land and Land use, and Involuntary Resettlement
- E&S OS 6: Habitat and Biodiversity Conservation and Sustainable Management of Living Natural Resources
- E&S OS 7: Vulnerable Groups
- E&S OS 8: Cultural Heritage
- E&S OS 9: Financial Intermediaries
- E&S OS 10: Stakeholder Engagement and Information Disclosure.

The proposed OTTL Geothermal Project shall be aligned with the AfDB E&S OSs as appropriate. The table below presents a discussion on E&S OSs triggered by the proposed geothermal project, their requirements and relevance.

Table 2-6: Summary on the expectation of each of the AfDB E&S Oss

E&S OS Standard	Requirements	Comment
E&S OS 1: Assessment and Management of Environmental and Social Risks and Impacts.	• The proponent shall undertake ESIA Study and assess, manage and monitor the environmental and social risks and impacts throughout the project life cycle. • The ESIA study • will include assessment of the existing baseline conditions. and potential risks and impacts, as well as potential risks and impacts in an ESIA • E&S risks and impacts related to gender in-equalities, climate change, and vulnerability should also be assessed. • The proponent shall develop a Stakeholder engagement plan and an information disclosure system. • A comprehensive stakeholder engagement should be carried out throughout the project life cycle. • The Proponent shall require that all contractors engaged in the project, set of activities or other initiatives operate in a manner consistent with the requirements of this Operating standard, including the specific requirements set out in the ESMP.	• A comprehensive E&S risk/impacts assessment was carried out following which an ESMP and a monitoring plan was prepared to guide management and monitoring of the risks and impacts throughout the project life cycle. • Monitoring of the E&S performance shall be carried out in accordance with the financing agreement, ESMP and Operation Standards. • An SEP was prepared for implementation to guide stakeholder engagement throughout the project lifecycle. The proponent shall use appropriate means for information disclosure to relevant stakeholders. • The proposed project shall also integrate climate change mitigation technologies as well enhancing gender equality through the project cycle. • The proponent shall ensure the contractors adhere to E&S risk mitigation and management procedures.
E&S OS 2: Labour and Working Conditions	The scope of application depends on the type of employment relationships between the proponent and the *project workers*. The term Project worker refers to: people employed or engaged directly by the proponent, including the proponent(s) of project/ activities and the implementing agencies that carry out projects, activities or other initiatives, to work specifically on the project (*direct workers, contracted workers, community workers, primary supply workers*); • The Proponent shall develop and implement written Labour Management Procedures (LMPs) applicable to the project. These procedures will set out the way in which project workers will be managed, as a minimum, in accordance with the requirements of national law and this OS. The LMPs will apply to different categories of project workers	The proponent shall establish and implement LMPs, • A Grievance Redress Mechanism for Workers, community and other external stakeholders shall be developed and implemented. • An Occupational Safety and Health Management Policy/Plan and an occupational incidents register shall be developed and implemented as subsidiary plans to the ESIA study. • Ensure the project activities shall not involve child labour.

	and the way in which the proponent shall require third parties to manage their workers. • The LMPs will clearly identify the terms and conditions under which community labour will be engaged, including the amount and method of payment and working hours. The LMPs will also specify the way in which community workers can raise grievances in relation to the project activities or other initiatives. • The LMPs will also address cases where child labour, forced labour, or Sexual Exploitation, Abuse and Harassment (SEAH) has occurred. • The proponent shall put in place Grievance Redress Mechanisms (GRM). • The proponent shall ensure measures relating to enhancement of Occupational Safety and Health and reporting, and protection of the workforce are put in place. • Identification of potential risks of child labour, forced labour and serious safety issues which may arise in relation to primary suppliers. • In case of significant risks of child labour or forced labour related to primary supplier workers, the proponent shall require the primary supplier to identify those risks.	• Ensuring employees' rights are observed including prohibition of SEAH. • The Proponent shall ensure all workers have terms and conditions of employment in appropriate form.
E&S OS 3: Resource Efficiency and Pollution Prevention and Management	▪ The Proponent shall include resource-efficiency and pollution-prevention principles in the project activities in accordance with the principles of cleaner production. ▪ The Proponent shall implement technically and financially feasible measures for improving the efficient consumption of energy, water, and raw materials, as well as other resources. These measures will integrate the principles of cleaner production into product design and production processes to conserve raw materials, energy and water, as well as other resources. ▪ The proponent shall avoid the release of pollutants or, when avoidance is not feasible, minimize and control the concentration and mass flow of their release using the performance levels and measures specified in national law or the EHSGs, whichever is most stringent. This applies to the release of pollutants to air, water, and land due to routine, non-routine, and accidental circumstances. ▪ The Proponent shall implement technically and financially feasible and cost-effective options to avoid or minimize air emissions/ GHGs emission during the design, construction, and operation of the project or activities.	• The proposed project water demand is low. • The project will apply appropriate technology to ensure maximum utilization of available steam, reinjection and H_2S monitoring. • The Proponent shall put in place measures to avoid the release of pollutants to air, water, and land or, when avoidance is not feasible, minimize and control the concentration and mass flow of their release using the performance levels and measures specified in national law. • The Proponent shall establish and implement a waste management plan applicable through the project life cycle for proper handling and

	▪ The proponent is required to ensure sound management of hazardous and non-hazardous waste as well as chemicals.	management of hazardous and non-hazardous wastes to control potential pollution. • The proponent shall ensure efficient utilization of raw materials. • The proponent shall establish and implement a chemical Management plan if necessitated by the quantity of chemicals use through the project life cycle. • The proponent shall ensure continuous monitoring of air quality to ensure any trace emissions are within permissible standards.
E&S OS 4: Community Health, Safety and Security	• The Proponent shall identify the public health and safety risks and impacts of the project on the communities within the project area of influence through the project life cycle. • The proponent shall develop and implement a Public Health and Safety Management Plan which should form an integral part of the project's overall ESMP. • The Public Health and Safety Management Plan should be regularly reviewed and updated as required. • The Proponent should identify and implement measures to address project-related emergency events that could compromise community health and safety. • The Proponent shall design, construct, operate, and decommission the structural elements of the project in accordance with national legal requirements and the ISS Guidance Notes, taking into consideration safety risks to third parties and affected communities • The design of the plant facilities will take into account the provision of universal access for persons with disabilities • The Proponent shall identify, evaluate, and monitor the potential traffic relevant to the project, and road safety risks to workers, affected communities, and road users throughout the operational life cycle. • The Proponent shall avoid or minimize the potential for community exposure to water-borne, water-based, water-related, and vector-borne diseases, as	• The Proponent shall develop and implement an ESMP incorporating a Public Health and Safety Management Plan (PHSMP). • This PHSMP will identify risks and impacts and propose mitigation measures and address requirements for emergency prevention, preparedness and response, and disease prevention and containment planning. • In addition, the Proponent shall develop an Emergency Response Plan covering both internal and external risks. • A traffic Management plan shall be developed. As guided by this plan, road safety assessment for each phase of the project or activities shall be undertaken and also monitoring of incidents and accidents, and regularly prepare the respective reports. These reports shall be used to identify safety issues, followed by establishment and implementation of measures to resolve them. • For vehicles or fleets of vehicles used for the project or activities, appropriate processes shall be put in place including driver training, to

	well as communicable and non-communicable diseases that could result from project activities. • The Proponent shall take necessary measures to avoid, mitigate, and manage the risks and potential adverse impacts on public health and safety arising from the influx of workers to the project. These risks and impacts may be associated with changes in population composition, intangible cultural heritage, health implications, exposure to communicable diseases, increased risk of gender-based violence (GBV) and sexual exploitation, abuse and harassment (SEAH), and increased vulnerability of communities in the area of influence of the project due to increased pressure on available health facilities. • To ensure that women, girls, boys, and men are protected from SEAH and GBV, and avoid and contain the spread of diseases associated with influx of Workers, especially sexually transmitted diseases (including HIV/AIDS), the proponent shall organize training and awareness programmes, and also put in place codes of conduct for workers and sensitize them on expectations of the codes. • The Proponent shall assess the risks to and impacts on workers and communities in and surrounding the project area of influence resulting from the use of arrangements provided by security personnel, whether privately outsourced or publicly provided.	improve driver and vehicle safety, as well as systems for monitoring and enforcement • The proponent shall in collaboration with Health facilities within the project area of influence monitor the pattern of spread of respiratory and communicable diseases within the community to ensure implementation of measures to address causative factors if related to proposed plant activities. • The risks and impacts resulting from influx of Workers may be associated with changes in population composition, intangible cultural heritage, health implications, exposure to communicable diseases, increased risk of gender-based violence (GBV) and sexual exploitation, abuse and harassment (SEAH), and increased vulnerability of communities in the area of influence of the project due to increased pressure on available health facilities. • Measures shall be taken to avoid or minimize the transmission of communicable diseases (HIV/AIDs) that may be associated with the influx of temporary or permanent labour. • All workers shall be required to sign and adhere to the Codes of conduct. • The proponent shall ensure that Security personnel does not pose any health and safety danger to members of the public, or community and their modes of operations respect human rights.
E&S OS 6: Habitat and Biodiversity Conservation and Sustainable Management of	• The Proponent shall undertake assessment of threats to biodiversity, for example, habitat loss, degradation and fragmentation, introduction of invasive alien species, nutrient loading, pollution, and incidental take, as well as projected climate change impacts. • The project is required to acquire services of a qualified biodiversity Expert for Biodiversity management.	• Though the proposed project has insignificant impacts on Biodiversity, the Proponent shall aim to avoid adverse impacts on biodiversity and habitats.

Living Natural Resources	• The proponent is required to avoid or minimize impacts on modified, natural and critical habitats.	• The Proponent shall decide on terms of employment for Biodiversity Management Expert whether on temporary, permanent or contractual. • When avoidance of adverse impacts is not possible, the mitigation measures will be implemented to minimize adverse impacts and restore biodiversity. • Continued Biodiversity assessment and habitats evaluation should continue through the project life cycle to ensure identification of any changes in the natural environment and wildlife. • The Proponent shall implement measures to avoid accidental or unintended introduction of alien/invasive species potentially during transportation of substrates and vectors (e.g. soil, ballast, and plant materials) that may harbor alien species. • Due to minimal direct risks/impacts on Biodiversity, the project may not require a Biodiversity Management Plan at this stage unless deemed important during operation phase.
E&S OS: Stakeholder Engagement and Information Disclosure.	• Requires engagement with stakeholders throughout the project life cycle. • Engagement should start as early as possible in the project development process and in a time frame that enables meaningful consultations with stakeholders on project design. • Consultation should be meaningful which is realized through provision of timely, relevant, understandable, and accessible information to stakeholders, and consulting them in a culturally appropriate manner, free of manipulation, interference, coercion, discrimination, intimidation, and reprisal. • It also requires maintenance a documented record of stakeholder engagement, a summary of the feedback received, and a brief explanation of whether or not the feedback was taken into account, in the ESIA Study. • A disclosure system for the ESIA study results and findings is recommended. • The proponent shall acquire services of qualified personnel for continued stakeholder engagement through the project life cycle.	• A Stakeholder Engagement Plan was prepared for the proposed project covering the entire project life cycle. • The Proponent will prepare, implement and maintain an information disclosure system for the project. • The Proponent carried out Stakeholder consultation during the ESIA process and the engagement shall continue through the project lifecycle. • The proponent shall decide on the terms of employment for stakeholder engagement personnel. These experts shall be involved in

		implementation and/or improvement of the SEP through the project life cycle.

2.6 International Conventions and Agreements

Kenya has ratified various conventions, treaties and have signed different agreements relevant to the proposed project. Some of these international instruments have been domesticated in the country using regulations. Reference is made to the most relevant instruments to verify how the proposed project design, implementation and operation processes are in line with the requirements of the international instruments.

2.6.1 Vienna Convention for the Protection of the Ozone Layer

Intergovernmental negotiations for an international agreement to phase out ozone depleting substances concluded in March 1985 with the adoption of the Vienna Convention for the Protection of the Ozone Layer. This Convention encourages intergovernmental cooperation on research, systematic observation of the ozone layer, monitoring of CFC production, and the exchange of information.

The Montreal Protocol on Substances that Deplete the Ozone Layer was adopted in September 1987 and was intended to allow the revision of phase out schedules on the basis of periodic scientific and technological assessments. The Protocol was adjusted to accelerate the phase out schedules. It has since been amended to introduce other kinds of control measures and to add new controlled substances to the list.

Relevance

The Proponent will ensure measures set out in the ESMMP are fully implemented to ensure adequate mitigation of adverse impacts of GHG emissions.

2.6.2 Convention on Biological Diversity

The purpose of this convention is to ensure the conservation and sustainable use of biodiversity. Kenya signed the convention on 5th June 1992 and ratified the same on 26th July 1992. The National Environment Management Authority (NEMA) is the national focal point to this Convention on Biological Diversity. The provisions of this Convention have been integrated in many laws of Kenya.

Relevance

The provisions of this convention will be considered to guide in developing measures to conserve the biodiversity (various plants, animals and the variety of the ecosystem) within the Menengai forest which can be impacted by the Project activities.

2.6.3 African Convention on the Conservation of Nature and Natural Resources

This convention reaffirms the importance of natural resources both renewable and non-renewable, particularly the soil, water, flora and fauna. The main objective is to facilitate sustainable use of the above resources. The convention was adopted in Algiers on 15th September, 1968 and came into force on 16th June 1969.

Relevance

Some indigenous trees exist within the project area whose conservation are important. The project shall encourage the planting of indigenous trees to try to restore a balance within the ecosystem.

2.6.4 The United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC is a “Rio Convention”, one of three adopted at the “Rio Earth Summit” in 1992. Its sister Rio Conventions are the UN Convention on Biological Diversity and the Convention to Combat Desertification. The UNFCCC was adopted on 9th May 1992 and came into force on 21st March 1994. The Convention has been ratified by 189 states. Kenya ratified the Convention on 30th August 1994.

The primary focus of this convention is to stabilize greenhouse gas concentrations at levels that allows ecosystems to adapt naturally to climate change so that food production is not threatened, while enabling economic development to proceed in a sustainable manner. It requires the State parties to establish measures or actions for mitigation of climate change in different sectors of the economy.

Relevance

Measures will be put in place to ensure minimization of emission of GHGs through the project life cycle. Of importance is to ensure continued monitoring during Operation phase. Geothermal Power is a clean renewable energy which contributes to lowering GHGs emissions hence this project is in line with Kenya's aspiration of promoting renewable energy to lower GHGs emission.

2.6.5 Convention on International Trade in Endangered Species

This Convention was adopted on 3rd March 1973 and came into force on 1st July 1975. The purpose of the Convention is to regulate the international trade in wild plants and animals that are at risk of extinction as a result of trade. The Convention seeks to control trade not only in live species but also in dead specimen and their derivatives. The Kenya Government ratified CITES on 13 December 1978. The lead agency for the CITES in Kenya is the Kenya Wildlife Service (KWS).

Relevance

There is no evidence of endangered plant and animal species within the site and also within the Menengai forest. However, the project developer will work in collaboration with relevant Lead Agencies (KFS, KWS) to ensure conservation of the forest, protection of habitats and prohibition of trade in endangered species if such species are discovered in the future.

2.6.6 The Paris Agreement, 2015

This Agreement aims to limit global warming to well below 2^{o}c and pursue efforts to limit it to 1.5^{o}c. The Agreement also aims to enhance countries' ability to adapt to the adverse impacts of climate change. In addition, the Agreement seeks to increase the resilience of countries to climate-related hazards and disasters Countries are also encouraged to take actions to mitigate GHGs emissions and transition to a low-carbon economy. Countries are required to submit Nationally Determined Contributions (NDCs) outlining their climate action plans and targets.

Relevance

Kenya has included geothermal energy in its NDCs as a means to reduce GHGs emissions and transition to a low carbon economy. Kenya's NDC and national plans aim to develop 5,000Mw of geothermal power by 2030. The proposed power plant will produce an additional 35MW. The proposed power plant introduces new technology with almost zero release of GHGs.

2.6.7 Convention on the Rights of the Child

The Convention on the Rights of the Child (CRC), 1989 is the most comprehensive compilation of international legal standards for the protection of the human rights of children. The CRC is also the most widely ratified international human rights treaty, ratified by all countries in the world, with the exception of two. The Convention acknowledges children as individuals with rights and responsibilities according to their age and development (rather than the property of their parents or as victims), as well as members of a family and community. Underlying the Convention are four main principles: non-discrimination, the best interests of the child, the right to life, survival and development and the right to participation.

The CRC reaffirms children's basic human rights to health, shelter and education. Special emphasis is placed on safeguarding family unity and the reunification of families (Articles 8, 10, 20). Another fundamental right enumerated in the Convention is the child's right to education and the obligation of states to make primary education free and compulsory for all children (Articles 28, 29). Education has also been identified as an effective and essential form of protection for displaced children. For example, displaced children in school may be more protected from the risks of military recruitment, exploitation and abuse. Educational and recreational activities, like sports, can also help children recover from the trauma of conflict and displacement *(Internal Displacement Monitoring Centre, 2004).*

Relevance

The developer will not allow employment of underage children through the project life cycle. In addition, during operation, in consultation with the Community, the Developer will consider education as part of the Corporate Social Responsibilities.

2.6.8 Convention on the Elimination of all forms of Discrimination against Women

The convention was adapted in 1979. It provides the basis for realizing equality between women and men through ensuring women's equal access to, and equal opportunities in political and public life as

well us education, health and employment. It also affirms the reproductive rights of women.

Relevance

The project will be implemented with full compliance to requirements of this convention. This will be through enabling women equal rights to men especially on employment opportunities and also respect Women rights through the project life cycle.

2.6.9 International Labour Organization's Conventions and Standards

Since 1919, the International Labour Organization (ILO) has developed and maintained a system of international labour standards aimed at promoting opportunities for women and men to obtain decent and productive work, in conditions of freedom, equity, security and dignity.

International labour standards are legal instruments drawn up by the ILO's constituents (governments, employers and workers) and set out basic principles and rights at work. They are either *conventions*, which are legally binding international treaties that may be ratified by member states, or *recommendations*, which serve as non-binding guidelines. Some of the key provisions that must be observed under the standards include:

- Freedom of association of workers;
  - Prevention of Forced labour;
  - Prevention of Child labour; and
  - Prevention of Discrimination

2.6.9.1 Key ILO Conventions which are relevant to the proposed project include;

Discrimination (Employment and Occupation) Convention (1958) (No.111): Calls for a national policy to eliminate discrimination in access to employment, training and working conditions, on grounds of race, colour, sex, religion, political opinion, national extraction or social origin and to promote equality of opportunity and treatment,

Equal Remuneration Convention (1951) (No.100): Calls for equal pay and benefits for men and women for work of equal value.

Minimum Age Convention (1973) No. 138): Aims at the abolition of child labour, stipulating that the minimum age for admission to employment shall not be less than the age of completion of compulsory schooling.

Worst Forms of Child Labour Convention (1999) (No. 182): Calls for immediate and effective measures to secure the prohibition and elimination of the worst forms of child labour which include slavery and similar practices, forced recruitment for use in armed conflict, use in prostitution and pornography, any illicit activity, as well as work which is likely to harm the health, safety and morals of children.

Relevance

Kenya has been a signatory to ILO since 1963 and all Labour conditions in the country are expected to abide by ILO provisions, through compliance to the country's Employment Act (2023), Children's Act (2022), Sexual offences Act (2006) and National Gender and Equality Act (2011).

3 PROJECT ENVIRONMENT DESCRIPTION

3.1 Physical Environment

3.1.1 Climate

The project area is classified into two main agro-climatic zones. The lowland areas of Rongai subcounty (Mogotio and Kisanana) in the north are located in semi-arid zone IV with an annual rainfall of 800 mm and mean temperatures of 30°C. Bahati within Nakuru North sub county and parts of 'Kampi ya Moto' divisions with an altitude of between 1800 m and 2400 m above sea level and average rainfall of between 760 mm and 1270 mm per year fall within a dry sub-humid equatorial climatic zone.

3.1.1.1 Temperature

The temperatures in Rongai and Nakuru North sub-counties of Kenya exhibit moderate variations throughout the year, reflecting their highland climates.

In Rongai sub county, the average high temperatures range from around 20.9°C (69.6°F) in July to 24.8°C (76.6°F) in March. The average low temperatures vary from 9.9°C (49.8°F) in January to 12.2°C (54°F) in April. The overall mean temperatures are relatively stable, maintaining a comfortable climate year-round

Nakuru North sub county, being close to Rongai sub county, experiences similar weather patterns. The average high temperatures range from 21.1°C (70°F) in July to 26.1°C (79°F) in February, while the average low temperatures range from 11.1°C (52°F) in July and August to 13°C (55.4°F) in April. The mean temperatures across the year are around 18°C (64°F) to 19°C (66°F)

These regions benefit from a mild climate with moderate temperatures, making them suitable for various agricultural activities and comfortable for residents and visitors alike.

Mean monthly temperatures for Rongai and Nakuru North sub counties are illustrated in Table 3.1below.

Table 3-1: Average monthly temperature

Month	Rongai Avg. High (°C/°F)	Rongai Avg. Low (°C/°F)	Rongai Avg. Temp (°C/°F)	Nakuru North Avg. High (°C/°F)	Nakuru North Avg. Low (°C/°F)	Nakuru North Avg. Temp (°C/°F)
January	24.7 / 76.5	9.9 / 49.8	17.3 / 63.1	24.4 / 75.9	12.6 / 54.7	18.4 / 65
February	25.3 / 77.5	10.0 / 50.0	17.7 / 63.9	26.1 / 79.0	12.5 / 54.5	19.3 / 66.8
March	24.8 / 76.6	11.0 / 51.8	17.9 / 64.2	26.0 / 78.7	12.9 / 55.2	19.4 / 67.0
April	24.1 / 75.4	12.2 / 54.0	18.2 / 64.8	23.8 / 74.8	13.0 / 55.4	18.2 / 64.8
May	23.3 / 73.9	12.1 / 53.8	17.7 / 63.9	22.8 / 73.0	12.6 / 54.7	17.4 / 63.4
June	22.2 / 72.0	11.7 / 53.1	16.9 / 62.4	22.0 / 71.7	11.8 / 53.2	16.7 / 62.1
July	20.9 / 69.6	10.9 / 51.6	15.9 / 60.6	21.1 / 70.0	11.2 / 52.1	16.0 / 60.8
August	21.3 / 70.3	11.2 / 52.1	16.3 / 61.3	21.3 / 70.3	11.1 / 52.0	16.1 / 60.9
September	23.3 / 73.9	11.9 / 53.4	17.6 / 63.7	22.6 / 72.8	11.1 / 52.0	16.9 / 62.3
October	23.7 / 74.7	12.1 / 53.8	17.9 / 64.2	22.9 / 73.2	12.0 / 53.6	17.4 / 63.2
November	22.8 / 73.0	11.7 / 53.1	17.2 / 63.0	21.9 / 71.4	12.6 / 54.7	17.0 / 62.6
December	24.3 / 75.7	10.8 / 51.4	17.6 / 63.7	22.6 / 72.8	12.7 / 54.8	17.4 / 63.4

Source: ***Weather Atlas, 2024***

3.1.1.2 Rainfall

Around Nakuru area, mean annual rainfall is approximately 900 mm. The rainfall regimes are bimodal with the long rains occurring in March to July and the short rains in September to November.

According to Climate-Data.org (2024) Nakuru North sub county of the project area experiences an average annual rainfall of approximately 657 mm (25.87 inches). This area experiences a range of weather patterns with significant rainfall occurring throughout the year, especially during the months of April and August. Rongai sub-county, being part of the larger Nakuru region, has similar rainfall patterns. Rongai also experiences substantial rainfall, particularly during the rainy seasons from March to May and October to December. Overall, both sub-counties experience moderate to high annual rainfall, supporting the agricultural activities in the region.

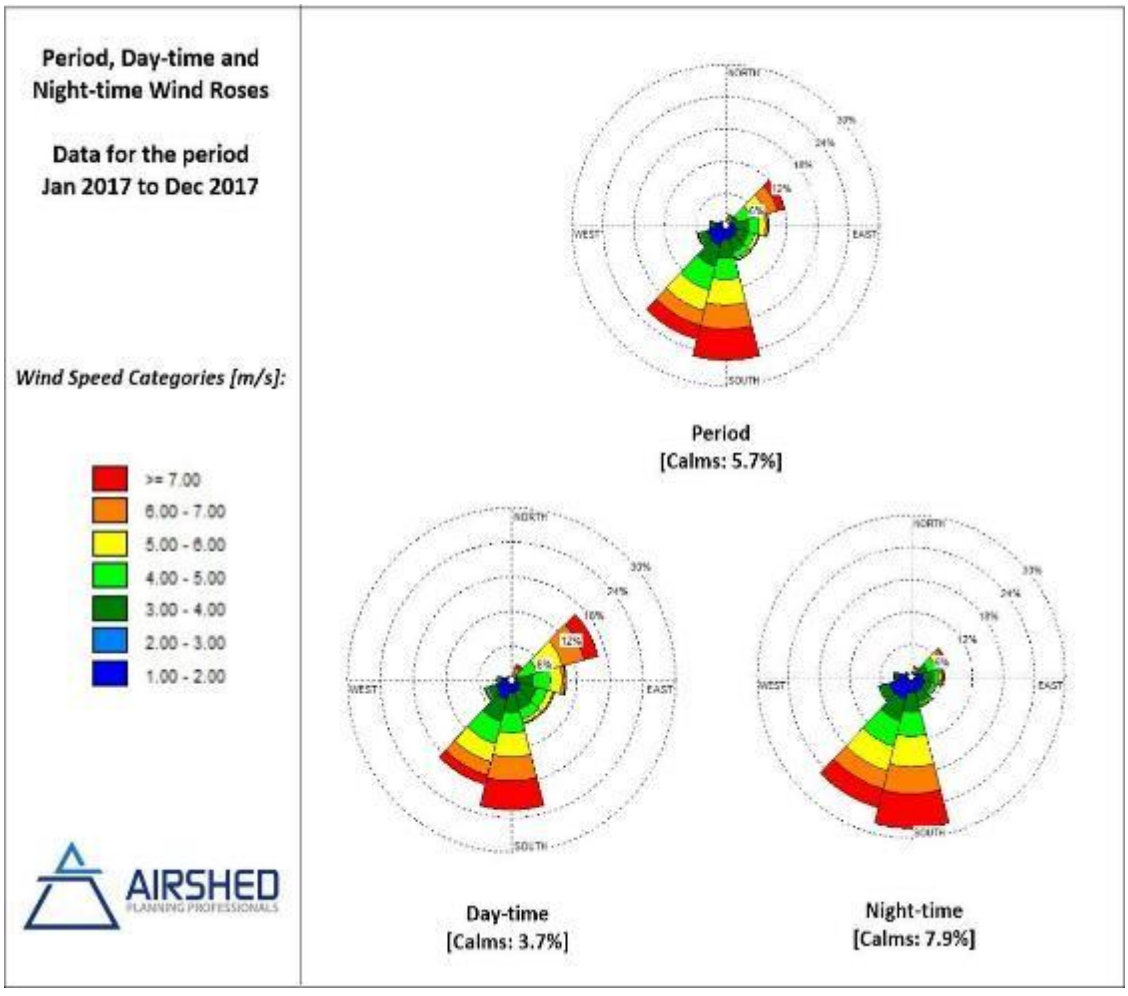
3.1.1.3 Surface wind field

Wind roses comprise 16 spokes, which represent the directions from which winds blew during a specific period. The colours used in the wind roses below, reflect categories of wind speeds: for example, yellow representing winds between 5 and 6m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. The frequency with which calms occurred, i.e. periods which the wind was below 1m/s are also indicated.

Figure 3-1 depicts the predominance of southerly winds with speeds of greater than 5m/s. The day-time wind rose shows an increase in winds from the north easterly sector and lower calms (3.7%), whereas the night-time wind rose shows an increase in the southerly winds and higher calms (7.9%).

The MM5 data used in the initial Quantum assessment depicted the predominance of south easterly and north-north-westerly winds.

Figure 3-1: Period, day- and night-time wind roses

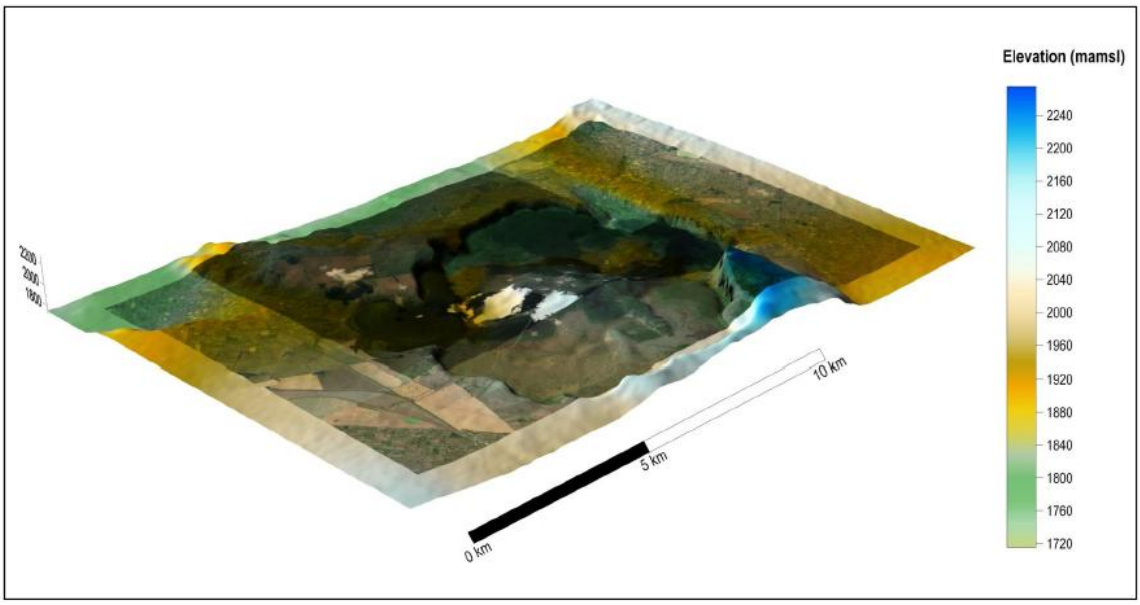


Source: Airshed Air Quality Impact Assessment report, 2024

3.1.2 Topography

An analysis of topographical data indicated a slope of more than 1:10 from areas of operations to the nearest elevated point. The topography of the study area is shown in Figure 3-2 overleaf.

Figure 3-2: Topography of study area



Source: Airshed Planning Professionals, 2024

3.1.3 Geology and soil

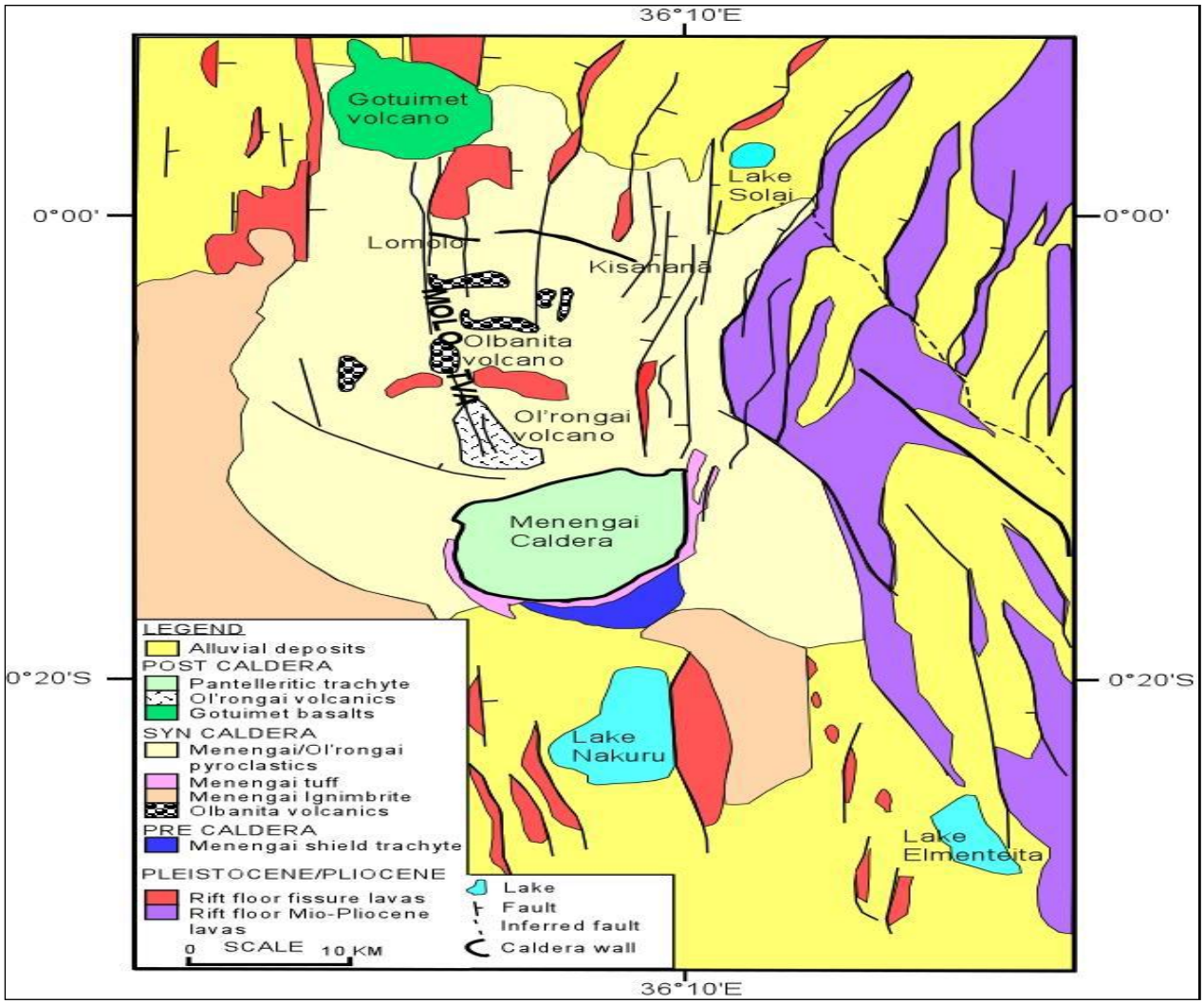
Menengai Caldera is characterized by two trachytic main rock series by age. The older one is that of Pliocene which is characterized by two successive strata. The earlier one is of Pliocene and is characterized by phonolitic trachytes. These appear to have formed during volcanic processes before the formation of the caldera as depicted by their outcrops on the walls of the caldera's ring-structure. Overlying the phonolitic trachytes is the successive stratum that comprises welded vitreous tuffs and ignimbrites. These extend briefly outwards from the ring-structure, except markedly longer extensions towards south east and north-west, with bias towards northwest direction (Figure 3-3). This implies a major direction of flow during the volcanic episode.

The younger rock series is recent (Quaternary) and is characterized by trachyte flows. Glassy flows are common among the recent series. This series cover almost all the caldera floor (Figure 3-3) and its occurrence depicts products of volcanic processes that accompanied or followed after the caldera-collapse.

Like in many other sections Eastern African Rift System, Menengai Caldera occurs within a normal-fault-system. Generally, the occurrence appears as an interruption of intense faulting and fracturing that runs north-south Kenya's rift valley. However, at and around the caldera, the ring-structure of the fault created by formation of the caldera is conspicuous. Other associated faults are also observed in and around the caldera. Other noticeable structures are lava flows depicted by the rocks structure. These include ropy, bandy, blocky and glassy structures of rocks observed inside the caldera during this study. The lithological and structural geology play a part in the physiography of the project area.

The soils in the prospect area are volcanic soils of varying thickness. These occur together with superficial deposits. Due to the physiography of the caldera, patches of alluvial deposits are found in some basinal features within the caldera, and the lower areas from the base of the volcano outwards.

Figure 3-3: Geological Map of Menengai Caldera

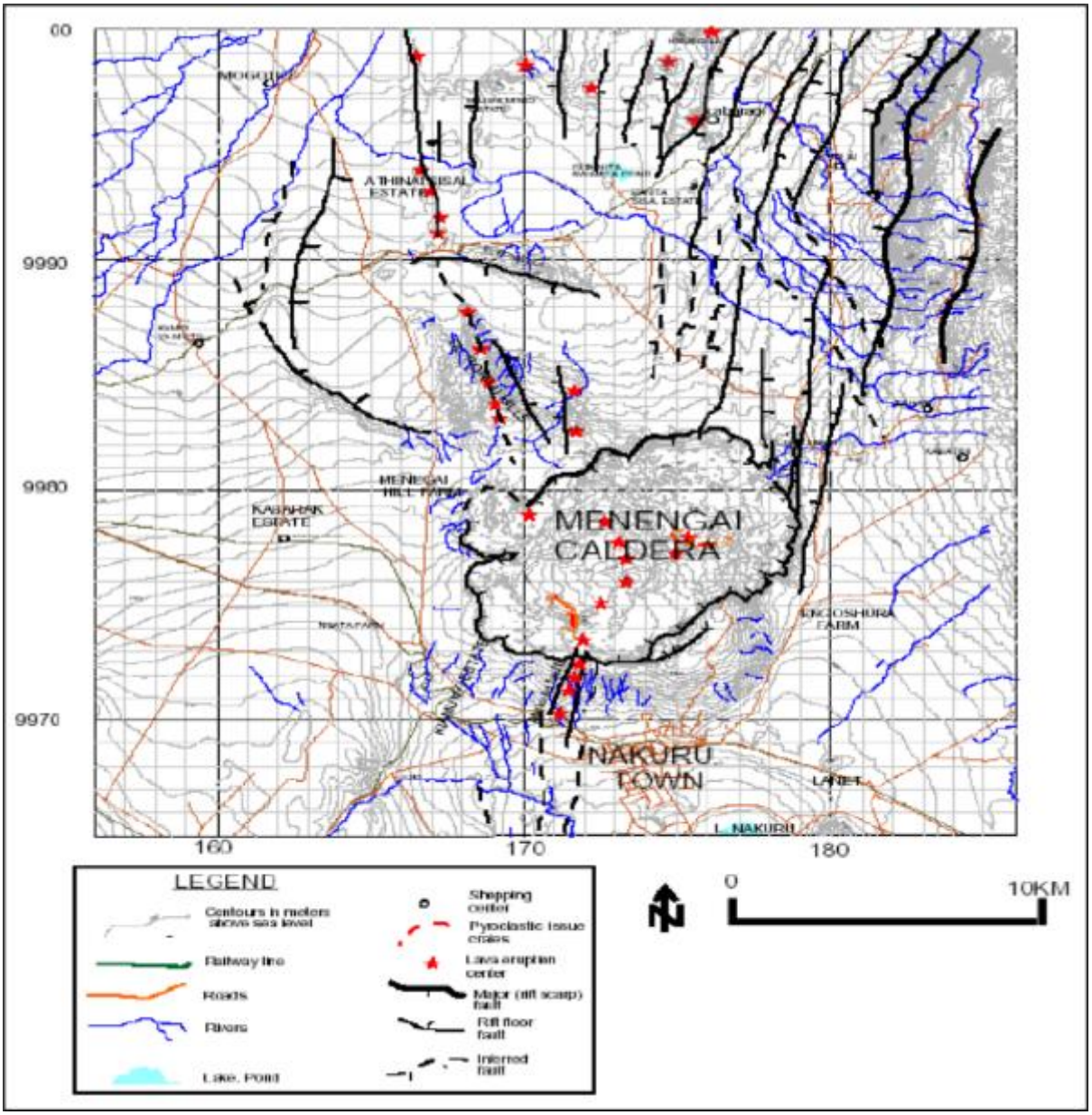


Source: GDC, 2024

3.1.4 Hydrology and Hydrogeology

The Menengai area lies on the rift floor that gently slopes northwards. On the east, the Bahati and Marmanet scarps bound the eastern inner rift trough and are relatively higher and wetter grounds. To the west, the rift floor slopes gently into a series of ridges connecting the Mau-Londiani-Kilombe hills. The surface drainage system is therefore largely internal from the east and the western scarps (Figure 3-4). On the rift floor, the drainage is mainly from Menengai Caldera northwards with the exception of the drainage from the southern rim or slopes of Menengai Caldera into Lake Nakuru. The permanent rivers in the area (but which are located outside the caldera) are Molo and Rongai in the NW area. The perennial rivers are the Crater and Olbanita streams in the eastern parts. The N-S, NE-SW, and NW-SW trending fault/fracture systems provide underground channels resulting to stream water disappearing underground at some places interrupting the Olbanita stream at several places. Other surface water bodies outside the caldera include Lakes Nakuru and Solai, and the Olbanita swamp.

Figure 3-4: Map of Menengai Volcano illustrating surface drainage patterns and lava eruption centers



Source: GDC, 2024

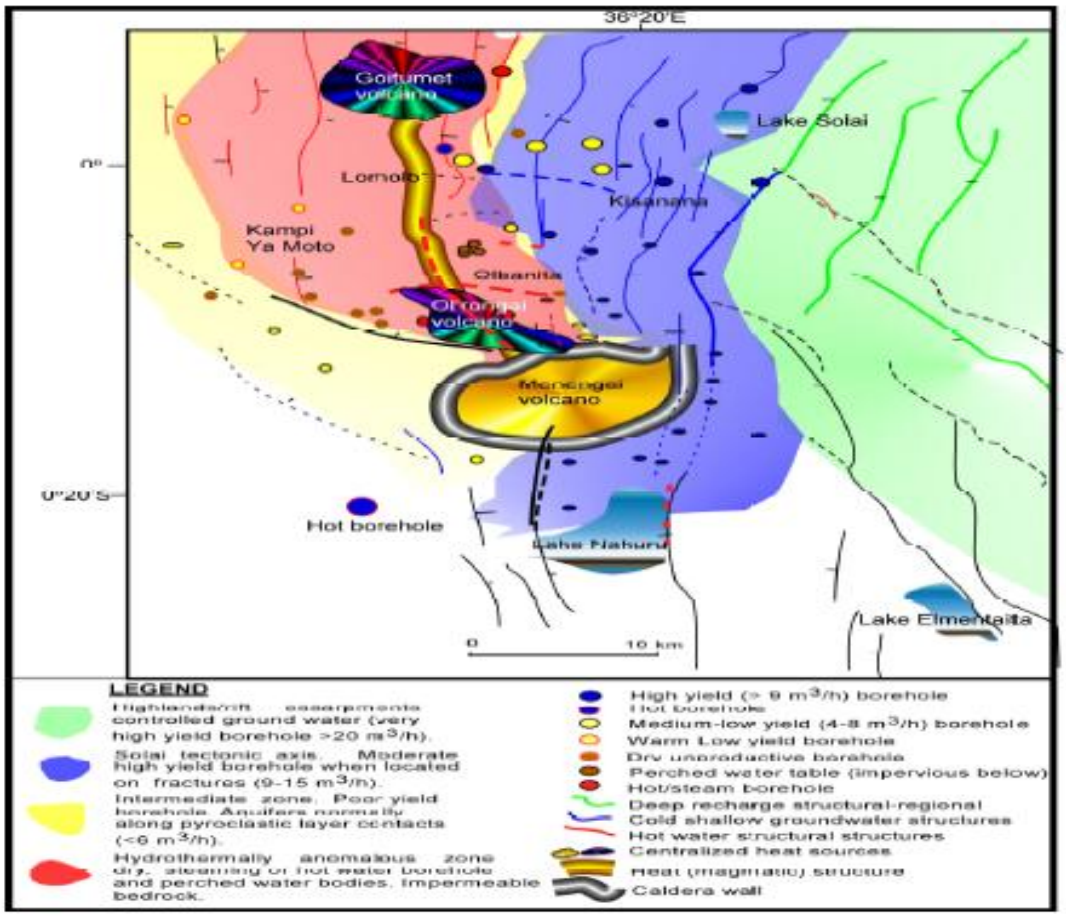
Lake Nakuru represents the intersection of a piezometric surface and a topographic surface (see **Error! Reference source not found.**). The ground water around Lake Nakuru and northwest of the lake is controlled by a sedimentary formation comprising of lake sediments and reworked pyroclastics. The boreholes immediately to the north and northwest of the lake show lake water contamination indicating interconnection (Geotermica Italiana Srl, 1987). The same sedimentary formations are found in the boreholes located in the east of Menengai caldera implying connectivity with the N-S running Solai tectonic axis. There is one location inside the caldera on the eastern rim where a cold spring (seasonal) occurs at the foot of the caldera, further confirming that the southern part of the Solai tectonic axis is an important control for groundwater movement.

The Olbanita swamp is located in an area dominated by dry and thermally anomalous boreholes. The productive ones are characterized by very shallow, low-yield aquifers that get depleted fast since the deeper formations are impervious. These are perched water bodies adjacent to the swamp. The swamp owes its existence to impervious bedrocks that have been affected by hydrothermal alteration. The formations underlying the swamp are the ignimbrite beds that show marked hydrothermal alteration.

Majority of the boreholes in the prospect area were drilled to between 100-200 m depths. The relative yields may be matched with petro-physical property of the feeder formations expounded below.

- *Very high yield boreholes (>20 m³/h)*: Hosted in fractured, fresh lavas and talus. These are boreholes located on the eastern scarps and Bahati areas and are normally fed by channels along rift scarps faults.
- *Moderate high yield boreholes (9-15 m³/h)*: Aquifers include lacustrine beds, reworked volcanicalstics and fractured lavas in the rift floor. These are mainly found in boreholes around Lake Nakuru, Nakuru town, to the east and north east of Menengai caldera along the Solai TVA and around Kisanana.
- *Poor yield Boreholes (<6 m³/h)*: Aquifers are inter-bedding contacts between tuff and ignimbrite beds. These types of boreholes are found to the east of Menengai caldera, 'Kampi ya Moto' and Rongai areas.
- *Dry and thermally anomalous boreholes*: These include the completely dry boreholes and those that encountered perched water bodies and therefore dried up after the aquifer was depleted and those that produced low-pressure steam, hot water and CO_2. These are distributed along the Molo TVA that extends from the Menengai caldera northward through the Ol Rongai volcano, Lomolo, Goitumet volcano (See **Figure 3-4**).

Figure 3-5: Hydrogeological regime of the Menengai and the surrounding



Source: GDC

The geology and soils of Menengai volcano partly control the surface run off pattern which is generally radial. Radiating away from the rim of the caldera are gullies and stream valleys along which run off water flows. The streams are seasonal and discharge into rivers at the floor of the rift valley. From the walls of the fault surrounding the caldera, similar gullies and seasonal streams drain radially into the caldera. One of the streams flows over structures within the caldera as illustrated in photo plate 3.1 below. This seasonal stream is located near the GDC pump station on the eastern side of the caldera at about 7.5km from the proposed power plant site.

*Plate 3-1**: A Stream adjacent to the water pump station inside the Caldera (Note the white coloration at the centre caused by a fumarole)***

The presence of boreholes in and outside the caldera is depictive of the hydrogeology of the project area. GDC has successfully drilled bore holes inside the caldera, while numerous other bore holes have been drilled in the wider Menengai area (Figure 3-6).

Geothermal wells with over 2km depth have been drilled in the caldera mainly in the central parts. This is indicative of occurrence of aquifers at different levels and with different water qualities. The structural geology and possible presence of porous volcanic rocks could be the main features that allow for ground water at the different levels and therefore different chemical composition depicted by the white colour geothermal spring at the bottom of the stream (See Plate 3.1 above).

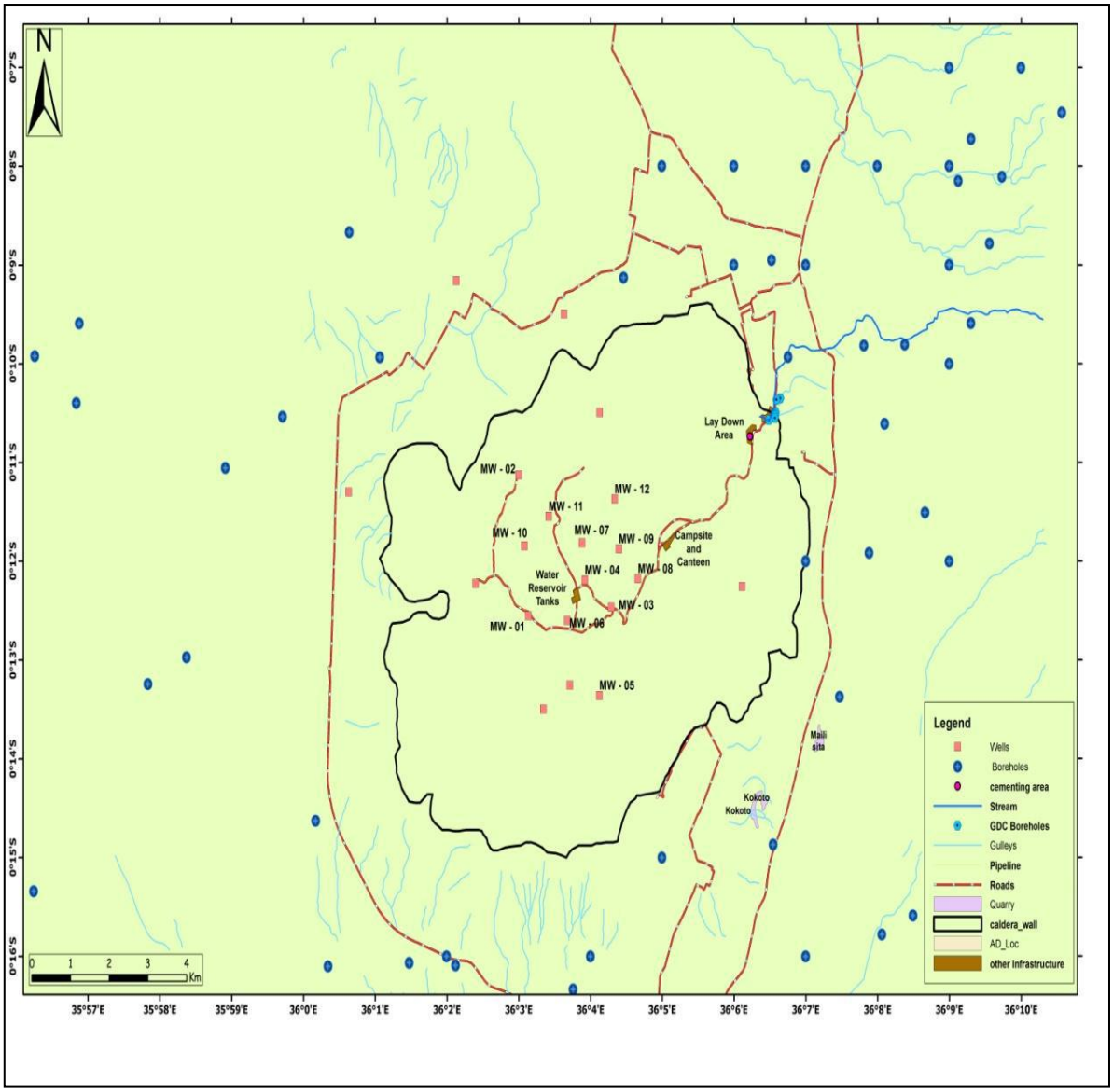


Figure 3-6: Map Showing Surface and Ground Hydrology at the Menengai Volcano

Source: GDC

3.1.5 Water and Effluent Quality

Laboratory analysis results of the quality of drilling water returns, geothermal brine and hot spring are presented in

Table 3-2 and Table 3-3 below.

Table 3-2: Quality of the Stream Water, Hot Spring and MW-01 Geothermal Brine

Parameter	**Stations**			**NEMA effluent standards**
	Geothermal feature (Plate 3.1)	**Stream at Pump Station Menengai**	**MW-01 Brine**	
pH	7.63	7.31	9.24	6.5-8.5
Chlorides(ppm)	7.18	0.69	444.8	
Total dissolved solids (ppm)	690.00	354.00	190.90	1.0
Conductivity (µS/cm)	544.00	95.30	313.00	10
Fluorides (ppm)	1.20	0.72	2.76	10
Turbidity (NTU)	15.17	291.00	0.14	0.5
Silica(ppm)	ND	ND	17.90	1.0
Aluminum(ppm)	0.81	10.57	0.05	1.0
Iron(ppm)	0.12	6.34	0.37	250
Potassium(ppm)	8.24	5.74	392.00	1.5
Manganese(ppm)	0.02	0.22	NIL	0.01
Lead(ppm)	ND	ND	0.10	2.0
Zinc(ppm)	0.02	0.12	ND	0.01
Cadmium(ppm)	ND	ND	ND	0.01
Copper	ND	1.13	ND	
Boron	ND	ND	ND	

Source: GDC Monitoring Report

Table 3-3: Effluent Quality of Drilling Water Returns and MW1 Geothermal Brine

Parameter	**Stations**	

	MW1 Drilling Water Returns	MW1 Brine	NEMA effluent standards
pH	7.58	9.72	6.5-8.5
Conductivity (mS/cm)	1.13	15430	
Sulphur (S)	117.3		1.0
Iron (Fe)	0.66	ND	10
Manganese (Mn)	2.89	ND	10
Zinc (Zn)	0.03	0.2	0.5
Copper (Cu)	<0.01	ND	1.0
Boron (B)	0.43	ND	1.0
Chloride (Cl)	10.99	1.0	250
Fluorides (F)	10.95	193.71	1.5
Cadmium (Cd)	<0.01		0.01
Chromium (Cr)	<0.01	0.007	2.0
Lead (Pb)	0.02	ND	0.01
Selenium (Se)	<0.01		0.01

Source: GDC Monitoring Report

The brine is alkaline whereas chloride concentration is high (444.4 ppm) which is typical of chloride geothermal water. Silica was also higher than the NEMA recommended limits. Except for chlorides and conductivity, which varied significantly (subject to experimental errors), compared to the GDC monitoring data, the rest of the data obtained during the ESIA study, fairly matched with the GDC data.

Toxic heavy metals such as lead, cadmium, zinc and copper were below detection limits. With proper disposal, the dangers of accumulation of heavy metals in the environment is minimal and even non-existent considering that the brine is alkaline and therefore uptake by plants especially lead and cadmium from geothermal water is inhibited (Simiyu, 2004). The drilling water returns and brine effluent will be discharged in lined ponds and later re-injected, to safeguard ground water.

Wanyororo spring water and raw water from Nakuru Water Sanitation Services Company (NAWASSCO) before treatment have elevated fluoride concentrations (See Table 3-4). However, after treatment the fluoride levels reduced to below recommended safe limit (1.5 ppm). Thus, water treatment is necessary in this area if fluoride associated effects have to be minimized.

Table 3-4: Quality of drinking water sources in Menengai project area

Parameters	NAWASSCO Treat Water	NAWASSCO Raw Water	Wanyororo Spring Water	KEBS Standards	W.H.O Standards
pH	8.91	8.87	1.4	6.5-8.5	8.5
Conductivity µS/cm	13.86	1030		2500	<1500
Chloride	1.0	50	4.93	250	<250
Fluoride	0.07	13.31	2.01	1.5	1.5

Sulfide	0.001	0.001	1.68	0.1	<84
Copper	ND	0.02	<0.01	1.0	<2.0
Zinc	0.72	0.23	<0.01	5.0	<3.0
Chromium	0.004	0.008	<0.01	0.05	<0.05
Boron	ND	ND	ND	<0.01	<0.3
Cadmium	ND	ND	ND	<0.01	<0.1
Lead	ND	ND	ND	0.01	<0.01
Nickel	ND	ND	ND	0.01	<0.02
Selenium	ND	ND	ND	<0.01	<0.02
Mercury	ND	ND	ND	<0.01	<0.01
Arsenic	ND	ND	ND	<0.01	<0.02

Source: GDC Monitoring Report

3.1.6 Air quality

The proposed geothermal power plant is located in an area affected by natural sources of atmospheric emissions, including steam, carbon dioxide, and H_2S, via natural geothermal features such as vents and fumaroles and in some areas the smell of hydrogen sulphide is perceptible. It is notable that a number of geothermal production wells have already been drilled within the caldera by GDC while some new well drilling and testing, including construction of drilling infrastructure (well pads and access roads) are still ongoing. These activities already have implications on the project area's air quality.

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by KRED to update the air quality impact specialist study for the proposed Geothermal Power Plant in. The proposed technology is different from the one Symbion had and has changed from the single flash unit to five units three utilizing the ORC technology through heat exchangers and two utilizing the screw expander. KRED therefore required updated air quality dispersion modelling to be conducted for the proposed Geothermal Power Plant to be located at the Menengai Area in Nakuru. The proposed technology change will change emission stack parameters, and therefore the dispersion potential.

The air quality impact assessment included a study of the receiving environment and the quantification and assessment of the impact of the proposed Menengai geothermal power plant on human health and the environment. The receiving environment was described in terms of local atmospheric dispersion potential, the location of potential air quality sensitive receptors (AQSRs) in relation to proposed activities as well as pre-development ambient pollutant levels.

The following were found:

- The wind direction for the area is predominantly from the south and northeast. Long term air quality impacts are therefore expected to the north and southwest of the proposed operations.
- Ambient air quality monitoring conducted at the wells by the Geothermal Development Company (GDC), indicated ambient air pollutant levels that exceed the odour threshold as well as the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 1 ppm.
- Several AQSRs are situated within the vicinity of the proposed power plants (several homesteads in the caldera, 3.5 km southwest of the plant, and areas outside of caldera 2 km northwest of the plant, Marigo, and 2.5 km north-northeast of the plant, Rigogo).

A comprehensive atmospheric emissions inventory was then compiled for the operational phase of the project. Pollutants quantified included the main pollutant of concern, hydrogen sulfide (H_2S). Estimated emissions along with information on the receiving environment were used as input to an atmospheric dispersion model which simulated ground level pollutant concentrations.

The following scenario were modelled:

- Scenario 1 – all three IPP (Globeleq emitting from a single stack and Kaishan and Sosain emitting from multiple vents)
- Scenario 2 – only Kaishan's impact emitting from 40 vents Simulated ground level pollutant concentrations were screened against internationally accepted reference inhalation concentrations.

The main findings of the impact study are listed below.

3.1.6.1 Health Impact:

- For Scenario 1, with Globeleq emitting from a single stack and Kaishan and Sosian emitting from multiple vents, simulated 24-hour ambient H_2S concentrations exceed the Iceland guideline of 50 µg/m^3 at some locations. However, the Kenyan Tolerance Limit and World Health Organization (WHO) daily guideline value of 150 µg/m^3 is not exceeded at any of the AQSRs. Simulated annual average ambient H2S concentrations exceed the California Office of Environmental Health Hazard Assessment (OEHHA) screening level for chronic exposure (10 µg/m3) at some of the AQSRs in the Rigogo area.
- For Scenario 2, Kaishan's incremental impact, simulated 24-hour ambient H_2S concentrations do not exceed the Iceland guideline of 50 µg/m^3 or Kenyan Tolerance Limit and the WHO daily guideline value of 150 µg/m^3 at any of the AQSRs. Simulated annual average ambient H_2S concentrations exceed the OEHHA screening level for chronic exposure (10 µg/m^3) at the Rigogo area.

3.1.6.2 Occupational Impact:

- For Scenario 1, the ACGIH TLV of 1ppm (1500 µg/m^3) is exceeded both on-site as well as ~ 300 m from the site boundary. For Scenario 2, the ACGIH TLV of 1ppm (1500 µg/m^3) is exceeded for a very small area just off-site. None of the scenarios exceed the WHO lowest observable adverse effect level (LOAEL) of 15 mg/m^3 (15 000 µg/m^3) or 10 ppm.

3.1.6.3 Odour Impact:

- The results of the modelling suggest it is possible that there will be a H_2S odour impact at the AQSRs.

To ensure the lowest possible impact on AQSRs and environment it is recommended that an air quality management plan in conjunction with GDC and the other IPPs (Globeleq Menengai Geothermal Limited& Sosian Energy Limited) should be adopted. In summary, this includes:

- The mitigation of sources of emission Various mitigation options should be investigated further.
- Ambient air quality monitoring, including:
- Installation of an H_2S gas monitoring network;
- Continuous operation of the H_2S gas monitoring systems to facilitate early detection and warning; and

Emergency planning involving community input to allow for effective response to monitoring system warnings.

Table 3-5: Summary of ambient air quality sampling results for H_2S in ppb

Monitored Sites	Jan	Feb	March	April	May	June	July	august	September	October	November	December
MW 17	0.21	22.50	62.77	1.01	0.70	0.1223		58.755	0	0	0	
MW 03	70.78	76.00	1.57	0.52	0.62	0.70	18.125	98.155	8.51 UP, 131 DW	0.63 UP, 13.17 DW	4.59 UP, 117.6 DW	
camp site	0.87	109.00	50.82	1.09	0.18	0.5455	10.39	1.28	1.38	0.79	1.78	
tree nursery	0.48	0.39	1.18	0.00	0.001	0	1.25	1.32	0	0	0	
laydown	51.12	136	0.16	0.14	0.001	0.095	0.86	1.37	1.42	1.53	2.34	
MW 18	240	0.19	0	0	0	0	0	0	0	0	0	
control room	0.82	0	0	0	0	0	0	0	0	0	0	
MW 10	16.31	81.39	51.38	0	0	0	0	0	0	0	0	
MW 19B	0.35	0.01	0	0	0	0	23.595	104.45	171 UP, 32.7 DW	1.06 UP, 1414 DW	0	
MW 01	0	64.99	0	0	0	1.2135	0.125	61.72	1330	0	0	
MW 21	0	0.18	0	0	0	0	0	0	0	0	0	
MW 13A	0	121.33	0	0	0	0	0	0	0	0	0	
MW 13B	0	23.42	0	0	0	0	0	0	0	0	0	
MW 19A	0	2.73	0	0	0	0	0	0	0	0	0	
MW 20	0	49.70	0	0.001	0	0	0	1.86	0	0	0	
MW 08	0	0.024	140	0	0	0	0	0	0	0	0	
MW 15	0	0	611.58	0	0.003	0.1165	103.9	1.05	1.15	2.45	0	
MW 20B	0	0	0	0	0.93	0.1113	0.8	0	0	102.3	1.34	
MW 10B	0	0	0	0	2.22	0.755	0	0	0	0	0	
MW 33A	0	0	0	0	0	0	1.67	1.55	0	0	0	

MW 34	0	0	0	0	0	0	0	0	0	1.86	2.41	

KEY	
UP	Upwind
Dw	Downwind
	No Monitoring

Source: GDC Air Quality Data

The concentrations of H_2S were monitored and it was found that they were high at the weir box in the discharging wells while in the rest of the working areas the concentration levels were zero ppm. At most of these monitored wells, the odour threshold (0.00046 ppm-0.002 ppm or 0.76-3.21 µg/m3) is frequently exceeded, as well as the ACGIH TLV for hydrogen sulphide which is set at 1 ppm (1.5 mg/m^3) for an eight-hour exposure.

Figure 3-7: Study area, site layout and AQSRs

3.1.7 Noise

Noise environment in the proposed project has already been modified by the existing activities of drilling operations and associated infrastructure development. The existing major sources of noise in the Menengai Caldera are generators supplying power to the rigs, discharging wells, electric motors, air compressors, mobile machinery, mud pumps, drilling operation, all of which operate around the clock. The environmental noise impact of geothermal drilling operations results from a combination of noise from all these sources. However, the noisiest drilling activities are not permanent.

Noise level monitoring and assessment in Menengai is carried out at least three times per week to establish both background and operational noise levels. This monitoring is carried out in compliance to the provisions of Environmental Management and Co-ordination (Noise and Excessive Vibration Pollution) (Control) Regulations 2009 regarding noise limits at the work place and also the Occupational Safety and Health and Act 2007. The noise level in the proposed project area was assessed using an Integrated Handheld Sound Level meter (Model Extech 407768). The noise level in the proposed project area was assessed using an Integrated Handheld Sound Level meter (Model Extech 407768).

The baseline acoustic environment was described in terms of the location of noise sensitive receptors (NSRs) in relation to the proposed development, the ability of the environment to attenuate noise over long distances and existing or pre-development noise levels. The following was found:

- NSRs include single homesteads, villages and community locations. The closest of these lies 2.54 km north-west of the proposed Kaishan Menengai facility;
- Atmospheric conditions are more conducive to noise attenuation during the day;
- The wind field is characterized by winds from the south. Noise impacts will be more notable towards the north (predominant downwind direction);
- Noise level measurements were limited. After careful consideration and analysis of available data representative baseline day- and night-time noise levels of 57.9 and 47.9 dBA were determined.

3.2 Biological Environment

3.2.1 *Background on the Menengai Forest*

Menengai Forest is part of the Mau Forest Complex which covers approximately 416,542 ha. This is the largest closed-canopy montane forest ecosystem in East Africa. The Menengai Forest Reserve was first set aside under Proclamation No. 44 of 1932 and later formally gazetted under Legal Notice No. 174 on 20 May 1964, covering a total of 6,018.9 ha. The bulk of this area—the 4,651ha caldera floor—has since been leased to the Geothermal Development Company (GDC) for steam drilling and green-energy exploration, while the remaining 1,367.9 ha continues under co-management by Kenya Forest Service (KFS) and the Menengai Community Forest Association (MCFA)

Under this arrangement, KFS retains legal ownership and provides technical oversight through its Menengai Forest Station (reporting to the Nakuru County Forest Conservator), while MCFA—the body representing forest-adjacent communities—carries out on-the-ground protection, fire surveillance, participatory planning and benefit-sharing. GDC bears sole responsibility for all geothermal operations within the leased caldera, including steam drilling, delivery to the three 35 MWe Independent Power Producers (IPPs), and the management (collection, containment and reinjection) of geothermal brine and associated H_2S risks. The IPPs (Globeleq Menengai Geothermal Limited , OrPower 22 and Sosian Energy) develop modular power plants on their respective leased plots, but they do not engage directly in forest or resource management. This clear delineation of roles ensures that KFS and MCFA safeguard the forest's biodiversity and community values, GDC manages all subsurface risks and infrastructure, and IPPs focus on power generation from the steam supplied by GDC.

3.2.2 *Floral Diversity & Structure*

Menengai Forest Reserve (6,018.9 ha) comprises five principal vegetation classes. These classes buffer natural ecosystems, support successional dynamics, and anchor project infrastructure within a broader forest landscape:

Table 3-6: Vegetation classes in the Menengai forest

Vegetation Class	Area (ha)	% of Total	Key Characteristics
Natural forest	281.8	4.7%	Steep slopes & riparian gullies; mature canopy (e.g., *Olea europaea*, *Rhus natalensis*).
Plantation forest	618.9	10.3%	*Eucalyptus* & *Acacia* stands in mixed age blocks.
Bushland	402.0	6.7%	Fire-adapted shrubs (*Tarchonanthus* spp.) & native grasses.
Degraded area	65.2	1.1%	Edges with invasive shrubs; priority for restoration.
GDC lease area	4651.0	77.3%	Mosaic of all classes plus geothermal infrastructure.

Menengai Forest Reserve supports a diverse mix of indigenous and exotic flora, spanning dryland woodlands, montane forest remnants, bushland mosaics, and managed plantations. A total of 26 key tree and shrub species have been documented in the Menengai Participatory Forest Management Plan (PFMP 2023–2027), several of which are ecologically or economically significant. Dominant native species include *Olea europaea* subsp. *africana* (wild olive), *Rhus natalensis*, *Croton megalocarpus* (Mukinduri), *Acacia tortilis*, *Juniperus procera*, and *Tarchonanthus camphoratus*. Exotic species such as *Eucalyptus saligna*, *Acacia mearnsii*, and *Callistemon citrinus* have been introduced over the years to serve as fuelwood, windbreaks, or reforestation buffer stands.

Of particular conservation concern is *Prunus africana* (African cherry), classified as **Vulnerable** on the IUCN Red List, and *Osyris lanceolata* (Sandalwood), listed as **Endangered**, both of which have suffered

from overharvesting. Restoration initiatives under the PFMP and BCLRMP include propagation of indigenous species through community nurseries managed by the Menengai Community Forest Association (MCFA). The full inventory and IUCN statuses are provided in **Appendix II**.

Within the immediate power plant site, the vegetation cover was generally interspersed comprising stunted trees, shrubs and tufted herbs. Open spaces between the vegetation had light trails indicating foraging visit by herbivores (livestock had been sighted nearby at the time of the visit). Floral species were readily identified from random observation made on site. While the OTTL site exhibited limited previous disturbance, the adjacent Globeleq Menengai Geothermal Limited and Sosian Energy Limited sites had been cleared and levelled in anticipation of power plant construction works. Similarly, the common access road to all the three IPP sites had been cleared of vegetation.

Photo 3-1:Floral Species within the plant site

General vegetation cover within OTTL plant site

Acacia hockii (shrub)

Monsonia angustifolia (Herb)

	
Faurea saligna (Tree)	*Rhus natalensis* (Shrub)
	
Myrsine africana (Herb)	*Oldenlandia wiedemannii* (Herb)
	
Pappea capensis (Tree)	*Protea gaguedi* (Tree)

3.2.3 Faunal Diversity

Menengai Forest supports a rich assemblage of wildlife species, with a total of 14 mammal and 46 bird species documented (PFMP 2023–2027), reflecting the ecological importance of the area as a biodiversity hotspot. Key mammalian fauna includethe leopard (*Panthera pardus*), rock hyrax (*Procavia cavensis*), and Kirk's dik-dik (*Mordoqua kirkii*), while avian life is dominated by both raptors such as the Verreaux's eagle and forest-dwelling species like the Abyssinian ground hornbill (*Bucorvus abyssinicus*).

The ecological value of these species extends beyond biodiversity conservation; they serve as crucial components of forest ecosystem functioning and possess significant potential for ecotourism development. Many species are also of conservation interest under the International Union for Conservation of Nature (IUCN) Red List, and their presence highlights the need for sustained protection and habitat management.

A detailed species inventory is provided in Appendix II. This annex includes scientific names, ecological significance, and the IUCN conservation status of each species to guide biodiversity conservation measures under this project.

3.3 Socio-Economic Characteristics

For proper definition of the socio-economic characteristics, the study considered the project area of influence to lie within about 5Km radius. This was based on the structure of Community Forest Association which considers community within the stated radius from Menengai Forest.

Menengai Geothermal field lies within Rongai and Nakuru North Sub Counties of Nakuru County. The primary zones of impact where the proposed geothermal power plant will be constructed is within the caldera area are as follows:

- Mercy Njeri sub location, Kiamunyi Location of Rongai sub county. Villages within this location are (3 No.) Kileleshwa, Valley, and Maciaro;
- Wanyororo sub location, Kirima Location of Nakuru North sub county. There is (1 No.) village within this zone of influence namely Wanyororo B village.
- Other villages that may be affected include Ol-Rongai and Arahuka villages.

3.3.1 Population and Household characteristics

The population figures for the two Sub counties as per the last (2019) National Population and Housing Census are presented in **Table 3-7** below.

Table 3-7: Population figures for Sub Counties within the Project Area

Sub County	Male	Female	Total Population 2019	Projected Population-2022	Projected Population-2023
Nakuru North	106,155	111,880	218,050	262,074	278,558
Rongai	99,976	99,922	199,906	202,864	215,624

Source: 2019 Population and Housing Census

The population estimates of the locations within the primary zones of influence as per key informant interviews with the local area chiefs are as follows;

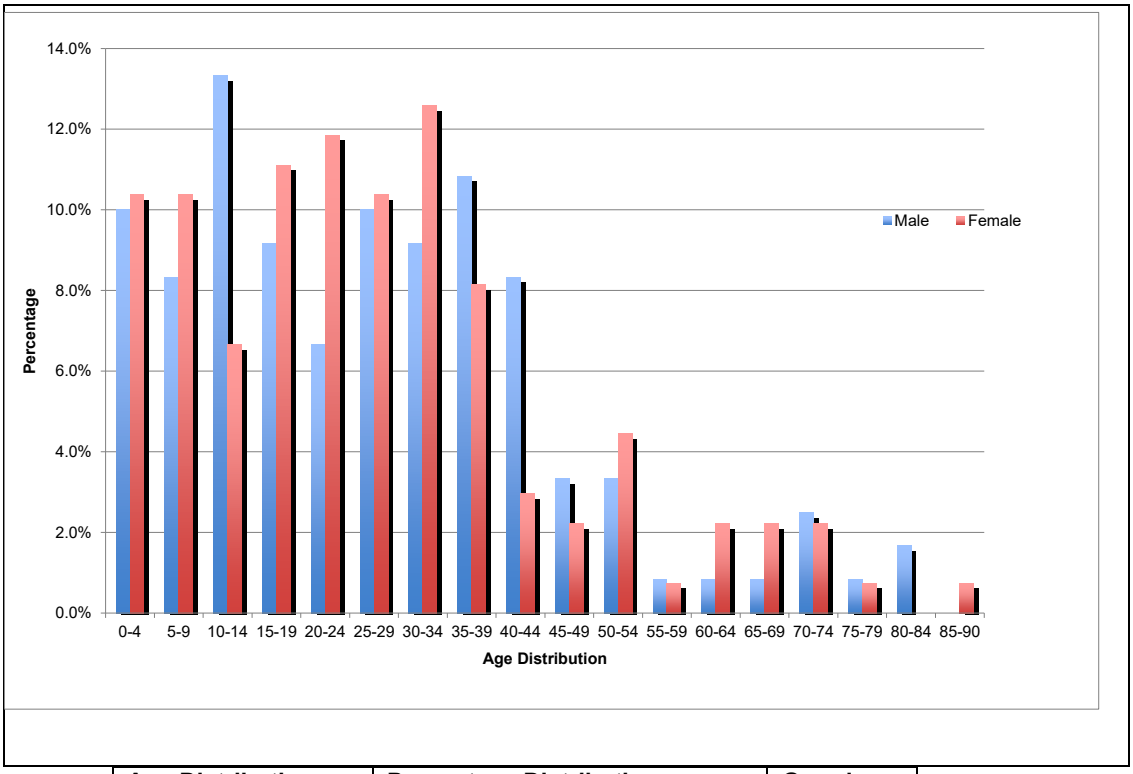
- Kirima Location; approximately 8,000 persons;
- Kiamunyi Location; approximately 10,000 persons

3.3.1.1 Demographic characteristics

The demographic characteristics of the study area population are presented in Table 3-8. Persons between the ages of 30-34 have the largest proportion of 11.0%. When taken together, as large as 29.4% of the sample are below the age of 15. The productive segment of the population (20 – 55yrs) is about 52.1% while old people (> 55 years) accounted for 8.4%. This indicates that the dependency ratio in the project area is relatively low, meaning that those not in working age do not have pressure on the working age group.

Table 3-8: Demographic characteristics of the study area

Age Distribution	Percentage Distribution		Grand Total
	Male	Female	
0-4	10.0	10.4	10.2
5-9	8.3	10.4	9.4
10-14	13.3	6.7	9.8



Age Distribution	Percentage Distribution		Grand Total
	Male	Female	
15-19	9.2	11.1	10.2
20-24	6.7	11.9	9.4
25-29	10.0	10.4	10.2
30-34	9.2	12.6	11.0
35-39	10.8	8.1	9.4
40-44	8.3	3.0	5.5
45-49	3.3	2.2	2.7
50-54	3.3	4.4	3.9
55-59	0.8	0.7	0.8
60-64	0.8	2.2	1.6
65-69	0.8	2.2	1.6
70-74	2.5	2.2	2.4
75-79	0.8	0.7	0.8
80-84	1.7	0.0	0.8
85-90	0.0	0.7	0.4
Grand Total	**100**	**100**	**100**

Figure 3-8: Demographic structure according to the Ages and Sex of the Population within the area of influence

3.3.1.2 Household headship

As presented in **Table 3-9** below, majority of households surveyed are male-headed (81.7%) whereas 18.3% of the households are female-headed.

Table 3-9: Household headship of the study area

Sex	Distribution	Area		Total
		Project area (Caldera)	Project neighboring communities	
Male	Frequency	3	656	659
	% within Area	75	88.4	81.7
Female	Frequency	1	86	87
	% within Area	25	11.6	18.3

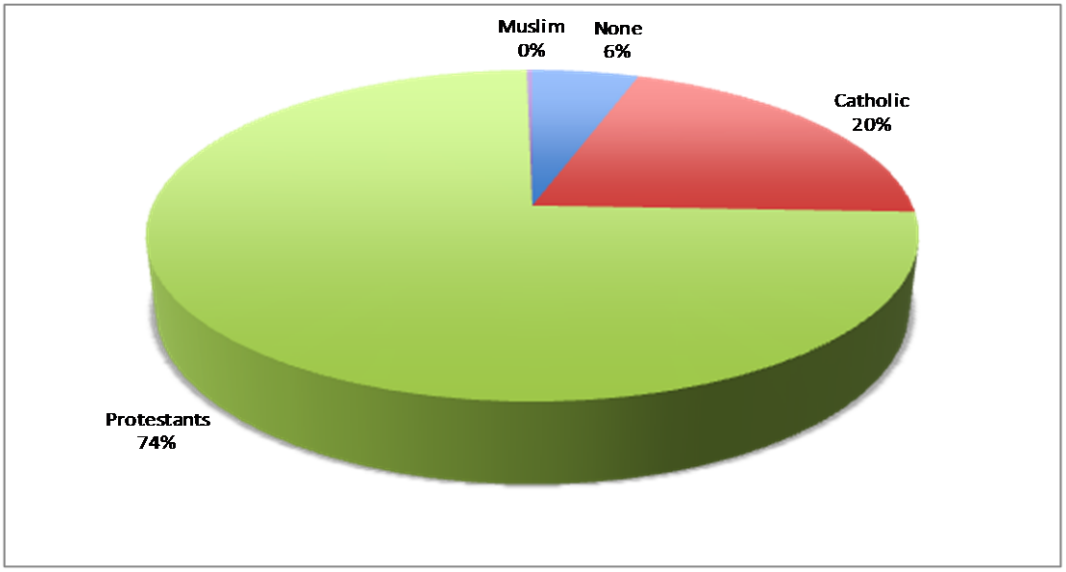
3.3.1.3 Religion

A survey of the households in the primary project area revealed that majority of the inhabitants were Catholics. For the communities within the project area of influence, the survey revealed two major religions professed by inhabitants of the area. These are Islam and Christianity. Muslims accounted for about 0.3% while Christians are over 94.4%. Only a small proportion (5%) had no religious affiliation. This distribution is shown in table 3.10 and illustrated in figure 3.9.

Table 3-10: Religious affiliation for communities within the project area of influence

Area	Distribution	None	Catholic	Protestant	Muslim	Total
Secondary impact zone	Frequency	151	577	2108	8	2844
	Percent (%)	5.3	20.3	74.1	0.3	100.0

Figure 3-9: Proportion of religious groups of respondents within the project area of influnce



3.3.1.4 Education

Educational institutions are organized into zones. The zones in the area covered by the project are Bahati and Solai zones. The number of various institutions and enrolment by third term (as at November 2014) are as indicated below.

Table 3-11: Student enrolment in Education institutions in Nakuru North Sub County

Category	No.	Students			Teachers		
		M	F	Total	M	F	Total
Public ECD	24						
Private ECD	45						
Public Primary	20	7,469	7,363	14,832	117	276	393
Private Primary	45	1,538	1,899	3,437	109	112	221
Public Secondary	16						
Private Secondary	16						
Tertiary (Public Polytechnic)	1						

Source: Education office, Maili Sita.

Teachers to pupil ratio from Table 3-11 is 1:38 in public primary schools and 1:16 in private primary schools.

Table 3-12: Student enrolment within educational institutions in Rongai Sub County

Category	No.	Boys	Girls	Total
Public ECD	88	3,710	3,655	7,365
Private ECD	92	2,221	2,195	4,416
Public primary	73	16,055	15,376	31,431
Private Primary	42	3,091	2,912	6,003
Public secondary	34	4,963	4,549	9,516
Private secondary	16	1,963	2,097	4,060
Tertiary college	-	-	-	
University	1	Not available	Not available	
Total		32,007	30,784	62,791

Source: Education office Rongai Sub County

3.3.2 Housing conditions

Shelter is one of the basic human needs and good quality of life includes having comfortable housing. Good housing is one of the first steps in any meaningful attempt to tackle social problems. There is generally a strong relationship between household economic conditions and quality of housing and as such information on housing characteristics is critical to explaining associations between households' social and economic conditions. Housing as a shelter is one of the basic needs of a human being. In this survey, we assessed the quality of respondent's houses in terms of roofing, walls and floor.

Out of the four households present in the caldera, one had a thatched roof and the rest were roofed with corrugated iron sheet. All the four houses had mud walls and earth floors.

Table 3-13 below shows the roofing, wall and floor characteristics of houses sampled within the project area of influence (secondary impact zone).

Table 3-13: Housing characteristics of within the project area of influence

Roofing Characteristics						
Area	**Distribution**	**Thatched**	**Corrugated Iron Sheet**	**Tiles**	**Others**	**Total**
Neighboring communities	Frequency	14	714	4	2	734
	(%)	1.9	97.3	0.5	0.3	100.0
Walls characteristics						
Area	**Distribution**	**Mud**	**Stone**	**Bricks**	**Other**	**Total**
Neighboring communities	Frequency	325	386	5	30	746
	(%)	43.6	51.7	0.7	4.0	100.0
Floor characteristics						
Area	**Distribution**	**Earth**	**Cement**	**Wooden**	**Others**	**Total**
Neighboring communities	Frequency	362	376	1	6	745
	(%)	48.6	50.5	0.1	0.8	100.0

3.3.3 Access to water and sanitation

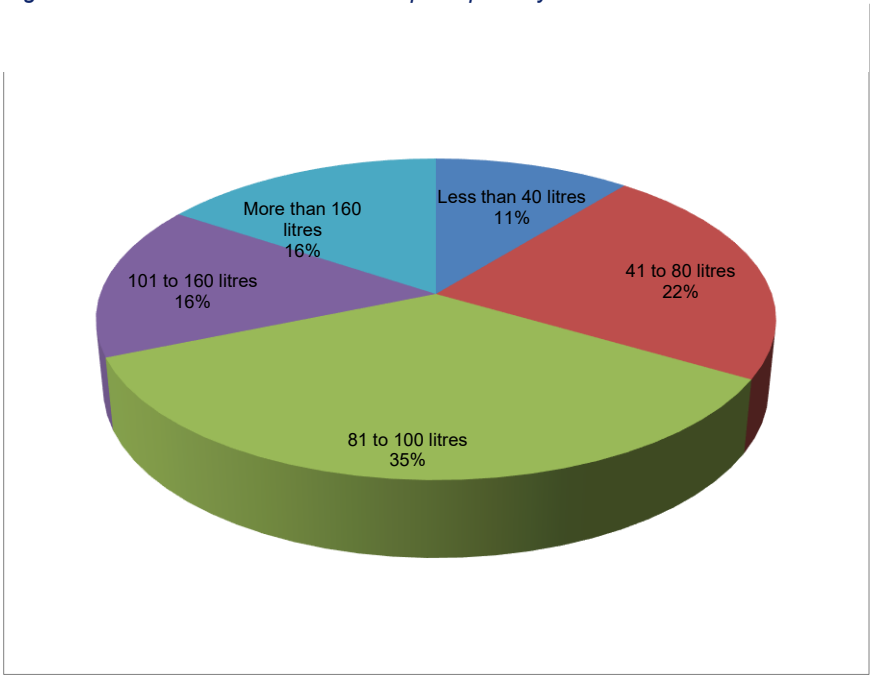
The main source of water for the households in the Caldera area is water vendors whereas for the communities within the project area of influence are: rainwater, piped community water and water vendors. Rainwater accounts for over 62% whereas piped community water and water vendors account for 45% and 31% respectively. Other sources of water include shallow wells (0.8%), rivers (4.4%), piped water to homesteads (12.5%), boreholes (3.2%), water pans (2.4%) and springs (1.5%). The distribution is shown in the table below.

Table 3-14: Sources of water for households within the project area of influence

Distribution	Springs	Boreholes	Shallow wells	Rainwater	Water pan	Piped Community	Piped homestead	River	Water vendors
Frequency	12	24	6	468	18	340	94	33	233
%	1.6	3.2	0.8	62.2	2.4	**45.2**	12.5	4.4	30.9

Time taken to fetch water from the different sources of water ranges from 30 minutes to more than an hour. Quantities of water by households and used per day is as illustrated in Figure 3.10 below.

Figure 3-10: Household water consumption per day



3.3.3.1 Water treatment

Within the project area, households treat water by boiling. Communities within the project area of influence treat their water by boiling (40%), chlorination (9%) and water filtering (0.5%). Majority of the respondents did not treat their water (59%) whereas less than 1% did not know what is done with their water.

3.3.3.2 Sanitation

Latrines are the only type of toilet used by households in the project area (caldera). Majority of the households sampled within the project area of influence, use pit latrines (92%) and the rest use flush toilets (8%).

3.3.4 Health conditions

3.3.4.1 Disease prevalence

According to the public health officer of Nakuru North Sub County, the most common prevalent diseases are as shown in Table 3-15 below.

Table 3-15: Common diseases affecting the population in Nakuru North Sub County

Diseases affecting persons under 5 years	**Rank**	**Diseases affecting persons over 5 years**	**Rank**
Disease of the respiratory system	1	Disease of the respiratory system	1
Diarrhea	2	Disease of the skin	2
Disease of the skin	3	Dental diseases	3
Clinical malaria	4	Rheumatism: joint pains	4
Confirmed malaria	5	Clinical malaria	5
Pneumonia	6	Typhoid fever	6
Eye infection	7	Confirmed malaria	7
Mumps	8	Diarrhea	8
Chicken pox	9	Urinary tract infections	9
Ear infection	10	Pneumonia	10

HIV/AIDs prevalence in the two Sub Counties stands at 3.7% in Rongai and 3.2% in Nakuru North sub counties. Most vulnerable groups to HIV/AIDS include; commercial sex workers, employees of flower farms, sisal estates, widows and orphans and vulnerable children.

3.3.4.2 Health institutions

Health institutions in the study area are categorized as either public or private. Public health institutions consisted of dispensaries, health centres and hospitals whereas private facilities are mainly private clinics and medicine stores.

Table 3-16: Health institutions in Nakuru North Sub County

Division	Public Facilities	Private
Kiamaina	4	8
Bahati	3	1
Dundori	3	5

In Rongai Sub County, the numbers of health institutions are:

- Health centres-5
- Dispensaries -14
- Others (private and FBO)-10

Doctor to patient ratio stands at 1:60,670 and 1:10,000 in Rongai and Nakuru North respectively which is higher than the WHO recommended ratio of 1:1,000.

3.3.5 Community problems

The community in the study area experience various social and environmental problems:

3.3.5.1 Social problems

A number of social problems exist in the project study area as identified by the respondents:

- Insecurity;
- Water scarcity;
- Youth unemployment;
- Poor infrastructure (roads); and
- Lack of health facilities.

3.3.5.2 Environmental problems

Environmental problems experienced by the communities in the project area said to be associated with geothermal exploration activities include:

- Air pollution;
- Noise and vibrations;
- Dust;
- Bad odours.

3.3.6 Archaeological background

No previous archaeological surveys have been carried out in the crater, and therefore no archaeological sites are recorded. However, there are several sites recorded on the map covering this area, Sheet Number 119/1, Series Y731. The sites, named GqJi 1-6 all belong to the Later Stone Age (LSA) with artefacts such as pottery, stone bowls and stone tools recovered from them. The closest site to the crater, GqJi6 is located about 5 km from northern edge of the crater. The area south of Menengai crater covered by map Sheet number 119/3 also has LSA sites (GrJi 1-70) with artefacts similar to those mentioned above. This area is interesting because it contains many prehistoric humans remains at sites such as Makalia, Bromheads and Nakuru burial sites. The high density of artefacts found in these sites is an indication of intense occupation over long periods of time. It is therefore likely that some form of

evidence of human occupation may be present in parts of the crater.

A targeted rapid archaeological field survey was conducted on 11 February 2015 in the area proposed for the OTTL 35 MW plant, under the guidance of a National Museums of Kenya (NMK) specialist. No caves, rock art, fossils or surface artefacts of cultural or historical value were encountered within the footprint of the power station or its immediate works areas. On 20 May 2025, NMK formally issued a "letter of no objection" (Appendix VIII), confirming that "no archaeological or heritage sites will be impacted by the proposed development" and that "no further archaeological mitigation or excavation is required." All earthworks will nonetheless follow the NMK chance-find procedure: should any previously unrecorded subsurface cultural material be uncovered during excavation, work in that area will cease immediately and NMK will be notified for on-site guidance.

There is however a slight possibility that human remains may be present, as they have been found in similar settings on Mt Suswa. These burials are usually marked with piles of loose stones commonly referred to as cairns. However, three caves were sited at the vicinity of the project proposed site as shown in the **Error! Reference source not found.** with their respective coordinates in Table 3-17. These caves are not used by any particular group but used by individuals.

Table 3-17: Coordinates of the Cave 1, 2 and 3

Way point	Eastings (m)	Northings (m)	Elevation(m)
Cave No. 1	171866	9972323	2082
Cave No. 2	172032	9972455	2142
Cave No. 3	171935	9972634	2118

Figure 3-11: Map showing the location of the three caves from the proposed site

3.3.7 Economic characteristics

Nakuru North and Rongai are predominantly agricultural sub counties with maize and wheat crops being the predominant crops grown and cattle rearing for milk production, especially in areas neighbouring the project area.

3.3.7.1 Employment status of persons living within the project area of influence

13.8% of the respondents interviewed were formally employed, 72.9% were informally employed and 13.3% were unemployed. The informally employed forms the largest proportion of the population since they are mainly semi-skilled and unskilled labour.

3.3.7.2 Income sources

The primary source of income for the households in the project area is farming. In the communities within the project area of influence, the primary source of income is farming followed by trading and salaried employees.

Table 3-18: Primary income sources

Area	Distribution	Farming	Trading	Salaried	Artisan	Other sources
Project Area (Menengai Geothermal Field)	Count	4	0	0	0	0
	% within Area	100	0	0	0	0
Neighboring communities	Count	656	219	202	102	102
	% within Area	51	17	16	8	8

3.3.8 Land tenure and use

The land tenure systems in Kenya are categorized as private, community and public land. The Menengai crater is public land under the management of KFS.

Land ownership in the communities neighboring the project area as presented by the respondents, is 86.2% privately owned, 12.8% public land and 1% communally owned.

Land in the project study area is used for agriculture, residential and commercial purposes. Within the primary impact zone, residential and agriculture are the main land uses. Land use in the project neighbouring areas is as shown in the Table 3-19 below.

Table 3-19: Land uses within the project area of influence

Distribution	Land use in the project study area				
	Residential	Cash crop farming	Subsistence farming	Commercial	Grazing/Pasture/ Fodder
Count	621	83	477	29	294
% within Area	41.3	5.5	31.7	1.9	19.5

3.3.9 Energy resources

The main source of energy for cooking is firewood (60.6%). This is followed by charcoal, which accounts for 32.8% as reflected in Table 3-20 below. The main source of energy for lighting is kerosene (48.1%) that is used in kerosene lamps to light homes in both the primary and secondary impact zones of the project. 44.5% of the households sampled are connected to the national electricity grid and use electricity for lighting their homes. 0.1% of the respondents do not light their household whereas 2.1% and 2.4% use battery powered lamps and LPG lamps respectively.

Table 3-20: Energy sources for cooking and lighting

Sources of energy for cooking						
Area	Distribution	Firewood	Charcoal	Kerosene	Electric cooker	LPG

Project Area	Count	4	0	0	0	0	
	% Within The Area	100	0	0	0	0	
Neighboring communities	Count	453	222	13	7	52	
	% Within The Area	60.6	29.7	1.7	0.9	7.0	
	Sources of energy for lighting						
Area	**Distribution**	**Battery lamp**	**Kerosene lamp**	**LPG Lamp**	**None**	**Electricity**	**Other**
Project Area	Count	0	4	0	0	0	0
	% within Area	0	100	0	0	0	0
Neighboring communities	Count	15	344	17	1	318	20
	% within Area	2.1	48.1	2.4	0.1	44.5	2.8

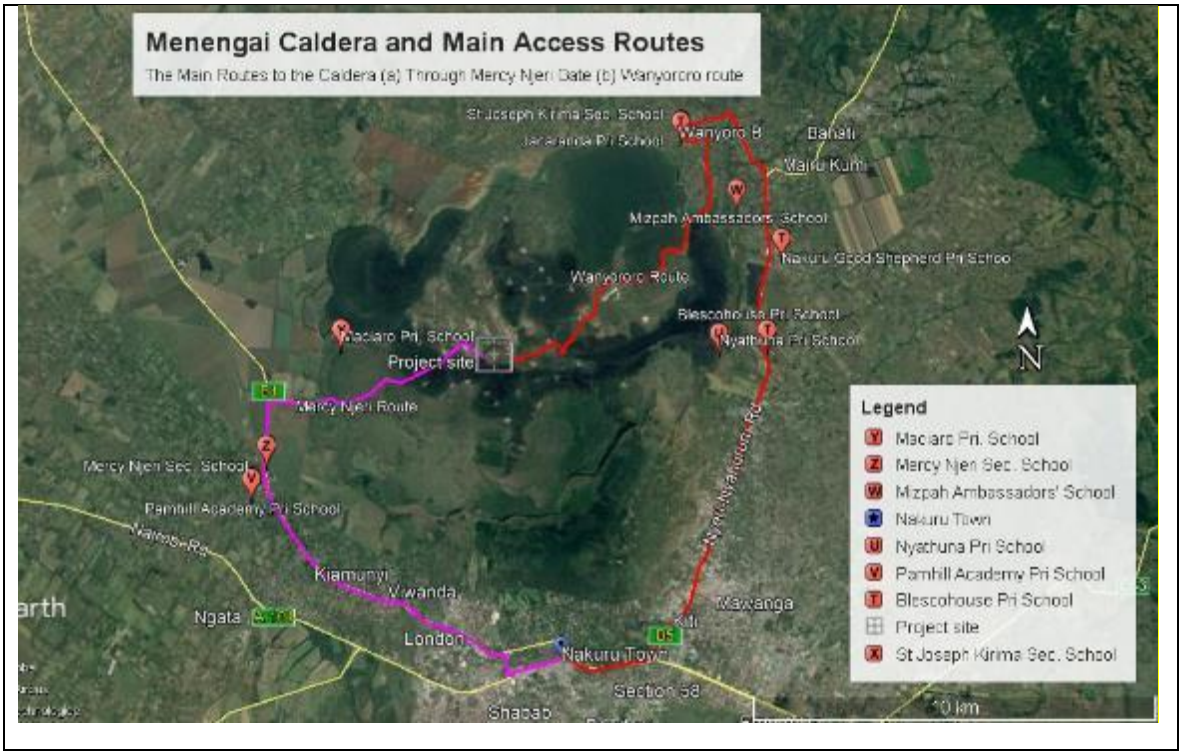
3.3.10 ***Roads access***

The project area is in the suburbs of Nakuru town. As a result, it enjoys good road networks including ready connecting to the Mombasa – Nairobi - Eldoret Malaba road, an international trunk road. The major roads off which the site can be accessed include the Nakuru – Bahati/Nyahururu road (bitumen surface) and Nakuru – Kabarak/Marigat (bitumen surface) road. Both of these roads are managed by the Kenya National Highways Authority (KeNHA). However, a short stretch of Maili Kumi - Solai section (off the Nakuru - Bahati) road is under the Kenya Rural Roads Authority (KeRRA).

Within the study area, communities are connected to each other by earth roads, constructed and maintained by the local county government. Some of the settlements are linked by poor road network and thus may be inaccessible during the rainy seasons.

Access roads to the caldera and internal roads within it are maintained by GDC and were in fairly good conditions at the time of site visit. Figure below shows the major road

Figure 3-12: Map Showing the major road networks and access Routes to the Project Area



3.3.11 *Tourism and hotel accommodation in Nakuru*

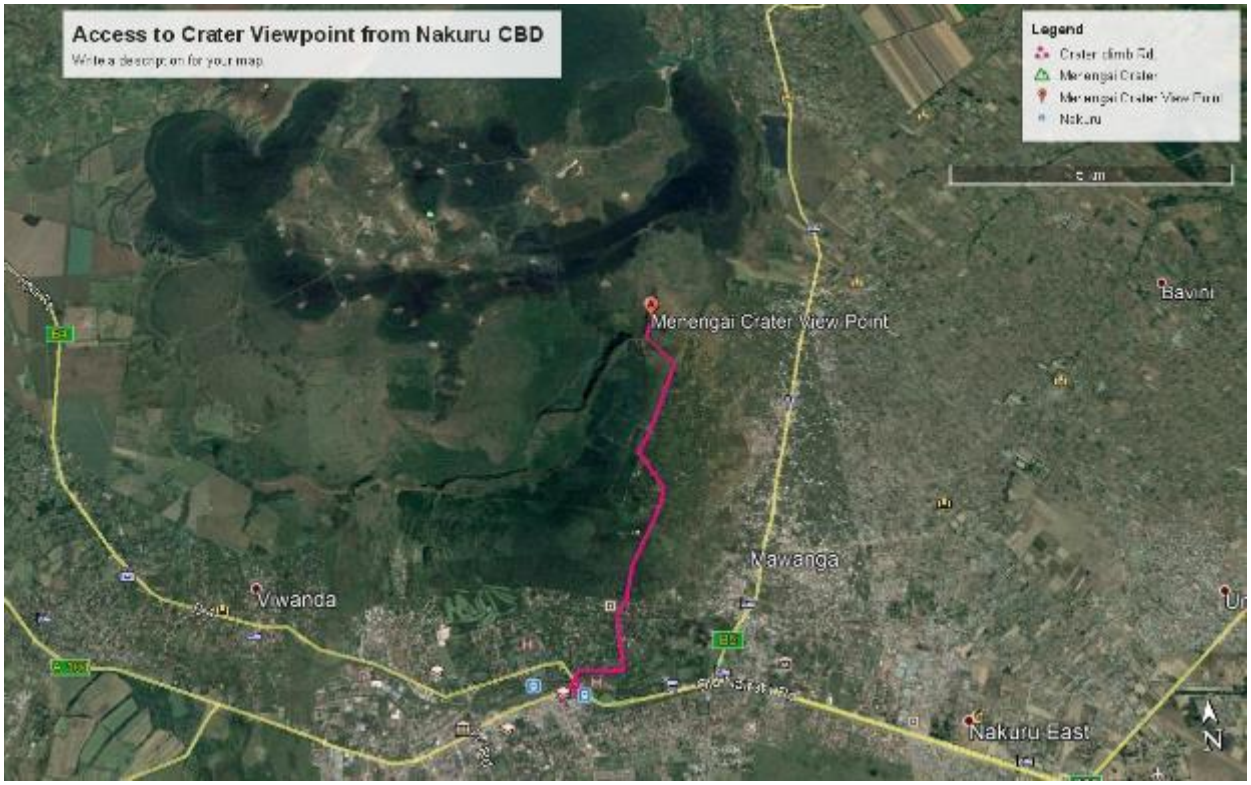
According to the Nakuru county integrated development plan (CIDP 2018-2022), Menengai crater (for picnics/nature trails and hiking) is among the tourist attractions in Nakuru County. National Parks in the County including Lake Nakuru National Park, Hells Gate National Park and Mt. Longonot National Park are the major tourist attractions. Other tourist sites include; Menengai Crater, Subukia Shrine, Lord Egerton Castle, Lake Naivasha, Lake Elementaita, Hyrax hill prehistoric site, Ol-doinyo Eburru volcano and Mau Forest. Private wildlife conservancies that attract tourists in the county include; Marura, Oserian and Kedong in Naivasha sub-County and Kigio and Soysambu in Gilgil sub-County. The main tourist activities include; bird watching, hiking, picnics, excursions and game drives. None of the above national parks and wildlife conservancies is in close proximity to the Menengai caldera.

Tourism Regulatory Authority (TRA) categorizes hotel establishments into five categories namely; town hotels, lodges and tented camps, vacation hotels, villas cottages and apartments. According to the Nakuru CIDP, the following are available in Nakuru County; town hotels 40, lodges 10 and one tented camp. The total bed occupancy for the classified establishments is approximately 1300 beds. The County has two 2-star hotels, four 3-star hotels, three 4-star hotels and one 5-star hotel. Unclassified hotels are numerous.

Standard hotel accommodation or rental housing for non-local workers can possibly be available along the Nakuru – Kabarak/Marigat road or within Nakuru town.

Tourism activities in Menengai crater are concentrated around the crater viewpoint area. This is at the extreme east of the caldera and about 2km from the power plant site (Figure 3:13).

Figure 3-13: Menengai crater viewpoint and access route relative to project site



Source: Modified from Google earth

The viewpoint has a different access route from those used to access the geothermal development areas hence no interaction between tourists and project construction activities are anticipated. From the existing number of classified town hotels in Nakuru (See Section 3.3.11), workers accommodation is unlikely to affect tourist accommodation and associated business.

3.4 Existing infrastructure and activities

3.4.1 Main infrastructure

The project location is not pristine. Various types of infrastructure are already developed within the Menengai caldera through the preceding geothermal exploration, drilling of steam production wells and a number of activities related activities are still ongoing. These include:

- Sosian Energy Limited and Globeleq Menengai Geothermal Limited (the other IPPS) infrastructure which in structural buildings, containers, and operational equipment;
  - Access Roads: graded access roads (with a cumulative length of 50km) to all established drilling pads' locations for all weather passage. These are currently used by various vehicular categories from light vans to heavy trucks. Both existing road access into the caldera are manned by private security guards who maintain records of traffic/visitors into the geothermal development area. It is a standard requirement that all visitors to the area have prior clearance with the GDC office in Nakuru before any visits. New areas are also being opened up. According to PISSA, it is GDC responsibility to maintain the access and internal roads within the Menengai geothermal field;
  - Drilling pads and associated features required for the drilling rigs and facilities including:
  - Drilling rigs;
  - Storage areas (laydown areas) for drilling materials;
  - Parking for service vehicles;
  - Ponds or 'sumps' for settling of drilling fluids; and
  - Space for well testing equipment.
  - Additional well pads under construction;
- Drilling camps (mainly for rig operating teams) with several containerized or portable cabin style buildings providing sleeping accommodation, kitchen and dining facilities, food and water storage, recreation room, showers, toilets and septic tanks to form a single accommodation unit;
  - Satellite for communication, Power and water supplies: Existing camps and drilling pads are connected to grid power supplies and internal piped network of water lines, mainly running along the access roads. New connections were ongoing at the time of field visit.

Photo plates presenting some of the existing facilities and activities within the caldera are presented below.

Photo 3-2: Existing facilities and activities within the caldera

Section of newly done access road and well pads within the caldera as observed from the Menengai view point

Section of an access road through Wanyororo area

Green houses under preparation within the Menengai well 3 site

A fenced Brine pond with lining one of the drilling well pad

Some of the GDC drilling rigs within the caldera as observed from the view pint

An existing discharge well at Menengai well 3 site. These are some of the activities contributing to the existing noise and H_2S levels within the caldera

A telecommunication mast near the view point/Mlima punda

Control room at the Menengai Sub-station

Pit latrine near the entrance through Mercy Njeri

A weather station at Mlima punda

Water storage tanks viewed from Mlima punda.

Non functional discharge wells

GDC has 10 existing boreholes within Menengai field that produce an average total yield of 360m^3/hr. The boreholes have varying pumps depending on yield, depth and pump chamber level. The current abstraction levels are less than the aquifer discharge potential in the area. The boreholes have good recharge potential with abstraction depths range between 16.1-50 m bgl. Generally, the Borehole yields are generally high. Water for domestic use is sourced from NAWASCO. Summary details of existing water situation is presented in the tables below.

Table 3-21: Current water abstraction capacity

Source	Unit	Average Yield	Qty	Total	Remarks
Groundwater	Borehole	30m^3/hr	10	300m^3/hr	
NAWASSCO	Line	90m^3/day	1	7.5m^3/hr	Contractual agreed amount-domestic
Stream/ runoff / temporary	Ponds	200m^3/hr	1	200m^3/hr	During rains
Brine	Ponds	100m^3/hr (MW-01 only)	1	100m^3/hr	Wells continuous discharge

TOTAL				607.5m^3/hr	

Source: GDC, 2024

Table 3-22: Current lifting/pumping and storage capacity

Pump 1- 10" Line	Pump 2-8" Line	Total	Remarks
240m^3/hr	240m^3/hr	480m^3/hr	Continuous pumping
Storage Capacity		17,600m^3/hr	This requires 40hrs (approximately 2days to fill)

3.4.2 Existing waste management within the Menengai geothermal area

From existing general GDC operations within the Caldera, waste generally emanates from rig operations, the drillers camp, central workshop and storage yards. It mainly consists of plastic containers, cartons, scrap metals, bentonite sacks, paper, waste oil and other food/domestic refuse. A waste inventory has been developed to keep track of the amount and types of wastes generated for mitigation measures. A compost pit was constructed to turn all organic (food) waste into manure which is then used at an existing tree nursery.

For the other wastes, a licensed waste handler is contracted to collect the waste on a regular/daily basis. Other wastes such as drill cuttings are contained in the lined waste water ponds. Liquid waste generated is mainly separated water (brine) during well-testing. This water is contained in lined (high density plastic) waste water ponds (the ponds are fenced with chain-link), mixed with potable water and re-used for drilling. Future plans entail reinjection of the water. The ponds will also eventually be covered upon successful well testing and area rehabilitation.

Disused oils/hydrocarbons are accumulated in designated site within the lay down area. The disused oils have commercial market and once quantities reach commercial levels, class for auctioning is done by the GDC disposal committee (chaired by the supply chain manager) and the winning bidders (licensed to handle/recycle used oil) collect the materials for subsequent reuse.

3.4.3 GDC afforestation program

GDC has an established tree nursery within the caldera for use in on site rehabilitation and social afforestation. Among its objectives, the GDC environment department is keen on restoration of the Menengai environs. The department sets an annual target of raising, planting and issuing 60,000 tree seedlings to farmers and institutions within the project area.

4 PROJECT DESCRIPTION

4.1 Introduction

The Project is to design, build, own and operate one of three 35MW geothermal powerplants on a site provided by GDC. GDC responsibilities, which are Associated Facilities for the Project and are provided according to the PISSA, include:

- Provision of the site, which is clearly marked measuring 140m by 180m
- Construction and maintenance of site access roads (According to clause 6.1.3 of the PISSA);
- Supply of steam during Operation;
- Disposal of condensate during Operations;
- Supply of construction and service water;
- Supply water at the water supply interface at the plant boundary.

Additionally, evacuation of the generated electrical power will be carried out by KETRACO, who have already executed provision of the following Associated Facilities:

- 15km 132kV transmission line; and
- 132kV substation.

4.2 Project Design

The proposed OTTL power plant shall consist of two units of screw expanders and three units of Organic Rankine Cycle (ORC), with a main steam inlet pressure of approximately 6 bar at the power plant fence interface. Each unit will have a generator, rotational driving equipment and all the required plant auxiliary equipment within the plant boundary limits (fence line) (see the Site Layout diagram - attached).

The 35MW Menengai plant requires space of 140m by 180m. In this space there shall be:

- Two sets of steam screw expanders;
- Three sets of ORC systems;
- Evaporative cooling Towers
- Condensate Injection system
- Balance of Plant (BOP) components

4.2.1 Project components

The main power plant system components include:

- Screw Expander Turbine Unit 1 and Unit 2 each designed for normal inlet steam conditions of 6.0 bar exhausting at 0.977 bar (a) and associated instrumentation with a generator rated at 10,000 kW, 3,000 rpm, 3 phase, 50 Hz, 11,000 Volts with
- Exhausted Steam Organic Rankine Cycle (ORC) Turbine Unit 3 and Unit 4 each design for normal inlet steam conditions of 0.98 bar exhausting at 0.83 bar (a) and associated instrumentation with a generator rated at 11,000 kW, 1,500 rpm, 3 phase, 50 Hz, 11,000 Volts
- Exhausted Steam ORC Turbine Unit 5designed for normal inlet steam conditions of 0.98 bar exhausting at 0.83 bar (a) and associated instrumentation with a generator rated at 3,600 kW, 1,500 rpm, 3 phase, 50 Hz, 11,000 Volts

Each unit has:

- Oil lubrication system.
- Steam system with associated piping and control system.
- Cooling tower and circulation system
- Auxiliary transformer (11.0 kV/0.4 kV)
- Control air supply,

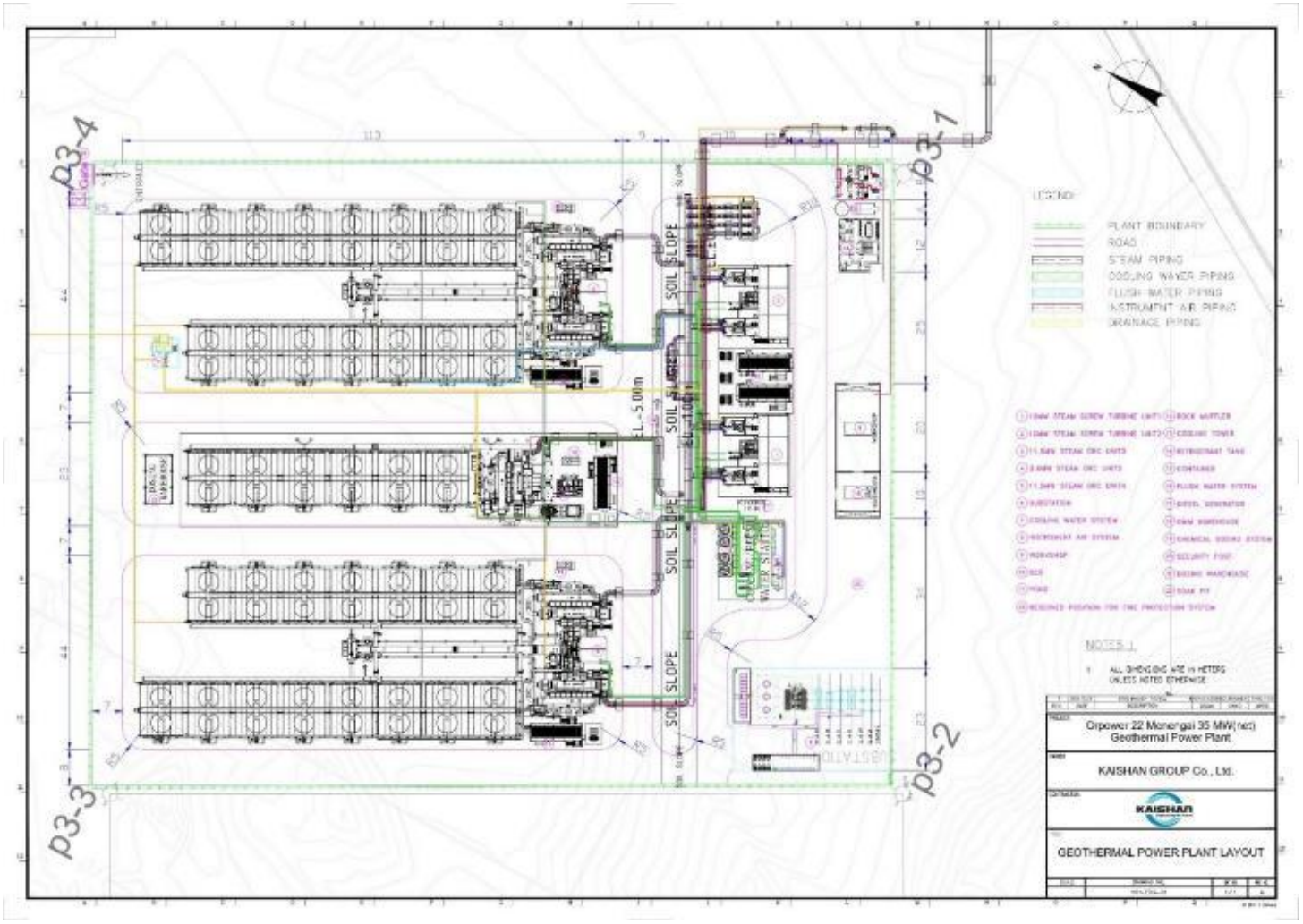
The power plant also has:

- Step-up transformer 60 MVA, ONAN/ANAF, 132/11 kV to connect from the 11 kV busbar of electricity generated by each unit to the KPLC switchyard via underground cables,
- Metering system

- Emergency Generator r – 400 kV, 820 kVA,
- Fire Protection system,
- H_2S detection system and alarm

See the project site layout below

Figure 4-1: Project Site Layout



4.2.2 Steam Supply

GDC will supply/deliver steam to the plant based on parameters in the PISSA Second Schedule. The steam received shall be at a pressure of 6bar and temperature of about 159ºC and 98% dry. The waste condensate and brine will be collected through a piped system and ejected by GDC to a reinjection well located on GDC's part of the project.

The responsibility of OTTL will be from the steam intake point to the agreed condensate discharge point on the boundary of OTTL's facility where the waste (Condensate and brine mixture) will be piped by GDC to a reinjection well that is expected to reach deep down into a cooler section of the aquifer.

4.2.3 Process Description

The steam supplied by GDC will have the average chemical properties as indicated in the PISSA Second Schedule. As shown in the example of the heat and mass balance attached in appendix III. The steam received at a pressure of 6bar and temperature of 158.8 deg C will be piped to the two Screw expanders unit 1 and 2 where the steam will through expansion rotate the units and, in the process, drop pressure to exit at 0.99 bar and a temperature of 99 deg C. The exhausted steam although at a low pressure has heat and is then piped into the Organic Rankine Cycle units 3, 4 and 5. Here the heat is transferred through heat exchangers to a medium that is pressurised and used to rotate the turbines. The condensate from the turbine outlets is then collected and pumped to the evaporative cooling condensers where it is cooled via a counter flow forced draft method to bring the temperatures from approx. 52 deg. C to 22 deg. C. This is then collected through a piped system and ejected by GDC to a reinjection well located on GDC's part of the project. The responsibility of OTTL will be from the steam intake point to the agreed condensate discharge point on the boundary of OTTL's facility where the waste (condensate and brine mixture) will be piped by GDC to a reinjection well that is expected to reach deep down into a cooler section of the aquifer.

There are several other fluid systems other than the steam system, such as the oil cooling system for the generator bearings, the pressurised air system used for instrumentation and to open and close the control valves and large valves. There is also a pH neutralisation system that uses caustic soda flakes and a non-foaming broad spectrum biocide that will be dosed into the system of circulating water for the control of bacteria, fungi and algae in a closed loop system.

At each unit the turbines rotate the generator and the total output of 35MW net from all the 5 units is stepped up from 11kV to 132kV and sold to Kenya Power and Lighting Company Limited (KPLC) via an energy metering circuit breaker.

The major infrastructure/power plant design and associated design standards can be found in the PISSA, First Schedule Part B, pp. 32 – 34.

4.2.4 Power Evacuation

Currently the Project area is within 15 km from an existing 132kV double circuit Tororo – Lessos – Juja line and about 30km to the Lanet 132kV substation. A 33KV line has also been extended into the Project area.

KETRACO had already developed a 15km 132kV double circuit transmission line from Menengai to an existing Soilo sub station (which will be expanded) and a 132kV substation next to the project site. KETRACO conducted ESIA and ARAP studies for the new transmission line. The ESIA for the transmission line and the accompanying sub-station has been approved by NEMA through Licence No. NEMA/EIA/PSL/526 issued on 5 September 2014. The transmission line has been aligned to minimize impacts on settlements and mainly passes through government land.

Photo 4-1: KETRACO Substations and transmission line within the project area of influence

<table>
<tr><td> 
</td><td>  </td></tr>
<tr><td colspan="2">Menengai sub-station within the geothermal field next to the proposed power plant site</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Soilo sub-station that will provide connection to the national grid</td><td>Transmission line approaching the Soilo sub-station from the Menengai sub-station.</td></tr>
</table>

4.3 Project Inputs

*4.3.1 **Geothermal steam***

Geothermal steam is the sole primary raw material in the project. This shall be supplied to the Power Plant from the production wells in the GDC Steam Gathering System for power generation and the resultant condensate will be pumped back into the reinjection wells, again by GDC.

The existing steam gathering system has a total of 25.5km above ground steam pipeline network connected to 19 productive wells (see Appendix III).

The steam received shall be at a pressure of 6bar and temperature of 22ºC and 98% dry. It will be collected through a piped system and ejected by GDC to a reinjection well located on GDC's part of the project.

Photo 4-2: OTTL, Globeleq and Sosian steam interphase point with the GDC installed steam gathering system

About 8,000 kg of steam will be consumed to generate one (1) megawatt (MW) of electricity per hour. The measured composition by volume of the main steam flowing through each of the existing turbines is:

- Steam – 96.7%; and
- Non-Condensable Gases (NCGs) Contents – 3.3%.

The composition of NCGs is provided in Table 4-1 below.

Table 4-1: Composition of non-condensable Gases (% by Volume) in Menengai Wells

NCG Contents (3.3% normal,4% max)	**% of NCG**
Carbon dioxide (CO2)	96.2%
Hydrogen Sulfide (H_2S)	3.0%
Hydrogen (H_2)	0.4%
Methane (CH4)	0.1%
Oxygen (O2)	0.3%
Total NCG flow	**100.00%**

4.3.2 Chemical dosing

Chemical dosing system shall be installed in the Power Plant for the cooling water circuit to prevent pH levels getting too low as well as prevent algae growth in cooling tower. These chemicals are biocides, dispersants, anti-sealants and pH control dosing chemicals. The chemical dosing system including its waste management shall be the responsibility of OTTL.

4.3.3 Water Supply

Raw water supply is required for construction, fire water, and potable water for drinking and domestic and for plant maintenance.

Water will be supplied to the Project from GDC water supply tanks within the Menengai Geothermal project area into a water storage tank on site for potable water required for normal plant use as well as

the fire water storage capacity required under the NFPA. Water will also be capable of being delivered by bowser truck in case water is not available from GDC.

GDC shall provide water to OTTL at the water supply interface point at the plant boundary in the quantities presented in Table 4-2. It is estimated that 230 cubic metres of water will be required for firefighting and an average of 30 litres per second as potable water.

Water provided by GDC does not guarantee the water quality and availability and therefore OTTL shall make its own contingency measures for the provision of water for operation/construction in the event that GDC is unable to provide the water. GDC shall be responsible for financing, supply, installation, testing and commissioning of the water supply system and meters up to the water supply interface point from the effective date. Whereas OTTL shall be responsible for the financing, supply, installation, testing and commissioning of the water supply system delivering water to the Lay Down Area and its water storage facility.

Table 4-2: OTTL's Estimated construction and operation water requirements

Use item	**Quantity (m^3/d)**
Construction phase	
Domestic consumption (sanitation) during construction	10
Concrete mixing	60
Dust suppression in high traffic areas	60
Operation phase	
Testing and commissioning	10
Operation and maintenance (sanitation)	10

4.3.4 *Turbine generator oil system*

The turbine generator oil system is required to:

- Supply lubrication oil for the bearings and mechanical seals of turbines and/or the generator;
- Supply the control and governor system with hydraulic oil.

Each turbine/generator island features necessary oil pumps, filters, coolers, tanks, control valve, relief valves and instrumentation. In the event of electrical supply cut out, emergency systems pump the oil round the system.

4.3.5 *Waste water*

It is recommended that oil separator is used to separate water contaminated with oil, before it is released into storm water drainage, provided that the oil concentration is not greater than 10mg/l.

Wastewater from toilets, kitchen, showers and sinks will be directed to a foul water drainage system and care taken to ensure no process effluents come into contact with this stream. This drainage system will meet the requirements and standards set by local authorities.

4.4 Project schedule and Phasing

The Project is to be commissioned within 17 months from the effective date of the PISSA as shown below.

Table 4-3: Project schedule

Milestones	Time (months)
PISSA Signature Date	1st November 2014
Target Effective Date	S + 6
Actual Effective Date	E
First Commissioning Date	E + 15
Required Grid Available (T-Line and substation commissioned)	E + 15
Required Steam Available (GDC works commissioned)	E + 15
Full Commercial Operations date	E + 17
Exit and Site restoration	9 Months after Expiry of Steam Supply Period.

Where "S" is the Signature date and "E" is the Effective date between GDC/KPLC and the OTTL in the mutually agreed PISSA/PPA. The actual effective date E was achieved on 01/11/2024 and construction commenced on schedule and is on course with expected commissioning date on 31/3/2026.The schedule is presented in more details in in Appendix III.

4.4.1 Construction Phase

The construction phase of the power plant by an EPC contractor is estimated to take approximately 17 months from October 2024 to February 2026. Similar projects would engage several sub-contractors with specialised skills. The entire construction work force during the construction phase is 327 workers out of which 295 are males and 32 Females..

42% of unskilled and semi-skilled workers will be recruited from the immediate local community and Nakuru town while the skilled workers are a mix of locals and expatriates. For general works, over 70% of the Workers will be from the local community. It is expected that the recruitment of unskilled workers or semi-skilled workers from the local community will be coordinated with GDC and the stakeholders committee which will include some youth community leaders.

Accommodation for non-local construction staff is arranged out of the project site. However, as a requirement by both KFS and GDC no teams of the IPPs will be housed on site (within the caldera) overnight during the construction phase apart from those providing security services. Therefore, the non-local construction workers would need to be housed in the suburbs of Nakuru town in an area closer to the site and or within the town, with provision for trucking to and from the site. The caldera is accessible via two routes: the Wanyororo route off the Nakuru – Nyahururu road which is approximately 8 Km and the Mercy Njeri route off the Nakuru – Mogotio/Eldama Ravine road which is also approximately 10Km. According to the PISSA agreement, OTTL is supposed to use the Wanyororo access only for equipment transportation because it not busy with traffic. Standard hotel accommodation or rental housing for non-local workers is available along the Nakuru – Mogotio/Eldama Ravine road (Kiamunyi and Mercy Njeri estates) or within Nakuru town. These range from approximately 15 to 25 km from the caldera.

OTTL intends to have regular engagement with other stakeholders to ensure coordination with other IPPs and GDC and provide a channel to monitor and manage any arising concerns.

The 33kv existing power line constructed by KPLC will provide the power required during the construction period.

External vendors will provide the necessary natural materials, such as sand, ballast, cement etc., as required.

4.4.2 Operations Phase

During the operations phase OTTL's obligation is to operate the power plant on a 24hrs basis with a total team of 30 – 40 staff and allow for contracted janitorial services and night and day cover of contracted security services. However, on site during the day would be on average a team of 15 to 20 staff while others may be off duty. The night shift is expected to be three persons for operations with a compliment of the night security team (PISSA 1st Schedule Part B pp. 10 – 19). The first and second schedules of the PISSA describe the process-inbuilt safety controls.

From the foregoing project description, it is clear that the main responsibility of OTTL will be within the site area (140m by 180m) set aside for the power plant. However, the power plant associated facilities including the vital input in the power generation, geothermal steam as well as the power evacuation system with be the responsibility of other players as summarised in the table below.

Table 4-4: Project and key Associated Facilities' management responsibilities

Project feature	**Responsibility for construction and maintenance**
Menengai geothermal field	GDC (with head lease from KFS)
Production wells and steam gathering system up to the plant boundary	GDC
Brine collection and Steam re-injection system	GDC
Power Plant (1x35MW)	**OTTL**
Access roads and internal roads within Menengai caldera up to the power plant area boundary	GDC
Water supply network up to the boundary of the plant area	GDC
Power evacuation line and substations	KETRACO (construction and KPLC (operation and maintenance)

4.4.3 Cumulative Activities

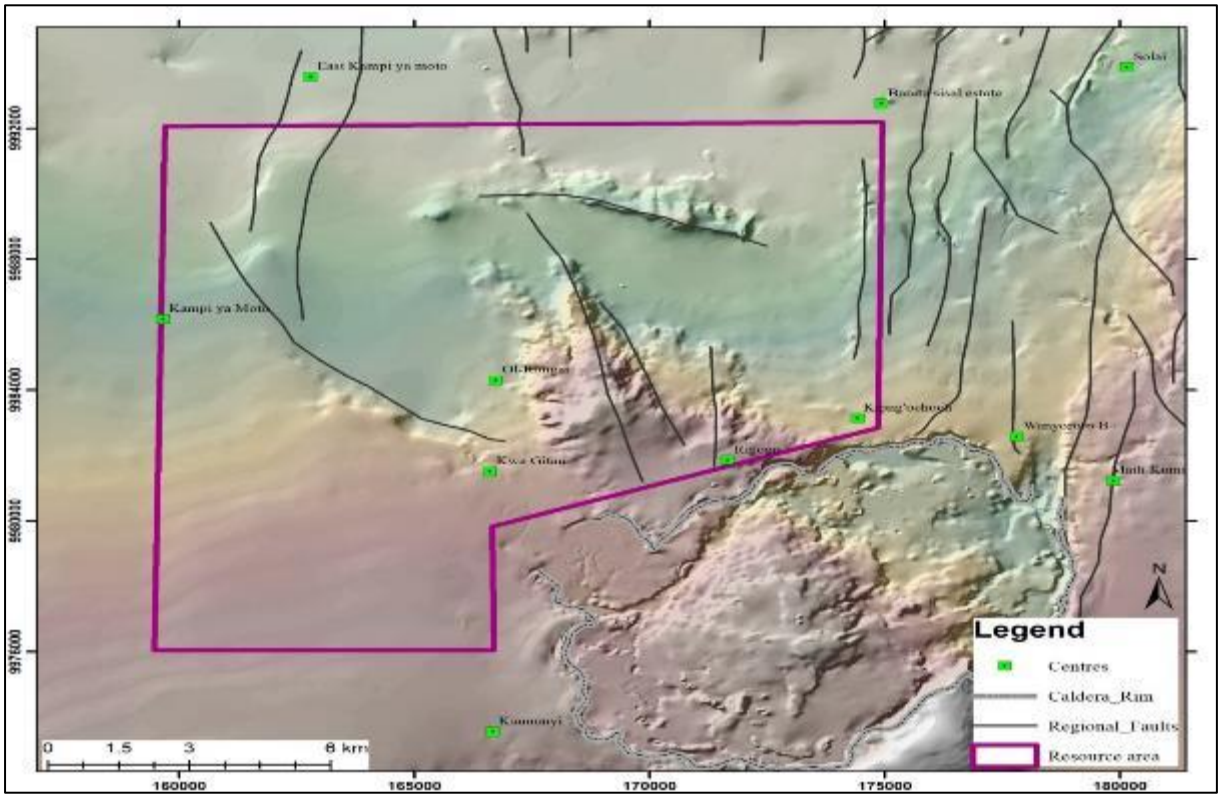
Construction and operation of 2X35MW plants by two other IPPs

As indicated in the introduction, the OTTL power plant is one of the three plants to be developed side by side by three IPPs under Phase I of the Menengai geothermal field development with a total of 105MW power generation capacity. The Globeleq power plant as at August 2025 was 70% done in terms of construction works while the Sosian Power plant was already operational. .. However, considering that the plants associated facilities are already in place, their operations will certainly occur concurrently for a significant portion of their operational life.

Development of Menengai geothermal field Phases II and III

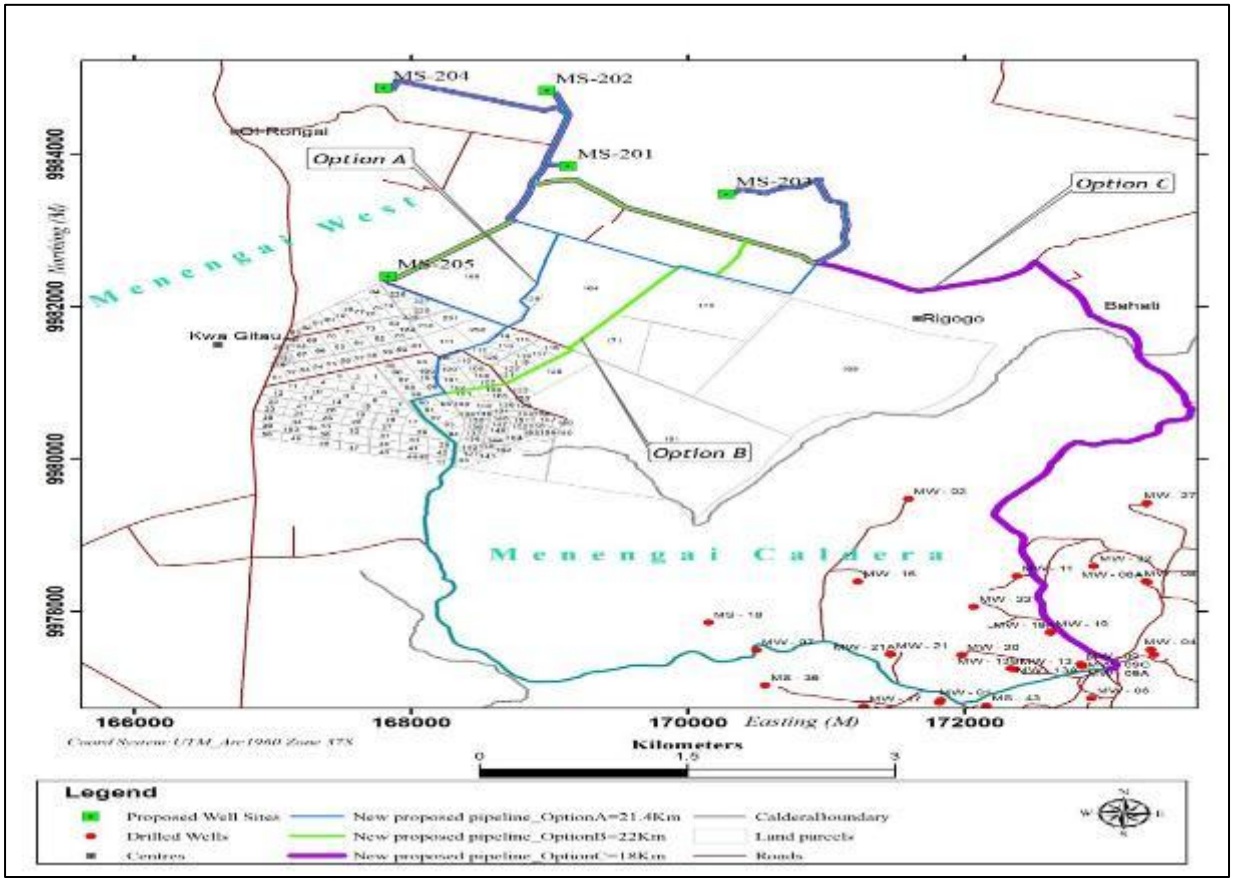
In addition to the development of the three power plants in Phase I, GDC has plans for Phases II and III of Menengai geothermal field development which is estimated to respectively have a capacity of 60MW and 300MW. Phase II will be done within the caldera and some of the production wells for Phase II development are already in place while additional ones will continue to be drilled. Similarly, the supporting steam gathering system and supporting infrastructure will be developed. The exact locations of the Phase II power plants were however unknown at the time of compiling this report. Phase III will be located in Menengai West, with the main resource area lying to west of the caldera. (See Figure 4-2 and Figure 4-3).

Figure 4-2: Menengai West resource area



Source: GDC, 2024

Figure 4-3: Proposed wells and pipeline options for Menengai West



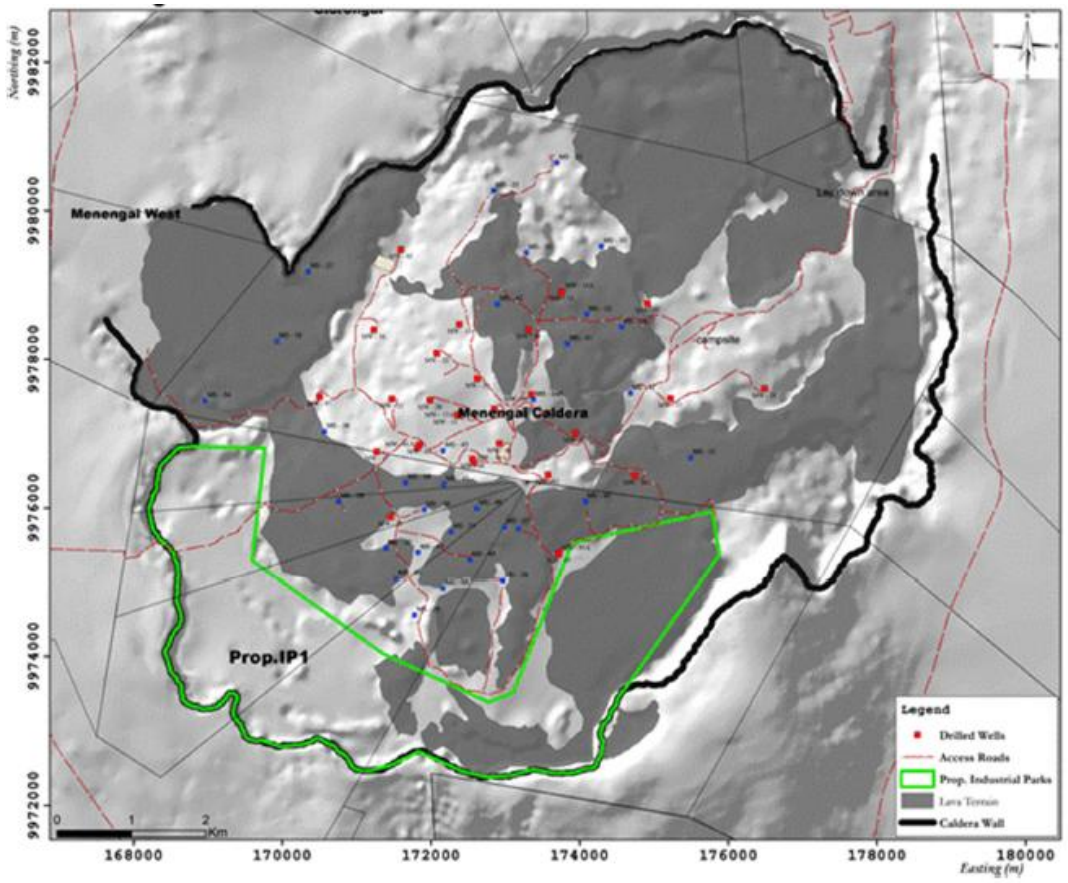
Source: GDC, 2024

Menengai Geothermal Industrial Park

As the drilling for geothermal energy continues in Menengai, more energy will become available for electricity generation. As a result, the production of separated geothermal brine, which is a by-product of geothermal electricity generation will also increase. The separated brine is normally reinjected back into the ground to replenish the geothermal reservoir. However, at the separation pressure of 7 bar absolute, the brine is at a temperature of around 165°C. The energy in the brine could be harnessed before reinjection. In addition, geothermal power generation produces other by-products such as no condensable gases and water; as well as dissolved substances, which can be extracted and turned into useful products.

The proposed geo-industrial park in Menengai is where the utilisation of these by-products of geothermal electricity generation or direct use of geothermal energy will take place. GDC has identified a potential location for the park on the south-western part of the Menengai geothermal field as shown in Figure 4-4.

Figure 4-4: Proposed Menengai geo-industrial park



Source: GDC 2016 as cited by United Nations University, 2017

On this land, the energy will be provided centrally for utilization by the industries. Besides energy supply, the industrial park will also be served with fresh water supply, access roads and telecommunication equipment. Proposed industrial activities to be supported in the industrial park include mainly horticulture, aquaculture, milk processing, crop drying among others.

5 PROJECT ALTERNATIVES

5.1 Alternative Forms of Energy for development

The project proposes to use geothermal form of energy. Below is the comparison of the different forms of energy development available in Kenya and their suitability for the Menengai site.

Table 5-1: Form of Energy

No.	Form of Energy	Comparison
1	Geothermal	Ideal for Menengai as the resource is readily available within Menengai field.
2	Hydro	It is affected by hydrology and not ideal for Menengai
3	Wind	Requires constant blowing of wind at a moderate speed that is able to run windmills throughout the year which does not take place within Menengai field and hence not ideal for Menengai field.
4	Thermal	Uses fossil fuel and therefore not clean energy. Not ideal for the Menengai site

5.2 No Action Alternative

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

According to the latest report posted by energy regulatory commission, the country's installed capacity of nominal and effective power generation is as presented in Table 5-2 below.

Table 5-2: Installed capacity of nominal and effective power generation in Kenya

Source (as at 2024)	Capacity (MW)	Capacity %
Hydro	872.4	24.38%
Geothermal	943.7	26.37%
Thermal	636.1	17.78%
Wind	436.1	12.19%
Solar	442.9	12.38%
Bioenergy	163.8	4.58%
WHRC	83.5	2.33%
Total	3,578.5	100.0%

Source; EPRA: Energy and Petroleum Regulatory Authority 2024

Kenya has an installed capacity of approximately 3.6 GW. Whilst about 24.38% is hydro power, about 26%% is geothermal and emergency thermal power at 17.78%. Wind power installation capacity is at 12.19%. Thermal energy sources have been used to make up for these shortfalls, geothermal sources contribute to the highest amount of electricity generated in the country.

However, Kenya Electricity Generating Company (KenGen), is responsible for generating approximately 90% of installed capacity. Independent Power Producers (IPPs) are responsible for about 10% of installed capacity. The following IPPs are active in Kenya: (a) Westmont (b) AEP Energy Africa (Iberafrica) (c) OrPower4 Inc. (a subsidiary of Ormat Technologies) (d) Tsavo Power Company (e) Aggreko (f) Africa Geothermal International

Due to over reliance in the hydropower over the last ten years the country has paid a high price over heavy reliance on single source of power. In 1999 and in 2002, severe droughts nearly brought the Kenyan economy to a standstill after the hydropower dams dried out leaving power rationing in its wake. This experience has underscored the need to diversify the power sources in Kenya.

The “No Action Alternative” will therefore involve several losses both to the proponent, the community and the Country as a whole. GDC, a 100% Government of Kenya owned company, is tasked with accelerating development of geothermal resources to support development of at least 10,000 MW by 2030 in line with Vision 2030. To this end, GDC has invested a lot in research and steam exploration with the ones in Menengai now ripe for development with agreement already signed between GDC and the IPPs.

Without implementation of the project, the following shortcomings are expected:

- The government will be unable to timely develop the energy resources required to spur Vision 2030;
- 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, electrical etc.) associated with the project in its host areas will not be undertaken;
- Lack of development, research and innovation in the Country; and
- Loss of money by government because money has been spent on exploration and well drilling phases.

The ‘no action alternative’ is therefore not feasible development option for this project.

5.3 Alternative sources of electricity generations

Among the considerations which are the alternatives ways to meet the power demand in Kenya are as discussed below in Table 5-3 below.

Table 5-3: Summary of the key project alternative considered

Project Alternatives and Reasons for Rejection		
Alternative	**Description**	**Reasons for Rejection**
Hydropower	Construction of new hydropower plants	▪ Extreme weather patterns including a warming trend in temperatures and increasing variability in rainfall resulting in droughts in Kenya. ▪ Unreliability of the existing hydropower generation due to the above. ▪ Potential negative environmental and social impacts. ▪ Limited potential for scale-up.
Oil	Construction of new Medium Speed Diesel (MDS) power plants.	▪ High operation costs. ▪ Highly dependent on oil prices. ▪ Negative environmental and social impacts.
Coal	Construction of coal fired power plants	▪ Local coal deposits have been reported in Kitui and Mwingi Districts. However, the viability of these deposits for commercial exploitation is yet to be demonstrated. ▪ For immediate project implementation, Kenya will have to rely on imported coal, which poses a number of challenges such as shipping and port handling logistics. ▪ Potential negative environmental and social impacts. ▪ Water supply constraint.
Wind	Development of the wind potential.	▪ Needs to be backed-up by base load capacity.
Solar PV or CSP	Development of the solar potential.	▪ Solar PV mainly for domestic installations. Concentrated Solar Power (CSP) mainly used for drying and water heating. ▪ CSP not cost effective for large-scale power generation.
Power imports	Importing power from neighboring countries	▪ National security. ▪ Limited potential for scale-up (the capacity of the Kenya Ethiopia interconnection line will be limited to 2,000 MW).
Nuclear	Construction of nuclear power plants	▪ Nuclear generating units are characterized by high capital investment and long lead times. ▪ Need to overcome many barriers and challenges ranging from political, environmental and social as well as technological.
Private sector	Geothermal field development by the private sector	▪ Drilling risk is a barrier to private sector investment. ▪ Rights for geothermal resource development (one single reservoir) cannot be shared.
Olkaria field	Development of the Olkaria domes geothermal field	▪ The field is located in the proximity of a conservation and recreational area, which is not acceptable from an environmental point of view. ▪ Limited geothermal resource, which is currently being developed by KenGen and Orpower4 to its maximum limit.

5.4 Advantages and Environmental benefits of Geothermal Energy

Geothermal energy has the following advantages:

- Geothermal energy is generally considered environmentally friendly and does not cause significant amounts of pollution;
  - Geothermal reservoirs are naturally replenished and therefore renewable;
  - Harnessing geothermal energy does not involve any fuels, which means less cost fluctuations and stable electricity prices;
  - Excellent for meeting the base load energy demand (as opposed to other renewable energy forms such as wind and solar);
  - It makes small footprint on land;
  - Recent technological advancements (e.g. enhanced geothermal systems) have made more resources exploitable and lowered costs of energy; and
  - There is massive potential of geothermal resource making it the ideal form of energy.

The use of geothermal energy as a source of power generation has a number of environmental benefits.

The project will directly contribute to economic growth by alleviating the persistent electricity interruptions that affect the productivity of the industrial, commercial and agricultural sections of the Kenyan economy. It will mitigate the effects of power shortages that hinder economic development in the short and long term, by providing base load power supply which is consistent with the least cost expansion plan. Moreover, it will supply the much-needed back-up power for Kenya's hydroelectric dam system which is prone to water shortages and climatic uncertainty.

The project will use an indigenous energy resource for power generation. Therefore, it will reduce exposure of the economy to fossil fuel price fluctuations and the associated exchange rate risk for fuel procurement. In addition, it will benefit regional environment (especially air quality) since geothermal electricity production produces none of the conventional air pollutants associated with alternative fossil fuel generation options. It will also supply jobs to some local residents and be a source of local economic growth.

The global benefits of the project include avoided GHG emissions. In particular it provides for substantial carbon dioxide emission reductions in comparison to fossil fuel-based generation of a similar capacity. Existing geothermal electric stations, that fall within the 50th percentile of all total life cycle emissions studies reviewed by the Intergovernmental Panel on Climate Change (IPCC), produce on average 45 kg of CO_2 equivalent emissions per megawatt-hour of generated electricity (kg CO_2eq/MW·h). For comparison, a coal-fired power plant emits 1,001 kg of CO_2 per megawatt-hour when not coupled with carbon capture and storage (CCS).

5.5 Alternative technologies for Geothermal Power Plants

Geothermal power plants can be divided into two main groups, steam cycles and binary cycles. Typically, the steam cycles are used at higher well enthalpies and binary cycles for lower enthalpies.

The steam cycles allow the fluid to boil, and then the steam is separated from the brine and expanded in a turbine. Usually, the brine is rejected to the environment or re-injected. The brine can be flashed again at a lower pressure if double flash system is used.

A binary cycle uses a secondary working fluid in a closed power generation cycle. A heat exchanger is used to transfer heat from the geothermal fluid to the working fluid, and the cooled brine is then rejected to the environment or re-injected.

5.5.1 Steam Cycle Power Plants

Geothermal Steam Cycle Power plants are similar to other steam turbine thermal power stations. Heat from a fuel source (in geothermal case, the earth's core) is used to heat water or another working fluid. They use water at temperatures greater than 150^0C that is separated and piped, then condensed steam is cooled at the cooling tower and the excess condensate re-injected.

Flash steam cycle plants are the most common type of geothermal power generation plants in operation today, which use water at temperatures greater than 182°C (455 K; 360 °F) that is pumped under high pressure to the generation equipment at the surface. The working steam is then used to turn a turbine of a generator, thereby producing electricity. The fluid is then cooled and returned to the heat source.

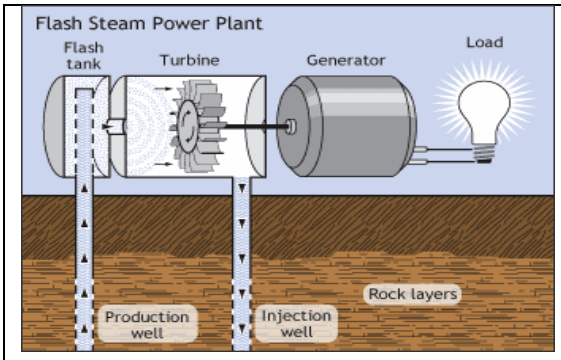
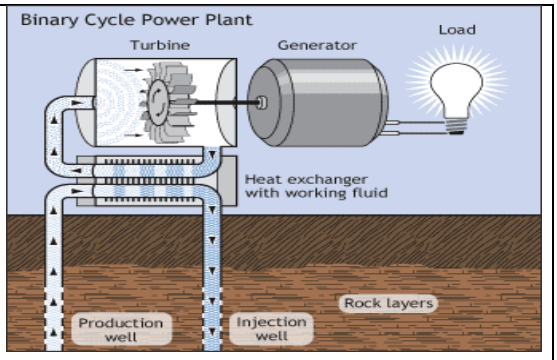
	
Flash Steam Power Plant	Binary – Cycle Power Plants.

Figure 5-1: A single-flash steam cycle is proposed for Menengai geothermal power plant.

5.5.2 Figure Binary-Cycle Power Plants

Most geothermal areas contain moderate-temperature water (below 400°F). Energy is extracted from these fluids in binary-cycle power plants. Hot geothermal fluid and a secondary (hence, "binary") fluid with a much lower boiling point than water pass through a heat exchanger. Heat from the geothermal fluid causes the secondary fluid to flash to vapor, which then drives the turbines. Because this is a closed-loop system, virtually nothing is emitted to the atmosphere. Moderate-temperature water is by far the more common geothermal resource, and most geothermal power plants in the future will be binary-cycle plants.

Binary cycle geothermal power generation plants differ from Dry Steam and Flash Steam systems in that the water or steam from the geothermal reservoir never comes in contact with the turbine units and this enables a longer life span for the turbines.

One key advantage is that Binary cycles operate at lower enthalpies (temperatures) and can be used on low temperature sources that are not suitable for traditional flash system geothermal power plants. Binary systems can utilize the condensate or brine in geothermal systems to increase the plant's output capacity.

The limitations of Binary Geothermal Power Plant include:

- High initial project cost;
- More maintenance costs and
- Highly skilled & trained manpower required for installation and running the plant

5.5.3 Recommendation for Menengai Power Plant Design

A single flash Steam Cycle is recommended for the Menengai power plant. This type of system has a high efficiency rate of converting steam to electricity and hence is cost effective. The issues of this system are:

- The risk of well enthalpy turning out to be different than planned.
- The risk of well enthalpy changing when utilization of the reservoir starts;
- The second separator stage is usually at pressures below silica saturation limit. This calls for acid or inhibitor dosing and has potential to cause increased maintenance costs or operational problems.

5.5.4 Alternative NCG extraction and dispersal technologies

There are two types of technologies that are commonly used for NCG extraction i.e. the stack and cooling tower technologies. A stack also known as a chimney is the duct built to expel NCG high above in the atmosphere. It may be conical or cylindrical in shape. It may be forced draft or natural draft in the stack to expel the gases.

A cooling tower is an evaporative heat transfer device in which atmospheric air cools warm water, with direct contact between the water and the air, by evaporating part of the water. Wet cooling towers have a hot water distribution system that showers or sprays the water evenly over a lattice work of closely

set horizontal slats or bars called fill or packing. The fill thoroughly mixes the falling water with air moving through the fill as the water splashes down from one fill level to the next due to gravity. Outside air enters the tower via louvers in the form of horizontal slats on the side of the tower. The slats usually slope downward to keep the water in. The intimate mix between water and air enhances heat and mass transfer (evaporation) which cools the water. The cold water is then collected in a concrete basin at the bottom of the tower where it is pumped back to the condenser. The cooling tower comprises a number of cells modularized such that one complete cell, including the associated non-condensable gas (NCG) dispersion system can be pulled out. The cells can be taken out of service for safe cleaning or maintenance whilst the other cells remain in operation.

Based on air quality modelling findings, cooling tower is preferred over the stack as far as dispersal of H_2S is concerned. OTTL has proposed use of cooling towers in the power plant.

6 PUBLIC AND STAKEHOLDER ENGAGEMENT

6.1 Introduction

The Constitution of Kenya (2010) makes Consultation and Public Participation (CPP) a central part of governance. CPP is also a mandatory procedure as stipulated by EMCA 1999 Section 58, on ESIA for achieving the fundamental principles of sustainable development. This chapter describes the consultation and public participation process followed by the Consultant and the feedback from the consultation.

Part III Section 17 of the Environmental (Impact Assessment and Audit) Regulations, 2003 requires that during the process of conducting an environmental impact assessment study, the project proponent seeks the views of persons who may be affected by the project.

In seeking the views of the public, the project proponent through GDC undertook 13 (No.) informal public consultation meetings within a period of 2 years from 21st March 2016 to 9th November 2018. 7 (No.) additional public consultations forming part of the supplemental ESIA studies were undertaken in 2024 in order to refresh the community regarding the project and seek any additional emergent potential impacts or concerns. Another consultative meeting with Menengai- Community Forest Association was held on 22nd August 2025. In the entire consultation process with the affected parties, explanation on the project description, impacts were provided and views of the public were noted.

6.2 Objectives of the consultation process

The overall goal of the consultations is to disseminate project information and to incorporate the views of the local community and other stakeholders in the identification of potential impacts, design of the mitigation measures and the management plan.

The specific objectives of the consultations are:

- Sensitize the community on the proposed project;
- Seek public views on the proposed project;
- Obtain public endorsement of the proposed project;
- Improve project design and, thereby, minimize conflicts and delays in implementation;
- Increase long term project sustainability and ownership;
- Increase the participation, effectiveness and sustainability of mitigation; and
- Update the public and the stakeholders on matters to do with the project.

Approach to the stakeholders' and public consultations is discussed in Section 1.6.4.

6.3 Stakeholder Analysis

Stakeholder analysis was undertaken to determine the stakeholders who will be affected directly or indirectly by the proposed project and who can contribute to or hinder its success. It is vital to ensure that all relevant stakeholders are consulted during project implementation so as to accord their support and advice.

The stakeholders are categorized into two groups; the primary stakeholders, and secondary stakeholders. Primary stakeholders are those who are directly affected by the developmental intervention either positively or negatively. They consist of the project proponent, the local population in the project's primary zone of influence/ impact.

Secondary stakeholders are those who influence a development intervention or those that are affected indirectly by the proposed project.

6.3.1 Stakeholder Identification

To enhance maximum participation and achieve a better output, the right stakeholders should be taken on board. This is done through stakeholder identification and involvement based on their needs, interests, relative power and potential impact on project outcome.

In this regard, two broad categories of stakeholders were identified. These include:

- *Primary stakeholders* – those who are the beneficiaries of a development intervention or those directly affected (positively or negatively).by the project;

- *Secondary stakeholder*- those who influence development or are indirectly affected by the project especially those stakeholders involved in resettlement planning and implementation. These include the implementing agency, relevant government departments, and local administration among others

Public and stakeholder engagements was conducted during an initial and supplemental ESIA. During this process the consultants held meetings and interacted with local people, provincial administration, and other groups represented such as women, youth, church leaders and health workers (see Appendix IV). The stakeholders identified and consulted during the initial and supplemental ESIA study, their affiliations and categorisation are presented in Table 6-1 below

Table 6-1: Composition of public and stakeholders consulted

Stakeholder	Description	Mode of Engagement
Proponent	GDC staff	Group Discussions; One-on-one interviews with specific departmental heads.
Local community	Residents of settlements bordering the project's immediate zone of influence that is the area directly outside the power stations and Menengai Crater	Information sessions followed by question-and-answer sessions through a public baraza/ meeting. The venues of the meetings had to be easily accessible to the people and included market centers or area chief's compounds.
	Key informants among the project affected persons. These included: a) Village Elders and Chairmen;	Meetings; One-on-one interviews.
Administrative Representatives of people in the greater project area, that is Nakuru County	Nakuru county District Commissioners, District Officers, Chiefs and Assistant Chiefs	Information sessions followed by focus group discussions

6.4 Modes for Public Consultation and Sensitization

To ensure consistency with the provision of IFC ESS 1, and AfDB, E&S- OS 1 and 10 which requires “effective community engagement and disclosure of Project related information and consultation with local communities on matters that directly affect them,” consultation meetings were held with identified stakeholders via the following modes;

6.4.1 Key Informant Interviews

Two Key Informant Interviews (KII) using structured questionnaires were conducted to representatives from the National Government Administration Office and Geothermal Development Company during the public consultation process. Informal Focused Group discussions were also held with Bahati Youth Empowerment Forum, Youth leaders, Menengai Grazers Association and Opinion leaders.

These approaches were widely used in gathering sociological data and opinions, priorities, and concerns of persons of interests with regard to the proposed project. Some of the concerns raised through the Key Informant interviews included: Noise pollution, Air pollution, Water pollution and Increased traffic jam in the project area as a result of the construction activities. The following impacts were anticipated during the operational phase: increased gaseous emission (H2S), depletion of natural resources such as water, environmental pollution resulting from discharge from the power plant among others. The KIIs further recommended for continuous engagement of the members of the community throughout the project phases, development and implementation of an Environmental Plan and continuous monitoring and evaluation of the project activities.

6.4.2 *Public meetings*

The selection of the public meeting venues was also done in consultation with the local leaders. The venues' selection was based on proximity to the proposed project ease of site accessibility, population, and renowned venues for holding public meetings in the respective project areas. All the affected locations and villages along proposed project were covered during the public consultation meetings.

A total of Seven (7) public meetings were held with residents within various locations of the project area in the year 2024. The supplemental ESIA consultation exercise in 2024 focused on the primary project zone of impact locations of Kirima and Wanyororo which were within a 5 – 10 Km radius of the proposed project site.

The table below summarizes attendance for the for the stakeholder consultation meetings. A total of over 455 participants attended formal public meetings of which 322 (70.7%) were male and 133 (29.3%) were female.

Table 6-2 Summary of Public meetings held in 2024

S/N	Venue	Date	Attendance		
			Male	Female	Total
1.	Wanyororo chief's camp at Wanyororo sub location, Kirima location, bahati division **Attendees:** Local administration, village elders, women, men, youth, PWD's	8 May 2024	**27**	**8**	**35**
2.	Maciaro Chief's camp at Ngata division, Kiamunyi location, Mercy Njeri sub location **Attendees:** Local administration, GDC, OrPower 22, village elders, women, men, youth, PWD's.	8 May 2024	**35**	**27**	**62**
3.	Wanyororo Chief's Office **Attendees:** Local administration, GDC, OrPower 22, community members	30th September 2024	**45**	**2**	**47**
4.	Arahuka Baraza Park **Attendees:** Local administration, GDC, OrPower 22, community members	1st October 2024	**62**	**16**	**78**
5.	Ol'Rongai Chief's Office **Attendees:** Local administration, GDC, OrPower 22, community members	2nd October 2024	**53**	**21**	**74**
6.	Mercy Njeri Social Hall	3rd October 2024	**49**	**27**	**76**

S/N	Venue	Date	Attendance		
			Male	Female	Total
	Attendees: Local administration, GDC, OrPower 22, community members				
7.	Maciaro Baraza Park **Attendees:** Local administration, GDC, OrPower 22, community members	4th October 2024	**51**	**32**	**83**
Total			**322 (70.7%)**	**133 (29.3%)**	**455**

The following informal meetings were also held within the period of March 2016 to November 2018

Table 6-3 Summary of Informal Public meetings

S/N	Venue	Date	Attendees
1.	Maciaro nursery school	21 March 2016	Opinion Leaders, Youth, Women, PWDs, Local, Administration, & GDC
2.	Ol' Rongai Center	30 March, 2016	Community members, DCC representative, Area chief and, GDC, team and assembly Rep.
3.	Polo Centre	25 March, 2016	Bahati Youth Empowerment Forum
4.	Polo Centre Boardroom	6 May 2016	Youth, administration and GDC
5.	Polo centre, Nakuru	3 March, 2017	Youth leaders and GDC
6.	Polo Centre, Nakuru.	5 January. 2018	Menengai Grazers Association and GDC team.
7.	Arahuka chief's office	27 February. 2018	Opinion Leaders, Youth, Women, PWDs, Local, Administration, Consultants & GDC
8.	Kiamunyi chief's office	27 February 2018	Opinion Leaders, Youth, Women, PWDs, Local, Administration, Consultants & GDC
9.	Wanyororo chief's	27 February 2018	Opinion Leaders, Youth, Women, PWDs, Local, Administration, Consultants & GDC

S/N	Venue	Date	Attendees
10.	Polo Centre Nakuru.	11 May 2018	Youths from all round the caldera, Deputy County Commissioner, Rongai and Nakuru North and GDC team
11.	Maciaro Farm.	8th August, 2018	Opinion Leaders, Youth
12.	Nakuru office & Menengai project	12 Nov. 2018	Nakuru County Assembly committee on water, Energy, Environment and Natural resources & GDC
13.	Ol-Rongai Chief's Office,	9 Nov 2018	Opinion Leaders, Youth, Women, PWDs, Local, Administration, Consultants & GDC
14.	Menengai KFS Offices	23rd Aug 2025	Offcials of Menengai Community Forest Association
15.	Menengai Community Forest Users Association	28th August 2025	CFA Officials

6.5 Key Stakeholder Meetings

A Key Stakeholder Meeting was held with the Menengai Community Forest Association (MCFA) on 22 Aug 2025 at KFS MCFA office. The meeting had 8 attendees, 5 male and 3 female

6.6 Issues Arising from the Stakeholder and Public Consultations

This section presents a chronology of stakeholder and public consultation in the year 2024 that were conducted with the main objective of informing the ESIA study. Matters discussed during the Key Informant Interviews and public meeting have been highlighted in this section. Table 6-4 shows a highlight of the issues and comments raised from the stakeholders. Minutes and attendance sheets of the public meetings are presented in appendices IV.

Table 6-4: Summary of records of stakeholder & community engagements

Meeting No.	Venue	Date	Composition	Issues of concerns /needs/ project impacts	Response
1	Maciaro Chief's camp at Ngata division, Kiamunyi location, Mercy Njeri sub location	8 May 2024	Local administration, GDC, Orpower 22, village elders, women, men, youth, PWD's	*Issues of concern raised/ potential negative impacts* ▪ Concern of potential increase in road erosion due to increase vehicle traffic; ▪ Potential increase in dust pollution due to increase in vehicle traffic and over speeding project vehicles; ▪ The project could result into influx of foreign labor populations which would lead to an increase in crime rates; ▪ Concern of potential increase in noise pollution during project construction and operation; ▪ The project proponent to consider providing scholarship and attachment opportunities to exemplary qualified youth in the community; ▪ The project to avoid discrimination in employment opportunities by only considering unskilled labor for the local community.	▪ Project proponent to enhance road maintenance and corrective measures such as provision of gabions to eroded sections of the road; ▪ Project proponent to erect speed bumps on the road and ensure dust control by use water bowser spraying machinery during dry season; ▪ Project proponent will prioritize security arrangement within its area of project operations; ▪ Project proponent will conduct periodic noise assessments to ensure noise levels are minimized within acceptable NEMA thresholds' ▪ The project proponent will hold consultative meetings with the community to agree on best fit Corporate Social Responsibility initiatives that can benefit the youth and community in general; ▪ The project proponent will expand the work carders for community employment opportunities to include unskilled and semi-skilled based on competency.
				Members of the public noted the following potential positive impacts that would arise from the project: ▪ Increase in land value in the area due to industrial growth; ▪ Employment creation for the local youth;	The potential positive impacts were dully noted

Meeting No.	Venue	Date	Composition	Issues of concerns /needs/ project impacts	Response
				▪ Decrease in consumption of illicit alcohol due to engagement in employment opportunities; ▪ Decrease in crime rates among the youth	
2	Wanyororo chief's camp at Wanyororo sub location, Kirima location, bahati division	8 May 2024	Local administration, GDC, Orpower 22, village elders, women, men, youth, PWD's	*Issues of concern raised/ potential negative impacts* ▪ Increase in the quota allocation of employment opportunities for the local community which was currently low; ▪ Impassable sections of project access roads during rainy seasons. ▪ Concern of previous unfulfilled promises by IPP's in operation in the area; ▪ Potential increase in dust pollution due to increase in vehicle traffic and over speeding project vehicles; ▪ Human wildlife conflict due to the increased activities in the caldera occasioned by baboons invading farmlands; *Members of the public noted the following potential positive impacts that would arise from the project:* ▪ Employment creation; ▪ Water supply has been an issue in the area it is expected that as part of the CSR the developers could help the community access water.	▪ The project proponent will expand the work carders for community employment opportunities to include unskilled and semi-skilled based on competency; ▪ GDC will enhance road maintenance measures during rainy seasons and repair affected sections' ▪ The project proponent will undertake additional public consultations and agree on workable CSR activities via a documented Memorandum of Understanding (MoU); ▪ Project proponent to erect speed bumps on the road and ensure dust control by use water bowser spraying machinery during dry season; ▪ The contractor to find a way of reducing noise that could cause disturbance to wildlife to especially at night causing them to run to their homesteads.

Meeting No.	Venue	Date	Composition	Issues of concerns /needs/ project impacts	Response
				▪ Acquisition of skills and knowledge from the specialist on site during construction to the local staff; ▪ The project will lead to improved development of infrastructure such as the access Roads ▪ It is expected that the developer will undertake several CSR projects for the benefit of the community	
3	Wanyororo Chief's Office	30 September 2024	Local administration, GDC, OrPower Twenty-two and community members	▪ One of the community members raised a concern on inclusive employment process with no discrimination on ability. evenly across villages	▪ The employment process will be inclusive to ensure gender equality and ensure incorporation of the PWDs. Transparency in the recruitment process will be highly practiced.
				▪ The project will lead to increased generation of waste throughout the construction and operational phases	▪ The solid waste generated by the project activities will be disposed at the designated areas. ▪ To manage liquid waste, water & steam form the geothermal production will be re-injected back to the reservoir after energy extraction.
4.	Arahuka Baraza Park	1st October 2024	Local administration, GDC, OrPower 22 and community members	▪ The community members sought to know the employment criteria of engaging workers from the community.	▪ Orpower has a HR policy that aligns with the Employment Act of 2007 and provides guidance on casual engagements with the community.

Meeting No.	Venue	Date	Composition	Issues of concerns /needs/ project impacts	Response
				▪ The members raised a concern on most jobs being favourable to men. They further requested for consideration of women in job opportunities.	▪ Most of the jobs dependent on the nature of the project are favourable to men. However, women will be given first priority for other opportunities such as cleaners, storekeepers and vendors.
5.	Ol'Rongai Chief's Office	2nd October 2024	Local administration, GDC, OrPower 22, community members	▪ Concern with the current mode of casual employment, citing unfair distribution of opportunities for casual labour.	▪ Engagement of casual staff had been a challenge for a while for GDC; this is because the expectations were very high especially in the beginning. There after a method was devised by which the community would be handling the recruitment by themselves using agreed formulas for equal opportunities such as regional balances etc. Capacity building also took place for officials who were elected in open fields around the project area, but there are still members who may not be satisfied. Youth who have raised issues over the method have complained through official mechanism and their issues addressed. GDC continues to conduct reviews periodically to ensure the situation remain manageable. At the moment no community members have proposed a better method than we currently have.
				▪ Contracts given to be extended from three (3) months to one year noting that the three months contracts are too short to empower the youth to be self-sufficient	▪ The 3-month contract is a guideline entrenched in labour laws however, we also prefer the 3 months so that more community members can work as it provides opportunity for rotational benefits. The youth are many but the opportunities are few. Short contracts give opportunity to more community members.

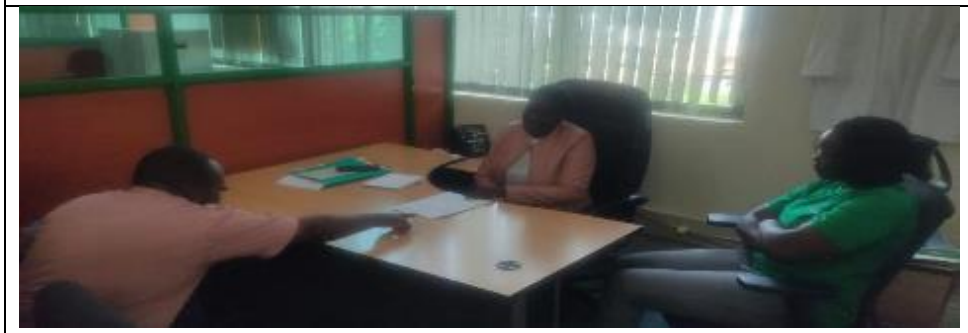
Meeting No.	Venue	Date	Composition	Issues of concerns /needs/ project impacts	Response
6.	Mercy Njeri Social Hall	3rd October 2024	Local administration, GDC, OrPower 22, community members	▪ The community members requested for the Community Liason Officer Position.	▪ Caldera community will be given priority once the opportunity arises.
				▪ Request for transparency in job advertisement and recruitment process.	▪ The job advertisement / recruitment process will be done through the local community administration and CEC Chairman. Scrutiny will be done by the local administration and committee to verify if the applicants are residents of the community.
				▪ The community members raised a concern on salary/wages to be paid to employees and noted that the amount should be reasonable.	▪ No employee will be paid below the government minimum wages for unskilled labour considering the city status of Nakuru. Daily 8 working hours are recommended and overtime will be calculated using basic pay. This shall apply to working on holidays and Sundays as well.
				▪ One of the members inquired on the tendering process for opportunities such as transport services.	▪ The community will be notified in cases of any open tenders for bidding. Food vendors will however be recruited from the community.
7.	Maciaro Baraza Park	4th October 2024	Local administration, GDC, OrPower 22, community members.	▪ The community members inquired about the subcontractor of the proposed project.	▪ Or Power will work with Kaishan Limited to deliver on the project.
				▪ There was a concern if the project will provide employment for skilled workers with no papers.	▪ Skilled workers will be employed based on their qualifications for the job. Academic/professional certificates shall be required during the recruitment process.
				▪ One of the members inquired whether OrPower would provide a water source to the community.	▪ There are plans to get a central point to dig a borehole for purpose of water provision.

Table 6-5: Key outcomes from the Key stakeholder meeting held with MCFA

Theme	Details	Recommendations/Requests
Engagement & Access		
Engagement & inclusion	MCFA are a primary stakeholder but are not invited to engagements with IPPs and lack an avenue to initiate engagement.	▪ Establish a Community Liaison Committee (CLC) ▪ Consider MCFA a major stakeholder ▪ Develop and implement a Stakeholder Engagement Plan (SEP).
Grievance access	Community is not aware of how to raise concerns.	▪ Fully implement the Community Grievance Redress Mechanism (GRM).
Employment & fairness	Orpower has not provided employment opportunities as expected and there is need for equitable access to skilled/unskilled jobs.	▪ Establish and implement a Labour Management Plan (LMP) to ensure fair access without discrimination.
CSR independence	Companies should not be tied by GDC, and they should be allowed to undertake independent CSR support to the community.	▪ GDC to allow Orpower to engage and support the community through CSR independently ▪ Implement feasible CSR with the community (PFMP).
Benefit-sharing (5%)	Community concerned they do not receive the 5% resource profit share.	▪ GDC should ensure that community's benefit from the 5% share of geothermal resource profit.
Forest Protection & Fire Readiness		
Fire readiness	GDC does not support putting off wildfires.	▪ Erect fire tower ▪ Procure modern firefighting equipment / fire engine ▪ Awareness creation ▪ Create fire breaks ▪ Provide water bowsers during fires.
Forest protection & grazing	There is need to curb illegal grazing and degradation.	▪ Implement electrical fencing ▪ Enforce grazing rules

Theme	Details	Recommendations/Requests
		▪ Sensitize on zero-grazing and improved breeds.
Security / charcoal	Risks from charcoal production; gaps in protection.	▪ Beef up protection/patrols ▪ Employ youth as forest scouts ▪ Develop IGAs for youth to deter charcoal activities.
Restoration, Water & Ecotourism		
Reforestation & nurseries	Rehabilitate the forest with indigenous trees; establish more nurseries.	▪ Plant more indigenous trees ▪ Support MCFA to turn the forest into an Indigenous trees forest (nurseries, transplanting).
Water for nurseries & wells	Need water for nurseries; drill wells.	▪ GDC to share water for tree nurseries ▪ Drill wells to promote conservation.
Ecotourism & community assets	Requests for zip-lining, nature trails, curio shops, resource centre, arboretum.	▪ Promote ecotourism (zip-lining, trails, curio shops) ▪ Establish resource centre ▪ Develop and operate the arboretum.
Community Services & Infrastructure		
Power & social services	Support connecting power to institutions (schools) within 5 km; equip the dispensary.	▪ Support power connection to institutions ▪ Support dispensary equipment.
Roads & access	Need roads to be developed.	▪ Consider developing roads in the area.

Photo 6-1: Sample photo grid of stakeholder consultations

	
Photoplate 1: public consultation exercise at Maciaro chief's camp	*Photoplate 2: public consultation exercise at Wanyoror chief's camp*
	
Photoplate 3: Key informant stakeholder consultation with GDC Community Liason officer	*Photoplate 4: introductory meeting with Orpower 22 site staff*

6.7 Menengai Project Committees

GDC has constituted committees that are engaged from time to time to assist during the project's activities. Separate committees have been constituted for tackling thematic issues and are proposed as follows:

- Youth committees;
- Wanyororo B community project water committee; and
- St. John Dispensary/Bahati hospital committee.

GDC has in place a Terms of Reference for the roles and responsibilities that the constituted committees will perform in the project. See Appendix VI.

6.7.1 Future Consultations

While most of the documented concerns above have been addressed in the ESMP proposed in this report, it is necessary to have a clearly defined plan for subsequent and continuous engagement of the stakeholders at various stages and on the various issues of interest. Therefore, regarding proposed activities by OTTL, a structured stakeholders engagement plan (SEP) inclusive of community grievance redress mechanisms is put in place by OTTL in close collaboration with GDC. The SEP provides for relevant stakeholders and appropriate consultation procedures throughout the project lifecycle. In addition, the means, nature and contents of engagement records are well defined. Given the presence of two other IPPs in the same area, broader liaison among the IPPs is necessary. This will be realized through a collaborative continuous stakeholder engagement exercise structured in consultation and executed together with GDC. GDC shall focus on issues relating to larger caldera while IPPs shall focus on issues relating to their plant's operations.

7 IMPACTS ASSESSMENT AND MITIGATION MEASURES

7.1 General

Actual and potential environmental and social impacts associated with geothermal power plant in Menengai are presented in this chapter. Impacts have been divided into positive and negative environmental, social, health and safety during the construction and operation phases of the project.

Cumulative impacts of the project are also assessed by considering effects of various planned activities of the project.

7.2 Methodology for Impacts Assessment

An environmental impact is any change to the existing condition of the environment caused by human activity or an external influence. Impacts may be:

- Positive (beneficial) or negative (adverse);
  - Direct or indirect, long-term or short-term in duration, and wide-spread or local in the extent of their effect.

Impacts are termed cumulative when they add incrementally to existing impacts. In the case of the project, potential environmental impacts would arise during the construction and the operations phases of the project and at both stages positive and negative impacts would occur.

7.2.1 Impact Identification

The study has predicted and evaluated anticipated impacts using internationally acceptable standard methods of impact prediction and evaluation. Constant reference to a checklist of project activities was made and scores were assigned in an assessment table in order to make an objective assessment of how each of the project activities would impact on a particular environmental and social medium. The significance of impacts is subjective, but the value judgments required were best arrived at by consensus.

The study team used several approaches such as brainstorming and use of checklists and matrices, to identify the main sources and establish the potential impacts from the proposed main project activities. Feedback from Public participation and consultation was also referred to in order to reduce uncertainty.

7.2.2 Impact significance

The purpose of this ESIA study report is to identify the significant impacts related to the project or activity under consideration and then to determine the appropriate means to enhance those which are positive, and avoid or mitigate those which are negative.

Significant impacts are defined, not necessarily in order of importance, as being those which:

a. Are subject to legislative control;
b. Relate to protected areas or to historically and culturally important areas;
c. Are of public concern and importance;
d. Are determined as such by technically competent specialists;
e. Trigger subsequent secondary impacts;
f. Elevate the risk to life threatening circumstances; and
g. Affect sensitive environmental factors and parameters.

7.2.3 Impact Assessment Scoring

To systematically identify, predict, evaluate and determine the significance of impacts resulting from the project construction and operation, a generic criterion developed by Haug *et al* (1984) was adopted as presented in Table 7-1. Precautionary principle was used to establish the significance of impacts and their management and mitigation i.e. where there is uncertainty or insufficient information, the Environmentalist erred on the side of caution.

Table 7-1: Criteria for assessing significance

SEVERITY OF IMPACT	***RATING***	***CONSEQUENCE***
Insignificant / non-harmful / less beneficial	**-1/ +1**	
Small/ Potentially harmful / Potentially beneficial	**-2/ +2**	
Significant / slightly harmful / Significantly beneficial	**-3/ +3**	
Great/ harmful / beneficial	**-4/ +4**	
Disastrous/ extremely harmful / extremely beneficial	**-5/+5**	
SPATIAL SCOPE OF IMPACT	**RATING**	
Activity specific	**-1/ +1**	
Right – of – way specific (within right – way)	**-2/ +2**	
Local area (within 5km of the project)	**-3/ +3**	
Regional	**-4/ +4**	
National	**-5/+5**	
DURATION OF IMPACT	**RATING**	
One day to one month	**-1/ +1**	
One month to one year	**-2/ +2**	
One year to ten years	**-3/ +3**	
Life of operation	**-4/ +4**	
Post closure	**-5/+5**	
FREQUENCY OF ACTIVITY / DURATION OF ACTIVITY	***RATING***	***LIKELIHOOD***
Annually or less / low	**-1/ +1**	
6monthly / temporary	**-2/ +2**	
Monthly / infrequent	**-3/ +3**	
Weekly/ life operation/ regularly / likely	**-4/ +4**	
Daily / permanent / high	**-5/+5**	
FREQUENCY OF IMPACT	**RATING**	
Almost never/ almost impossible	**-1/ +1**	
Very seldom / highly unlikely	**-2/ +2**	
Infrequent / unlikely/seldom	**-3/ +3**	
Often / regularly/ likely/ possible	**-4/ +4**	
Daily / highly likely/ definitely	**-5/+5**	

Table 7-2: Significance rating matrix

		CONSEQUENCE (Severity+ Spatial Scope + Duration)														
LIKELIHOOD (Frequency of activity + Frequency of	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150

Table 7-3: Negative mitigation ratings

Significance Ratings	***Value***	***Negative Impact Management Recommendation***	***Positive Impact Management Recommendation***
Very High	**126-150**	Improve proposed management	Maintain proposed management
High	**101-125**	Improve proposed management	Maintain proposed management
Medium - High	**76-100**	Improve proposed management	Maintain proposed management
Low - Medium	**51-75**	Maintain proposed management	Improve proposed management
Low	**26-50**	Maintain proposed management	Improve proposed management
Very low	**1-25**	Maintain proposed management	Improve proposed management

7.3 Positive Impacts during construction

7.3.1 Creation of Employment Opportunities

The construction phase of the project will be characterized by recruitment of significant numbers of skilled and unskilled people to work with the contractor. Some skilled persons likely to be recruited include engineers, project managers, masons, carpenters, mechanics etc.

The projected number of construction staff for the project construction phase is 327 persons. These persons will however not be employed through-out the17 months of the construction phase, as the demand for particular staff will be based on the construction program at any one point in time.

The PISSA already encourages OTTL to prioritize local/Kenyan suppliers as well as recruitment of local casual labour, provided that these will not jeopardize any of OTTL's obligations in undertaking the project.

An increase in population of this magnitude will create a corresponding intermittent or periodic peak in demand for goods and services such as food for construction workers, healthcare and need for transport services. Some of these needs can be readily satisfied by people living within the project area where local women can provide food vending services, and shops will also benefit from increase of sales. All these avenues are bound to create new employment / cash-based income generating activities.

From the review of minutes of meeting during and after the original ESIA Study by GDC, there is an unfounded expectation that the employment opportunities provided by the project will significantly reduce the unemployment rates in the immediate project area. This expectation needs to be managed to avoid complaints and protests by the local community members.

Considering the geographical location of Nakuru County, the risk of immigrant labour from outside the country was deemed to be low. However, considering that the northern corridor passes through Nakuru town, some level of monitoring on use of immigrant labour by the project is required.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+5*
Spatial scope of impact	*+5*
Duration of impact	*+3*
Frequency of activity / duration of activity	*+5*
Frequency of impact	*+5*
Result	***+130 Very High***

Enhancement measures

In order to improve direct employment opportunities by OTTL and its contractors / sub-contractors and make the project attractive to the people living in the area, the following are vital:

- All project workers (OTTL, EPC Contractor and related sub-contractors) will be employed and remunerated in accordance with the provisions of Kenyan labour laws including the Employment Act, WIBA, Labour Relations Act and the Occupational Safety and Health Act; as well as and best international practices as contained in ILO and IFC Performance Standard 2: Labour and Working Conditions;
- Due to the nature of the construction work, OTTL, the EPC Contractor and all primary sub-contractors will not employ persons below the age of 18 years to work directly on the project. As such, submission of a National Identification (ID) Card (or its equivalent for non-Kenyan staff) will be a requirement for all persons seeking to work under the project;
- The appointed EPC contractor shall be required to have a human resource policy and related human resource management procedures in compliance with the local labour laws, applicable ILO standards that will include but not be limited to the following aspects:
- Local Labour Recruitment Strategy with an equitable spread among the surrounding Rongai and Nakuru North sub-counties;
- Gender mainstreaming strategies with an action plan for affirmative action and target quotas as required for men, women and persons with disability (PWDs);
- Gender segregated protection strategies for workers against sexual harassment, sexual exploitation and gender-based violence in the work place;
- Facilities, procedures and records to demonstrate application of non-discrimination principles;
- Program for capacity building and training of men, women and youth to facilitate them to access semi-skilled and skilled labour opportunities during the project construction phase. The program will include targets for training and absorption of trained beneficiaries into the construction program;

- Staff Code of Conduct and related Management Response Procedures as required;
- Mechanisms for updating staff wages to at least meet the amounts set in the latest gazetted minimum wage orders;
- Staff Grievance Mechanisms;
- Mechanisms for reporting to OTTL and GDC on grievances regarding employment of local community members;
- Mechanisms for allocation of time and resources for staff training on all the elements required under the project ESMP. All trainings will be supported by review mechanisms to check the impact / improvement of staff knowledge and skills;
- Gender segregated monthly and quarterly HR reporting to OTTL on all the above listed aspects. The reporting will also indicate the nationality of the staff (as supported by legally recognized documents) as a tag to facilitate monitoring of the working terms for immigrant labourers;
- The appointed EPC Contractor will integrate disclosure of information on employment opportunities available to the local community, mechanisms to access these opportunities and periodic reporting to the local community on actual employment awarded into his quarterly stakeholder engagement schedule;
- OTTL will include the above requirements into the EPC Contract for the Contractor to customize to his operations at the OTTL Menengai Power Plant;
- OTTL will monitor the implementation of the labour related programs, as well as the performance and improvement strategies applied by the EPC Contractor and record the lessons learnt;
- OTTL will establish a grievance mechanism that takes into consideration the various actors and their roles at the geothermal field;[1]
- OTTL together with Kaishan (the Contractor) will develop a Retrenchment Strategy in good time, in the event of down-sizing due to technological or financial changes, organizational structuring or mergers and acquisition in accordance with the requirements of Kenyan law and relevant requirements / policies as guided by the parent companies and other applicable stakeholders.

The above requirements will also apply to the O&M Contractor and OTTL for the operation phase of the project.

7.3.2 Income Generating Opportunities for local community

During construction phase the neighbouring local community (particularly the women) to the project sites will get an opportunity to start small income generating activities such as:

- Sale of food to the construction staff; and
- Opening up shops to sell basic necessities to the construction staff.

This will increase and diversify income streams for the communities hosting the project and improve socio-economic status of their families.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+4*
Spatial scope of impact	*+3*
Duration of impact	*+3*
Frequency of activity / duration of activity	*+5*
Frequency of impact	*+5*
Result	***+100 High***

Enhancement

[1] Appendix x provides a proposal on a grievance mechanism for adoption by OTTL

- It is proposed that water should be provided at the catering area through a Water Tank or stand pipe to improve hygienic conditions; and
- Women who want to participate be advised to get clearance from local Public Health offices in Rongai and Nakuru North sub counties.

7.3.3 Improved Local Economy

With project increased earnings of both the local population and the new population coming in search for labour, the amount of money in circulation will increase. With the increased earnings, purchases of local goods and services by the construction labour force will positively impact the local economy. Similarly, increase in imports of construction and process equipment and in the supply of local construction materials will change economic dynamics of the entire Nakuru County. This will therefore have a positive impact in terms of economic development. Improvement of the quality of life of the local community during construction is anticipated to arise from improved local socio-economy.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+4*
Spatial scope of impact	*+4*
Duration of impact	*+3*
Frequency of activity / duration of activity	*+4*
Frequency of impact	*+4*
Result	***+88 Medium - High***

7.3.4 Local Market Opportunities

This is an advantage to the sellers of construction materials who will get contracts to supply the materials and services during construction phase. In addition, the local people will be selling food and other merchandise to the construction workforce. This means therefore that there will be an increase in revenue opportunities for the local population due to the presence of non-resident workers.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+4*
Spatial scope of impact	*+3*
Duration of impact	*+3*
Frequency of activity / duration of activity	*+5*
Frequency of impact	*+4*
Result	***+90 Medium - High***

7.3.5 Improved infrastructure and social services

The development of access roads for use during the geothermal exploration and production wells development by GDC has already improved access across villages and open up areas that have been lacking efficient access such as the Wanyororo. This is a development attested by the consultees contacted during the study.

The projected increase in population and subsequent revenue growth from power plant construction is also likely to lead to development of social amenities such as improved water supply, development of social halls within established town centres and improvement of standards and number of medical facilities.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+3*
Spatial scope of impact	*+3*
Duration of impact	*+4*
Frequency of activity / duration of activity	*+5*
Frequency of impact	*+4*
Result	**+ 90 *Medium - High***

7.3.6 Information, Education and Communication

With the implementation of the power plant, there will be development of additional skills for those taking advantage of new opportunities. There will also be diffusion of know-how from the more qualified personnel to the local personnel who participate in the construction activities.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+3*
Spatial scope of impact	*+4*
Duration of impact	*+3*
Frequency of activity / duration of activity	*+2*
Frequency of impact	*+3*
Result	**+ 50 *Low***

Enhancement measures

- OTTL can intentionally include local training during the construction and equipment installation as part of scope of the selected contractors

7.4 Negative Impacts during construction

7.4.1 Flora and Habitat Loss

Vegetation clearing will be required for the power plant site (approximately 140 m x 180 m area) and associated infrastructure (laydown areas, pipeline routes, access roads). This will result in the loss of bushes, shrubs, and some trees in the Menengai caldera project area. Given that the footprint is relatively small and in a previously disturbed geothermal field, the impact on flora is site-specific and of short-term duration (confined largely to the construction period). The habitat is mostly common bushland; critically endangered plant species are not known at the exact site (the East African Sandalwood Osyris lanceolata, an endangered species found elsewhere in the caldera, was not observed in the project footprint during surveys).

Clearing and disposal of unwanted materials from the plant area and introduction of foundation construction/fill materials from outside the caldera can encourage sprouting of invasive/alien species both at the construction site and in locations where the disposal of cleared materials is done off-site. Such invasive species like *Nicotiana glauca, Ricinus communis* and *Lantana camara* are however widely distributed in the region and the associated significance is deemed low. Nonetheless, there establishment at the project site or spread by the project activities should not be prevented.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-2*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-4*
Result	***-36 Low***

Mitigation measures

- Minimize clearing: clearly demarcate construction zones and restrict vegetation clearing to only what is necessary for structures and safety clearances. Mature trees outside the direct footprint will be left in place whenever possible;
- Develop and implement a Bio-diversity Management Plan as part of the Construction ESMP.
- Protect sensitive species: If any sandalwood or other protected plant is encountered, mark and avoid it; brief construction crews on the importance of such species;
- Re-vegetation and Restoration: After construction, all disturbed areas (including temporary work areas, pipeline trenches, and road edges) will be replanted with native vegetation from the area. Indigenous plant species suitable for the local ecology (e.g. *Acacia hockii*, *Protea gaguedi*, *Rhus spp*., local grasses) will be used to help the habitat recover. Topsoil removed during excavation will be stored and reused in landscaping to encourage natural seedbank regeneration.
- Control of Invasive Species: Soil disturbance can lead to invasive weeds colonizing the area (species like Lantana camara and Ricinus communis are already common in the region). OTTL and the contractor will monitor for invasive seedlings and uproot them on sight to prevent their spread. Any fill or construction materials brought from outside will be inspected to avoid introducing new invasive plant propagules
- Community Awareness: The project, in liaison with Kenya Forest Service (KFS) and Kenya Wildlife Service (KWS), will engage local communities to discourage practices like charcoal burning or firewood harvesting in the surrounding forest (not caused by the project but a cumulative pressure).
- Monitoring: KFS, GDC, and OTTL will jointly monitor vegetation recovery in rehabilitated areas, checking for successful re-growth and any new invasive species over the months following construction.
- The residual impact on flora is expected to be minor and reversible, ensuring no net loss of critical vegetation, consistent with the intent of IFC Performance Standard 6 (Biodiversity Conservation).

7.4.2 Impact on Fauna

The project area is part of a forest hosting wildlife such as monkeys, leopards, several bird species and reptiles. The most significant effect of geothermal power plant construction and operation on the environment is noise, power transmission cables and air pollution. These may disturb the habitat, interfere with breeding and displace the animals and thus increase animal-human conflicts. However, given the relatively low presence of fauna in the project area the impacts are not expected to be very significant.

7.4.2.1 Impacts on Macro Fauna (Mainly Mammals)

The project lies within a gazetted forest reserve that hosts some **wildlife**, though large mammal presence in the immediate area is limited. Species observed or known in the caldera include primates (baboons, monkeys), small mammals (e.g. rodents, hyrax), birds, and reptiles; occasional larger fauna like leopards have been reported in the wider Menengai area. Construction activities will generate noise, dust, and human movement that can disturb animals and alter their behavior. Potential impacts on fauna during construction include: habitat disturbance and displacement of animals from cleared areas, avoidance of the noisy construction zone, and possible increased human-wildlife encounters/conflicts. For example, monkeys or baboons may flee deeper into the forest or into neighboring farms due to the noise and presence of workers, potentially increasing crop-raiding or conflict with locals. Nocturnal wildlife could be disrupted by construction lights at night. Additionally, there is a risk that wildlife (especially smaller animals like snakes or birds) could fall into open trenches or pits, or scavengers could be attracted to construction waste, leading to harm (e.g. ingestion of contaminants or persecution of attracted predators like snakes). However, given the already low density of large fauna in the project's vicinity (the site is an open bush without dense populations or known critical habitats), these impacts are expected to be of low magnitude and mostly temporary. The significance without mitigation is considered low.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-2*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-4*
Result	***-36 Low***

Mitigation measures

- Contractors will fence off or cover open excavations and install escape ramps in trenches to prevent animals from becoming trapped or injured. All construction debris and wastes will be properly managed (no littering) to avoid attracting opportunistic scavengers that could in turn attract predators (snakes, raptors, etc.).
- Limit construction work to daylight hours (see noise mitigation) to preserve a quiet period at night for wildlife. Use directional lighting that illuminates work areas but not the broader forest (and use down-shielded, low-glare bulbs) to reduce disturbance to nocturnal animals and birds;
- Enforce a strict speed limit for project vehicles on all access roads. Within the caldera, speeds will be kept low (e.g. 20–30 km/h). This will reduce the risk of vehicle-wildlife collisions.
- Train workers not to harass or poach wildlife. Any sighting of large or dangerous wildlife (snakes, leopards, etc.) on site must be reported to the site manager and handled in coordination with KWS rather than workers taking action themselves;
- OTTL will collaborate with KWS and GDC's environmental team to monitor wildlife movements in and around the construction area. If evidence arises of animals being displaced into community areas, KWS can step up patrols or community awareness to mitigate human-wildlife conflict. If any particularly sensitive species are observed breeding or nesting near the site, construction in that area will be adjusted to avoid disturbance (e.g. establish a no-go buffer until the animals move on)

7.4.2.2 Impact on Avifauna

The Menengai area hosts various bird species, including raptors, passerines, and waterbirds in nearby areas. Construction could affect birds through noise, vibrations, and habitat disturbance (removal of vegetation that might have been perching or nesting sites). Of particular concern is the use of powerful floodlights at night, which can disorient nocturnal birds or disrupt avian flight paths. Also, any tall structures like cranes or the drilling rig (if used) could pose a collision risk, especially if not lit properly (though during construction the tallest structures will be temporary and relatively low). The impact on

birds is assessed as minor – the area is not known as a critical bird habitat or migratory stopover, and daytime construction noise will simply cause birds to avoid the immediate vicinity.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-2*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-4*
Result	***-36 Low***

Mitigation measures

- The project will avoid nighttime construction to the extent possible, thus minimizing use of bright lights when birds are most vulnerable.
- If night lighting is required for security, it will be downward-facing and shielded (no upward beams) to reduce skyglow. Lighting will be limited to the minimum area necessary
- Vegetation clearing will ideally be timed outside of peak bird nesting seasons to avoid destruction of active nests (if any are found, a buffer will be left and KWS consulted)
- Speed limits on roads (as mentioned) also protect ground-dwelling birds like guineafowl or francolins from vehicle strikes

7.4.2.3 Impacts on Herpetofauna

The major impacts on reptiles during the construction phase include (but not limited to) the following:

- Clearing of vegetation on higher grounds may lead to excessive run off at lower elevations which may lead to washing out and/or filling the breeding burrows of reptiles (and other animals);
- Site clearing may result to movement and relocation of surface materials such as rocks, which are ideal keystone habitat features used by cold blooded reptiles for sun basking e.g. by the endangered African rock python noted in the area; and
- Ground vibrations during the construction phase are also bound to negatively affect reptiles.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-2*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-5*
Frequency of impact	*-3*
Result	***-56 Low - Medium***

Mitigation measures

- OTTL and GDC should liaise with KWS to capture any reptile encountered hiding under rocks and sheltered terrains such as *Python sebae* and safely release them in suitable alternative habitats;
- Limit movement heavy earth machinery only to necessary areas within the plant site

7.4.2.4 Impacts on Invertebrates

The major foreseen impacts on invertebrates are not limited to the following:

- Vegetation clearing may in turn lead to increased run off, which may wash away important invertebrate groups;
- Affected insects may interfere with vital ecosystem functions and processes such as pollination hence vegetation regeneration.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-2*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-5*
Frequency of impact	*-2*
Result	***-49 Low***

Mitigation measures

- Re-vegetation of the cleared vegetation.

7.4.3 Landscape Character Impacts

During the construction process vegetation and other natural elements shall be cleared from the project area resulting in a change of the landscape character. Creation of new ground levels during construction shall also result in a minor change in the area topography.

This landscape character area has been identified as having medium landscape sensitivity. It forms part of tourist attraction with an established crater view point. Overall, the predicted magnitude of change in landscape resource is medium. Therefore, the predicted significance of landscape impact is moderate.

7.4.3.1 Visual Impacts

The assessment of the existing visual environment and the impact of the proposed development and its various components on visual receptors have established that there will be potential visual impacts during construction and operation. It is notable that the caldera has a view point at the eastern rim from which tourists enjoy its scenic features. The elements that shall intrude the scenic view are;

- Power Station Structures;
- Site Lighting – During construction and operation; and
- Construction Equipment – Temporary during construction.

Visual sensitivity for the area can be described as medium as activities already undertaken by GDC have had visual intrusion and the total plant area is relatively small in size (140x180m). Overall, the predicted magnitude of change in visual resource is low.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-1*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-4*
Frequency of impact	*-4*
Result	***-48 Low***

Mitigation measures

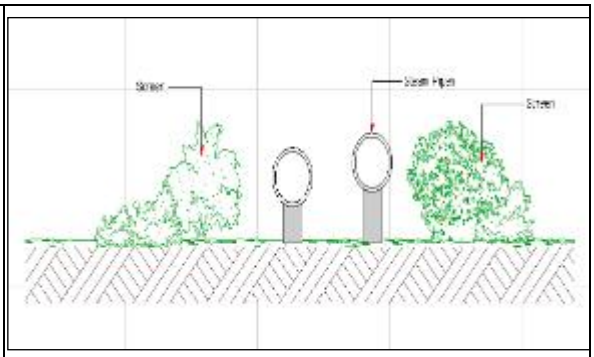
The mitigation measures proposed to deal with the anticipated impacts are shown in the table below:

Impact	**Mitigation**
Loss of Vegetation Cover	Limiting vegetation clearing to defined construction areas only; Preparation of a landscape planting plan for the entire project area. Planting plan to be comprised of 75% indigenous species and to be rid of any invasive species
Topography Change	Limitation of earthworks to construction areas only
Soil disturbance	Stripped topsoil to be preserved and used during landscaping. All embankments to be vegetated or stone pitched to prevent soil erosion.

7.4.3.2 Visual Environment

Visual impacts shall be mitigated by physical and visual integration of the proposed development and associated features into surrounding landscape. This mitigation measures shall include the following:

Impact	**Mitigation**
Typical visual intrusion by steam gathering pipes from wells to a power station 	Planting appropriate vegetation screen along the steam pipes to reduce visual intrusion across the landscape. Pipeline and water storage tanks colouring adopted by GDC is green.

	 •
View intrusion by the power station structures	The colour of structures within the project area should be carefully selected to reduce visual impact. Neutral, non-reflective colours blend well with the surrounding landscape.
Lighting	Lighting to be switched off when not required; Lighting of temporary working areas and site compounds during periods of darkness to be minimized where possible.

7.4.3.3 Residual Impacts

If a proper post construction planting plan is developed, implemented fully and new vegetation establishes well, there shall be minimum residual impact on the landscape character. Likewise, if the visual impact mitigation measures are implemented, the visual impact shall be significantly reduced ensuring there are minimal residual effects.

Mitigation measures

- OTTL and GDC should undertake holistic studies on cumulative visual impacts to the entire caldera, in this coherent mitigation measures should be proposed.

7.4.4 Soil Erosion and Geology

Construction involves excavation (for foundations, trenches for piping and cables, etc.), which can expose soil to erosion by wind or rainfall. The caldera has loose ash and volcanic soils in places that, if not managed, could easily wash away or form gullies. Heavy construction vehicles could compact soil and damage soil structure as well. If blasting is needed for any hard rock excavation or geothermal steam pipeline routing, it could cause localized ground vibration and scatter rock debris. Without controls, there is potential for landscape scarring, unstable slopes, or sediment runoff from the site.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-2*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-4*
Frequency of impact	*-3*
Result	***-49 Low***

Mitigation measures

7.4.4.1 Erosion Control

- The contractor will implement a Soil Erosion Management Plan. This includes conserving topsoil (stripping and stockpiling it for later use in reclamation), and installing temporary drainage ditches, silt fences, or sediment traps to intercept runoff and capture sediments during construction. All embankments or earth piles will be either covered, compacted, or temporarily vegetated to prevent erosion by wind or water. After construction, slopes will be re-contoured to natural form and stabilized with vegetation or stone pitching as appropriate.
- Isolated sites with installations and frequent human presence that require re-vegetation will be surrounded by less palatable native species to act as plant screens and reduce pressure from wildlife and livestock foraging. Presence of well rooted vegetation will act as soil stabilization for the areas. *Croton sp* is recommended among the woody species.

7.4.4.2 Geotechnical Supervision

- A supervising engineer will ensure that cut and fill, especially on any slopes, follows engineering best practice to avoid collapse. If the project involves cut slopes, their stability will be assessed and mitigated (e.g., through terracing or retaining structures) to prevent landslips
- Any **Borrow Pits and Quarries** will be carefully sited and managed. Preferably existing quarries will be used. If a new borrow pit is opened, it will not be in environmentally sensitive areas and will be rehabilitated after use (proper contouring and planting).

7.4.5 Impact on natural sources of raw materials

No materials sites (quarry and other borrow areas) have been confirmed for the project. Some materials may be sourced within the existing GDC quarries within the caldera while others from commercial quarries outside the project area. If such sites are not reinstated and rehabilitated after project completion, they may cause landscape scarring, dangers of overhanging cliffs and falling rocks which creates environmental, health and safety hazards.

From previous consultations, it was established that some of the commercial quarries already existing in the site neighbourhoods immediately outside the crater e.g. in Maili sita area, have been associated with public safety concerns and structural integrity of nearby buildings. If the contractor sources materials from such quarries, the locals may develop resentment towards the project as this will be seen as promoting risky activities.

Given the size of area to be developed, the volumes of materials envisaged to be involved is very minimal and this impact is deemed to be of low significance.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-3*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-3*
Result	***-45 Low***

Mitigation measures

- Appropriate authorization including from NEMA and Mines and Geology department to do or use any new borrows pits and quarries will be obtained before commencing activities;
- Any new borrow pits and quarries shall be located more than 100 meters from watercourses in a position that will facilitate the prevention of storm-water runoff from the site from entering the watercourse;

- Notice will be given 14 days to nearby communities of intention to excavate in the borrow pits or quarries;
- Borrow pits rehabilitation plans, will be prepared prior to use and approved by the local authorities;
- Storm-water and groundwater controls through appropriate drainage shall be implemented to prevent runoff entering streams and the slumping of soil from hillside above;
- The use of borrow pits or quarries for material spoil sites must be approved by the local authorities (and/or with the appropriate consent of the "landowner"). Where this occurs, the materials spoiled in the borrow pit shall be profiled to fit into the surrounding landscape covered with topsoil and re-vegetated.
- In the event that blasting for rock will be done the following mitigation measures are proposed:
- A current and valid authorization from the Department of Mines prior to any blasting activity shall be obtained;
- A qualified and registered blaster by the Department of Mines and Geology shall supervise all blasting and rock-splitting operations at all times;
- The Contractor shall ensure that appropriate pre blast monitoring records are in place (i.e. photographic and inspection records of structures in close proximity to the blast area);
- OTTL and the Contractor shall ensure that emergency services are notified, in writing, a minimum of 24 hours prior to any blasting activities commencing on Site;
- OTTL and the Contractor shall take necessary precautions to prevent damage to special features and the general environment, which includes the removal of fly-rock. Environmental damage caused by blasting/drilling shall be repaired at the Contractor's expense;
- The Contractor shall ensure that adequate notification is provided to the local communities immediately prior to all blasting. It is preferable that warning / informative signage and billboards be erected at the site indicating operation hours as well as commencement and end of operations. All signals shall also be clearly given;
- OTTL and the Contractor shall use blast mats for cover material during blasting. Topsoil shall not be used as blast cover;
- Precautionary and corrective measures will be taken to avert defacing and deformation of the land features;
- The contractor shall ensure that all his/her staff who shall be involved in blasting shall have the correct personal protective equipment (PPE).

7.4.6 Water Resources

The major water supplies in the project area are from underground abstractions developed by GDC within the caldera and supplemented by NAWASCO supplies (Table 3-21). The underground water developed by GDC is used for construction and related activities while NAWASCO supplies are for domestic needs. Currently there are no supply constraints. The project will require water during the construction and operation stages (see Table 4-2). While the requirements are not anticipated to have pressure on the existing supplies, construction activities may result in misuse of water resources if conservation measures are not adopted.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-1*
Spatial scope of impact	*-3*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-4*
Frequency of impact	*-3*
Result	***-42 Low***

Mitigation measures

For good practice the following mitigation measures are proposed, which the same are as proposed for the construction of the Menengai power plant:

- The contractor will use water judiciously: e.g., use trigger-controlled nozzles for spraying, reuse water where possible (water used for washing equipment or curing concrete can be reused for dust control). Records of water usage will be kept to monitor consumption;
- Leaks in pipes or tanks will be promptly repaired. Employee awareness campaigns will encourage water-saving habits (no unnecessary running taps, etc.). In addition, rainwater harvesting will be practiced where feasible (e.g., from roofs of site offices) to supplement water needs;
- OTTL will ensure all water abstraction is done under valid permits and does not exceed sustainable yields;
- All grey and wash-down water will be contained for later removal by vacuum truck;
- All sewage from toilets will be managed through septic tanks or removed off-site by licensed handlers so that no sewage contaminates soil or groundwater;
- Concrete wash water (which has high pH) will also be collected in lined pits or tanks and treated or removed, not allowed to runoff into soil;
- Construction equipment maintenance will be done at a designated area with a bunded floor or drip trays to catch oil spills;
- Fuel and chemicals on site (diesel, lubricants, paints) will be stored in a secure area with an impervious base and secondary containment (bunds) to prevent any leaks reaching soil or water;
- Vehicles and machinery will be regularly inspected for fuel or oil leaks;
- Temporary drainage will be installed to channel stormwater away from disturbed areas and to prevent flooding or erosion.
- The workforce will be provided with adequate mobile toilets or septic systems. Workers are strictly prohibited from defecating in the bush or near watercourses; non-compliance will result in disciplinary action.

7.4.7 Air Quality and Dust

Construction activities will generate dust (particulate matter) and exhaust emissions that can affect air quality locally. The main sources of dust are land clearing, excavation, earthworks, and the movement of vehicles on unpaved roads. In the dry season, dust levels can become high along the access routes, which pass near a few settlements (notably Wanyororo and Mercy Njeri villages on the caldera's access roads). Residents along these roads, as well as workers on site, could experience nuisance dust, which can irritate the eyes and respiratory system. Baseline data shows respiratory illnesses are a leading health issue in the area, so dust must be controlled to avoid exacerbating this. Additionally, heavy machinery and trucks will emit pollutants like NO_2, SO_2, CO, and particulate from diesel engines, but these are relatively minor and transient sources. There are no sensitive receptors (like schools or hospitals) immediately adjacent to the construction site (the nearest communities are outside the caldera), so the most significant dust impacts will be along transport routes through settled areas. Without mitigation, dust impact significance could be medium to high during dry, windy conditions, causing inconvenience to the public and minor health effects.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-3*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-4*
Frequency of impact	*-3*
Result	***-49 Low***

Mitigation measures

The following mitigation measures will be implemented to minimize or reduce impact on air quality for proposed projects:

- The contractor will water spray exposed soil surfaces, access roads, and construction tracks regularly, especially during dry weather. A water bowser (truck) will be dedicated to this task to keep dust down on the roads through Wanyororo and other populated areas whenever there is traffic
- All project vehicles will observe low speed limits on unpaved roads to minimize dust generation.
- Trucks transporting friable materials (like sand, cement, soil) will be covered with tarpaulins to prevent dust blowing off. Stockpiles of fine materials on site will be covered or kept damp
- All construction machinery and generators will be kept in good maintenance per manufacturer specs. Well-maintained engines burn fuel more cleanly, reducing smoke and pollutants
- Workers in high dust areas will be provided with appropriate PPE like dust masks or respirators
- The project will conduct daily visual monitoring of dust levels, and if high dust is observed (e.g., obscuring vision beyond 50 m or causing complaints), additional suppression will be applied. In settled areas, community liaison officers will check in with residents about dust nuisance.

7.4.8 Noise and vibration

Construction will involve noise from earth-moving equipment (bulldozers, excavators), trucks, concrete mixers, and potentially rock drilling or blasting. Noise levels can be high at the source (often 80–100 dBA near heavy machinery). This can be a nuisance to workers and nearby residents, and at very high levels or prolonged exposure, can cause hearing loss to unprotected workers. Vibration may result from compaction equipment or blasting, which could affect nearby structures if any were very close (in this case, the nearest village is a few kilometers away, so structural vibration impact on public buildings is negligible). Baseline measurements around ongoing geothermal drilling operations in Menengai indicate that existing noise levels near the wells were already above some national limits (due to drilling rig noise). However, communities around Menengai are at a considerable distance, and construction noise will primarily affect workers on site and any fauna within earshot. People living along access roads might hear increased traffic noise, but this is intermittent and during daytime. Significance of unmitigated noise impact is moderate (mainly occupational concern, with minor off-site impact).

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-3*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-5*
Frequency of impact	*-4*
Result	***-72 Low - Medium***

Mitigations

- Contractors will choose equipment models with noise suppression features where possible;
- All equipment will have functional exhaust mufflers/silencers to reduce engine noise.
- Any noisy equipment that shows a change in sound (indicating broken mufflers) will be removed for maintenance;
- Noisy activities will be limited to daytime hours;
- All workers operating noisy machinery or in high noise zones will be provided with earplugs or earmuffs and required to wear them. This will protect against hearing damage;
- Drivers will be instructed to not honk horns unnecessarily and to avoid revving engines.

7.4.9 Solid wastes and Hazardous Waste

Construction will generate solid wastes including: excavated spoils (soil and rock), construction debris (scrap metal, wood, concrete rubble, packaging), and domestic waste from the workforce (food scraps, paper, plastics). If not properly handled, these wastes could cause environmental pollution (through litter or leachate), attract pests or wild scavengers, and pose safety hazards. Dumping waste illegally could also create public nuisance or conflicts with communities. In addition, certain hazardous wastes

will likely be present, such as waste oils, used oil filters, oily rags, paint containers, spent welding rods, or chemical containers. These contain substances that can contaminate soil and water if spilled.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-3*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-4*
Result	***-48 Low***

Mitigation

The project must comply with Kenya's Waste Management Regulations and GIIP for waste. Mitigation measures for waste management: The EPC contractor will implement a Waste Management Plan (WMP) aligned with IFC guidelines and the principles of reduce, reuse, recycle:

- Minimize Waste Generation – Order materials in appropriate quantities to avoid excess. Use reusable packaging where possible
- Segregation and On-site Handling – At the construction yard, provide clearly labeled bins for different waste streams: wood, scrap metal, plastics, organic, etc
- Hazardous wastes (like oily rags, chemical solvents) will be separated and stored in secure, covered containers on an impermeable surface, to await proper disposal. These will be labeled and safety data sheets maintained
- Reuse and Recycling – Where feasible, materials will be reused: e.g., formwork wood can be reused multiple times, cleared brush can be given to local communities for firewood where appropriate; scrap metal offcuts will be collected and sold to recyclers, excess excavated soil might be used for landscaping or given to local people for use (with NEMA approval if off-site);
- All wastes that cannot be reused on-site will be transported off-site by NEMA-licensed waste handlers to approved disposal facilities. There will be no disposal or burial of waste on the project site (since it's a forest reserve) except as part of designed rehabilitation (e.g., using inert rocks to backfill quarries);
- All domestic refuse will go to a designated landfill (likely the Nakuru County landfill) via a contracted garbage collection service;
- Used oil and filters from machinery maintenance will be collected and sent to licensed oil recyclers or appropriate hazardous waste disposal;
- Workers will be instructed on waste segregation and discouraged from littering;
- The site will have dedicated waste storage areas that are regularly cleaned;
- Wastewater and sewage will be addressed through installation of septic tanks or holding tanks, with regular emptying by a licensed sewage exhauster. No site wastewater will be released into the environment untreated;
- The WMP will require keeping a log of all waste types, quantities, and how they were disposed (with documentation from waste contractors). The environment officer will conduct weekly inspections to ensure waste is being properly segregated and removed timely.

7.4.10 ***Labor Influx***

During peak construction, the Project has employed 327 workers, the vast majority drawn from the immediately adjacent villages. Because the site lies deep within the forest reserve—with no on-site accommodation—the influx of external workers is minimal and essentially invisible to local Menengai communities. Any non-local specialists or contractors will continue to reside in Nakuru—a well-served, cosmopolitan center with ample housing, water, sanitation and transport infrastructure—and commute daily. Consequently, the greatest impacts of labor influx will fall on Nakuru, not Menengai.

However, even limited commuting of mostly male workers with disposable income can elevate certain health and social risks in Nakuru:

- *Communicable Diseases*: – Increased cash flow and new social networks can raise HIV/AIDS, other STIs, respiratory infections and water-borne diseases in apartment clusters. Casual or transactional sexual relationships near worker lodgings may amplify STIs.
- *Community Safety*: – *Concentrations* of predominantly male workers can draw commercial sex work and, without proper safeguards, heighten gender-based harassment or violence.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-3*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-3*
Frequency of impact	*-3*
Result	***-48 Low***

Recommendations

- Conduct quarterly HIV/AIDS and STI education sessions for all project workers residing in Nakuru lodgings, in partnership with local health authorities and NGOs;
- Train 5–10 volunteer peer educators from the workforce to provide ongoing safe-sex dialogue;
- Distribute two condoms per worker per week via discreet dispensers in common areas;
- Facilitate monthly voluntary counselling and testing (VCT) clinics in worker neighborhoods;
- Require every project staff member to sign and adhere to a Code of Conduct that prohibits harassment, assault, sexual relations with minors, and multiple concurrent partnerships;
- Organize biannual community sensitization forums in communities within the project area of influence, covering hygiene, sanitation, HIV/STI prevention, and vector-borne disease awareness;
- Provide printed and poster-based informational materials in English and Swahili to workers on communicable diseases and community health and safety procedures.
- Track key indicators monthly—condoms distributed, VCT participation rates, and any uptick in STI/HIV cases—and review trends with County Health; escalate awareness efforts if cases rise by more than 10% year over year;
- Capture all health-related complaints (e.g., dust-related coughing, suspected outbreaks) through the existing grievance mechanisms (Appendix X&XI) for rapid follow-up and resolution.

7.4.11 Sexual Exploitation and Abuse (SEA) and Workplace Sexual Harassment (SH) and other forms of Gender-Based Violence (GBV)

Despite the predominantly local workforce and the fact that all external specialists commute daily from Nakuru rather than living near Menengai, the Project recognizes that even small numbers of higher-paid, non-local workers can alter social dynamics in their Nakuru apartment clusters. In particular, the opportunity for transactional relationships or informal “after-hours” gatherings near worker lodgings may expose women and girls in those neighborhoods to heightened risks of harassment or exploitation.

Even when most workers are local hires and specialists commute from Nakuru, unequal power dynamics and rising incomes can fuel new GBV risks both on and off site. Supervisors or foremen—who control work assignments, overtime pay and performance reviews—may abuse that authority to solicit sexual favors or intimidate women, whether fellow workers or community members. At the same time, increased disposable income among local laborers can lead to higher rates of alcohol consumption, which studies have linked to spikes in domestic violence and community disturbances. OTTL will therefore implement the following bespoke measures to address these layered risks.

Mitigation Measures

- Ensure all site supervisors attend a mandatory “Power & Consent” briefing, reinforcing the CoC’s prohibition on abuse of authority and outlining immediate removal from duty for any violations;
- Include anonymous reporting channels in the GRM (Appendix X&XI) so that workers can safely report any SEA/SH incidents without fear of reprisal;
- Ensure every staff member signs the Code of Conduct before starting work; any breach—ranging from harassment to coercion—should trigger automatic disciplinary procedures up to contract termination;
- Hold quarterly alcohol-harm awareness sessions for workers on site emphasizing how substance misuse can lead to CoC violations such as domestic abuse or workplace harassment;
- Sensitize all host-community villages to inform families that violence or exploitation by project workers is a punishable CoC offense and should be reported.

7.4.12 Community Health and Safety

Construction brings certain community health and safety risks primarily related to increased traffic, potential accidents, interaction between workers and locals, and communicable diseases. While the project site itself is inside a controlled caldera area (with limited public access), the impacts can occur in surrounding communities and along transport routes

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-3*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-3*
Frequency of impact	*-3*
Result	***-48 Low***

7.4.12.1 Traffic and Road Safety

Construction will lead to a rise in traffic on public roads leading to the site. This includes movement of heavy trucks carrying equipment and materials (e.g. turbines, construction materials) and daily transport of workers. The main routes from Nakuru to Menengai (such as the Nairobi-Nakuru highway to Bahati, and local roads like Wanyororo access road and Mercy Njeri/Kabarak road) pass near settlements, schools, and trading centers. The hazards include: dust and noise from the trucks (discussed above), and the risk of traffic accidents involving pedestrians (especially schoolchildren who walk to school) or other road users. Children are particularly vulnerable during morning and afternoon when going to and from school. Livestock crossing roads could also be hit. Without mitigation, the introduction of dozens of additional vehicles (ranging from pickups and minibuses to heavy tippers and tankers) raises the likelihood of collisions or near-misses.

Recommendations

- The contractor will develop a comprehensive Traffic Management Plan (TMP) for the construction phase and ensure adoption and implementation by the project contractor. The TMP will be prepared by the contractor and reviewed/approved by OTTL and GDC. Core elements of the TMP: *(a) Community Awareness* – Before construction starts, nearby communities will be informed about the forthcoming increase in traffic. Advance public notifications (through barazas or local notices) will give information on periods of intensive haulage. School teachers and students will be sensitized on road safety (look both ways, etc.). *(b) Vehicle Controls* – All project drivers will undergo defensive driving training and must adhere to the code of conduct which emphasizes safety (speed limits, no alcohol, mandatory seatbelts, etc.). Speed limits will be strictly enforced through random spot checks. For heavy trucks, escort vehicles and flagmen will be used if transporting oversized loads (e.g., the turbine). Movement of the largest loads will be done during off-peak hours to reduce interaction with public traffic. *(c) Road Improvements and Signage* – The contractor will coordinate with GDC and local authorities to maintain and if necessary, improve the access roads. *(d) Logistics*

Planning – Construction traffic will be scheduled to minimize trips during times when roads are busy with community use (e.g., avoid school opening/closing hours for major truck convoys). For material deliveries from Mombasa port, the plan may include using railway to Nairobi if feasible for bulk equipment, to cut long-distance trucking. *(e) Monitoring and Enforcement* – The project will assign personnel or use GDC's existing gate checks to monitor vehicle movement in/out of the caldera.

- All project vehicles will have identification and possibly GPS trackers to monitor speed. Any violations of traffic rules by contractors will lead to penalties or removal of drivers. OTTL's community liaison will keep open communication with locals; if complaints arise about reckless driving or dust, the TMP will be adjusted
- The contractor will track any traffic incidents in a log (even minor incidents) and report them. Speed compliance may be audited using GPS data. If accident rates increase, further interventions (like more bumps or stricter penalties) will be implemented.

7.4.12.2 Public Safety and Site Security

The project site inside Menengai caldera is fenced and guarded as part of the geothermal field managed by GDC. Public access to the caldera is restricted – typically one needs permission to enter by vehicle. Therefore, direct interaction between local residents and the construction site is expected to be minimal. However, it was noted that occasionally herders (pastoralists) do enter parts of the caldera with livestock. There is a possibility that curious community members, including children, might attempt to approach the construction out of curiosity or to seek casual work. Hazards include: unauthorized people or livestock could be injured by construction activities (e.g. open pits, moving machinery), or theft/vandalism could lead to dangerous situations (such as someone stealing and mishandling explosive materials or chemicals). In addition, the government has established a Critical Infrastructure Police Unit (CIPU) that has a base in the caldera that can be provide security in case of escalated cases. Also, at borrow sites outside the caldera, local residents could be exposed to hazards like flying rocks from quarrying or unsecured heavy equipment. However, use of private or public security personnel may have associated risks posed to workers and members of the community in case of enforcement or arrest of workers or members of the community by the security personnel.

Recommendations

- The site will have 24/7 security to prevent unauthorized entry.
- A solid perimeter fence will be maintained around active work areas to keep both people and animals out.
- Appropriate warning signs ("Danger – No Unauthorized Entry – Construction in Progress") will be posted around the site in languages/illustrations understandable to the locals
- For herders who traditionally graze in some parts of the caldera, GDC (with KFS) will engage them to avoid coming near the power plant area during construction. Community liaison will inform them of the dangers (like heavy truck traffic and machinery) and possibly assist in identifying alternative grazing paths (the area is a reserve, so KFS has a role in restricting grazing).
- All hazardous materials will be secured under lock and key, with strict inventory control. OTTL will have an emergency preparedness plan addressing public safety
- OTTL will implement a grievance redress mechanism (GRM) for the community to raise any safety concerns or complaints.
- Ensure awareness creation among workers and members of the community on security arrangements for the project and train the security personnel on human rights and expected adherence to ensure safety of the workers and communities in the hands of the security personnel or even during their day-to-day interactions.

7.4.13 Occupation and general public health and safety

Construction work inherently comes with OHS hazards that need careful management to protect workers. In Menengai, such hazards include: operating heavy machinery (risk of accidents or rollovers), falls from height (when assembling structures or working on rigs), electrical hazards from live equipment and welding, exposure to noise, dust, and potentially hydrogen sulfide (H_2S) gas from geothermal wells, vibration from machinery, being struck by moving objects or falling loads, confined space risks (working in tanks or trenches), and encounters with local wildlife (snake bites, scorpion stings). Without strict safety measures, the likelihood of worker injury or illness would be high. The project is committed to achieving a "zero harm" workplace, complying with the Occupational Safety and Health Act, 2007 and IFC EHS Guidelines for Occupational Health & Safety.

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Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-5*
Spatial scope of impact	*-3*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-3*
Frequency of impact	*-3*
Result	***-66 Low - Medium***

Recommendation / Mitigation

- The Contractor shall implement the measures outlined in the OSH Management Plan (Appendix IX);
- Contractor must develop Construction Safety and Health Policy in compliance with OSHA, IFCs Environmental, Health and Safety Guidelines among other international best practices;
- The EPC Contractor must have a dedicated Health and Safety Officer/Manager on site at all times. This officer will conduct risk assessments, safety trainings, and daily toolbox talks;
- All workers and subcontractors will receive a safety induction before starting work, covering site rules, PPE use, emergency procedures, and hazard awareness. Specialized training will be provided for high-risk jobs;
- Regular safety meetings (daily briefings and monthly reviews) will reinforce key messages;
- Appropriate PPE will be provided free of charge to all project personnel and its use will be mandatory;
- Before starting new activities, the contractor will perform Job Safety Analyses (JSAs) or risk assessments to identify hazards and implement controls;
- Permit-to-Work system will be enforced for particularly dangerous jobs: e.g. hot work (welding) permit, height work permit, confined space entry permit. Confined spaces (like tanks, vaults) will be tested for oxygen and toxic gases and proper ventilation arranged, in line with EHS guidelines for confined space entry;
- Ensure scaffolding is erected by competent persons and inspected;
- Employees must use full-body harnesses and lifelines for any work above 2 m where there is fall risk. Open edges will have guardrails. Ladder safety will be emphasized;
- All electrical installations will be done by licensed electricians and will meet safety standards (proper grounding, circuit breakers);
- A lockout-tagout (LOTO) procedure will be implemented for any energized system: equipment will be de-energized and locked out before maintenance;
- Crane and lifting operations will be planned by qualified rigging supervisors;
- All lifting gear will be certified and inspected;
- No one will be allowed under suspended loads;
  - Spotters will guide vehicle movement on site;
  - Machines will have reverse alarms;
- Regular maintenance of machinery (as mentioned) not only reduces emissions but prevents malfunctions that could cause injury. Any mobile plant shall be operated by licensed personnel;
- The site will have a traffic management plan internally too – with designated routes, speed limits, and separate pedestrian walkways;
- Banksmen will assist when trucks are reversing;
- An Emergency preparedness and Response Plan (ERP) will be in place, covering likely risk scenarios such as personal injury accidents, well blowout or pipeline rupture, fire, chemical spill, or H_2S release;
- Adequate drinking water, sanitation, rest breaks, and shelter will be provided to keep workers healthy and comfortable. Particular attention is given to prevent heat stress (Menengai can have strong sun): shaded rest areas and access to drinking water are ensured;
- An accident/incident register will be maintained to log all incidents, even near misses. Each will be investigated to find root causes and implement corrective actions.

7.4.14 *Risks of wildfires*

Consultations established that the vegetation within the caldera is prone to natural wildfires. These fires normally occur during the dry season between the month of November to January. Activities of power plant construction staff within the caldera and any temporary camp (if adopted) including improper disposal of any cleared vegetation, of cigarette buts and handling of flammable materials are likely to increase incidences of wildfires within the caldera and even the surrounding areas especially during dry spells. This can negatively affect forage available for both wildlife and livestock. There is also potential for economic losses especially if the fire affects livelihood activities in Menengai forest. The wild fires also has the potential to cause harm especially to local communities who engage in putting of the fires without appropriate tools and equipment.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-3*
Duration of impact	*-1*
Frequency of activity / duration of activity	*-1*
Frequency of impact	*-3*
Result	***-32 Low***

Mitigation

- Include an adequate fire buffer zone around the proposed power plant construction site and the construction camp, where developed. This could be open bare ground/un-vegetated areas and planting fire resistant trees e.g. Mexican green ash (*Fraxinus sp*) around the plant should be maintained throughout during the construction and the operation period;
- Where temporary contractor's camp is adopted, additional fire hazard management measures shall be instituted including installation and maintenance of appropriate portable and automatic fires extinguishers as necessary; and
    - Liaise with GDC and Menengai KFS office to sensitize construction and operation staff on wildfires and train on emergency responses.

7.4.15 *Impacts of fuel and chemical storage on site*

During the construction period for the Menengai Power Plant, oil spills may occur from the various equipment using petroleum-based fuels and lubricants. Spilled chemicals can contaminate soil as well as pollute water resources within the caldera. However, chances of surface water pollution are low given that there is no permanent surface water body within the caldera while the seasonal stream available is located approximately 7.5km away from the proposed plant site with no direct drainage connectivity. In addition, given the radially inward drainage pattern of the caldera, surface activities within the caldera are not likely to directly interact with surface water bodies found outside the caldera.

It is anticipated that refueling and maintenance of large vehicles will take place on the construction site/lay down area and that, correspondingly, there will be storage of fuel and lubricants on the site. Hazardous and flammable substances (e.g. diesel oil, paints, thinner, solvents, etc.) when improperly stored and handled on site can become potential environmental health hazards.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-2*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-3*
Result	***-45 Low***

Mitigation measures

- Ensure that the employees on site are aware of the company procedures for dealing with spills and leaks from oil storage tanks for the construction machinery though induction and safety training;
- In case of spillage, isolate the source of oil spill and contain the spillage using sandbags, sawdust, absorbent material and/or other materials approved by NEMA;
- Ensure that there is always a supply of absorbent material such as saw dust on site during construction, readily available to absorb/breakdown spill from machinery or oil storage;
- All vehicles and equipment should be kept in good working order, serviced regularly and stored in an area approved site by GDC and OTTL;
- Ensure that filling areas, Oil storage drums / products storage areas have a smooth impermeable (concrete or thick plastic covered in gravel) floor. The floor should be bunded and sloped towards a sump to contain any spillages of substances in accordance with *The Kenya Bureau of Standards (KEBS) KS 1969: 2006 The Petroleum Industry -The installation of underground storage tanks, pumps/dispensers and pipe work at service stations and consumer installations - Code of Practice.*

7.4.16 ***Potential Impacts on archaeological features***

No archaeological sites have been recorded and no surface artefacts were seen on the proposed development site. However, since the absence of artefacts on the surface does not exclude the possibility existence of artefacts or features buried in the ground, there is a chance of encountering buried artefacts during excavation and other earthwork construction activities. Without proper planning in place to manage such encounters, any artefacts encountered by chance may be interfered with. The anticipated impacts are therefore rated insignificant but precautionary approach adopted.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-2*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-4*
Frequency of impact	*-2*
Result	***-36 Low***

Mitigation measures

- Contractor shall be required to have a chance find procedure;
- OTTL shall notify NMK if any artefacts or bones are uncovered in the course of excavations. This is in accordance with the National Museums of Kenya Chance Find Procedure which aims to minimize damage to objects accidentally uncovered during the construction phase;

- If something is discovered in the course of excavation, the exercise must be stopped to determine whether a rescue operation needs to be carried out. This requires a pause in the construction and removal of the objects in question and only then can the construction continue. Any questionable objects must be shown to NMK archaeologist in order to determine its value, and any of the management options outlined in the procedure applied. Decisions regarding cultural heritage must be consistent with the requirements of IFC Performance Standard 8 and the UNESCO 1972 World Heritage Convention.

7.4.17 ***Land take and displacement***

The proposed power plant will be located in Menengai geothermal field within the Menengai caldera which is a gazetted government forest reserve under the management of KFS. KFS already has leased this land to GDC that has subsequently sub-leased the power plant area (140 x 180m) to OTTL. As such there will be no land take or displacement of any settlements by OTTL to pave way for the power plant construction. Further, geothermal exploration drilling by GDC is already on-going in the caldera and the proposed plant therefore fits on the existing land use. No change of user will be necessary for the proposed power plant site.

From both noise and air quality modelling outcomes, no adverse public health impacts are anticipated on the nearest sensitive receptors (settlements) due to the proposed OTTL power plant hence no resettlement is anticipated based on community health concerns.

It is however notable that way leave was required for one of the project's associated facilities, the transmission to evacuate power generated from the plant to the national grid. The land requirement for the transmission line is outside the scope of the current study and was handled separately by KETRACO, the agency charged with construction and maintenance of such lines in Kenya. KETRACO has already undertaken implemented an abbreviated Resettlement Action Plan (ARAP) studies for the transmission line as discussed in section 4.1.4 of this report. The line did not necessitate any physical displacement of individuals but affected 25 parcels of land, 6 parcels belonging to the government and the rest to private individuals. According to the status update received from KETRACO (see Appendix V), all the private individuals have been paid their compensation packages apart from 2 absentee land owners and 1 parcel over which land succession has delayed the compensation process.

Finally, land take for the Wanyororo access road was undertaken in order to provide for a wider Right of Way (RoW) for the access road. From consultations with GDC, it was reported that compensation for all the landowners who ceded land fronting their properties to allow for the expanded RoW have all been compensated. At the time of this assessment, there were no records of grievances concerning the compensation and payment process, all prior issues having been resolved by the time.

7.5 Positive Impacts during operation

During the Operation Phase, the Project owner shall contract an Operation and Maintenance Contractor. The O&M Contractor shall be required to comply with the project Operation-ESMP as prepared by the Project Owner which shall form part of the contract terms.

7.5.1 ***Improved Energy Supply and Climate Benefits***

Once operational, the 35 MW geothermal power plant will provide a steady supply of electricity to Kenya's national grid, contributing to meeting the growing power demand and improving grid reliability. This aligns with Kenya's Vision 2030 development goals of enhancing energy security. The geothermal plant will generate renewable energy with minimal greenhouse gas emissions compared to fossil fuel power plants – geothermal emissions are roughly 1% of the sulfur oxides and nitrogen oxides, and 5% of the CO_2, of an equivalent coal-fired plant. In Menengai's case, most CO_2 and other gases in the geothermal fluid will be re-injected or otherwise controlled, making the facility climate-friendly. This helps Kenya move toward a lower-carbon grid and contributes to global efforts to mitigate climate change. It is recommended that the project be registered under the Clean Development Mechanism (CDM) or similar carbon credit programs to monetize these climate benefits, which can also bring revenue to the country and local community projects.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+5*
Spatial scope of impact	*+5*
Duration of impact	*+4*
Frequency of activity / duration of activity	*+5*
Frequency of impact	*+5*
Result	***+140 Very High***

7.5.2 Employment and Economic Development

During the operations phase (expected to be 25–30 years or more), the plant will create about 15 permanent jobs (plant operators, engineers, technicians, security, etc.) as well as additional indirect jobs in maintenance, catering, and other support services. OTTL has committed to maximize local employment for these long-term positions, hiring and training Kenyan staff to operate and maintain the plant. This will build local technical capacity in geothermal power generation – an important skill set for the region. Additionally, by injecting reliable power into the grid, the project supports broader economic growth: industries and businesses depending on electricity will benefit from improved power stability. Locally, employees spending their salaries will continue to support shops, markets, transport and other services. The project may also spur infrastructure improvements (like better roads or communications at the site) that indirectly benefit the community. Overall, these socio-economic benefits help reduce unemployment and can improve living standards around the Menengai area. The positive impact on employment and local economy in operation, while smaller in scale than construction, is long-term and thus significant. OTTL will maintain policies of local procurement for consumables and services during operation whenever feasible (for example, hiring local companies for cleaning services, or buying some supplies locally), further extending the economic benefits to the community.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+5*
Spatial scope of impact	*+5*
Duration of impact	*+4*
Frequency of activity / duration of activity	*+4*
Frequency of impact	*+5*
Result	***+126 Very High***

7.5.3 Technology Transfer and Skills Enhancement

Being a relatively new geothermal project, OTTL (with involvement of international partners) will introduce modern geothermal technology and practices. Through training programs and day-to-day operation, Kenyan employees will gain skills in plant operations, turbine technology, health & safety, and environmental management. This human capital development is a positive impact, enhancing the pool of skilled technicians and engineers in the country's geothermal sector. Over time, such capacity building will enable Kenya to develop more geothermal resources with less reliance on foreign expertise.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+5*
Spatial scope of impact	*+5*
Duration of impact	*+4*
Frequency of activity / duration of activity	*+4*
Frequency of impact	*+5*
Result	***+126 Very High***

7.5.4 Enhanced Tourism and Educational Opportunities

Menengai crater is a scenic tourist attraction (noted for its panoramic views and hiking trails). The geothermal project, when operational, can become an additional point of interest – so-called industrial tourism. Visitors may be interested in seeing the geothermal wells and power station as part of a tour (geothermal visitor centers exist at other sites like Olkaria). The KFS (Kenya Forest Service) plans to brand the Menengai viewpoint for eco-tourism, and the presence of a successful geothermal operation could be integrated into an educational tourist experience. This might include a small information center about geothermal energy, which can educate school groups and tourists on renewable energy and geology. Thus, the project could indirectly boost tourism by adding to the attractions of the area, potentially benefiting local guides and businesses. If managed well (with proper safety for visitors), this can raise awareness about clean energy and bring pride to the local community for hosting a state-of-the-art geothermal facility.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+4*
Spatial scope of impact	*+5*
Duration of impact	*+4*
Frequency of activity / duration of activity	*+4*
Frequency of impact	*+4*
Result	***+104 Very High***

7.5.5 Potential for Carbon Market

Geothermal power stations are eligible for CDM because they release lower greenhouse gases than thermal power plants. When the Menengai Power Station will be included as a CDM project, community projects around the area are likely to benefit from revenue generated from CDM through financing of community projects.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+3*
Spatial scope of impact	*+4*
Duration of impact	*+3*
Frequency of activity / duration of activity	*+4*
Frequency of impact	*+3*
Result	**+ 70 *Low - Medium***

7.6 Negative Impacts during operation

7.6.1 Impact on Biodiversity

During operation, the presence of the power plant and ancillary infrastructure may have some continuing impacts on the local ecosystem, albeit much reduced from construction. The footprint will remain mostly cleared and fenced, preventing larger animals from entering the plant area (which can be a safety measure but also means a small loss of habitat access). Over time, if vegetation is not managed;

Invasive plant species could colonize the disturbed areas around the site and along access roads. This could alter the local plant community composition. Weeds like *Lantana camara* or *Nicotiana glauca* are known colonizers and could spread further if not controlled.

Also, *wildlife interactions* in operation include: occasional wild animals wandering near warm infrastructure (animals might be drawn to warm pipes or water; for instance, baboons might climb on structures, or birds might roost on them

Another aspect is lighting at night: the plant will have security floodlights which, if too broad, could affect bats or insects and the predators that feed on them. Also, noise from the plant might keep some animals away from the immediate vicinity (though many will habituate if the noise is steady and not too loud

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-3*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-2*
Result	***-40 Low***

Mitigation measures

- Prepare and implement a Biodiversity Management Plan;
- Any invasive weeds that sprout in the plant vicinity will be promptly removed to prevent spread;
- All hot effluent pipelines are in closed systems (insulated and often buried) so wildlife cannot contact them;

- To mitigate light pollution, we will use directional lighting with shields to prevent upward or horizontal glare. Lights will be turned off or dimmed where not needed. This protects nocturnal wildlife and preserves the night sky;
- OTTL, along with GDC and KWS, will continue with wildlife monitoring in the caldera even during operation. If any unusual patterns are noted (like if operation of three plants seems to be causing notable wildlife displacement or increased human-wildlife conflict at the caldera periphery), adaptive management will be undertaken.

7.6.2 Operation wastes

Operation of the geothermal power plant is not anticipated to generate significant quantities of wastes. Geothermal technologies do not generate significant volumes of solid waste. Typical wastes generated during the operational phase include:

- Maintenance wastes include:
  - ✓ Waste oils and lubricants
  - ✓ Scrap metal
  - ✓ Waste electrical and electronic components.
  - ✓ Batteries
  - ✓ Contaminated rags
  - ✓ (Potentially) Contaminated spill response equipment
  - ✓ Contaminated safety clothing, gloves, masks, and equipment
  - ✓ Waste wood
  - ✓ Waste paints and solvents
  - ✓ Contaminated plant and machinery, including filters
- Domestic and food (catering services) wastes (from operation staff estimated to be a maximum of 15)
- Sewage wastes.
- Sludges (potentially contaminated with silica compounds, chlorides, arsenic, mercury, vanadium, nickel, and other heavy metals could be generated).
- Oily water and run-off.
- Elemental sulphur from the treatment of H_2S.
- Geothermal brine.

Since the surrounding area is an open veld, storm water will be allowed to flow on the ground as a sheet flow. Domestic waste generated by the operation staff estimated to be a maximum of 15. The proposed domestic waste water management system is presented in section 4.2 while solid wastes will be regularly collected for disposal by a contracted waste handler. The major industrial waste is brine (the wastewater from geothermal plants). Hydrocarbon-based wastes (e.g. spent lubricants, used oil etc.) generated through regular maintenance of the turbine and associated machines are hazardous.

Improper handling of these wastes could be very detrimental to the biophysical environment

With the enclosed drainage system within the caldera, any surface pollution will be localized and may not directly affect any neighbouring communities. However, with existing operations, there have been allegations by some consulted stakeholders that the materials used for lining brine ponds are of poor quality and are also regularly vandalized exposing receiving environments to brine pollution.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-2*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-5*
Frequency of impact	*-3*
Result	***-72 Low-Medium***

Mitigation measures

- Waste from catering services should be collected in lidded bins disposed offsite at landfills to avoid attraction scavengers to the project site;
- Waste such as oil, paints and lubricants should be designated a specific area within the site where they are placed/gathered before final off-disposal; this area should be constructed to prevent leakage which can lead to soil contamination as well as secured from scavenging wildlife;
- Monitoring of waste should be continuous by tracking the volume of volume and type generated and establishing the treatment, storage, transport and disposal methods.

7.6.3 Fire risk

With the installation of the power plant and related substations and transmission lines and associated control infrastructure, there is likely to be a fire hazard during operation that may arise from faulty equipment or even human error. Fire occurrence may not only be detrimental to the development and energy supply to the national grid but also to the safety of operation staff. However, with implementation of best industry practices and in-built emergency fire suppression measures, the anticipated impact will be significantly reduced.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-2*
Duration of impact	*-1*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-2*
Result	***-28 Low***

Mitigation measures

- Ensure best international industry practice;
- Maintain and regularly inspect for serviceability, the installed fire protection system of fire water tanks, fire extinguishers, fire hydrants, hose reels, fire alarms and sprinklers;
- Formulate a fire emergency response plan for the operation phase. in liaison with GDC and KFS, this should be integrated with the overall Menengai geothermal field emergency response plan;
- Train some staff to be fire marshals in line with the OSHA 2007 requirements;
- Regularly inspect the installed firefighting equipment to ensure serviceability and maintain records;
- undertake regular general safety and fire safety audits by independent experts to inform any other emergency preparedness improvement measures, where necessary.

7.6.4 Accidental chemical spills

During plant operation, hydrocarbons and other chemicals such as solvents, coolants, acids, and, alkalis will be used. Any shortcomings in the handling of these chemicals can lead to accidental spillage and improper disposal of these hydrocarbons can be harmful to the receiving environments, mainly the soil and internal natural surface drainages. There is, however, no open surface water body within the immediate vicinity of the proposed plant and such impacts will mainly affect soils and plants.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-2*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-2*
Result	***-36 Low***

Mitigation measures

- Spill and drip trays used during servicing of machinery;
- Use septic tanks while ensuring doesn't flow to the surface;
- O&M operator shall prepare a Chemical/hydrocarbon Response plan for accidental spills to be formulated and routinely tested;
- Bunded storage areas and secondary containment for oil and chemicals;
- Use of an oil interceptor in the plant. Monitoring records for interceptors should include levels of oil and grease, total suspended solids and Total chromium, copper, iron and zinc;
- Storage of fuel and other flammable materials shall comply with standard fire safety and other hazardous materials handling regulations;
- A secured compound shall be provided for storage tanks for chemicals and fuel. All chemicals and fuels shall be stored with manufacturer's instructions in mind as per the material safety data sheets;
- Storage areas or secondary containment shall be constructed of waterproof reinforced concrete or approved equivalent, which is not adversely affected by contact with chemicals captured within them;
- The minimum volume for secondary containment shall be 110% of the capacity of the largest tank system, plus 10% of the total capacity of all other separate tanks and containers within the bund wall with closed valves for controlled draining during rains;
- Pipe-work carrying product from the tank to facilities outside the containment shall be provided with secondary containment;
- Tank equipment such as dispensing hoses, valves, meters, pumps, and gauges shall be located within the containment or provided with own containment.

7.6.5 Occupational health and safety

Due to the fact that there are going to be staff working in different areas of the plant, accidents are likely to occur within the plant area. Some workers will also be likely exposed to high levels of noise, heat and H_2S which are detrimental to health. Noise and H2S exposure are the major occupational safety and health hazards identified so far.

Prior to connecting the completed plant to the steam gathering system, the PISSA has a requirement for a joint inspection to verify both the power plant and the steam gathering system protection equipment and mechanisms. This is toward ensuring that the associated safety measures are synchronized.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-1*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-3*
Frequency of impact	*-4*
Result	***-63 Low - Medium***

Mitigation measures

- OTTL will have an EHS Manager (or team) responsible for the plant's safety. Safe Operating Procedures (SOPs) will be in place for all routine activities (startup, shutdown, chemical handling, etc.) and Permit-to-Work system for non-routine or hazardous tasks (maintenance on energized systems, confined space entry, etc.)
- Regular safety trainings and drills shall be carried to keep staff prepared;
- An emergency response plan specifically addressing operational emergencies will be in place;
- Continuous H_2S monitoring in areas like gas extraction system, and personal H_2S detectors for any worker doing work where gas shall be in place;
- PPE like hearing protection, insulating gloves, arc-flash suits for electrical work, and fall protection for any work at height, will be maintained and strictly used;
- Workers will have regular medical check-ups, focusing on hearing tests, lung function if exposed to any gases;
  - ✓ The plant team will conduct at least annual drills for scenarios such as fire, severe injury, H_2S leak, etc., in coordination with GDC and other IPPs;
  - ✓ The power plant will implement process safety management – including instrumentation that can automatically shut valves if unsafe conditions detected (e.g., high pressure in a separator triggers emergency shutdown). Pressure vessels and safety valves will be regularly inspected and certified.

7.6.6 Operations-Phase On-Site Occupancy

No accommodation is permitted within the caldera, however the power plant will be operated on a 24/7 basis. The Project has planned to construct staff housing development in the neighboring community area in Maciaro for O&M Staff. The 24/7 operation of the plant by the O & M team will draw modest but continuous demands on water, sanitation, waste collection, security and health services. Without proper design, the compound's grey- and black-water could leach into the soil or nearby drainage, its refuse bins may overflow and attract pests, and shared facilities could become vectors for respiratory or gastrointestinal illness. Occasional vendor traffic and after-hours gatherings risk noise or light disturbance, while a mixed-gender workforce living in a remote fenced enclave can face safety or harassment issues if lighting and patrols are inadequate.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-4*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-3*
Frequency of impact	*-4*
Result	***-84 Medium-High***

Mitigation measures

- Monitor water consumption,
- Install a lined septic tank with soak-away field > 50 m from any watercourse; engage a licensed hauler for biannual desludging;
- Provide covered, segregated bins for organic, recyclable and residual waste; arrange weekly collection by a licensed service;
- Enforce a daily cleaning schedule for all kitchens, bathrooms and common areas; supply hand-sanitizer stations at all entries;
- Restrict vendor and service-vehicle access to 08:00–17:00 via a single secured gate; require all vehicles to display ID and limit engine idling;
- Equip the compound with perimeter lighting, CCTV coverage and nightly security patrols trained in anti-harassment protocols;
- Cover or treat all water-holding structures monthly with larvicide and clear drains weekly to prevent mosquito breeding;
- Install LED lighting with motion sensors and consider solar water heaters; track generator run-hours to minimize emissions;
- Display the Project Code of Conduct and grievance contacts prominently; log any accommodation-related complaints for resolution within 48 hours.

7.6.7 Operation off site accommodation

Project Owner has planned to put up Operation and Maintenance staff housing quarters at Maciaro village, a few kilometres from the plant. This facility will be occupied from 1st October 2025. A total of between 10-15 workers shall be accommodated. The occupation of these houses has associated impacts for example solid and liquid waste generation. There is also need to promote energy saving in the houses. These houses may also be used to perpetuate societal vices as well as becoming a security threat to occupiers if no adequate security measures in place.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-2*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-5*
Frequency of impact	*-3*
Result	***-72 Low - Medium***

Photo 7-1 Photo of the Operation & Maintenance staff housing

Mitigation measures

- Monitor water consumption, install water saving apparatus like dual flush systems for toilets and install a Biodigester to promote reuse grey-water for landscaping;
- Provide covered, segregated bins for organic, recyclable and residual waste; arrange weekly collection by a licensed service;
- Restrict vendor and service-vehicle access to 08:00–17:00 via a single secured gate; require all vehicles to display ID and limit engine idling;
- Provide adequate security for the facility and prohibit unauthorized access;
- Install solar power within the facility;

7.6.8 Impacts on local water resources

Project water requirements are presented in Table 4-2. The water supplies will mainly be by the GDC through its existing water infrastructure as summarized in Table 3-21. The project requirements are not envisaged to exert pressure on local supplies. Nonetheless, water conservation efforts are necessary.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-4*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-3*
Frequency of impact	*-4*
Result	***-84 Medium-High***

Mitigation

- OTTL and GDC should continually monitor water utilization in the plant's operation and enhance conservation efforts through water efficient fixtures;
- Formulate efficient water use practices for both domestic and plant water requirements; and
- Maintain and audit water use records.

7.6.9 High socio-economic interest by communities

Public consultations conducted to date revealed that the local communities have high socioeconomic interests and a lot of expectations with the geothermal power development activities going on within the Menengai caldera. Some expectations and even false information are held by the communities. These include but are not limited to:

- Employment opportunities to benefit majority of the locals but never realized due to favouritism and nepotism;
- Political interest by different leaders; and
- Feeling that even basic contracts are awarded to non-locals.

Improper handling and misrepresentation of facts about the project by the various players (mainly GDC and two other IPPs) within the Menengai geothermal area can hurt the good standing with the community and overall performance.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-4*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-2*
Result	***-44 Low***

Mitigation

Given the presence of other IPPs in the project area, the following measures should be undertaken both at OTTL level and in collaboration with GDC and the other IPPs as feasible:

- Develop and implement a community liaison strategy with proper communication and feedback mechanism. Any community social responsibility should be communicated through this strategy;
- Develop a clear and transparent employment policy for the local communities and ensure its fair implementation: and
- The expectation that many community members will be employed during the operational phase of the project needs to be managed. Community members should be informed of the limited employment opportunities. If at all possible, the project should notify community members of the number of jobs available, the skills required, employment period and the selection criteria of the project. In doing so community members would be well informed of the actual employment opportunities. This would reduce expectations and prevent disappointment thereby instilling community trust in the project. This is essential if the project is to maintain healthy and cooperative relationships with the communities.

7.6.10 Air emissions

The most significant emissions from the Geothermal Power Plant operation will potentially include the release of NCGs from steam vents and cooling towers.. Although NCGs can be considered 'natural' in the sense that they are already emitted from numerous existing fumaroles and vents, the power station will emit these in larger quantities than might be experienced naturally. Additionally, steam gathering system pipeline failures due to damage or corrosion as well as drilling of new wells in the Menengai geothermal area could result in unplanned releases of steam and NCGs.

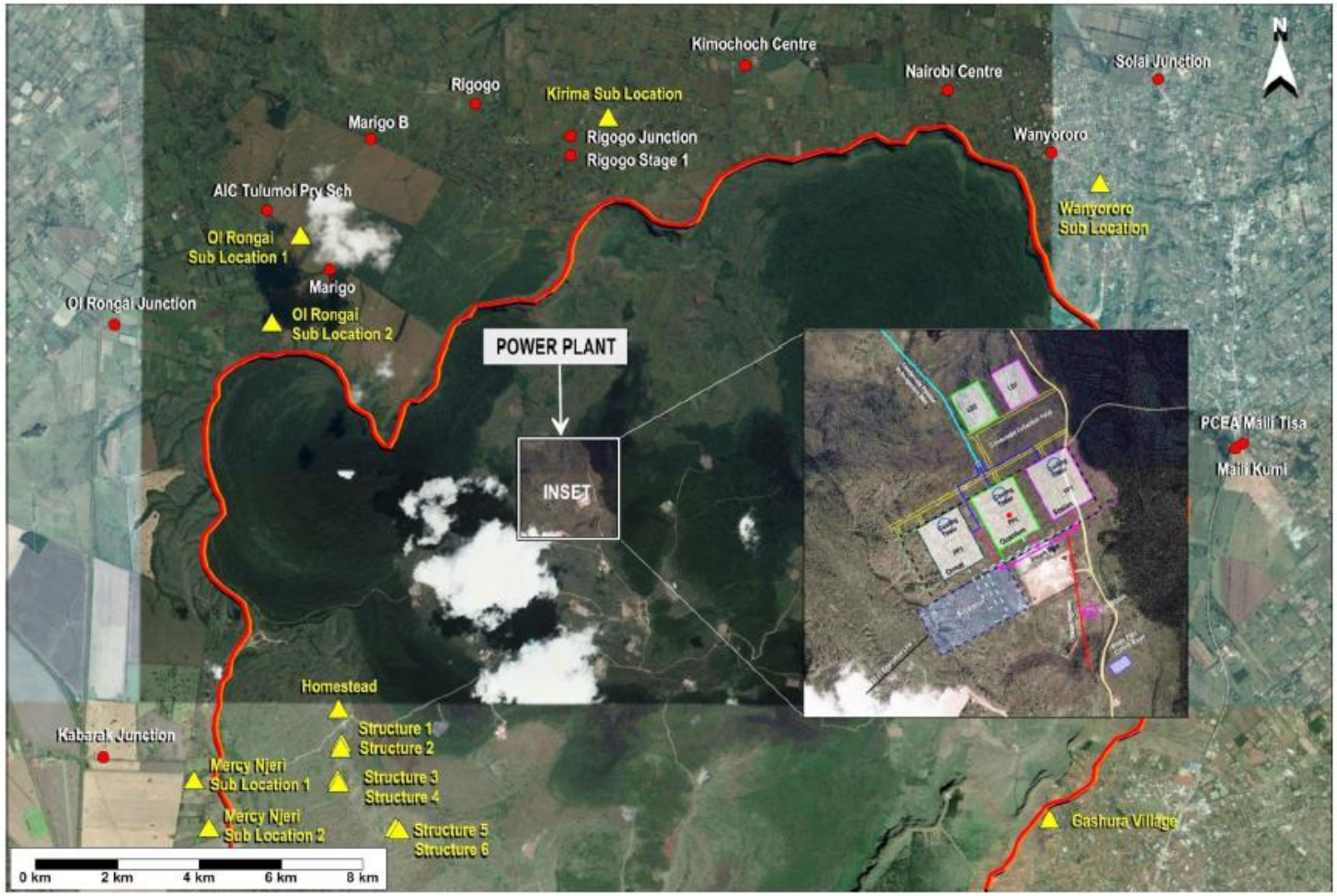
The composition of NCGs of the Menengai wells is shown in Table 4-1. H_2S and CO_2 are the predominant NCGs. H_2S is an odorous compound commonly found in geothermal areas and released through natural sources. It presents an unpleasant, typically “rotten eggs” odour at relatively low concentrations and is toxic in higher concentrations. CO_2 is not significant in terms of direct impact to human health but is a greenhouse gas. Studies on the effects of elevated CO_2 levels on vegetation around geothermal power plants in the US have shown that growth and productivity of commercial crops actually increased.

Combustion gas emissions during operation will be limited to emergency generators, firewater pumps, and service vehicles required for transporting any maintenance equipment and materials.

Air quality impact assessment study due to the proposed power plant established the following:

- Wind direction in the project area is predominantly from the south and northeast. Any long-term air quality impacts are therefore expected to the north and southwest of the proposed plant site.
- Ambient air quality monitoring conducted at the wells by the Geothermal Development Company (GDC), from 2016 to 2019 indicated ambient air pollutant levels that exceed the odour threshold as well as the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 1 ppm;
- Several AQSRs are situated within the vicinity of the proposed power plant (some homesteads in the caldera, 3.5 km southwest of the plant, and areas outside of caldera 2 km northwest of the plant, Marigo, and 2.5 km north-northeast of the plant, Rigogo). (Figure 7-1).

Figure 7-1: Study area, site layout, AQSRs and NSRs



Source; Airshed Planning Professionals

The establishment of a comprehensive emission inventory formed the basis for the assessment of the air quality impacts from the project's operations on the receiving environment. A summary of quantified emissions and source input parameters presented in Table 7-5.

Potential impacts on air quality have been modelled for the OTTL plant alone and as well as the cumulative impacts when operating together with the other two power plants. Table 7-4 shows possible scenarios that may be encountered.

Table 7-4: Scenarios considered form the three IPPs

Scenario	Equipment and arrangement options	IPP and Emission Point		
		Kaishan	Globeleq	Sosian
1	Assuming Globeleq single stack and Kaishan and Sosian dispersal from multiple vents	Multiple vents	Single stack	Multiple vents
2	Incremental impact from OTTL dispersal from 4 cooling tower fans	Multiple vents	-	-

Scenario 2 presents air quality impact with only the OTTL power plant operating while the other scenario considered the cumulative impact of the three power plants by all the IPPs already contracted by GDC.

All scenarios were simulated, considering the emission parameters in Table 7-5 for OTTL, and are reported in the subsequent sections.

Table 7-5: Estimated stack parameters and emission rates for OTTL/Kaishan

Equipment and arrangement options	Stack parameters				Stack emissions		
	Height (m)	Diameter (m)	Velocity (m/s)	Temp (°C)	H2S per stack (g/s)	H2S total (g/s)	H2S total (tpa)
Assuming multiple (34) vents	10.3	4.5	4.8	52	3.29	112	3467

7.6.10.1 Screening of Simulated Human Health Impacts from H2S

For Scenario 1, with Globeleq emitting from a single stack and Kaishan and Sosian emitting from multiple vents, simulated 24-hour ambient H_2S concentrations exceed the Iceland guideline of 50 µg/m³ at some of the AQSRs, but not the Kenyan Tolerance Limit of 150 µg/m³ with 3 allowable exceedances' or WHO daily guideline value of 150 µg/m³ (Table 7-6). Simulated annual average ambient H_2S concentrations exceed the OEHHA screening level for chronic exposure (10 µg/m³) at some of the AQSRs. Isopleth plots for are shown in Figure 7-2,

Figure 7-3 and Figure 7-4.

Table 7-6: Simulated ambient H_2S concentrations during operation phase for Scenario 1.

AQSRs		Simulated Ambient H2S Concentrations During the Operational Phase (1)		
Number	**Description**	**4th Highest 24-hour Ground Level Conc. (µg/m3)**	**2nd Highest 24-hour Ground Level Conc. (µg/m3)**	**Annual Ave. Ground Level Conc. (µg/m3)**
1	Structure 1	40	47	4.7
2	Structure 2	39	46	4.3
3	Structure 3	34	38	3.0
4	Structure 4	33	37	2.7
5	Structure 5	8	13	0.4
6	Structure 6	7	12	0.3
7	Structure 7	49	**58**	7.0
8	Marigo area 1	30	36	6.7
9	Marigo area 2	39	44	8.5
10	Marigo area 3	23	29	5.2
11	Rigogo area 1	112	**115**	**36.9**
12	Rigogo area 2	99	**122**	**35.5**
13	GDC Campsite	33	34	3.0
14	Pumphouse and nursery	12	22	1.9
15	Mlima Punda	2	4	0.04
16	Laydown	14	17	2.2
17	Control room	53	**58**	3.3
	Criteria	**150 (Kenya)** **Kenya allows for 3 exceedances per year**	**50 (Iceland)** **150 (WHO)**	**10 (OEHHA)**

(1) Values in bold indicate exceedances of guidelines or standards

Figure 7-2: 99.73th percentile of daily ground level H2S concentrations – Scenario 1

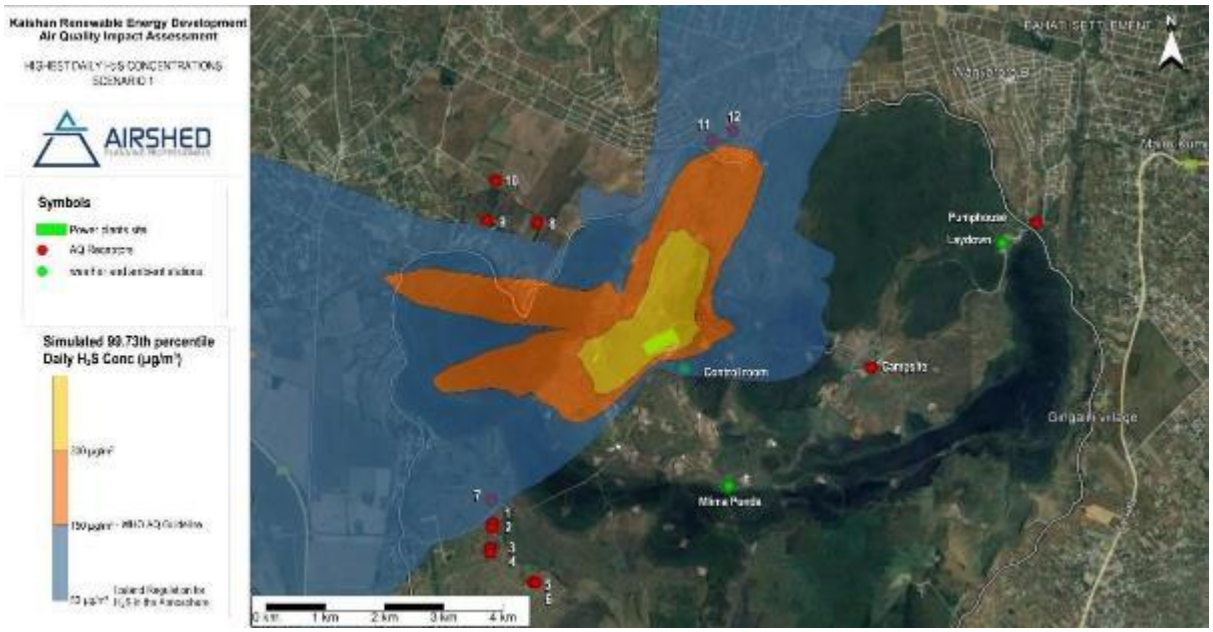


Figure 7-3: 99.2th percentile of daily ground level H_2S concentrations – Scenario 1

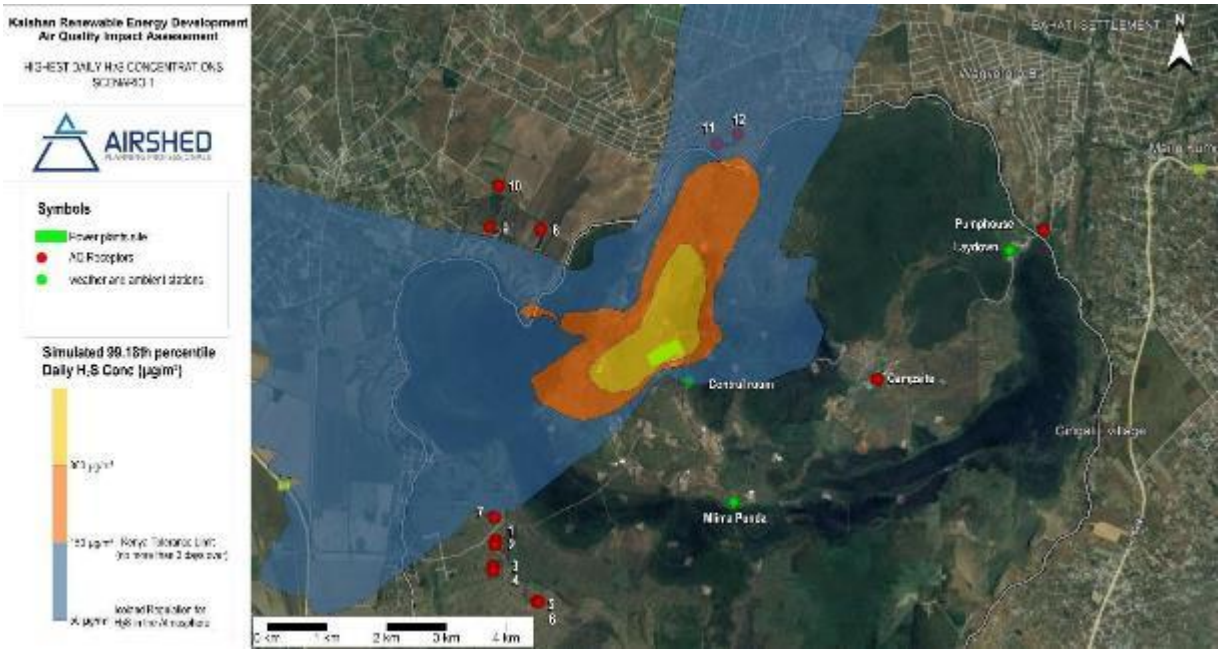
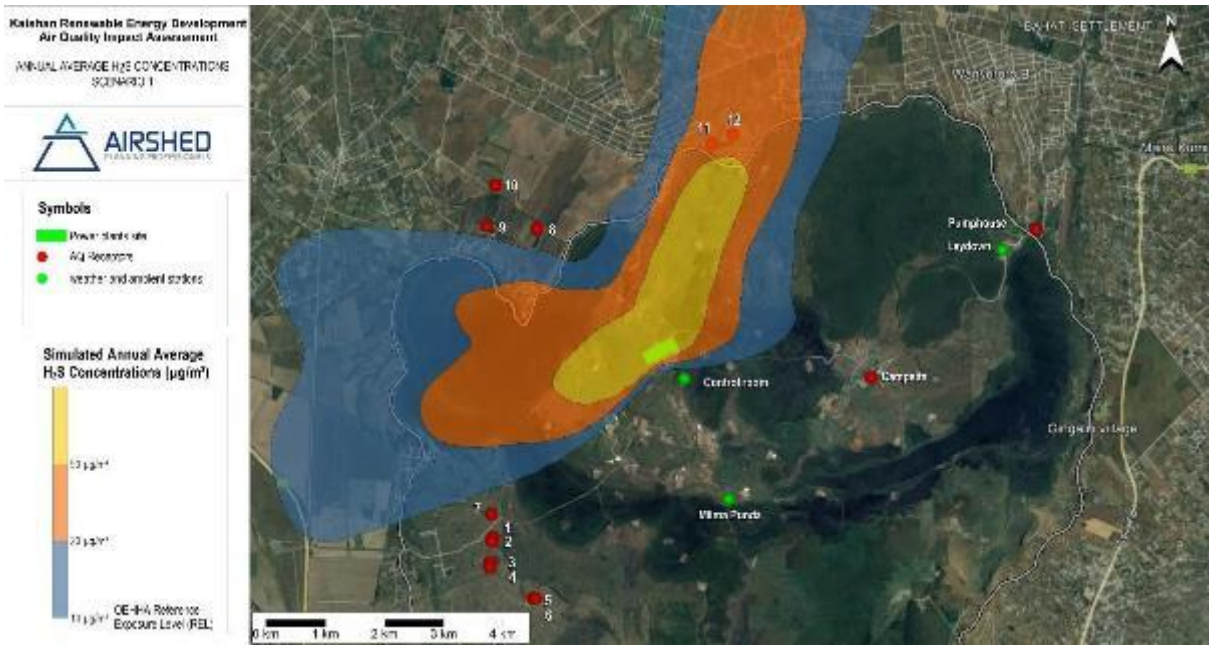


Figure 7-4: Annual average ground level H_2S concentrations – Scenario 1



For Scenario 2, showing Kaishan's incremental impact, simulated 24-hour ambient H_2S concentrations do not exceed the Iceland guideline of 50 µg/m³ or the Kenyan Tolerance Limit of 150 µg/m³ with 3 allowable exceedances or the WHO daily guideline value of 150 µg/m³ at any of the AQSRs. Simulated annual average ambient H_2S concentrations exceed the OEHHA screening level for chronic exposure (10 µg/m³) at two of the AQSRs (Table 7-7).Isopleths are shown in Figure 7-5, Figure 7-6 and Figure 7-7

Table 7-7: Simulated ambient H_2S concentrations during operation for Scenario 2

AQSRs		Simulated Ambient H2S Concentrations During the Operational Phase (1)		
Number	**Description**	**4th Highest 24-hour Ground Level Conc. (µg/m3)**	**2nd Highest 24-hour Ground Level Conc. (µg/m3)**	**Annual Ave. Ground Level Conc. (µg/m3)**
1.	Structure 1	13	16	1.6
2.	Structure 2	12	15	1.5
3.	Structure 3	11	12	1.0
4.	Structure 4	10	11	0.9
5.	Structure 5	2	3	0.1
6.	Structure 6	2	3	0.1
7.	Structure 7	16	20	2.5
8.	Marigo area 1	11	13	2.1
9.	Marigo area 2	11	16	2.0
10.	Marigo area 3	10	11	1.6
11.	Rigogo area 1	37	41	**13.4**
12.	Rigogo area 2	40	45	**12.9**
	GDC Campsite	11	16	1.0
	Pumphouse and nursery	4	8	0.6
	Mlima Punda	1	2	0.02
	Laydown	5	5	0.7
	Control room	24	34	2.0
	Criteria	**150 (Kenya)** **Kenya allows for 3 exceedances per year**	**50 (Iceland)** **150 (WHO)**	**10 (OEHHA)**

(1) Values in bold indicate exceedances of guidelines or standards

Figure 7-5: Highest daily ground level H_2S concentrations – Scenario 2

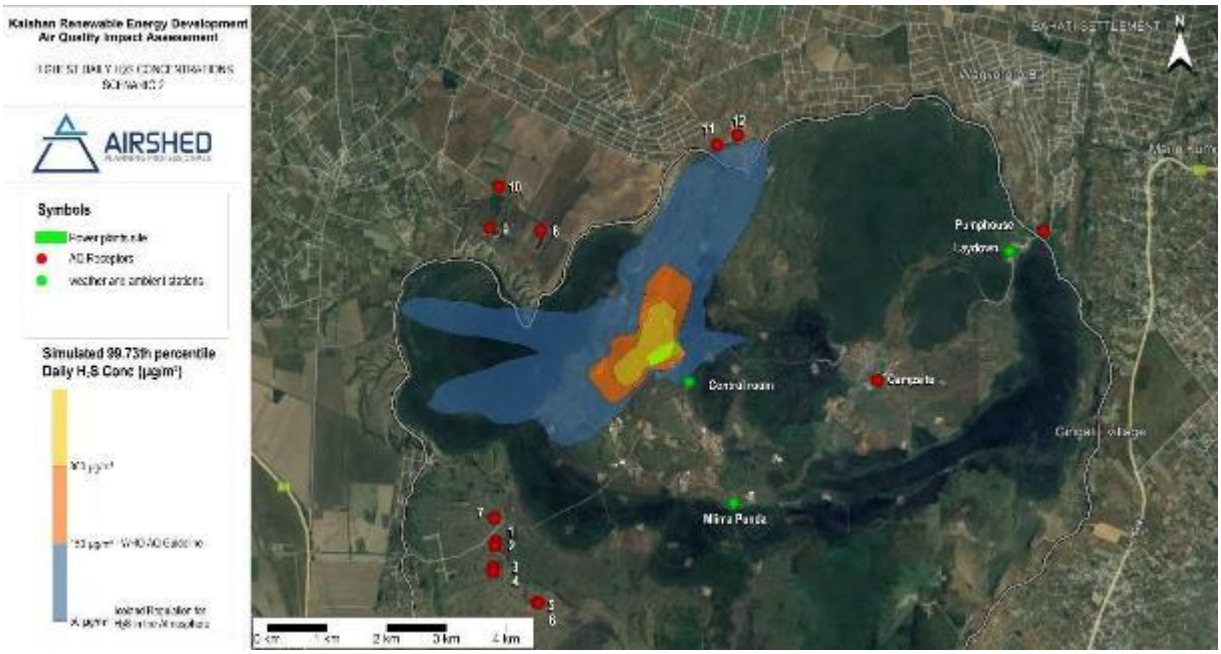


Figure 7-6: 99.2th percentile of daily ground level H2S concentrations – Scenario 2

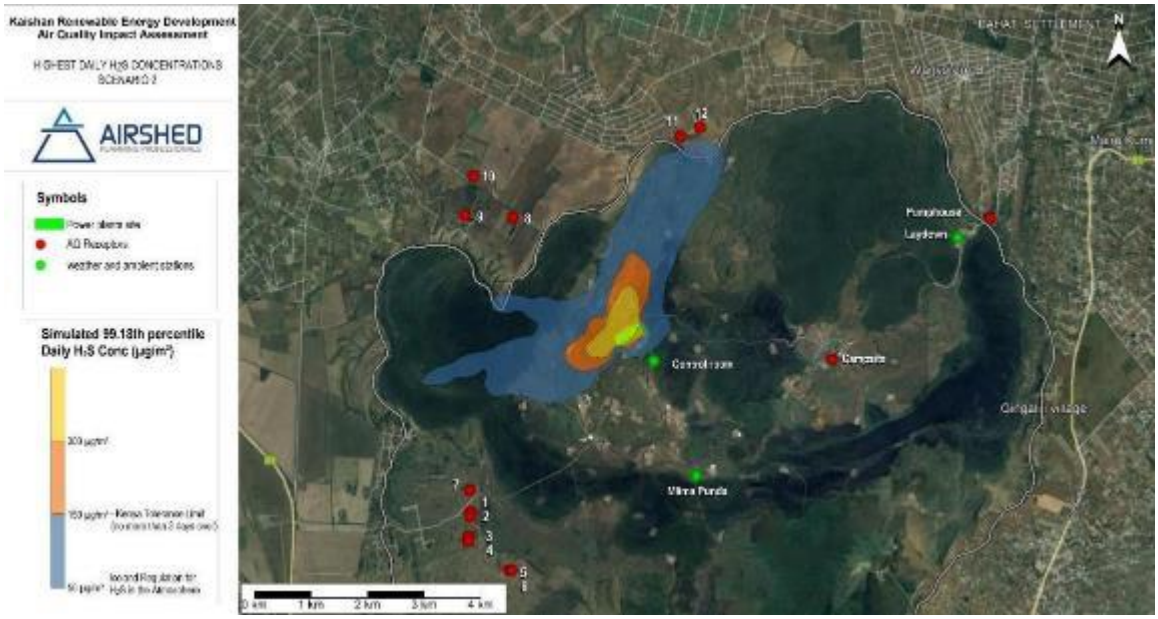
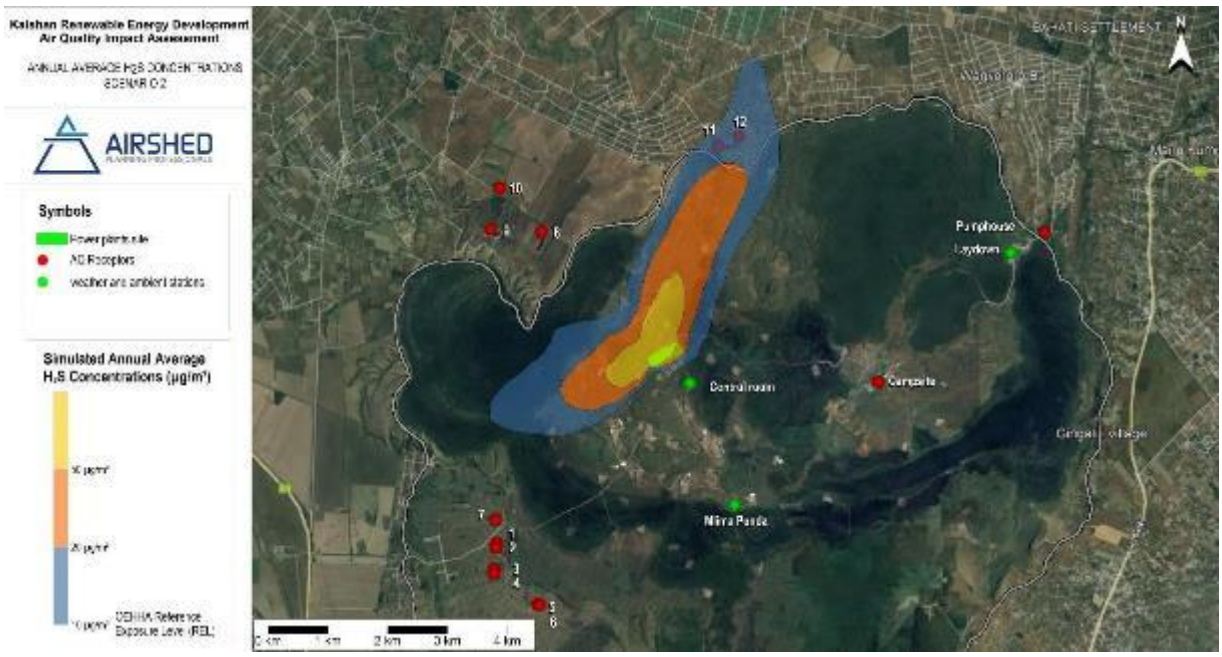


Figure 7-7: Annual average ground level H_2S concentrations – Scenario 2



7.6.10.2 Analysis of H_2S Emissions for Occupational Health Impact

To assess occupational health only the plant boundary is considered. For Scenario 1, the ACGIH TLV of 1ppm (1500 µg/m³) is exceeded both on-site as well as ~ 500 m from the site boundary. For Scenario 2, the ACGIH TLV of 1ppm (1500 µg/m³) is exceeded in the vicinity of the three IPPs (~ 150 m). For Scenario 3, the TLV is not exceeded (Figure 7-8 to Figure 7-10). None of the scenarios exceed the WHO lowest observable adverse effect level (LOAEL) of 15 mg/m³ (15 000 µg/m³) or 10 ppm.

Figure 7-8: Highest 8-hr ground level H_2S concentrations – Scenario 1

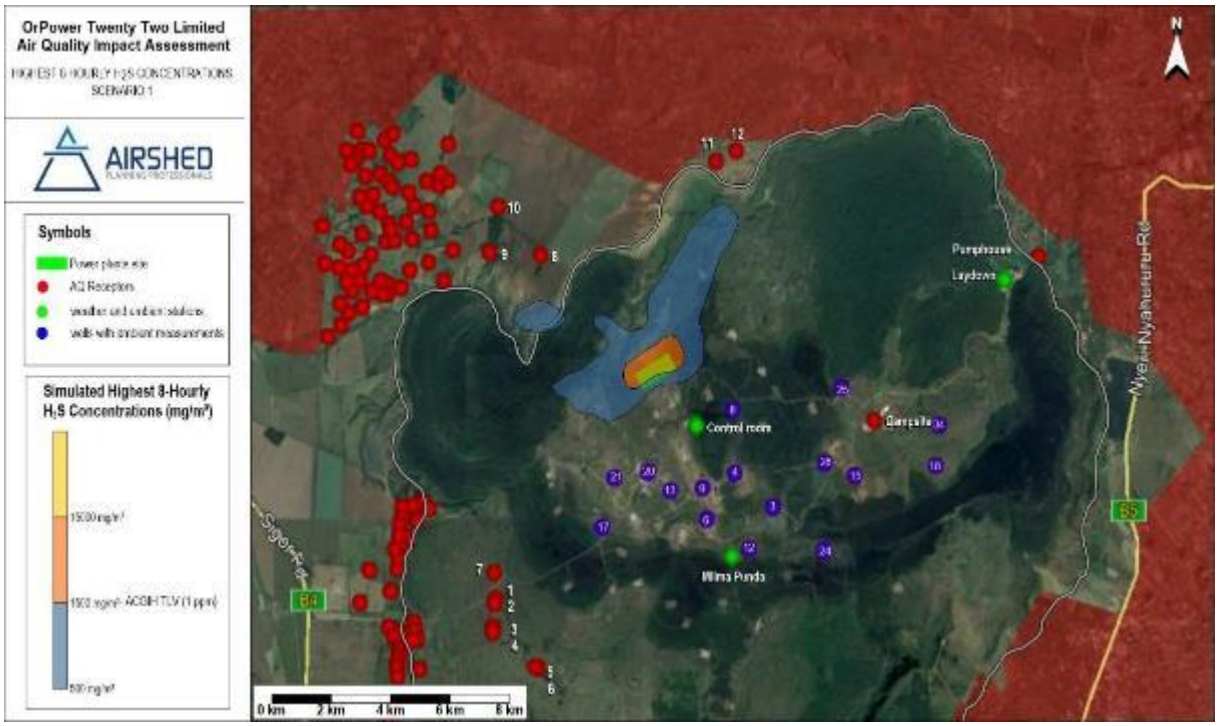


Figure 7-9: Highest 8-hr ground level H2S concentrations – Scenario 2

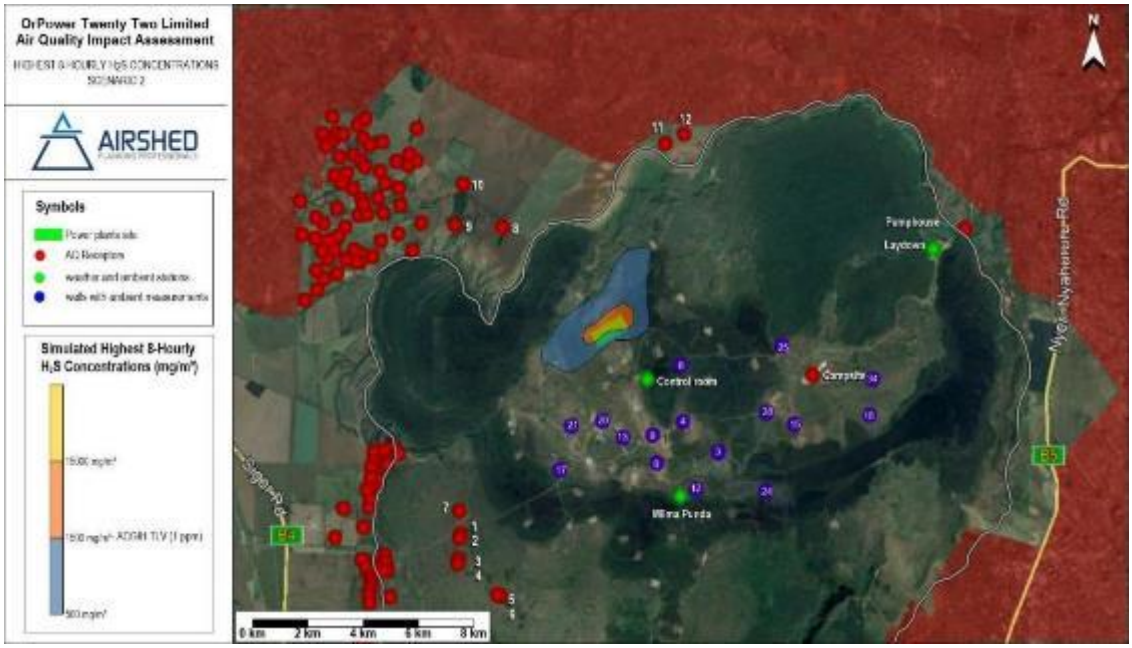
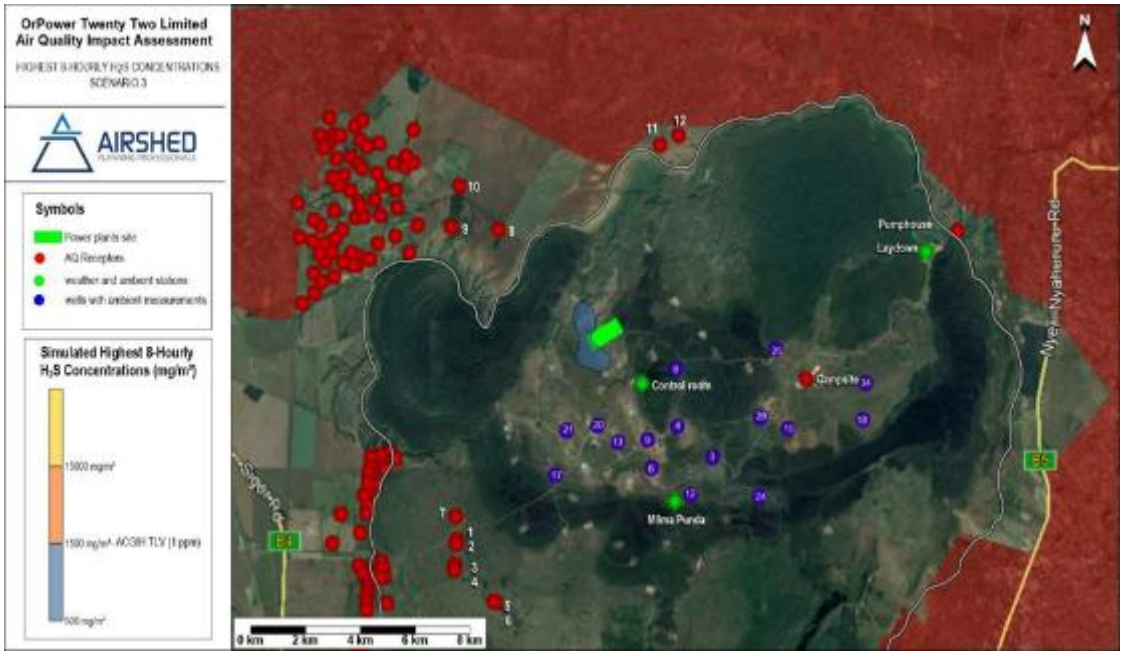


Figure 7-10: Highest 8-hr ground level H2S concentrations – Scenario 3



7.6.10.3 Simulated Odour Impacts from H_2S emissions

Relative to the WHO odour guidelines, the results of the modelling suggest that a H_2S odour impact is possible and it has the potential under certain meteorological conditions to be regarded as a nuisance (offensive or objectionable) in a number of receptor areas (Figure 7-11 to

Figure 7-13). For Scenario 3, the New Zealand guideline value (70 µg/m³ for geothermal areas) is only exceeded at two of the selected sensitive receptors (Table 7-8).

Table 7-8: Simulated 98th percentile hourly H_2S concentrations during the operational phase for Scenario 1, 2, 3

AQSRs		98th percentile 1-hour Ground Level Conc. (µg/m³) (1)		
Number	**Description**	**Scenario 1**	**Scenario 2**	**Scenario 3**
1.	Structure 1	46	43	14
2.	Structure 2	42	39	13
3.	Structure 3	28	25	7
4.	Structure 4	25	22	6
5.	Structure 5	1	1	0
6.	Structure 6	1	1	0
7.	Structure 7	75	69	24
8.	Marigo area 1	149	129	32
9.	Marigo area 2	175	145	26
10.	Marigo area 3	85	74	21
11.	Rigogo area 1	251	212	84
12.	Rigogo area 2	265	213	86
13.	GDC Campsite	43	28	6
14.	Pumphouse and nursery	37	31	6
15.	Mlima Punda	0	0	0
16.	Laydown	39	31	7
17.	Control room	0	0	0
	Criteria	70 (New Zealand) 7 (WHO)		

(1) Values in bold indicate exceedances of guidelines or standards

Figure 7-11: Highest hourly ground level H_2S concentrations – Scenario 1

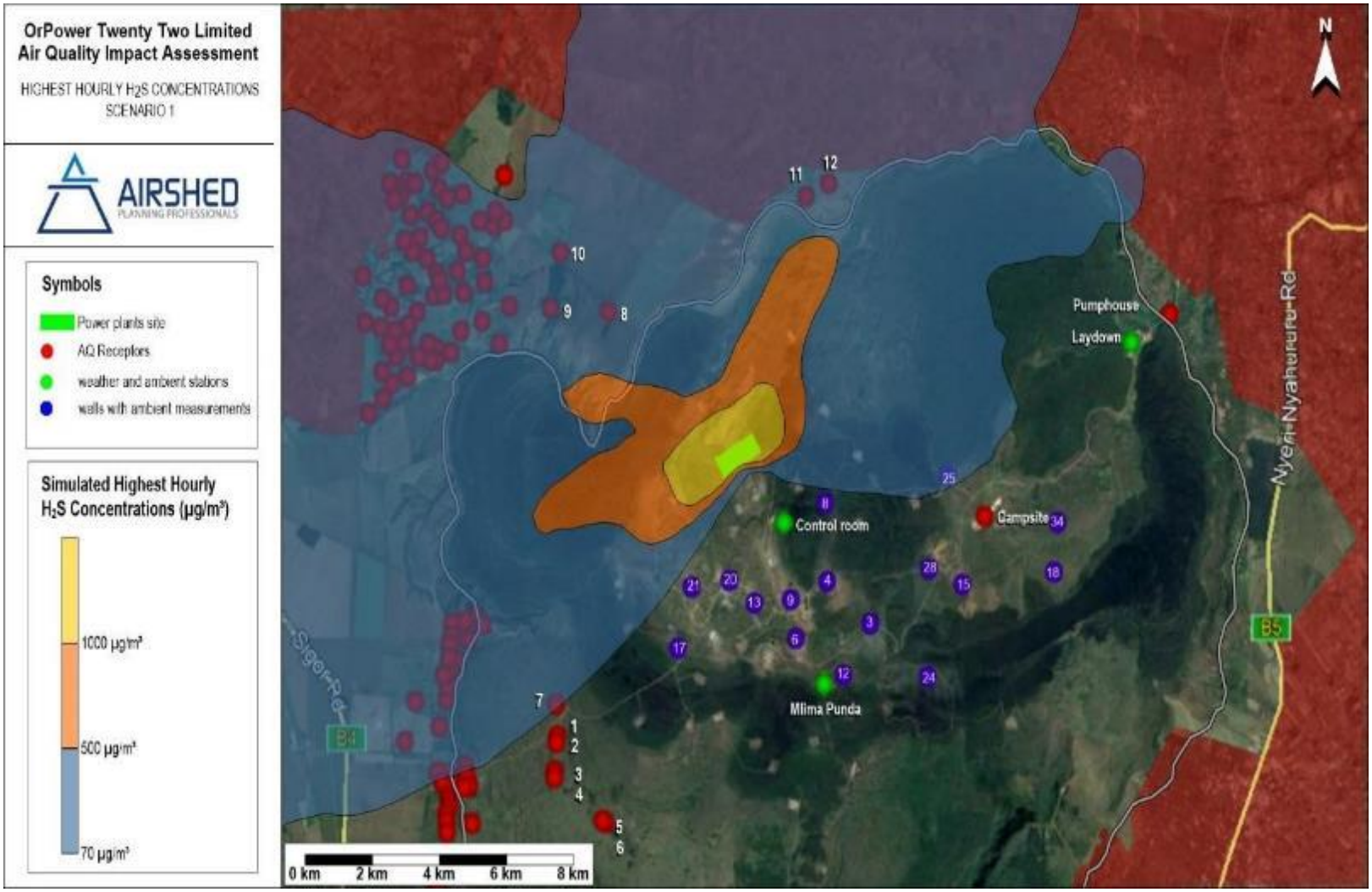


Figure 7-12: Highest hourly ground level H_2S concentrations – Scenario 2

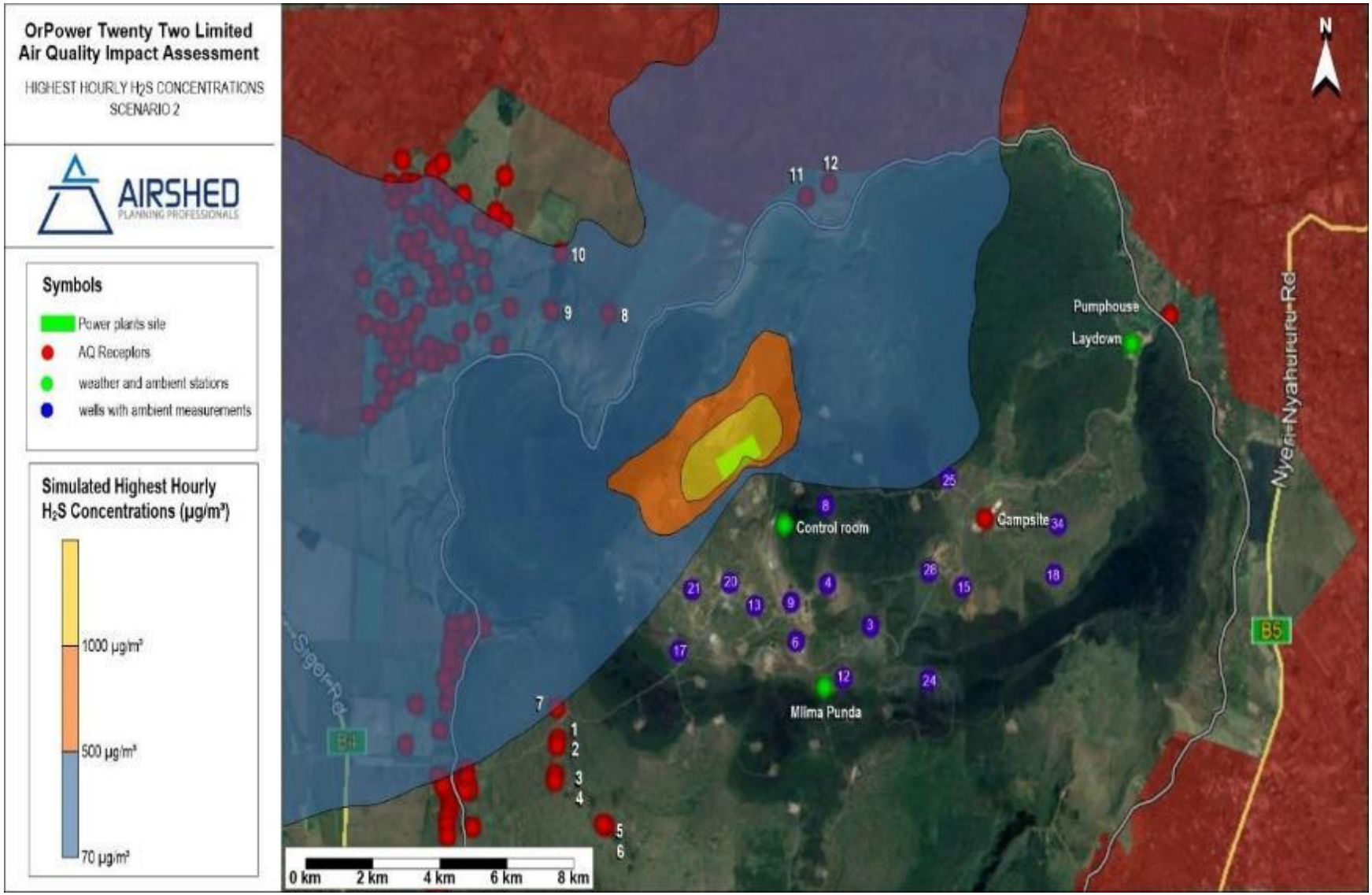
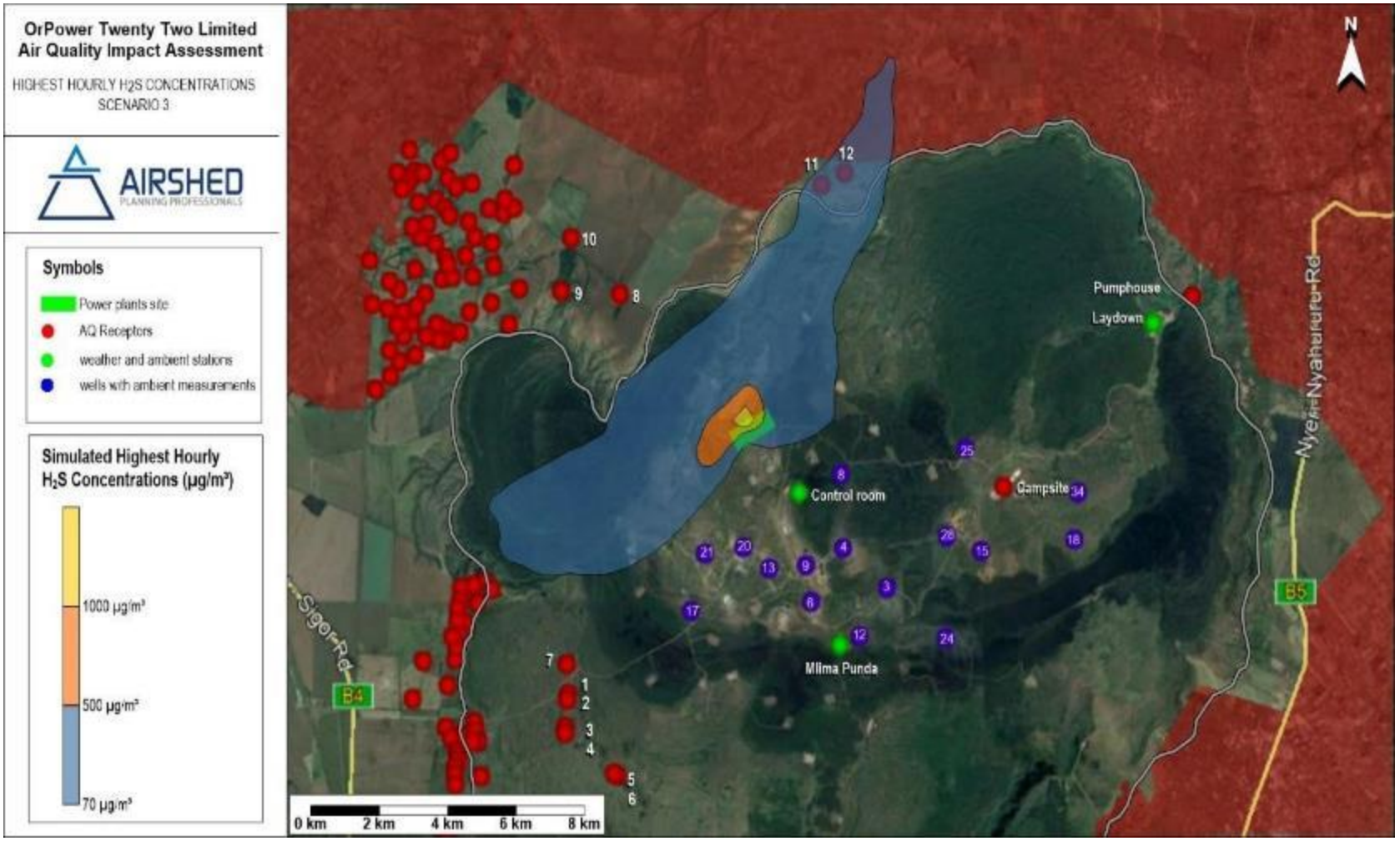


Figure 7-13: Highest hourly ground level H_2S concentrations – Scenario 3



7.6.10.4 Conclusions

From the air dispersion modelling, OTTL operations alone (scenario 2) will not result in H_2S emissions beyond the WHO and Iceland threshold guidelines for community safety. This indicates that no adverse public health impacts are anticipated with H_2S emissions from the plant's operation relative to WHO standards. However, the cumulative impacts, assuming the other two plants each emit from a single stack, will result in some exceedance of the Iceland thresholds. The study reference standards adopted are IFC in which case the WHO applies. Therefore, it can be concluded that the envisaged emissions even from cumulative impacts are within the IFC prescribed standards.

With regard to odour, results suggest that a H_2S odour impact from cumulative operation of all the three plants is possible and it has the potential under certain meteorological conditions to be regarded as a nuisance in some locations relative to WHO guidelines (7 µg/m³). For Scenario 3, with only OTTL plant's incremental impacts, the New Zealand guideline value (70 µg/m³ for geothermal areas) is only exceeded at two of the potential sensitive receptors in Rigogo area (Table 7-8). Given the natural occurrence of H_2S in the project area, the New Zealand guideline value for odour nuisance is deemed applicable for the settlements bordering the Menengai crater.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-3*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-4*
Frequency of impact	*-5*
Result	***-99 Medium - High***

Mitigation measures

The following options have been provided by the IFC (2007) EHS Guidelines for Geothermal Plants to manage emissions to air:

- OTTL should adopt the cooling tower technology and also incorporate H_2S safety systems for the plant for the occupational hazard detection system. This will facilitate continuous monitoring and allow any further mitigation interventions where necessary;
- If necessary, use of abatement systems to remove H_2S emissions from NCGs. Examples of H_2S controls can include wet or dry scrubber systems or a liquid phase reduction / oxidation system, while Hg emissions controls may include gas stream condensation with further separation or adsorption methods.

To ensure the lowest possible impact on AQSRs and the environment it is recommended that an air quality management plan should be jointly adopted by all the IPPs and GDC in their operations within the Menengai geothermal field. This includes:

- The mitigation of sources of emission;
  - ✓ The management of associated air quality impacts; and
  - ✓ Ambient air quality monitoring both within the caldera an at the identified sensitive receptors.

While OTTL can readily do the plant-specific air quality management plan, close collaboration will be required among all the IPPs in Menengai Geothermal area and GDC to achieve overall success.

For occupational health impacts, it is certain that some workers will occasionally be exposed to elevated H_2S concentrations. Mitigations measures proposed include:

- ✓ Daily monitoring of H_2S within the Plant boundaries and other active activity sites within the caldera;
- ✓ Training of all workers on the dangers of being exposed to H_2S; and

- ✓ Installation of automatic H_2S data logging monitors with alarm system including use of personal monitors by staff in potentially dangerous areas;

For odour impacts, liaison strategy for communication with communities who may be affected by nuisance is recommended in addition to the air quality management plan for the Menengai geothermal field. Such community liaison should incorporate sharing of the monitoring results for transparency and to allay any community health fears.

7.6.11 Operation Noise impacts

During operation phase noise will be generated by a number of elements at the plant. The main sources of noise will include:

- The steam turbine;
  - ✓ The generator;
  - ✓ The droplet separator;
  - ✓ The steam strainer;
  - ✓ Valves (main and stop valves);
  - ✓ Pumps (incl. oil pumps, vacuum pumps, hot well pumps and cooling water pumps)
- The main condenser;
  - ✓ The cooling towers; and
  - ✓ Transformers

The main noise sources inventory as provided by OTTL and applied in the noise dispersion modelling by Airshed is presented in the table below.

Table 7-9: Source inventory summary for the OTTL/Kaishan Geothermal Power Plant

Point	Description	Qty. per facility	Height of source (m)	LP at 1 m (dBA)	Distance from source of LP (m)
N01	Unit 1 – Generator	1	3.6	85	1
A02	Unit 1 – Screw Turbine 1	1	3.6	85	1
A03	Unit 1 – Screw Turbine 2	1	3.6	85	1
A04	Unit 2 – Generator	1	3.6	85	1
A05	Unit 2 – Screw Turbine 1	1	3.6	85	1
A06	Unit 2 – Screw Turbine 2	1	3.6	85	1
A07	Unit 3 – Generator	1	3.0	85	1
A08	Unit 3 – ORC Turbine	1	3.0	85	1
A09	Unit 3 – ECC Fan	30	8.7	79.9	1
A10	Unit 3 – Blower	2	4.5	95	1
A11	Unit 3 – Refrigerant Pump	2	2.5	85	1
A12	Unit 4 – Generator	1	3.2	85	1
A13	Unit 4 – ORC Expander 1	1	3.2	85	1
A14	Unit 4 – ORC Expander 2	1	3.2	85	1
A15	Unit 4 – ECC Fan	12	8.7	79.9	1
A16	Unit 4 – Blower	1	4.5	95	1
A17	Unit 4 – Refrigerant Pump	1	2.0	85	1
A18	Unit 5 – Generator	1	3.0	85	1
A19	Unit 5 – ORC Turbine	1	3.0	85	1
A20	Unit 5 – ECC Fan	30	8.7	79.9	1
A21	Unit 5 – Blower	2	4.5	95	1
A22	Unit 5 – Refrigerant Pump	2	2.5	85	1
A23	Rock Muffler	1	1.2	NA	1
A24	Cooling System ECC Fan	4	8.7	79.7	1

(a) *The spectral breakdown for a typical turbine, as provided by OTTL, is given in Table 7-11.*

(b) *Only one pump operates at a time.*

Table 7-10: Spectral breakdown for a typical turbine

Source	Octave Band Sound Power Levels; LWi (dB)									LWA (dBA)
	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	
Turbine/Generator Enclosure	61.8	71.1	80.1	77.3	74.7	76.2	75.5	73.1	72.5	85

Based on the anticipated extent of impacts and the location of potential noise sensitive receptors (NSRs), propagation of noise was calculated over a distance of approximately 12 km east-west by 9 km north-south at 20 m intervals. Results are presented in tabular and isopleths forms. An isopleth is a line on a map connecting points at which a given variable (in this case LP) has a specified constant value. This is analogous to contour lines on a map showing terrain elevation. In the assessment of environmental noise, isopleths present lines of constant noise level as a function of distance.

7.6.11.1 Noise Sensitive Receptors

From atmospheric conditions of the project area, noise impacts are expected to be most notable to the north-north-west and south-south east during the day. During the night it is expected to be most significant to the north-north-west of proposed operations. Location of likely NSRs is shown in Figure 7-1. These include single homesteads, villages, small towns as well as community locations. The closest NSRs are situated approximately 3.5 km north-west of the facility on the crater rim at Marigo. Within the crater itself the individual homestead and structures to the south-west (approximately 3.7 km from the facility) are the closest. No area designated as silent zone is within immediate proximity of the proposed power plant.

7.6.11.2 Noise modelling Results

Table 7-11 gives a summary of maximum downwind distances over which Kenyan sound level limits and IFC noise level guidelines are exceeded should the OTTL geothermal power plant be operational on its own (Figure 7-14, Figure 7-16, Figure 7-18 and Figure 7-20) and with the Sosian and Globeleq facilities (Figure 7-15, Figure 7-17: , Figure 7-19: I and Figure 7-21: I).

Table 7-11: Maximum downwind distances over which Kenyan and IFC noise criteria are exceeded

Source	Kenya Sound Level Limits		IFC Noise Level Guidelines	
	Day-time (50 dBA)	Night-time (35 dBA)	Day-time (55 dBA)	Night-time (45 dBA)
OTTL Geothermal Power Plant				
Incremental	50 dBA at 190 m	35 dBA at 600 m	55 dBA at 100 m	45 dBA at 310 m
Cumulative (in addition to baseline)	Baseline of dBA[a] exceeds limit	Baseline of dBA[b] exceeds limit	Baseline of 57.9 dBA[a] exceeds guideline	Baseline of 47.9 dBA[b] exceeds guideline

Increase above baseline	Not applicable	Not applicable	3 dBA at 90 m	3 dBA at 270 m
OTTL, Sosian Energy Limited and Globeleq Menengai Geothermal Limited Geothermal Power Plants				
Incremental	50 dBA at 530 m	35 dBA 1 970 m	55 dBA at 390 m	45 dBA at 790 m
Cumulative (in addition to baseline)	Baseline of dBA(a) exceeds limit	Baseline of dBA(b) exceeds limit	Baseline of 57.9 dBA(a) exceeds guideline	Baseline of 47.9 dBA(b) exceeds guideline
Increase above baseline	Not applicable	Not applicable	3 dBA at 390 m	3 dBA at 610 m

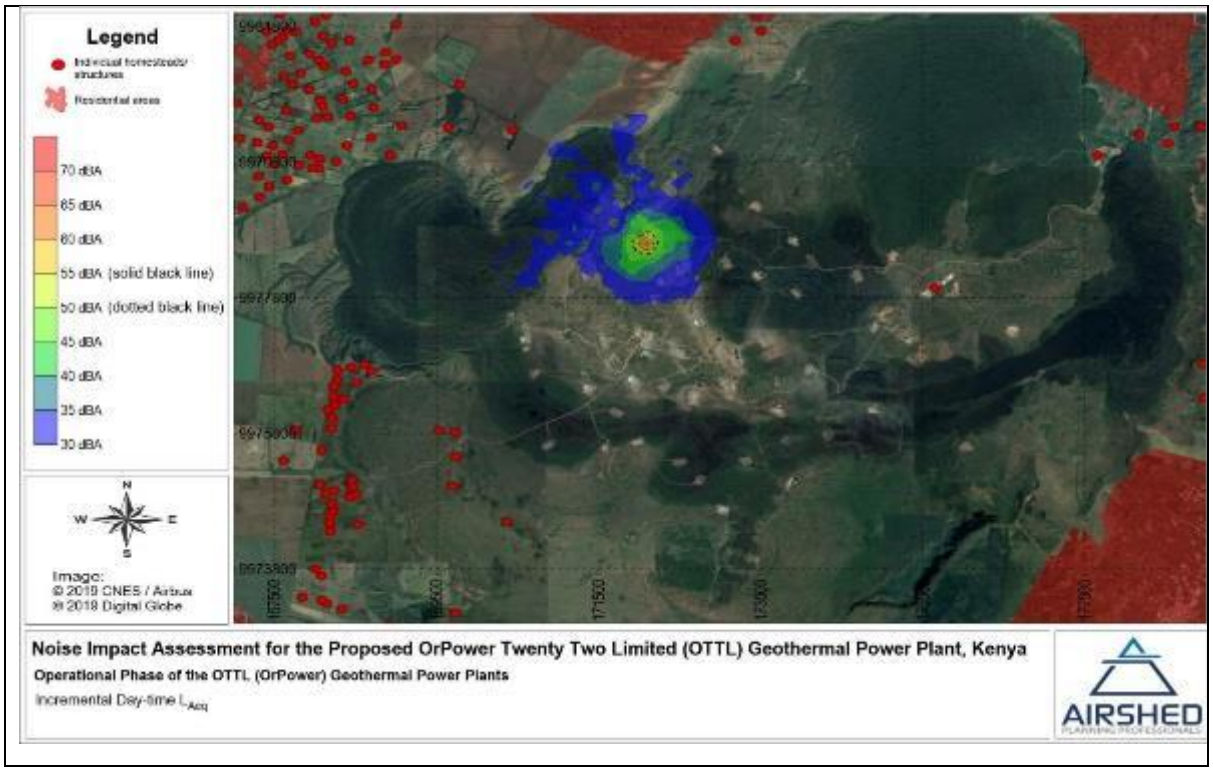
From Table 7-11 it is evident that even with all the three power plants operating simultaneously the overall maximum increase in noise level over the baseline will reduce to less than 3 dBA at around 610m. As expected, the noise impact would be most notable at night when baseline noise levels are lower and assessment criteria more stringent. Since the closest NSRs are situated at least 3 km away from these sites it is unlikely that a change in day or nighttime noise levels will be detected at these locations. SANS 10103 (2008) indicates that at an increase of between 0 and 5 dBA, sporadic complaints with little or no community action may be expected.

The relatively small impact area is the combined result of the baseline noise levels (already in exceedance of assessment criteria), the design specifications of the facilities (i.e. galvanized steel sheet cladding of building that contains major noise sources), and the absence of permanent NSRs within 2 km radius from site.

It can therefore be concluded that, when referring to noise levels and increases in ambient noise levels as a result of the geothermal power plants' operational design parameters, such as turbine hall cladding with galvanized steel sheets, will be sufficient to ensure that no annoyance will be caused at the closest NSRs.

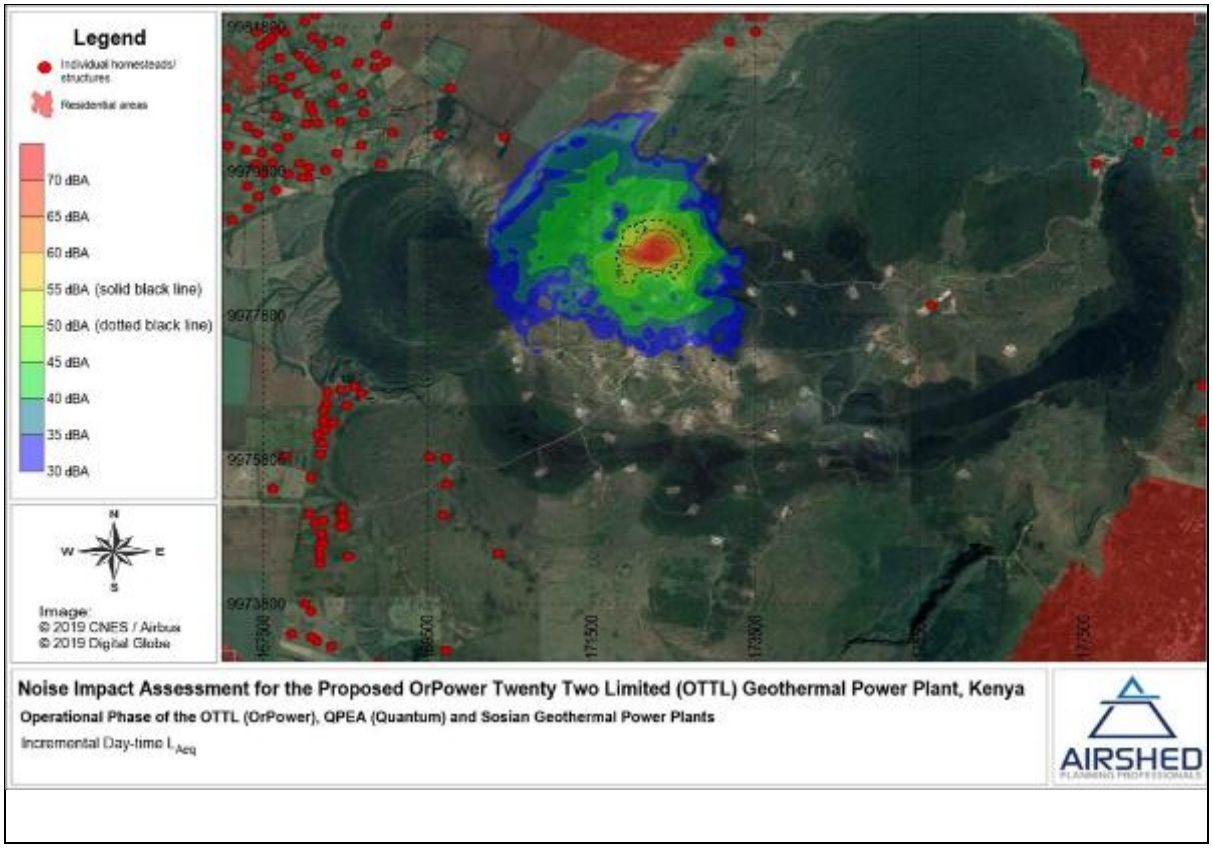
It was concluded that, provided the management plan recommend in this report is adopted, NSR's will not be affected negatively or find noise from the facility annoying. The cladding of the turbine is considered sufficient from an environmental noise perspective i.e. for impacts at NSRs.

Figure 7-14: Incremental day-time LAeq as a result of the operational phase of the OTTL Geothermal Power Plant



Source: Airshed Noise Assessment results

Figure 7-15: Incremental day-time LAeq as a result of the operational phase of the OTTL, Sosian and GMGL Geothermal Power Plants

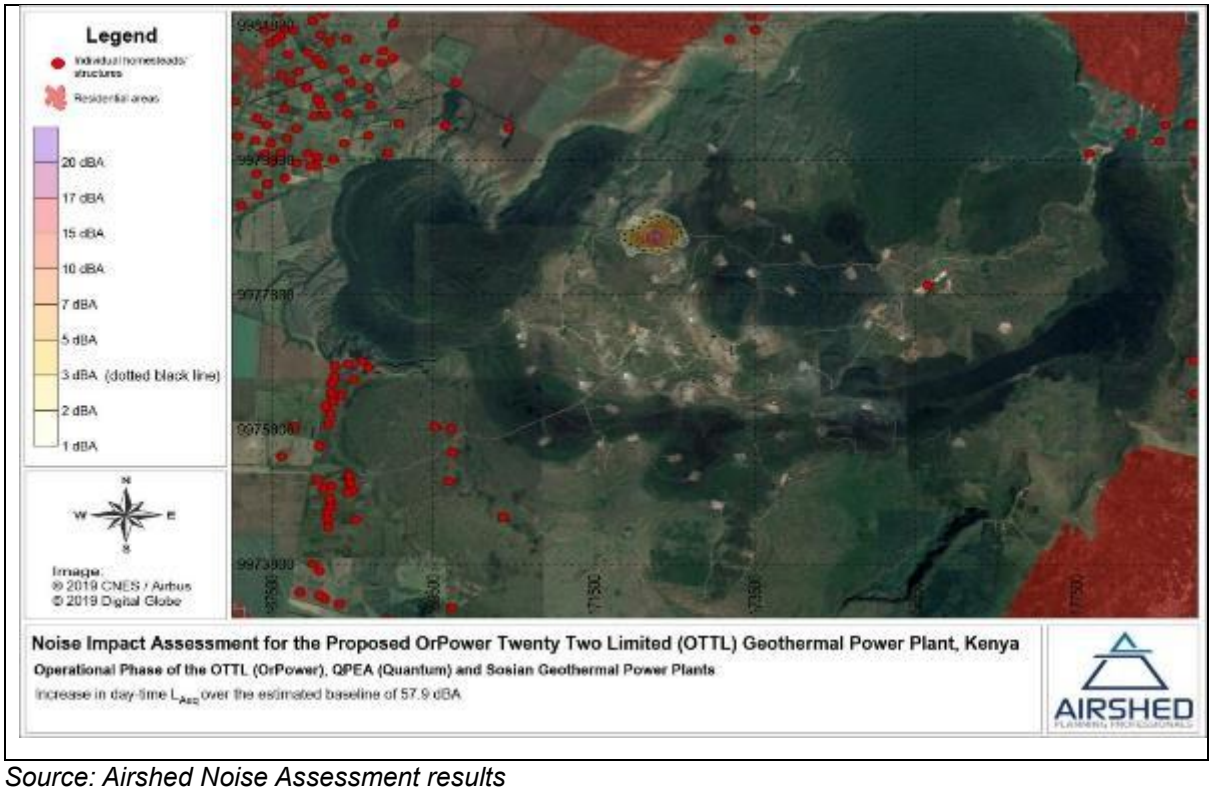


Source: Airshed Noise Assessment results

Figure 7-16: Increase in day-time LAeq over the baseline of 57.9 dBA as a result of the operational phase of the OTTL Geothermal Power Plant

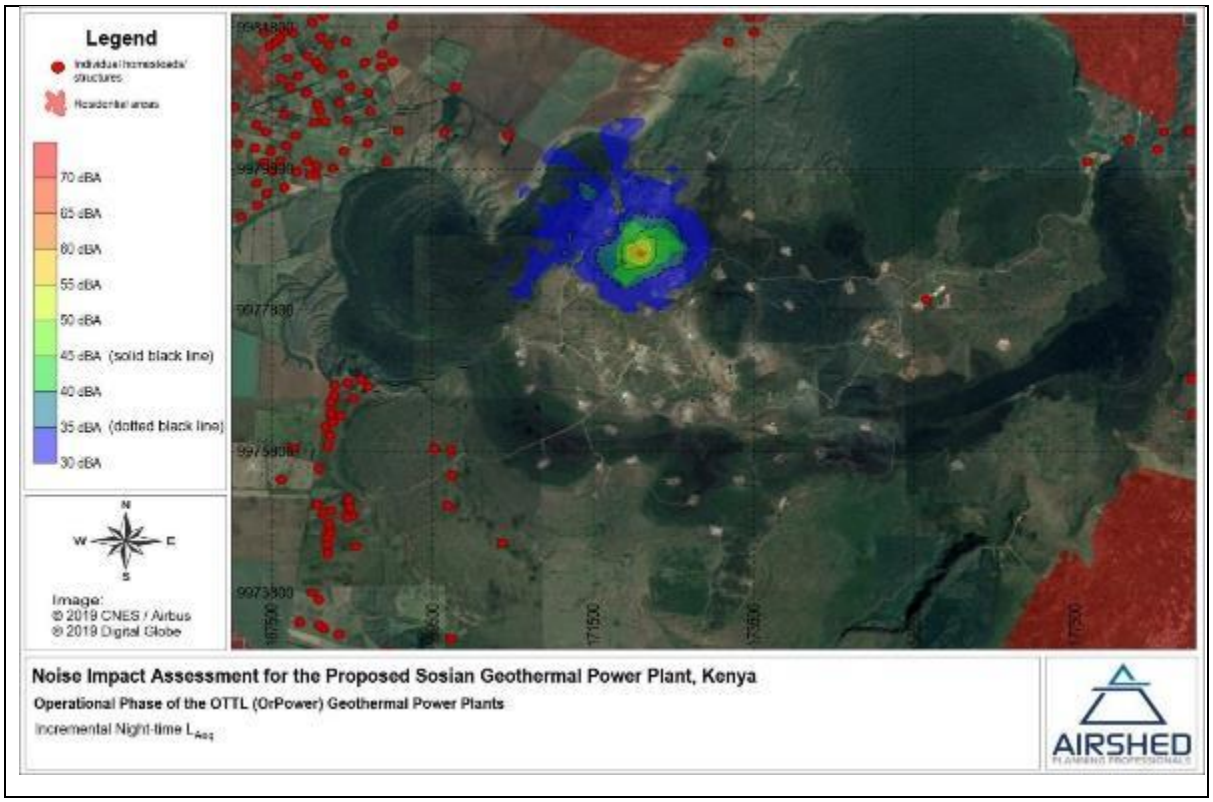
Source: Airshed Noise Assessment results

Figure 7-17: Increase in day-time LAeq over the baseline of 57.9 dBA as a result of the operational phase of the OTTL, Sosian and Globeleq Geothermal Power Plants



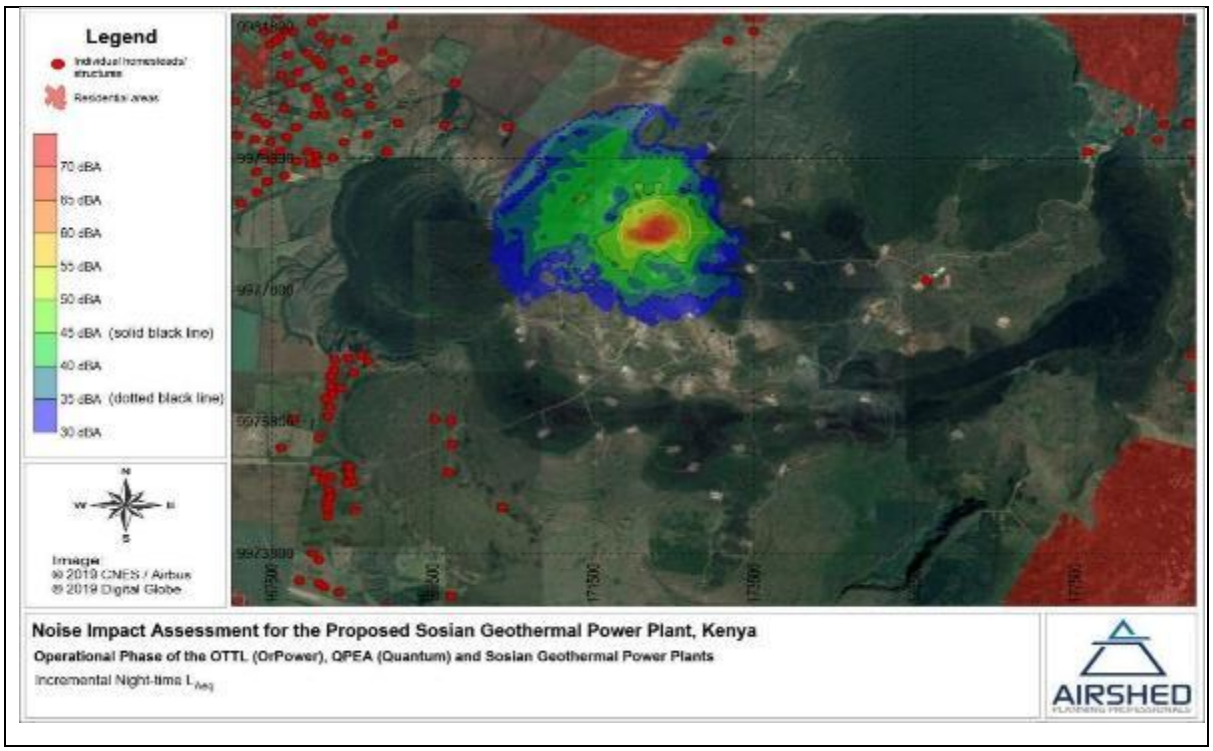
Source: Airshed Noise Assessment results

Figure 7-18: Incremental night-time LAeq as a result of the operational phase of the OTTL Geothermal Power Plant



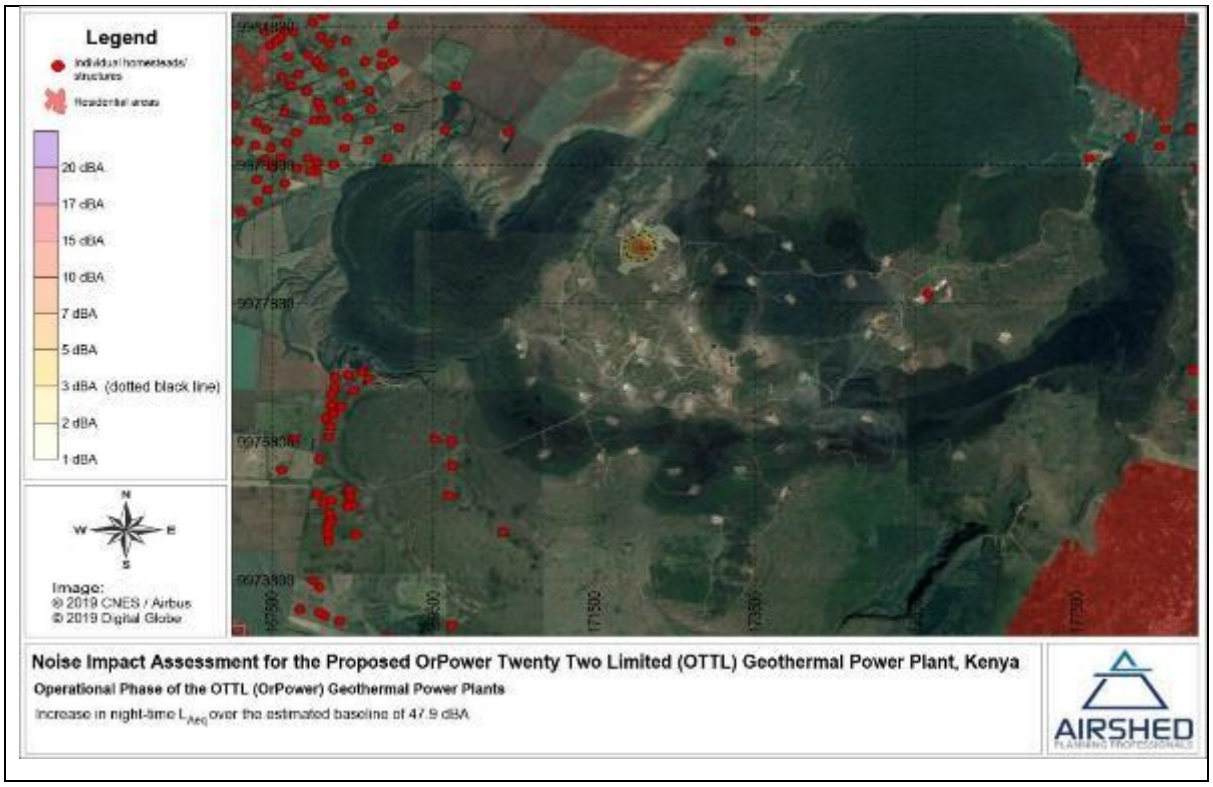
Source: Airshed Noise Assessment results

Figure 7-19: Incremental night-time LAeq as a result of the operational phase of the OTTL, Sosian and Globeleq Geothermal Power Plants



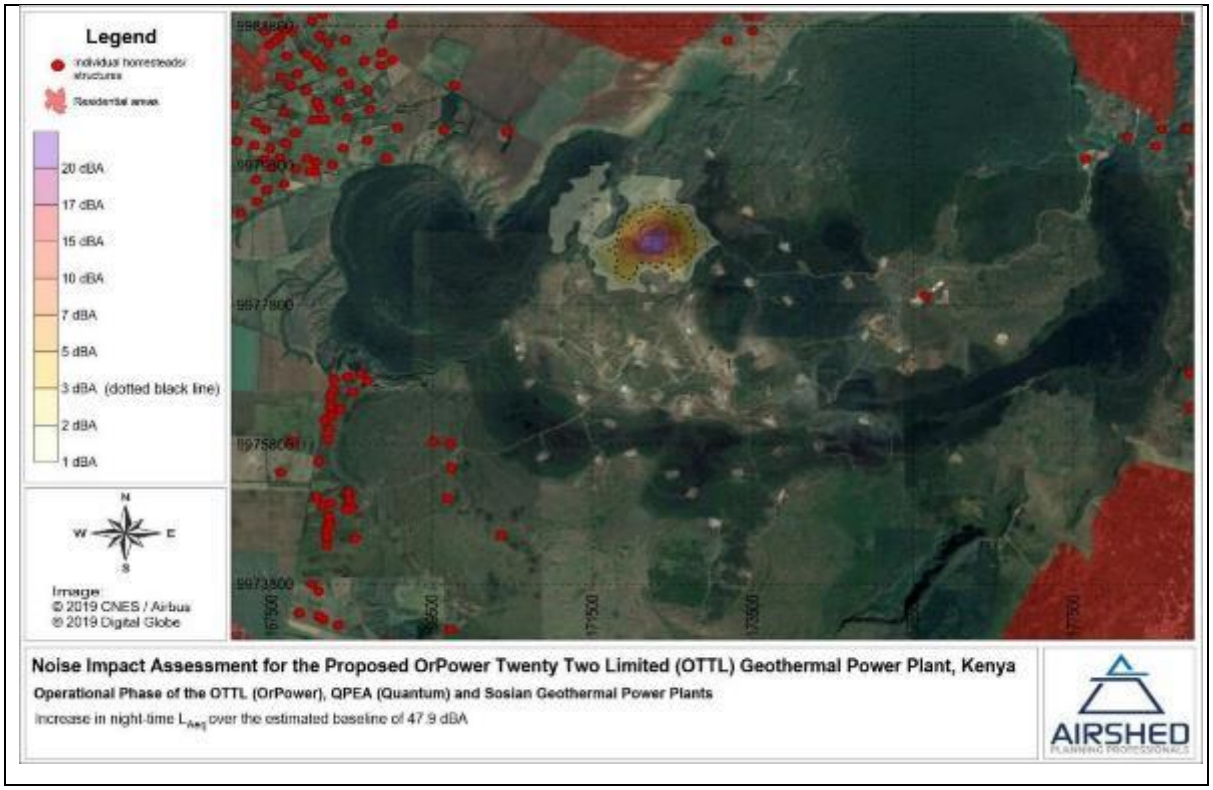
Source: Airshed Noise Assessment results

Figure 7-20: Increase in night-time LAeq over the baseline of 47.9 dBA as a result of the operational phase of the OTTL Geothermal Power Plant



Source: Airshed Noise Assessment results

Figure 7-21: Increase in night-time LAeq over the baseline of 47.9 dBA as a result of the operational phase of the OTTL, Sosian and Globeleq Geothermal Power Plants



Source: Airshed Noise Assessment results

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-2*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-5*
Frequency of impact	*-3*
Result	***-64 Low- Medium***

Mitigation measures

In order to minimize impacts of both construction and operational noise on the receiving environment it is recommended that the following measures be adopted as part of the noise management plan.

Good Engineering and Operational Practices

- To minimize noise generation, equipment vendors must be required to guarantee optimized equipment design noise levels;
- Acoustic attenuation devices should be installed on all ventilation outlet and high-pressure gas or liquid should not be ventilated directly to the atmosphere, but through an attenuation chamber or device;
- Vibrating equipment must be on vibration isolation mountings;
- The site layout should be designed in such a manner that the noisiest sections of the plant are at the center of the site, using surrounding buildings as noise attenuation shields;
- Implement routine equipment maintenance program to minimize noise/vibration associated with mobile parts power transmission/vibration;
- Plant areas/sections with excessive noise should be clearly labelled with warning signages and those accessing them required to have appropriate PPEs to protect against excessive noise i.e. ear plugs/muffs;
- A plan to monitor noise levels, record and respond to complaints and mitigate impacts should be developed. This to include regular monitoring of noise levels will need to be made during operation as per current practice in existing GDC operations.

Monitoring

It is recommended that short term 24-hour to 1-week sampling be conducted at the facility boundaries as well as nearest NSRs. Monitoring should be conducted in accordance with the procedures specified by the IFC (2007). Samples, at least 24-hours in duration should include the following parameters: L_{Aeq}, L_{A90}, and the un-weighted octave band sound pressure levels (L_{Zeq}). In the interpretation and reporting of sampled environmental noise levels, use should be made of a trained specialist. In addition to ambient noise monitoring, it is recommended that source noise measurements of turbine building facades and sources located inside and outside buildings be sampled to verify L_W's applied in noise modeling study.

7.6.12 Community Health and Safety

Many community health and safety aspects during operation have been touched upon under environment (e.g., air quality and H_2S, traffic).

To summarize and add: during operation, traffic volumes drop drastically (only a few maintenance vehicles and staff transport, not convoys of trucks).

Thus, road safety risk to communities becomes very low compared to construction. Nonetheless, OTTL will ensure any ongoing traffic adheres to the same rules (speed limits, etc.), and maintain signage and any road improvements done.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-4*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-2*
Result	***-44 Low***

- The **H_2S exposure** to the community has been mitigated through technology and monitoring as discussed – so community health risk from plant emissions is minimal.
- **Emergency events** (like an unplanned large release or a fire) are highly unlikely and have their own response plans. OTTL will work with GDC and local authorities to incorporate the power plant into area emergency preparedness
- **Security**: There will be security personnel at the plant, which is important for both asset protection and community safety (ensuring no intruders who might get hurt or cause sabotage). OTTL will train security staff in accordance with IFC PS4 and UN Voluntary Principles on
- **Security and Human Rights** emphasizing that security forces (mostly unarmed guards contracted) must respect the community, use minimum force, and not infringe on human rights. Because the site is in a remote area, significant security issues with community are not anticipated, but this is a standard compliance measure for lenders.
- Additionally, stakeholder engagement continues in the operational phase.
- OTTL will have a Community Liaison contact who, together with GDC's community relations team, will maintain open communication with local communities, address any complaints, and inform the community of any significant activities (like maintenance works that might cause flaring or noise).
- OTTL will manage expectations through stakeholder engagement. The company will also explore Corporate Social Responsibility (CSR) projects during operations

7.7 Negative Impacts during Decommissioning

Decommissioning will involve take out of the power plants and associated infrastructures after useful life. OTTL agreement with GDC is to install the power Plant on a Build Own and Operate (BOO) basis for 25 years, a typical economic design life of the major project equipment. However, it is not uncommon for power plant such as the proposed development to operate for 40 years or more.

The decision to decommission the Power Station will depend on its economic viability and continued well productivity. Decommissioning must take account of the environmental legislation and the technology available at the time.

The notable adverse impact at this phase is leaving abandoned plant, equipment and buildings without any attempt to rehabilitate leading to the deterioration of habitat. Unplanned, careless and disorganized site decommissioning can result in interference of habitat. Site decommissioning will involve closure and removal of facilities and disconnection from wells, including infrastructures such as roads and pipelines and finally vegetation restoration and landscaping. Vegetation can restore naturally through succession or intervened rehabilitation to achieve average status with the neighbouring area.

An additional problem is the abandoned wells (holes) which can be fall off for wildlife and human. This will be the responsibility of GDC who is in charge of the steam gathering system.

A lot of solid waste will also be generated during decommissioning. The majority of the solid wastes generated will be similar to the construction phase of the project. These include;

- Demolition rubble;
  - Top soils and excavation wastes;
  - General demolition wastes;
  - Waste metal (including, disc cutters piping etc.);

- Waste oils and lubricants;
- Waste paints and solvents;
- Empty paint, oil and chemical/ solvent containers;
- Wood;
- Plastics;
- Electrical cabling and electrical components;
- Domestic wastes, including food wastes;
- Plant Sewage effluent;
- Paper;
- Empty oxygen and acetylene tanks (if oxy-acetylene welding and cutting required); and
- Glass.

OTTL would develop a decommissioning plan for the power plant, incorporating both safety and environmental management and the works would be undertaken in accordance with an Environmental Management Plan.

The first step of decommissioning will be to make the plant safe for work in accordance with relevant safety procedures. The Power Station would be de-energized in conjunction with the electricity network operators, Kenya Power and KETRACO. Disused equipment and materials would be sold where possible or disposed of off-site by a licensed contractor. Closed vessels, pipes and other areas which could have hazardous gases present would be vented in accordance with normal operating procedures. These would then be tested to ensure that they are safe for entry or removal.

Once the power plant is completely disconnected, and all hazardous materials removed, it will be handed over to a competent contractor (or contractors) to complete the dismantling and demolition work.

These decommissioning steps may be summarized and involve the following steps presented below;

- Make the site safe – ensure all electrical connections and supplies are disconnected and any dangerous chemical stores are identified and made safe;
- Removal and sale/recycling of plant and materials;
- Disposal of waste materials by appropriate methods in accordance with waste management regulations; and
- Re-instatement and landscaping of the power plant site with suitable mix of indigenous species. This should be done in liaison with the local KFS office.

OTTL must prepare and submit the power plant's decommissioning plan to NEMA for approval at least three months before decommissioning.

Given that OTTL is only directly responsible for facilities within its plant boundary, it will be necessary that the power plant's decommissioning plan clearly define the level of decommissioning responsibilities applicable to the other players i.e. GDC for the steam gathering system and associated re-injection wells, site access roads and water supply infrastructure; and KPLC and KETRACO for the power substation and evacuation line.

7.8 Cumulative Impacts

Menengai geothermal field has been developed as a geothermal park with multiple investors. OTTL's 35MW plant is one of three similar plants (the others by Globeleq Menengai Geothermal Limited and Sosian Energy, each 35 MW) planned in the caldera, all utilizing steam supplied by GDC's wells. Therefore, while each plant's impacts may be limited, the cumulative effect of all three (total ~105 MW) plus GDC's ongoing activities must be considered. Key cumulative aspects:

Cumulative Air Emissions: If all three power plants emit H_2S, the combined concentration could be higher than one alone. Air dispersion modelling was done for scenarios of one, two, and all three plants operating. The results show that even under a conservative scenario (each plant venting through a single large stack without gas reinjection), the combined H_2S levels at receptors remain within the WHO/IFC guideline of 150 µg/m³ (24-hr). There were slight exceedances noted of the more stringent Iceland 50 µg/m³ guideline in some spots in cumulative scenario, but Kenyan and WHO limits were not exceeded. Chronic exposure levels (e.g., OEHHA 10 µg/m³ guideline for odour nuisance) could be marginally exceeded at some points within the caldera with all plants, and indeed odour could be

noticeable at times. However, these levels are not harmful, only a potential nuisance. As a mitigation, all IPPs are adopting gas abatement to some degree, so actual emissions will be lower than that worst-case model. Additionally, the power plants are spaced apart in the field; dispersion will dilute combined plumes. **Conclusion:** cumulative H_2S emissions are **within acceptable standards (IFC/WHO)** and will be managed by each plant meeting its emission targets, effectively keeping the cumulative impact acceptable. If odour becomes a community concern, a joint task force (GDC + IPPs) might implement a **field-wide H_2S monitoring network** and potentially add further abatement at one or more plants if needed to reduce the odour footprint. But significant health impacts are not expected cumulatively.

Cumulative Water Use: GDC provides water for construction. During operation, water use by each 35MW plant (especially if wet cooling is used) could be substantial – roughly, a flash plant with wet cooling might consume a few hundred cubic meters of water per day. All three might then require perhaps 500–800m³/day. GDC has drilled water boreholes in the caldera tapping groundwater for this purpose. Currently, supply has been ample with no noted drawdown issues. **Cumulatively**, continued monitoring of these aquifers is needed to ensure sustainable use. If water levels begin dropping, users may need to reduce consumption or supplement. The project's measures to recycle water and harvest rain will contribute slightly to easing demand. But essentially, water impact remains local to the caldera's aquifer – a finite but so far adequate resource. All projects combined will stay within permitted abstraction volumes (set by WRA). If more water is needed, alternatives like piped water from NAWASCO (which is already used for some domestic supply) may be considered.

Cumulative Noise: Having three power plants and multiple well pads in one area means combined noise emissions. However, noise impact is highly localized; beyond a few hundred meters, plant noise dissipates. The nearest communities are on the crater rim, some distance away, so it's unlikely the noise from inside the caldera will significantly add up there. **Within the caldera**, workers or wildlife could experience additive noise from multiple plants if near them. Each plant is obligated to meet noise limits at the boundary; modelling including all plants shows compliance at receptors with some margin. There was a recommendation that equipment vendors for all plants guarantee optimized low-noise designs to minimize cumulative effect. All three IPPs are implementing noise control (enclosures, silencers). If two or three plants vent steam simultaneously (e.g., emergency or maintenance vents), that could produce a loud combined noise for a short time. Coordination in operations (via GDC's control of steam field) can reduce the chance of simultaneous loud events. **Residual cumulative noise** is not expected to exceed standards, but it will be monitored. As a precaution, if any one plant's noise is higher than expected, further mitigation could be required as it adds to others – but currently each is designed to be compliant on its own.

Cumulative Land and Visual: With multiple facilities, more of the caldera floor gets occupied or altered. There will also be a **132kV substation and lines** connecting the plants to the grid. KETRACO built a substation and transmission line for Menengai. Visually, three dispersed plants and steam plumes might have a larger footprint. There is a concern that if not planned well, the caldera could look industrialized. However, GDC and the IPPs have planned sites in a cluster and are using similar colour schemes, so the visual profile is unified. The **cumulative visual impact** needs a strategic approach: KFS and stakeholders have suggested a **holistic visual impact study** to address how all infrastructure (wells, pipes, plants) affects tourism and aesthetics. The idea would be to identify additional measures like planting tree screens around the caldera rim viewpoints or creating a visitor centre that explains the sight of steam plumes so tourists appreciate it rather than see it negatively. Since Menengai is not as famous as, say, Nakuru National Park, the tourism is niche; nonetheless, any tourism development will incorporate the geothermal landscape. The cumulative visual impact is moderate, but with cooperative management (all parties painting structures green, etc.), it's mitigated to an acceptable level.

Cumulative Ecology: Having more wells and plants means more noise, lights, and human presence across the caldera, which cumulatively could further discourage wildlife from residing in the area. Already, large fauna presence is low. It may effectively convert parts of the caldera into an industrial zone long-term, potentially displacing any more sensitive wildlife to surrounding areas (like Menengai Forest outside the immediate project zone). KWS and GDC will monitor any changes such as wildlife moving out or increased human-wildlife conflict at edges as animals may avoid the interior and roam perimeter. So far, given the low density to start with, **no significant cumulative biodiversity loss** is expected – most species present were common and mobile and can utilize other parts of the forest. The caldera rim and outer slopes remain relatively undisturbed, so those can serve as refuge. The three IPPs plus GDC could consider jointly supporting a **conservation program** (for example, habitat

restoration in another part of the forest reserve, or supporting KWS anti-poaching patrols) as a good practice offset for the overall development impact on the ecosystem.

Cumulative Socio-Economic: Multiple projects can bring cumulative social benefits – more jobs (three plants employ ~45 direct staff plus support services), more business for local suppliers, and potentially community projects from each. On the flip side, cumulative negative social impacts like labor influx were managed: at peak, the three constructions together had a larger workforce than one, but they were staggered in time to some extent. Now during operation, the presence of a geothermal industry in the area might attract more people looking for jobs (in-migration to Nakuru or nearby villages). This in-migration is not significant compared to city growth generally, but it's a point to watch – whether multiple projects strain local infrastructure (like housing, schools). With only ~45 direct jobs and some contractors, this is minor. The local county government is aware of Menengai's development and can plan for any needed services. Cumulative stakeholder engagement: the community sees not just one company but several and GDC. Coordination is done through the community liaison committee that GDC set up. All IPPs feed into that, so messages are consistent and grievances addressed collectively if needed. For example, if locals complained about dust during construction, all contractors of all projects were informed through GDC to manage the roads – a collaborative approach. This will continue.

In summary, the cumulative impacts have been assessed and found to be manageable with collaborative efforts. All three IPPs and GDC are bound by the same standards (IFC Performance Standards, EHS Guidelines) as required by the financing. Regular joint monitoring will be undertaken, especially for air and overall field management. According to the analysis, even when considering all plants together, impacts remain within IFC/WBG guidelines and Kenyan standards. Cumulative effects like odour are noted as a potential issue under certain conditions, but mitigation measures (gas re-injection, etc.) are expected to keep this to a minimum. The MENENGAI geothermal project, as a whole, demonstrates a successful case of multiple stakeholders co-existing with proper planning – providing clean power while minimizing negative impacts through shared infrastructure (steam field) and coordinated management.

One area of cumulative concern sometimes is induced seismicity (small earthquakes from mass extraction/reinjection). GDC monitors seismic activity in Menengai. So far, no significant induced quakes have been reported. Reinjection actually helps avoid subsidence and large seismic events. All operators will follow protocols to adjust injection rates if any unusual seismicity is detected.

Overall, no cumulative impact has been identified that would be unacceptable or unmitigable. Each impact domain has been evaluated and either remains below thresholds or is being addressed by combined efforts of the project proponents.

7.9 Climate Risk and vulnerability Assessment

From the onset, it is noteworthy that geothermal energy is a prioritized source of clean energy towards reduction of greenhouse gas emissions to combat climate change. In view of this, the proposed geothermal project shall not be considered as a contributor to climate change although its minimal significance shall be considered. Some Green House Gases specifically H_2S, CO2, and CH_4 shall be released from the geothermal power plant but in insignificant quantities. The construction and operation of the geothermal power plant can be negatively influenced by the climate change in a number of ways, potentially influencing the viability, efficiency, and safety of such projects. The direct impacts of climate change include water availability, which is manifested through drought, floods and water temperature. Climate change can increase the frequency and severity of droughts, which can affect the availability of water resources necessary for geothermal plants. Changes in water temperatures can affect the efficiency of geothermal plants, which often use water for cooling purposes. Increased frequency of extreme precipitation events can lead to flooding, which might affect the construction timeline and the safety of the infrastructure. More frequent and severe storms can affect the infrastructure and safety protocols, necessitating robust and resilient construction strategies. Temperature changes have also an effect on ground temperatures can therefore affect the efficiency of geothermal energy extraction. For instance, increasing ambient temperatures can decrease the efficiency of cooling systems used in geothermal plants.

In recent years, Kenya and in this case Nakuru County, has experienced seasons of depressed rains and heavy torrents. The depressed rains may not have any significant impact on the Geothermal project infrastructure. However, heavy torrents and deep percolation have the potential to affect the structural integrity of the power plants. Such heavy rains can lead to structural defects that can affect power

plants, cut off access roads to the geothermal power plant affecting transportation of material and workers hence affecting the supply chains and potentially increasing the cost and time required for construction. These heavy rains can also cause damage to water and steam utilities. Disruption of transportation networks, may also

Mitigation

To effectively assess these potential climate change impacts, up-to-date prior information on weather situation (proper forecasting) shall be required. This will be facilitated through GDC Meteorological Station and National weather updates from the Kenya Meteorological department. During construction of facilities, proper drainage systems shall be constructed to bar the facilities from effects of flooding. The is need for regular maintenance of the roads to cushion the project and local communities from transport disruption. To ensure Green House Gases emissions are maintained within permissible levels, regular monitoring and reporting shall be carried out to enable emission levels trend tracking.

8 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

8.1 Introduction

The Environmental Social Management Plan (ESMP) is developed to demonstrate how site-specific concerns and mitigation measures are managed through the detailed design, pre-construction, construction and post-construction / operation phase of the Project. It provides confidence on the part of project planners that a reliable scheme will be put in place to deal with any contingency that may arise during all phases of development, from preliminary study to abandonment.

Environmental management activities of the proposed Geothermal Power Plant Project will be governed by a series of regulations that impose standards and mitigation of environmental hazards. Thus, it is a planned and integrated program aimed at ensuring that both identified and unidentified impacts that may arise during the various phases of the project are brought to an acceptable level.

This Environmental Management Plan has the following specific long-term objectives:

- Ensure compliance with legislation and Company policy;
- Achieve, enhance and demonstrate sound environmental performance built around the principle of continuous improvement;
- Integrate environment fully into the business;
- Rationalise and streamline existing environmental activities to add value in efficiency and effectiveness;
- Encourage and achieve the highest performance and response from individual employees and contractors;
- Provide standards for overall planning, operation, audit and review;
- Enable management to establish environmental priorities;
- Be applicable throughout the organisation;
- Hold early consultations with communities and regulating authorities to ensure hitch free operations.

8.2 E&S Management Sub-plans

The following subsidiary sub-plans for shall be prepared by the Contractor of the proposed geothermal Power Plant as part of the Construction ESMP

i. Chemical Management Plan
ii. Waste Management Plan
iii. Labour Management Plan
iv. Traffic Management Plan
v. Guidelines of Times of Work and Safety and Health Behaviour
vi. Safety and Health procedures for visitors
vii. Biodiversity Monitoring and Management Plan

8.3 Framework for Implementation of the ESMP and capacity requirements

Implementation of the ESMP shall be a collaborative exercise depending on the nature of the risks/impacts as well as management structure of Caldera where the project is situated. Whereas it is the role of the Proponent as the project owner (OTTL) to ensure implementation of the ESMP, the plan shall be either escalated to Contractor (Kaishan) for implementation in the form of construction-ESMP during construction phase and also in the form of an Operations and Maintenance- ESMP during operations phase. The contractor shall be required to ensure all Sub-contractors engaged in the project are conversant with the ESMP and its implementation requirements and procedures. Depending on the nature of impacts, GDC and KFS shall also be involved if the effects of impacts emanating from the project site are beyond the project boundaries hence affecting the caldera ecosystem.

Implementation of the ESMP will require the project owner and/or the contractors and other stakeholders to have adequate capacity in the form of human resource skills and applicable equipment. The necessary human resource skills required include; EHS Monitoring, Environmental and Social risks identification, assessment, analysis and reporting, biodiversity management, Labour management, Occupational Safety and Health management including First Aid skills. EHS Monitoring skills required include Air and water quality and noise levels. ESMP implementation also necessitates establishment

and implementation of a Grievance Redress Mechanism for reporting of EHS incidents occurring beyond project boundaries. Details on HR capacity and skills required are provided in the EHS organization structure provided as an annex in this report.

Relevant equipment to compliment human resource capacity shall also be required. The equipment are provided in details in the EHS Management Equipment plan which is also provided as an Annex to this report. Different individuals and stakeholder institutions shall play specified roles towards effective implementation of the ESMP as described in the table below.

Table 8-1: ESMP Implementation Framework.

Entity	Core Responsibilities	Escalation / Reporting
OrPower Twenty-Two Ltd (OTTL) Management	▪ Approve & fund all ESMP deliverables, annual budgets and capex for EHS measures. ▪ Appoint and empower Project Manager & EHS Manager, set corporate E&S policy. ▪ Review & endorse Contractor's ESMS, audit reports and third-party review findings. ▪ Chair monthly E&S Management Committee (site-level), collate KPIs, non-conformances, corrective actions. ▪ Liaise with GDC on Caldera-level E&S issues, and with financiers (IFC) on E&S performance.	Reports to OTTL HQ ESG/EHS Steering Committee
Project Contractor	▪ Embed ESMP obligations in all sub-contracts; resource & retain a full-time EHS Manager onsite. ▪ Implement Construction ESMP: site inspections, Job Safety Analyses, PPE issuance. ▪ Deliver daily toolbox talks, weekly site audits & monthly E&S reports. ▪ Escalate all major incident investigations and corrective-action plans to OTTL site team within 24 hrs. ▪ Maintain up-to-date training matrix and competency records.	Reports to OTTL Site EHS Manager; escalates to OTTL HQ
GDC (Caldera-Level)	▪ Provide oversight of subsurface and forest-margin impacts (brine, H_2S, forestry). ▪ Share Caldera-wide monitoring data (air, water, biodiversity) monthly with OTTL & Contractor. ▪ Lead community liaison on forest issues, co-chair Caldera E&S Committee. ▪ Verify Contractor and OTTL compliance with lease and PFMP commitments. ▪ Escalate any wellfield or brine-hazard emergencies to Caldera E&S Management Committee.	Reports to Caldera-level E&S Management Committee
OTTL Site Manager	▪ Ensure plant boundary EHS compliance (stack emissions, wastewater reinjection operations). ▪ Implement Operational ESMP: periodic audits of air, noise, waste. ▪ Coordinate O&M team training, emergency drills. ▪ Log and close-out all grievances & health/safety incidents onsite.	Reports to OTTL Site EHS Manager; CC GDC EHS Department

	▪ Submit monthly operational E&S performance report to OTTL and GDC.	
Kenya Forest Service (KFS)	▪ Issue and enforce PFMP permits (grazing, beekeeping) and forest by-laws. ▪ Jointly monitor revegetation, invasive species removal with Contractor & GDC. ▪ Validate survival rates and technical guidance on restoration. ▪ Co-chair community patrol-training and fire-line exercises. ▪ Escalate any illegal harvesting or fire outbreaks into Caldera E&S forums.	Reports to National PFMP Secretariat
NEMA / EPRA	▪ Monitor legal compliance (EIA conditions, emissions permits) via quarterly site inspections. ▪ Review and approve all ESMP revisions and annual environmental audits. ▪ Enforce corrective actions for any non-compliances. ▪ Issue enforcement notices or fines for permit breaches. ▪ Verify closure of non-conformances in quarterly reports.	Reports to Ministry of Environment, Parliament
Nakuru County Government	▪ Support county-level public health & social services for project-impacted communities. ▪ Collaborate on housing, waste and water-service planning in host villages. ▪ Participate in grievance hearings alongside OTTL and GDC. ▪ Provide rapid response teams for any public safety incidents. ▪ Escalate unresolved community complaints to cabinet-level E&S committee.	Reports to County E&S Coordination Unit

8.4 Environmental and Social Management Plan during Construction Phase

During the implementation of the ESMP, OTTL has to take the top lead in implementing the ESMP within the project site (Power plant) whereas other institutions e.g. GDC has to take the top lead within the entire Caldera as applicable.

The table below gives a summary of the Environmental and Social Management Plans during construction phase of the project.

Table 8-2: Summary of the Environmental and Social Management Plans during Construction Phase

Environmental and Social Aspects	Recommended mitigation and/ or management measure	Location	Responsibility for implementation	Estimated Cost (KES)
Impact on flora	▪ Minimize clearing: clearly demarcate construction zones and restrict vegetation clearing to only what is necessary for structures and safety clearances. Mature trees outside the direct footprint will be left in place whenever possible; ▪ Protect sensitive species: If any sandalwood or other protected plant is encountered, mark and avoid it; brief construction crews on the importance of such species; ▪ Re-vegetation and Restoration: After construction, all disturbed areas (including temporary work areas, pipeline trenches, and road edges) will be replanted with native vegetation from the area. Indigenous plant species suitable for the local ecology (e.g. Acacia hockii, Protea gaguedi, Rhus spp., local grasses) will be used to help the habitat recover. Topsoil removed during excavation will be stored and reused in landscaping to encourage natural seedbank regeneration. ▪ Control of Invasive Species: Soil disturbance can lead to invasive weeds colonizing the area (species like *Lantana camara* and *Ricinus communis* are already common in the region). OTTL and the contractor will monitor for invasive seedlings and uproot them on sight to prevent their spread. Any fill or construction materials brought from outside will be inspected to avoid introducing new invasive plant propagules ▪ Community Awareness: The project, in liaison with Kenya Forest Service (KFS) and Kenya Wildlife Service (KWS), will engage local communities to discourage practices like charcoal burning or firewood harvesting in the surrounding forest (not caused by the project but a cumulative pressure).; ▪ Monitoring: KFS, GDC, and OTTL will jointly monitor vegetation recovery in rehabilitated areas, checking for successful re-growth and any invasive species over the months following construction;	Construction site Menengai Geothermal Field (Laydown area and access road)	Contractor OTTL GDC KFS	500,000

Impact on macro fauna	▪ Contractors will fence off or cover temporary open excavations and install escape ramps in trenches to prevent trapping of or injury to wild animals. ▪ Ensure rehabilitation of all temporary open excavations and trenches. ▪ All construction debris and wastes will be properly managed (no littering) to avoid attracting opportunistic scavengers that could in turn attract predators (snakes, raptors, etc.). ▪ Limit construction work to daylight hours (see noise mitigation) to preserve a quiet period at night for wildlife. Use directional lighting that illuminates work areas but not the broader forest (and use down-shielded, low-glare bulbs) to reduce disturbance to nocturnal animals and birds; ▪ Enforce a strict speed limit for project vehicles on all access roads. Within the caldera, speeds will be kept low (e.g. 20–30 km/h). This will reduce the risk of vehicle-wildlife collisions. ▪ Train workers not to harass or poach wildlife. Any sighting of large or dangerous wildlife (snakes, leopards, etc.) on site must be reported to the site manager and handled in coordination with KWS rather than workers taking action themselves; ▪ OTTL will collaborate with KWS and GDC's environmental team to monitor wildlife movements in and around the construction area. If evidence arises of animals being displaced into community areas, KWS can step up patrols or community awareness to mitigate human-wildlife conflict. If any particularly sensitive species are observed breeding or nesting near the site, construction in that area will be adjusted to avoid disturbance (e.g. establish a no-go buffer until the animals move on)	Construction site Menengai Geothermal Field (Laydown area and access road)	Contractor OTTL GDC GDC OTTL	100,000
Impact on Avifauna	▪ The project will avoid nighttime construction to the extent possible, thus minimizing use of bright lights when birds are most vulnerable. ▪ If night lighting is required for security, it will be downward-facing and shielded (no upward beams) to reduce skyglow. Lighting will be limited to the minimum area necessary ▪ Vegetation clearing will ideally be timed outside of peak bird nesting seasons to avoid destruction of active nests (if any are found, a buffer will be left and KWS consulted)	Construction site Menengai Geothermal Field (Laydown area,	Contractor OTTL GDC and KETRACO KWS	0

	▪ Speed limits on roads (as mentioned) also protect ground-dwelling birds like guineafowl or francolins from vehicle strikes.	Transmission line)	FOMEC	
Impact on Herpetofauna and invertebrates	▪ OTTL and GDC should liaise with KWS to capture any reptile encountered hiding under rocks and sheltered terrains such as Python sebae and safely release them in suitable alternative habitats; ▪ Limit movement of heavy earth machinery only to necessary areas within the plant site ▪ Vegetation clearing may in turn lead to increased run off, which may wash away important invertebrate groups;	Construction site Menengai Geothermal Field (Laydown area and access road)	Contractor OTTL GDC KFS	80,000
Landscape and visual intrusion impacts	▪ Limitation of vegetation clearance and earthworks to construction areas only Implementation of soil conservation measures; ▪ Re-vegetation in areas not meant for permanent works as soon as feasible; ▪ Paint structures within the project area with colours that will reduce visual impact. Neutral, non-reflective colours blend well with the surrounding landscape. ▪ Additional pipeline and plant's external surfaces colouring should be green or use appropriate colour; ▪ Lighting to be switched off when not required; ▪ Lighting of temporary working areas and site compounds during periods of darkness to be minimized where possible; ▪ Preparation of a landscaping plan for the entire project area. Planting plan to be comprised of 75% indigenous species and to be rid of any invasive species. ▪ Stripped topsoil to be preserved and used during landscaping; and ▪ All embankments to be vegetated or stone pitched to prevent soil erosion.	Construction site Menengai Geothermal Field (Laydown area and access road)	Contractor OTTL GDC	450,000
Soil erosion and Geology	▪ Conserve topsoil (stripping and stockpiling it for later use in reclamation),		Contractor	150,000

	▪ Install temporary drainage ditches, silt fences, or sediment traps to intercept runoff and capture sediments during construction.	Construction site	OTTL	
Impact on natural sources of construction materials	▪ There is no planned need for a quarry site however if needed then: ▪ Obtain appropriate authorization including from NEMA and Mines and Geology department to establish or use any proposed borrows pits and quarries will be obtained before commencing activities; ▪ Any new borrow pits and quarries shall be located more than 100 meters from watercourses in a position that will facilitate the prevention of storm-water runoff from the site from entering the watercourse; ▪ A 14 days' notice will be given to nearby communities on intention to excavate in the borrow pits or quarries; ▪ Borrow areas' rehabilitation plans will be prepared prior to use and approved by the local authorities; ▪ Storm-water and groundwater controls through appropriate drainage structures shall be implemented to prevent runoff entering streams and the slumping of soil from hillside above; ▪ The use of borrow pits or quarries for material spoil sites must be approved by the local authorities (and/or with the appropriate consent of the "landowner"). Where this occurs, the materials spoiled in the borrow pit shall be profiled to fit into the surrounding landscape covered with topsoil and re-vegetated.	Quarry site	Contractor	0

Impact on water resources	▪ The contractor will use water judiciously: e.g., use trigger-controlled nozzles for spraying, reuse water where possible (water used for washing equipment or curing concrete can be reused for dust control). Records of water usage will be kept to monitor consumption ▪ Leaks in pipes or tanks will be promptly repaired. Employee awareness campaigns will encourage water-saving habits (no unnecessary running taps, etc.). In addition, rainwater harvesting will be practiced where feasible (e.g., from roofs of site offices) to supplement water needs ▪ OTTL will ensure all water abstraction is done under valid permits and does not exceed sustainable yields; ▪ All grey and wash-down water will be contained for later removal by vacuum truck ▪ All sewage from toilets will be managed through septic tanks or removed off-site by licensed handlers so that no sewage contaminates soil or groundwater. ▪ Concrete wash water (which has high pH) will also be collected in lined pits or tanks and treated or removed, not allowed to runoff into soil ▪ Construction equipment maintenance will be done at a designated area with a bunded floor or drip trays to catch oil spills ▪ Fuel and chemicals on site (diesel, lubricants, paints) will be stored in a secure area with an impervious base and secondary containment (bunds) to prevent any leaks reaching soil or water ▪ Vehicles and machinery will be regularly inspected for fuel or oil leaks ▪ Temporary drainage will be installed to channel stormwater away from disturbed areas and to prevent flooding or erosion ▪ The workforce will be provided with adequate mobile toilets or septic systems.	Construction site Menengai Geothermal Field (Laydown area and the entire Caldera)	OTTL contractor Contractor OTTL GDC	100,000
Air quality and dust	▪ The contractor will regularly sprinkle on exposed loose surfaces, access roads, and construction tracks regularly, especially during dry weather. A water bowser (truck) will be dedicated to this task to minimize or avoid dust on the roads through Wanyororo and other populated areas whenever there is traffic.	Construction site	Contractor OTTL	450,000

	▪ All project vehicles will observe low speed limits on unpaved roads to minimize dust generation. ▪ Trucks transporting friable materials (like sand, cement, soil) will be covered with tarpaulins to prevent dust blowing off. Stockpiles of fine materials on site will be covered or kept damp ▪ All construction machinery and generators will be maintained in good in accordance with manufacturers specifications. ▪ Workers in high dust areas will be provided with appropriate PPE like dust masks or respirators. ▪ The project will conduct daily visual monitoring of dust levels, and if high dust is observed (e.g., obscuring vision beyond 50 m or causing complaints), additional suppression will be applied. In settled areas, community liaison officers will check in with residents about dust nuisance.			
Noise and Vibration	▪ Contractors will choose equipment models with noise suppression features where possible. ▪ All equipment will have functional exhaust mufflers/silencers to reduce engine noise. ▪ Any noisy equipment that shows a change in sound (indicating broken mufflers) will be removed for maintenance. ▪ Noisy activities will be limited to daytime hours ▪ All workers operating noisy machinery or in high noise zones will be provided with earplugs or earmuffs and required to wear them. This will protect against hearing damage ▪ Drivers will be instructed to not honk horns unnecessarily and to avoid revving engines			150,000
Solid waste	▪ Minimize Waste Generation – Order materials in appropriate quantities to avoid excess. Use reusable packaging where possible. ▪ Segregation and On-site Handling – At the construction yard, provide clearly labeled bins for different waste streams: wood, scrap metal, plastics, organic, etc ▪ Hazardous wastes (like oily rags, chemical solvents) will be separated and stored in secure, covered containers on an impermeable surface, to await proper disposal. These will be labeled and safety data sheets maintained	Construction site	Contractor OTTL	350,000

	▪ Reuse and Recycling – Where feasible, materials will be reused: e.g., formwork wood can be reused multiple times; cleared brush can be given to local communities for firewood where appropriate; scrap metal offcuts will be collected and sold to recyclers; excess excavated soil might be used for landscaping or given to local people for use (with NEMA approval if off-site) ▪ All wastes that cannot be reused on-site and domestic refuse will be transported off-site by NEMA-licensed waste handlers to approved disposal facilities. There will be no disposal or burial of waste on the project site (since it's a forest reserve) except as part of designed rehabilitation (e.g., using inert rocks to backfill quarries). ▪ Used oil and filters from machinery maintenance will be collected and sent to licensed oil recyclers or appropriate hazardous waste disposal sites. ▪ Workers will be instructed on waste segregation and discouraged from littering ▪ The site will have dedicated waste storage areas that are regularly cleaned ▪ Wastewater and sewage will be addressed through installation of septic tanks or holding tanks, with regular emptying by a licensed sewage exhauster. No site wastewater will be released into the environment untreated ▪ The Contractor will be required to keep a log of all waste types, quantities, and how they were disposed (with documentation from waste contractors.			
Labor influx	▪ Train volunteer peer educators from the workforce to provide ongoing safe-sex dialogue. ▪ Distribute condoms via discreet dispensers in common areas. ▪ Facilitate monthly voluntary counseling and testing (VCT) clinics in worker neighborhoods. ▪ Require every project staff member to sign and adhere to a Code of Conduct that prohibits harassment, assault, sexual relations with minors, and multiple concurrent partnerships. ▪ Organize biannual community sensitization forums in Nakuru, covering hygiene, sanitation, HIV/STI prevention, and vector-borne disease awareness.			100,000

	▪ Provide printed and poster-based informational materials in English and Swahili at lodging clusters and local health centers. ▪ Track key indicators monthly—condoms distributed, VCT participation rates, and any uptick in STI/HIV cases—and review trends with County Health; escalate awareness efforts if cases rise by more than 10% year over year. ▪ Capture all health-related complaints (e.g., dust-related coughing, suspected outbreaks) through the existing grievance mechanisms for rapid follow-up and resolution.			
Sexual Exploitation and Abuse (SEA) and Workplace Sexual Harassment (SH) and other forms of Gender-Based Violence (GBV)	▪ Ensure all site supervisors attend a mandatory “Power & Consent” briefing, reinforcing the CoC’s prohibition on abuse of authority and outlining immediate removal from duty for any violations. ▪ Include anonymous reporting channels in the GRM so that workers can safely report any SEA/SH incidents without fear of reprisal. ▪ Ensure every staff member signs the Code of Conduct before starting work; any breach—ranging from harassment to coercion—should trigger automatic disciplinary procedures up to contract termination. ▪ Hold quarterly alcohol-harm awareness sessions on site and in Nakuru lodgings, emphasizing how substance misuse can lead to CoC violations such as domestic abuse or workplace harassment. ▪ Sensitize all host-community villages to inform families that violence or exploitation by project workers is a punishable CoC offense and should be reported			400,000

Traffic and Road safety	▪ Develop and implement a contractor-prepared Traffic Management Plan (TMP), reviewed and approved by OTTL and GDC. ▪ Issue public notifications (barazas, notices), in advance to nearby villages detailing periods of heavy truck movements. ▪ Conduct road-safety briefings for teachers, students, and community members before haulage begins. ▪ Require all project drivers to complete defensive-driving training and sign the Code of Conduct mandating seat-belt use, adherence to posted speed limits, and zero alcohol tolerance. ▪ Install GPS trackers on all project vehicles and conduct random spot-checks to enforce speed limits; apply penalties or remove drivers for any violations. ▪ Use escort vehicles and flagmen for oversized loads; schedule these movements during off-peak hours to minimize interaction with local traffic. ▪ Coordinate with GDC and local authorities to repair and upgrade access roads and install clear signage at key points. ▪ Schedule bulk deliveries (e.g., turbine components) via rail to Nairobi when feasible, reducing long-haul trucking through villages. ▪ Maintain a traffic-incident log for any accidents or near-misses; review monthly and implement additional measures (speed bumps, revised schedules) if incident rates rise.	Construction site	GDC OTTL Contractor	100,000
Public Safety & Site Security	▪ Provide 24/7 security guards at all compound gates and active work areas to prevent unauthorized entry. ▪ Hoarding the entire construction footprint. ▪ Post durable “Danger–No Unauthorized Entry” signs in English, Swahili, and with clear pictograms at all fence lines and access points. ▪ Engage local herders through MCFA/KFS liaison to inform them of construction hazards and offer alternative grazing routes outside the plant zone. ▪ Secure all explosives, chemicals, and other hazardous materials in locked storage with strict inventory controls and daily checks. ▪ Conduct weekly fence-line patrols and inspections to identify and repair any breaches or damage.			600,000

	▪ Include public-safety scenarios (lost child, livestock straying, trespasser injury) in the Emergency Preparedness Plan, with clear response procedures. ▪ Implement the existing Grievance Redress Mechanism (GRM) to allow community members to report safety concerns; acknowledge every complaint within 48 hours. ▪ Provide a dedicated safety hotline number on all site-boundary signage and in local village noticeboards for immediate reporting of hazards			
Occupational and public health and safety	▪ Contractor must develop Construction Safety and Health Policy in compliance with OSHA, IFCs Environmental, Health and Safety Guidelines among other international best practices; ▪ The EPC Contractor must have a dedicated Health and Safety Officer/Manager on site at all times. This officer will conduct risk assessments, safety trainings, and daily toolbox talks ▪ All workers and subcontractors will receive a safety induction before starting work, covering site rules, PPE use, emergency procedures, and hazard awareness. Specialized training will be provided for high-risk jobs ▪ Regular safety meetings (daily briefings and monthly reviews) will reinforce key messages ▪ Appropriate PPE will be provided free of charge to all project personnel and its use will be mandatory ▪ Before starting new activities, the contractor will perform Job Safety Analyses (JSAs) or risk assessments to identify hazards and implement controls ▪ Permit-to-Work system will be enforced for particularly dangerous jobs: e.g. hot work (welding) permit, height work permit, confined space entry permit. Confined spaces (like tanks, vaults) will be tested for oxygen and toxic gases and proper ventilation arranged, in line with EHS guidelines for confined space entry. ▪ Ensure scaffolding is erected by competent persons and inspected. ▪ Employees must use full-body harnesses and lifelines for any work above 2 m where there is fall risk. Open edges will have guardrails. Ladder safety will be emphasized.	Construction site Menengai Geothermal Field (Laydown area and access road)	OTTL Contractor	500,000

	▪ All electrical installations will be done by licensed electricians and will meet safety standards (proper grounding, circuit breakers). ▪ A lockout-tagout (LOTO) procedure will be implemented for any energized system: equipment will be de-energized and locked out before maintenance. ▪ Crane and lifting operations will be planned by qualified rigging supervisors. ▪ All lifting gear will be certified and inspected. ▪ No one will be allowed under suspended loads. ▪ Spotters will guide vehicle movement on site. ▪ Machines will have reverse alarms. ▪ Regular maintenance of machinery (as mentioned) not only reduces emissions but prevents malfunctions that could cause injury. Any mobile plant shall be operated by licensed personnel. ▪ The site will have a traffic management plan internally too – with designated routes, speed limits, and separate pedestrian walkways. ▪ Banksmen will assist when trucks are reversing. ▪ An Emergency Response Plan (ERP) will be in place, covering likely scenarios such as personal injury accidents, well blowout or pipeline rupture, fire, chemical spill, or H_2S release ▪ Adequate drinking water, sanitation, rest breaks, and shelter will be provided to keep workers healthy and comfortable. Particular attention is given to prevent heat stress (Menengai can have strong sun): shaded rest areas and access to drinking water are ensured. ▪ An accident/incident register will be maintained to log all incidents, even near misses. Each will be investigated to find root causes and implement corrective actions.			
Contractor's camp	▪ Workers transport to and from site shall be incorporated in the contractor's traffic management plan with the aim of optimizing trips to and from site; ▪ No worker's camp is permitted in the caldera, however a worker's camp within the Nakuru County will require approvals and permits in compliance with County regulations.	Contractor's camp	Contractor OTTL	150,000

	▪ Any contractor's camp should have a comprehensive waste management and sanitation plan and facilities commensurate with population of workers and activities in the camps; ▪ Any storage tanks and equipment should have correct labels and Material Safety Data Sheets; Adequate Emergency Response Plan should be in place in the camps; ▪ The contractor should employ best practice management "housekeeping" (site cleanliness, waste disposal etc.) at all times; and ▪ The contractor's facilities should be completely removed from site after use and the land restored to its previous condition or better.			
Risk of wild fires	▪ Include an adequate fire buffer zone around the proposed power plant construction site. This could be open bare ground/un-vegetated areas and planting fire resistant trees e.g. Mexican green ash (Fraxinus sp) around the plant should be maintained throughout during the construction and the operation period; and ▪ Liaise with the Menengai KFS office to sensitize construction and operation staff on wildfires and train on emergency responses.	Construction site Menengai Geothermal Field	Contractor OTTL GDC KFS	200,000
Fuel and chemical spills	▪ Establish and implement procedures for spills management. ▪ Banding of oil chemical storage facilities. ▪ In case of spillage, isolate the source of oil spill and contain the spillage using sandbags, sawdust, absorbent material and/or other materials approved by NEMA; ensure that there is always a supply of absorbent material such as saw dust on site during construction, readily available to absorb/breakdown spill from machinery or oil storage; ▪ All vehicles and equipment should be kept in good working order, serviced regularly and stored in an area approved site by GDC and OTTL; ▪ Ensure that filling areas, Oil storage drums / products storage areas have a smooth impermeable (concrete or thick plastic covered in gravel) floor. The floor should be bunded and sloped towards a sump to contain any spillages of substances in accordance with The Kenya Bureau of Standards (KEBS) KS	Construction site	Contractor OTTL	300,000

	1969: 2006 The Petroleum Industry -The installation of underground storage tanks, pumps/dispensers and pipe work at service stations and consumer installations - Code of Practice.			
Chance encounter and interference with buried archaeological artefacts.	▪ Maintain contacts with an archaeologist from NMK during the earthworks, to be called upon for guidance in case of any chance find (Appendix VII); ▪ Implement the chance find procedure, as necessary.	Construction site	Contractor OTTL NMK	50,000
Total Estimated Construction-Phase ESMP Cost				**4,230,000**

8.5 Environmental and Social Management Plan during Operation Phase

During the implementation of the ESMP, OTTL has to take the lead in implementing the ESMP within the project site (Power plant) whereas GDC has to take the overall responsibility for all the geothermal development activities within the Caldera.

The table below gives a summary of the Environmental and Social Management Plans during operation phases of the project.

Table 8-3: Environmental and Social Management Plan during Operation Phase

Environmental and Social Aspects	Recommended mitigation and/ or management measure	Location	Responsibility for implementation	Cost
Impact on Biodiversity	▪ Any invasive weeds that sprout in the plant vicinity will be promptly removed to prevent spread. ▪ All hot effluent pipelines are in closed systems (insulated and often buried) so wildlife cannot contact them. ▪ To mitigate light pollution, use directional lighting with shields to prevent upward or horizontal glare. Lights will be turned off or dimmed where not needed. This protects nocturnal wildlife and preserves the night sky. ▪ OTTL, along with GDC and KWS, will continue wildlife monitoring in the caldera even into operation. If any unusual patterns are noted (like if operation of the plants seems to be causing notable wildlife displacement or increased human-wildlife conflict at the caldera periphery), adaptive management will be undertaken.	Power Plant Site Menengai Geothermal Field	OTTL GDC KFS	250,000
Operation solid wastes	▪ Use integrated solid waste management system i.e. source reduction; reuse; and recycling; ▪ Donate any recyclable materials to local community groups, institutions and individuals; ▪ Provide segregated waste respectable/bins within the plant premises and create awareness among staff on usage; ▪ Segregate any hazardous wastes (e.g. oil contaminated disused parts, disused lubricants etc.) in purpose-built and clearly labelled receptacles before final disposal from site; ▪ Dispose waste responsibly through a licensed waste handler for final disposal at designates sites; ▪ Domestic waste such as food waste be properly disposed and collected in lidded receptacles to prevent animals from scavenging and to improve general hygiene of the site; ▪ Ensure compliance with waste management regulations; ▪ Track waste handling from generation to final disposal in line with the waste management regulations.	Power Plant Site	OTTL	240,000

Environmental and Social Aspects	Recommended mitigation and/ or management measure	Location	Responsibility for implementation	Cost
Operation liquid wastes	▪ Domestic waste water and sewer from septic tanks should be disposed through NEMA- licensed exhaust service providers; ▪ Maintain a valid effluent discharge licence in accordance with NEMA requirements; ▪ Track waste handling from generation to final disposal in line with the EMCA waste management regulations.	Powerplant site	OTTL	300,000
Fire	▪ A fire protection system of fire water tanks, fire extinguishers, fire hydrants, hose reels, fire alarms and sprinklers has been incorporated in the design; ▪ Formulate a plant fire emergency response plan and liaise with GDC on integrating with the overall Menengai geothermal field emergency response plan; ▪ Ensure no smoking signage is put up in the necessary areas; ▪ Maintain a fire break (against wild fires) along the plant boundary; ▪ Train some staff to be fire marshals and ensure availability on site at any given time in line with OSHA requirements; ▪ Carry out regular (at least once annually) fire drills; ▪ Regularly inspect the installed firefighting equipment to ensure serviceability and maintain records. ▪ Undertake regular fire and safety audits in line with the OSHA requirements.	Power Plant Site	OTTL	100,000
Accidental Oil spill/Hazardous pollution	▪ Spill and drip trays used during servicing of machinery; ▪ Use septic tanks while ensuring doesn't flow to the surface; ▪ Response plans for accidental spills to be formulated and routinely tested; ▪ Bunded storage areas and secondary containment for oil and other chemicals; ▪ Use of an oil interceptor for surface drainage within the plant; ▪ Storage of fuel and other flammable materials shall comply with standard fire safety regulations; ▪ A secured compound shall be provided for storage tanks for chemicals and fuel. All chemicals and fuels shall be stored with manufacturer's instructions in mind as per the material safety data sheets; ▪ Storage areas or secondary containment shall be constructed of waterproof reinforced concrete or approved equivalent, which is not adversely affected by contact with chemicals captured within them; ▪ The minimum volume for secondary containment shall be 110% of the capacity of the largest tank system, plus 10% of the total capacity of all other separate tanks	Power Plant Site	OTTL Nakuru County Government	100,000

Environmental and Social Aspects	Recommended mitigation and/ or management measure	Location	Responsibility for implementation	Cost
	and containers within the bund wall with closed valves for controlled draining during rains; ▪ Pipe-work carrying product from the tank to facilities outside the containment shall be provided with secondary containment; ▪ Tank equipment such as dispensing hoses, valves, meters, pumps, and gauges shall be located within the containment or provided with own containment.			
Occupational safety and health	▪ Formulate a plant occupational safety and health management plan prior to commissioning. The plan as a minimum MUST have and require: ▪ Compliance with GDC Health, Safety and Environment policy; ▪ Compliance with OSHA, 2007; ▪ Continuous H_2S monitoring within the plant premises; ▪ Equipping employees with necessary Personal Protective Equipment (PPE) including personal H_2S monitors for workers in exposed environments; ▪ Regular and induction training, of members of the safety committee and new staff respectively on First Aid; ▪ Ensure the plant and office blocks have adequate supply of First Aid Kits; ▪ Location of appropriate safety and warring signs around the plant and within special locations for anticipated elevated levels of H_2S and noise; ▪ Inspections on conditions of machinery and equipment -Register the plant as a workplace with DOSH; ▪ Medical examination of all employees before, during and after termination of employment in line with the medical examination rules; ▪ Detailed emergency response plan; ▪ Provision and display of relevant emergency contacts; and ▪ Regular annual independent Occupational Health and Safety audits.	Power Plant Site	OTTL	500,000
Operations-Phase On-Site Occupancy	▪ Monitor water consumption. ▪ Install a lined septic tank with soak-away field > 50 m from any watercourse; engage a licensed hauler for biannual desludging. ▪ Provide covered, segregated bins for organic, recyclable and residual waste; arrange weekly collection by a licensed service. ▪ Enforce a daily cleaning schedule for all kitchens, bathrooms and common areas; supply hand-sanitizer stations at all entries.	Power Plant site	OTTL	500,000

Environmental and Social Aspects	Recommended mitigation and/ or management measure	Location	Responsibility for implementation	Cost
	▪ Restrict vendor and service-vehicle access to 08:00–17:00 via a single secured gate; require all vehicles to display ID and limit engine idling. ▪ Equip the compound with perimeter lighting, CCTV coverage and nightly security patrols trained in anti-harassment protocols. ▪ Cover or treat all water-holding structures monthly with larvicide and clear drains weekly to prevent mosquito breeding. ▪ Install LED lighting with motion sensors and consider solar water heaters; track generator run-hours to minimize emissions. ▪ Display the Project Code of Conduct and grievance contacts prominently; log any accommodation-related complaints for resolution within 48 hours.			
Operation Phase off site accommodation	▪ Monitor water consumption, install water saving apparatus like dual flush systems for toilets and install a Biodigester to promote reuse grey-water for landscaping; ▪ Provide covered, segregated bins for organic, recyclable and residual waste; arrange weekly collection by a licensed service; ▪ Restrict vendor and service-vehicle access to 08:00–17:00 via a single secured gate; require all vehicles to display ID and limit engine idling; ▪ Provide adequate security for the facility and prohibit unauthorized access; ▪ Install solar power within the facility.	External Housing site	OTTL	450,000
Impact on water resources	▪ Ensure design incorporate water efficient cooling system and installation water efficient fixtures for domestic application; ▪ Meter and monitor water use throughout the operation life.	Power Plant Site	OTTL, GDC	150,000

Environmental and Social Aspects	Recommended mitigation and/ or management measure	Location	Responsibility for implementation	Cost
High socio-economic interest by communities	▪ Develop and implement a community liaison strategy with proper communication and feedback mechanism. Any community social responsibility should be communicated through this strategy; ▪ Develop a clear and transparent employment policy for the local communities and ensure its fair implementation: and ▪ The expectation that many community members will be employed during the operation phase of the project needs to be managed. Community members should be informed of the limited employment opportunities. If at all possible, the project should notify community members of the number of jobs available, the skills required, employment period and the selection criteria of the project. In doing so community members would be well informed of the actual employment opportunities. This would reduce expectations and prevent disappointment thereby instilling community trust in the project. This is essential if the project is to maintain healthy and cooperative relationships with the communities.	Menengai Geothermal Field and the nearby communities	OTTL, GDC	1,100,000
Air quality	▪ OTTL should adopt the cooling tower technology and also incorporate H_2S safety systems for the plant as well as for the occupational hazard detection system. This will facilitate continuous monitoring and allow any further mitigation interventions where necessary. ▪ Installation of H_2S monitors and daily monitoring of H_2S with alarm system within the Plant boundaries ▪ Adopt collaborative (with GDC and other IPPs) air quality management plan incorporating: ▪ Installation of H_2S monitors and regular monitoring of H_2S within the caldera boundaries and at selected locations within the identified potential sensitive receptors; ▪ Liaison strategy for communication with communities who may be affected by odour nuisance. This should include disclosure of air quality monitoring results	Power plant Menengai Geothermal Field and All identified AQSRs	OTTL OTTL, GDC and other IPPs	500,000

Environmental and Social Aspects	Recommended mitigation and/ or management measure	Location	Responsibility for implementation	Cost
Cumulative Noise and Vibration impacts	▪ Require plant equipment vendors to guarantee optimized equipment design noise levels; ▪ Install acoustic attenuation devices on all ventilation outlet and high-pressure gas or liquid should not be ventilated directly to the atmosphere, but through an attenuation chamber or device; ▪ Ensure plant vibrating equipment are on vibration isolation mountings; ▪ Ensure all exposed staff have and use noise protection equipment e.g. ear plugs: ▪ Regularly monitor noise levels due to the plant and keep records; ▪ Regular servicing of machines deployed on site ▪ Liaise with GDC to extend the regular monitoring of noise levels within the caldera to selected locations within the nearby settlements; ▪ Develop a liaison strategy for communication with communities who may be affected by cumulative noise nuisance.	Power Plant Site	OTTL	200,000
Total Annual O-Phase ESMP Cost				**3,940,000**
Estimated O-Phase ESMP Cost for the 25-year period				**98,950,000**

8.6 Environmental and Social Management Plan during Decommissioning Phase

OTTL must prepare and submit a power plant decommissioning plan to NEMA for approval at least three months before decommissioning in line with NEMA license conditions. The plan shall include an update of all activities involved in the decommissioning process, identification of potential environmental, safety and health risks associated with the process and review of relevant standards applicable. Table 8-4 gives a summary of the preliminary Environmental and Social Management Plans during decommissioning phase of the project. The plan does not include decommissioning of wells which are assumed to be the responsibility of GDC. Key issues identified at this stage are:

- Occupational safety and health of demolition staff.
- Management of demolition wastes; and
- Rehabilitation of site biophysical environment.

Table 8-4: Summary of the Environmental and Social Management Plans during Decommissioning

Environmental and Social Aspects	Recommended mitigation and/ or management measure	Location	Responsibility for implementation	Cost
Occupational safety and health	▪ Make the site safe by ensuring all electrical connections and supplies are disconnected and any dangerous chemical stores are identified and made safe ▪ Comply to the OSHA; ▪ Provide for appropriate warning and informative signage; ▪ Any closed vessels, pipes and other areas which could have hazardous gases present would be vented in accordance with normal operating procedures. These would then be tested to ensure that they are safe for entry or removal; ▪ Provide for First Aid facilities for staff as per the OSHA, 2007; ▪ Monitor H_2S levels during demolition works; ▪ Maintain appropriate and serviceable firefighting equipment on site; ▪ Designate an emergency assembly point within the plant and create general awareness on use for all staff; ▪ Provide and clearly display emergency contacts; and ▪ Develop a detailed and demolition-specific Emergency Response Plan	Power Plant Site	OTTL KETRACO and KPLC OTTL and Contractor	1,350,000
Redundant plant equipment and recyclable wastes	▪ Careful removal and sale/recycling of usable plant and materials	Power Plant Site	OTTL	1,000,000
Non-recyclable demolition waste	▪ Ensure demolition wastes are segregated on site; ▪ Disposal of waste materials by appropriate methods in accordance with waste management regulations; ▪ Procure services of licensed waste handlers for safe disposal of both hazardous and non-hazardous wastes; and ▪ No burning of any wastes should be done on site.	Power Plant Site	OTTL	5,700,000
Re-instatement of biophysical environment	▪ Landscape of the power plant site with suitable mix of indigenous species. This should be done in liaison with the; and ▪ Ensure landscaped species are established prior to final close out of the site	Power Plant Site	OTTL and KFS	1,700,000

Environmental and Social Aspects	Recommended mitigation and/ or management measure	Location	Responsibility for implementation	Cost
▪ **Total Decommissioning Cost**				**9,750,000**

8.7 Environmental and Social Monitoring

8.7.1 Monitoring framework

The Environmental and Social Management Plan will be subject to monitoring. In general, monitoring will have two key elements:

- Routine monitoring against set standards or performance criteria; and
- Periodic review or evaluation. This will often focus on the effectiveness and impact of the programme or plan as a whole. In some cases, independent parties will undertake review and evaluation.

As a mechanism for public participation in monitoring, project monitors shall as part of their duties, provide an opportunity for the locals to be heard. The general public shall have an opportunity to speak freely about the project and any problems encountered as a result of its construction activities.

8.7.2 Monitoring Plan

The monitoring plan evaluates the effectiveness of the management and implementation of the mitigation measures associated with the projected environmental and social impacts.

The monitoring plan is complementary to the audits, inspections and reporting activities defined in the Section 8.2. framework for implementation of the ESMP.

The proposed monitoring plan is summarized in Table 8-5, Monitoring Plan. The table lists the related indicators, the items to be measured, the measurement frequency and the person/institution responsible and monitoring cost estimate.

Table 8-5: Monitoring Plan

Project Activity / Aspect	Means of Verification	Indicators	Institutional Responsibilities	Monitoring Responsibility	Frequency	Annual Cost (KES)
Impact on Flora (vegetation loss)	Visual inspection	• Records of cleared vs. rehabilitated areas• % soil cover• Absence of new erosion features	Contractor, OTTL	OTTL	Weekly (Const.) Quarterly (Oper.)	480,000
		• Abundance of key species	GDC, KFS	GDC/KFS	Quarterly (Oper.)	200,000
Impacts on Fauna	Site inspections & incident logs	• Inclusion of KWS/KFS in CoC & ERP • Wildlife encounter records	OTTL, Contractor	OTTL	Continuous	360,000
		• Abundance of wildlife species • Incident response logs	GDC, KWS	GDC/KWS	Quarterly (Oper.)	240,000
Dust & Air Emissions	Plan review & parameter measurements	• AQMP & H&S Plan active • PPE usage records • Dust suppression logs • Emission data (TSP, SO_2, H_2S) • Fuel use receipts • Community complaints	Contractor, OTTL, GDC, NEMA	Contractor / OTTL / GDC	Monthly	720,000

H_2S Monitoring	Air-quality monitor reports	• H_2S readings from handheld & auto loggers	OTTL	OTTL	2×/week (handheld)Continuous (logger)	600,000
CO_2 Monitoring	Annual monitoring report	• CO_2 measurements	OTTL	OTTL	Annually	100,000
Worker & Public Safety (Dust)	AQ & noise records, visual checks, TMP, GRM logs	• Dust & noise data • Traffic-plan compliance • Sensitization records • GRM entries	Contractor, OTTL	Contractor / OTTL	2× dry season	240,000
OHS	Safety records & inspections	• OHS management system active • Permits • Training logs • Incident stats • OSHA audit reports	Contractor, OTTL	Contractor / OTTL	Daily	1,200,000
	Maintenance records of fire appliances	• Quarterly service certificates from suppliers	OTTL	OTTL	Quarterly	160,000
Water Resources Conservation	Design & record review	• Design measures installed • Re-injection records • Metered usage • Water-quality logs	OTTL, GDC	OTTL	Monthly (Oper.)	360,000

Waste Management	Site observations & waste manifests	• Waste-minimization plan active • Housekeeping audits • Waste-handler approvals & manifests	OTTL, GDC	OTTL	Annual (Const. & Oper.)	300,000
Effluent Quality	Lab test reports	• Oil & grease • TSS, Cr, Cu, Fe, Zn levels	OTTL	OTTL	Quarterly	240,000
Hazardous Materials Storage	Spill-incident soil tests & visual checks	• Current MSDS on-site • Secondary containment audit • Soil contaminant levels	Contractor, OTTL	OTTL	Monthly audit / Daily check	360,000
Traffic Safety & Management	Visual checks & incident logs	• TMP approved & active • Accident register • Barriers & signage	Contractor, OTTL	Contractor / OTTL	Monthly	240,000
Public Awareness & Perceptions	SEP & GRM records, event reports	• SEP implementation logs • GRM entries • Event attendance lists	OTTL	OTTL	Monthly	180,000
Noise (Occupational & Ambient)	Noise meter logs & equipment logs	• Procurement specs enforced • PPE usage • Maintenance logs	Contractor, OTTL	Contractor / OTTL	Daily	480,000

Soil Erosion	Visual inspections & slope assessments	• Erosion markers • % revegetation cover • Sediment fan records	Contractor, OTTL	Contractor / OTTL	Weekly (Const.)	200,000
Solid & Hazardous Waste	Waste stream inventories & regular inspections	• Waste plan active • Disposal manifests	Contractor, OTTL	Contractor / OTTL	Continuous	300,000
Community & Stakeholder Engagement	SEP records & stakeholder feedback	• SEP milestones met • GRM usage • Feedback summaries	GDC, OTTL	GDC / OTTL	Monthly	200,000
HIV/AIDS & Public Health	Outreach & health campaign logs	• Service provider MOU • Session attendance • Materials distributed	OTTL, Contractor	OTTL	Monthly	240,000
Power Generation Performance	Plant SCADA & sales records	• Installed capacity • Annual generation vs. target	OTTL, KPLC	OTTL	Annually	– (internal)
Employment Opportunities	HR & labor returns	• Number of employees by gender/region • Code of Conduct compliance	OTTL, Contractors	OTTL	Monthly	– (internal)

9 CONCLUSION AND RECOMMENDATIONS

In general, the proposed project will result in appreciable benefits to the country power production in line with Kenyan Vision 2030, and create opportunities for both social and economic development.

The SUEIA has demonstrated that the overall impacts associated with the Geothermal Power Plant Project in Menengai can be managed within reasonable and acceptable limits by applying all identified mitigation measures contained in this report. There is no land take for the power plant. From both noise and air quality modelling outcomes, no adverse public health impacts are anticipated on the nearest sensitive receptors (settlements) relative to the adopted WHO and Kenyan standards. Further, the requisite conditions for most of the mitigations have been incorporated by OTTL on project design documents reviewed by the consultant.

The identified potential adverse impacts of the proposed project shall be eliminated or significantly minimized through the implementation of the recommended mitigation measures. The benefits that will be derived from the proposed power plant project are therefore much greater than the short-term environmental effect.

Public and stakeholders' consultations feedback to date revealed that the local communities have high socioeconomic interests and a lot of expectations with the geothermal power development activities going on within the Menengai caldera. It is recommended that OTTL, in liaison with GDC develop and implement a community liaison strategy with proper communication and feedback mechanism; and a clear and transparent employment policy for the local communities.

It is recommended that the proposed project be implemented in compliance with all the relevant legislation and planning requirements of Kenya at all times. In line with this, the proponent OTTL and the contractor (s) must take the legislative framework reviewed in this report into consideration, during and after the implementation of the project, as will be appropriate. Further, the following are recommended:

- OTTL management should establish an Environment, Safety and Health department with suitably qualified staff in the field of environment, social and occupational safety and health management. The department will work in liaison with GDC, OTTL contractors and relevant government lead agencies to ensure sound environmental and social performance;
- In liaison with GDC, ensure that community expectations are managed through well-structured stakeholders' engagement plan;
- Ensure compliance with NEMA approval conditions throughout the project phases;
- Ensure that the appointed contractor adopts the ESMP, formulate and implement all the management plans required by the ESMP;
- Ensure that monthly environmental health and social monitoring is carried out to comply with the monitoring plan; and
- Ensure statutory annual environmental as well as occupational safety and health audits are carried out annually throughout the project implementation and operation period.

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11 APPENDICES

Appendix I: Registration Certificates, Permits and Licenses

- Land lease document (GDC Land sub-lease to OTTL)
- NEMA ESIA License
- OTTL Certificates
- Certificate of incorporation
- Certificate of Change of Name
- EPRA/ERC Letter
- OTTL Business permits and Development Planning Approval.
- Nairobi County Business Permit
- Nakuru County Business Permit
- Nakuru County Planning Approvals
- OTTL Electricity Generation License
- GDC Geothermal License

Appendix II: Biodiversity Checklists

- List of Plants found in the Menengai forest
- List of Wildlife Species found in Menengai forest

Appendix III: Project site illustrations and updated schedule

- Project Site in the Menengai Geothermal Field
- Project Site Layout
- Updated Project Schedule

Appendix IV: Records of Public and stakeholder engagement done

- Minutes and Attendance sheets for the public meetings
- Filled Key Informant Interviews Questionnaires

Appendix V: Transmission Line ARAP Status

Appendix VI: Menengai Project Committee Terms of Reference

Appendix VII: Chance Find Procedures

Appendix VIII NMK Letter of no objection

Appendix IX: OSH Management Plan.

Appendix X: External Grievance Redress Mechanism

Appendix XI: Worker's Grievance Redress Mechanism

Appendix XII: Emergency Preparedness and Response Plan

Appendix XIII: Stakeholder Engagement Plan

Appendix XIV: EHS Policy Statement

Appendix XV: Air Quality Impact Assessment for the Proposed Kaishan Renewable Energy Development Geothermal Power Plant in Kenya

Appendix XVI: Noise Impact Assessment for the Proposed Kaishan Menengai Geothermal Power Plant in Kenya