



ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) STUDY REPORT

SUSWA GEOTHERMAL DEVELOPMENT PROJECT IN NAROK AND KAJIADO COUNTIES

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Research on Environment and Development Planning (REDPLAN) Consultants Ltd. is a registered firm of experts by the National Environment Management Authority (License No.1485) confirms that the contents of this report are a true representation of the Environmental and Social Impact Assessment (ESIA) study of the proposed Suswa Geothermal Development Project within the Central Rift Region.

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EXECUTIVE SUMMARY

The Ministry of Energy awarded Geothermal Development Company (GDC) (GDC) Ltd. a geothermal prospecting license covering a concession area surrounding Mount Suswa and its environs for Suswa Geothermal Development Project. The Government established, and continues to support and fund, GDC so as to manage the geothermal exploration risk and attract investors. GDC has the mandate to develop and implement a rigorous monitoring and evaluation framework for the Geothermal Development Plan of drilling an estimated 1,130 wells to provide steam for the planned 5,000MW to meet projected capacity by 2030. Suswa Geothermal Development Project is one of the series of these wells that GDC plans to implement. After the exploratory and appraisal wells, GDC will encourage public private partnership to do further production drilling through joint ventures.

Geographically, the prospecting area centres on Mount Suswa, lies within Kajiado and Narok Counties and is adjacent to Nakuru County. About 50 km from Nairobi, Mount Suswa comprises a 12 km diameter double caldera system, a vast network of obsidian caves and habitat to a variety of wild animals and plants. The surrounding area is an expansive plain of volcanic ash. The ultimate goal of this project is to develop geothermal power to generate electricity. The licence allows GDC to explore for geothermal energy, produce and convert steam to electricity and build a geothermal power plant. The electrical power output of the project will be sold to Kenya Power Company Limited (KPC) under a Power Purchase Agreement (PPA).

Activities that have been considered during the resource exploration and drilling phase are temporary and are conducted at a smaller scale than those during the construction, operations and maintenance, and decommissioning and site reclamation phases. However it is a requirement under EMCA (1999) that environmental and social impact considerations in order to conform to local and international standards of its execution. Based on this knowledge, Geothermal Development Company Ltd (GDC) contracted Research on Environment and Development Planning (REDPLAN) Consultants Limited, a Kenya environmental consultancy firm, to carry out an assessment of the potential environmental and social impacts of the proposed project. This ESIA will primarily cover the drilling of the first four exploration wells, the potential for the follow-on appraisal and production drilling plan should the project prove to be commercial.

The objectives of the environmental and social impact assessment were:

- To establish baseline environmental conditions involving surveys of geology and land, weather and noise conditions, ecology and socioeconomic conditions;

- To examine the effects that the drilling of wells and production will have on both the ecosystem and local development;
- To identify social and economic sectors of everyday life (education, markets and health issues and disease prevalence) which may be impacted by the project; and
- To collect views and opinions of local communities concerning the environmental effects during project construction and operation.

The ESIA Study, was conducted in accordance with the Legal requirement stipulated in the Environmental Management and Coordination Act (EMCA) of 1999 and its subsequent supplements; the Environmental (Impact Assessment and Audit) Regulation, 2003 (Rev. 2009); EMCA (Waste Management) Regulations, 2006 and EMCA (Water Quality) Regulations, 2006; EMCA (Controlled Substance) Regulations, 2007; EMCA (noise and excessive vibration, pollution) control regulations, 2009; EMCA (Emissions Control) Regulations, 2006; EMC (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit Sharing) Regulations, 2006; the Land Acts, the Water Act 2002 and the Irrigation Act among other pertinent legal and institutional frameworks regulating major development including the World Bank Environmental and Social Safeguard Policies. The World Bank safeguard policies taken into consideration during project impact evaluation are Operation Policy (OP)/Bank Procedure (BP) for Environmental Assessment (4.01); OP/BP for Natural Habitats (4.04); OP/BP for Forests (4.36); OP/BP for Pest Management (4.09); OP/BP for Indigenous People (4.10); OP/BP for Physical Cultural Resources (4.11); OP/BP for Involuntary Resettlement (4.12); ; OP/BP for Projects on International Water Ways (7.50), and OP/BP for Public Disclosure 17.50. The study team also followed requirements of other financing institutions subscribing to the Equator Principles.

Different methods were used to collect data including interviews with stakeholders (traders, Heads of Departments, NGO officials, etc), Household survey using questionnaires, Focus Group Discussions, Transect Walks and observations. The ESIA methodology adopted an endogenous approach to ensure that: (1) Suswa Geothermal Development Project documents were reviewed and lessons learnt from other geothermal projects were considered; (2) the views of all stakeholders have been considered; and (3) the potential adverse consequences have been considered and mitigation or compensatory mechanisms developed. A participatory process to ESIA study also ensured that the proposed measures to Environmental Management Plan (EMP) in the project area is derived endogenously, the assumption being that any proposed intervention would be appropriate to local cultural, social and institutional settings.

REDPLAN investigated the environmental and social impacts according to the approved Terms of Reference by National Environmental Management Authority (NEMA). The ESIA study provides a description of baseline environmental characteristics of the area, legislative and regulatory framework for geothermal development, summary of positive and negative impacts of the proposed project, consideration of taking on board local development interventions that the communities in the concession area expressed such as lack of access to drinking and livestock water, poor roads, social services (health, education and markets) and Environmental Management Plan (EMP) and Monitoring Plan.

The general conclusions regarding the ESIA of the Suswa Prospect Geothermal Drilling Project are:

- 1) The inhabitants welcome the Suswa Geothermal Development Project and perceive the proposed project as beneficial to different sectors of both the national as well as the local development through improved transportation and access to water, health and education, and improved agriculture, tourism and cottage industries. But the community requires government's commitment in the fulfilment of the proposed development.
- 2) Land is privately owned by individuals and about 106 households reside within the concession area. In addition there are 9 schools; 6 of which are Government owned and 3 are privately owned within the designated project area. Two schools and two homesteads are very close to the proposed locations of the wells. GDC will make every attempt to minimize any relocation during the exploratory phase of the project.
- 3) Geothermal exploratory drilling may generate negative environmental impacts for which mitigation measures have been suggested.
- 4) The socioeconomic studies include assessment of population growth and demography, education and health facilities, access to potable water supplies and the local economy. The main conclusion is that the benefits that are likely to accrue in the area as a result of the Suswa Geothermal Development Project tend to outweigh the negative impacts.
- 5) There are sufficient mitigation measures that are planned through the Environmental Management Plan (EMP) to commend the Suswa Geothermal Development Project.

Recommendations

(1) On compensation of affected land and homesteads:

In case there may be compensation of affected of land parcels, homesteads and public facilities: (a) the views of the relevant stakeholders will be considered; (b) there will be adequate negotiation about compensation; (c) the potential adverse consequences will be considered; and (d) that government's compensatory mechanisms will be adhered to.

(2) Enhancement of eco-tourism:

It is concluded that the improvements on infrastructure will enhance accessibility to the area. Based on the information available, the implementation of the project may be used to formulate an integrated ecotourism plan for Mount Suswa Conservancy Trust (MSCT) and Empaash Oloirienito Conservancy (EOC).

Kenya Wildlife Service (KWS), National Museums of Kenya (NMK), Mount Suswa Conservation Trust (MSCT), EOC and GDC should maintain a formal meeting structure to establish and develop an integrated ecotourism plan. KWS and NMK should provide the leadership. Basic park rules regarding welfare of animals and preservation of caves as cultural artifacts need to be established.

(3) Support to Community Initiatives

It is prudent to support vocational training and local libraries and develop instructional materials for use in schools for the development information on geothermal energy

(4) Environmental and social monitoring:

GDC has the responsibility of Environmental and Social Monitoring for the geothermal resources and the welfare of workers employed in the project and any other impacts resulting from geothermal development that may affect the health of the local inhabitants. Key areas to monitor will include:

- a) Economic and social development;
- b) Labour and Housing market;
- c) Local consumer product price, and
- d) Rate of social disruption such as use of drugs, alcoholism, mental health, etc

(5) On alternative action:

The development and use of the geothermal resource will increase in Kenya, and these sources will include the other geothermal sites that have been identified along the central and north rift. These other geothermal areas will also augment the national electricity requirements. In the event that this project is not implemented, the lost opportunity to generate power from the Mount Suswa and surrounding areas would represent a loss to Kenya's power infrastructure, economy and population. National reductions in fossil fuel use and improvements in energy efficiency would not occur and Kenya's Ministry of Energy's (MOE) ability to achieve its energy objectives under Vision 2030 would be impaired.

Many of the potential environmental and social impacts will be reduced by implementing good industry practices and restoring disturbed areas once drilling activities have been completed. Potential impacts from these activities are presented below.

A summary of impacts and mitigation measures of Suswa Geothermal Development Project are shown in the Table below.

Possible Impact	Mitigation measures
Vegetation and Habitat Loss	<ul style="list-style-type: none">• Minimise vegetation clearance by carrying out a thorough site planning.• Refill disturbed areas excavated during construction of access road and site preparation period.• Ensure minimum disruption of migration routes.• Rehabilitate affected sites with fast growing grasses e.g. star grass.• Employ selective bush clearing to ensure sapling regrowth.
Human-Wildlife conflicts	<ul style="list-style-type: none">• Strictly control clearance of vegetation and minimize areas taken by roads, building and asphalted surfaces.• Control and minimize disturbance of wildlife corridors.• Game/cattle proof fencing of water ponds to prevent access to geothermal brine.• Provide troughs for domestic animals and water holes for wildlife at reasonable distances from the drilling sites.• Monitor trends in the local biology and relate changes to project impacts.

<p>Solid waste management</p>	<ul style="list-style-type: none"> • Proper disposal of both waste water and oil spills through septic tanks at designated points away from the outer caldera zone where most of the drilling will be done. • Receptacles shall be provided for waste storage prior to collection. • Resource recovery will be encouraged once the project takes off so as to shrink waste stream and recover non-recyclables. • Refuse collection vehicles will be covered to prevent scatter by wind. • All persons involved in waste collection shall be in full protection attire.
<p>Air quality.</p>	<ul style="list-style-type: none"> • Provide appropriate warnings at work site. • Provide and clearly display emergency contacts. • Develop and implement detailed and site specific Emergency Response Plans. • Provision of adequate ventilation of occupied buildings to avoid accumulation of hydrogen sulphide gas. • Regularly maintain construction plant and machinery. • Sensitize construction workers on suppression of idling vehicles and machinery.
<p>Water pollution</p>	<ul style="list-style-type: none"> • Re-inject all brine and steam condensate into deep wells to avoid possible pollution of natural resources. • Fence off any brine ponds to prevent access by animals and humans.
<p>Water supply and Augmentation</p>	<ul style="list-style-type: none"> • Use brine or steam condensate from the first well for drilling. • Drill water boreholes. • Pipeline/Truck water from Kengen storage at Olkaria IV Domes area. • Promote roof water catchments and reduce competition for water • Increase water harvesting by providing more water storage facilities within and outside the project area. • Support community integration in water use management programme to avoid water use conflicts within the water source points by encouraging registration of community individuals in the existing WRUAs.

Dust Pollution from construction of road and rigs, quarrying and excavation	<ul style="list-style-type: none"> • Continuous road surface watering during the construction period to minimize dust generation and air pollution. • Suppress dust with water to reduce dust emissions where applicable. • Limit the speed of vehicles on dust access roads • Use of air dust filters to reduce air pollution.
Death of animals from road accidents	<ul style="list-style-type: none"> • Install and enforce speed limits for all project vehicles. • Put up appropriate road signs to notify motorists about pedestrian/animal crossings and the conditions of the road. • Take advantage of off peak hours to truck materials to the site. • Employ well trained and experienced drivers.
Fire hazard and fire outbreaks	<ul style="list-style-type: none"> • Put in place fire surveillance and early warning system to raise alarms during high fire hazard seasons. • Carry out fire drills regularly. • Provide First Aid kits.
Soil erosion	<ul style="list-style-type: none"> • Control earth works. • Compact loose soils. • Design roads with adequate drainage ways. • Plant trees along the steep Suswa caldera slopes to reduce gully development and soil erosion on the slopes. • Plant grass along the road side and pathways to reduce soil erosion.
Noise and Vibrations	<ul style="list-style-type: none"> • Maintain plant and machinery in good condition in accordance with manufacturer's specifications. • Where feasible, use of noise silencers in the machinery exhaust pipes to minimize noise generation and incorporate low-noise systems, such as ventilation systems, pumps, generators, compressors, and fans. • Prohibit movement of heavy vehicles after 6.30pm. • Sensitize workers on risks of exposure to excessive noise. • Monitoring noise levels against recommended threshold values.
Erosion of aesthetic, cultural, archaeological and/or spiritual value of places	<ul style="list-style-type: none"> • Observe sensitivity and, where applicable, support conservation of the Maasai cultural assets and shrines. • Training and career development for local, regional, territorial residents.

	<ul style="list-style-type: none"> • Cap and protect fumaroles selecting few that could be of touristic nature. • Safety awareness workshops for workers.
Insecurity	<ul style="list-style-type: none"> • Enhance security by providing more security patrols within the site areas. • All gates should be controlled by security personnel at all times.
Compensation of affected land parcels and properties	<ul style="list-style-type: none"> • Avoid, where feasible, and minimize relocation by exploring all measures to realign any structures within the Concession Area. • Where relocation or resettlement is unavoidable, plan for compensation adequately and through a transparent community consultation process.
Deforestation for fuel energy for project workers	<ul style="list-style-type: none"> • Ensure GDC workers do not use biomass energy and support use of alternative energy sources. • Encourage community tree planting for wood fuel.

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ACRONYMS

BGS	British Geological Society
CDM	Clean Development Mechanism
CERs	Certified Emissions Reductions
CITES	Convention on International Trade of Endangered Species
DTCD	Department of Technical Cooperation for Development
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EMCA	Environmental management and Coordination Act
EMP	Environmental Management Plan
EOC	Empaash Oloirienito Conservancy
EP	Equator Principles
ERC	Electricity Regulatory Commission
ESIA	Environmental and Social Impact Assessment
GDC	Geothermal Development Company
GHGs	Green House Gasses
GIS	Geographic Information System
GOK	Government of Kenya
IEA	International Energy Agency
IFC	International Finance Corporation
ILO	International Labour Organization
Kengen	Kenya Electricity Generating Company
KIA	Kenya Investment Authority
KPC	Kenya Power Company
KPLC	Kenya Power & Lighting Company (now Kenya Power)
KWS	Kenya Wildlife Service
KWSTI	Kenya Wildlife Service Training Institute
LDCs	Least development Countries
masl	metres above sea level
MOE	Ministry of Energy
MOU	Memorandum of Understanding
MSCT	Mount Suswa Conservancy Trust
MWe	Megawatts of electricity
NBWRUA	Naivasha Water Resources Users Association
NEMA	National Environment Management Authority
NGOs	Non-Governmental Organisations
NMK	National Museums of Kenya
PCR	Physical and Cultural Resources
PD	Programme Document
PDD	Project Design Document

PPA	Power Purchase agreement
ppm	parts per million
UNCCD	United Nations Convention on Combating Desertification
UNESCO	United Nations Educational Cultural and Scientific Organisation
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WHO	World Health Organization
WRMA	Water Resources management Authority
WRUA	Water Resources Users Association

**ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) STUDY
SUSWA PROSPECT GEOTHERMAL DRILLING PROJECT**

CHAPTER 1: BACKGROUND

1. Description of Proposed Suswa Prospect Geothermal Drilling Project

1.1 Site description

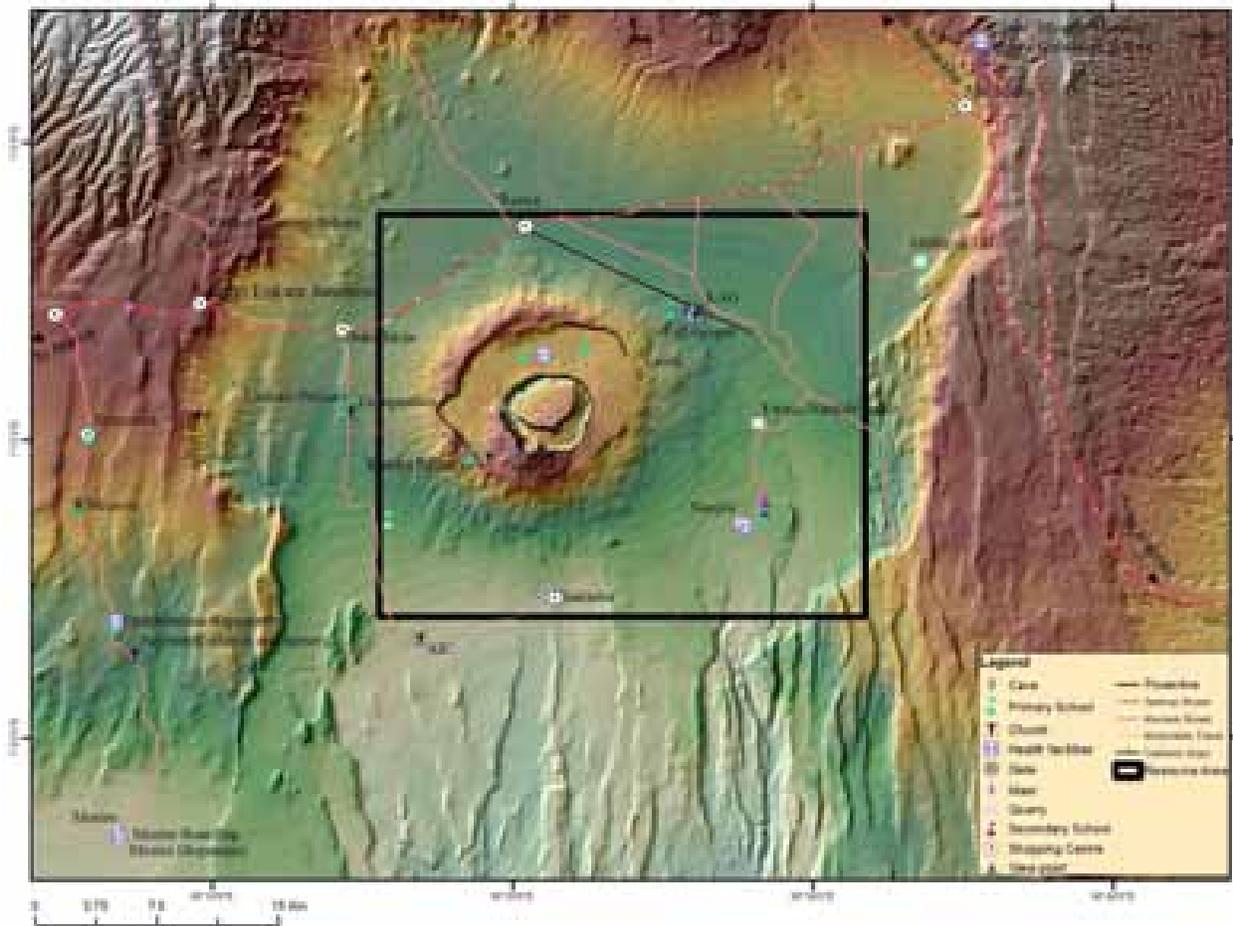
The project area is located in Mount Suswa and its calderas, which border the Narok North and Kajiado North districts in both Kajiado and Narok Counties. Mount Suswa is made up of two calderas; the inner (younger or smaller) caldera and the outer (older or major) caldera. The outer caldera measures about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

1.2 Project Purpose and Design

The Ministry of Energy, through the Energy Act 2006, is mandated to improve energy efficiency, reduce dependence on imported oil, decrease energy consumption, create and retain jobs, and promote renewable energy. The present project is therefore designed to:

- Reduce fossil fuel emissions;
- Reduce the total energy use of the eligible entities;
- Improve energy efficiency in the transportation, building, and other appropriate sectors; and
- Create and retain jobs.

Figure 1: Geothermal Development of the Suswa Area



From the perspective of the resource, a geothermal project can be divided into the following phases:

- Project definition and reconnaissance evaluation
- Detailed exploration
- Exploratory drilling and delineation
- Resource analysis and assessment of development potential
- Field development
- Steam production and resource management

GDC has carried out investigation of the project area and has considered its suitability for geothermal potential by converting geothermal steam to electric power. The current ESIA covers detailed exploration and exploratory drilling of four geothermal wells and appraisal drilling. If, after completion of exploratory and appraisal drilling, geothermal power production is found to be commercially viable, GDC or their agent will carry out drilling and testing of production wells, drilling of re-injection wells, steam field development and, construction and operation of a geothermal power plant.

Phase 3 will involve additional drilling and testing of more production wells, drilling of re-injection wells and, further development of the steam field and the power plant. Construction of power plant will undergo the following phases, in parallel with geothermal field development: bid tendering, design, manufacturing and delivery, construction, commissioning and operation. By the completion of phase 3, which will consist additional production and re-injection wells, the developed steam field and the power plant, is expected to generate up to 400 MW of electricity with much of it being channeled to the national electricity grid.

Although the exact coordinates of the four exploratory wells has been mapped, shown in Figure 2, it is believed that there is some flexibility to change the drilling sites that are too close to a homestead or near a school. Based on the conceptual model of the reservoir, the geothermal wells are expected to be about 2.1 to 2.5 km deep.

The energy sector in Kenya is composed of biomass, fossil fuels, electricity and other renewable energy as the major sources of energy. The commercial energy is dominated by wood fuel 68%, petroleum 22%, electricity 9% and others including coal and solar (1%). The energy sector generates its electrical power from hydro (56%), thermal oil (26%), geothermal (16%), co-generation (0.09%), and wind (0.01% and imports (0.2%).

1.3 Project Description

Suswa is about 80 km by road from the capital city of Nairobi. A 32 km length of a standard width¹ of 6.5m road will be used to access the project area. The main road is expected to branch from Mai Mahiu – Narok Road (B3) at a place called Mtaro, a distance of 12 km from Suswa shopping centre in the direction of Mai Mahiu. The road is expected to traverse the Akira plains to the Mt. Suswa Conservancy signpost covering a distance of 11 km. From the Suswa Conservancy Signpost, the road will cover a distance of 5 km to climb to the concession boundary and cover another 6 km to reach the rim of the outer - caldera. Thereafter, the road can traverse the outer caldera floor to serve the proposed well sites. The outer caldera has a diameter of 10 km; this being the longest straight distance the road can traverse across the outer caldera where most of the geothermal development activities are expected to take place. This is the basis of the estimation of 32 km as maximum total length of the main access road that the concessioner will build to reach the project area and anticipated geothermal power plant. Feeder roads will branch from this access road to well pads.

¹ In general, a "travel lane" is 3.5 to 4.5 m., so the narrowest requirements are 6.5 m. of pavement. The average car or pickup is 3-4.5 m. wide, and dump trucks and school buses are 5.0m (Pioneer Institute for Public Policy Research www.pioneerinstitute.org)

Based on the results from the Survey, Suswa geothermal prospect has a resource that warrants further exploratory. Drilling of four exploratory wells will help to determine if the area is capable of commercial geothermal power production. The target structure, expected to be at about 2100m depth must have good permeability and high temperature in order for a geothermal resource to be present. The exploratory wells are drilled continuously, 24 hours per day and one well is expected to take between 45 and 60 days to complete. The drilling of four exploratory wells should take about 6 months.

Four exploration wells have been proposed to be drilled during this first phase in the sites shown in Figure 2. Each well pad will occupy an area of about 50 m by 80 m. A water storage reservoir that measures 30.0 m (length), 10.0m (width), and 3.0 m (depth) will be used. The water storage will be designed to minimize space. Location of the proposed wells are Exploration well 1 (**SW-01**) Northings 9868534 Eastings 204196; Exploration well 2 (**SW-02**) Northings 9874476 Eastings 208591; Exploration well 3 (**SW-03**) Northings 9873804 Eastings 201954 and Exploration well 4 (**SW-04**) Northings 9877644 N Eastings 204168.

If these first exploration wells are successful, step-out/appraisal wells will be drilled to target fractures and other geological structures and to expand the productive area of the geothermal reservoir as shown in Figure 1.

The Government established, and continues to support and fund, GDC so as to manage the geothermal exploration risk and attract investors. GDC has the mandate to develop and implement a rigorous monitoring and evaluation framework for the Geothermal Development Plan of drilling an estimated 1,130 wells to provide steam for the planned 5,000MW to meet projected capacity by 2030. Suswa Geothermal Drilling project is one of the series of these wells that GDC plans to implement. GDC will carry out drilling works and accommodate a small team of about 25 workers in a temporary and portable living camp within the Project Site. The space occupied by the drilling works shall be minimized to avoid infringing on private property and any settled areas.

During the operational stage of the project, the workforce is expected to adopt a normal drilling work shift system of two shifts of 12 hours each. After completion of the first well and subsequent wells, well testing will take place to determine the steam production levels and thus the electricity rates that may be produced from the geothermal field. Results of the well surveys and tests may confirm the quantity and quality of the geothermal resource and together with results of the earlier investigations; a more defined conceptual model shall be developed. The resource analysis and assessment of development potential, field development and steam production and resource management will be undertaken after the confirmation of the exploitable size of the resource. After the exploratory and appraisal wells, GDC will encourage public private partnership to do further production drilling.

Table 1: GPS Points Positions and Coordinates

No	GPS Point Position	GPS Point Coordinates
1	Mt. Suswa Conservancy entrance gate.	S 01.09606°, E 036.43472°± 2m
2	New watering troughs just within where there used to be old Ol Gumi water tanks.	S 01.09908°, E 036.42192° ±3m.
3	Starting point to the outer crate on Mt Suswa which lies within the Kisharu location in Narok area.	S 01.11265°, E 036.40047°±3m
4	Water pan outside the crater, It's also known as Kisharu dam.	S. 01.12143°, E 036.40130°±3m
5	Entrance to Cave number 18 in Mt. Suswa	S 01.13208°, E 036.40472°±4m
6	Mt. Suswa conservancy entrance on Mai Maiu, Suswa road.	S 01.103182°, E 036.43843°±3m
7	Suswa Police post along the Mai Maiu, Suswa main road.	S 01.03182°, E 036.39569°±3m
8	Junction that connects to Ngong along the suswa Mai Mahiu road.	S 01.04696°, E 03639569°±3m
9	Suswa market/ shopping centre.	S 01.04761°, E 036.33510°±2m
10	Suswa Livestock market.	S 01.05595°, E 036.33554°±4m.
11	Suswa there is also a Women's market.	S 01.04867°, S 036.33470°±4m
12	Duka Moja along Suswa, Narok road near the old water pipeline.	S 01.10539°, E 036.25555°±4m
13	West of point A of the outer rim.	S 01.15530°, E 036.29328°±3m
14	Suswa conservancy west gate.	S 01.16923°, E 036.30321°±4m
15	Karuka Primary School in the western side of the conservancy.	S 01.17816°, E 036.31176°±3m
16	Inner crater of Mt. Suswa	S 01.14966°, E 036.32857°±2m
17	Modern fumerole for harvesting steam water in the Narok North.	S 01.12231°, S 036.43203°±3m
18	Narok North and Kajiado North boarder.	S 01.12010°, E 036.34203°±3m
19	New Kisharu Dispensary.	S 01.12134°, E 036.35207°±2m
20	Kisharu, Kenya Assemblies of God.	S 01.11860°, E 03636037°±2m.
21	Ponds and pans along the Mai Mahiu, Suswa road, just before you reach Suswa market.	S 01.04209°, S 036.34734°±2m
22	Ewaso River.	S 01.13297°, E 036.48801°±2m
23	Ewaso Kedong market.	S 01.14977°, E 036.50054°±4m.
24	Ewaso Kedong D.Os Offices	S 01.15373°, E 036.49826°±4m.
25	Ewaso Kedong Dispensary in Inkuishin Sub-location	S01.15298°, E 036.49982°±3m

Source: Field investigations

1.4 Project Strategy

There are five dimensions of the project strategy that are essential to ensure delivery of a successful geothermal project, and these include:

- Project Document - demonstrates how the project manager intends to deliver the project through a project scope, interfaces, programme, etc.
- Environmental and social Impact Assessment including risks and Safety - identifies environmental and social risks, consequences, and mitigation measures.
- Assurance and Value Improvement Component - provides assurance through project audits, compliance checks, project reviews, project assist, best quality assurance and quality control.
- Finance Component - spells out costs, schedules, economics, project financing, contingencies and risk analysis. It also addresses transparency issues to ensure sound project management and promote effective decision making.
- Deployment of the right people at the right place at the right time, throughout the project life cycle. It deals with access to experienced project professionals to aid the success of the project.
- Management of project team by instituting requirements such as sound leadership, correct values, attitudes and behaviors, effective organizational structure, appropriate resourcing, clear and complimentary votes and responsibilities.

1.5 Project Activities

The project will start at low key while the access road is being surveyed and construction starts. The expected number of workers for this exploratory drilling will be less than 50 personnel including security guards². Phase I project activities will include:

- a) Construction of access road to branch from Mai Mahiu – Narok road (B3) at 16km from Suswa Market Centre.
- b) Develop/survey a water supply from any of the alternative sources
- c) Fencing and securing of the drilling site
- d) Transportation of moving equipment
- e) Construction of drilling pads
- f) Construction of water storage facilities including dug pits and other temporary surface storage
- g) Clearing space for parking of drilling/service vehicles
- h) Construction of stores for drilling materials
- i) Construction of a drilling Camp site

² Assuming that geothermal development creates on average four professional jobs per MW in plant and infrastructure construction and 1.7 jobs per MW in operation and maintenance, based on findings from Olkaria (personal discussion)

- j) Drilling of exploratory and appraisal wells
- k) Labor transportation for construction
- l) Construction of a secured wastewater pond for drilling refuse
- m) Space for well testing equipment
- n) Provisions for workforce offices, meeting, storage and sanitation facilities

If viability of geothermal reservoir resource is established upon exploration and appraisal stage (in phase 1), Phase 2 project activities will include drilling of production wells, drilling of re-injection wells, steam field development and geothermal power plant development (construction of 50 MW Unit 1 of geothermal power plant by 2016). Phase 3 project activities will include drilling of more production and re-injection wells, further steam field development, and development of the power plant (construction of 350 MW Phase 2 of geothermal power plant by 2019).

Other activities that will be considered in Phase 2 include full design of the power station, storage and piping system. Piping especially shall be designed to minimize pipe lengths and reduce any negative impacts on flora and fauna, visibility and enhance benefits of the entire Mount Suswa natural resources.

1.6 Access Road Construction

Suswa is accessed via several existing earth tracks that branch off the Mai Mahiu - Narok (B3) paved road in the southerly direction. The tracks generally run in a southerly / south easterly direction to reach a crossing point with a signpost of Mt. Suswa Conservancy on the slope of the hill, from which there exists a single track up the hill.

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

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

With proper road design and appropriate drainage, this route has been selected as the most environmentally appropriate for development. The choice is based on distance (it is the shortest access road), cost of the road (the option is likely to be the least costly), physiographic characteristics (the access road runs mostly through Akira Ranch, a flat terrain with few or no human settlements and fewer bends along the route passage).

This is likely to reduce the construction cost of the road and visibility. The proposed access road route is located away from any market centers hereby reducing the possibility of accidents or any negative interaction between project vehicles and population centers such as dust pollution and reduced visibility.

1.7 Water Requirements for Drilling of Exploratory Wells

The most important need for water is drilling of geothermal wells. There will also be a need to supply water for project staff while working in the area. The project may, in the process of getting drilling water, supply water to local communities. There are 4 alternatives for supply of water. The water supply study to meet this requirement was based on the following philosophy:

- The eventual use of the selected option for drilling usage, power station development and domestic use for station staff.
- Allowing provision for community use as a social responsibility
- Sustainability of the selected option.
- Cost of the selected option.
- Preference not to disrupt current water used for community domestic purposes.

Several water supply options have been investigated.

Option 1 involves water delivery by tankers at a cost of US\$4,960,000. This assumes that tankers are used to bring the water required for the drilling of the first three wells. Subsequently, these wells are used to produce water for the drilling of all other wells.

Option 2 is an improvement of the existing DCK pipeline at a cost of US\$9,400,000. Further investigations are required to ascertain the length of the pipe sections that need replacing, although the cost assumes replacement and construction of the entire 55km pipe. The water permit requires that an EIA permit for the project be approved by NEMA. The application must also be commented on by Naivasha Basin Water Resources Users Association (NBWRUA) before it is approved by the WRMA.

Option 3 involves construction of boreholes at Mai Mahiu/Kijabe or Northwest of Suswa at a cost of US\$8,300,000. This option involves hydro-geological investigations to ascertain the availability of ground water and an EIA study and NEMA approval and eventual approval by WRMA. This has already been done by the project proponent.

Option 4 is the construction of pipeline from Kanywa Dam in Nyandarua District. Reports indicate that the dam has enough water to meet requirements for community water needs, drilling requirements and geothermal power plant development. Further studies are needed to verify capacity and water rights issues.

Potentially, the water source is suggested to come from three areas, namely, improvement of existing DCK pipeline, construction of a connection pipeline from Kanywa Dam and drilling/equipping additional borehole(s). Detailed costing has not been carried out, but the choices demonstrate confidence in the entire development of the area.

At this point in the project planning, water will be obtained from Olkaria Geothermal station with prior arrangements with KenGen. The costs of the pipeline options could be wholly borne by the GOK, as part of the wider provision of water supply for regional development and to enhance the standard of living of the people of Kenya. The reduced cost incurred by the Suswa Geothermal Project Development could be passed on to the people of Kenya through reduced power rates as per GDC's Suswa Development Philosophy as previously shared with Ministry of Energy (MOE) .

1.8 Delivery of Water to the Suswa drill site area

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

The average journey time between Naivasha and Suswa, including loading and offloading is 2 hours. That means each tanker can make four round trips in a single day. It is reasonable to calculate that a maximum of 15 tanker trucks will therefore be required to deliver 1,100m³ per day and support drilling of the first exploration well. It should be noted that any geothermal fluids produced during the drilling of the first exploration well may reduce the water requirement for the second and third exploration wells.

1.9 Staff Camp and Canteen

Depending on how the drilling and road crew staffing is arranged, the road works and drilling personnel as well as other key personnel may be able to stay at a portable site staff camp which would be deployed and installed with water, power and a canteen. Note that this facility may be deployed offsite, depending on final design discussions. The shop could be contracted to a private proprietor for a period of one year renewable. The canteen could sell food, drinks, on-the-counter drugs, and other essential commodities. The canteen should be located in such a way that it could also serve local people since there is currently no single such facility in the entire caldera area and residents have to travel to far distances to seek canteen services.

1.10 Security arrangements

The site is isolated and therefore proper security arrangements will be needed. Besides fencing the drilling site, where additional stores will be kept, the water storage tanks and other stores will need to be secured. The security will also cover regular police patrols to enhance the security of the workers in the - Suswa area.

1.11 Decommissioning Phase

GDC will complete initial drilling within 6 months. In the event that the steam reservoir is determined to be inadequate GDC will have to dismantle and restore the environment to its former state. Activities of decommissioning include:

- a) closure of steam field and power plant and demolition work,
- b) Dismantling of equipment and machinery;
- c) Site restitution;
- d) Construction materials and energy requirements;
- e) Solid waste management from dismantled materials;
- f) Liquid effluents;
- g) De-staffing and retrenchment of employees; and
- h) Transfer of concession back to concessioner.

1.12 Description of Project Alternatives

Suswa is one of the sites for geothermal power development that has been identified by the Government of Kenya. However geothermal power potential is widespread along the entire Rift Valley floor from Lake Turkana in the North to Lake Magadi on the Tanzania border. The demand for power is growing very fast as the country gears towards achieving the goals of Vision 2030. In order to facilitate the required expansion of the economy, recently the government established the Rural Electrification Authority

(REA) to ensure that electricity propels rural development, especially the *Jua Kali* industries. The geothermal power as a source of electricity is preferred (see Simiyu, 2010).

The other methods of energy production may be considered includes hydropower, thermal, wind and solar energy, biogas. Except for hydro whose potential is soon going to be exhausted, the other renewable energy sources are usually developed in small scale only.

CHAPTER 2: ESIA APPROACH AND METHODOLOGY

2.1 Introduction

REDPLAN was retained by GDC to carry out an Environmental and Socio-Economic Impact Assessment (ESIA) study before geothermal drilling and development of infrastructure for exploitation of geothermal energy to generate electricity for the national grid. The approved Terms of Reference is shown as Annex 2.

The objectives of the study are:

- To establish baseline conditions of the socioeconomic conditions;
- To establish baseline biological and biophysical conditions;
- To examine the effects that the drilling of the exploratory and appraisal wells, construction of roads, well pads and the geothermal power plants will have on the ecosystem and local development;
- To suggest mitigating measures and limitations to the negative impacts above;
- To identify the different sectors of everyday life which may be impacted positively by access to adequate safe water for households and livestock; infrastructure and access to services; and
- To engage the communities, create awareness and seek the local residents' views and opinions on the environmental effects during project construction and operation.

2.2 Approach and Methodology

The ESIA was carried out as an independent study. The purpose of environmental and social impact assessment (ESIA) is to identify, analyze, and communicate potential environmental and social impacts of planned projects to the concerned people and assist GDC to make rational decisions. The standard methods for ESIA were used in carrying out the Suswa Prospect Geothermal Drilling Project ESIA.

2.3 Public Consultations

Before the study, there were a series of public consultations with the affected people living in the three districts in a participatory approach. Three categories of persons were met: The Government officials including the Provincial Commissioner, County Commissioners, County Governors, District Leaders and Heads of departments and local opinion leaders. The local opinion leaders appointed two persons from each region to support the consultants during the fieldwork.

The public consultation was aimed at:

- i) Providing consistent accurate project related information to all stakeholders;
- ii) Listening and responding to stakeholders' views and concerns;
- iii) Identifying areas of inclusion in the ESIA process to ensure a smooth and efficient stakeholders approval process;
- iv) Discussing project risks and possible mitigation measures prior to the development of the project; and
- v) Receiving feedback from various stakeholders prior to submission of the approved document.

Public consultation under the ESIA regulations requires at least three separate consultation exercises during the preparation of the ESIA and there may also be a requirement for a public hearing after submission of the ESIA document. As noted, public consultation is also required during the CDM accreditation process, and could be undertaken at the same time as consultation about the environmental and social aspects of the project. However the CDM consultation is more narrowly focused and may have different timing so may occur separately.

Table 2 is a matrix of public participation techniques used to implement the public participation program for the Suswa ESIA study. List of participants for each meeting are shown in Annex 1.

Figure 3: Chief of Kisharu sub-location addressing the elders at the border point



Table 2: Public Participation Methods

Dates for the meetings/surveys	Public participation technique	Activity description
March 11 th – April 26 th	Kick off- public information meetings	Assessors held meetings with the Provincial Administration and other stakeholders at the PC's office in Nakuru to announce the planning process to the administrators and other stakeholders and to make a presentation covering the project purpose and general plan approach to conducting the ESIA. Participating were the Provincial Commissioner, District Commissioners of Kajiado North, Narok North, and Naivasha Districts as well as various stakeholders including local administration and community elders. A total of three such meetings were conducted- 1 in Nakuru and 2 at Mai Mahiu. The proponent and representative of the MOE attended these meetings which were organized with the support of local government administration.
May 21 st – May 27 th	Direct socio-economic surveys	A questionnaire was employed to capture socioeconomic information from communities living in the project area. This constituted of a survey to solicit comments, opinions, and community goals via a printed survey sent to residents within the project area. A total of 50 questionnaires were administered to household heads.
Ewuaso Kedong on the 23 th May. Suswa Market on 22 nd May	Public Meetings	Hearing was a public meeting for various stakeholders to explain the ESIA study and receive their observations and comments on the geothermal power development.
	Consultative meetings from Lead agencies (EMCA, 1999, Schedule 3)	Draft ESIA report to be presented to the regulatory agency, NEMA. NEMA through the District Environment Officers will receive comments on the ESIA draft report.

Figure 4: Consultation with the Local Elders and Leaders



2.4 Data Collection Techniques

Data was collected to determine the baseline and establish monitoring and evaluation including forecasting the impact of changes due to planned development. While it is recognized that there is difficulty in measuring change over a short period of time, it is necessary to build time series of data necessary for analyzing the influence of such a project on the population impacted by it. But perhaps the most difficult challenge was the confounding effect on factors external to the project. For instance, how does one isolate the effects that may be attributable to the actual residents in the neighbourhood from those that are not stakeholders?

Further consultations with the Ministry of Energy, Geothermal Development Company (GDC), and KENGEN were done to obtain an in-depth review of previous Environmental Impact Assessments (EIAs) carried out for the KENGEN as well as other relevant reports of projects done near the present site or geothermal exploration, drilling and development in the country. The Team obtained published geophysical, geologic, and socio-economic reports and topographic and thematic maps to inform the present study. Satellite images and aerial photos were obtained from the Survey of Kenya.

2.5 Observation Methods

The consultants took a one-day tour of the project site to familiarise with the area. Observation methods were employed to gather first hand data on a wide range of population behaviours, to capture a great variety of interactions, and to openly explore the political dynamics. By directly observing population activities in the market centres, the ESIA study team were able to develop a holistic perspective and an understanding of the context within which the population operates and hence how the prospect geothermal drilling project may fit into the socio-economic development of the area and of the local population. Observational methods also allowed the team to learn about things the population may be unaware of or those they were unwilling or unable to discuss in an interview or during Focus Group Discussions. Also, observation instruments such as cameras and GPS helped to capture population activities as well as the physical environment, which are useful to the ESIA study report.

2.6 Literature Reviews

There exists a wealth of a data and information regarding the environmental and social conditions in Suswa area which formed a useful foundation for the implementation of the ESIA study and essential for the proposed exploratory drilling exercise. Where documents did exist, the study team constructed maps, images and photos using data sources from agencies such as the KWS Offices in Naivasha, District headquarters of Narok North, Naivasha and Kajiado North, Survey of Kenya and Regional Centre for Mapping of Resources for Development (RCMRD), Water Resources Management Authority³ (WRMA), Water Resources Users Associations⁴ (WRUAs), and from KENGEN offices in Olkaria. Where they exist, spatial databases were found to be useful.

One of the main sources of data were the vegetation surveys which were used to determine vegetation types, estimate areas they occupy (whether endemic), identify plant species present, and map the locations where the vegetation types occur. Although the field work was done during the wet season (between April and June), the results compares well with previous studies⁵.

Fauna surveys were used to identify wild animal species present in the Suswa area, obtain information on the animals especially whether there may be rare and endangered species, and assess and predict possible impacts of the project on the wild animals. Large wild animal surveys were used to locate and where possible count

³ WRMA provided water resources development plans.

⁴ The Naivasha Water Resources Users' Association chairman and other officials were extremely helpful in identifying water supply sources.

⁵ Kenya Power Company (1993). Draft Report on Surface Investigations of Suswa Geothermal Prospect, July 19

the animals. The survey was also used to identify important habitats where large animals could be found almost on a daily basis.

2.7 Focus Group Discussions

Focus Group Discussions (FGDs) complemented questionnaire for primary data collection. FGDs were particularly useful for their ability to exploit group dynamics to procure rich information. The FGD study targeted groups and sections of the public, such as at Suswa market centre and Ewaso Kedong, where group dynamics helped in procuring better data than other methods of data collection. The main point is that discussions had a tendency to bringing out insights and understandings in ways which simple questionnaire items may not be able to tap. Also, FGDs tapped emotional and unconscious motivations not amenable to methods such as questionnaires and interviews. More FGD's well held in the respective district Headquarters to collect views on the respective departmental government line ministries.

Figure 5: Focus group interview with community leaders at Ewaso market centre



Most of the participants of the FGDs were able to express themselves in either Kiswahili or English. However use of any language was acceptable because the enumerators spoke local dialects.

Figure 6: Focus group discussion with Community Elders from Kajiado North district on the eastern rim of the outer crater



2.8 Questionnaire

The survey used questionnaires to provide a baseline database to the best of detail, coverage and quality. The study used four different types of questionnaires to cover households, household diaries, market prices and community questionnaires. The questionnaire targeted residents around the geothermal concession area, and Kenya government officials drawn from relevant ministries and government energy agencies, NGOs, local communities, CBO's, opinion leaders, faith-based organisations, human rights groups, and development organizations that have an interest in the Suswa area.

Of particular interest was the socioeconomic survey of all the households in the prospect drilling area because these are the ones directly affected by the project. A comprehensive questionnaire (Annex 1) for data collection was developed, whereby it captured the following information: household bio data, livelihoods, infrastructure inventories including road network, water, schools and health facilities, houses, commercial properties and social services infrastructure. There were no well-defined stakeholders groups.

The important factors which were considered in identifying the range of perceptions included:

- Gender
- Age group

- Socio economic levels
- Occupation
- Location
- Clan
- Land ownership

The team prepared an analysis of survey results and studies to establish redress mechanism and resettlement parameters, to design appropriate income restoration.

2.9 Interviews

Interviews were carried out to acquire information from local people on socioeconomics and local concerns about the prospect geothermal drilling project. One-to-one interviews were considered suitable for senior officials from GDC, government and NGOs. Interview format was flexible and designed to suit various personalities.

2.10 Data Analysis

An Inventory was used to show the assets at the household level, enterprise and community level. These indicators will help in identifying the linkages between present socio-economics and achievements of the desired goals. The economic parameters considered in this study were:

- i) Percentage of people living below poverty line;
- ii) Life expectancy;
- iii) Infants mortality and percentage mortality of children below 5 years of age;
- iv) Education levels (primary, secondary, tertiary or within a given bracket);
- v) Mortality rates;
- vi) Enrolment rates in different levels of education;
- vii) People who have access to water and basic sanitation services;
- viii) Population lacking functional literacy skills;
- ix) Inequalities in maternal and child health;
- x) Long-term unemployment; and
- xi) Communication infrastructure.

2.11 Impact Identification, Impact Significance and Mitigation Measures

Various methods and techniques of data analysis have been employed in the present study. Thematic maps that identified features as population settlement, infrastructure, soil composition, natural vegetation areas, water resources and land use pattern. Exploratory data analysis was done using tables and graphs to present and visualize data.

Spatial data analyzes were done using Geographic Information Systems (GIS) which also supported GIS map production.

In order to evaluate the significance of predicted impacts, a set of criteria adopted from the NEMA Regulations, World Bank and Equator Principles Criteria of World Health Standards are applied: emissions-based criteria which comprise standards for air and water quality, and noise; and environmental quality based criteria, which comprise significance criteria for valued ecosystem components or similar attributes. Because of paucity of data, reference points to evaluate impact significance were:

- Environmental standards established by EMCA 1999 in Kenya and at international level (including the World Bank Group);
- Level of public concern; and
- Scientific and professional evidence for loss/disruption of valued resource stocks and ecological functions; negative impact on social values, quality of life and livelihood; and foreclosure of land and resource use opportunities.

Environmental standards, objectives and targets used to evaluate impact significance are prescribed in law and regulations such as limits on waste/emission discharges and/or concentrations; ambient air and water quality standards; environmental objectives and targets contained in policy and strategy; and approved or statutory plans that protect areas, allocate, zone, or regulate the use of land and natural resources. The criteria used to evaluate whether or not adverse impacts are significant:

- Environmental loss and deterioration;
- Social impacts resulting directly or indirectly from environmental change;
- Non-conformity with environmental standards, objectives and guidelines;
- Likelihood and acceptability of risk;
- Reductions in species diversity;
- Depletion or fragmentation on plant and animal habitat;
- Loss of threatened, rare or endangered species⁶;
- Impairment of ecological integrity, resilience or health e.g. disruption of food chains; decline in species population; alterations in predator prey relationships.
- Threats to human health and safety e.g. from release of persistent and/or toxic chemicals;
- Decline in commercially valuable or locally important species or resources e.g. forests and farmland;
- Loss of areas or environmental components that have cultural, recreational or aesthetic value;
- Displacement of people⁷;

⁶ The large-eared free-tailed Bat/Giant Mastiff Bat called *Otomops martiensseni*

⁷ For example relocation of a school and a couple of homesteads

- Disruption of communities by influx of a workforce, e.g. during project construction;
- Pressures on services, transportation, and infrastructure.

GIS was used to produce overlays that identify, predict, assign relative significance to, and communicate impacts in a given geographical reference frame. The data presentation has been done in the form of suitable maps, matrices and in dedicated annexes. Checklists of environmental impact indicators were designed to stimulate the impact assessors to think broadly about possible consequences of contemplated project actions. These checklists were completed during the familiarisation tour in the project area. Assessors were asked to consider any other factors that were not on the checklist in order to avoid ignoring some important environmental and social aspects if they were not on the checklist. The checklist is attached as Annex 3. The assessors employed matrices to relate a list of project actions and a list of impact indicators as a way of identifying cause-and-effect relationships while Flow Diagrams (Figure 1) have been used to show connections between a particular development action and the potential resulting environmental or social impact. By linking development action and potential impacts, impacts analysts were able to identify action-effect-impact relationships and hence visualize the connection between action and impact. Figure 2 below demonstrates the entire ESIA process.

Each of these factors was used to support decisions on significance, geographical coverage and short term/long term impacts of any of the elements.

The environmental and social impacts were categorised as short term (ST) implying that the impacts were limited to a short duration or to a specific phase of the project. The long term (LT) meant that the impact would persist beyond any single phase while reversible (R) impact is one in which there will be management control and reverse of the impact if it occurs. An Irreversible Impact (IR) is one that will not be controlled but the impact may be managed or mitigated. Local (L) impact is one that is limited in geographical scale while Wide (W) or widespread impact is one that covers a large geographical area. Additionally the team considered Significant Impact (SI) as one that would impact under unusual conditions while Normal (N) represents those that are not significant.

The focus of environmental mitigation is to eliminate, offset, or reduce the resulting adverse environmental impacts of a project to the acceptable levels. In addition, there are strong indications that may be borrowed from analogous development and decisions that have been made in Olkaria and other similar situations. While it is true that the Suswa development is similar to other geothermal developments in Olkaria,

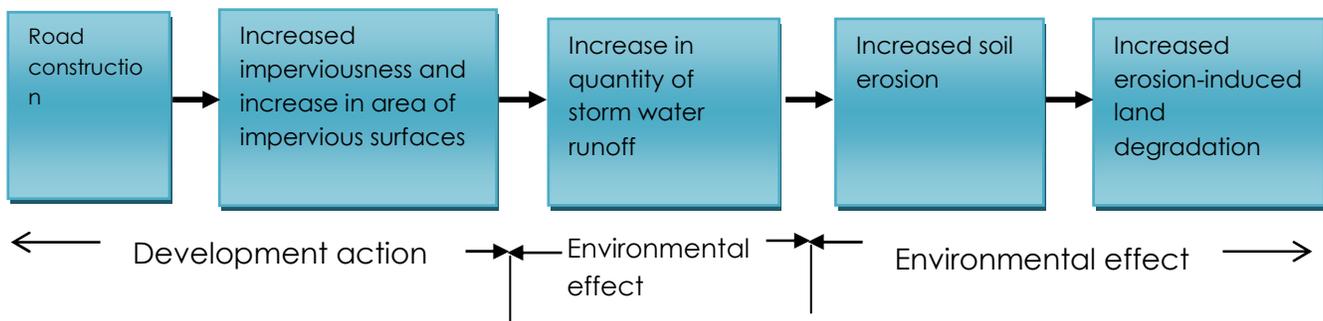
Menengai and Eburru, the present assessment has introduced objective tools for decision-making. The objectives of mitigation are to:

- Find better alternatives and ways of doing things;
- Enhance the environmental and social benefits of a project;
- Avoid, minimize or remedy adverse impacts; and
- Ensure that residual adverse impacts are kept within acceptable levels.

It is important that these mitigation measures are implemented and monitored in an orderly manner. This involves Environmental Management Plan (EMP) the objectives of which are to:

- Ensure that mitigation measures are implemented;
- Establish systems and procedures for implementation;
- Monitor the effectiveness of mitigation measures; and
- Take any necessary action when unforeseen impacts occur.

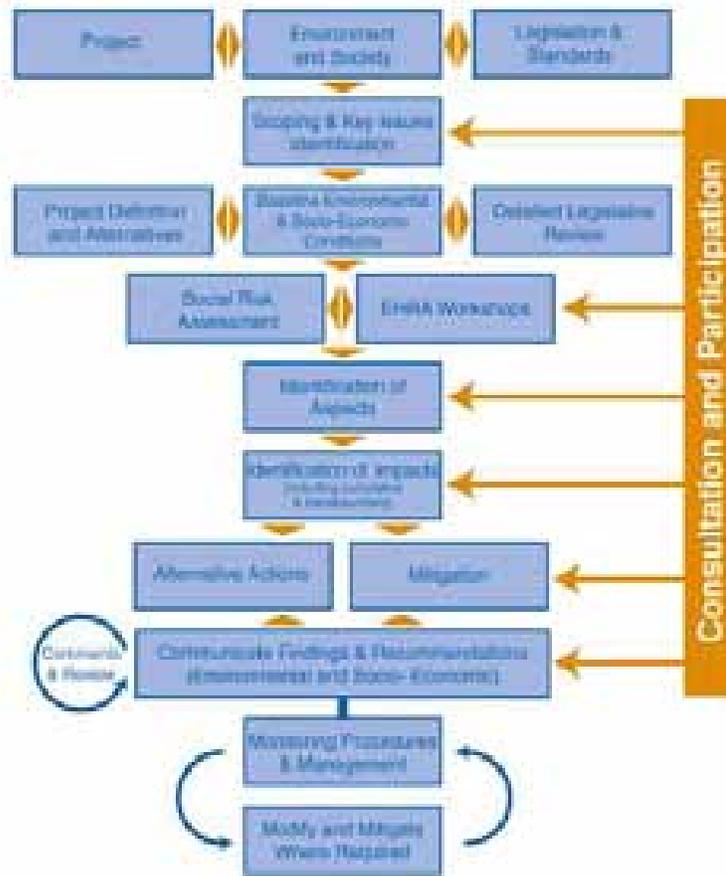
Figure 7: Flow diagram showing Potential Impacts of Road Construction



Elements of mitigation are organized into a hierarchy of actions:

- Avoid adverse impacts as far as possible by use of preventive measures;
- Minimize or reduce adverse impacts to 'as low as practicable' levels; and
- Remedy or compensate for adverse residual impacts, which are unavoidable and cannot be reduced further.

Figure 8: ESIA Process



Source: Environmental and Social Impact Assessment Methodology, November 2002

By applying a flow diagram, it is much easier to more clearly visualize the sequence of events that lead to soil and land degradation as a result of road construction. We can then interpret the diagram in the context of local terrain and slope so that we can attach significance on potential environmental impact. Assessors based all impact predictions on conceptual models of how the universe functions as well as experiences from similar projects undertaken elsewhere. Scientific methods were used to obtain useful predictions, particularly for impacts of the proposed project on the biogeophysical aspects. For example, given the dominant wind direction within the project area together with topography, it is possible to estimate direction of most of the air pollution and possible receptors of air pollution. Assessors also used ranking scales to indicate whether there will be degradation, no change, or enhancement of environmental quality.

2.12 Challenges of the Present Approach and Methodology

Environment and Social Impact Assessment (ESIA) is the systematic analysis used during project preparation to identify and evaluate the potential environmental and socio-economic and cultural impacts of the proposed Suswa Prospect Geothermal Drilling Power development on the lives and circumstances of people, their families and their communities. If such potential impacts are significant and adverse, ESIA can assist the developer, and other entities to the Environmental Impact Assessment (EIA) process, find ways to reduce, remove or prevent these impacts from happening. ESIA therefore recognizes the importance of relationships between people, culture, economic activities and the biophysical environment.

While tending to focus on the avoidance of adverse impacts, ESIA also provides a forum for planning how to maximize the beneficial impacts of a proposed development. Beneficial impacts can include a better standard of living due to increased access to employment, business opportunities, training and education, greater access to and from a community and increased funding to improve social infrastructure and cultural maintenance programs. This ESIA study report therefore specifies how the adverse impacts identified in the study will be mitigated and beneficial impacts enhanced.

The survey team, with involvement of the Local Administration and opinion leaders in the project area, selected people who represent different perceptions and viewpoints. These people were selected because they understood the complex local conditions, and particularly issues relating to the cultural and socio economic aspects and the consequent impact of development of the proposed Suswa Prospect Geothermal Drilling Power project. By crosschecking information from the different interviewees, it became clear that representative views of the target community, their leaders and the stakeholders were converging.

2.13 Quality Assurance

Our field supervisors and research assistants were recruited and trained to the best standards possible to conduct the study. Social Impact assessment (SIA) is therefore meant to be part of the adaptive management of policies governing the Prospect geothermal drilling power project and to assist communities to cope with change resulting from the project. SIA has common elements, including participation of stakeholders, consideration of alternatives, establishing baseline conditions, scoping important issues, predicting likely impacts (including indirect, multiple order and cumulative impacts), predicting community response to impacts, redesign of alternatives, development of mitigation strategies, implementation of monitoring

schemes, and follow-up evaluation. SIA implying an endogenous ongoing participatory process focused on bringing about improved sustainable livelihoods, we expect the Community leaders to follow up on the issues suggested in the present study with the relevant authorities.

The ESIA has been carried out according to the known government policies, legislations and regulatory provisions and in compliance with the World Bank Safeguard policies and the Equator Principles.

CHAPTER 3: POLICY AND LEGISLATIVE FRAMEWORK

3.1 Guiding Principles of this ESIA

The guiding principles of the present ESIA are that:

- 1) The present Suswa Prospect geothermal drilling power development needs to enhance the standard of living of the local inhabitants, the districts and for the general economy of the entire country;
- 2) Consultations with key stakeholders must be completed in order to clarify the rights, obligations and interests *a priori*;
- 3) There will be minimum relocation, or purchase of any land, and where this will be necessary the government will follow its policies and laws relating to acquisition of land, relocation and resettlement;
- 4) Strengthening of partnerships between the government of Kenya, the company and the local community;
- 5) Establishing a sound baseline in order to build a strong monitoring as well as environmental and social impact regime following the development; and
- 6) Establish an independent monitoring and grievance procedures by the government and the company.

3.2 National Policy framework

3.2.1 Vision 2030

Kenya's long-term economic development plan, known as Vision 2030, recognizes that infrastructure, and in particular a reliable power supply, is vital in sparking economic growth. The level and intensity of commercial energy use in a country is a key indicator of the degree of economic growth and development. The challenges facing the power sector in Kenya include weak transmission and distribution infrastructure, high cost of power, low per capita power consumption, and low countrywide electricity access. Through the early 2000s, the lack of reliable energy supply in the country lowered the annual sale revenues of Kenyan firms by approximately 7% and reduced Kenya's annual GDP growth by about 1.5%. Electricity access in Kenya is still extremely low in comparison to that of peer economies. Kenya's countrywide rate of household access to electricity is about 20%, far below that of other African countries with similar per capita income levels.

3.2.2 Sessional Paper on Environment and Development

The overall goal of the Sessional Paper no.6 of 1999, Draft Environmental Policy, rev. is to ensure that environmental concerns are integrated into the national planning and

management processes and provide guidelines for environmentally sustainable development. The objectives are to conserve and manage the natural resources of Kenya including air, land, flora, and fauna and promote environmental conservation with regard to soil fertility, soil conservation, biodiversity, and to foster afforestation activities; and to protect water catchment areas. More importantly the policy emphasizes the enhancement of public awareness and appreciation of the essential linkages between development and environment, involving NGOs, private sector, and local communities in the management of natural resources and their living environment and ensures that an environmental impact assessment report is undertaken for all public and private projects and programmes. The Suswa Prospect Geothermal Drilling Project must be seen in the same light that it promotes this integrated approach to environmental management and development without compromising livelihoods of the local indigenous people.

3.2.3 Draft National Forest policy

The Forest Sector plays vital roles in the livelihood of the Kenyan population through provision of invaluable forest related goods and services. The most significant contribution is in the energy supply for domestic and industrial processes, provision of timber for construction and trees for regulation of water flow. It is estimated that 80% of the rural population use biomass energy while urban development and hydro energy rely heavily on water. As important as our forests are to the national economy, their sustainable development and management continues to be hampered by a number of factors, including inadequate financial resources and the lack of an enabling policy. The sector is vital for mitigating against GHG through carbon sequestration.

3.2.4 Draft Wildlife Management Policy

Wildlife resources contribute directly and indirectly to the local and national economy through revenue generation and wealth creation. Wildlife accounted for 70% of the gross tourism earnings, 25% of the Gross Domestic Product (GDP) and more than 10% of total formal sector employment. The policy aims at enhancing wildlife conservation in the country; Significantly reducing wildlife poaching especially of endangered species such as elephants and rhinos; Establishing a unitary institution, KWS, to be responsible for wildlife conservation and management countrywide; and Establishing the Kenya Wildlife Service Training Institute (KWSTI) that continues to play an important role in human capacity development. Suswa is a protected area managed in partnership with communities.

3.2.5 National Energy policy

Kenya's National Energy Policy⁸ emphasizes the need for sustainable energy supplies in adequate quantities at effective costs, so as to achieve national development goals. The policy also emphasizes delivery of quality energy services so as to ensure that Kenya will continue to attract investments in those economic activities of which energy inputs are basic to production at competitive prices. The country is dependent mainly on three forms of energy namely: petroleum, electricity and wood-fuel. To a lesser extent wind, solar and biogas are used as alternative energy sources. Petroleum is the major source of commercial energy in the country providing about 87% of the country's requirements. The transport sector consumes more than half of the petroleum fuels used in the country. Industry consumes some 31% of petroleum fuels.

3.2.6 Sessional Paper on Water Resources Development, 1999

The National Water Policy⁹ was adopted by Parliament as Sessional Paper No. 1 of 1999. The policy shifted the government's role away from direct service provision to regulatory functions. At that time it was anticipated that service provision would be left to municipalities, the private sector and communities. However the Water Act 2002 repealed the previous legislation and set in motion a separation of functions and established several water regulatory institutions.

3.2.7 National Involuntary Resettlement Policy

The policies, laws, guidelines on resettlement is the guiding principle of the planning, implementation and monitoring of involuntary resettlement caused by development projects, which involve land acquisition and legal restriction of access to project land. The aim is first to avoid resettlement as much as possible and where it is necessary, then the policy aims at minimizing and mitigating the adverse impacts through provision of guidelines on the resettlement process.

The specific aim is to assist the affected communities to improve or restore their living standards to pre-displacement levels. Relevant Kenya laws considered include:

- The Constitution of Kenya Section 70
- The Land Acquisition Act Chapter 295
- The Way leaves Act, etc.

⁸ Draft National Energy Policy, Government of Kenya.

⁹ Republic of Kenya, *Sessional paper no. 1 of 1999 on National Policy on Water Resources Management and Development*. Ministry of Water Resources, 1999

The impacts due to involuntary resettlement from development projects, may give rise to economic, social and environmental risks resulting in production systems being dismantled, assets or income sources lost, people being relocated to environments where their productive skills may be less applicable and the competition of resources increases. In this respect, community institutions and social networks will be weakened; kin groups dispersed; cultural identity, traditional authority and the potential mutual help will diminish or be lost substantially.

3.2.8 Occupational Health and Safety Rules related to Geothermal Development

In a typical geothermal field, gas analysis will be conducted frequently in the early years of the project, and less frequently in later years, as the reservoir becomes stabilized. In many classical reservoirs, the non-condensable gas fraction declines over time.

3.2.9 Local County By-Laws

Local authorities, until the advent of the new constitution were in charge of local governance. It had three levels, namely, cities, municipality, county council and urban council. Municipalities and towns are other forms of urban authorities and are generally named after their central town. County Councils are essentially rural. Each district has a maximum of one county council, such that they cover all areas not taken up by urban authorities. Counties are usually named after their respective districts, which often bear the same name as the district capital. Thus Counties are often named after a major town, but their land area may cover the surroundings, not the town itself. Some districts have only one local authority, which are almost all county Councils. With the enactment of the new constitution, the county Councils are now represented by the county governments which comprises of several districts together.

The local authorities govern by passing a series of by laws that range from public health to licensing of bars and restaurants. The County Councils of Narok, Kajiado and Nakuru will likely have a lot of sway on the local governance in the Suswa area.

3.3 Kenya's Legal Framework

3.3.1 Constitution of Kenya

In geothermal power development, it is important to understand these policies, legislations and regulations in relation to the five phases of exploration, drilling, power plant construction, operations and decommissioning. These legislations often specify

standards with which the project must comply and each stage has been considered to reduce lengthy licensing process or public consultation requirements.

Constitution under Article 35 provides the right of access to information in which case where the public are entitled to information while Article 40 describes the right to property. Article 42 and 43 deal with Clean and Healthy Environment to the extent to which the present process of ESIA must conform to the present constitution. Article 56 deals with rights of minorities and marginalized groups which the Maasai are considered to belong. Chapter 5 deals with Land and Environment and Article 66 for any land by regulating the use, the safety and the planning among other public interests, or if the development and utilization of the said land is to promote public benefit:-

- a) The necessity for expropriation is great enough to justify any hardship caused to any persons Law for prompt payment of full compensation makes the provision
- b) The constitution however only provides general guidelines, and detailed procedures for land acquisition are elaborated under the Land Acquisition Act in Chapter 295 for private land and Chapter 288 for unregistered Community Lands in the new Land Policy 2010.

3.3.2 Environmental Management and Coordination Act (EMCA) of 1999 and its regulations

The EMCA of 1999 came late in the development of geothermal energy in Kenya. It is an overall legal instrument for managing environmental issues and has created several institutions for this management—the key one being the National Environmental Management Authority (NEMA). The EMCA provides for establishing appropriate legal and constitutional frameworks for sustainable management of the environment and natural resources in Kenya. The EMCA outlines EIA procedures, environmental audits, monitoring procedures, and transmission and environmental-quality standards.

The government enacted the EMCA to address the ever-growing negative environmental concerns of human activity on the environment. Generation and use of energy is a factor contributing to atmospheric pollution, land degradation, and global warming. The EMCA also provides for establishing provincial and district environmental committees and a Public Complaints Committee. The law, therefore, gives the public voice and a chance to participate in matters related to the environment. NEMA requires all power projects-before a license is issued-to undergo an EIA and conduct public disclosure involving all the stakeholders. In addition, an Environmental Management Plan and regular environmental monitoring and audits are required.

Under the EMCA, the Energy Regulatory Commission (ERC) is recognized as the lead agency for the enforcement of environmental and safety regulations in the electric power sub-sector, the functions of which are conferred by the Energy Act of 2006. The EMCA requires the ERC to take into account the need to protect the environment, conserve natural resources, and protect the health and safety of service users and the public at large when reviewing applications for licenses.

3.3.3 Energy Act of 2006

This Act governs the importation, exportation, generation, transmission, distribution, supply or use of electrical energy; importation, exportation, transportation, refining, storing and selling of petroleum or petroleum products; production, transportation, distribution and supply of any other form of energy, and to all works or apparatus for any or all of these purposes. The Act also regulates distribution of electrical energy, petroleum and natural gas as well as renewable energy, and energy efficiency.

3.3.4 Geothermal Resources Act of 1982

Geothermal energy is controlled the Geothermal Resources Act No. 12 of 1982. All geothermal resources are invested in the government and a licence for geothermal drilling must be obtained from the Minister for Energy and Petroleum and Petroleum.

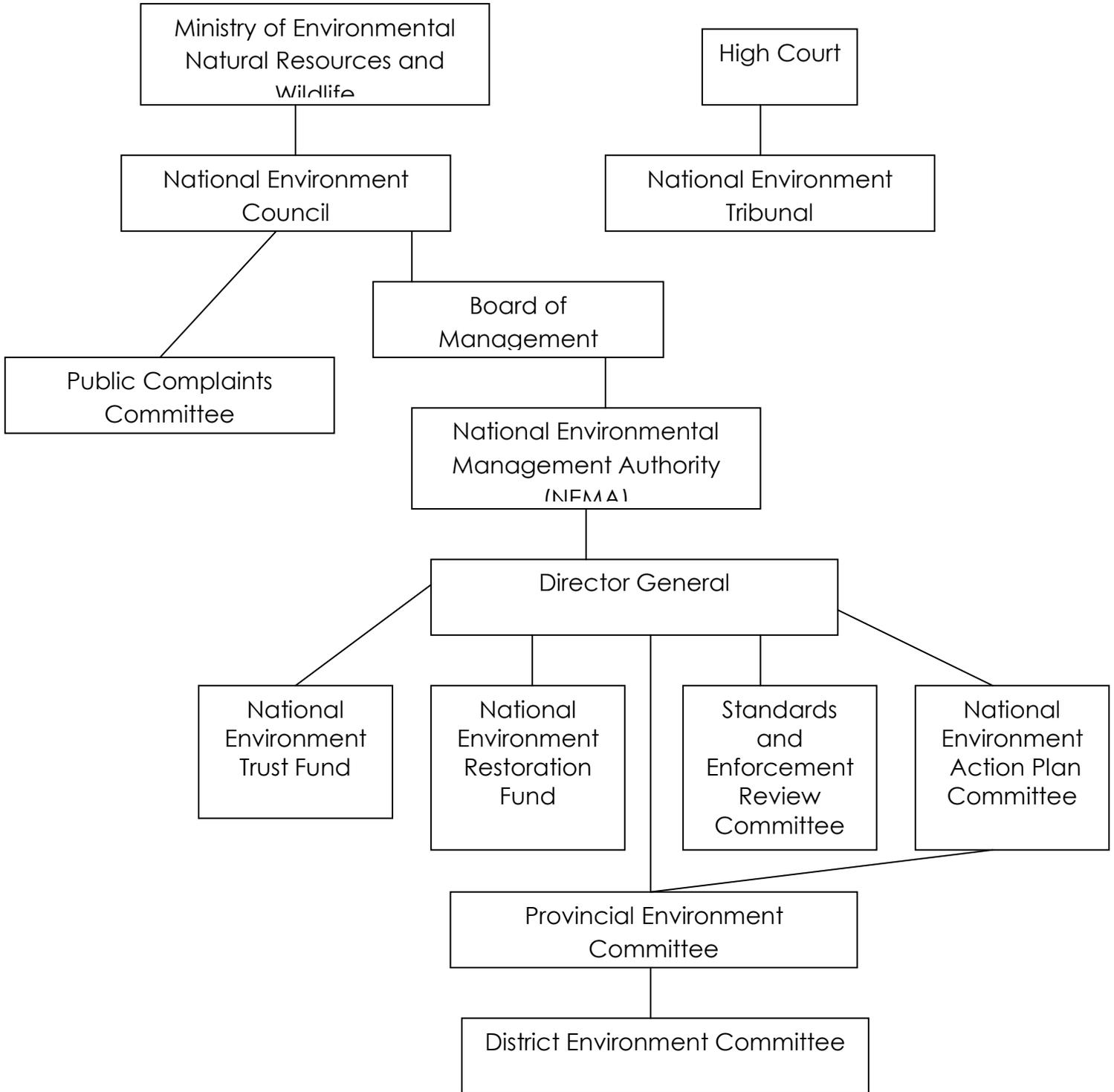
3.3.5 Water Act of 2002 and its subsidiary legislations

The Water Act, 2002 to provide for the management, conservation, use and control of water resources and for the acquisition and regulation of rights to use water; to provide for the regulation and management of water supply and sewerage services and for related purposes. It effected the separation of policy making from regulation, management of water resources from the provision of water services, decentralization of functions to lower-level public institutions; and the involvement of non-government entities in both the management of water resources and the provision of water services. It also commercialized water supply services and the standardization of water quality and services. In this respect the Act established institutions in charge of each function.

In order to use water, there must be a water abstraction license. The license to abstract water from a borehole or surface water body is obtained from Water Resources Management Authority (WRMA). A borehole drilling permit is required in order to construct a borehole for water supply or geothermal drilling purposes or both. A drilling permit must be obtained from WRMA for abstraction of water. The application for water abstraction or drilling a borehole must be supported by appropriate hydrological/hydrogeological studies. Although significant temporary water supply

volumes are required to support drilling activities, negligible permanent supply is required for the power station.

Figure 9: Environmental Management and Coordination Act Institutional Framework



The other relevant legislations include:

- Forest Act of 2005
- Wildlife (Conservation and Management) Act, Cap 376 and the 1989 amendment
- Local Government Act, Cap 265 (rev. 1998)
- Land Acquisition Act of 1992

3.3.6 Masai Customary Law

The Maasais are governed by strict customary laws. Under 'customary law,' rights over land tend to be inclusive (many people 'included' as right holders), ambiguous (different rights overlap), and negotiable (rights specified through the agency of social process). But customary land tenure, in all its flexibility, seems to lack the certainty brought about by formal land registration. Maasai, for instance, have a clear notion of *e-rishata* or division or separation that constitutes a boundary, but their borders are zones more than lines. Individuals and families, whose rights are derived from the community, mingle together as they use land in common, with access being subject to negotiation and potential conflict. One would expect then, that titling Maasai land would have reduced uncertainty of tenure and social conflict, but in fact, instances of uncertainty and conflict have risen.

3.3.7 Land (Group Representative) Act 1968

The Act provides for incorporation of representatives of groups to have been recorded as owners of the land under the Land Adjudication Act, and for purposes connected with collective pastoral management and resources use. Group Ranch Committee disregarded many of the rules for its own administration and as a result, lost public support and legitimacy; it failed to hold annual general meetings, it showed favoritism in allocating land (to themselves, family, friends), took bribes, used collective funds to survey land designated for the favored few, and withheld allocations for those who disagreed with its actions. The registered members of Group ranches have since subdivided the land and registered such parcels of land under their individual names.

3.3.8 Licenses and Permits

Several legislations require issuance of licenses or permits whenever the conditions of the legislation are met.

Table 3: Permits and Licences

Legislation	Permit/Licenses Required
National Environmental Management and Coordination Act (EMCA) of 1999	<ul style="list-style-type: none"> • Licence for drilling • Emission licenses • Effluent discharge • Operation of Waste disposal • License to generate hazardous waste
Energy Act, 2006	<ul style="list-style-type: none"> • Generation, importation and exportation, transmission or distribution of electric energy; • Enhance energy efficiency and conservation • Supply of electric energy to consumers.
Geothermal Resources Act of 1982	<ul style="list-style-type: none"> • Geothermal Resources Authority and License
Electric Power Act 1998	<ul style="list-style-type: none"> • Electricity generating license
Wildlife (Conservation and Management) Act of 1976	<ul style="list-style-type: none"> ▪ Manages wildlife, subsequently, through an Amendment to the Act in 1989, establishes the Kenya Wildlife Service (KWS).
Building Code Act 1997	<ul style="list-style-type: none"> • Usually held by Ministry of Public Works and Housing and as by laws in the Local Authorities • Regulates safety and measures for construction of buildings
Radiation Protection Act 1985	<ul style="list-style-type: none"> • Provide for the protection of the public and radiation workers from the dangers arising from the use of devices or material capable of producing ionizing radiation and for connected purposes • Licence for owning, purchasing, acquiring, importing, manufacturing, selling or dealing in, or stores, uses, disposes of or exports any kind of irradiating device or radioactive material or any other source of ionizing radiation
Water Act 2002	<ul style="list-style-type: none"> ▪ Establishes management, distribution of water supply and water rights through a permit system. ▪ WRMA licenses water abstraction from rivers and groundwater. ▪ Water Resources User Associations (WRUAs) is established to manage and conserve water at the lowest level. ▪ Water Services Board licences water service providers.
Trade License Act, Cap 497	<ul style="list-style-type: none"> ▪ Trade license

Penal Code, Cap 63, 1930, Part XVII	<ul style="list-style-type: none"> • One of the oldest statutes on air quality management, i.e. On "offences Against Health and Convenience" in Sections 191-193 strictly prohibiting releasing of foul air which affects the health of other persons.
Standards Act, Cap 496	<ul style="list-style-type: none"> • Permit to use standardisation
Building Codes of 1968	<ul style="list-style-type: none"> ▪ Controls standards and codes of construction materials
Work Injury and Benefits Act of 2007	<ul style="list-style-type: none"> ▪ Provide for compensation to employees for work related injuries and diseases contracted in the course of their employment and for connected purposes. ▪ Every employer must register with the Director
Public Health Act, Cap 242	<ul style="list-style-type: none"> ▪ Licences for eating places such as restaurants and kiosks
Occupational Health and Safety Act of 2007	<ul style="list-style-type: none"> ▪ Workplace health and safety standards ▪ Inspects and registers of workplaces
Food, Drugs, and Chemical Substances Act, Cap 254 (rev. 1992)	<ul style="list-style-type: none"> ▪ Prohibition against sale of unwholesome, poisonous or adulterated food
Use of Poisonous Substances Act, Cap 247 (rev. 198)	<ul style="list-style-type: none"> • Licence for disposal/storage of poisonous substances
Physical Planning Act, Cap 286	<ul style="list-style-type: none"> • Development application • Development permission for geothermal drilling
Traffic Act, Cap 403	<ul style="list-style-type: none"> • Licence for driving or operating a vehicle
Transport Licensing Board Act, Cap 404	<ul style="list-style-type: none"> • License for public service vehicles (PSVs)
Scrap Metal Act 1972 rev.	<ul style="list-style-type: none"> • License for removal and sale of scrap metal

3.4 International Legal Requirements

3.4.1 United Nations Framework Convention on Climate Change (UNFCCC) of 1992 and its Kyoto Protocol (1997)

This convention sets objective criteria of stabilising greenhouse gas concentrations in the atmosphere at a level intended to prevent human-induced interference with the global climate. The Kyoto Protocol, drawn up in 1997, provides a voluntary arrangement in which the developed nations agreed to limit their greenhouse gas emissions relative to the levels of the 1990.

UNFCCC requirements regarding accreditation to Clean Development Mechanism (CDM) of the Kyoto Protocol must be made to secure certified emissions reductions or CERs available through the CDM. CDM allows projects in developing countries to generate emission credits if they result in emission levels lower than would otherwise be the case; these credits can be marketed and eventually counted against a developed country's emission obligation. The IEA provides analysis on the effectiveness of the different emissions trading scheme options, both at international and domestic level.

The Kenyan administration attaches high priority to CDM, which is seen as an instrument for mobilizing investments in the country and advancing the development of new industrial projects. National CDM guidelines had already been developed and Kenya already has quite a substantial number of projects in the pipeline, including some that have already been approved by the competent national authority (NEMA). The third extension phase of the Olkaria II Unit III is registered under CDM and is earning Kengen revenue through CERs.¹⁰ While NEMA is responsible for regulating and supervising CDM in Kenya, climate protection investments are promoted by the new Kenya Investment Authority (KIA), a successor to the earlier Investment Promotion Centre (IPC). Since KIA is not yet operational for CDM.

3.4.2 Convention on Biological Diversity of 1994

The project is located in the Conservation Area and shall be governed by the *Convention on Biological Diversity of 1994*. The object of the Convention is the conservation of biodiversity, its sustainable use and fair and equitable sharing of

¹⁰ Capacity increased from 70 MW to 105 MW, KenGen has signed an emission reduction purchase agreement (ERPA) with the World Bank's Community Development Carbon Fund for 900,000 t of CO₂e. KENGEN also has prepared Letters of Intent for the Eburru geothermal power station (annual electricity generation of 21 GWh; anticipated CO₂e savings according to KenGen of 13,400 t a year); the Redevelopment of Tana Power Station Project (130.3 GWh; 83,200 t CO₂e a year), the optimization of the Kiambere power station (60 GWh; 38,300 t CO₂e annually) as well as the Kipevu Combined Cycle Project (223 GWh; an annual 142,500 t CO₂e).

benefits arising out of the use of the utilisation of genetic resources. The biodiversity conservation in Mt. Suswa Conservancy and the surrounding areas and its importance to the national heritage as well as economy of Kenya is well known.

3.4.2 African Convention on the Conservation of Nature and Natural Resources of 1968

This convention aimed to undertake to adopt the measures necessary to ensure conservation, utilization and development of soil, water, flora and fauna resources in accordance with scientific principles and with due regard to the best interests of the people. Kenya has moved ahead of many states in realizing the objectives of the treaty. Among the species protected under this convention is the secretary bird which is endemic in the project area.

3.4.3 Convention concerning the protection of the world cultural and natural heritage

Kenya is member of the The World Heritage Committee which consists of representatives from 21 States Parties to the Convention concerning the protection of the world cultural and natural heritage, elected by the General Assembly of States Parties to the Convention. World Heritage Convention is an international Treaty for the preservation of sites of global significance created in 1927 by United Nations Educational, Scientific and Cultural Organization (UNESCO). These are; Lamu Old Town (Cultural), Mt. Kenya (Natural), Lake Turkana National Parks (Natural) and now Sacred Mijikenda Kaya Forests (Cultural landscape). The present study postulates that the Mt. Suswa Caves could be designated a natural heritage site to boost its significance and ensure its protection.

3.4.4 Convention of Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention) of 1971

This convention is applicable to the present study so far as decision may be made regarding the water supply requirement from the Lake Naivasha and its environs which is a Ramsar site. Lake Naivasha water would be used if the water trucking option were chosen to supply water to the Suswa drill sites. If the DCK pipeline improvement option were chosen, then two new wells would be drilled near the existing three wells to supply the additional water volumes required for the Suswa drill sites. The main water source for the proposed drilling project is from the Olkaria area.

3.4.5 Convention on the International Trade in Endangered Species (CITES) of Wild Fauna and Fauna, 1990

This is a 1990 treaty that regulates the wildlife trade and protects forests as habitat for endangered species. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival and it accords varying degrees of protection to many species of animals and plants. The project area is noted for its unique bats and flowers.

The Mount Suswa *bat*¹¹ has not been declared an endangered species, discussion between the Governments of Kenya and democratic Republic of Congo are considering it for listing as an endangered species.

3.4.6. Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) of 1979

The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) of 1979 aims to conserve terrestrial, marine and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale. Since the Convention's entry into force, its membership has grown steadily to include over 100 Parties from Africa, Central and South America, Asia, Europe and Oceania. The Convention was signed in 1979 in Bonn (hence the name) and entered into force in 1983.

3.4.7 U.N. Convention to Combat Desertification (UNCCD), 1992

U.N. Convention to Combat Desertification (UNCCD), 1992 in those countries experiencing serious drought and/or desertification, particularly in Africa is a convention to combat desertification and mitigate the effects of drought through national action programs that incorporate long-term strategies supported by international cooperation and partnership arrangements. The Convention is based on the principles of participation, partnership and decentralization - the backbone of Good Governance and Sustainable Development. National Action Programmes (NAPs) are one of the key instruments in the implementation of the Convention.

Desertification is a very important area of concern for Kenya and especially in the present area of ESIA which is in ASALs region. Studies in 1997 showed that 64% of Kenya's land area was potentially subject to moderate desertification and about 23%

¹¹ There is a proposal for Inclusion of African population of Large-eared Free-tailed Bat/Giant Mastiff Bat *Otomops martiensseni* on Appendix I

were vulnerable to severe to very severe desertification. In the northern rangelands, 12.3% suffered from severe land degradation, 52% to moderate land degradation, and 33% faced slight vulnerability to degradation. The latter study identified degradation in ASALs as a potential precursor to widespread desertification (KLA n.d.). In the early 2000s, approximately 30% of Kenya was affected by very severe to severe land degradation (UNEP, 2002) and an estimated 12 million people, or a third of the Kenya's population, depended directly on land that is being degraded (Bai and others, 2008). The droughts of 1970-2000 accelerated soil degradation and reduced per-capita food production (GoK, 2002). The proponent is advised to engage in activities geared towards eradicating drought through conserving forest cover, developing tree programmes with relevant ministries/local communities, encouraging clean energy use and water conservation.

3.4.8 Convention on the Ban of the Import into Africa and the Control of Trans boundary Movements and Management of Hazardous Wastes (Bamako Convention)

Convention on the Ban of the Import into Africa and the Control of Trans boundary Movements and Management of Hazardous Wastes (Bamako Convention) is a treaty of African nations prohibiting the import of any hazardous (including radioactive) waste. The Convention was negotiated by twelve nations of the Organization of African Unity at Bamako, Mali in January, 1991, and came into force in 1998.

Impetus for the Bamako Convention arose from the failure of the Basel Convention to prohibit trade of hazardous waste to less developed countries (LDCs), and from the realization that many developed nations were exporting toxic wastes to Africa.

It is based on the precautionary principle that states that a preventive regulatory actions in regards to environmental protection should be taken even in the absence of a conclusive scientific proof that a given substance or activity harms the environment.

3.4.9 International Convention on Substances that Deplete the Ozone Layer (Vienna Convention) of 1985

International Convention on Substances that Deplete the Ozone Layer of 1985 and its Montreal Protocol of 1987 also called the Vienna Convention was concluded in March 1985. It encourages intergovernmental cooperation on research, systematic observation of the ozone layer, monitoring of CFC production, and exchange of information. The Montreal Protocol, adopted in 1987, was intended to allow the revision of phase out schedules on the basis of periodic scientific and technological assessments.

3.5 World Bank and Other Partners' Safeguard Policies on Environmental and Social Management

This EIA study is also based on World Bank Operational Policies covering environmental and social management safeguards. Reference has been made to the World Bank Safeguard Policies, the World Bank Group Environmental, Health, and Safety (EHS) Guidelines namely the EHS Guidelines and the World Bank Environmental Assessment Source Book Volume II, which provides the relevant sectoral guidelines including the Banks Operation Policies/Bank Procedures. The objective of the World Bank's environmental and social safeguard policies is to prevent and mitigate undue harm to people and their environment in the development process. These policies provide guidelines for bank and borrower staff in the identification, preparation, and implementation of programs and projects. Operational policies have often provided a platform for the participation of stakeholders in project design and have been an important instrument for building ownership among local populations (World Bank, 1999-2006).

The World Bank Environmental Assessment Sourcebook (Volumes I, II, and III) is intended to provide practical guidance for designing environmentally sustainable bank-assisted projects. The sourcebook collates various bank policies, procedures and guidelines into a single source. Additionally, the Bank's Pollution Prevention and Abatement Handbook 1998 describe pollution prevention and abatement measures, as well as emission levels that are acceptable to the Bank. These standards have been applied in decision making in the present study.

3.5.1 World Bank Operational Policy 4.01-Environmental Assessment

The environmental assessment process provides insights to ascertain the applicability of other WB safeguard policies to specific projects. This is especially the case for the policies on natural habitats, pest management, and physical cultural resources that are typically considered within the EA process. The policy describes an environmental assessment (EA) process for the proposed project. The breadth, depth, and type of analysis of the EA process depend on the nature, scale, and potential environmental impact of the proposed project. The policy favours preventive measures over mitigatory or compensatory measures, whenever feasible.

The operational principles of the policy require the environmental assessment process to undertake the following:

- Evaluate adequacy of existing legal and institution frameworks, including applicable international environmental agreements. This policy aims to ensure that projects contravening the agreements are not financed.

- Stakeholder consultation before and during project implementation.
- Engage service of independent experts to undertake the environmental assessment.
- Provide measures to link the environmental process and findings with studies of economics, financial, institutional, social and technical analysis of the proposed project.
- Develop programmes for strengthening of institutional capacity in environmental management.

The requirements of the policy are similar to those of EMCA, 1999, which aim to ensure sustainable project implementation. Most of the requirements of this safeguard policy have been responded to in this report, by evaluating the impact of the project, its alternatives, existing legislative framework and, conducting public consultations and by proposing mitigation measures for the potential impacts identified.

3.5. 2 World Bank Operational Policy 4.04-Natural Habitats

This operational policy requires that the study use a precautionary approach to natural resource management, to ensure environmental sustainability. The policy requires conservation of critical habitat during project development. To ensure conservation and project sustainability the policy requires that:

- Project alternative be sought when working in fragile environment areas;
- Key stakeholders are engaged in project design, implementation, monitoring and evaluation including mitigation planning.

The requirements of this policy were observed as much as possible during the EIA study. The consulting team engaged several stakeholders during project impact so as to incorporate their concerns and views in the EMP. This policy is not triggered by the proposed project as the project area does not directly fall within conserved and/or protected natural habitats. Mount Suswa is a well known natural habitat to several bird species, e.g. and wild animals especially baboons, bats and Thomsons Gazelle.

3.5.3 World Bank Operational Policy 4.36-Forests

This operational policy provides measures for protection of forests through impact evaluation and conservation of forest during project development. This policy ensures that the health and quality of forest and right and welfare of people and their level of dependence upon the forest is fully protected.

This policy is not triggered by the proposed project as the project area does not directly fall within conserved and/or protected forest. Restoration activities that enhances biodiversity and forest ecosystem such as afforestation and protection of indigenous trees should also be observed and encouraged including community participation activities.

3.5.4 World Bank Operational Policy 4.09-Pest Management

This policy promotes the use of ecological based pest management practices. The policy requires that procured pesticides should meet the WHO recommendations and not be among those on the restricted list of formulated products found in the WHO Classes IA and IB or Class II. This policy is not triggered by the proposed project as it shall not involve use of pesticides despite the fact that the project will involve bush clearing to pave way for development of various project components and landscaping of project area on completion using trees, grasses and other vegetation to improve aesthetic value of the area, control soil erosion and, act as windbreakers among other functions. All activities involving handling of vegetation will be manual labour based thus not necessitate use of pesticides. It is recommended that plant enrichment will be done using organic manure if necessary which can be locally found.

3.5.5 World Bank Operational Policy 4.11-Physical Cultural Resources

This policy guides in preserving physical cultural resources and helps reduce chances of their destruction or damage. The policy considers Physical Cultural Resources (PCR) to be resources of archeological, paleontological, historical, architectural, and religious (including circumcision sites), aesthetic or other cultural significance. The policy is triggered by this project because Mount Suswa is considered a shrine and has physical or cultural resources that may be impacted by the project. Attention shall be paid to these cultural resources and the National Museum of Kenya has been consulted on the way forward.

3.5.6 International Policy on Involuntary Resettlement/Relocation and Compensation of People World Bank WB OP/BP 4.12

This policy requires that a Resettlement Action Plan (RAP) be prepared for all projects that anticipate land acquisition and displacement affecting shelter, livelihood and associated impacts. Resettlement due to infrastructure development is not a new phenomenon in Kenya but the government has no Policy Document or Act that aims at ensuring that persons, who suffer displacement and resettlement arising from such development activities, are compensated adequately for their losses at replacement costs. The World Bank's Operational Policy 4.12, (OP) has been designed to mitigate against impoverishment risks associated with Involuntary Resettlement and the restoration or improvement of income-earning capacity of the Project Affected Persons (PAP). The policy requires full public participation in resettlement planning and implementation and describes the conditions that borrowers are obliged to meet in operations involving involuntary resettlement.

The prospect geothermal drilling site, site offices and construction of other amenities will require that land be acquired from the state or from private owners. The second reason that has triggered the OP is that some sections of the access road may encroach on private land. The rehabilitation of the road will require borrowing materials, and the schools may be located too close to drilling sites. The school may require relocation while the homesteads may require resettlement thus the need of developing a RAP. The principle policy of this OP is to ensure that development projects sponsored by the Bank does not cause undue disturbance to livelihoods of those who depend on the project or its associated resources. There is therefore a need to develop a Resettlement Action Plan (RAP) for the project that shall propose a procedure that will be followed to ensure that the livelihood of those affected by the project is restored as much as possible.

3.5.7 World Bank Operational Policy 4.10-Indigenous People

This policy requires projects to be designed and implemented in a way that fosters full respect for Indigenous Peoples' (IPs) dignity, human rights and cultural uniqueness. It also ensures that the IPs receive culturally compatible social and economic benefits and do not suffer adverse effects during the development process. This policy is triggered because the proposed project area is in Masailand that identifies with the areas according to the OP description of IP.

3.5.8 World Bank Operational Policy BP 17.50- Public Disclosure

This BP encourages Public Disclosure (PD) or Involvement as a means of improving the planning and implementation process of projects. This procedure gives governmental agencies responsibility of monitoring and managing the environmental and social impacts of development projects, particularly those impacting on natural resources and local communities. The policy provides information that ensures that effective PD is carried out by project proponents and their representatives. The BP requires that public involvement be integrated with resettlement, compensation and indigenous peoples' studies. Monitoring and grievances address mechanism should also be incorporated in the project plan.

The proposed project incorporated public participation and stakeholder consultations as part of the ESIA studies, in order to collect the views of the local communities and their leaders for incorporation into the project mitigation plan. The consultation was successful and the community members gave a number of views that have been considered for enhancing their livelihoods as well as in the mitigation plan.

3.6 Equator Principles

Equator Principles (EP) was adopted by IFC as a part of performance standards, General EHS Guidelines of 2007 and EHS Guidelines or Geothermal Generation of 2007. Within the IFC, the Suswa Prospect Geothermal Drilling Power Project is a category B project – which implies a project with potentially limited adverse environmental or social impacts that are few in number, generally site specific, largely reversible, and readily addressed through mitigation measures. Compliance with the Equator Principles (EP) is a requirement of many commercial banks for new project financing with total capital costs of US\$10 million or more¹². These principles are:

- a. Review and categorise based on International Finance Corporation (IFC) criteria
- b. Social and Environmental Assessment
- c. Applicable Social and Environmental standards
- d. Action Plan and Management System
- e. Consultation and Disclosure
- f. Grievance Mechanism
- g. Independent Review
- h. Covenants requiring compliance
- i. Independent Monitoring and Reporting
- j. Public Reporting Process and Experience

¹² (<http://www.equator-principles.com/>)

The EP relates to good practice with specified applicable social and environmental performance and generally requires compliance with the Performance standards and guidelines of the IFC dependent upon the economic status of the country.

3.7 Environmental Compliance Standards

The study adopted various safeguard standards to provide benchmarks for assessing every impact of geothermal power development activity. Many of these standards such as Effluent Discharge Standards, Noise Emission Standards, etc have been given in the tables 4, 5 and 6 while the others are shown in Annexes.

Table 4: Effluent discharge standards criteria for NEMA and World Bank

Pollutant or Effluent parameter	Maximum allowable limits	
	NEMA discharge standard (mg/l)	World Bank/ IFC standard (mg/l)
Ammonia	100	10
Biological oxygen demand (BOD)	30	50
Chemical oxygen demand (COD)	50	250
Chromium (VI)	0.05	0.1
Chromium (Total)	2	0.5
Iron	1.0	0.5
pH	6.5-8.5	6-9
Oil & grease	Nil	10
Hydrogen sulphide		15ppm
Total residual chlorine	0.10	0.2
Total suspended solids (TSS)	30	50
Total Dissolved Solids	1200	
Temperature	±3°C above ambient temperature of receptor	±3°C above ambient temperature of receptor
Zinc	0.5	2.0
Boron	1.0	
Sulphate	0.1	1.0
Fluoride	1.5	20
Arsenic	0.02	0.1
Cadmium	0.01	0.1

Sources: NEMA Environmental Management and Coordination Act (Water Quality) Regulations, 2006 and World Bank Pollution Prevention and Abatement Handbook, 1998

The standard ambient noise levels have been adopted to relocate educational institutions and any homesteads within the proposed drilling site.

Table 5: NEMA Ambient Noise Levels Criteria

Receptor		Maximum allowable noise in decibels	
		Day time	Night time
A	Silent Zone	40	35
B	Places of worship	40	35
C	Residential : Indoor	45	35
	Outdoor	50	35
D	Mixed residential (with some commercial and places of entertainment)	55	35
E	Commercial	60	35

Source: NEMA Environmental Management and Coordination Act (Noise And Excessive Vibration Pollution) (Control) Regulations, 2009.

Table 6: World Bank Ambient Noise Levels Criteria

Receptor		Maximum allowable noise in decibels	
		World Bank	
		Day time	Night time
Residential, institutional, and educational	55	45	
Industrial and commercial	70	70	

Source: World Bank Pollution Prevention and Abatement Handbook, 1998.

CHAPTER 4: ASSESSMENT OF THE BIO-PHYSICAL ENVIRONMENT

4.1 Size, Topography, Climate and Rainfall

The project area consists generally of lowlands except the Mount Suswa and the surrounding domes. The northern side of Mount Suswa is generally a rolling sloppy area which is dissected by gullies. Geomorphologically, there are pronounced cattle tracks along the road to the Mount Suswa calderas and evidence of intense runoff and flash floods during the rains. There are major sources of soil erosion noticed along the path to the top of the mountain. The area is generally dominated by scattered acacia tree species from the foot to the top of the mountain, which is an indication of dry weather conditions and depressed rainfall amounts. On the western side, there is more vegetation indicating wetter conditions. More gullies were visible on the roadsides as we travelled from Mount Suswa to Duka Moja (Ilasit Shopping Centre) which lies in the direction of Narok (about 10km from Suswa shopping centre) along the Narok-Mahimai-Nairobi Highway (Road B3).

The project area lies in two administrative districts – Kajiado North and Narok North. The topography on the side of Narok North district is broadly divided into two: the highlands and the lowlands, which are approximately 3,000 and 1000-1400 m.a.s.l respectively. The topography may be as low as 460m.a.s.l. in Mosiro area. The highlands have a high potential for agricultural productivity while the lowlands are suitable for livestock rearing. Rainfall in the area ranges from 1200 mm-1800 mm in highlands and about 1400 mm in lowlands. Mean temperatures range from 5°C in July to 28°C in December to February.

On the side of Kajiado North district the topography is characterized by plains and occasional volcanic hills and valleys ranging in altitude from about 500m around Lake Magadi to about 2,500 metres in the Ngong Hills. The short rains start in October-December while the long rains fall between March and May. Rainfall is generally influenced by altitude. Temperatures range from a mean maximum of 34°C around Lake Magadi to a mean minimum of 22°C on the slopes of Ngong Hills. In the project area, days are sunny but temperatures significantly cool down during the nights.

Table 7: Rainfall (in mm) distribution of Kedong Valley and Longonot Farm

Stat	Ja	Fe	Ma	Ap	Ma	Ju	Jul	Au	Se	Oc	No	De	Mean Annual
1	30	47	56	125	97	34	31	36	47	54	65	58	680
2	45	42	76	175	130	33	17	19	20	34	55	65	710
3	30	28	54	132	155	104	161	182	96	56	63	48	1108

Key: 1: Longonot Farm, 9036214, Alt. 1890 m; 2: Kedong Valley, 9036011, Alt. 1890 m; 3: Kijabe Hill Estate, 9036000, alt. 2057 m.

Source: Farm Management Handbook of Kenya, vol. II, Part B, Central Kenya, p. 382.

4.3 Geology of Suswa volcano and environs

Suswa volcano is part of the Kenya Dome, an elevated area about 2000 m above sea level. The Kenya Dome is located in the axial graben of the Kenya Rift (Figure 1), formed during the Late Miocene, and continued to be active in Early Pliocene (Baker *et al.*, 1972). Volcanoes in the area are associated with fissure eruptions of mafic lavas and caldera products of felsic rocks (Baker, 1987; Baker *et al.*, 1972). Volcanism is prominent along the rift axis but also in the flanks (Price *et al.*, 1985; Davies and Macdonald, 1987; Macdonald *et al.*, 1987; Simonetti and Bell, 1995, Omenda, 1997; Velador *et al.*, 2003; Macdonald and Scaillet, 2006; Ren *et al.*, 2006; Macdonald *et al.*, 2008). The Kenya Dome area has three caldera volcanoes – Menengai, Longonot, and Suswa. Menengai caldera volcano is a trachytic composition (Leat and Macdonald, 1984); Longonot is composed by trachyte and mixed (trachyte/basalt) lava flows (Clarke *et al.*, 1990; Heumann and Davies, 2002; Rogers *et al.*, 2004; Scott and Bailey, 1984), while Suswa has a composition of trachytic-phonolitic lava flows and pyroclastic rocks (Clarke *et al.*, 1990; Johnson, 1969; Nash *et al.*, 1969; Skilling, 1993). The Olkaria volcanic complex is also found in the Dome area but has no caldera. There is evidence of magma mixing at Olkaria complex, Menengai, Longonot and Suswa (Leat and Macdonald, 1984; Macdonald *et al.*, 2008; Rogers *et al.*, 2004).

Mount Suswa is a Quaternary volcano built of pre- and syn-caldera trachyte and post-caldera phonolite. This association is intriguing from a petrologic stand, as scientists try to understand the genesis of highly alkaline rocks, and is important for understanding the geodynamics of the Kenya Rift, in that the other Quaternary central volcanoes are trachyte and rhyolite, not phonolite. Other characteristics of the Suswa volcano are that it is underlain by a shallow, high density body which we interpret to be the residuum of the chamber which fed the volcano, and that high heat flow makes it one of the best targets for geothermal exploration. Previous studies included mapping, whole-rock and mineral chemistry, and documentation of magmatic carbon dioxide (CO₂) in syn-caldera trachytic ignimbrite. Pre- and syn-caldera trachyte are more silica

(SiO₂)-rich, in both the whole-rock and glass, than the phonolites, and have feldspars less An-rich. Other indices correlate with these, and imply that the trachytes are more evolved than phonolites. Trace element concentrations for the pre-caldera trachyte span the entire range for the volcano and form their own separate array. The sun-caldera trachyte and the phonolite form a coherent array, and the trachyte has higher concentrations of incompatible elements. Our preferred model at this time is that the pre-caldera trachyte was an early discreet magma pulse, followed by a separate pulse in which a zoned magma chamber developed. A volatile-rich, evolved trachyte cap overlay more primitive phonolites. The cap vented to form the caldera, followed by eruption of phonolite from the main chamber. Gravity data at Mount Suswa show existence of shallow magma beneath the calderas and geothermometric temperatures exceeding 250°C. Resistivity data show evidence of a geothermal reservoir. Hot geothermal fluids probably flow through the lineaments and fractures indicating permeability.

Figure 10: Geology of Suswa volcano

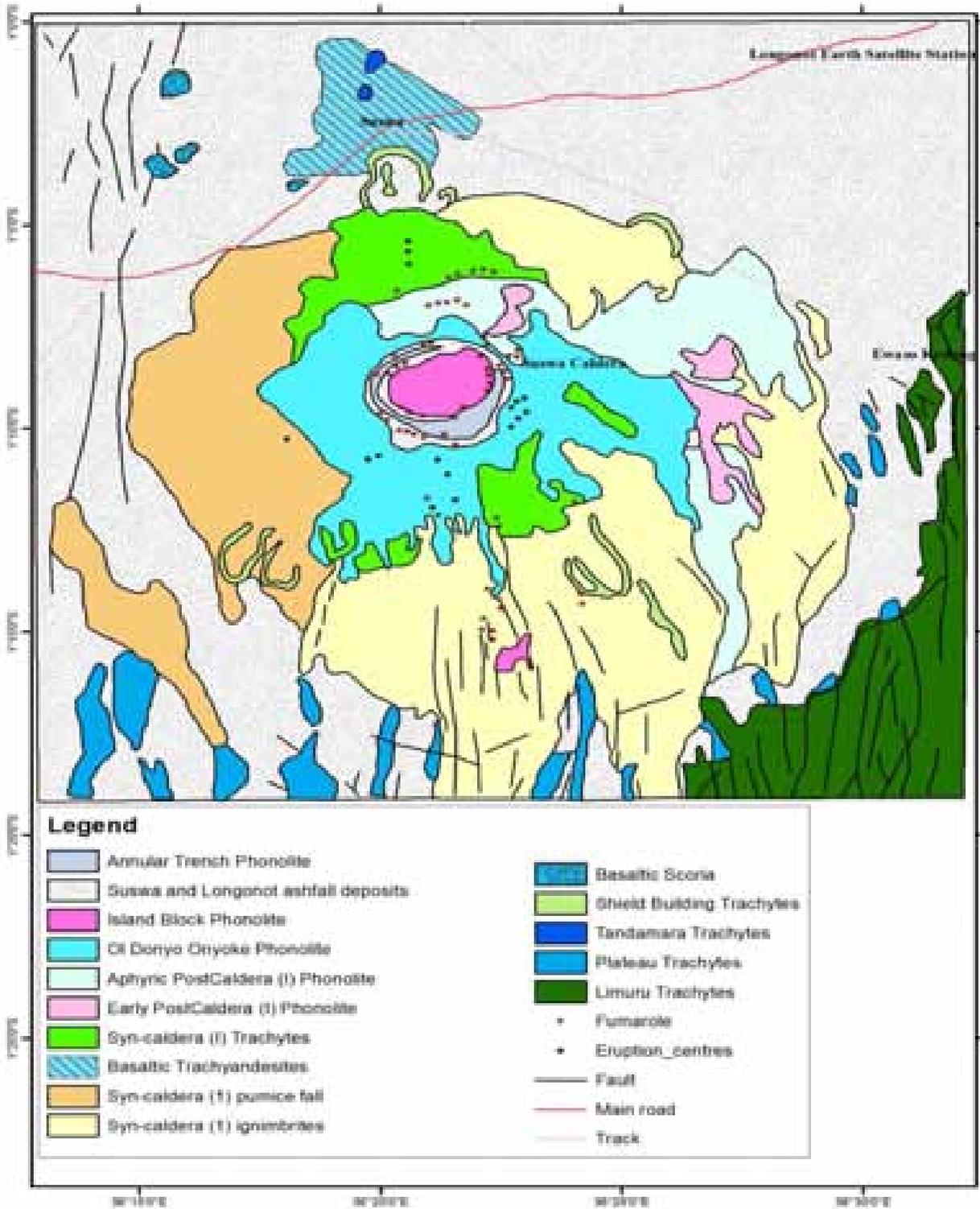
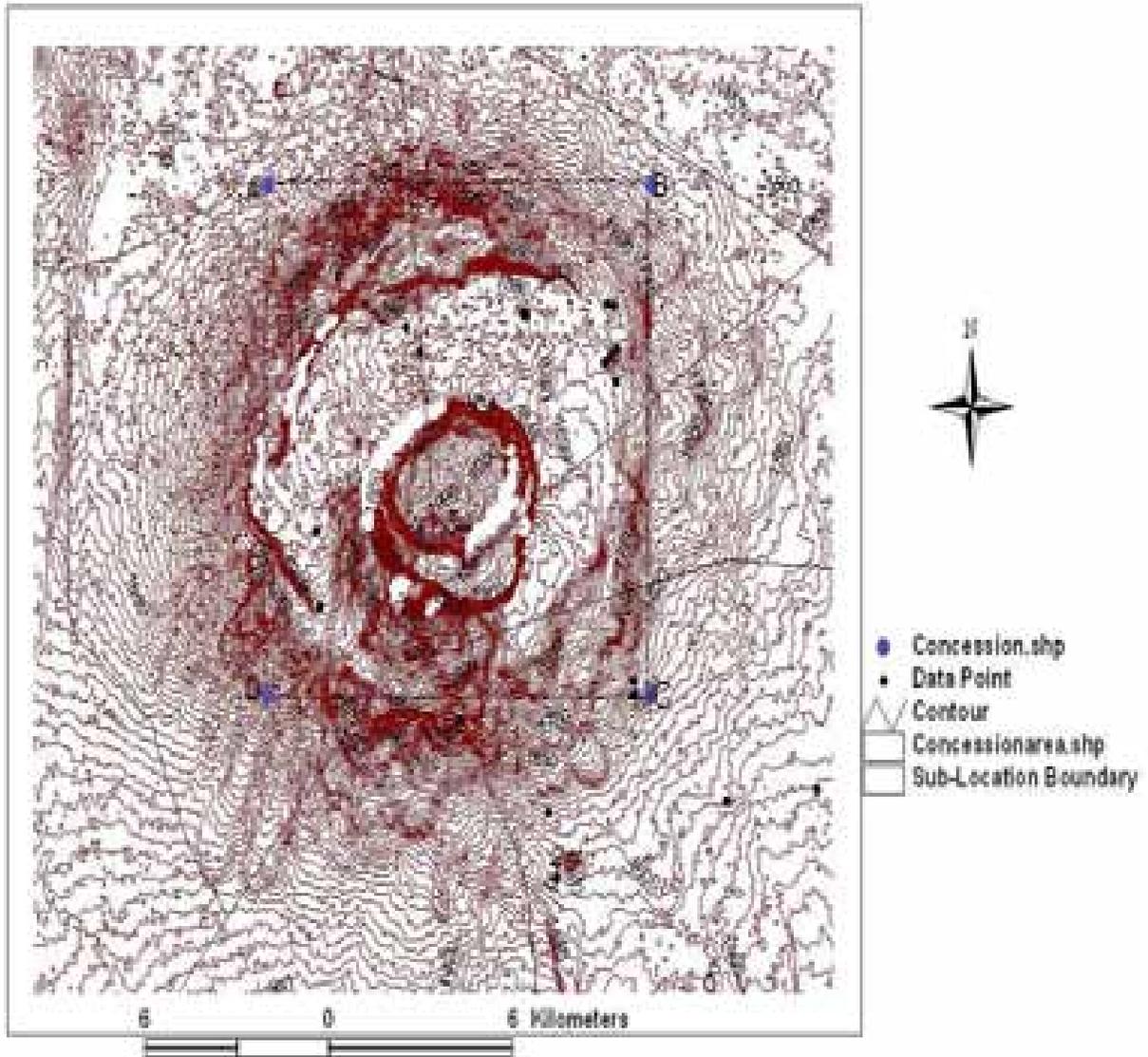


Figure 11: Topography of the Concession Area of Suswa



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

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



Figure 12: Sections of the wall of the Inner Caldera showing landslides and rockfalls to the bottom

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

The Mount Suswa area consists of four major lineaments: Suswa, Ol'Esayeti, Olorgesaille, and Ewaso Kedong. Suswa is a NE-SE lineament that extends from SE of Suswa through the Olkaria West Field joining the Mau rift faults. Other lineaments trending NW-SE or NE-SW pass the Suswa caldera and run parallel to Suswa lineament. One lineament passes through Suswa caldera with a trend ENE-WSW, runs sub-parallel to the Kedong-Ng'iro accommodation zone and joins the Rift scarp at a locality that is also the source of Ewaso Kedong River. Ol'Esayeti and Olorgesaille lineaments are NNW-SSE trending structures that are sub-parallel to the Nguruman detachment and are interpreted as pre-rift (Tertiary) faults that have been rejuvenated during the Quaternary times.

There is only one major volcano-tectonic axis in Suswa and it passes through the Suswa caldera to the Ol'Doinyo Nyoke crater. The axis is defined by an alignment of volcanic centers in the south and Tandamara volcanic center in the north. In the Suswa caldera, the evidence of the tectonic axis is a visible micrograben cutting through the northern outer caldera wall. Minor axes too occur within the caldera. The other major volcano-tectonic axis is the Longonot axis, which joins the crater in Lake Naivasha, Longonot

Volcano, Mlima Panya and a detachment block in the eastern scarp. The south Rift stratigraphy consists of Precambrian metamorphic basement rocks that are overlain by Tertiary volcanics (i.e. basalts, trachytes, and tuffaceous intercalations) within which the magma chamber under Suswa is likely hosted. Overlaying the unit is the Kinangop Tuff Formation (consists of tuffs, welded ignimbrites and trachytes) which in turn are overlain by the Limuru and plateau trachytes which are exposed in the southern sector.

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



Figure 13: The edges of the inner crater: Evidence of landslides and rock falls.



Figure 14: A section of the flat grassy section of the outer caldera floor during the dry season and with evidence of livestock tracts



Figure 15: A section of the flat grassy section of the outer caldera floor during the wet season

4.4 Hydrogeology

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

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

Under the Akira plains, subterranean streams, N-S trending faults and E-W trending faults control the flow, which is deep.

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

4.5 Geothermal Manifestations, Potential, and Accessibility

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

Geothermal manifestations of Suswa are concentrated along the walls of the outer and inner calderas and some are found on the floor of the outer caldera, and a few on the southern slopes of the mountain. The development of the Suswa geothermal system will depend on the up flow within the calderas. The main heat source is most likely located under the inner caldera due to high temperature fumaroles located there. According to Omenda (1993), permeability of the Suswa geothermal system is likely to be low due to abundant dykes expected in the subsurface and deep exploration wells are recommended to access the geothermal resource. Deep well drilling is likely to encounter 'roof' syenitic rocks within a few to several kilometres.

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

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

4.6 Geochemistry

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

(P₂O₅). The total oxide content in Suswa rocks ranges between 97 and 100 percent. This assertion may need confirmation by further geochemical analyzes.

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

4.7 Fumaroles

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

Winds in the area are easterlies and air pollution transport is likely to go westwards. One study (Marani, *et al.*, 2000) continuously monitored changes in hydrogen sulphide concentrations with distance away from the Olkaria I power station and one discharging well (one well being tested) and correlated the changes with weather parameters. The study found that concentration levels of hydrogen sulphide decayed to levels less than 0.3ppm at distances of 0.5km from the power station and several hundred meters from a discharging well. The study found no evidence that hydrogen sulphide contributed to acid rain around the power station vicinity. However, hydrogen sulphide seemed to build up to unsafe levels (considering an 8-hour exposure period) when winds were calm causing poor atmospheric dilution. Dust pollution resulting from project works may have an effect on the local atmospheric conditions.

4.8 Soil Characteristics

The highlands of Narok district have rich volcanic soils suitable for intensive agricultural production and potential for growing wheat, barley, maize, beans and potatoes as well as production of wool sheep and dairy farming. These areas are inhabited by large-scale farmers. The lowland areas are inhabited by nomadic pastoralists and small scale farmers. The soils of the district are diverse in nature. Within the concession area, soils

vary by topography from mountains to plains and seasonal swamps. Most parts of the concession area have deep well-drained soils but there are isolated parts with shallow soils. Water logging occurs mainly in patches on plains and along watercourses. The main soil types in the district are the dark-brown volcanic soils found on Mount Suswa.

The soils on the southern slopes of Mount Suswa are generally shallow and rocky. They appear to be less fertile as indicated by the kind of vegetation which dominates these slopes. Inside the calderas the soils appear to be deep and quite fertile with a high agricultural potential. On the western side, the slopes are well vegetated indicating deep fertile soils. There are intensive agricultural activities on these areas. There is less evidence of soil erosion except along the cattle tracts. These slopes (on the western side) are well covered with grass which reduces incidences of soil erosion.

Figure 16: Unattended soil disposal after road repair along the road to Mt. Suswa crater.



Gullies form as a result of soil erosion. Soil erosion can be generally severe unless the land is carefully managed. In overgrazed rangelands, soils are easily washed away by rainwater. Wild animals also play a significant role in soil erosion. The most noticeable agent of soil erosion in the area is rainwater. Wind erosion is of minimal importance in this area because the area is fairly vegetated. Water erosion involves first the detachment of soil on any bare surface, devoid of vegetation and the actual transport of the detached soil leading to soil loss. Any surface left bare is very susceptible to water erosion. The highest vulnerability to erosion hazard is observed at the slopes of Mt. Suswa. Soil erosion will become a serious problem in the prospect geothermal drilling project area only when the ground cover is removed or run-off patterns disturbed as a result of development activities and fires.



Figure 17: Gullies and evidence of soil erosion on the slopes



Figure 18: Soil erosion showing gullies along the road to Mount Suswa crater showing widening of the gullies after the rains

Mitigation measures to soil erosion include construction of terraces along the slopes of the hills; planting grass and indigenous shrubs and bushes; regulation of grazing techniques and herd numbers among the inhabitants of the Mt. Suswa region in the project area.

Figure 19: Evidence of gully erosion with pronounced gullies



4.9 Water Resources

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

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

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

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

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

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

Other sources of water are the local rivers, boreholes, dams/pans, shallow wells and seasonal streams. The Little Ewaso Kedong River has a substantial flow but the water is not adequate to meet the needs of the people and certainly would not meet the drilling water requirements.



Figure 20: A section of Ewaso Kedong River along the Suswa-Ewaso Road

Table 8. Water Users: Households by main source of water and District¹³

	Pond/Dam	Stream Spring	Rain	Water	Total
Well	Harvested	Vendor Borehole			
Narok North	6,990	24,806 8,977	898	8,458	55,885
Kajiado North	4,227	4,327 30,411	987	20,232	108,358
Naivasha	2,575	5,089 30,277	6,179	27,420	105,318

Kenya National Bureau of Statistics: 2009 Kenya population and Housing Census

4.10 Water Supply

4. 10.1 Water supply issues and concerns

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

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

¹³ Ground water potentiality is very poor and the average distance to water sources range from 6 -15kms (*District Dev Reports 2008-2012*) during the wet and dry seasons respectively. At the same time, the environmental benefit deriving from improved wastewater management will have a greater impact on the ecosystem.

Table 9: Waters Users: Rural households by main source of water

	Pond/Dam	Well/ Borehole	StreamSpring/ Harvested	Rain/ Vendor	Water	Total
Narok North	6,945	24,717	7,744	441	1,097	62,412
Kajiado North	3,811	3,723	12,435	558	3,931	34,427
Naivasha	1,989	3,819	12,923	3,649	4,547	36,293

In terms of range management, open range grazing is the most common method of using pastures. Rotational grazing is limited in areas in which land is owned communially. Paddocking is a common way of managing pastures, water, and livestock herds especially for milking cows. However it was noticed that overgrazing is a key problem facing the grazing ranges especially during the dry season. The range is also an important source of herbs used to cure several human and livestock diseases. Most of the knowledge – grazing, herd management, medicine, and water management – used for range management has been passed over from generation to generation

Figure 21: Livestock watering point on the Ewaso-Kedong Water Supply pipeline



[Notable from the photo is serious water wastage from a pipeline leak. This water point serves both domestic and livestock water supply.]

Figure 22: Dilapidated cattle trough which also serves a drawing point for domestic water supply



Figure 23: Watering point used for washing clothes, bathing and watering livestock.



The water point in Figure 15 is used for washing clothes, bathing and watering livestock. Such an arrangement is susceptible to health risks and water pollution

Figure 24: The last water Tank on the Ewaso-Kedong Pipeline¹⁴.



Figure 16 shows a water tank on the Ewaso-Kedong pipeline system without water and abandoned¹⁵. It is the last water tank along the supply system and is located just outside the main project area.



Figure 25: A water pan inside the outer crater

¹⁴ This is linked to pipeline breakage, hence reduction in pressure to take water to this last point.

The water pans inside the outer caldera are generally very small in size. There are only two water pans which have little water holding capacity compared to the demand of water in the caldera.

Figure 26: Steam jet structures that are used for water collection inside the crater



During the drought period it takes more than a day to fill a 20 litre Jerrican. The water from the steam jets is only used for drinking purposes without any water quality testing.

Figure 27: Water supply collection from steam jets

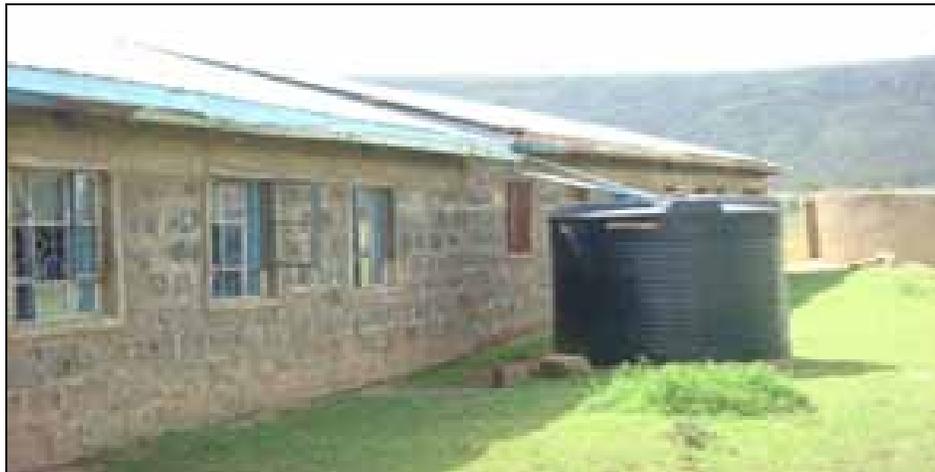


The steam water sources are revered for having some healing power. Although this has not been able to be proven, other evidence shows that such water sources have high fluoride.

Figure 28: Modern steam harvesting structure with a storage plastic tank



Figure 29: Water harvesting tank at Kisharu Primary School inside the outer crater



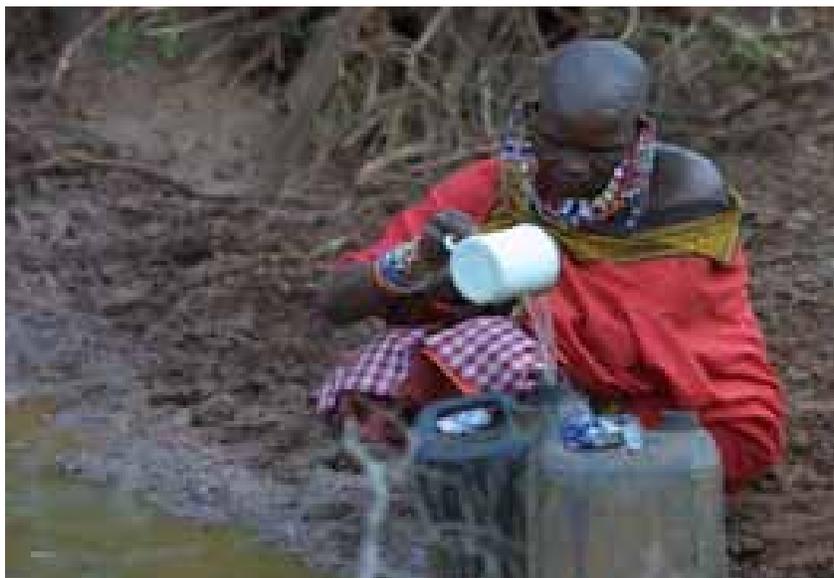
The community needs to be encouraged to embrace water harvesting as a means to supplement the existing meagre water sources in the crater. The provision of safe drinking water and basic sanitation is among the most critical challenges for achieving sustainable development over the next decade and beyond. Suswa and Ewuaso Kedong areas lack access to safe drinking water for households, and to livestock. Most households reported unhygienic disposal of human wastes and the use of the bushes as toilets was predominant. Several illnesses were recorded at the Ewuaso Kedong dispensary ranging from respiratory tract infections (FTI's), Typhoid, Diarrhea, Malaria etc.

Figure 30: Women travel long distances to fetch water on donkeys



Water is hard to find in the sections of Suswa and Ewaso Kedong. Figure 21 shows women travel long distances to fetch and use of donkey to transport water is popular in the area. Humans often share water sources with livestock. Families have to travel long distances in search of water during the dry season, remove children from schools, and men migrate to far places with animals in search of water and pasture. There are no permanent rivers or boreholes. Natural springs are the only dependable sources of water during the dry season. However, the springs are uncovered, undeveloped and easily get contaminated from human and animal traffic.

Figure 31: Contaminated spring water used by community and 5000 cattle during the dry season



Water is very scarce and access to water is a long enduring process throughout the project area. Women trek long distances to obtain their domestic requirement, often limited to 20 litres only during the period due to the distance and load they have to carry. Figure 22 is a contaminated spring water source that serves at least 1000 community members and 5000 cattle during the dry season.

Figure 32: Women trekking to draw water for domestic use



4. 10.2 Possible Sources of Water for Drilling

During the period of field survey two alternative sources of water were identified and are proposed for consideration. These were selected based on their water potentials and proximity to - Suswa project site. The sources are:

- Kanywa Dam near Soko Mjinga along the Naivasha-Nakuru highway (see photos 24-27)
- Water from Olkaria geothermal sites.

Kanywa Dam is located in the Nyandarua escarpment is close to the Naivasha-Nakuru highway and has enough water to supply drilling activities in Suswa especially if supply from Lake Naivasha raises (as it is likely to) complex issues that may delay the project. In particular, issues of ownership of Kanywa dam did not appear complex at the time of the study. Lake Naivasha, is a *Ramsar* site, has unique hydrological conditions and is home to hundreds of bird species and other fauna making it a conservation hotspot. Though Lake Naivasha has no visible surface outlet, it has not become saline despite the high evaporation rates. This indicates a subsurface outflow that has been a major subject of speculation. Ground water resources include the deep geothermal aquifer,

which is not directly linked to the lake, and the upper aquifer of fresh water, which is believed to have a direct link to the lake.

Kanywa Dam an extensive dam covering an approximate area of 32,375m² and representing 9.4% of the total land area of 85 acres (344,000m²). The dam is located in Nyandarua District near the famous Soko Mjinga market along the Naivasha-Nakuru highway. It is boarded by the former Eastern Africa Saw millers which were manufacturing matches. These were the only water users of the water from the dam and had a water intake as shown by the plate below.

Figure 33: A general view of Kanywa Dam



Figure 34: More View of the water dam



Currently Kanywa dam is conservatively holding an approximate amount of water equivalent to 269,000m³. This volume of water is continuously recharged by the prevailing high amounts of rainfall that occurs almost throughout the year from the Nyandarua ranges (Aberdares). The water in Dam is not being used by the community within its vicinity since most of the people have sunk boreholes or wells within their homes. The land where the dam is located slopes in a north-south direction towards Kijabe Hospital and onto the Mai Mahiu area making it ideal for abstraction. If the water is stored in high raised water tank it can flow through gravity to Suswa. However, the project proponents intend to draw water for drilling purposes from the Olkaria geothermal system areas and drilling of water boreholes in the Mai Mahiu – Kijabe/Kinale Forest area.

Major environmental issues identified include:

- Cultivation of horticultural crops near the dam as indicated in plate number
- Livestock grazing near the dam and in the Kinale forest which the proposed borehole site.

Figure 35: Cultivation of Vegetable crops on the Dam sides



The two alternatives sources (i.e Kanywa Dam and Olkaria) are considered based on the distance for the water pipeline to Suswa as well as the use of gravity flow of water as opposed to water pumping. The costs of the tanker option on the other hand would be borne entirely or mostly by the project. This non-permanent cost would be in the Suswa Development Plan costs and would have to be reflected in the power rate. Therefore, it is recommended that pipeline options are not ruled out at this stage and that further discussions could be held between the Ministry of Energy and the relevant authorities to establish whether there are existing plans to provide water to the region

and if future plans exist then they could be expedited to accommodate Suswa and regional development.

The two water supply alternatives (both Kanywa Dam and the Olkaria) are located at high elevations and provide a possibility of gravity flow which would save on any water pumping costs. In either case, the water may be initially stored in a high elevated water tank before being released to flow by gravity to the project area. These water supply alternatives are likely to be less expensive in terms of running costs once handed over to the communities for their operations and management. These water sources (Kanywa Dam and proposed Olkaria pipeline) and any other that may be developed by the company would be handed over to the community once the initial drilling phase is completed.

Figure 36: Dam site showing the water intake of the Eastern African Millers and Match Box manufacturers



The water intake of the Eastern African Millers and Match Box manufacturers has since been abandoned.

Another alternative water supply for drilling is the proposed borehole to be located in Maki location, Kijabe Division of Lari District whose parcel of land lies at approximate coordinates 37N 0233692E, 989708N. The borehole site is at an altitude of about 2530 a.m.s.l and is within the Kenya highlands. The climate of the site is sub-humid with rainfall for most of the year. The rainfall is bimodal (occurring March-May, October-December) with an average annual rainfall ranges from 1000-1600mm. The mean daily minimum and maximum temperatures are 10-20°C (TAMS, 1980). The average potential evaporation is between 1,300-2,100mm per year (Sombroek, *et al*, 1980).

The community water demand at the proposed borehole site is estimated at 60m³/day but this yield will need to be supplemented by another source in order to serve drilling water requirements particularly at the initial stages of the drilling phase. The hydrogeological survey report of the area indicated that groundwater occurs in highly transmissive coarse sediments within the lava flows or tuffs and/or fractured zones within the tuffs. There are six boreholes within the proximity of the proposed borehole site. Table 10 provides the aquifer characteristics with notes that explain the terms and symbols as used in the investigation. The numbers 1 to 9 in the notes are the columns in the table. The lowest borehole identification numbers (2138 and 9518) the oldest holes and the recent boreholes have been drilled by Constituency Development Fund (CDF) in Lari.

Table 10: Location of boreholes in the areas near Mount Suswa

1	2	3	4	5	6	7	8	9
ID	Owner	Year Drilled	Distance / Bearing	Depth ⁵ (m.)	WSL ⁶	WRL ⁷ (m.)	Tested Yield (m ³ /hr)	PWL
2138	Kenya Railways	1953	6/SE	124	46	35	13.6	45
9518	AIC Kijabe Hosp	1991	1.8/SW	193	26(i),41(ii)	7	4.62	145
11674	Rift Valley Academy	1997	1.5/SW	114	43(i),103(ii)	45	18.4	97
13433	Rift Valley Academy	2001	2/SSW	202	38(i),91(ii)	69	2.8	124
CDF BH 1	Lari	2007	8/SW	200	55(i),164(ii)	150	5.0	154
CDF BH 2	Lari	2007	8.2/SSW	200	45(i),78(ii),162(iii)	110	30	162.1
Average				172			12.4	

Source: Hydrogeological Report (2005).

Notes:

1. Identification Number by the Ministry of Water and Irrigation
2. Owner of the Borehole
3. Year drilled

4. Distance/Bearing to borehole
5. Total drilled depth in meters below the ground level (m bgl).
6. Water Struck Level (WSL) (i), (ii) and (iii) depth at which the aquifer was encountered in metres below ground level (m bgl).
7. Water Rest Level (WRL), depth of piezometric surface or water table in metres below ground level (m bgl).
8. Tested yield in m³/hr (generally higher than sustainable yield).
9. Drawdown-Maximum draw during the Test Pumping, given by Piezometric Water Level (PWL)

The report further indicated that the site is located in a hydrogeological zone which is characterized by a variable groundwater potential. Boreholes within the area have been tested at yields ranging between 2.8 to 30m³/hr with an average of 9.9m³/hr. The average depth of the boreholes in the area is 172m.

The boreholes specific capacities, S, were calculated, (Driscoll, 1986):

$$S = Q/s \quad \dots\dots\dots (1)$$

where

Q is the yield during the pump test, and

s is the draw down i.e., PWL-WRL.

Transmissivity, T, on the other hand was calculated using the formula:

$$T = 0.183Q/s \quad \dots (2)$$

However, this formula is applicable where the test data is available in log scale which was not the case in the survey. The estimated transmissivity, T, using the Logan's formula (Logan, 1964):

$$T = 1.22Q/s \quad \dots\dots\dots (3)$$

The drawback of this estimate is that it sometimes over estimates, nevertheless the formula gives a fair indication of the transmissivity. The results of the calculations are presented in Table 11.

Table 11: Specific capacities and transmissivity of the boreholes within the site area

ID	Owner	Yield (m ³ /hr)	Draw down (s) (m.)	Specific Capacity s-m ³ /m/hr	Transmissivity m ² /day
2138	Kenya Railways	13.6	10	1.36	39.8208
9518	AIC Kijabe Hosp	4.62	135	0.034222	1.002027
11674	Rift Valley Academy	18.4	52	0.353846	10.36062
15423	Rift Valley Academy	2.8	55	0.050909	1.490618
CDF BH 1	Lari	5.0	4	1.25	38.6
CDF BH 2	Lari	30.0	52.1	0.575816	16.85988
Average				0.604132	17.68899

Source: Maki Location hydrogeological survey report.

Table 11 indicates that the boreholes are characterized by small to large draw downs. The specific capacities and transmissivities of the boreholes are high with an average of about 0.60m³/m/hr and 17.7m²/day respectively. This indicates a good potential for groundwater in the area.

Simple estimations of the hydraulic conductivity derived as:

$$T = K.D \dots\dots\dots(4)$$

where

K is the hydraulic conductivity (m/day),

T is the transmissivity (m²/day), and

D is the aquifer thickness, (m).

Rearranging, (4), we obtain

$$K = T/D \dots\dots\dots (5)$$

Aquifer thickness within the area was estimated at 50m.

Groundwater flux (Q) can be estimated using the Darcy's formula:

$$Q = T.i.W \dots\dots\dots (6)$$

where:

Q is Groundwater flux (m³/day)

T is the transmissivity (m²/day) of the borehole,

i is the gradient, and

W is the width (m).

The slope, I , is calculated from average of several areas and is about 0.10. W is taken to be the width of 1km or 1000 m. Some of the results from the survey are indicated in Table 12.

Table 12: Hydraulic conductivity and groundwater flux derived from adjacent boreholes

Borehole Identification	Owner	Hydraulic Conductivity (m/day)	Groundwater Flux (m ³ /day)
2138	Kenya Railways	0.99552	3982.08
9518	AIC Kijabe Hospital	0.025051	100.2027
11674	Rift Valley Academy	0.259015	1036.062
13423	Rift Valley Academy	0.037265	149.0618
CDF BH 1	Lari	0.915	3660
CDF BH 2	Lari	0.421497	1685.988
Average		0.442225	1768.899

Source: Maki Location Survey Report.

4.11 Flora and fauna

4.11.1 Flora

The most dominant vegetation types in Suswa area are the evergreen and semi-evergreen species. About seven vegetation communities were distinct: grassland; bushland; *Juniperus* woodlands; bushed grassland; bush-shrubland; shrub-grassland, and rock outcrops. Topography, soil type, drainage and rock structure seem to be some of the factors that dictate the geographic distribution of these vegetation communities. The largest open grassland consists of *Cynodon*/*Digitaria* associations found in relatively flat areas of the mountain Volcano. The dominant grass species are *Cynodon dactylon* and *Digitaria scalarum*, although the former dominates the dense tall clumps. Other common species include *Themeda triandra*, *Harpachne schimperi*, and *Justica* sp. There is also a sparse distribution of *Tarchonanthus comphrotus* (Leleshwa) and *Acacia drepanolobium* in the clump areas.



Figure 37: Grassland and Shrubs in the Project Area- *Tarchonanthus camphrotus* (Leleshwa) **Figure 38** *Acacia drepanolobium*

The dominant plant species in the bushland are *Tarchonanthus camphoratus* and *Acacia drepanolobium*. The bushland is open and extensive with diverse topography which forms micro habitats in the Suswa areas. The most common woody species are *Acacia drepanolobium* and *Tarchonanthus camphoratus*. The bushland areas also have combinations of grasses and other herbaceous species including *Setaria sphacelata* and *Eragrostis cilianensis*. *Chloris gayana* appears in patches that are more open.

Juniperus woodlands cover various parts of the area in the caldera and foot of the mountain. The most dominant species are *Acacia xanthophloea*, *Juniperus procera* (cedar), *Ficus thonningi*, *Dodonea viscosa*, and *Euphorbia inequilatera*. The distribution of this community of vegetation is probably related to differing water retention capacity of soils and geothermal features such as steam vents. These areas are also likely to form important grazing areas of the local Maasai people.

The bushed grassland community occupies an extensive part of Suswa area. The dominant woody species are *Tarchonanthus camphorates* and *Acacia drepanolobium*. Another woody species is *Dodonea latifolia*. The dominant grasses of this vegetation community are *Digitaria macroblephara*, *Cymbopogon caesius*, *Setaria sphacelata*, and *Themeda triandra*. *Cynodon* occurs in raised grounds and is frequented by wild animals. *Setaria sphacelata* mostly occurs in sloppy rocky grounds with shallower soils while *Digitaria* is found in areas with deeper soils. Plant species such as *Striga sp.*, *Cassia mimosoides*, *Hibiscus*, *Salvia monsomia*, *Tephrosia* are the herbaceous species of the bushed grassland community. The bushed shrubland

community dominate the Olugumi area of Mount Suswa, continues upward the Suswa outer caldera and ends at the top of the caldera. The area is characterized by shallow soils with *Acacia drepanolobium* being the dominant species. There is also *Tarchonanthus comphratus* but tends to be stunted in growth.

Within the shrubbed grassland community, the dominant vegetation type is a composition of *Tarconanthus*, *Acacia*, *Cymbopogen*, *Themeda* and *Setaria*. Tall *Tarchonanthus comphratus* shrubs sometimes grow to tall trees. The dominant grasses in this community are *Cymbopogon caesius* and *Themeda triandra* with *Setaria sphacelata*, *Zornia apiculata*, *Indigofera sp*, *Ocimum sp*, *Achyranthes asperacleome monophylla*, *Heliotrioium sp*, a *Chenopodium sp* occurring in association.



Figure 39: *Acacia Tortilis* in degraded land resulting from over stocking

This tree lies next to the rim of the outer caldera. It is socially important because it acts as an informal meeting point for local people to chat about everyday issues facing their community.



Figure 40: Forest cover on the outer slope of the inner caldera.

The list the plant species found within the Mount Suswa Geothermal Project area shown in Annex I.

Current degradation of vegetation around Suswa geothermal area is a result of the encroachment on forests especially uncontrolled felling of indigenous trees and clearance of vegetation cover can undermine the functioning of ecosystems in the area. Some felling of trees was observed around Suswa most probably motivated by demand for charcoal in neighbouring urban centres, demand for land for crop cultivation, and human settlement. Loss of vegetation might also result from poor grazing practices. Without interventions, future development and expansion of infrastructure such as schools and markets would cause further vegetation loss. Conservation measures include protection under the Mt. Suswa Conservancy, prohibition of deforestation and timber harvesting.

On whole, the vegetation of the project area includes acacia trees, grass and indigenous shrubs and bushes. The outside of the outer caldera has sparse vegetation and volcanic rocks; the inside of the outer crater has fertile flat land with grass, bushes and trees; the inner crater is deeply forested and has generally remained untouched by human activities.

4.11.2 Fauna

The distribution of large animal species was estimated by transect walks, and surveying along roads and footpaths. The survey identified important habitats and got information from local people regarding wild animal sightings.

The following large animals have been sighted in outer caldera area: Thomson's gazelle, Dik-dik, and Grant gazelle. Locals reported having sighted Hyrax, Leopard, Lion, Hyena, Elephants, and Buffalo. According to local people, elephants visit the area particularly in the month of July, may be to feed on the lush vegetation in area during this time of the year. However, local people confirmed that such elephant visits are not regular. Baboons and monkeys are also common around the cave system found on the southern sector of the outer caldera. The avifauna sighted included Kori Bustard and Secretary Bird. Further around the Suswa Police Post located along Road B3, there were sightings of Zebra and Kongoni (Cokes' hartebeest).

Figure 41: Kori Bustard bird inside the crater



Kori Bustard bird, the largest flying bird on the earth was seen inside the crater.

Zebras and Thomson's gazelle seem to be the most abundant large animal species in the Suswa ecosystem. The Kongoni are often found with zebra because the association leads to ecological facilitation in which the zebra eats the tougher stalks and stem of grass while leaving the grass for the Kongoni. An animal count in 2010 by the Kenya Wildlife Service (KWS) on the Akira Ranch is shown in the Table 13.

Figure 42: Vegetation cover typical within the caldera



Figure 43: Typical vegetation cover *Acacia drepanolobium* within the caldera



Table 13: Wild Animal Counts on Akira Ranch in April 2010

Type	Count
Zebras	585
Thomson's Gazelles	2835
Grant Gazelles	300
Elands	200
Dik Dik	16
Impala	186
Warthogs	9
Giraffes	51
African Hare	3
Guinea Fowl	73
Duiker	10
Ostrich	29
Kongoni	300
Buffaloes	176
Hyena	2

Source: KWS Records, 2010

The KWS count in Table 13 was restricted to Akira ranch that is located more or less on the plains and therefore does represent the fauna on Mt. Suswa itself.

The species distribution of the wildlife indicates that water-dependent animals are the majority hence the tendency for fauna to move to the watering points during droughts but found scattered all over the plains during the wet season. Wild animals are likely to drink from drilling water storage pond if such ponds are not properly fenced.

4.11.3 Large-eared Free-tailed Bat/Giant Mastiff Bat *Otomops martiensseni*

At the local caves there is a unique species of bats. Government of Kenya has applied for the inclusion of the African population of Large-eared Free-tailed Bat/Giant Mastiff Bat *Otomops martiensseni* on Appendix 2 IUCN Red List Categories and Criteria Version 3.1. Another proposal for the inclusion of *O. martiensseni* on Appendix II was sent independently by the Government of the Democratic Republic of the Congo. The details of the Suswa bat are:

Taxon:

1.1. Class: Mammalia

1.2. Order: Chiroptera

1.3. Family: Molossidae

1.4. Genus/species/subspecies: *Otomops martiensseni* (Matschie, 1897)¹⁶

1.5. Common name: English: Large-eared Free-tailed Bat, giant mastiff bat

French: Grand molosse à grandes oreilles

At the time of the first cave explorations on Mount Suswa, *Otomops martiensseni* (Matschie 1897) was very common although in certain caves only (Glover *et al.* 1964, King 1971). Its presence in the area is documented by seven specimens collected on 20th March 1963, 3rd and 5th August 1963, and on 18th October 1964 (Harrison 1965). Williams (1967) recorded large colonies in deep, remote caves on Mt. Suswa and it was estimated that the lava tunnel network in this area harboured hundreds of these bats (Hayman 1967, Hayman and Hill 1971).

The few colonies that have been found contain many hundreds of bats packed close together in the lava tunnels on Mt. Suswa (Kingdon 1974) later confirmed by Timberlake (1977) in Suswa Cave 18, see also STEPHAN, H who reported specimen SMF 57456-7 on 29th April 1979; quoted by BARON *et al.* 1996a). In 1982 the Mount Suswa population in Cave 18, and in connected lava tubes, was still regarded as one of the largest known colonies (SIMONS 1982). In June 1985, LEWIS (1985) found the floor of one cave, used as set by film makers, full of hundreds of *O. martiensseni* were still present. Later, KINGDON (1997) estimated, that *O. martiensseni* congregated in the tens of thousands in their breeding caves of which only two were known in Kenya at that time. The second one in the Ithundu (Kimakia) lava tube (02°21'31"S - 37°42'50"E, map sheet SA-37-10 Kibwezi, Kajiado Distr., Kenya. Both were larger than any other known colony of *O. martiensseni*.

4.11.4 Land Tenure and Land Use

Land ownership in Maasailand is wrought with uncertainties because very few areas have title deeds. In Mount Suswa area the community members have title deeds to the land, in which a large majority had been born in, but the few who did not have title deeds confirmed that survey and adjudication had been done, plot numbers given and sketch maps completed pending issuance of title deeds. The land size ranged between 50 - 250 acres per household. The average land size held by most community members was about 100 acres per household. In these parcels, mixed farming is practised in the highland areas of Ewuaso, Suswa and Mai Mahiu, including the lowland areas of Naivasha. The crops grown are maize, beans and potatoes, which are cultivated using hoes and tractors ploughs. Land was owned by the community and utilized based on membership of the sections. The group ranch concept represented a

¹⁶ Quoted in Petr Benda^{1,2*}, Masaa M. Al-Jumaily³, Antonín Reiter^{4,2}, Abdul Karim Nasher³, Noteworthy Records Of Bats From Yemen With Description Of A New Species From Socotra, *Hystrix It. J. Mamm.* (n.s.) 22(1) 2011: 23-56

new approach to pastoral development and was a first attempt to radically transform a nomadic subsistence production system into a sedentary, commercially oriented system. It called for major changes in Maasai social and political organization and livestock management strategies.

The group ranch development plan envisaged:

- Adjudication of trust land into 'ranches' with freehold title deeds held by groups
- Registration of permanent members of each ranch; these members were thus to be excluded from other ranches
- Allocation of grazing quotas to members to limit animal numbers to the carrying capacity of the ranches
- Development of shared ranch infrastructure such as water points, dips, stock handling facilities and firebreaks, using loans. Members would pay user fees and be collectively responsible for loan repayment
- Members would manage their own livestock and would be able to obtain loans for purchasing breeding stock and cattle for fattening
- A group ranch committee would be elected to manage all group ranch affairs including overseeing infrastructural development and loan repayments; enforcing grazing quotas and grazing management; and maintaining the integrity of the group ranch boundary.
- The Group Ranch Committee would be assisted by a hired ranch manager and the extension service

Clearly the Maasai espoused the concept of group ranches largely to stem encroachment of farmers of other ethnic groups on Maasai territory and because of the promise of finance to develop ranch infrastructure. Boundary maintenance was also an integral part of the group ranch concept. By tying people to small fixed areas of land, it was hoped to sedentarize the Maasai, to make them aware of the scarcity and value of land, and to encourage them to make the investment necessary to improve the land. Clearly the Maasai now realize that land is both finite and valuable, and increasingly, they identify with their group ranch rather than with their section.

The group ranch structure reduced the flexibility and mobility of the traditional Maasai system and The Maasai no longer move freely to within their sections or even within their subsection. Some localities and even neighborhoods have been split by group ranch boundaries. Group ranches exacerbated the erosion of traditional authority promoted in colonial times, including the authority to control grazing resources, but in general the group ranch committees were not able to replace the traditional authorities. The group ranch concept did not work due to many problems and Suswa Group Ranch has since been subdivided into individually owned pieces of land measuring 30 acres each.

These portions of land are inadequate in sustaining a pastoral lifestyle and the Maasai in this area move their livestock to other areas including Mt. Suswa for grazing.

Land use varies with altitude. With reliable rainfall and good fertile soils, the highland sections are host to large scale farms of wheat, barley, maize, beans and potatoes as well as production of wool sheep and dairy farming. The lowlands are characterized by less reliable rainfall and poor quality soils. These areas offer good pasture for ranching and are therefore used for livestock production. There is also cultivation of sorghum, millet and sweet potatoes within these areas. Livestock keeping is predominant on the slopes of Mount Suswa but there is subsistence cultivation of maize, beans and potatoes within the caldera floor.

On the Kajiado side of the project area, land has been subdivided and a freehold system is in place. However, the cattle economy of the Maasai people still necessitates a communal approach to pasture and water management. Pasture and water commons are still a favoured approach to traditional natural resource management. The land freeholders are not allowed to make individual decisions about land without involving the community. This means households cannot decide how to use their parcels without involving the community leadership. Subdivision may have been a strategy to protect the Maasai land from possible invasion by outsiders. On the Narok side of the Suswa Volcano, a communal land tenure system is still in place. Regardless of which side (whether in Kajiado North or Narok North District) a Maasai homestead may lie, the people of Mount Suswa see themselves as one people. The Ranches are privately owned. Lack of water and competition for it is a key primary problem that limits production in the area. Conflicts over water escalate during the dry season and periods of drought. Such conflicts are often best resolved by traditional leadership assisted by local government administration.

CHAPTER 5: SOCIO-ECONOMIC CHARACTERISTICS OF THE PROJECT AREA

5.1 Socio-cultural system of the Maasai and its application to the proposed project

The Maasai community operates a patriarchal system with clear social status and roles for members – men, women, and children. A man is the unquestionable head of the family and is allowed by customs to marry as many wives as he wants, but each wife has her own hut in a homestead/*boma* (*manyata*). Women bear the responsibility of building the huts in a *manyata*. Husbands are the owners of most family stock but wives are allowed to own a few. Women also milk the cows. Young boys are inducted early into a culture of herdsmanship while girls help their mothers with household chores such as fetching water and firewood. When a boy reaches a certain age - about 15 years – he is initiated into another key stage of life called Moranism. *Morans* have a duty to be brave and to protect the community from any real and perceived dangers and enemies. The initiation takes place by circumcision, seclusion and graduation in that sequence. *Morans* form the defence of the community and are not allowed to marry until they graduate into junior elders. Once, a junior elder, a *moran* can marry and raise family. A junior elder who demonstrates extraordinary wisdom may be promoted to a senior elder, a key social position within the Maasai people. Among the senior elders, the community gets its political leadership. The Maasai also have another leader called the *Laiyon* who is the community's overseer or prophet. The *Laiyon* foretells how certain events and activities (such as the proposed project) will affect the community in future. His authority and predictions are unquestionable and religiously followed.

The Maasai have been going through a socio-economic transformation necessitated by modern pressure. Cultural practices such as marrying off girls at an early age and cattle raiding are on the decline and, most have embraced and recognized the value of education. Though still trailing many other parts of Kenya, it is not uncommon to meet Maasai intellectual and professional elites. The community's members also continue to up their participation in the modern economy. However, the Maasai socio-cultural system still revolves around the livestock economy. Livestock remains the most important asset (in terms of social value) to a Maasai household.

The Maasai community has customary laws that protect the culture, wildlife and habitat. For example, the customs prohibit the people from fencing around water holes or grazing pastures. Wildlife is free to drink water and graze anywhere in Maasailand. Their law also prohibits, through taboos, the Maasai people from consuming game meat. The Maasai community established their customary laws with a great deal of thought and concern to the ecosystem and culture. There is strong adherence and commitment to their traditional law and sacred places around the project prospect area of Mount Suswa.

Table 14: Population Distribution by Sex, Number of households, Area, Density and District

Location	Male	Female	Total Population	Number of Households	Rea (km ²)	Population density
Narok North	132,911	125,633	258,544	55,885	4,662.7	55
Kajiado North	195,955	191,583	387,538	108,358	7,400.9	52
Naivasha	190,082	186,161	376,243	105,318	3,034.6	124

Source: Kenya National Bureau of Statistics -2009 Kenya Population and Housing Census



Figure 44: Maasai homestead within the floor of outer caldera

The community lives in the vicinity of the conservancy adjoining community land and stretch up to the outer caldera forming part of the geothermal drilling project area. The land in this area is owned by individual private ownership. The development of the power plants is unlikely to displace or directly affect any of the indigenous community and their culture. Though there is likely to be some limited interaction with the community in-terms of project operations and maintenance, including increased number of visitors to the Mount Suswa Conservancy and the caves, methods of ensuring that they benefit from the project has to be devised.

The Maasai communities will also enjoy gains from infrastructure development, including provision of potable water, initially intended for the use during drilling of the first exploratory wells. The community should organize themselves and seek partnerships to extend access to Ewuaso Kedong Township, Najili market, Duka Moja and Suswa market centres. Additional benefits arising from construction of the roads to the

geothermal sites include improved access road to the primary schools within the project area. The community suggested a need for a new secondary school as there is none in the neighbourhood of the nine primary schools to absorb some of the pupils in transition.

Table 15: Demography of Ewaso Division

Sublocation	Male	Female	Total	Number of Households	Area (km ²)	Population Density
Enkorika	1,150	1,113	2,263	432	263.3	9
Nkiushin	1,373	1,415	2,788	584	58.9	47
Kisharu	364	413	777	148	21.7	36
Najile	1,805	1,868	3,673	664	170.3	22
Olgumi	773	920	1,693	300	57.9	29

Source: Kenya National Bureau of Statistics -2009 Kenya Population and Housing Census

In the project area and adjacent areas, local Maasai tribesmen revere Mount Suswa and perform important cultural ceremonies at this mountain. Locals refer to the two neighbour Mountains Suswa and Longonot as Twin Mountains and the land between them as “land of blessings” or “land between the Twin Mountains”. The land between the two mountains also forms a grazing range for people of Suswa. Local Maasai believe that people who live in this land are blessed with plenty of everything – livestock wealth, freedom from disease, fertility and children, water and pasture, food, and peace. Local people graduate Maasai *Morans* at Mount Suswa just as they bless barren women and pray for the healing of the sick at the same place. Testimonies abound that such blessings always work – for example, barren Maasai women blessed at Mount Suswa start having children. Local people also believe that ancestors often speak to the people from the deep moat or gorge that form the inner caldera. The Maasai people make the most important socio-cultural and political declarations at Suswa market.

5.2 Population, demography and human settlements

5.2.1 The Maasai household and potential benefit from the project

The community inhabiting the Suswa Geothermal Concession area in Kajiado North and Narok North Districts is a homogeneous Maasai population predominantly from the Keekonyokie clan. Other smaller clans include the Suswa, Ilmakesen, Ilmolelian, Ilmorelian, Ilukumai, and Irkeiakishu respectively. The present consultation confirmed the following:

- The inhabitants of the prospect project area are mainly a pastoralist community that keeps cows, goats, sheep and donkeys.

- The total population is the Maasai and the accurate number of inhabitants could be ascertained only by the enumeration of households. (see Annex 8).
- Many respondents regarded their present location of residence as their permanent homes, though they sometimes split herds, especially during droughts, and move their livestock to some other places including the higher parts of Mount Suswa, for a while in search of pasture and water.

Table 16: Demography of Ewuaso Division in Kajiado North District

Location/Sub-locations	Male	Female	Total Population	Number of Households	Area (km²)	Population Density
Oloombokishi	1,534	1,275	2,809	666	86.2	33
Enooseiya	1,867	1,677	3,544	824	26.6	133
Olopironto Location	3,401	2,952	6,353	1,490	112.8	56
Enoosopukia Location	5,565	5,100	10,665	2,187	401.8	27

Table 17: Demography of Mau Division in Narok North District

Location/Sub-Location	Male	Female	Total Population	Number of Households	Area (km²)	Population Density
Suswa	2,354	2,349	4,703	867	84.5	56
Olesharo	1,227	1,158	2,385	458	151.5	16
Oloikarere	1,984	1,593	3,577	862	165.8	22
Suswa Location	5,565	5,100	10,665	2,187	401.8	27

Source: Kenya National Bureau of Statistics -2009 Kenya Population and Housing Census

Table 18: Demography of Districts and by Divisions of Mount Suswa Area

District/Divisio	Male	Females	Total Population	Number of Households	Area (km ²)	Population debsity
Naivasha District	190,082	186,161	376,243	105,318	3,034.6	24
Mai Mahiu Div	19,282	19,264	38,243	9,661	582.6	66
Narok North District	132,911	125,633	258,544	55,885	4,662.7	55
Suswa Div	5,565	5,100	10,665	2187	401.8	27
Kajiado North District	195,955	191,583	387,538	108,358	400.9	52
Ewaso Div	18,208	19,065	37,273	7,501	2,934.3	13

Source: Kenya National Bureau of Statistics -2009 Kenya Population and Housing Census)

The goal of development is to expand the capabilities of people to live the lives they choose to lead (*Amartya Sean 1990*). Development aims at improving people's lives (livelihoods, security, environmental, physical and mental well being) and it is most appropriately defined with their active participation. Maasai pastoralists inhabit the outer caldera but the inner caldera is not inhabited and densely forested.

The main socioeconomic activity in the outer caldera is pastoralism. Drilling would require careful handling of all waste streams to eliminate poisoning of livestock that might consume it. Any livestock poisoning accidents could undermine local support for the project since the Maasai people place high premium on their livestock. There is also some crop cultivation of maize, potatoes, and beans as well as tourism. The prospect geothermal drilling project will certainly alter the current socioeconomic profile of the local area.

Table 19: Kisharu Settlement Scheme and Households

Area	Number of manyattas/bomas
Morogo	10
Outer Caldera Floor Side A	9
Outer Caldera Floor Side B	19
Outer Caldera	18
Total	56

Table 20: Number of households in the Sampu Orkuo Location

No	Population	Nos. of manyattas/bomas
	Ntingunini	16
	Chachu	3
	Sempui	12
	Maria	8
	Moitalel	10
	Ntiparo	27
	Nkayiyia	39
	Koseli	16
	Jeremiah	12
	Sarite	20
	Ole Kerenke	21
	Korioko	21
	Isaka	9
	Lemolinka	21
	Kauntai	9
	Lazaro	23
	Kitashi	23
	Total	50

Source: Mr. Jeremia, Chairman, Suswa Conservancy.

Table 21: Location of Households within the Suswa Concession Area, Suswa Side

Name	Description	Northings	Eastings
Homestead	Household interviewed	9875813	0210827
Homestead2	Household interviewed	9875645	0210653
Homestead3	Household interviewed	9875481	0210468
Conservancy camp	Suswa conservancy field office	9875355	0210325
Homestead5	Household interviewed	9876795	0210761
Pentecost Church	Inside the outer crater	9876570	0207897
Gicheru (Kisharu) School	Primary school	9876657	0207792
Olng'uswe School	Primary and Nursery School	9876308	0203993
Homestead6		9871701	0201083
Homestead7		9869988	0201184
Entrance to the caves	Tourist attraction. The names of the caves that converge at this point are 14A, 14B and 14C	9875082	0210846
Sign post to Suswa Conservancy caves	Road marking	9876842	0210523
Steam collection points	Steam is trapped, cooled and collected	9875766	0204422

Table 22: Location of Households within the Suswa prospect project Area, Ewaso Kedong' Side

Name	Description	Northings	Eastings
Water tanks	The tanks were constructed for storage but are empty (outside the concession area)	9865871	0217379
Tank2	At Olo Dung'oro, Enkorika (outside the concession area)	9865604	0214436
Homestead		9868338	0211389
Homestead		9868035	0211426
Tank3	Constructed using CDF at Soitamutai (outside the concession area)	9863865	0208904
School	Government constructed	9865350	0208633
School	Government constructed	9867435	0205744
Homestead		986800	0211345



Figure 45: Some settlements inside the caldera showing a mixture of traditional manyattas and modern buildings.



Figure 46: Traditional homestead also called *manyatta*

Table 23: Population of the districts of Suswa Area

Mai Mahiu Division, Naivasha District						
Location/Sub Location	males	Female	Total Population	Number fo Households	Area (km ²)	Population density
Mai Maahiu	12,659	12,402	25,081	6,538	392.6	64
Satellite s/location	2,557	2,294	4,851	880	288.5	17
Suswa Location Mau Division in Narok North District						
Suswa Sublocation	2,354	2,349	4,703	867	84.5	56
Olesharo Sublocation	1,227	1,158	2,385	458	151.5	16
Enoosopukia sSubloc	7,412	7,122	14,534	2,984	224.1	65
Ewaso Division in Kekonyokie North Location in Kajiado North						
Inkiushin Sub-location	1,373	1,415	2,788	584	58.9	47
Kisharu	364	413	777	148	21.7	36
Olgumi	773	920	1,693	300	57.9	29
Najile Location						
Ewaso & Olentoko Sub-locations	1,805	1,868	3,673	664	170.3	22
Enkorika Sub-location	1,150	1,113	2,263	432	263	

Source: Kenya National Bureau of Statistics -2009 Kenya Population and Housing Census

The population by each District, Division, Sex, density in the administrative units is given in the Table 22. Table 23 shows the analysis of the household composition and land ownership. The number of respondents was males composed of upwards of 92%.

Table 24: Household Analysis

Analysis	Number	%
Number of Households Sampled	40	
Valid	38	
No. of Males respondents	35	92%
No. of Females respondents	3	8%
Households Practicing Crop Farming	28	74%
Households Not Practicing Crop Farming	10	26%
Average Acreage of Land Owned in Kajiado North	173.0	
Average Acreage of Land Owned in Narok	29.7	

Suswa Market is in Enosopukia Sub-location in Enosopukia Location in Mau Division. The population of Suswa Market cannot be separated from that of the sub-location.



Figure 47: Typical housing upgrades inside the caldera



Figure 48: Modern and traditional housing in the Caldera

Ewuaso Township and Najile Market get supplies from Kijabe pipeline which ends at Najile. There are masonry tanks at ground level serving domestic users and livestock, but pressure is very low and often no water reaches them. Some tanks are dry and pipes broken at sections although no spillage was witnessed which confirmed that no water was flowing.



Figure 49: Modern homestead with permanent structures

5.5 Health Sector

5.5.1 Access to Health Facilities

While it is commonly believed that health impacts are social impacts, a qualified health impact assessment expert may be considered to thoroughly examine the health impacts that are likely to occur as a result of a geothermal project drilling, implementation and operation.

There are two public hospitals in Kajiado District, namely at Kajiado town and at Oloitokitok while two hospitals are located in Narok town and in Kilgoris in Narok District. There are four health centres at Suswa, Eraso, Olgumi and Najile. The respective dispensaries are located far from the communities and they resort to ride on donkeys ambulances to carry the sick. The private hospitals include Kijabe Mission Hospital in Naivasha District, Tenwek Hospital in Bomet District and Maela District Hospitals. Referral cases are sent to hospitals in Nairobi, especially Kenyatta National Hospital.

Figure 50: Inkunshishi dispensary at Ewuaso Kedong market centre



The use of traditional remedies is also widespread and traditional healers (*loibons*) and herbalists still play an important medical role. In Suswa there are two private clinics; one in Suswa town and the other at Olasiti.

Figure 51: Some traditional herbs on sale at Suswa market on a Market day.



Figure 52: A newly constructed dispensary block inside the crater



Figure 53: A section of the dispensary under construction



In that case, it would be important to do a baseline survey of local health and disease incidences before the project to avoid speculation during and after implementation.

5.5.2 Child and Maternal Health

Water-related diseases are the most common causes of death and illness among the poor in developing countries where children under 5 are particularly affected. The community considered water supply as their priority number one. This is understandable bearing that as many as 41.9 per 1000 deaths of children under 5 per year occur due to diarrhoea in the district (*District Development Plan 2008-2012*). Other water-borne diseases were typhoid, cholera skin and eye infections; malaria, and pneumonia.. Providing sustainable access to safe water supply and basic sanitation together with hygiene education reduces water-related health risks and child morbidity and mortality.

Water users in Suswa get supplies from vendors supplying by tanker trucks from Kijabe and Naivasha respectively, as there is no portable water supply connecting Suswa to the Kijabe pipeline. Access to water supply sources in the proximity to settlements and health institutions will support fewer miscarriages from heavy water transport and safer home birth. This is particularly valid for post-natal hygiene practices, both concerning midwives and eliminating stagnant water around the households and water points can contribute to reduction of the high incidence of malaria especially in dry areas like Suswa and Ewuaso Kedong areas. The local population has embraced modern medicine and will be beneficiaries of improved medical care as a result of the project in the area.

5.6 Roads Infrastructure Development

A survey of the road condition was undertaken with the twin objectives of establishing the current condition of the Suswa access roads and recommending upgrades necessary for making the roads passable in all weather for drilling access. The survey also determined the environmental and social impacts associated with upgrading the access roads to gravel standards. All roads leading to the site which are already completed to bitumen standards are Road B3 between Mai Mahiu and Suswa and the Satellite Station Road.



Figure 54: The unpaved road access from Suswa Market Centre to Suswa prospect geothermal drilling area

The Satellite Station Road is to bitumen standards but was found to be extremely deteriorated and rendered unsuitable for use by either drilling traffic. This road will have to be upgraded prior to moving the drill rig to the site and certainly for any amount of steady traffic to Suswa drill sites. The Ngong –Ewaso Kedong road is Class D and has been regraded and drainage constructed at sections, with funding from Africa Development Bank (AfDB). However, there is no classified road access from Suswa Market or Duka Moja Market Centres to the prospect geothermal drilling area around the outer caldera.

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

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

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

Each of the above noted sections was surveyed and three separate access roads from Road B3 to the Mt. Suswa Conservancy signpost were surveyed. Road upgrades have been discussed in detail regarding the remedial works required on each individual road section in order to upgrade the roads to gravel standards for all weather passage. It should be noted also that the route of section 1 is a livestock watering route, mainly during the dry seasons when the cattle are driven to Lake Naivasha area and south towards Lake Magadi and Narok.

A review of literature found that the infrastructure cost estimate of US\$2,700,000 for the access road rehabilitation was arrived at based on tentative estimated quantities and rates of the various bill items from cost data of past projects adjusted for location and inflation indices. Within the prospect geothermal drilling area the road costs are estimated at US\$1,290,000 and outside the project area the costs are estimated at US\$1,410,000. Improvements in transport will have the greatest impact on poor people when other sectoral interventions are adequately in place. Without good transport, many other sectoral interventions are likely to be ineffective.



Figure 55: Unpaved road from Suswa Market to the prospect Geothermal drilling Area



Figure 56: Unpaved road from Suswa Conservancy Trust base station



Figure 57(a) and (b): Tracks are prone to sheet and gully erosion

The study found a positive correlation between roads improvement and enhancement of the socio-economic status of the communities in the villages through:

- Better access to employment opportunities via improved connectivity (improved roads and new or better road transport services) to other villages, towns;
- More opportunities for local employment and better wages in the villages as a result of the increase in commercial enterprises and economic growth in the villages;
- Increase in deposits and loans at the established local bank branches;

- Decline in infant mortality rate and maternal mortality rate as a result of improved access to medical facilities, enabling trained medical practitioners to attend more births;
- Decreases in the dropout rate from primary and middle-level schools and an increase in girls travelling outside the villages for high school and college education;
- Better prices for farmers through direct sales of livestock and agricultural crops at local markets instead of via middlemen, thereby improving the farmers' profit margins;
- Easier travel for the poorest groups (men and women) outside the villages in search of work and business opportunities.

5.7 Agriculture and Livestock

The Maasai traditionally keep large herds of cattle because cattle are food, a form of wealth as well as dignity amongst clan members (social status). This wealth has been negatively impacted on recently by drought, famine and land adjudication. The shrinking nature of land has meant that they own fewer cattle than before. Climate change is also threatening their survival since they inhabit arid and semi-arid parts of Eastern Africa. There is subsistence farming and the crops grown are maize, beans and potatoes.

About 74% of the households interviewed practice crop production and the crops grown include maize, beans and potatoes. These are used as subsistence crops by the inhabitants of the caldera to supplement other animal foods such as meat, milk and blood. With a good rain year, crop harvests can be good and may average 20-25 ninety-kilogramme bags per acre per year. With the growing uncertainty caused by climate change, crop production might increasingly become an important part of the Suswa economy.

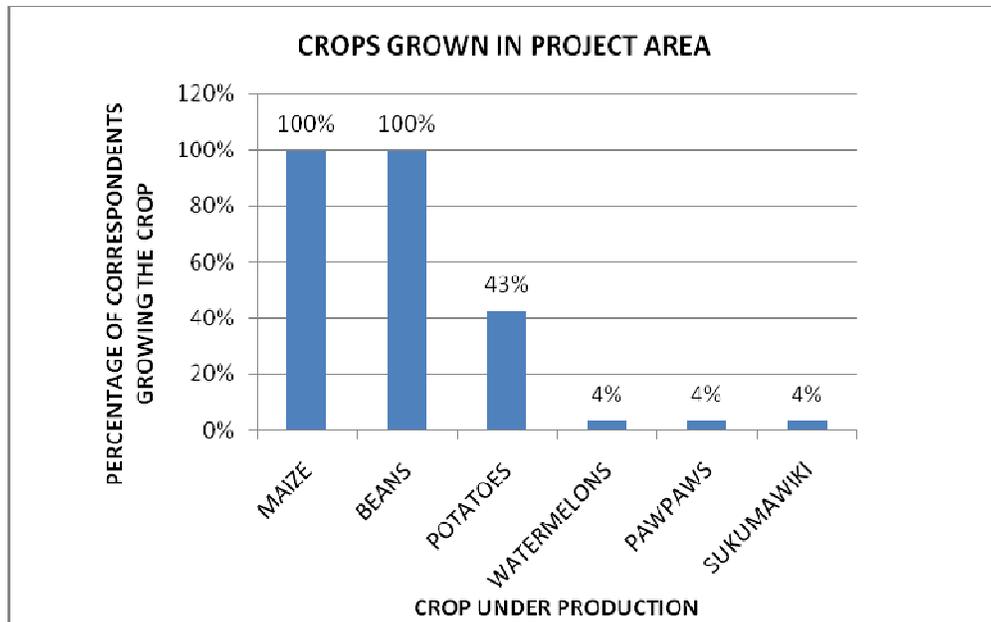


Figure 58: Crops Types grown in Project Area

The construction of roads and improved access into the remote parts shall open up opportunities for agricultural development in the concession area. The Suswa area can exploit the potential, albeit as small-holders, to complement pastoralist activities and subsistence gardening.



Figure 59: Subsistence farming in the Suswa prospect geothermal drilling area

Most male informants said they were livestock keepers and livestock traders from their herds, which they complimented with some purchased for sale at Suswa Market or Ewaso Market respectively. A private abattoir is at Suswa market and serves meat traders from as far as Naivasha and Nairobi. The productivity of a pastoral livestock production system depends largely on animal management, availability of water and the distribution, productivity and quality of forage. Forage and water resources are largely determined by the geomorphology and soil types of the grazing area, altitude and rainfall. Water is one of the limiting resources within the Suswa plains.



Figure 60: Different livestock Herds: of Goats, Sheep and Cattle



Figure 61: A shared water source showing devegetation resulting from livestock watering

The most common breed of sheep is a cross breed between indigenous (Maasai red sheep) and merino. The Sahiwal is the most common breed of cattle and has been a result of cross breeding between the indigenous cattle and the sepu. Cross bred of sebu and sahiwal is also common.



Figure 62: Herd of Cattle trekking to watering point

Table 24 below shows categories of livestock kept in each district. About 92% of the herd are goats and sheep, partly because of reduced land sizes and limited pasture. Animal routes develop tracks that are prone to wind and sheet erosion.

Table 25: Livestock Population by Type and District

	Cattle	Sheep	Goats	Camels	Donkeys	Pigs	Indigenous chicken	Chicken commercial
Kajiado North	151,295	314,080	236,790	991	21,419	5,321	150,216	237,367
Narok North	255,881	529,492	219,394	116	38,796	3,959	113,328	17,324
Naivasha	139,501	240,746	115,363	67	19,375	6,390	222,316	8,481

Source: Kenya National Bureau of Statistics: 2009 Kenya population and Housing Census
 There has been a reduction in livestock population over the last plan period (2003-2007) occasioned by persistent drought and famine that have negatively impacted on the pastures and water availability. Suswa area lost over 70% of their livestock population to the extended drought.

Dependence on pastoral activities resulting in overstocking may be attributed to lack of alternative livelihood by the communities. Smallholder vegetation production can be a viable option to complement livestock keeping if access to an adequate supply of water for small-scale irrigation (of plants and not land) can be ensured in the areas where crop cultivation is practiced.

A primary livestock production goal for the Maasai is to produce milk for consumption by the household; very little milk is sold. Animals are sold for cash primarily to buy subsistence goods, services and production inputs. It is however important to note that the traditional Maasai reliance on milk for subsistence has begun to change dramatically, largely due to increases in human population, but also due to unequal distribution of cattle among the population. Increased awareness on the milk market and the associated income levels is also another factor to declining traditional milk consumption among the Masaaai communities. Farmer-herder conflicts are likely to arise as farmers, especially irrigated agriculture, picks up due to readily available water supply. Common livestock diseases are Foot-and-mouth, Nagana, East coast fever, Yellow fever, and Anthrax.

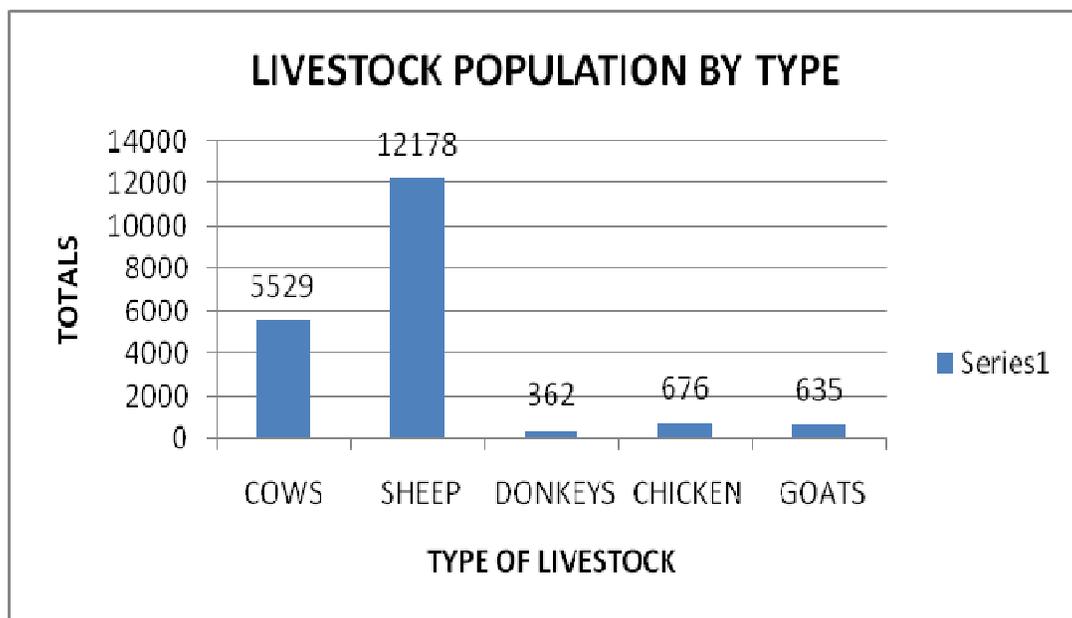


Figure 63: Livestock Population by Type

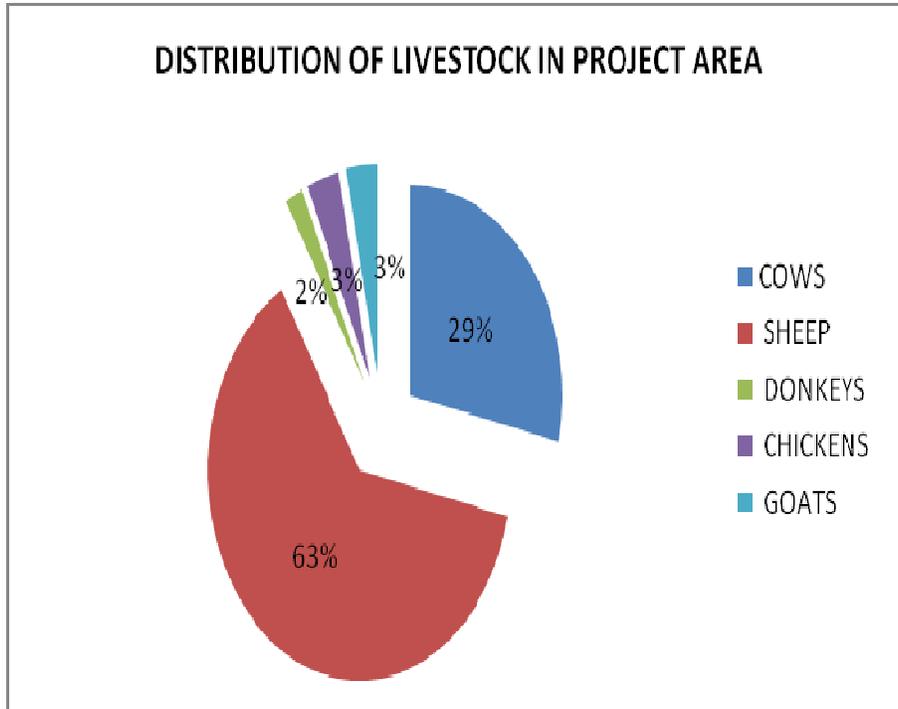


Figure 64: Distribution of Livestock in Project Area

The benefits and concerns of the community with regard to the project are displayed in Figure 50 below.

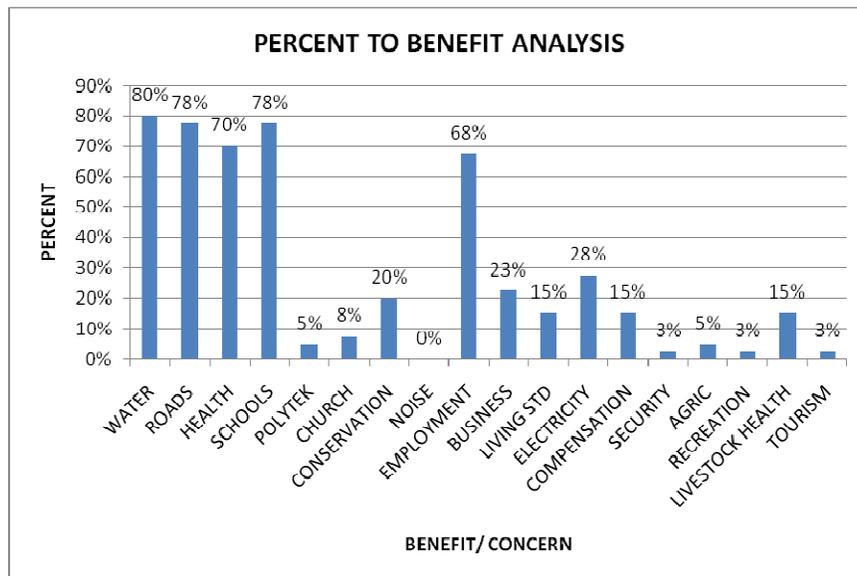


Figure 65: Desirable Benefit from the Project



Figure 66: Livestock source of water from pans in the area.



Figure 67: A water tank next to Suwa-Ewaso road and a homestead with cattle grazing

Overgrazing is generally common around watering points as large herds which often include some from communities or from distant areas share the scarce water available. Pans or earth dams are most common for watering livestock. These pans and earth dams are owned by individuals or clans for their livestock. There were no community owned pans or dams in the area.



Figure 68: Sheep and Goat grazing

5.8 Cooperatives, Trade and Commerce

Although the districts have a number of cooperative societies in agriculture, ranching and quarrying, no visible activity was witnessed in the prospect geothermal drilling project area. The mainstay of the population is predominantly pastoral livestock rearing, mainly cattle, sheep and goats, with some donkeys. This exposes the communities to the vagaries of drought due to climate change, there is low involvement in growing drought resistant crops and rearing drought resistant livestock such as camels which have been successfully introduced in other Arid and Semi-Arid Lands (ASALs) districts. There are no reliable channels to assist farmers in marketing their produce like onions, potatoes and tomatoes most of which are sold at poor prices in the local markets at Suswa, Duka Moja, Najili and Ewaso Kedong markets.

Figure 69: livestock market at suswa town showing different livestock



Just like any development project, geothermal development stimulates creation of additional economic activities, indirect jobs and generates tax and revenue for the respective counties. The geothermal industry provides a wide range of employment opportunities from exploration, drilling, repair and maintenance of turbines and other operations. Through the economic multiplier effect, incomes and jobs will increase and the economy shall grow. Especially during the construction stage, workers shall require residences, camping facilities, restaurants, etc. The construction phase involves far more workers than the operations and maintenance stage.



Figure 70: Smallholder maize growing in the background

The increased labour force requires an increase in transport, rental houses and could lead to pressure on existing social infrastructure in Suswa Market Centre and Mai Mahiu Township.

Currently, only 15% of Kenyans have access to electricity from the country currently installed capacity of 1218 MWe. Geothermal only contributes 11% of the total with an installed capacity of 205 MWe. Electricity provision to the population will increase local economic benefits including increase in trade and business, income from rent and transport services, improved access to essential services etc.

5.9 Environmental Health

The purpose of this section is to determine baseline information in environmental health and hygiene in the region. Table 26 gives an indication of methods of waste disposal from Suswa and Mai Mahiu Townships.

Table 26: Types and methods of waste disposal

Type of Waste	Method Of Disposal
Human waste (urine and faecal)	Pit latrine or open defecation
Animal waste	Sale as manure, use for thatching
Industrial waste from Jua Kali enterprises	Negligible
Papers/ plastic/ cloth	Burning

The towns do not have any solid waste management departments. Sewer connections were limited to the major towns in the area such as Naivasha, Kajiado Town and House water connections are few at Mai Mahiu and more than 62.5% of households use pit latrines. The remaining households resort to open defecation. This is unsafe and makes sanitation difficult as well as being unhygienic.

Table 27: Sanitation Level in the Districts

	Main Sewer	Septic tank	Cess Pool	VIP Pit Latrine	Pit Latrine ¹⁷	Bucket	Bush	Other	Total
Naivasha	6,958	4,114	2,521	6,797	82,509	78	2,260	8 1	105,318
Narok North	138	992	27	1,656	31,124	15	21,867	66	55,885
Kajiado North	2,170	16725							
Total	9,366	11,761	2,548	8,453	113,633	93	24,127	74	161,203

Source: Kenya National Bureau of Statistics: 2009 Kenya Population and Housing Census

¹⁷ Improved pit latrines are those that are covered or have cemented floor.

Where drilling is going on, people are bound to stay in one place for some time. Facilities such as pit latrines and portable toilets are necessary within the vicinity of drilling site. Proper sewage disposal measures should be done to avoid sewage pollution. Most of the polluting nutrients enter watercourses through effluents from sewage treatment works, untreated sewage or from farming activities.

Drilling operations uses a lot of materials. Some will be broken and hence they have to be replaced. The solid wastes may include metals, plastics and rocks. All solid wastes from drilling operations must be disposed of safely.

5.10 National and International Utilization of Guano

Guano is derived from bats' droppings. It has very high concentration of nitrate. Guano exploitation for fertilizer in Kenya may have caused changes in microclimate within cave roost sites and decline or loss of bat populations. In the absence of any monitoring, it is not possible to determine the economic use of guano from the Mount Suswa caves. Thus, there is a need for further investigation on how this potential natural resource can be exploited by the local communities as a fertilizer and possibly in treatment of poor quality roughage fed to ruminants.



Figure 71: Najili Market, Ewaso Kedong Division

5.11 Urban Centres in Suswa area

Mai Mahiu, located in Kenya's Rift Valley, approximately 50 miles northwest of Nairobi, is a small truck stop town with an estimated population of 30,000 inhabitants. Major sources of income for residents include agriculture, animal husbandry, *jua kali* labor (generally known as the "informal sector"), quarry excavation, small business, and self-employment, including night watchmen. The town center is densely populated with small-businesses such as cyber cafes, hardware shops, M-Pesa agents, stationery shops, petrol stations, bank branches, supermarkets, chemists, etc on either side of the main highway that passes through from Nairobi to Naivasha. Residential housing spans outward in all directions, encompassing an area of roughly ten square miles. Grid electricity was brought to the town in 1998; however, the majority of residents do not have access to electricity in their homes. In some cases homes are not electrified because they are too far from the grid and in other cases because the homeowners cannot afford a connection fee despite being relatively close to a potential connection point. An average family in Mai Mahiu makes around Ksh 5,000 per month, equivalent to US\$65¹⁸

Ewuaso Kedong' is located about 25 km north of Ngong Town. The main economic activities include retail shops, motorcycle taxis (*Boda bodas*), water ferrying, and gasoline sales. The township is located at DMS Latitude 10° 9' 00" and DMS 36° 34' 00".

Suswa, is a small Market on Mai Mahiu-Narok road with a population of 3,000 ([cwionline.org/ suswa-orphans](http://cwionline.org/suswa-orphans)) sits on the northern slopes of the volcanic Mt. Suswa with a peak at Oldoinyo Nyukie (Google Earth 1°02'59.71"S and 36°20'01.25E). Some of the economic activities include hoteliers, *nyama choma* eateries, retail shops, and car park. The town has no electricity supply and at night, the major shops in the town use generators. Most male informants said they were livestock keepers and livestock traders from their herds, which they complimented with some purchased for sale at Suswa Market or Ewuaso Market respectively. There is a private abattoir at Suswa market and serves meat traders from as far as Naivasha and Nairobi.

The three towns obtain all of their water from Kijabe. People from Suswa ferry water from as far as Mai Mahiu and Ewuaso. The other water source is Lake Naivasha via a pipeline which currently is broken down. The surrounding land belonging to the township may be used in future for expansion and further settlement for the labour lines. Suswa Township has about 120 ha. of land in case of expansion. But this can be larger as most people who own land within the vicinity of the town are willing to subdivide their land into plots for future development.

¹⁸ . Mumbi, M. Personal Communication. 20 November 2009

Suswa is under Narok County Council (NCC) so all administrative matters are handled from Narok while Ewaso Kedong' falls under Olkejuado County Council (OCC). Mai Mahiu falls under Naivasha County Council. Administratively, the Governors of the County Councils oversee all matters of these towns.

In Suswa there are two open markets days. Wednesday is the largest market day where the primary commodity on sale is livestock (cattle, sheep and goats). Other commodities traded include food stuffs (maize, beans, potatoes and an assortment of vegetables), cloths and other house wares. Saturday is a smaller market day dealing with sheep and food stuffs. In Ewaso Kedong, the main market is on Monday while the smaller one is on Thursday; both days trading the same commodities as those of Suswa. In Mai Mahiu, the markets are on Monday and Thursday, and like Ewaso but the commodities traded are primarily food stuffs. Unlike Ewaso and Suswa there is a permanent market at Mai Mahiu with stalls where traders sell food stuffs on a daily basis. The main goods traded at the markets are livestock, green foods and maize.

5.12 Tourism and Wildlife Conservation

In the tourism sector, Kenya aims to be one of the top ten long-haul tourist destinations in the world, offering a high-end, diverse, and distinctive visitor experience to achieve higher tourist revenue yield by increasing the country's premium safari parks and improving facilities in all under-utilised parks.

5.12.1 Mount Suswa Conservation Trust

There are not many observable tourism activities when one visits Mount Suswa. However, the potential of the Suswa volcano as a tourist attraction is evident from the various natural features observable in the area – the outer and inner calderas and the beautiful mountains around, the pristine island block that is surrounded by the inner caldera, the amazing cave systems locally known as 'tunnel/lava tubes' and the bats found in one of the cave tunnel tubes and the awesome mountain cliffs. Hikers, bikers, rock climbers and camping safari goers would certainly enjoy a visit to this terrain. Mount Suswa Conservancy is famous for diverse flora and fauna. Additionally, cultural tourists would enjoy learning about the culture of the local Maasai people and the influence of the surrounding Kikuyus. Other attractions include numerous fumaroles (steam vents or steam jets) which the locals have developed, albeit crudely, to tap the steam and condense it to water for drinking and livestock use. This tourism potential could be developed to earn income for local people and, the counties and national governments.

Some local people are beginning to develop a tourism potential of the area and a number of community-owned campsites are being constructed; these being one of the initiatives of the local Mt. Suswa Conservancy¹⁹ to promote tourism in the area. The Conservancy covers a geographic area that is about the same size as the area covered by the Suswa volcano. The Conservancy headquarters is located within the outer caldera about 1.0 km. westwards of the caves and about 5 km eastwards of the inner caldera.



Figure 72: Camp site under construction next to the edge of the inner caldera for tourist use.

¹⁹ Experience Adventure Caving, Mountain Climbing & Wild Camping in Mt. Suswa Caves. +254 0722 856 703/ 0725 233 592, Johnson.sipitiek@acc.or.ke/ jackkodonoyo@yahoo.com, 93 - 00208 Ngong Hills



Figure 73: Thomson Gazelle in the outer caldera as evidence of wild animals in the area



Figure 74: One of the collapsed entrances to the caves

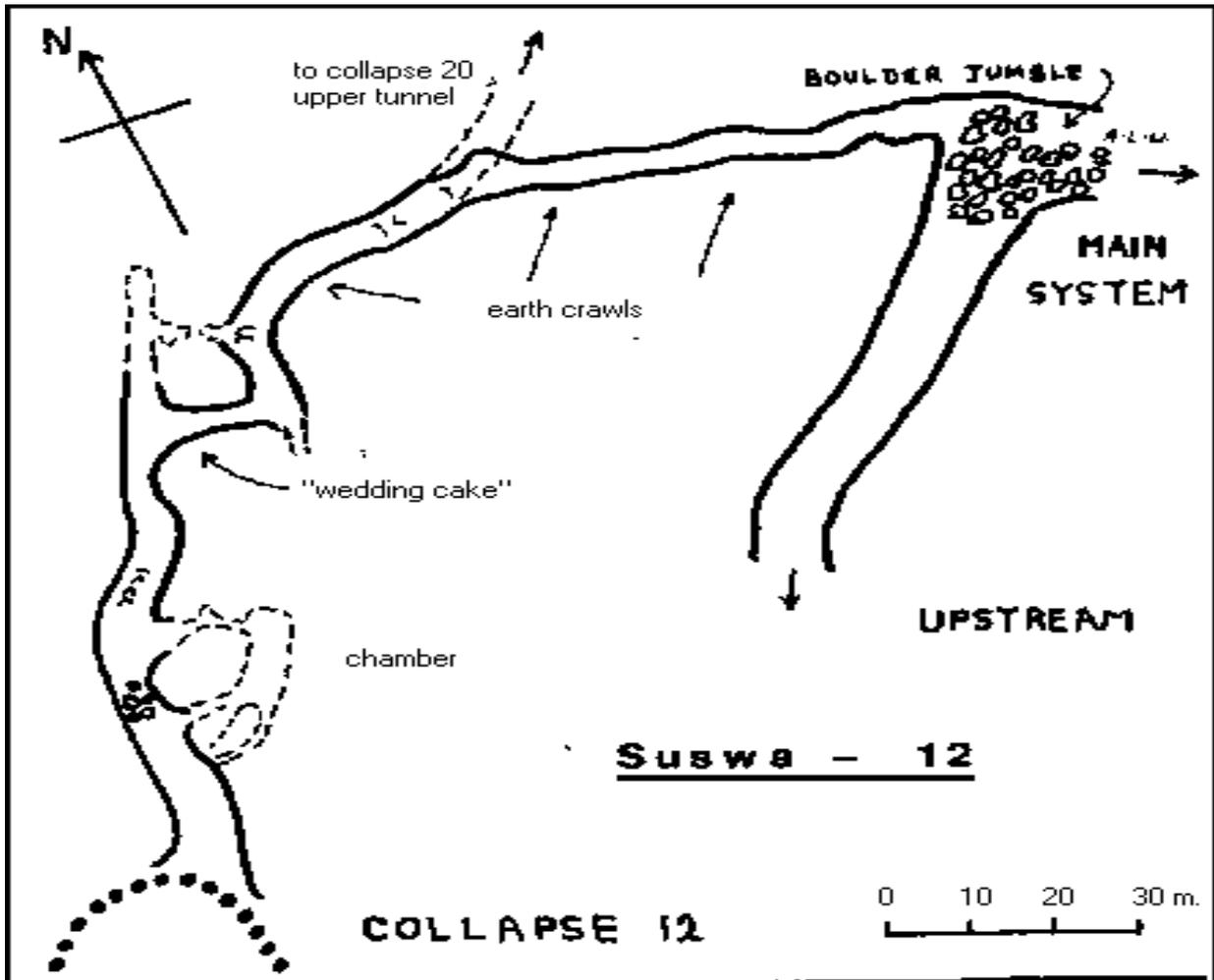


Figure 75: Entrance to the Suswa caves

One of the most amazing and unique geological formations of Mount Suswa is the caves, which local people refer to as “tunnel tubes”. The team of environmental and social impact assessors visited the underground ‘tunnels’ during field visits and found evidence of fire areas showing humans may be making stays at the caves. The caves are home to bats, birds and hyraxes. Baboons sleep in some cave entrances. Local people use the caves for camping, praying and fasting. These give the caves both tourism and religious values. The area is now managed as the Suswa Conservancy and camping is permitted – there are a number of sensational camp sites where one can feel totally isolated. Kenya Wildlife Service (KWS), and Suswa Conservancy and GDC may establish a Memorandum of Understanding (MoU) regarding the geothermal power operations within the conservancy²⁰. The main concerns of the Suswa Conservancy and Kenya Wildlife Service and other conservationists will revolve around effluent disposal, emissions, animal accidents (traffic), loss of habitat, harassment of animals, blockage of seasonal animal migration routes, noise and odour which are addressed in this report.

²⁰ There is a MoU between KENGEN, KWS regarding the management of Hells Gate Park, and a similar arrangement may be entered into with Suswa conservancy.

Figure 76: Mount Suswa Cave System



(source:<http://www.kilimanjaro.cc/eam/12.gif>)

There was evidence that the caves are hiding grounds for leopards, breeding ground for bats, and meeting ground for baboons. Mount Suswa is part of the Maasai Mara-Aberdares tourist circuit. There was evidence that parts of the caves had collapsed in recent historical times.

Mitigation measures planned include plant operations to maintain conservation of these unique scenic features and wildlife species within the area. Steam pipelines on major animal routes should be looped to provide easy movements for the wildlife such as giraffes within the area. Protect the caves from serious

Figure 78: View inside a section of a cave



vibration to avoid the collapse of the cave roofs. During operations, high voltage lines and silencers are a potential danger to birds and as such they should be constructed to avoid right angle crossing of known bird flying routes. To avoid vehicle-animal accidents in the park, a speed limit of 40 km/h should be observed while game proof fencing should be constructed to keep the animals away from brine pools.

Figure 79: Sign post for Mt. Suswa Conservancy along the Narok-Mai mahiu Road junction



Figure 80: Mt. Suswa Conservation Trust base office in the Suswa prospect geothermal drilling project area



5.12.2 Empaash Oloirienito Conservancy

The Empaash Oloirienito Conservancy (EOC) is composed of sixteen land owners who decided to consolidate their parcels of land under the supervision of Kenya Wildlife Service and managed as a backcountry area of the Nairobi National Park. After amalgamation or combination of the specific and individual lands, the resultant area will be 2,137 ha. If an adjacent 270 ha of government land on the top of the hills were included, the total acreage would be 2,400 ha. Participating landowners who designate part of their land to protection will be compensated for their land use by a portion of the entrance fees paid by visiting tourists.

EOC is located to the northwest of Nairobi, and borders both Oltepesi near Oloorgesalie and Mosiro Group Ranch, and is strategically important as the Nairobi National Park and Ngong Hills forest buffer zone. Although the area is struggling with a depressed, largely agrarian, economy and a high level of out-migration, EOC has significant potential for land and wildlife conservation, economic, social, and cultural development. With funding and support, EOC believes that the region's rich natural resource and cultural wealth can be used to expand cultural and eco-based tourism, and provide a significant economic and social development in the local communities.

This eco-tourism route is not a hiking trail; rather it is a route that connects Nairobi National Park and other conservation areas in the Mara-Amboseli tourism circuit where tourists can stop to observe birds and wildlife. This trail will be instrumental in bringing tourists to enjoy their stay outside of Nairobi city. The communities within the buffer zone of this national park and the entire country will realize new and greater economic benefit from this eco-tourism. It is possible to plan the Suswa Circuit with the EOC in mind.

5.13 Education

Kajiado North and Narok North Districts have illiteracy rates of 48.2% which can be attributed to a combination of factors which include high dropout rate, low transition and completion rates among others²¹. All schools in the Suswa prospect geothermal drilling project area are community initiatives. Some of the teachers are provided by the government while parents complemented by hiring additional teachers through the respective schools Parents/Teachers Associations (PTAs).

Maasai are increasingly aware that they live in a changing world, that the lives of their children will be very different from their own. They stress the importance of education to the child's general ability to cope with the wider environment; as they deal more and

²¹ District Development Plan 2008 -2012 Office of the Prime Minister

more with non-Maasai, they realize that both literacy and a sound knowledge of Swahili is necessary. The reason most commonly given for sending children to school, however, is the hope that they will find employment. Parents view a son's education as a good investment, citing cases of employed children sending money to their parents to buy cattle. Unfortunately, the prospects for employment for Maasai school-leavers seem limited and many remain in the ranches as pastoralists and traders.

Table 28: Rural Population Aged 3 years and above by Sex, School Attendance Status and District

	At School	%	Left School	%	Never Attended School	%	Not Stated	%	Total
Naivasha									
<i>Total:</i>	55,320	41.4	57,319	42.9	19,341	14.5	1,721	1.3	133,701
Male	28,549	42.8	29,016	43.5	8,069	12.1	1,007	1.5	66,641
Female	26,771	39.9	28,303	42.2	11,272	16.8	714	1.1	67,060
Narok North									
<i>Total:</i>	85,306	37.2	66,304	28.9	71,759	31.3	5,976	2.6	229,345
Male	44,806	38.0	37,021	31.4	32,130	27.2	3,955	3.4	117,912
Female	40,500	36.3	29,283	26.3	39,629	35.6	2,021	1.8	111,433
Kajiado North									
<i>Total:</i>	50,621	37.1	46,475	34.1	37,454	27.4	1,908	1.4	136,458
Male	26,419	38.2	25,227	36.4	16,418	23.7	1,160	1.7	69,224
Female	24,202	36.0	21,248	31.6	21,036	31.3	748	1.1	67,234

Source: 2009 Kenya Population and Housing Census, Kenya National Bureau of Statistics

A majority of the households interviewed have had basic formal education. Out of the sample of respondents, 2 had college education and 5 respondents said they had secondary school education. The facilities found in the community include nine primary schools, namely, Karuka Primary School, Olgosua Primary School, Kisharu Primary School and Olgumi Adventist Primary School, Maasai Soila Girls School, Empashi Primary School, Olesharo Primary School, Enkiloriti Primary School and Olodungoro Primary School, respectively. Not all schools had pre-primary classes for children.



Figure 81: Permanent school: Najili Primary School block within the project area in Ewaso Kedong' Division



Figure 82: Semi-permanent school block within the project area in Mau Division



Figure 83: Semi-permanent school block in Ewaso Kedong' Division within the project area

Not all schools had pre-primary classes for children. No High School or tertiary institution such as a village polytechnic or college exists in the project area. Most of the schools have temporary structures and basic sanitation is inadequate in all schools.



Figure 84: Kisharu Primary School with permanent structures within the project areas.



Figure 85: Inside a classroom at Kisharu Primary School

No	Name	Type ²²	Ownership	Management	Funding	Source Of Water	Student Population	Boys	Girls	School Feeding	TS C ²³	Untrained ²⁴
1	Sairrashie Pri	2	Govt	Committee	Community And Govt	Rain Water	230	126	104	Yes.	7	4
2	Oleshari Pri	2	District Education Board	Committee	FDE	Rain Water	584	295	294	No	9	5
3	Kisharu Pri	2	Govt	Committee	Community And Govt	Rain Water	440	280	160	No	8	4
4	Olng'uswa	2	Community And Church (P.O.M.C)	Committee	Comunity & Church	Pond At Olgumi	110	55	55	No	0	4
5	Karuka Pri	2	Govt	Committee	Community And Govt	Pond	250	100	150	No	2	4
6	Olgumi Adventist Pri	2	Private	Board	Church	Pipe	350	188	138	No	4	2
7	Olgumi Pri	2	Govt	Committee	Fundraising	N/A	430	177	202	Yes,	5	4
8	Olodung'uro Pri	2	Govt	Committee	Community And Govt	Water Pans	358	200	158	Yes	6	2
9	Elkiloriti Pri	2	District Education Board	Committee	Govt	Rain Water	148	73	75	Yes	3	3
10	Maasai Soila Girls	1	Private	Proprietor	St. Barnados Nairobi	Vendors	120	0	120	Yes	10	0
11	Empaash Pri	2	Govt	Committee	Govt	Vendors	440	210	220	Yes	8	2

Table 29 Educational Institution within project Area

²² 1=Boarding, 2= Day, 3= Boarding And Day

²³ No. of teachers employed by TSC

²⁴ No of Untrained teachers

Table 30: Infrastructure Properties of schools within the project area

No	Name	Classes	Perm	Semi-	Temp	Toilets	Housing	Perm	Semi	Temp	Commu	Dispensary and Distanc	Road (1=	Challenges
1	Sairrashie Pri	7	3	4	0	4	2	1	1	0	6	Najjile. 14km	2	Water, Teachers Houses, Transport
2	Oleshari Pri	8	7	0	1	10	8	4	4	0	5	Najjile. 15km	2	Teaching/ Learning Material, Classrooms, Large Catchment, toilets/ Latrines
3	Kisharu Pri	6	6	0	0	4	8	0	0	8	4	Olgumi. 10km	No Road	Water, Books, Road, Classrooms (Permanent), Toilets, Teachers Houses, Desks, School Feeding
4	Olng'uswa	2	0	0	2	1	0	0	0	0	4	Olgumi. 15km	2	Water, Classrooms, Books, Desks, Teachers Houses, Train Teachers, Staffrooms, Fencing School
5	Karuka Pri	5	0	0	5	5	2	0	0	2	4		2	Road, Water, Hospital, Train Teachers, Books, Desks, Classrooms, Teachers Houses, Staffroom and Offices, School Fence
6	Olgumi Adventist Pri	6	3	2	1	2	3	0	0	3	3	2km	2	Short Of Teaching Staff, Teaching Materials, Infrastructure And Source Of Food For Pupils, Climatic Conditions, No Electricity
7	Olgumi Pri	8	8	0	0	4	1	0	1	0	5		2	Staff Shortage, Few Classes, River Diverted Near The School
8	Olodung'uro Pri	8	7	0	1	7	3	0	3	0	5	Najjile. 10km	2	Water And Classrooms Inadequate And Some Are

No	Name	Classes	Perm	Semi-	Temp	Toilets	Housing	Perm	Semi	Temp	Commu	Dispensary and Distanc	Road (1=	Challenges
														Overcrowded, While One Class Is Temporarily Hosted In a church Premises Outside The School
9	Elkiloriti Pri	5	3	2	0	4	1	0	0	1	4	20km	2	Classrooms, Teachers Quarters, Water, Health Facilities, Road, Learning And Teaching Materials, Staffing
10	Maasai Soila Girls	8	5	3	0	9	6	0	6	0	2	2 Km	2	Electricity, Water, Classrooms, And Teachers Quarters, Library Books
11	Empaash Pri	8	2	6	0	15	0	0	0	0	10	5 Km	1	No water during droughts to prepare meals for children, facilities, classrooms, Administration Block, Teachers Quarters, Library And Library Books

CHAPTER 6: ENVIRONMENTAL IMPACT ASSESSMENT

6.1 Introduction

This environmental analysis has considered the main phases associated with geothermal energy development. These include the Exploration and Drilling, Production and Utilization and Decommissioning phases.

The Exploration phase involves determining the viability of the geothermal resource. Along with exploration drilling, the construction of roads, well pads and power plant sites are examined as they naturally follow the exploration phase. Other possibilities that are also worthy of examination at this stage include that each drill site may be a few hundred square meters in area, and the soil in these areas might be compacted and changed; there could be deposition of waste soil and drill mud; air pollution could result from gas emissions, smoke exhaust from generators, compressors and vehicles; during well testing, steam and spray could have an adverse effect on the local vegetation with trees and grass being scalded; dust carried by wind blowing across exposed surfaces might have a deleterious effect and the potential exists for hydrogen sulphide exposure.

The Production and Utilization phase involves construction of the power plant together with the pipeline network that connects steam wells to the power plant. Soil movement for the construction of pipelines, the power plant and other buildings might affect land. During operation, subsidence and induced seismicity are possible effects. Hydrogen sulphide produced from wells and cooling towers of the power plant is an important aspect of an environmental study. There are other gases such as sulphur oxides, nitrogen oxides, chlorine, and methane as well as several trace elements that need attention especially with respect to their interaction with humans, area biology and physical structures that might be corroded by acidic gases. In addition to this, the potential for acid rain due to acidic gases should be examined.

Geothermal facilities are removed after their useful life in a process called Decommissioning. Typical activities during the decommissioning/reclamation phase include closure of all facilities and wells, removal of above ground components and gravel from well pads, access roads (if not maintained for other uses), and other ancillary facility sites, re-contouring the surface, and revegetation. Impacts would be similar to those addressed for the construction phase; however, many of these impacts would be reduced by implementing good industry practices. Restoration during this phase would also ensure that impacts beyond the life of the geothermal energy development are avoided or minimized.

Table 32 is a matrix showing impact categories during the four phases while Table 33 shows the significance of predicted impacts, impact category, predicted impacts, positive/negative, duration (short term/long term), reversibility (reversible/irreversible) and significance (high, medium, low). The table has included comments explaining criteria for rating significance. Out of the 12 issues described, 4 issues out of 12 may have a harmful impact on the environment. The impacts that rank significantly high are those associated with valued resource stocks and ecological functions; negative impacts on social values, quality of life and livelihood and foreclosure of land and resource use opportunities.

Table 34 shows a summary of proposed environmental mitigation measures. The Exploration Drilling and Construction Phases have considerably higher impacts than the Production/Operation and Utilization phase and Decommissioning phase. The first wells will be drilled where they are located on the map. Subsequent wells (if any) will be drilled based on the information gathered from the first wells. The plant will ultimately be placed in a location according to the steam field drilling results. This means that the plant will be close to some wells but quite far from other wells. The reduced impact of gas emissions is because many of the gaseous impacts associated with geothermal power generation tend to decay with time and most of the landscape, flora and fauna disturbance are rehabilitated and hence the environment may be enhanced rather than deteriorate. Proper landscape planning and minimization of leveled surface for vehicle parking, stores, water reservoirs, etc will eliminate destruction to the sprawling scenery that would be against the development of eco-tourism of Mount Suswa as suggested in the present study.

6.2 Environmental Impacts

6.2.1 Construction of Roads, Well Pad, and Sump Pit Construction

The development and or improvement of access roads to the proposed drilling sites will include:

- i) Clearing vegetation along the access routes and drilling sites;
- ii) Development of pits for road borrow materials;
- iii) Increase in labour and service transport vehicles to and from site; and,
- iv) A potential for an increase in accidents due to the increase in frequency of vehicular traffic and pedestrian and animal traffic using the new roadways.

Since the maximum width of the road will be on average only 6.5 m wide, the impact on original vegetation will be minimal. The drilling sites have grassy patches and lava rocks and therefore do not have much vegetation to be cleared. The design of

roadways has considered ditch profiles that accommodate expected rainfall accumulations as well as have runoff controls to prevent gully erosion during periods of high rainfall.

The major impact shall therefore be increased vehicular traffic due to an increase in labour and service transport vehicles to and from site, thus affecting wildlife crossings and the amount of dust and noise generated. The increase in vehicular and pedestrian movement increases the potential for accidents. The proposed mitigation measures regarding increased traffic are:

- (i) Abide by the speed limits and by laws.
- (ii) Movement of heavy construction traffic should be planned appropriately.
- (iii) Prevention of soil erosion during upgrading and use of access road and regular watering should be done to avoid impact of dust.
- (iv) Rehabilitation of pits for road construction.
- (v) Establish maintenance responsibilities and ensure that road rehabilitation takes place as soon as possible.

Table 31: Matrix showing various Impact Categories during the four phases of development

Impact category	Environmental and social impacts			
	Preliminary Exploration ²⁵	Drilling/Construction Phase	Production and utilisation Phase	Decommissioning Phase
Flora & fauna	Clearing and devegetation, levelling of land surface; excavated materials, drainage requirements. Traffic affecting wildlife	Acidic gases such as hydrogen sulphide may affect vegetation if encountered in high enough concentrations. Well pads are 50x80 m. Installation of pipeline requires the removal of vegetation and soils Trace metals may affect vegetation and soils if encountered in high enough concentrations. Traffic affecting wildlife	Well pads would be constructed in previously disturbed areas. Application of modern technology will reduce any impact on flora and fauna. Traffic affecting wildlife	Clearing site, rehabilitating site and planting trees. Traffic affecting wildlife
Air quality	Dust particles from machinery	Dust particles from	Limited impact	Limited impact

²⁵ Exploration activities such as location and installation of facilities and equipment, and exploratory drilling will interfere with local grazing regimes.

Impact category	Environmental and social impacts			
	Preliminary Exploration ²⁵	Drilling/Construction Phase	Production and utilisation Phase	Decommissioning Phase
	and vehicular fumes ²⁶ . Oil leakages, grease and oil products	machinery, vehicular fumes and geothermal gases		
Noise Pollution and Vibrations	Noise generated from machinery for construction of road, water storage facilities, vehicular transport of equipment to drilling sites	Noise resulting from earth-moving equipment (related to road, well pad, and sump pit construction), vehicle traffic, seismic surveys, blasting, and drill rig operations	Noise from power houses, transformers, and cooling towers	Localised in scale.
Water quality	Water required for reducing dust during construction	Geothermal gases such as hydrogen sulphide (if present) may escape into the air reducing pH of rainwater. Very limited.	Limited because of reinjection of brine back into the geothermal reservoir.	Limited impact
Soils and geology	Lots of bush clearing, levelling of land, construction of buildings causing soil compaction, erosion, and dust	More paved surfaces causing runoff if not properly designed, loose soil may be	Drainage improved; ponds for livestock water established.	Rehabilitation, reforestation, grass cover.

²⁶ Air quality impacts from construction activities for the well pads, pipelines, and power plant would be localized and temporary.

Impact category	Environmental and social impacts			
	Preliminary Exploration ²⁵	Drilling/Construction Phase	Production and utilisation Phase	Decommissioning Phase
	pollution	swept by storms. Vibrations during drilling may affect caves.		
Recreation, culture and aesthetics	Limited facilities available	Limited facilities, increased population, new cultures, machinery and drill rigs may affect the visual quality of the area	Application of environmentally friendly technology, beautification of the sites, afforestation, Better facilities, etc; Increased tourists	May negatively affect the area.
Health and disease	Health issues limited; geothermal gases may trigger respiratory ailments; non native labour population	Limited facilities; non native labour population	New health centres for the population and for workers; non native labour population	Negative impact; non native labour population
Infrastructure	Construction will increase devegetation, earth moving causing dust storms; Potential for traffic accidents will increase which would have an effect on both people and livestock.	Construction, dust, air pollution, traffic accidents involving people, wildlife and livestock.	Traffic accidents; Limited impact	Limited impact
Population, demography and	Increase in population, more men compared to women, traffic accidents	Increase in population, more men compared to	Population stable, more men compared to women	Decreasing population, more men compared to women,

Impact category	Environmental and social impacts			
	Preliminary Exploration ²⁵	Drilling/Construction Phase	Production and utilisation Phase	Decommissioning Phase
settlements		women, traffic accidents		traffic accidents
Local economy	Begins to grow, influx of people seeking employment, and <i>Jua Kali</i> and other trade opportunities.	Specialised jobs may increase, but may not significantly benefit the local communities; traffic congestion, municipal waste management	Limited jobs; traffic congestion, municipal waste management	More jobs as labourers are required to dismantle machinery and clear the site.
Visibility and emergency management	Noise, dust and vegetation clearance. Emergency Health and safety to be put in place.	Noise, dust and vegetable clearance. Emergency elements to put in place.	Limited as steam wells are capped	Noise and dust as machinery are removed and the landscape rehabilitated
Gender and Youth	Employment opportunities	Limited number of employment, opportunities for <i>jua kali</i> and trade opportunities begin to open up	New jobs limited	Employment opportunities decrease

Table 32: Matrix showing significance of predicted impacts

Impact category	Predicted impacts	Positive/negative	Duration (Short term/ Long term)	Reversibility (Reversible/ Irreversible)	Significance (High, Medium, Low)	Comments (explain criteria for rating significance)
Flora & fauna	Devegetation, soil excavation; vehicular traffic affecting wildlife crossings	-	Short/long term	Reversible	High	Along access roads, construction sites. Regulate speed limits along major wildlife routes.
Air quality	Air pollution from dust, H ₂ S; geothermal gases, vehicular fumes from machinery and vehicles	-	short	Reversible	High	Control dust, geothermal gases limited, produced water and steam is re-injected into the geothermal reservoir
Noise Pollution and Vibrations	Earth-moving equipment (related to road, well pad, and sump pit construction), vehicle traffic, seismic surveys, blasting, and drill rig operations. Decibels ranging from 80 to 115 ²⁷ .		Short/long		Low	Generally localized and can be reduced by the addition of mufflers or other soundproofing
Water quality	Over use of surface	-	short	Irreversible	Low	Limited for initial well

²⁷ Estimates based on industry figures and assumes standard equipment that are well maintained.

Impact category	Predicted impacts	Positive/negative	Duration (Short term/ Long term)	Reversibility (Reversible/ Irreversible)	Significance (High, Medium, Low)	Comments (explain criteria for rating significance)
	and ground water					drilling only; Sustainable management
Soils and geology	Loose excavated soils, dust, increased surface runoff, vibrations may affect the caves;	-	short	Reversible	Low	Along access roads, construction sites; plan drilling sites away from caves
Recreation and aesthetics	Obtrusive machinery and rigs, pipelines, increased tourists	-/+	Long term	Irreversible	Low	Application of modern technology; beautification of the concession area.
Health and disease	Increased incidence of negative health issues arising from non-native labour population	-	Long term	Reversible	High	HIV/AIDS awareness, improved health services; Anti Retroviral drugs available
Infrastructure	Negative traffic affecting wildlife; vehicular traffic congestion	-/+	Long term	Reversible	High	Speed limit along animal crossings/routes; Tourism increase due to developments; Increased ranching and sale of livestock products.
Population, demography &	Influx of people during construction; more	-	Short term	n/a	Low	Relocation of homesteads and schools

Impact category	Predicted impacts	Positive/negative	Duration (Short term/ Long term)	Reversibility (Reversible/ Irreversible)	Significance (High, Medium, Low)	Comments (explain criteria for rating significance)
settlements	men compared to women, vehicular traffic accidents; limited housing					will be compensated; investment appetite will increase
Local economy	Rapid economic growth; Loss of grazing and farming areas	+/-	Long term	n/a	High	Maasai Community Development and Cultural Association
Local culture and lifestyle	Loss of grazing area close to the power stations, livelihoods changes	-	Long term	Irreversible	Medium	Maasai Community Development and Cultural Association
Visibility and emergency management	Devegetation; obtrusive rigs and machinery, accidents	-	Long term	Reversible	High	Health and safety training; control speed on roads along animal crossings, pedestrians, etc
Gender issues and youth	Influx of young people; more men compared to women,	-/+	Long term	Reversible	Low	Maasai Community Development and Cultural Association

Table 33: Summary of proposed environmental mitigation measures

Project Phase	Predicted impact and source of impact	Mitigation/enhancement measures
Exploration	<p>Devegetation and soil excavation of sites for construction of building, roads, water tanks, stores and warehouse sheds and roads</p> <p>Dust bowls caused by vehicular movement and traffic affecting wildlife movements</p> <p>Air pollution from dust, H₂S; geothermal gases, vehicular fumes from machinery and vehicles</p> <p>Seismic vibrations may destroy the caves;</p> <p>Loss aesthetics and negative visual impact due to obtrusive machinery, rigs, and pipelines</p> <p>Noise of drilling rigs and machinery</p> <p>Flood lights during construction and for security</p> <p>Solid waste, drilling mud, petroleum products from lubricants and fuels, and cements.</p> <p>Pollution from tower sludge and construction and normal-maintenance debris may hold trace elements of mercury²⁸</p>	<p>Minimize areas that will be cleared</p> <p>Determine solid waste disposal site.</p> <p>Build water access roads to control dust.</p> <p>Use equipment with neutral, non-reflective colours that blend with the surrounding rocks or trees.</p> <p>Product storage and transport usually follow safe storage of lubricants and fuels</p>
Drilling and Construction	<p>Seismic vibrations may affect the caves;</p> <p>Noise of drilling steam wells and heavy machinery</p> <p>Dust bowls caused by vehicular movement</p> <p>Soil disturbance and leveling of ground during construction of building, roads and warehouse sheds</p> <p>Solid waste, drilling mud, petroleum products from lubricants and fuels, and cements.</p>	<p>Using equipment with neutral, non-reflective colours that blend with the surrounding rocks or trees.</p> <p>Noise levels will be minimal. Power plant operation starts, noise mufflers must be used to keep the environmental noise level below the 65 dB</p>

²⁸ Oduor, Jennifer A., Environmental and Social Considerations in Geothermal Development, TS 1E - Environment and Energy: Policy and Practice, Facing the Challenges – Building the Capacity FIG Congress 2010, Sydney, Australia, 11-16 April 2010

Project Phase	Predicted impact and source of impact	Mitigation/enhancement measures
	Heavy vehicular movements causing vibrations Flood lights at construction sites and for security interfering with wildlife	Minimize storm water runoff at the drilling pads through drainage and collection of run-off in a reserve tank.
Operation and utilization	Flood lights during construction and for security Noise of testing steam wells and heavy machinery	Reduce working area and locate power plants close to the wells. This will reduce the operation area and hence the flood lit area.
Decommissioning	Rehabilitation of soil and leveling of ground Heavy vehicular movements evacuating machinery from site Revegetation of sites	Re-design and use for buildings, access roads, water tanks, stores and warehouse sheds to blend with the Mount Suswa ecotourism.

6.2.2 Drilling Operation

The drilling rigs, construction of the geothermal plant, long pipelines, and water tanks will generate noise, vibration effects and cause visual intrusion in a tourist set up. Noise sources in geothermal facilities are mainly related to well drilling, steam flashing and venting. Other sources of noise include equipment related to pumping facilities, turbines, and temporary pipe flushing activities.

Noise occupational health and safety criteria in Kenya, regardless of hearing protection, is 85 dB in a work place for an employee working an eight-hour day²⁹. Other than the drill rig during drilling, noise levels fall below the recommended exposure limit. In only a few instances do rig equipment noises exceed 85 dB. The highest noise (up to 120 dB) occurs during the vertical discharge of wells during start-up, before they are discharged through a separator. In the past, the period of vertical discharge has been reduced to not more than 30 minutes to clear cuttings and other debris from the well. Horizontal discharge through separators reduces noise to below 85 dB. Today's technology and better-designed separators are in use and therefore wells are discharged for shorter periods, not exceeding two months (Kubo, 2001).

Table 34: Indicative noise levels during drilling and construction

Operation	Noise Level (dB)
Air drilling	85–120
Mud drilling	80
Discharging wells vertically (to remove drilling debris)	Up to 120
Normal well testing through silencers	70–110
Diesel engines (to operate compressors and provide electricity)	45–55
Heavy machinery (e.g., for earth moving during construction)	Up to 90
Power plant operation (Olkaria II)	65 - 70

During drilling of the geothermal wells, some level of vibration/seismic effects may be felt, and these vibrations may reach the caves. The siting of the wells will be important in

²⁹ The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, Legal Notice No. 61, 2009

ensuring that the caves, which may be an important habitat for baboons and bats, as well as a tourist attraction and destination for hiking and cultural/religious activities, are not affected by vibrations. These vibrations however are limited to the Exploratory and Development phase that will likely take a short time to complete.

Table 35: World Bank Requirements on Noise Level (World Bank, 1998)

World Bank maximum allowable ambient noise level		
	Maximum allowable limit (hourly) in dB (A)	
Receptor	Day time (0700-2200hr)	Night (2200-0700)
Residential, Institutional and Education	55	45
Industrial and Commercial	70	70

The high Visual Absorption Capacity (VAC) of Suswa and Ewaso Kedong areas will be mitigated by using equipment with neutral, non-reflective colours once operations begin and most of the equipment belongs to the project that blend with the surrounding rocks or trees to reduce the visual impacts. During operations, for instance, the powerhouse and the limited pipelines may be coloured in light brown and green to blend with the surrounding environment. In Olkaria for example the steam loop is high enough to permit zebras, buffaloes, and even some giraffes to pass beneath and is painted green to blend with the environment as shown in Figure 67. The number of workers will be controlled according to the different phases of geothermal power development.

Table 36: Occupational Health and Safety Exposure Limits for Noise Emissions

Sound Level (dB)	Maximum permitted time length of exposure (hours per day)
80	16
85	8
90	2
100	1
105	0.5
110	0.25
115	0.125
>115	0

Source: Kubo, B. Noise Emission Level Monitoring around Olkaria Geothermal Power Project, January³⁰

³⁰ Kubo, B. Noise Emission Level Monitoring around Olkaria Geothermal Power Project, January, Y 2005-May 2006, GDC/UNU/KenGen, Geothermal Training Programme, Lake Bogoria and Lake Naivasha, Kenya, Oct. 29 – Nov. 19, 2010.

Table 37: Protection of workers from noise: Requirements of hearing protectors (Ear Mufflers)

Sound level (dB)	Maximum class of hearing protectors
85-95	C
96-105	B
106 and over	A

Source: Kubo, B. Noise Emission Level Monitoring around Olkaria Geothermal Power Project, January, Y 2005-May 2006.



Figure 86: Steam pipe is painted green to blend with the environment, Olkaria

However, services like cleaning and guarding may be outsourced through contracts with the local communities. A large amount of the other labor will be outsourced to communities on a casual basis during times of power-station construction and maintenance.

6.2.3 Impacts of Geothermal Gas Emissions

It is possible to assess the impact of geothermal gas emissions on humans and wildlife (fauna and flora, see Table 31). Occupational exposure to geothermal gases, mainly hydrogen sulphide gas, may occur during non-routine release of geothermal fluids (for example, pipeline failures) and maintenance work in confined spaces such as

pipelines, turbines, and condensers. The significance of the hydrogen sulphide hazard may vary depending on the location and geological formation particular to the facility. Table 39 shows the effect of hydrogen sulphide on human beings. A 0.03 ppm sampled at 60 minutes intervals has been agreed upon by the Kenya Power Company and the Government of Kenya as the minimum level tolerable for residential areas as well as areas supporting commercially, culturally, or scientifically important vegetation.³¹

6.2.4 Impacts on Surface and Groundwater Resources

The extraction, reinjection, and discharge of geothermal fluids may affect the quality and quantity of surface and groundwater resources. Examples of specific impacts include the inadvertent introduction of geothermal fluids into shallower productive aquifers during extraction and reinjection activities or a reduction in the flow of hot thermal springs due to withdrawal activities. The technology for harnessing and utilizing geothermal energy has been carefully developed to minimize possible ground water pollution.

Production and injection wells are lined with steel casing and cement to isolate fluid from environment and ground water resources. Continuous sonic logging measurements done on casing and cement at the time of drilling the well, ensure that no leakage occurs. The brine component can have harmful chemical substances, is hot, and can burn humans and animals. It was discovered the trace element concentration levels in wastewater from most wells fall within the international-water quality criteria for protecting plants and animals (mammals) against any potential ecotoxicological risk, except for arsenic, boron, and molybdenum in wastewater from a few wells (Wetang'ula and Snorrason, 2005). Geothermal wastewater could be a potential ecotoxicological hazard due to these trace elements without a proper disposal strategy. The fluoride level in wastewater from all the wells is high, typical of the Kenyan Rift waters.

Ponds are generally fenced off to prevent both wild and domestic animals from entering to drink the water—and possibly drown, especially during the dry spell when water is scarce in the park. Alternative drinking water points for animals have been provided at strategic locations for this purpose. The reinjection of waste water back into the geothermal reservoir is an environmentally friendly way of increasing its productive

³¹ See Ogola, Pacifica F. Achieng Environmental and Social Considerations in Geothermal Development. Paper to be presented at Workshop for Decision Makers on Geothermal Projects and Management, organized by UNU-GTP and KenGen in Naivasha, Kenya, 14-18 November, 2005

life. Based on reinjection experiences from Olkaria I, all the separated water from the Olkaria II Field has been re-injected into four infield wells.

The power station blow-down water is re-injected in two wells located some distance outside the producing field, to avoid cooling the reservoir. In 2001 during the construction of Olkaria II and after 20 years of Olkaria I operations, KenGen received complaints from local pastoral peoples that the brine was killing their cattle and making their women miscarry. The allegations could not be verified by the complainants and it was learned later the complaints had no basis and were meant to draw attention for more jobs as an attempt to seek some form of compensation.

Table 38: Effect of Hydrogen sulphide on human beings

Concentration in ppm	Effect
1-10	Offensive odour
10-20	Occupational exposure limit
20-100	Ceiling of occupation exposure limit. Worker must wear breathing apparatus
100 - 200	Loss of sense of smell in 2-15 minutes. May burn throat and chest. Causes headache and nausea, coughing and skin irritation
200-500	Loss of reasoning and balance. Respiratory disturbance in 2-5 minutes. Prompt resuscitation required.
500-700	Immediate unconsciousness with one sniff. Causes seizures, loss of control of bowels and bladder. Breathing stops and death will result if no resuscitation is performed
700-1000	Immediate unconsciousness. Death or permanent brain damage may result unless rescued promptly
1000-2000	Immediate collapse with respiratory failure and death

Source: Ogola, Pacifica F. Achieng Environmental and Social Considerations in Geothermal Development. Paper to be presented at Workshop for Decision Makers on Geothermal Projects and Management, organized by UNU-GTP and KenGen in Naivasha, Kenya, 14-18 November, 2005

Extraction and reinjection activities impacts will be considered after:

- Elaboration of a comprehensive geological and hydrogeological model including overall geological, structural and tectonic architecture, reservoir size, boundaries, geotechnical and hydraulic host rock properties;
- Completion of a hydrogeological and water balance assessment during the project planning stage to identify hydraulic interconnections between the

geothermal extraction and reinjection points and any sources of potable water or surface water features.

Table 39 shows the potential negative impacts and mitigation measures in consideration for EMP to assist in costing the interventions by the responsible entities. Short term (ST) implies that the impacts will be limited to a short duration or to a specific phase of the project. The Long term (LT) means that the impact will persist beyond any single phase. Reversible (R) impact is one in which there will be management control that may reverse the impact if it occurs, while an Irreversible (IR) impact is one that will not be controlled but may be managed. Local (L) impact is one that is limited in geographical scale while Wide (W) or widespread impact is one that covers a large geographical area. Significant Impact (SI) and Normal (N) are respectively injurious to the habitat, wildlife and or humans and not significant.

Table 39: Potential Negative Impacts and Mitigation Measures for EMP

Potential Negative Impacts	Level of Impact		
	During exploration	Operation/Utilisation	Decommissioning
Increased soil erosion and sediment transport during road construction	High, ST	Limited; ST	Unknown
Geothermal gaseous emissions into the air	High, ST	Limited	Absent
Generation of dust pollution during the construction of the roads infrastructure	High; ST	Limited	Absent
Insecurity in the newly expanded urban centres	High, LT	High, LT	Unknown
Increased prevalence and spread of diseases such as HIV/AIDS.	High, ST	Limited, LT	Limited
Erosion of cultural practices	High, LT	High, LT	Limited
Generation of more noise through vibrations of the drilling machinery	High, ST	Low, LT	Absent
Vegetation clearance within the drilling area	High, LT	Absent	Absent
Generation of more vehicular noise and machinery	High, LT	Absent	Absent

Potential Negative Impacts	Level of Impact		
	During exploration	Operation/Utilisation	Decommissioning
Landscape deformation through excavation for installation of machinery	Limited, LT	Absent	Absent
Waste water discharge and spilt brine to the surrounding environment	Limited, ST	Absent	Absent
Oil spill from the heavy machinery and equipments	Low, LT	Limited, LT	Absent
Disposal of Wastes	Low; ST	Low, LT	Low, LT
Surface and ground water pollution	Absent	Absent	Absent
Potential for collapse of caves due to increased vibration	LT	LT	Absent
Power-transmission lines	Absent	Limited, LT	Absent

6.2.5 Disposal of Wastes

Geothermal development produces significant amounts of waste such as drilling mud, petroleum products from lubricants and fuels, and cements. Because of heavy metals—particularly arsenic—contained in geothermal waters, these solid wastes are often classified as hazardous hence suitable disposal methods are needed. The main concern is that these wastes may be toxic to humans and wildlife (flora and fauna). However drilling mud is either lost through circulation in the well or ends up in drilling sumps as solid waste for disposal. Since a lot of fuel and lubricants are used when a single well is drilled, product storage and transport usually follow safe storage regulations of lubricants and fuels. Other important solid waste includes cooling tower sludge (may hold mercury) and construction and normal-maintenance debris. All are transported safely to designated disposal sites or landfills periodically monitored and audited for environmental compliance.

Some of the dissolved minerals can have a negative impact to the environment if not re-injected back into the reservoir. Separated and condensed thermal water from the plants is routinely re-injected to the ground minimizing the release of steam and thermal water to the environment. The concentrations of these chemical constituents are largely controlled by their influx to the deep circulating geothermal fluids, which extract them from either enclosing rocks or degassing magma. Once geothermal energy has

been extracted, the spent geothermal fluids are either disposed of into the surface environment in ponds or sumps before re-injection or immediately re-injected back into the geothermal reservoir to avoid pollution of surface waters, as well as to maintain reservoir pressure. In cases of surface discharges, the spent geothermal fluids, may subsequently join regional underground and surface natural water bodies such as lakes, rivers, and estuaries, and become sources of trace metal contamination or pollution in these ecosystems.

Some geothermal fluids, on the other hand, contain by-products, which often have valuable minerals that can be recovered and recycled for industrial use. These include salts that can be crystallized and used while silica solids can be used in cosmetic production as is done at the Blue lagoon of Iceland.

6.2.6 Gaseous Emissions into the atmosphere

The increase in deployment of geothermal energy will have a large net positive effect on the environment in comparison with the development of fossil fuels. This is in accordance with the Kyoto resolutions on global climate change. During production, geothermal power plants emit insignificant amounts of CO₂, SO₂ and absolutely no nitrogen oxides in comparison to thermal plants. Olkaria steam has 1% non-condensable gases. Of these, 92% is CO₂, 3% H₂S, and the rest methane, nitrogen, and hydrogen³². Hydrogen sulphide (H₂S) gas emission is the major gas concern, due to the unpleasant smell and toxicity at moderate concentrations. Technology now exists for reducing the gas emissions into the atmosphere.

These small quantities from geothermal plants are not emitted during power production as a result of combustion but are natural constituents of a geothermal reservoir. The gases would eventually vent into the atmosphere under natural conditions although at much lower rates (Goff, 2000).

In addition to the prevention and control of emissions and exposure to H₂S gas described in the environmental and occupational health and safety sections above, the potential for exposures to members of the community should be carefully considered during the planning process and the necessary precautions implemented.

³² Opondo, K.M. and S. Arrnsson, Amorphous silica scales deposited in a geothermal well at Olkaria, Kenya. Proceeding of the 12th International Symposium on Water-Rock Interaction, Kunming, China, 31st July- 5th August 2007.

Where the potential for community exposure is significant, examples of mitigation measures shall include:

- Siting of potential significant emissions sources with consideration of H₂S gas exposure to nearby communities (considering key environmental factors such as proximity, morphology and prevailing wind directions);
- Installation of a H₂S gas monitoring network with the number and location of monitoring stations determined through air dispersion modeling, taking into account the location of emissions sources and areas of community use and habitation;
- Continuous operation of the H₂S gas monitoring systems to facilitate early detection and warning; and
- Emergency planning involving community input to allow for effective response to monitoring system warnings.

Measurements at the Olkaria power plants have recorded 1-minute concentrations not exceeding 1.25 ppm. Monitoring is done three times a week at most locations around the power station and at least once in a week for sites further away. There are 10 main monitoring sites, distributed to cover residential areas, occupational workplace areas, and park entry points around Olkaria. The occupational exposure limit of H₂S in workplaces is 10 ppm for an average 8-hour day. The H₂S levels at Olkaria are far below the occupational exposure limit. The maximum value recorded is 4.40 ppm at the power station.

6.2.7 Confined Spaces

Confined space hazards in this and any other industry sector are potentially fatal. Confined space entry by workers and the potential for accidents may vary among geothermal facilities depending on design, on-site equipment, and presence of groundwater or geothermal fluids. Specific and unique areas for confined space entry may include the turbine, condenser, and cooling water tower (during maintenance activities), monitoring equipment sheds (during sampling), and the well hole “cellar” (a subsurface depression created for drilling purposes). Geothermal power facilities will develop and implement confined space entry procedures as described in the General EHS Guidelines.

6.2.8 Power-transmission Lines

Power-transmission lines require an EIA to avoid visual impact and collisions by birds. Sometimes assistance from the personnel of the Kenya Wildlife Service is required to avoid crossing scenic areas that form important breeding and nesting grounds for

various birds and animals. Presently there were no observations of specific habitats that may be affected by the existing 220 KV power lines that pass at the floor of the rift and outside the Suswa prospect geothermal drilling boundary. Monitoring is suggested in order to avoid power-line collisions and electrocution of migratory birds along their route to the north.

6.2.9 Compensation of affected Households and land parcels

There is a minimum distance from which any homestead, school or public facility may be near the drilling sites or power generation. Where such minimum distances may occur, there such facilities shall be relocated. Noise assessment in the Suswa project area shows that some settlements or social facilities may fall within the 35dB noise contour and will therefore require adequate noise mitigation measures. ILO recommends a threshold of 85 decibels. Any potential relocation criteria will be based on the potential interferences that are likely to occur as a result of the drilling.

Tables 40 below shows the location of the proposed wells, schools and homesteads within the proposed site 1 for this initial exploratory drilling.

Table 40: Coordinates of Household within the Suswa Prospect Geothermal drilling project Area (GPS) Section SUSWA

Name	Description	Eastings	Northings
Homestead 1	Household interviewed	0210827	9875813
Homestead 2	Household interviewed	0210653	9875645
Homestead 3	Household interviewed	0210468	9875481
Suswa Conservancy Base Station	Suswa Conservancy Base office	0210325	9875355
Homestead 5	Household interviewed	0210761	9876795
Pentecost Church	Inside the outer crater	0207897	9876570
Kisharu Primary School	Primary school	0207792	9876657
Olong'uswa School	Primary and Nursery School	0203993	9876308
Homestead 6		0201083	9871701
Exploration well 3 (SW-03)		201954	9873804
Entrance to the caves	Tourist attraction. The names of the caves that converge at this point are 14A, 14B	0210846	9875082

	and 14C		
Sign post to Suswa Conservancy caves	Road marking	0210523	9876842
Hot Springs	Steam is harvested and condensed for domestic use	0204422	9875766
Exploration well 1 (SW-01)		204196	9868534
Exploration well 2 (SW-02)		208591	9874476
Exploration well 4 (SW-04)		204168	9877644

Table 41: Section EWUASO KEDONG'

Name	Description	Eastings	Northings
Water tanks at	Najili Market ³³	0217379	9865871
Tank 2	At Olo Dung'oro	0214436	9865604
Homestead		0211389	9868338
Homestead		0211426	9868035
Tank 3	At Soitamutai	0208904	
Primary School	Public	0208633	
Primary School	Public	0205744	
Homestead		0211345	

The two schools and homesteads marked within a distance of 1 km. required adequate mitigation measures against potential noise emission. The inventories of the homesteads have been given and the types of building and desks in schools have also been listed, in case of compensation.

Where the proposed sites are too close to settlement, the other possible option will be to shift the location of the proposed sites for the well to avoid any potential relocation.

³³ The tanks were constructed for storage but are empty

6.2.10 Agriculture

There were a couple of maize/beans farms within the outer caldera that may be stopped. In this respect, the crops will be compensated accordingly. The compensation criteria will be decided at the appropriate time.

6.2 11 Religious and cultural heritage

Important religious and cultural heritage will be determined so that NMK may advice on how to fence them off or enhance their values for the betterment of the community as well as tourists.

6.2.12 Harvesting Steam for Domestic Water Supply

Water supply for the households and livestock in the project area has significant consequences both in terms of productivity, health and other monetary costs. The sources of water include fumaroles or hot springs and pans/dams.

By reducing the water-related health risks and thereby improving the health status of the population, improved water supply and sanitation facilities will exert their positive impact on basic education by relieving girls from their water fetching duties. Both boys' and girls' school attendance and educational achievements are known to improve significantly with reduced health-risks and better nutritional status from improved water supply and sanitation, as well as reduced injuries and strain from water carrying, particularly for girls. Chronic early childhood diarrhoea can result in permanent effects on brain development with the resulting impact on a child's learning achievements.

6.3 Cumulative Impacts of Geothermal Power Development

The main health impact normally related to operating geothermal fields is occupational exposure to geothermal gases like hydrogen sulphide (H₂S). The health impacts during construction are dust and accident related, and these are expected to be reported in monthly progress reports. It is suggested that, during construction stage, in consultation with the communities, a new dispensary with government personnel and medicines within the project site, be constructed to meet the health requirements of the communities, and construction workers and GDC staff on site. The main public health facilities are located far from the project site in Naivasha and Kijabe towns, while existing referral facilities are in Nairobi.

The health benefits of geothermal brine are known worldwide. In Olkaria, the local Maasai community and some workers use the brine for skin ailments. Local people attribute low incidence of waterborne diseases such as cholera and typhoid to the use of water from the fumaroles. Key findings from public participation were as follows:

- a) Improved access to water supply for use by the community after the initial drilling phase of the first well.
- b) Improved roads infrastructure within the project area and its environment.
- c) Creation of more employment opportunities for the local people leading to enhanced community livelihoods.
- d) Increased urban development in the local urban centres to provide housing for the project workers.
- e) Enhanced tourist opportunities by opening up the Suswa Conservancy and the Suswa Caves to tourists.

- f) Enhanced education opportunities to the local community children through improved school facilities by providing improved school and boarding facilities.
- g) Increased job opportunities through enhanced provision of electricity by government to the local areas for use by *Jua kali* artisans from the project area.
- h) Protection and conservation of the Maasai shrines used for the graduation celebration of the Maasai Morans to preserve their culture and cultural sites.
- i) Mount Suswa Conservancy and Empaash Oloirienito Conservancy (EOC) would market their products together in association with the Maasai Mara tourist circuit
- j) Enhanced markets for animal products such as meat and milk leading to increased economic empowerment for the local communities.

6.4 Compatibility with other land-uses

Geothermal power plants require relatively little land. They can be sited in farmland and forests and can share land with cattle and local wildlife as expected in this project.

6.5 Renewability of Geothermal Resource

Geothermal energy has been classified under clean and renewable resource. The resource can be described as renewable only if the rate of extraction is less than the recharge rate. Sustainable use of the resource can be attained through reinjection and reservoir flow monitoring.

6.6 Main Concerns of Local People about the Project

6.6.1 Ensuring Compliance

NEMA has the responsibility to ensure that the Environmental Management Plan and Environmental Monitoring Action Plan are implemented in an effective and efficient manner. Measures will be taken to ensure that relevant laws, regulations, agreements (including resettlement and compensation agreements) and recommendations are followed. Each year, the Geothermal Operator will submit an Annual Environmental Audit as required by law.

Each county has a NEMA county Director Environment (CDE) in charge of monitoring and compliance. NEMA will ensure that the CDE is facilitated adequately to monitor implementation of the Management Plan and the Monitoring Action Plan. The monitoring Plan has been costed for information to key stakeholders.

Table 42: Impacts and mitigation measures of Suswa Prospect Geothermal Drilling Project

Possible Impact	Mitigation measures
Vegetation and Habitat Loss	<ul style="list-style-type: none"> • Minimise vegetation clearance by carrying out a thorough site planning. • Refill disturbed areas excavated during construction of access road and site preparation period. • Ensure minimum disruption of migration routes. • Rehabilitate of the affected sites with fast growing grasses e.g. star grass. • Employ selective bush clearing to ensure sapling regrowth.
Human-Wildlife conflicts	<ul style="list-style-type: none"> • Strictly control clearance of vegetation and minimize areas taken by roads, building and asphalted surfaces. • Control and minimize disturbance of wildlife corridors. • Game/cattle proof fencing of water ponds to prevent access to geothermal brine. • Route the transmission line away from bird migratory routes. • Provide troughs for domestic animals and water holes for wildlife at reasonable distances from the drilling sites. • Monitor trends in the local biology and relate changes to project impacts.
Solid waste management	<ul style="list-style-type: none"> • Proper disposal of both waste water and oil spills through septic tanks at designated points away from the outer caldera zone where most of the drilling will be done. • Receptacles shall be provided for waste storage prior to collection. • Resource recovery will be encouraged once the project takes off so as to shrink waste stream and recover non-recyclables. • Refuse collection vehicles will be covered to prevent scatter by wind. • All persons involved in waste collection shall be in full protection attire.
Air quality.	<ul style="list-style-type: none"> • Provide appropriate warnings at work site. • Provide and clearly display emergency contacts.

Possible Impact	Mitigation measures
	<ul style="list-style-type: none"> • Develop and implement detailed and site specific Emergency Response Plans. • Provision of adequate ventilation of occupied buildings to avoid accumulation of hydrogen sulphide gas. • Regularly maintain construction plant and machinery. • Sensitize construction workers on suppression of idling vehicles and machinery.
Water pollution	<ul style="list-style-type: none"> • Re-inject all brine and steam condensate into deep wells to avoid possible pollution of natural resources. • Fence off any brine ponds to prevent access by animals and humans. •
Water supply and Augmentation	<ul style="list-style-type: none"> • Use brine or steam condensate from the first well for drilling. • Drill additional boreholes. • Truck/ water pipeline from Kengen storage. • Increase water harvesting by providing more water storage facilities within and outside the project area. • Support community integration in water use management programme to avoid water use conflicts within the water source points by encouraging registration of community individuals in the existing WRUA's.
Dust Pollution from construction of road and rigs, quarrying and excavation	<ul style="list-style-type: none"> • Continuous road surface watering during the construction period to minimize dust generation and air pollution. • Suppress dust with water to reduce dust emissions. • Limit the speed of vehicles on dust access roads • Use of air dust filters to reduce air pollution.

Possible Impact	Mitigation measures
Death of animals from road accidents	<ul style="list-style-type: none"> • Install and enforce speed limits for all project vehicles. • Put up appropriate road signs to notify motorists about pedestrian/animal crossings and the conditions of the road. • Take advantage of off peak hours to truck movement to the site. • Employ well trained and experienced drivers.
Fire hazard and fire outbreaks	<ul style="list-style-type: none"> • Put in place fire surveillance and early warning system to raise alarms during high fire hazard seasons. • Carry out fire drills regularly. • Provide First Aid kits.
Wind erosion	<ul style="list-style-type: none"> • Control earth works. • Compact loose soils. • Plant trees along the steep Mt. Suswa slopes to reduce gully development and soil erosion on the slopes. • Plant grass along the road side and pathways to reduce soil erosion.
Noise and Vibrations	<ul style="list-style-type: none"> • Monitoring noise levels against recommended threshold values. • Maintain plant and machinery in good condition in accordance with manufacturer's specifications. • Where feasible, use of noise silencers in the machinery exhaust pipes to minimize noise generation and incorporate low-noise systems, such as ventilation systems, pumps, generators, compressors, and fans • Prohibit movement of heavy vehicles after 6.30pm. • Sensitize workers on risks of exposure to excessive noise.
Erosion of aesthetic, cultural, archaeological and/or spiritual value of places	<ul style="list-style-type: none"> • Protection and conservation of the Maasai shrines. • Training and career development for local, regional, territorial residents. • Cap and protect fumaroles selecting few that could be of touristic nature. • Safety awareness workshops for workers.
Insecurity	<ul style="list-style-type: none"> • Enhance security by providing more security patrols within the site areas.

Possible Impact	Mitigation measures
	<ul style="list-style-type: none"> • All gates should be controlled by security personnel at all times.
Compensation of affected land parcels and properties	<ul style="list-style-type: none"> • Relocation shall be minimized where feasible, exploring all measures to realign any structures within the Concession Area. • Where relocation or resettlement is unavoidable, plan for compensation adequately. • Establish a transparent community consultation process.
Deforestation for fuel energy for project workers	<ul style="list-style-type: none"> • Provide workers with alternative energy sources. • Encourage community tree planting for wood fuel.

CHAPTER 7: DECOMMISSIONING AND SITE RECLAMATION

7.1 General Decommissioning Features

Potential environmental impacts from decommissioning and site reclamation activities are generally similar to those during the construction phase, but of shorter duration than those during the operations and maintenance phase. Geothermal facilities are removed after their useful life. Following decommissioning, the site would be restored (reclaimed) to approximate its original condition or to some standard that results in stable environmental conditions. Typical activities during the decommissioning/reclamation phase include:

- closure of all facilities and wells;
- removal of aboveground components and gravel from well pads, access roads (if not maintained for other uses), and other ancillary facility sites;
- Recontouring the surface; and revegetation.
- Impacts would be similar to those addressed for the construction phase; however, many of these impacts would be reduced by implementing good industry practices. Restoration during this phase would also ensure that impacts beyond the life of the geothermal energy development are avoided or minimized.

7.2 Noise Pollution

Sources of noise during decommissioning would be similar to those during drilling and construction and would be generated primarily by construction equipment and vehicular traffic. To residential areas located nearby, noise levels could exceed the EPA guideline but would be intermittent and extend for only a limited time.

7.3 Air Quality

Emissions generated by activities during the decommissioning and reclamation phase include vehicle emissions, diesel emissions from large construction equipment and generators, and dust from many sources such as land clearing, structure removal, cement mixing, backfilling, dumping, reclamation of disturbed areas (grading, seeding, planting), and truck and equipment traffic.

7.4 Maasai Cultural Resources

Decommissioning activities would have little potential to impact cultural resources because these resources would have been sustainably enhanced professionally during

the life of the project. Visual impacts of the geothermal development would be mitigated if the area was restored to its pre-development condition.

7.5 Ecological Services and Tourism

Impacts to Ecological Services and Tourism from decommissioning and reclamation activities would be similar in nature to the impacts that would occur during construction and drilling, but at a reduced magnitude. There would be a temporary increase in noise and visual disturbance associated with the dismantling and removal of project facilities and reclamation. Impacts to wildlife habitat would be minimal, and injury and mortality rates of vegetation and wildlife would be much lower than they would be during construction and drilling. Removal of above ground structures would eliminate the impacts to wildlife that occurred during operation (e.g., bird collisions and habitat fragmentation). Removal of sump pits would also eliminate a potential source of concern to wildlife species. Following site reclamation, the ecological services at the project site could eventually return to pre-project conditions for Suswa Wildlife Conservancy. Grasses and indigenous trees planted during the life of the project may be more plentiful during early years of reclamation than existed prior to project development. This could increase forage for some wildlife species. Reclamation of forest or savanna bushland could take longer.

Decommissioning activities would have only temporary and minor visual effects, resulting from the presence of workers, vehicles, and construction equipment (including lighting for safety); and from vegetation damage, dust generation, scarring of the terrain, and altering landforms or contours as structures are dismantled and removed. Reclamation to restore visual resources to pre-disturbance conditions would lessen these impacts.

7.6 Hazardous Materials and Waste Management

Substantial amounts of solid and industrial waste would be generated during the dismantling of geothermal structures and facilities. Much of the solid material can be recycled and sold as scrap or used for other projects; the remaining nonhazardous waste would be sent to pre-arranged disposal facilities. Industrial wastes (oils, hydraulic fluids, coolants, solvents, and cleaning agents) would be treated similarly to wastes during the operation and utilization phases (e.g. put in containers, characterized and labeled, possibly stored briefly, and transported by a licensed hauler to an appropriate permitted off-site disposal facility). Impacts could result if these wastes were not properly handled and were released to the environment. In case of environmental contamination at a site during the operation and utilization phase, decommissioning

and reclamation activities could include removal of the in situ contamination for transportation to a designated off-site disposal facility.

7.7 Health and Safety

Potential human health and safety impacts during decommissioning and reclamation would be similar to those during the exploration and drilling and construction phases; and relate to earthmoving, use of large equipment, dismantling of industrial components (power plant, substation, and pipeline systems), and transportation of overweight and oversized materials. Adverse impacts could include the risk of electrical fires and wildfires caused by project activities and vehicular accidents due to increased traffic on local roads. The potential for such impacts can be minimized if appropriate safety procedures are implemented.

7.8 Land Use

Land use impacts resulting from drilling and construction could be largely reversed by decommissioning, depending on the end use selected for the project site.

7.9 Socioeconomic Impacts

Direct impacts would include the creation of temporary but new jobs for workers during decommissioning and reclamation activities. Indirect impacts are those impacts that would occur as a result of the new economic development and would include things such as new jobs at businesses that support the workforce or that provide project materials. Adverse effects to property values may be anticipated as a result of decommissioning. Because of sustainable eco-tourism that has developed over the period, site reclamation could result in improved economic values of residential properties adjacent to the conservancy. The loss of royalty and tax revenue could adversely impact the counties' economies.

7.10. Soils and Geologic Resources

Impacts to soils and geologic resources would be similar to those occurring during the construction phase. Dismantling and removing roads, well pads, the geothermal power plant, and structures related to the power plant (e.g., the pipeline system and transmission lines) would occur during this phase. These activities would cause topographic changes. Soil compaction, impermeability, and concrete surfaces may cause an increase in surface runoff, potentially causing increased sheet, rill, and gully

erosion. However, altering drainage patterns could also accelerate erosion and create slope instability.

7.11 Surface Water and Groundwater Resources

The decommissioning and reclamation phase would involve ground-disturbing activities (related to dismantling facility structures and recontouring the surface) that could lead to an increase in soil erosion and surface runoff. Impacts to surface water would be moderate but temporary and could be reduced by implementing best management practices based on storm water conservation and management. Activities during this phase also include plugging and capping of production and injection wells. Improper abandonment could allow wells to serve as pathways for geothermal fluids to migrate to other aquifers, affecting both the geothermal resource and the quality of the affected aquifers. Proper well closure and capping would reduce the risk of these impacts.

Water would be also be used to control dust from road traffic and for consumptive use by workers. Depending on availability, it may be trucked in from off-site or obtained from local groundwater wells or nearby municipal supplies. Upon completion of decommissioning, water consumption associated with the facility operations would end and disturbed areas would be contoured and revegetated to minimize the long-term potential for soil erosion and water quality related impacts.

CHAPTER 8: ENVIRONMENTAL MONITORING PLAN

8.1 Approach

An environmental monitoring plan is normally designed and included in the EIA report. Monitoring is done to identify and mitigate changes in the environment brought about by the geothermal project development. This is done during exploration, drilling, construction and operation. The monitoring plan has all the identified possible impacts, their mitigations and the person responsible for implementation. A cost is also attached to all monitoring plan analyzed. Participatory approach is encouraged in monitoring social issues. Table 43 highlights some of the key environmental and social issues³⁴ that will be monitored in geothermal development. Additional guidance on applicable sampling and analytical methods for emissions and effluents is provided in the General EHS Guidelines.

Table 43: Social and Environmental Monitoring Action Plan Matrix

Monitoring Parameters	Environmental Monitoring Parameters	Responsible Institution	Timeframe	Estimated cost (USD/year)
Land use changes	Soil and vegetation degradation (erosion)	NEMA; GDC	Through construction phase	2,160
	Water use and consumption	WRUAs, WRMA, District Water Office; GDC	Throughout construction and development phase	3,000
	Ecosystem (plants and animals)	KWS; NMK; Conservancy	Throughout life of project ³⁵	1,080
	Water and gas chemistry	GDC	Throughout life of project	2,000
Public health and safety Community complaints	Surface and ground water chemistry and levels	GDC	Throughout life of project	1,800
	Noise level	GDC	First month during well drilling and construction	800
	Air pollution and precipitation chemistry	GDC	Throughout project's life	1,200

³⁴ The elements of a monitoring plan normally include selection of the parameters of concern; the method of collection and handling of samples (specifying the location, the frequency, type, and quantity of samples, and sampling equipment); sample analysis (or, alternatively, on-line monitoring); and a format for reporting the results (World Bank Group, 1999).

³⁵ Throughout life of project implies monitoring during exploration, drilling, construction and operation

	Seismic monitoring, geo-hazard monitoring	GDC	Throughout life of project to safeguard integrity of caves	2,000
	Occupational health and safety performance	GDC	Through out	1,500
	Employment and household incomes; Resettlement (if applicable)	NBS Leaders'	Construction phase only	Annual Surveys
Traffic volume Business and services subsidence	Demographic changes (wildlife and human); (if applicable)	NBS	Through out All phases	Annual surveys
	Tourism	MSC	Through out All phases	Monthly records

The main objective of this Environmental Monitoring Plan is to monitor all activities to be undertaken by GDC, especially activities impacting the following environmental components: physical-chemical, biological, socioeconomic, and public health. GDC is obliged and responsible for the prevention and the mitigation of such negative impacts caused by the activities. Objectives of the Environmental Monitoring Plan (EMP) are:

- To monitor environmental components affected by the activities of the development of the Suswa geothermal field and power plant in accordance to the ESIA study undertaken;
- To ensure that the implementation of the Environmental Monitoring Plan is on target and that it minimizes the negative impacts and maximizes the positive impacts of the proposed activities.

8.2 Soil Compaction, Erosion and Devegetation

Bush clearing, opening up access roads and increased vehicular movements are likely going to cause soil compaction/destabilisation, increased runoff and consequently increased soil erosion. Although significant soil erosion may be reduced by starting work before the rains and therefore there will be sufficient time to design and carry out proper drainage. The roads outside the concession area will be done by the government while the access roads within the concession will be constructed by GDC. NEMA through the CDE shall monitor and ensure that proper works are done in a timely manner. Sheet, gully and wind erosion will be monitored very closely.

8.3 Water use and consumption

The project is sited in a semi-arid and arid environment. It will be prudent to ensure that water use and water consumption is carefully planned and regulated to avoid wastage and over-consumption. The relevant WRUAs in collaboration with the WRMA office shall ensure that water is used in a satisfactory manner.

8.4 Ecosystem (flora & fauna)

The ecosystem in Mount Suswa is little understood since it lies along the migratory route of birds escaping the winter in Europe. It is also home to the endemic bat and unique flower. With the expected improved wildlife protection and increased tourist activities, there likely will be changes in the flora and fauna of the area.

8.5 Water and gas chemistry

Spent geothermal fluids are typically re-injected to the host rock formation, resulting in minor effluent volumes involving reject waters. Potential contaminants in geothermal effluents will vary according to the mineralogy of the host geological formation, temperature of the geothermal water, and site-specific facility processes. 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.

In order to limit degradation of the deep geothermal aquifers, reservoir performance at different exploitation capacities by simulation studies, is carried out. Sustainable management of the reservoir by maintaining adequate balance between geothermal fluid withdrawal and recharge of disposed fluid is done once operation begins.

8.6 Surface and Ground Water Chemistry and Levels

While pollution monitoring is essentially the monitoring of various chemical species and other potentially harmful agents (such as particulate matter) in the environment and important in the context of geothermal power plants, it is only a part of a thorough and well rounded geothermal environmental monitoring program. The World Bank Group's (WBG) description is therefore not complete in the context of geothermal power plants, but can nevertheless serve as a basis that can be extended to the other factors of concern to design a sound environmental monitoring program.

The groundwater monitoring wells would be constructed in compliance with the DEQ's *Groundwater Monitoring Well Drilling, Construction, and Decommissioning* guidance

document (DEQ 1992). A small drill rig would be required to drill the wells. The drilling method would depend upon the site-specific geologic and hydrogeologic conditions. The monitoring data would be used to quantify the relationship between geothermal pumping and injection and localized groundwater levels to ensure that surrounding users are not adversely impacted.

There is a possible risk on water pollution from heavy metals like As, B, Hg, Zn, Pb, Cl, Li, etc from geothermal fluid. Therefore, water quality monitoring has to be done more regularly and consistently by NEMA and GDC to determine its quality and impacts of surrounding agricultural activities on its ecosystem. The impact of these pollutants on availability of water for domestic and livestock use should be determined and prevented.

8.7 Air pollution and precipitation chemistry

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 such as the Air Quality Guidelines of the World Health Organization (WHO), 2000.

The most important indicator is hydrogen sulphide concentration in the ambient air especially during well drilling and production testing. Measurement of H₂S concentrations in ambient air will be recorded using H₂S monitoring equipment. Sites close to homesteads and schools will be considered top priority.

8.9 Noise

The EMCA 1999 recognizes the fact that any person emitting noise in excess of noise emission standards commits an offence. It legalizes the process of Environmental Impact Assessment and compliance with the set emission goals, permissible standards, and control strategies and technologies for noise emission as mandatory. The level of noise has also been known to affect wildlife, either by interrupting their breeding or simply annoying them³⁶.

³⁶ Gladwin, D.N., D. A. Asherin, and K. M. Mancini (1987). Effects of aircraft noise and sonic booms on fish and wildlife: results of a survey of U.S. Fish and Wildlife Service Endangered Species and Ecological Services Field Offices, Refuges, Hatcheries, and Research Centers. National Ecology Research Center, Fort Collins. Krausman P.R, et al (1993). Effects of simulated aircraft noise on heart rates and behavior of desert ungulates, University of Arizona. <http://www.sound.media.mit.edu/~dpwe/AUDITORY/asmtgs/asa93ott/4pAB/4pAB3.html>

With establishment of noise emission standards, it will be a requirement to obtain temporary permits from the National Environment Management Authority (NEMA) allowing for emissions of noise in excess of established standards for a period not exceeding three months. Levels of noise rise during well drilling and production testing and also during mobilization of equipment and materials. A number of noise monitoring sites shall be selected to determine potential-noise sources in the project area. Few sites will be designated as noise monitoring sites or stations within the concession area. Noise-level measurements may be taken twice a week in all the monitoring sites and stations.

8.10 Employment, Business Opportunities and Household Incomes

There will be a need to monitor the number of local people employed as casuals and permanent employees. A record will be kept of the numbers, percentages, areas of origin of GDC's and its contractors Villages in the vicinity of the development of Mount Suswa geothermal field and power plant project area are expected to be beneficiaries of the project in terms of increased employment opportunities.

The District Trade Officers will collect data on purchases of goods and services carried out by GDC and its contractors and contracts awarded to local companies. National Bureau of Statistics will collect data on the growth of local businesses before, during and after construction stage.

Perspectives on expected benefits from geothermal projects include construction of modern schools including availability of scholarships, increased number of people employed by GDC and other related institutions, increased local voice on Board of management of companies undertaking geothermal development, promotion of local products (built abattoirs, tanneries, etc), improved water and sanitation. The local inhabitants prefer to see benefits targeting pastoralist economy because they may not be able to compete due to historical legacy.

On the other hand, there were perspectives on expected community losses from geothermal projects, and these include cultural erosion – Maasai will finally embrace cultural change and attire, loss of Maasai identity due to intermarriages, globalization forces, etc., Maasai are one of the few remaining indigenous tribes in Kenya, and much of Kenya's international tourism branding is related to the Maasai culture.

In any case, the annual surveys are done by the National Bureau of Statistics (NBS). NBS will also compute job and business opportunities during construction period.

8.11 Occupational Health and Safety

Occupational health and safety performance should be evaluated against internationally published exposure guidelines, of which examples 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 Health and Safety (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 and other similar sources.

The project shall make every effort to reduce the number of accidents among project workers (whether directly employed or subcontracted) to a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. Monitoring shall be designed and implemented by accredited professionals as part of an occupational health and safety monitoring program. Facilities should also maintain a record of occupational accidents and diseases and dangerous occurrences and accidents. Additional guidance on occupational health and safety monitoring programs is provided in the General Environmental Health and Safety (EHS) Guidelines. Fatality rates may be benchmarked against the performance of facilities in this sector in developed countries through consultation with published sources (e.g. US Bureau of Labor Statistics and UK Health and Safety Executive).

8.12 Equator Principles

The present ESIA has met all the requirements of the Equator Principles (EPs). The EPs are a voluntary set of standards for determining, assessing and managing social and environmental risk in project financing. Project financing, a method of funding in which the lender looks primarily to the revenues generated by a single project both as the source of repayment and as security for the exposure, plays an important role in financing development throughout the world.

The EIA report has addressed the following:

- Provided baseline environmental and social conditions;
- Relevant laws and regulations and applicable international treaties and agreements;
- Supports sustainable development and use of renewable resources;
- Protection of human health, cultural properties and biodiversity including endangered species and sensitive ecosystems;

- Use of dangerous substances;
- Major hazards;
- Occupational health and safety (OHS);
- Fire prevention and life safety;
- Socioeconomic impacts;
- Land acquisition and land use;
- Involuntary resettlement;
- Impacts on indigenous peoples and communities;
- Cumulative impacts of existing projects, the proposed project and anticipated future projects;
- Participation of affected parties in the ESIA process;
- Consideration of feasible environmentally and socially preferable alternatives;
- Efficient production, delivery and use of energy; and
- Pollution prevention and waste minimisation, pollution controls (liquid effluent and air emissions) and solid and chemical waste management.

The conclusions arrived at below reflect the results of the ESIA study and has included considerations of the EPs.

CHAPTER 9: CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions drawn from ESIA

The development of the Suswa Prospect Geothermal Drilling Power Project will cause limited adverse impacts to the environment compared to other conventional energy developments. Moreover all the known environmental impacts resulting from this geothermal development can be more than adequately mitigated. In developing geothermal projects, it is recommended that GDC factor the costs of environmental and social mitigation measures into the total project cost. All the national and international legal requirements, including Equator Principles, have been used to benchmark the Environmental Management Plan and Environmental Monitoring Action Plan. Ultimately, the project likely will enhance development and conservation of the environment.

The EMAP has included preliminary costs estimates attached to all mitigation measures. A participatory approach has been used in developing community development requirements and for monitoring social issues as required (World Bank, 1994).

The general conclusions regarding the ESIA of the Suswa Prospect Geothermal Drilling Project:

- 1) The inhabitants welcome the Suswa Prospect Geothermal Drilling Power Project and perceive the proposed project as beneficial to different sectors of both the national as well as the local development by enhancing transportation, access to water, health, education, and improving agriculture and tourism. However, they need assurance that the government's commitment will be fulfilled and the communities concerns will be addressed.
- 2) Land is privately owned by individuals, each household owning between 100-400 acres to which they have been issued with letters of allotment with beacons established. The lists of individuals who own land, acreage and their household assets have been documented carefully for further work in case there will be relocation and resettlement. There are approximately **106** households inside the project area. In addition, there are **9** schools of which **6** are Government owned and **3** are privately owned. One school and two homesteads appear to be within close locations of the proposed drilling wells sites.
- 3) GDC must make every attempt to minimize any relocation during drilling phase of the project. This is likely to be economically sound and socially acceptable to the community during the exploratory drilling phase. Once the geothermal potential is established to be viable and commercial, then the schools and any settlements near the drilling wells can be relocated if required and probably compensated.

- 4) Water for drilling will be obtained from Mai Mahiu/Kijabe water boreholes, KenGen's Olkaria IV Domes geothermal area storage reservoir tanks.
- 5) The road network to the caldera is already identified and would require proper drainage during construction. It should also try to avoid Suswa market to minimize any disturbances arising from the dust.
- 6) Development of geothermal power for electricity generates environmental impacts during drilling, power generation and decommissioning; such negative impacts include possibility of increased seismic activities, aesthetics and visual obstruction of pipelines, exposure to geothermal gases, mainly hydrogen sulphide gas; surface and groundwater pollution; increased vehicular traffic and dust pollution from the service roads; soil erosion associated with ground compaction generating increased surface runoff and gulying along road sides; exposure to physical hazards associated with the wells and related pipeline networks; hazards resulting from contact with hot components, equipment failure, or the presence of active and abandoned well infrastructure; power-transmission lines that may cause visual impact and collisions by birds; may affect important breeding and nesting grounds for various animal and bird species and occupational hazards.
- 7) The negative impacts that ranked significantly high are those associated with valued resource stocks and ecological functions; negative impact on social values, quality of life and livelihood; and foreclosure of land and resource use opportunities.
- 8) The impacts during drilling and Construction phases are higher than the Operation and utilization phase and Decommissioning phase. However, the available mitigation measures are plausible, adequate and inexpensive.
- 9) Gaseous impacts associated with geothermal power generation tend to decay with time, most of the landscape, flora and fauna disturbances are rehabilitated and hence the environment may be enhanced rather than deteriorate with time. Proper landscape planning and minimization of leveled surface for vehicle parking, stores, water reservoirs, etc will eliminate destruction to the sprawling scenery that would be against the development of eco-tourism of Suswa Conservancy as suggested in the present study.
- 10) The socioeconomic studies include population, education, health, water supplies and the local economy. The social impacts includes increased population in the small townships, increased demand for housing and other social amenities such access to clean water, health services, and schools. The main conclusion is that these impacts will generate investment appetite and improved economic activity in the area. Although increased tourism numbers may impact negatively the social life, the traditional Maasai people are already exposed to the outside world.
- 11) The benefits that are likely to accrue in the area tend to outweigh negative impacts.

- 12) GDC has the responsibility of Environmental Monitoring for the geothermal resources and monitoring impacts that may affect the health of the local inhabitants.

9.2 Recommendations

- (1) Oncompensation of affected households:

In case there may be compensation for affected land parcels, homesteads and public facilities: (a) the views of the relevant stakeholders will be considered; (b) the government and GDC will conduct adequate negotiation about compensation; (c) the potential adverse consequences have been considered; and (d) the policy has been redesigned to reduce these consequences and mitigation or compensatory mechanisms developed. Because it is a participatory process where the proposed reform is derived endogenously, the assumption is that the planned intervention would be appropriate to local cultural, social and institutional settings.

- (2) Enhancement of Eco-tourism:

It is concluded that the improvements on infrastructure will enhance accessibility to the area. Based on the information available, the implementation of the project may be used to formulate an integrated ecotourism plan for Mount Suswa Conservancy and Empaash Oloirienito Conservancy (EOC). The future power station will itself attract visitors. KWS, NMK, MSC, EOC and GDC should maintain a formal meeting structure to establish and develop an integrated ecotourism plan. KWS and NMK should provide the leadership. Basic park rules regarding welfare of animals and preservation of caves as cultural artifacts need to be established. With this in mind, significant impacts will be managed adequately.

- (3) Environmental monitoring:

GDC has the responsibility of Environmental Monitoring for the geothermal resources and the welfare of its employees in the project and monitoring impacts that may affect the health of the local inhabitants.

- (4) On alternative action:

The use of the geothermal resource would increase from other sources that have been identified along the central and north rift. No power would be generated from Mount Suswa or sold to the electricity company. But other sources will augment the national electricity requirements. Furthermore, reductions in fossil fuel use and improvements in

energy efficiency would not occur and Ministry of Energy's ability to achieve its objectives under the Strategic Electricity Production Program and the ARRA would be impaired.

There are sufficient mitigation measures that are planned through the Environmental Management Plan (EMP).

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ANNEXES

Annex 1: List of Participants at Various workshops and meetings

**ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR SUSWSA
GEOTHERMAL PROJECT**

NAIVASHA DISTRICT
25.06.2013

Participation Form

Sy/No.	Name	Position	Organization	Telephone No.	Signature
1	Michael K. Kariuki	DCC	ODP	071257463	[Signature]
2	Michael K. Kariuki	ACC	ODP	072132136	[Signature]
3	Leonard M. Kibuki	DEAD	M.O.E	0720396163	[Signature]
4	JAMES AYUSA	D.Y.O	MINISTRY	072260411	[Signature]
5	John Mwangi	ACOMTAT	NGO	072144124	[Signature]
6	Susan Kamukoo	PHD	MOH	072452101	[Signature]
7	John K. Mwangi	CLM	NGO	070735241	[Signature]
8	Nicholas M. Kariuki	S.F.O	MOFA	072375473	[Signature]
9	Francis Mwangi	D/MPD	MOA	072360014	[Signature]
10	Josiah Mwangi	Member	NGO	072401637	[Signature]
11	John Kibuki	DEAD	MOI	071211212	[Signature]
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13	Daniel Mwangi	ADWD	WATER	073223457	[Signature]
14	Virginia M. Kariuki	ASCO	NIOE	072377051	[Signature]
15	Anne W. Mwangi	ALASDA	M.O.L	072090034	[Signature]
16	H. Oporo	ODP	ODP	2061626	[Signature]
17	F. Mwangi	DEPT	MOA	072069966	[Signature]
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**CONSULTING SERVICES FOR ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR SUSWA GEOTHERMAL PROJECT
 COMMISSIONED BY GEOTHERMAL DEVELOPMENT COMPANY**

DATE: 21/5/18

KISHARU ELDERS.

NAME	ORGANIZATION	ID NUMBER	TELEPHONE	SIGNATURE
Simon Tadiyin	D.o.P	263533912	0129212960	
Masak Khosrokin	M.S.C.T.	12981852	0721 897609	
Joseph Tebayun	Elder	11680321	0710279606	
Rafael Kaulis	Environment	2509790	0724 225071	
Supri/Santia Nikhu	Quarter	12981234	0720925746	

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR SUSWA GEOTHERMAL PROJECT (GDC)

PARTICIPATION SHEET KATIADO NORTH DISTRICT DATE 6/6/2013
GOVERNMENT HODs

	Name	Organization/ Position	Tel. Number	Email Address	Signature
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REOPLAN CONSULTANTS LTD

GOVERNMENT of OPINION LEADERS MEETING
REDPLAN Consultants Ltd, WAHASHA DISTRICT

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CONSULTING SERVICES FOR ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR SUSWA GEOTHERMAL PROJECT
 COMMISSIONED BY GEOTHERMAL DEVELOPMENT COMPANY
 DATE: 11/12/2013

NAME	ORGANIZATION	ID NUMBER	TELEPHONE	SIGNATURE
John Kinyu	District Development office	21754261	0720-221273	<i>John Kinyu</i>
Solius Kipnui	KIRUA	5212799	0725 22688	<i>Solius Kipnui</i>
Mukuna Mwangi	O.O.P	11708412	071316219	<i>Mukuna Mwangi</i>
MWELI DIAMBA	District water office NYS	6566160	078523059	<i>Mweli Diamba</i>
John Hwangi	WVLA Com	25726209	0716849112	<i>John Hwangi</i>
SAMUEL KISAI	LEAKSA	5225893	072094119	<i>Samuel Kisai</i>
Isabel Nyong'o	Catholic Mission	3456789	071249974	<i>Isabel Nyong'o</i>

GOVERNMENT OF OPINION LEADERS MEETING

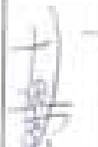
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CONSULTING SERVICES FOR ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR SUSWA GEOTHERMAL PROJECT
COMMISSIONED BY GEOTHERMAL DEVELOPMENT COMPANY

DATE: 14.7.2015

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John N. MUKIRYO	WRMA	8990874	0702317499	
Audrey DUNGE	NSIS	25158662	0117849252	
Miriam DUNDA	WDA	02926313	0720530270	
Idwarah KUCUKA	Provincial Council	03525769	0712810584	
Darius RICAL	Provincial Council	9795675	0702241806	
Nimona S. SINDIGA	Nairobi North	2085178	0723337800	

Annex
2:
Survey

GOVERNMENT OF APINIHUN LEADERS MEETING

RDDPLAN Consultants Ltd.

Outside the box KASTINGO NORTH/EAST DISTRICTS

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TEL: +254 20 2017313

**CONSULTING SERVICES FOR ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR SUSWA GEOTHERMAL PROJECT
COMMISSIONED BY GEOTHERMAL DEVELOPMENT COMPANY**

DATE: 19.04.2015

NAME	ORGANIZATION	ID NUMBER	TELEPHONE	SIGNATURE
Maria S. Lebere	Women Representative	10745044	0725426516	
Leticia Pudei	Village Elder	6853196	0716639081	
Togole Kambui	Visit Clerk	21803812	0720194249	
Moses Teeka	Chief	23105235	0721996657	

Instruments

QUESTIONNAIRE - HOUSEHOLDS

(Name of interviewer----- Date:-----)

The Government of Kenya has given **concession to GDC** to invest in production electricity from (geothermal) wells to be drilled in the area of Mt.Suswa, subject to fulfilment of regulatory legislations and consultations with the communities and stakeholders, which are being observed.

1= Strongly agree

2= Agree

3= Disagree

4= Strongly disagree

(a) BACKGROUND OF THE RESPONDENT (HEAD OF HOUSEHOLD)

Name of the respondent -----

Sex of the respondent -----

Age/Age Group -----

Clan -----

Marital status (married, widowed, divorced) -----Number of wives -----

Level of education of head of household (Primary, secondary, post-secondary, college) -----

Number of children ----- (Girls: -----Boys-----) How many are in school (Girls-----Boys -----)

How many have completed school? -----How many have dropped from schooling? -----(Boys-----)(Girls-----)

*Specify the school level they dropped: lower primary, upper primary, secondary) -----

How many are females: ----- How many are in school-----Have left school uncompleted? -----

*Specify at what levels they left school (primary, ----- secondary - -----)

How many stay home to assist in domestic chores? -----

How many are involved in herding livestock? -----

Are you employed? ----- If not what is your primary sources of income? -----

Do you have any alternative livelihood activities? ----- If yes (*specify) -----

(b) LAND OWNERSHIP/LAND USE

How many acres of land do you own in the project area? ----- Do you own land elsewhere? -----

If yes, state where? ----- How many acres -----

How much of your land is used for 1) crop production ----- 2) livestock grazing ----- *Other(specify) -----

If you practice agriculture, please list the crops you grow -----

(c) LIVESTOCK PRODUCTION

What species of livestock do you raise? (Cattle, sheep and goats, donkeys) ---

Can you describe your livestock management strategy? (Keep mixed species, herd splitting seasonally, herd splitting year round etc) Other -----

Do you take your livestock to Mt. Suswa for grazing? -----If yes, in what season (dry or wet) and for how long? -----

How much livestock have you lost during the last one year?

From diseases: Cattle ----- Sheep and Goats -----

From Drought: Cattle ----- Sheep and Goats -----

Other causes (specify) ----- Cattle ----- Sheep and Goats -----

How frequently do sell your livestock? ----- Where do you take them for sale? -----

(d) HEALTH ISSUES

Number of children ever born -----

Do you have access to health services? -----

Do you have access to family planning services? -----

Have you lost any children? How many under 5 years? -----
Over 5 years -----

From what illnesses? -----

Have your children been immunized? -----

Do you have their immunization cards? -----

Where do you go for treatment for minor illnesses? -----

Major/severe illnesses? -----

How far is the nearest Health facility from your home? -----

What means of transportation do you use to take members of your family to hospital? -----

Indicate if you have ever suffered from any of the following illnesses:

- Eye infection-----
- Respiratory-----
- Vector- borne diseases -----
-
- Water- borne -----

Are you aware of strategies for prevention of HIV and STIs? -----

Do you ever consult traditional (herbal) medicine specialists? -----

(e) WATER AND SANITATION

What is your main source of water for domestic use? -----

Is the water safe for drinking? ----- If not how do you treat it? -----

How far is this water source from your home? -----

What is your main source of water for livestock use? -----

How far is this water source from your home? -----

Do you share water source with livestock?----- and Wildlife? -

Do you face the problem of water scarcity? -----

How do you deal with the problem of water scarcity? -----

Do you experience water competition in this area? ----- If yes, what are the reasons -----

-----What period of year is this situation critical? -----

How do you resolve such conflict? -----

Do you have a latrine at your homestead? -----

Duly signed in confirmation of the records of the interview

Date----- Name----- (I/D

No.-----) Tel:-----

QUESTIONNAIRE - FOCUS GROUPS

(Name of interviewer----- Date:-----
----)

(a) EDUCATION INSTITUTION

The Government of Kenya has given concession to GDC to invest in production electricity from (geothermal) wells to be drilled in the area of Mt. Suswa, subject to fulfilment of regulatory legislations and consultations with the communities and stakeholders, which are being observed.

1= Strongly agree

2= Agree

3= Disagree

4= Strongly disagree

Name of School (pre-primary, primary or secondary) -----

Type of school: Boarding ----- Day ----- Day and Boarding -----

Ownership of school -----

What is the Management structure (committee, board, proprietor) -----

Major source of funding -----

Has water supply; ----- if not, distance from main source of water -----

Type (s) of main source (s) of water -----

Enrollment capacity for the whole school -----

Number of pupils/students enrolled in each class:

ECD/Class/Form	Boys	Girls
Total		

How is drop-out/retention of pupils/students in the school -----

Transition to post-primary/post-secondary -----

Do you have school feeding programme -----

Number of TSC/trained teachers ----- PTA/untrained teachers

Number of classrooms ----- Permanent -----semi-permanent -----
-----Temporary-----

Number of toilets ----- type of toilets: Pit latrines ----- flush
toilets -----

Teachers Housing -----Permanent ----- semi-permanent -----
- Temporary -----

How many teachers commute to school ----- Average
distance commuted -----

School dispensary or distance to nearest health facility -----

Road access to the school: tarmac or seasonal -----

What are the major challenges facing the school?-----

Duly signed in confirmation of the records of the interview

Date----- Name----- (I/D
No.-----)

Position-----Tel:-----

(b) GROUP RANCH

The Government of Kenya has given concession to GDC to invest in production electricity from (geothermal) wells to be drilled in the area of Mt.Suswa, subject to fulfilment of regulatory legislations and consultations with the communities and stakeholders, which are being observed.

1= Strongly agree

2= Agree

3= Disagree

4= Strongly disagree

Name of Group -----

Address:-----

Number of group members ----- Names of Officials and IDs:-----

Year Established-----

Group Ranch Land Registration Number -----

Location:-----Division-----
District-----

When did members last hold election of officials?-----

Do members hold regular/scheduled meetings?-----If Yes, state date of last meeting:-----

Do members graze livestock on Mt. Suswa?-----

Major sources of water supply for livestock (within the ranch); -----

-----If not, distance from main source of water:-----

Duly signed in confirmation of the records of the interview

Signature-----Name:----- (I/D No.-----
-----) Position-----

Signature-----Name----- (I/D No.-----
-----) Position-----

(c) HEALTH INSTITUTION

The Government of Kenya has given concession to GDC to invest in production electricity from (geothermal) wells to be drilled in the area of Mt. Suswa, subject to fulfilment of regulatory legislations and consultations with the communities and stakeholders, which are being observed.

1= Strongly agree

2= Agree

3= Disagree

4= Strongly disagree

Name of Hospital/Health Centre/dispensary -----

Year of establishment -----Ownership (*Community, Government, Mission, Private) --

What is the Management structure (committee, board, proprietor) -----

Major source of funding -----

Has water supply; ----- if not, distance from main source of water -----

Type (s) of main source (s) of water -----

Staffing: Doctors -----, Clinical Officers -----, Nurses -----

In patient facilities -----
Ambulance -----
Main buildings ----- (Permanent -----semi-permanent -----Temporary)
-----)
Staff Housing ----- (Permanent ----- semi-permanent -----
Temporary -----)
Number of toilets ----- Type of toilets: Pit latrines -----flush
toilets -----
Staff Housing ----- (Permanent ----- semi-permanent -----
Temporary -----)
How many members of staff commute to work ----- average distance
commuted -----
Road access to the health facility: tarmac or seasonal -----

What are the major challenges facing the facility?

Duly signed in confirmation of the records of the interview:-----

*Official's Name: 1.----- (I/D No.-----
-) Position:-----*

Annex: 3: Checklist of Plant Species Found In Suswa Area

<u>Name Species</u>	<u>Family</u>
Thunbergia alata sims	Acanthaceae
Hypoestes aristata	Acanthaceae
Pellaea Sp	Acantaceae
Sanseveria SP	Agavanceae
Gomphrena celosioides	Arnaranthaceae
Aerva lanata	Amaranthaceae
Amranthus hybridus	Arnaranthaceae
Cyathula Cylindrica	Arnaranthaceae
Rhus Sp	Anacardiaceae
Acokanthera schimperi	Apocynaceae
Asplenium aethiopicum	Aspleniaceae
Cassia Sp	Ceasalpiniaceae
Tarchomanthus camphoratus	Cornpositae
Osteospermum vaillantii	Cornpositae
Bidens pilosa	Compositae
Felicia abyssinica	Cornpositae
Felicia municata	Cornpositae
Helichrysum Sp	Cornpositae
Gutenbergia cordifolia	Cornpositae
Senecio handensis	Cornpositae
Hirpicium diffusum	Cornpositae
Silene burchellii	Caryophullaceae
Pollivhis campestris	Caryophullaceae
Capparis fomentosa	Capparaceae
Macma Sp	Capparaceae
Chenopodium Sp	Chenopodiaceae
Crassula volkensii	Crassulaceae
Crassula alba	Crassulaceae
Crassula coleae	Crassulaceae
Kalanchoe Sp	Crassulaceae
Crambe abyssinica	Cruciferae
Farsetia Sp	Cruciferae
Zehneria scabra	Cucurbitaceae
Juniperus procera	Cupressaceae
Cyperus Sp	Cyperaceae
Mariscus amauropus	Cyperaceae
Agauria salicifolia	Ericaceae

Erica arborea	Ericaceae
Euphorbia inaequilatera	Euphorbiaceae
Euphorbia kibwezensis	Euphorbiaceae
Phyllanthus rotundifolius	Euphorbiaceae
Geranium aculeolatum	Geraniaceae
Mansonia angustifolia	Geraniaceae
Setaria pumila	Gramineae
Evagrostis cilianesis	Gramineae
Cynodon dactylon	Gramineae
Chioris gayana	Gramineae
Sporobolus fimbriatus	Gramineae
Panicum maximum	Gramineae
Pennisetum Sp	Gramineae
Cynodon niemuensis	Gramineae
Hyparrhenia hirta	Gramineae
Themeda triandra	Gramineae
Digitaria abyssinica	Gramineae
Aristida Sp	Gramineae
Cymbopogon nardus	Gramineae
Sporobolus africanus	Gramineae
Setaria sphacelata	Gramineae
Hypericum revolutum	Hypericaceae
Gloriosa superba	Liliaceae
Leucas glabrata	Labiatae
Plectranthus Sp	Labiatae
Fuerstia africana	Labiatae
Abutilon Sp	Malvaceae
Hibiscus	Malvaceae
Sida Sp	Malvaceae
Pavonia pateus	Malvaceae
Ekebergia capensis	Meliaceae
Acacia Xanthophloea	Mimosaceae
Acacia seyal	Mimosaceae
Acacia gerrardii	Mimosaceae
Acacia drepanolobium	Mimosaceae
Ficus thouningi	Moraceae
Ficus ingens	Moraceae
Ficus natalensis	Moraceae
Olea africana	Oleaceae
Oxalis obliquifolia	Oxalidace

Tephrosia Sp	Papiolionaceae
Zornia fratensis	Papiolionaceae
CrotalariaSp	Papiolionaceae
Indigof era Sp	Papiolionaceae
Polygala abyssinica	Polygalaceae
Galium Sp	Rubiaceae
Oldenlandia Sp	Rubiaceae
Pentas zanzibarica	Rubiaceae
Kohautia caespitosa	Rubiaceae
Tedeia simplicifolia	Rutaceae
Dodonea viscosa	Spindaceae
Dodonea angustifolia	Spindaceae
Craterostigma pumilum	Scrophulariaceae
Striga asiatica	Scrophulariaceae
Pseudosopubia hildebranti	Scrophulariaceae
Cycnium Sp	Scrophulariaceae
Misopates orontium	Scrophulariaceae
Solanum incanum	Solanaceae
Datura stramonium	Solanaceae
Nicotiana glauca	Solanaceae
Femla communis	Umbelliferae
Lantana camara	Verbenaceae
Lippia javanica	Verbenaceae
Tribulus terrestris	Zygphyllaceae

Annex 4: Checklist of wild animal species found in the Suswa area

Common Name of Species	Biological Name of Species	Number Counted in the Last Count
Large herbivores		
Grant gazelle	<i>Gazelle grantii roselveti</i>	
Thomson's gazelle	<i>G. thomsonii thomsonii</i>	
Dik-dik	<i>Rynchotragus kirkii</i>	
Zebra	<i>Equus burcheli grantii</i>	
Impala	<i>Aepyuceros melampus</i>	
Large carnivores		
Others		
Rats	<i>Tachyorectes SPP</i>	
Avifauna (Birds)		
Kori bustard		
Secretary bird		

Source: Project documents

Annex 5: Requirements of the Equator Principles

The 'Equator Principles' (2003) outline the industry approach taken by financial institutions in determining, assessing and managing environmental risk in project financing. In 2006 the IFC finalised a review of its environmental and social standards, resulting in the development of a set of Performance Standards:

PS 1: Social and Environmental Assessment and Management System

PS 2: Labour and Working Conditions

PS 3: Pollution Prevention and Abatement

PS 4: Community Health, Safety and Security

PS 5: Land Acquisition and Involuntary Resettlement

PS 6: Biodiversity and Sustainable Natural Resource Management

PS 7: Indigenous Peoples

PS 8: Cultural Heritage

The revised Equator Principles address the following:

Principle 1: Review and Categorisation

Principle 2: Social and Environmental Assessment

Principle 3: Applicable Social and Environmental Assessment

Principle 4: Action Plan and Management System

Principle 5: Consultation and Disclosure

Principle 6: Grievance Mechanism

Principle 7: Independent Review

Principle 8: Covenants

Principle 9: Independent Monitoring and Reporting

Principle 10: Equator Principles Financial Institutions Reporting

The *Category A* principle classification criteria refer to significant adverse environmental impacts affecting sensitive sites, or diverse impacts, or they are unprecedented.

A *Category B* project is defined as those where the potential adverse environmental impacts on human populations, or environmentally important areas, are less adverse than those of *Category A* projects. The Mount Suswa geothermal Project impacts are generally site specific (*Category B*) and few of them are irreversible while mitigation can be more readily designed than *Category A* projects. Accordance with *Category A* requirements, recommendations have been made to prevent, minimise, mitigate or compensate for adverse impacts identified. Whilst the project is more closely aligned to *Category B* classification, the following *Category A* requirements will be incorporated within the EIA process through the full assessment of potential impacts as follows:

- Identification of opportunities to improve environmental performance;
- Preparation of a full environmental assessment i.e. a full EIA;

- Preparation of an Environmental Management Plan (based on the EA);
- Provide an EMP with mitigation, monitoring and management of risk;
- Undertake consultations in a structured and culturally sensitive way;
- Provide a non technical summary for public review; and
- The EA and EMP will be subject to an Independent Review.

A review of the broad Equator Principles criteria and requirements for the classification of *Category A and B* projects has indicated that the Mount Suswa Prospect Geothermal Drilling Project is more closely aligned to *Category B* due to the relatively few "sensitive impacts", as described under Equator Principles *Category A*, the reversibility of most effects and the ability to mitigate more readily those impacts which can be predicted.

Despite the classification aligning more closely with *Category B*, the preparation and presentation of the ESIA will extend beyond the requirements of a *Category B* EA and will broadly meet the full assessment and reporting standards required for *Category A* projects. While information will be disseminated to interested parties as required, it is not proposed to provide a 60 day advertising period which would be mandatory for *Category A* projects

Annex 6: UNFCCC Requirements for Projects Wishing to Secure Certified Emissions Reductions (CERs)

Based on the international treaty United Nations Framework Convention on Climate Change (UNFCCC) reached in 1992, it has been a common goal for nations around the world to implement policies aimed at reducing emissions of greenhouse gases (GHGs) to contain the effect of global warming that may cause global climate changes. Under the Kyoto Protocol adopted by the UNFCCC parties in Kyoto, Japan, in 1997 and entered into force in 2005, developed countries, with commitments to cap their national GHGs emission levels, have developed or are developing emission trading schemes based on the allocated carbon emission credits. Carbon emission credits called European Union Allowances (EUAs) became tradable by European entities under the European Union Emission Trading Scheme (EU ETS).

Under the Clean Development Mechanism (CDM) of the Kyoto Protocol, clean development projects located in developing countries are issued with tradable carbon emission credits, known as Certified Emission Reductions (CERs), as an incentive for developing countries to implement projects to reduce GHG emissions. CERs may be purchased as a substitute for the EUA carbon credits.

The Kyoto Protocol also introduced CDM applicable to those developing countries ratifying the Kyoto Protocol, but who have not committed any carbon emission reduction target, namely, Non-Annex I Parties. Under CDM, clean development projects implemented in Non-Annex I Parties and certified by the Designated National Authority under the UNFCCC may obtain credits called CERs, which represent the emission of 1 metric ton of carbon dioxide equivalent (CO₂e) each. CDM project owners can sell CERs to Annex I Parties for compliance with emission offsets within a certain limit². The proceeds become additional financial incentives for developing countries to implement clean development projects. As such, EUAs and CERs are closely linked in valuation. Kyoto Protocol also provides a similar mechanism among Annex I Parties called Joint Implementations (JI)³.

Apart from the Kyoto Protocol, voluntary carbon markets are also developed by concerned entities to meet environmental responsibility goals. These voluntary carbon markets are not regulated by governments and the offset products, known as Voluntary Emission Reductions or Verified Emission Reductions (VERs), vary in quality in terms of sustainable technology, baseline setting, calculation of reduced emissions, and their procedures for validation, verification and registration. There is no commonly accepted standard for VERs and participants may choose to use various types of VERs for carbon offset.

Voluntary carbon credit buyers are mainly businesses, non-governmental organisations, government agencies, international conferences, and individuals. Most of them are based in the EU, North America or Australia and to some extent Asia. Many VERs come from projects in renewable energy, efficiency improvements or conservation projects. Voluntary carbon offset trading is project-based transactions and is mainly an OTC market. For example, HSBC announced in 2004 that it would go carbon neutral by 2006. It achieved carbon neutrality in 2005 by offsetting its emissions through the purchases of VERs from projects around the world. Cathay Pacific also launched a carbon emissions reduction project for their customers to offset their carbon footprint via a VER purchase programme.

Stakeholders in the carbon market benefit from the CDM Bazaar. The site covers all aspects of supply and demand relating to CDM projects. The main objective of the CDM Bazaar is to help create an efficient and transparent global market for buyers, sellers and service providers associated with the CDM. It aims to reduce transaction costs in the CDM project cycle by facilitating information exchange. The CDM Bazaar is of particular value to buyers, sellers, service providers and potential project participants in developing countries. As a seller it is not always easy to find buyers. The CDM Bazaar can help you attract offers from a larger pool of potential buyers. As a seller you can post CDM project ideas, information about projects at various stages of development, notices of primary market or secondary market CERs you have for sale.

CDM Approval and Authorization Guide

- a) Seek application from the DNA for CDM is NEMA
- b) Letters of approval and authorization – reason for authorization, when to apply, how long it takes, to receive a response. Marrakesh Accord (Agreements reached at COP-7 which set out detailed rules and procedures, building on the provisions of the Kyoto Protocol. The Accords include modalities and procedures for a CDM as defined in Article 12 of the Kyoto Protocol, and guidelines for the implementation of Article 6 of the Kyoto Protocol).
- c) Information required for a letter of approval
- d) Approval and authorization requirements – ensuring participation is in accordance with UN requirements
- e) Other Trading Blocks' requirements and Roles of each block

Annex 7: Analysis of benefits and concerns of the sampled population

Kajiado

No	Benefits Expected From Project	Other Concerns
1	Access To Water, Improved Roads, Partner To Build School	
2	Water, Road, Employment, School Building, Hospitals	
3	Water,Roads, Hospitals, Employment, School, Polytechnic, Care For The Environment	
4	Employment, Water, Road, Hospital, School, Train Teachers, Care For Environment	
6	Water, Road, Hospital, School	
7	Water, School, Hospital, Road	
8	Road, Water, Employment, Hospital	
9	None	
10	Water, School, Building, Road, Hospital	
11	Road, Water, Employment	
13	Job Creation, Business Enhancement, Improved Living Standards, Better Schools, Dispensary Near The Community, Water For Homes And Households, Road From Suswa To Mt. Suswa, Secondary Schools, Polytechnic	
15	Employment, Water, Roads, Hospitals, Schools, Electricity, Enhanced Markets& Improved Livelihoods, Market For Livestock Products	
16	Water, Secondary School, Polytechnic, Primary Boarding School, All Weather Road, Hospital. Also To Be Compensated For The Pipes That Have Been Installed To Harvest Steam If The Geothermal Wells Are Going To Be In The Installation Area	
17	Water, Education, Fencing And Security, Transport, Improve Agriculture, Recreation And Sport, Conservation Of Environment And Planting Of Trees	

19	Water, Roads, Schools-Boarding Primary, Secondary; Hospitals, Electricity, Employment, Education Bursary,	
20	Hospital, School Development, Bursary Fund, Scholarships, Boarding Schools, Church Development, Water Development, Roads, Employment, Electricity, Livestock Market, Pasture Improvement, Cattle Dip, Veterinary Services, Milk Market Outlets, Tourism Development	Relocation, Adequate Compensation, Effect Of Smoke, Effect On Land And Effect On Caves, Tangible Benefit
21	Education, Road, Water, Health Services, Employment, Community Assistances, Boarding School- Primary And Secondary	Destruction Of The Habitat, Smoke, Shaking, Noise, Dust
22	Water, Employment, School- Boarding, Hospital, Road,	
23	To Get Involved, Water Development, Health Facility, School Development, Employment, Help Disabled, Cattle Dip, Help Microfinance Industry	
24	Slaughter House, Water, Road, Employment, Electricity, School- Boarding And Secondry; Csr Through Sponsorship Of Students	
25	None	

Narok

No	Benefits Expected From Project	Other Concerns
26	Education, (Bursary, School, Development, Boarding Primary And Secondary), Microfinance, Hospital Roads, Water, Employment, Cattle Dip, Vet Services, Plant Trees/ Grass, Slaughter House, Carbon Credit, Dairy Factory, Special Schools	Resettlement (Should Not Be Forced, But Land Should Be Rented Or Compensated), Community Involvement In The Project, Follow Up On The Community Needs, Brief The Whole Community Not Just Individuals.

27	Schools (Primary And Secondary Boarding), Water Supply, Road, Electricity, Employment, Health Facilities, Churches- Improve Old And Build New, Dips And Veterinary Services, Livestock Market, Slaughter House	Loss Of Grazing Land, Land Degradation From Discharge, Compensation For Land Lost To The Project, Relocation, Human/ Wildlife Conflict, Air Pollution, Failure To Provide Services As Promised, Involvement In The Project, Effect On Livestock And Human Breeding
28	Employment, Water, Road, Hospital, School	
29	Farm Machinery, Agriculture, Livestock Market	
30	Road Network, Health Facilities, Education Facilities, Electricity, Job Opportunities	
31	Health Facilities, Road Access, Water, Electricity, Schools- Primary And Secondary, Employment	
32	Roads, Water, Health Facilities, Schools, Churches, Assist In Bursary For Children, Employment	
33	Roads, Hospitals, Water, Schools, Employment, Livestock Market And Slaughter House	
34	Better School, Road, Clean Water, Health Services, Electricity, Clean Water, Employment Opportunities, Mitigation Measures From The Effects Of Geothermal	
35	Water, Schools, Electricity To Institutions Adn Homes, Health Facilities, Road, Employment Opportunities, Education, Cattle Dip, Mitigation Measures For Effects Of Geothermal	
36	Water, Health Facility, Electricity, Conservation Of The Environment, Employment Of Locals, Bursary, Roads,	

	Compensation	
37	Water, Health Facility, School Building, Roads, Employment, Electricity, Bursary For School Children, Environment Conservation	
38	Employment, Water, Road, Hospital, School	
39	Employment For Residence, Health Facilities, School, Water, Cattle Dips, Electricity, Roads, Minimise Relocation And If Any Should Be Compensated Well	
40	Employment, Water, Road, Hospital, School	

Annex 8: Demographic Characteristics and Household Assets of Ruaka Area

Population Of Raruka Area										
Prepared By: Jackson Shonko										
No	Name	Wives	Children	Cows	Sheep	Donkey	Chicken	Goats	Average	
1	Shomet Nkalo	2	10	200	380	21	21		80	
2	Salaton Nkalo	2	26	200	323	30	22		200	
3	Sabaya Punyua	1	10	40	60	6	27		60	
4	Mpoyo Nkalo Josah	1	4	36	40	2	4		30	
5	Kaiyok Nkalo	1	8	20	80	6	12		30	
6	Parsorira Salaash	2	5	30	150	7	17		30	
7	Lantano Nkalo	1	4	24	127	8	7		60	
8	Joshua Koyei	1	10	124	294	6	10		60	
9	Sakayian Toris	2	12	221	330	11	20		60	
10	Tumpes Toris	2	4	127	237	7	12		60	
11	Nkaru Toris	2	13	228	423	11	9		70	
12	Tipape Murkuku	3	24	60	284	8	27		60	
13	Tomosiany Shonko	3	37	179	674	18	29		90	
14	Salaash Shonko	1	5	52	174	4	2		60	
15	Saitoti Toris	1	6	80	200			50		
16	Lentimi Toris	2	12	70	140			44		
17	Liki Toris	1	4	70	150			40		
18	Shayo Toris	2	13	89	212			20		
19	Lemotinga Shonko	2	13	270	800	18	27		60	
20	Musa Shonko	1	2	74	110	6	8		30	
21	Sakuda Ripoi Sarum	2	8	100	100					

Population Of Raruka Area

Prepared By: Jackson Shonko

No	Name	Wives	Children	Cows	Sheep	Donkey	Chicken	Goats	Average	
22	Patrick Toris	3	37	200	450			50		
23	Johana Toris	2	18	70	200					
24	Letoya Toris	2	14	150	350			80		
25	Samuel Toris	2	12	100	100			50		
26	Musa Toris	2	17	112	220			50		
27	Soitanane Toris	1	7	82	190			48		
28	Maripet Toris	4	36	280	323	11	15		116	
29	Saitet Kurraru	2	32	150	292	8	12		120	
30	Santamo Kurraru	2	10	120	212	6	28		124	
31	Samuel Kurraru	2	8	102	210	7	12		108	
32	Sitonik Kurraru	3	7	84	198	13	22		102	
33	Luka Ole Mapelu Toris	2	20	338	688	18	37		322	
34	Setek Kurraru	2	12	80	200	10	33		60	
35	Daniel Sekuyia	3	16	224	420	12	28		240	
36	Rembesa Sekuyia	1	4	74	154					
37	Romo Karei	1	2	30	124	8	12		70	
38	Kasaine Mpa	3	18	50	101	6	27		100	
39	Sasine Nkalo	2	19	50	127	6	19		40	
40	Sanja Nkalo	1	6	60	101	8	10		80	
41	Moses Nkalo	1	2	20	50	4	21		24	
42	Sinkori Kurraru	3	15	48	94	5	13		60	
43	Parsiutei Kurraru	1	8	10	50	2	6		60	
44	Salau Nkalo	2	11	30	40	4	6		90	

Population Of Raruka Area

Prepared By: Jackson Shonko

No	Name	Wives	Children	Cows	Sheep	Donkey	Chicken	Goats	Average	
45	Mukulu Nkalo	1	8	4	16	2	10		60	
46	Limpei Toris	2	19	86	340			60		
47	Parsorora Toris	1	7	41	80			20		
48	Mapelu Toris	1	3	22	60			15		
49	Jack Lukeine Toris	2	18	86	200			40		
50	Kirauti Toris	1	4	24	40			18		
51	Tenkes Kulangush	1	4	100	160	4	6		60	
52	Paulo Shonko	1	4	150	200	18	7		60	
53	Sorimpan Shonko	2	8	20	160	2	10		60	
54	Komeiyan Shonko	1	10	10	36	2	30		60	
55	Tumpes Shonko	1	7	30	60	2	4		60	
56	Mumpasoi Shonko	1	13	18	70	3	8		60	
57	Mukwe Nkalo	1	8	20	100	4	14		60	
58	Kirisiet Nkalo	1	8	20	100	4	14		60	
59	Leshinka Nkalo	1	4	70	224	24	18		70	
60	Billy Toris	2	6	70	150			50		Total Livestock Pop.
	Sum			5529	12178	362	676	635		19380
	Percentages			29%	63%	2%	3%	3%		
	Sum Of Blank Entries					18	18	45	18	

Per Household	Average Number Of Wives	1.7								
	Average Number Of Children		11.5							
	Average Number Of Cows			92.15						
	Average Number Of Sheep				202.97					
	Average Number Of Donkeys					8.62				
	Average Number Of Chicken						16.10			
	Average Number Of Goats									

Annex 9: WHO Limits For Processed Water

Wastewater Parameter	Maximum Concentration (mg/l)
Biological Oxygen Demand (BOD)	50
Chemical Oxygen Demand (BOD)	250
Total Suspended Solids (TSS)	50
Oil and Grease	10
Heavy metals (Total)	10
Total Chromium as Cr	0.5
Total Copper as Cu	0.5
Total Iron as Fe	1.0
Total Zinc as Zn	1.0
Total Chloride as Cl	0.2
Total Arsenic as As	0.1
Total Lead as Pb	0.1
Total Mercury as Hg	0.01
Total Nickel as Ni	0.5
pH	6 – 9 unit less