140MW OLKARIA V GEOTHERMAL POWER PLANT IN GREATER OLKARIA AREA IN NAIVASHA SUB-COUNTY, NAKURU COUNTY

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

140MW OLKARIA V GEOTHERMAL POWER PLANT IN GREATER OLKARIA AREA

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

(ESIA) REPORT

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EXECUTIVE SUMMARY

E1 Introduction

This document is an Environmental and Social Impact assessment (ESIA) report for the proposed fifth Geothermal Power Plant to be called Olkaria V Power Station. The project is expected to generate an additional 140MWe of electricity per day to the national electricity grid.

KenGen has an ambitious strategy to increase its geothermal power generation capacity by 1260MWe by 2018. Currently two projects to generate 280MWe are under construction i.e. Olkaria I unit 4 & 5 and Olkaria IV.

The company is now proposing to construct a 140MWe geothermal power plant in the Olkaria geothermal field. Subsequently KenGen prepared an Environmental and Social Impact Assessment Project Report (Ref No.: NEMA/PR/5/2/11,379) and thereafter submitted this report to the National Environment Management Authority (NEMA). Following the review of the report by NEMA the proponent (KenGen) was advised to carry out an ESIA study in order to ensure an in depth evaluation of the potential impacts and wider public consultation through a letter dated 2 October 2013.

To comply with the NEMA requirements KenGen commissioned GIBB Africa Ltd a firm of Experts to undertake a full ESIA Study for its proposed Olkaria V Geothermal Power Plant at the Domes Area in Olkaria in Naivasha District. GIBB therefore prepared and submitted to NEMA the Terms of Reference (ToR) for this study for approval. The Terms of Reference was approved on 26 January 2014.

The geothermal wells exploration and drilling phases has not been considered in detail in this report because this stage is essentially complete at this time and NEMA had issued license for the ESIA for drilling for the geothermal wells.

Project Description

The proposed power generation system and plant configuration have a conceptual design similar to those of the Olkaria IV Power Plant, under construction. The proposed project involves the construction of a power plant and associated infrastructure such as the cooling tower, steam gathering system, switchyard and transmission line.

The proposed plant site for Olkaria V is the wide flat area in the current Olo Nongot village, outside Hell's Gate national Park. The plant system will be a single flash condensing type (steam flash). The proposed site for the power plant is patches of grassland with the dominant tree species being *Tarconanthus camphoratus* and *Acacia drepanalobium in the proximity*. The site is a strategically positioned and hence very suitable for construction of a geothermal power plant.

Project Location

The Olkaria V project is in Olkaria Domes located about 120km Northwest of Nairobi. Administratively, the project is located within Hells Gate location, Central division of Naivasha Sub County, Nakuru County of Kenya.

Methodology

This ESIA Report has been prepared in accordance with the Environmental (Impact Assessment and Audit) Regulations of 2003. It is also guided by the World Bank's requirements for industrial projects and JBIC Guidelines.
The study methodology comprised the following activities:

- Preliminary meetings;

- Data collection and Document review;
- Site inspection and discussions with site personnel;
- Air and Noise Dispersion Modelling;
- Ecological Assessment;
- Social Impact Assessment;
- Community Resources Mapping;
- Meetings with stakeholders;
- Public Consultation;
- Data Analysis;
- Reporting.

The ESIA Report has confined itself to the construction of Olkaria V and associated infrastructure, although where necessary, issues that have implications on both existing Olkaria I and Olkaria II stations and the Olkaria IV under construction have been examined under cumulative impacts.

E2 Legislative and Administrative framework

According to section 58 (1) of the Kenya Government's *Environmental Management Coordination Act (EMCA)*, *Number 8 of 1999* the proposed construction of *Olkaria V Geothermal Power Station* project falls under the prescribed list of projects for which environmental impact assessment is mandatory, prior to implementation *(Second Schedule, page 174 of EMCA No.10 electrical infrastructure section (a) electrical generation stations).*

The EMCA has led to the setting up of various Regulations and Guidelines relevant to the project which include the following:

- *Environmental Impact Assessment and Audit Regulations, 2003 Legal Notice No. 101;*
- *Environmental Management and Coordination, Conservation of Biological Diversity (BD) Regulations 2006;*
- *Environmental Management and Coordination (Fossil Fuel Emission Control) Regulations 2006;*
- *Environmental Management and Coordination (Noise and Excessive Vibration Pollution) Control Regulations, 2009;*
- *Environmental Management and Coordination (Wetlands, Riverbanks, Lake Shores and Sea Shore Management) Regulations 2009;*
- *Environmental Management and Co-ordination (Waste Management) Regulations 2006;*
- *Environmental Management and Coordination (Controlled Substances) Regulations 2007;*
- *Water Quality Regulations of 2006;*
- *Waste Management Regulations, 2006;*

Other sectoral legislation relevant to the Project includes:

- *Energy Act No. 12 of 2006;*
- *Geothermal Resources Act;*
- *Occupational Health and Safety Act;*
- *Water Act 2002;*
- *The Wildlife (Conservation and Management) Act;*
- *The Fisheries Act;*
- *Local Government Act Chapter 265 (Revised 1998);*
- *The Physical Planning Act Chapter 286;*
- *The Land Acquisition Act Chapter 295;*
- *Registered Land Act Chapter 300;*
- *The Survey Act;*
- *The Tourist Industry Licensing Act.*
- *Public Health Act, 1986;*

- *Water Act 2002;*
- *Employment Act & Other Labour Related Laws;*

The International Guidelines relevant to the project that have been discussed in the report include:

- *IFC's Environmental, Health and Safety Guidelines for Polychlorinated Biphenyls (PCBs) (July 1, 1998);*
- *IFC Environmental, Health, and Safety Guidelines for Geothermal Power Generation;*
- *IFC's Environmental, Health and Safety Guidelines for Hazardous Materials Management Guidelines (December, 2001);*
- *IFC-IGA Geothermal Exploration Best practices, March 2013;*
- *Japan's Official Development Assistance Charter, June 30 1992*
- *Japan International Cooperation Agency (JICA) guidelines for Environmental and Social considerations April 2010.*
- *World Bank safeguard policies.*

Based on the International Guidelines the proposed Project has been classified as Category A or Category 1 requiring Full Environmental and Social Impact Assessment Study.

KenGen's Environmental Management Systems

Since inception, KenGen has had Environmental Management as an integral component of its business planning. To meet the basic environmentally sound and socially acceptable practices at the local and international level, the company initiated the certification and implementation of ISO 14001:2004 environmental management system (EMS) standards. Through the EMS system, KenGen has identified and documented its significant environmental aspects and related impacts on the environment and set in place interventions to manage these aspects.

Through EMS standard, KenGen has articulated its commitment towards a long term environmentally sustainable development to the public and its stakeholders through an Environmental Policy Statement, which is also aligned with its vision and mission statements. The environmental policy statement commits the organisation to compliance with applicable laws and regulations, prevention of pollution, continuous improvement and accountability to the internal and external stakeholders and the public at large.

To successfully sustain the good environmental management practices, KenGen has a fully fledged Environment, Safety & Liaison Section at Olkaria to undertake the implementation of environmental and social management plans and monitoring various parameters of the existing Olkaria I and Olkaria II Power Plants and those under construction.

E3 Description of the Project Environment

Climate

The climatic features in the Rift Valley, including the project area, are closely related to the altitudinal changes and variations induced by the local topography. The floor of the Rift Valley experiences higher temperatures than the highlands. The mean minimum monthly temperature in the project area has been recorded to range from 15.9 - 17.8˚C with a mean of 16.8˚C. The mean monthly maximum temperatures range from 24.6 - 28.3˚C and the month of July is the coldest month while the hottest month is February.

Air quality

The existing geothermal power stations in Olkaria operate by steam gathering from the production wells. The steam runs turbines that produce the electrical energy, that is convert mechanical into electrical energy. The used steam is discharged as liquid water and vapour. The water vapour is harmless in the atmosphere, but associated with the steam are non-condensable gases including carbon dioxide (CO_2), methane (CH_4) and hydrogen sulphide (H_2S). The CO_2 and CH_4 do not pose a threat to ambient air quality, although they are, along

with water vapour, greenhouse gases, but H_2S can have health implications at high concentrations.

The study has adopted WHO guidelines and standards for hydrogen sulphide. The guidelines regulate the permissible 24-hour average concentrations exposure exceeding 0.10ppm (0.15 mg/m^3).

Kenya has not yet developed ambient air quality standards for hydrogen sulphide. The draft Environmental Management and Co-ordination (Air Quality) Regulations, 2008 and the Factories and Other Places of Work (Hazardous substances) Rules, 2007 refer to occupational exposure limits of (14 mg/m^3) 10 ppm as a time-weighted average (TWA) and (21 mg/m^3) 15 ppm as a short-term exposure limit. These are occupational health standards and are not appropriate for assessing ambient air exposures to which the general public might be exposed. For ambient exposures it is necessary to consider both health and potential nuisance effects.

The objective of these monitoring programs is for occupational health exposures rather than environmental conditions, but the data provide some guidance as to the maximum levels that are likely to arise in the environment close to the power stations and give some "spot" samples of condition in more remote areas for example at the Lake View and Lake Side residential areas. The observations relate to average concentrations over a few minutes and are all made during the day.

Some of these sites are in locations that could reasonably be classed as accessible to the public or at least representative of this area, e.g. KWS Gate, Lake Side, Lake View and the well sites (OW 10 and OW22). Most of the locations record low concentrations, at the well sites as would be expected, the odour threshold is frequently exceeded, but none of the observation exceed the United States the TLV for hydrogen sulphide which is set at 10ppm (15mg/m^3) for an eight hour exposure.

Noise quality

The geothermal power stations assessed in this study generate noise from many sources, which can be aggregated into two main sources; the cooling towers and the plant or building housing and the turbines at Olkaria I & II.

In addition, geothermal projects involve two other potentially significant sources of noise, namely; construction of drill pads and drilling and testing of wells prior to converting them to production wells. While these latter operations are temporary (lasting for months to a period of around a year) they are potentially significant.

Noise data monitoring is done concurrently and in same areas as hydrogen sulphide.

Kenyan standards as prescribed by the Environment Management and Co-ordination (Noise and Excessive Vibration Pollution) (Control) Regulations 2009 require night time maximum permissible levels of 35 dB(A) (LAeq-10h) for commercial areas, residential areas and silent zones.

Lake Naivasha Basin

The proposed site is approximately 6 km to the south of Lake Naivasha which is the largest water body in the area comprising of four lakes: Lake Naivasha, (145 square Km), Crescent Island (2.1 square Km), Oloiden (5.5 square Km), and Sonachi (0.6 square Km). The lakes are hydrologically connected either at the surface or by groundwater flow. The Crescent Island, the deepest part of the Lake (18 m depth) can be connected to the main lake, depending on lake levels. Oloiden is a smaller lake to the south end of Lake Naivasha, and depending on lake levels, can be distinct from the main lake. The main lake is shallow (max. 8 m). Further, Crater Lake or Sonachi is located near the south-western part of Lake Naivasha, is independent from the main lake. The main Lake is fed by two perennial rivers namely the Malewa and Gilgil Rivers discharging 80% and 20% respectively, of the total flow.

Topography

The project area, including Lake Naivasha and environs, is situated in the floor of the Great Rift Valley. The Lake Naivasha basin covers an area of 3,400 km^2 and the lake itself stands at around 1,885 metres above sea level (masl). The lake basin is bound to the west by the Mau Escarpment (3,080 masl), and to the south and south east by the Olkaria and Longonot Mountains. To the east of the lake basin is the Kinangop Plateau. The Nyandarua (Aberdare) Range (3,900 masl) lies to its north and north east and the Eburru volcanic pile flanks the western side of lake basin. The general topography of the study area is characterised by a wide range of features associated with volcanic activity. They include craters, remnants of preexisting craters, fault scarps, fissures and steam jets. The Olkaria area where the geothermal station is located comprises volcanic features that consist of steep sided domes formed from pyroclastic rock and lava flows. The domes enclose an approximately circular depression that has been cut by the Ol Njorowa Gorge, which was formed by out flowing water from Lake Naivasha. The Olkaria I and II Power Stations are located in the centre of the depression. Within this complex, there are several small valleys that drain the upper slopes and discharge runoff and sediments to the foot slopes and plains below. To the north of Olkaria, the topographical features are dominated by depressions of four water bodies including the Crescent Island, the main Lake, Lake Oloidien and Crater Lakes.

Geology

The geology of Lake Naivasha area has been described by Thompson and Dodson (1958). Along the floor of the Rift Valley, the most common rocks are basically quaternary deposits mainly the pyroclastic rocks, which consist of tuffs and ashes. The tuffs are usually medium to pale grey in colour but are sometimes green, yellow, pink or purple, occasionally calcified and brown when weathered. The tuffs are quarried for building purposes. The lavas are also a major geological feature of the Rift Valley. They range from under saturated basic rocks (tephrites) to acid rocks (rhyorites and obsidians) with numerous gradations in between. Close to the project area, the geology is complex and usually consists of several geological formations. Around the Olkaria area, rocks are volcanic with lake and fluvatile sediments. The volcanic rocks in the area consist of tephrites, basalts, trachytes, phonolites, ashes, tuffs, agglomerates and the acid lava rhyolite, commendite and obsidian. The lake beds are mainly composed of reworked volcanic material or sub-aqueously deposited pyroclastics.

Baseline Ecological Surveys

Intensive ecological surveys of plants, mammals, birds, reptiles, amphibians and insects species were conducted using suitable standard sampling methods. Species richness, distribution and habitat preference were assessed.

Flora

Plant surveys investigated vegetation types and their relative abundance (dominance rating along line transects Line transects were established and used as baseline upon which biological sampling plots were located. Plots of 20x20 m placed at intervals of 50 m were marked along the transect and used to quantify species distribution patterns and vegetation dominance (Mutangah, et al., 1997). Each plot was further sub-divided into 4 (10x10 m) small plots within which vegetation parameters were determined. In each 10x10 m plot all vascular plant species were enumerated and recorded under the three major life forms i.e. trees, shrubs and herbs (including grasses and pteridophytes). Species were recorded and categorized according to their vegetation life form i.e, trees, shrubs and herbs including grasses

A total of 53 vascular plants within 27 families were recorded within the proposed Olkaria V Geothermal Power Plant in February 2014. The site broadly constitutes two vegetation types (floral associations) namely: Open Grass/shrub-land and Bushland. Bushland have a strong presence of *Tarchonanthus camphoratus*, dotted with *Acacia drepanolobium* and a diversity of herbaceous and grass species. A characteristic grass tussock (*Hyparrhenia dregeana*) very

effective in binding soil and preventing soil erosion occurs underneath some parts of *Tarchonanthus* bushland area. The open grassland/shrubland occurred mainly in the ¾ÅÁ ⁴ ! settlements of Oloosinyat and Olonong'ot earmarked for drilling and power plant construction.

Fauna species

Mammals

Diferent survey methods were applied for different species due to the varied ease of observation. Conspicuous and large mammals were simply noted and counted by direct observations. Indirect methods that indicate the presence of certain animals will also be largely used as evidence of mammalian species presence. This entailed searching for traits such as dung, feeding signs, footprints, burrows and dens. In this case specialized live traps i.e. Sherman trap and Tomahawk were used. In all these methods, transects were systematically and representatively placed in the different habitat types.

A total of 28 mammals species were recorded for the site. These include 13 species whose presence at the project site was confirmed during the field survey conducted in February 2014 and an additional 15 known to occur in Hell's gate National Park. They include two species of conservation concern namely; Leopard (Near Threatened) and Chanler's Mountain Reedbuck (Endangered). It is noteworthy that the area is rich in small mammal diversity which has not been adequately surveyed. During the field survey reported here, two such nocturnal mammals were trapped and released back to wild i.e. White-tailed Mongoose and Bush Rat. More intensive surveyed for small mammals, which play important ecological role in the ecosystem and hence whose welfare/interest should be addressed during the project implementation are recommended.

Avifauna

Bird surveys involved timed species count (TSC), point transect, mist-netting, general observations and total counts.

TSC was used a method for rapid checklist building and to establish the relative abundance bird species in the survey area. Each TSC was separated by at least 100 m or 10 min walk from the next.

With point transects, Birds were surveyed within different habitat types by point counts based on distance sampling protocol to estimate the abundance of birds and species richness (Thomas et al 2010). Along each transect, point counts were conducted at intervals of 100 m. At every point observers will wait for 1 minute (settling-in period) before counting all the birds seen or heard within a 50m radius for the next 9 minutes.

Mist-nests were used to sample understory species and other skulking species. Several 18m and 12m standard mist-nets were laid thicket habitats area along small paths and trails as far as possible to avoid habitat destruction. Mist netting sessions ran from 0600hrs to 1000hrs during the morning and from 1500hrs to 1800hrs in the evenings. Mist nets were shifted to new locations after every two days. All birds species caught were identified, ringed and various biometric measurements taken.

Total counts were done for birds occurring in flocks whether in flight, roosting or in open water mass were counted directly to establish the total number.

A total of 105 bird species within 41 families were documented from the area. These include 71 species recorded during the said survey and an additional 34 known from Hell's gate national park. They include two endangered Vulture species for which Hell's gate is famous for i.e. Ruppel's Vulture and White-backed Vulture. Furthermore, these birds include 18 migratory species of which 11 visit Kenya and Africa from Europe and Asia while 7 are intra-African migrants. Such large number of species and individual migratory birds are expected here since the site falls within the Rift valley – a major fly way form migratory birds which include

heavy birds as well as small ones. The welfare of these as well as the resident birds species should be fully considered during the project implementation.

Herpetofauna

Systematic Sampling Survey (SSS) that involves search-and-seize sampling method were used for survey herptiles. In addition, trapping techniques that involves the use of 20m standard straight-line drift fences and pitfall traps was used.

Information recorded for specimen captured were species, locality, date, time, habitat characteristics and any other biologically important information. The captured animals were later released after data recording.

A total of 30 herpetofauna species were documented from this area. These include 15 snake species of which three were confirmed to occur at the site and include the African Rock Python know to occur within the gorges and valley bushlands. The presence of the only two tortoise species known from this area was confirmed and three lizard species out of six know from the area were recorded. Herpetofauna is highly sensitive to habitat modification especially fresh water dwelling frogs, while surface run-off is major threat the breeding especially for snake and tortoises.

Invertebrates

Sweep nets were used to collect butterflies and other flying insects along transect which run across each selected sampling habitat/plot.

Pitfall traps were used to collect crawling arthropods; while, pond nets/aquatic nets were used to sample aquatic invertebrates. Malaise trap were used to trap flying insect mainly Diptera.

A total of 30 species invertebrate within six order and 18 families were recorded at the project site during the field survey. Invertebrates play very key role in the ecosystem especially maintaining vegetation cover through plant pollination. Majority are indeed very sensitive to habitat modification, making them good indicators of environmental degradation which may lead to their disappearance from an area hence loss of the ecosystem functions they mechanistically mediate!

Fish

There were no wetland habitats for fish at the project site. The project may nonetheless have impact on the fish species in Lake Naivasha through water abstraction.

Social Environment

The proposed power plant will be constructed at the presently Olo Nongot village with its' steam production wells spread to Olo Sinyat Village. The construction of the project components will necessitate the relocation of communities living in the above villages except Olo Mayaina Kubwa. The required relocation planning of these communities villages was conducted in 2009 under a different project Olkaria IV and the Memorandum of Understanding between KenGen and the Project Affected Persons signed in 1st July 2013 (A copy attached in Appendix VI).

E4 Project Components

The proposed Olkaria V project will have the same design specifications as Olkaria IV, under construction. The design will require a steam flow of 7.5 tonnes/hour/Mega Watt (t/h/MW). To ensure that two 70MW turbines generating 140MW steam supply will flow at 1050 t/h with an additional reserve of 10% (105 t/h) of required steam. In total the steam required will be 1,155 t/h. The generation process flow will basically consist of the following steps:

- Steam from the production wells will pass through a separator, where water (or brine)

will be separated from the steam;
- The brine will be re-injected into a deep well;
- The steam will pass through steam scrubbers before being transmitted to impact reaction turbine, which will generate electricity;
- After passing over the turbine, the steam will be condensed;
- Hot condensate will be pumped through the cooling towers. Non condensable gases will be emitted from the cooling towers, while cool condensate will be re-circulated to the condenser;
- As the circulating condensate will be acidic, it will be dosed with soda ash (sodium carbonate). In addition, the condensate will be dosed with biocide (hypochlorite) to prevent bacteria growing in the fins of the cooling tower;
- Any additional condensate will be pumped into different re-injection wells.

Issues affecting the community

Both the communities living within the project location and neighbouring villages / centers noted that the biggest problem affecting them is youth unemployment. During the stakeholder consultations, the community members requested that the proposed project should alleviate unemployment issues by absorbing bulk of the youth in the local area to work in its construction and operation stages.

The second issue that was of great concern to the community in the nucleus of the project is insecurity and lack of health facilities. This is supported by the fact that more than 62.3% of the population from Olkaria go for more than 15kms to access medical care.

Projected increase in population in the project area following the commencement of the proposed project could aggravate the problem of insecurity. The survey found that the nearest police station to the project area is located in Kongoni, and this serves a very wide catchment area. To control insecurity, It is therefore proposed that a police station or AP post be located within the existing and or the new proposed geothermal field.

Issues Affecting the Community

Ol Karia Villages		**Neighboring communities**	
Community problem	**Percentage acknowledgement**	**Community problem**	**Percentage acknowledgement**
Insecurity	75.4	Insecurity	68.9
Youth unemployment	91.8	Youth unemployment	97.8
Infrastructure	60.7	Infrastructure	70.5
Lack of land	37.7	Lack of land	51.1
Lack of health facilities	75.4	Lack of health facilities	53.3
Floods	21.3	Floods	37.8
Lack of schools	67.2	Lack of schools	35.6
No grazing area	52.5	No grazing area	17.8
High population	29.5	High population	53.3
Other	16.4	Other	4.5

E5 Project Alternatives and Technologies

There are two geothermal power plant technologies being used to convert hydrothermal fluids to electricity. The conversion technologies are flash and binary cycle. The type of conversion used depends on the state of the fluid (whether steam or water) and its temperature. The proposed Power Station will use flash steam technology.

E6 Stakeholders Consulted

A total of 6 public sensitization meetings were held across the project area with the help of the local administration.

Schedule of public meetings

No.	Village	Date	Time	Venue
1.	Olonongot	31/01/14	10.00am	Olo Nongot grounds
2.	Olosinyat	31/01/14	3.44pm	Olo Sinyat grounds
3.	Cultural Center, Olomayiana Ndogo and Olomayiana Kubwa	2/02/14	3.00pm	Cultural center grounds
4.	Narasha and Olomunyak	6/02/14	11.00am	Narasha Grounds
5.	Inkorienito	6/02/14	3.00pm	Inkorienito Church
6.	Kamere	7/02/14	3.00pm	Kamere Market

E7 Environmental and social impacts and mitigation measures

Positive Impacts

Positive Impacts during Construction

Income Generating Opportunities for Local Community

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

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

Increase power supply to the national grid and thereby stabilization of electricity

The objective of this project is to construct a 140MW geothermal power plant with associated infrastructure to be known as Olkaria V to contribute towards meeting the ever increasing demand for electric power in the country. The project is part of the vision 2030 power projects that are supposed to power the country.

Improved Local Economy

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

Create Employment Opportunities

The construction phase of the project will be characterised by recruitment of significant numbers of people to work with the contractors. There will also be an influx of new people into the project area. The projected number of construction staff is 900 persons. An increase in population of this magnitude will create a corresponding increase in demand for goods and

services such as food for construction workers, housing, healthcare and need for transport. These needs will be satisfied by people living within the project area where local women will provide food vending services, homes will rent out spaces for the new population and shops will also benefit from increase of sales. All these avenues are bound to create new employment opportunities.

Local Market Opportunities

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

Improved infrastructure and Social Services

The development of access roads to be used during the construction process will boost access across villages and open up areas that have been lacking efficient access such as the Narasha and Inkorienito.

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

Potential for Carbon Market

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

Information, Education and Communication

There will be development of additional skills for those taking advantage of new opportunities. There will also be diffusion of know-how from the more qualified personnel towards the local personnel.

Positive Impacts during Operation

Employment Creation

The project will create direct and indirect employment opportunities. Direct employment opportunities will include worker in the geothermal plant, labour force employed in supporting business such as transportation, increase in trade therefore development of new businesses

Urbanisation

Currently, most urban centres in the project area are located along the major roads. With the operationalization of the additional geothermal plant project it is expected that urban centres are going to proliferate further, especially on areas for loading and offloading farm produce.

Negative Impacts

Impact on Flora

Loss of Migratory Corridors or Prime Dispersal Areas

- During the construction phase selective and minimal clearing and removal of natural vegetation will be done at the project area which includes the ecologically sensitive areas such as gorges, valley vegetation, thickets, along ridges;
- *Invansive species such as Nicotianum glauca* and *Solanum incanum,* which was recorded in the area may gain opportunity to proliferate after native vegetation is cleared during construction.

Impact on Fauna

Impacts on Macrofauna (mainly Mammals)

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

- Loss and disturbance of habitat may lead to disappearance of some rare wildlife such as leopards known to occur in the area today. Other animals such Giraffes may temporarily stop using the area;
- Increased vehicle and human traffic in this area may result in many resident species leaving the area. Many forms of human-wildlife conflicts may occur e.g. poaching and accidents due to the high human and vehicle traffic in the area.
- Dust during the construction phase may cause poor visibility which may result to wild animals being knocked by vehicles;
- Steam Pipelines may block way for the larger mammals. Blocking migration routes and corridors may result in isolation of some populations in 'island like' spaces, which could interfere with their breeding patterns and genetic variability;
- Too visible the pipelines may not only deter animals from going near them as they follow their corridors but also reduces the aesthetic value of the landscape.
- KWS and KenGen should monitor wildlife abundance, distribution and movement in relation to this infrastructural development during construction and operation stages to aid in decision making.

Impact on Avifauna

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

- Fugitive dust from roads settling on perching and nesting sites may push some birds from the site;
- As a result of vegetation clearing habitat for birds that occur in thickets will be lost. The may create habitats for species associated with more open areas especially along the pipelines;
- Certain birds such as pipits, wagtails and ant eater chats are typically grassland species and occur within the open grassland at Olo Sinyat and Olo Nongot targeted for installation of steam gathering system and power plant construction respectively. These species will be displaced during construction activities in the area. However they may find other habitats closer to the area;
- Migrating bird's species may be affected by transmission lines erected across their fly ways where they are either electrocuted or collides with transmission lines. For instance vultures that travel long distances during the day return to Vulture cliff to roost.

Impacts on Herpetofauna

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

- Clearing of vegetation on higher grounds may lead to excessive run off at lower elevations which may lead to washing out and/or filling the breeding burrows of reptiles (and other animals);

- Site clearing may result to movement and relocation of surface materials such as rocks, which are ideal keystone habitat features used by cold blooded reptiles for sun basking;
- Vibrations during the construction phase is also bound to negatively affect reptiles;

Landscape Character Impacts

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

This landscape character area has been identified as having medium landscape sensitivity. Overall, the predicted magnitude of change in landscape resource is medium. Therefore, the predicted significance of landscape impact is moderate.

Visual Impacts

The assessment of the existing visual environment and the impact of the proposed development and its various components on visual receptors have established that there will be potential visual impacts during construction and operation. The elements that shall intrude/obscure the scenic view are;

- Above-ground steam pipes above the ground from the storm wells to the power station
- Power Station Structures;
- Site Lighting – During construction and operation;
- Construction Equipment – Temporary during construction.

Visual sensitivity for the area has been identified as high sensitivity. Overall, the predicted magnitude of change in visual resource is medium. Therefore, the predicted significance of visual impact is moderate.

Visual Environment

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

Residual Impacts

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

Soil Erosion

This Project will involve earthworks that will have impact on the soils; thus the appropriate and timely erosion control measures will arrest and minimize soil loss and siltation as well as the sedimentation of down slope water courses. The measures will be effected immediately after subsequent construction activities to prevent extended exposure to the agents of erosion and as per the management plan and monitoring recommendations.

The following mitigation measures are recommended for the proposed development:

Site Soil Conservation Measures

Site clearing or disturbance of the natural vegetation will be planned and approved as part of project management process. Among the areas that require immediate restoration, the Contractor will allow minimal vegetation clearing and disturbance on the slopes to avoid difficulties during restoration.

Areas inevitably disturbed, cleared, excavated, or/and exposed during construction will be re-vegetated using native grass species, preferably of species growing in the immediate pristine environment to allow harmony with the surrounding and minimize duration for watering and care. The restoration period will require monitoring of the re-vegetated sites to assess impacts of heavy foraging, patch growth as well as gulley formation. For instance, tussock grass becomes dominant mid slope up to the valley bottoms hence preferred as the grass cover restoration for such an area.

Isolated sites with installations and frequent human presence that require re-vegetation will be surrounded by less palatable native species to act as plant screens and reduce pressure from wildlife foraging. Presence of well rooted vegetation will act as soil stabilization for the areas. *Taconanthus compharatus* that is locally native and wide spread is recommended among the woody species.

Impact on Quarry Sites

Materials sites (quarry and other borrow areas) if not reinstated and rehabilitated after project completion, cause landscape scarring, dangers of overhanging cliffs and falling rocks which creates environmental, health and safety hazards.

The following are the mitigation measures proposed during extraction of natural resources for materials:

- Appropriate authorisation to do or use any proposed borrows pits and quarries will be obtained before commencing activities;
- Borrow pits and quarries shall be located more than 100 meters from watercourses in a position that will facilitate the prevention of storm-water runoff from the site from entering the watercourse;
- Notice will be given 14 days to nearby communities of intention to excavate in the borrow pits or quarries;
- Borrow rehabilitation plans, will be prepared prior to use and approved by the local authorities;
- Storm-water and groundwater controls shall be implemented to prevent runoff entering streams and the slumping of soil from hillside above;
- The use of borrow pits or quarries for material spoil sites must be approved by the local authorities (and/or with the appropriate consent of the “landowner”). Where this occurs, the materials spoiled in the borrow pit shall be profiled to fit into the surrounding landscape and covered with topsoil.

Landslides and soil creep

The proposed site has a highly undulating terrain, which will require digging up of the ground levelling and foundation piling during construction; such activities make the ground and soils unstable in sloppy areas that may trigger landslides and soil creep. There is likely going to be reduction of shear strength caused by digging at mid-slope or at the foot of the slope during construction.

Water Resources

The Olkaria geothermal field has abstracted water from Lake Naivasha before; the Olkaria V project will require water during the construction and operation stage. The project may result to misuse of water resources if conservation measures are not adopted. Incidental oil and chemical spills may result to water pollution.

Air Quality and Dust

Air quality will be affected by the construction of the proposed geothermal power plants both during construction and operation. During construction the main emission sources include dust from earthworks and tail gases from construction equipment and vehicles. The dust will settle on flora, and can cause respiratory problems and nuisance for local residents

Noise and vibration

There are several sources of noise during construction and operation. During construction the main sources will include blasting, heavy equipment, generators and transportation vehicles. During operation the main noise source is the operation of the plant itself. Noise levels have been monitored in connection to the operation of the Olkaria geothermal power plants for several years. According to measurements the general noise levels have been within acceptable noise levels. New measurements also indicate the same results. In rare cases where the limit is exceeded, the use of personal protective equipment was recommended.

Noise levels in residential areas did not exceed the limits set by the Kenyan National Environment Management Authority.

During construction, it is proposed that personal protective equipment will be provided to workers. Encourage the adoption of low noise technology and practice for machines during drilling and construction.

Daily monitoring of noise levels will need to be made during operation as per current practice.

Solid wastes

The construction phase will generate two types of solid wastes: spoils and household refuse.

Construction waste will be generated while the works are ongoing. This will consist of building materials, concrete, paper and plastic (for example from packaging materials and lagging), timber, scrap metal, etc. Apart from visual impacts, debris can affect water quality.

During construction the Contractors will construct various facilities, which have to be removed and dismantled on completion of the works. Adopt recycle and reuse measures for some of the spoils generated such as woody spoils generated from construction work will be stock piled to manageable size on regular intervals, valued and given to surrounding community as fuel wood as a cost effective measure. This will require a strategic and mutual understanding between the involved parties that is the local community, KenGen and the Contractor.

Sludge disposal will involve drying, encasing in concrete and burying due to hazardous and non-biodegradable nature.

Septic waste and accidental spillage resulting in contamination of chemicals and soil

- Spill and drip trays used during servicing of machinery
- Use septic tanks while ensuring doesn't flow to the surface
- Response plans for accidental spills to be formulated and routinely tested
- Bunded storage areas and secondary containment for oil and chemicals
- Use of an oil interceptor in the plant

Loss of land and resettlement

Loss of Land in Olo Nongot, Olo sinyat, Maasai Cultural Center and Olo Mayiana Ndogo belonging to individuals and institutions i.e., churches and schools, will be affected in various degrees within the project area where the project is to be sited. Resettlement will be accompanied with mental and psychological torture experienced by the locals on speculation of land loss.

A Resettlement Action Plan study was undertaken in the year 2009 under the Olkaria IV power plant project to develop a proposal of how to relocate the community. The study was finalised and subsequently a Memorandum of Understanding signed on 1st July 2013 to that effect. Therefore the land loss and displacement of persons associated with Olkaria V power plant will be compensated under the later mentioned project before construction works begin.

Economic displacement of persons

Economically Displaced People are defined here as people whose livelihoods are affected by the project land acquisition to such an extent that even if they are not physically displaced they will have to move to regain similar economic opportunities. This category of persons includes persons selling their artwork works in Maasai Cultural Center who will loss trading site and subsequently loss revenue.

Spread of communicable diseases

During the construction phase there is a risk of spread of communicable diseases such as tuberculosis, diarrhoea, Upper respiratory tract infections and pulmonary infections. Aspects of the physical environment that promote transmission of diseases include: inadequate housing, disposal of wastes and ventilation which are likely to occur during the construction phase of the project.

In addition to the above, most of the areas within the project area and neighbouring villages do not have proper sanitation facilities. From the baseline survey it was found that only 27.8% of the population in the nucleus of the project area have toilet facilities in their compounds and 72.2% of the population in the neighbouring communities have the same facilities. This means that with the influx of people, there will be a likelihood of increase in diseases such as typhoid, tuberculosis, diarrhoeal diseases, malaria, respiratory diseases, dysentery and cholera. The project area of influence is already affected by these pandemic diseases.

Increase in Amount and Tonnage of Traffic

Construction traffic is bound to increase with the commencement of development of Olkaria V power plant. This traffic will vary from fast, light vehicles used for transport of supervisors, minibuses transporting workers to site, pickups, tracked excavators, fuel tankers, and tipping trucks (dump trucks).

Within the park, most of the roads to the production wells and exploration sites are murram or of gravel type. This is likely to result in dusty environment and noise pollution within the area as a result of the anticipated heavy traffic along the roads during construction phase. The negative health and aesthetic effects will be on residents and the natural environment respectively.

The impact of increased traffic will be felt past the project site level to the neighbouring community. This will be through increase in the number of fast moving vehicles in these areas. Secondly, the design criteria for the existing roads did not factor in the current usage which they are subjected to and are thus bound to be dilapidated within a short duration.

Occupation health and safety

The construction process is estimated to take 6-8 years. These activities may involve employment of hundreds of workers in site, increasing chances of workplace accidents, injuries and illnesses. Health and safety of workers at the work place is a sure motivator to enhance productivity. It will thus be paramount that the contractor adheres to best practices in occupational health and safety.

HIV / AIDs and Sexually Transmitted Infections

During construction, the project is likely to bring in a significant population of new people in the project area chances are high that new infection rates will increase. This is due to the fact that the traders, workers and business people will have money to spend and some may use it to attract women from the project area in a bid to solicit for sex, thereby creating avenues for spread of HIV/AIDS.

Housing of staff

The proposed project is projected to directly inject 900 skilled and unskilled professionals in during its construction. Associated with these employments is the indirect workforce in support systems that are going to be further injected into the area.

From consultations with both the stakeholders and local community, they noted that one of the biggest problems in the area is overpopulation in the neighbouring settlements which has caused a strain on the social amenities. Increase in population has also resulted in increase in insecurity.

Insecurity

Due to the Increase in population there is likely to be increase in insecurity.

Impact on Air Quality

Geothermal power station release carbon dioxide and methane known to be greenhouse gases; nevertheless, this development is expected to result in no impact on the local climate.

The emission levels for carbon dioxide generated by geothermal stations are relatively low compared to coal fired power plant. An equivalent amount of electrical energy delivered by a coal-fired power station, with 37 per cent efficiency burning black coal with calorific value of 23 MJ/kg and carbon content of 65 per cent, would result in the emission of approximately eleven times as much (964 027 tonnes) of carbon dioxide. Nevertheless, the quantities of these gases emitted will be substantially less than from a fuel-burning power station of a similar capacity. The amount of methane emitted is estimated to be 119 tonnes per year for the two power stations generating 104MW for one year.

The following management and mitigation measures are proposed:

- Situate automatic H_2S sensors around the plant;
- Ensure cooling towers are sited properly;
- Put up additional monitoring stations for precipitation chemistry;
- Monitor changes in geothermal development technology and adopt, if necessary;
- Daily Monitoring of H_2S will be carried out;
- Educate workers on the dangers of exposure to H_2S.

Impacts of Fuel and Chemical Storage on Site from the substation

Spilled chemicals can contaminate soil as well as pollute inshore waters and hazardous and flammable substances (e.g. diesel oil, paints, thinner, solvents, etc.) when improperly stored and handled on the site become potential health hazards for construction workers. It is anticipated that refueling and maintenance of large vehicles will take place on the construction site and that, correspondingly, there will be storage of fuel and lubricants on the site.

During the construction period for the Olkaria Substation and transmission line, oil spills may occur.

The design in nutshell should consider the following mitigation measures during operation of the project, which will include the following:

- The Contractor should ensure that the employees on site are aware of the company procedures for dealing with spills and leaks from oil storage tanks for the construction machinery though induction and safety training;
- In case of spillage the contractor should isolate the source of oil spill and contain the spillage using sandbags, sawdust, absorbent material and/or other materials approved by KenGen;
- KenGen and the contractor should ensure that there is always a supply of absorbent material such as saw dust on site during construction, readily available to absorb/breakdown spill from machinery or oil storage;
- All vehicles and equipment should be kept in good working order, serviced regularly

and stored in an area approved by KenGen;

- The KenGen should ensure that filling areas, Oil storage drums / products storage areas have a smooth impermeable (concrete or thick plastic covered in gravel) floor. The floor should be bunded and sloped towards a sump to contain any spillages of substances in accordance with *The Kenya Bureau of Standards (KEBS) KS 1969: 2006 The Petroleum Industry -The installation of underground storage tanks, pumps/dispensers and pipe work at service stations and consumer installations - Code of Practice.*

Negative Impacts during Decommissioning

Decommissioning will involve take out of the power plans and associated infrastructures after useful life. The notable adverse impact at this phase is leaving abandoned plant, equipment and buildings without any attempt to rehabilitate leading to the deterioration of habitat. Unplanned, careless and disorganised site decommissioning can result in interference of habitat. Site decommissioning will involve closure and removal of facilities and wells, including linear infrastructures such as roads and pipelines and finally vegetation restoration and landscaping. Vegetation can restore naturally through succession or intervened rehabilitation to achieve average status with the neighbouring area.

E8 Environmental and social management and monitoring plan

The Environmental, safety and Liaison Section at Olkaria carries out monitoring activities for the entire geothermal development. It is recommended that monitoring of the following continues, as stipulated in the Environmental Operational Procedures:

- Precipitation chemistry;
- Significant environmental elements;
- Meteorology;
- Noise levels;
- Hydrogen sulphide.
- Water quality

Conclusions

As the country seeks to realize the Vision 2030 blueprint; this is spurring a rise in economic investments and a demand for energy generation from different forms. It is against this background, that the proposed 140 MWe Olkaria V has great economic significance. Nonetheless, the dwindling and erratic rainfall patterns as well as rising population are adding more pressure to the current generation capacity creating the need to diversify so as to sustainably rationalize the demand and supply sides.

The potential for perpetual steam production has given geothermal resources development a strong basis for renewable energy generation through massive green projects in Kenya. Since 1981, the Olkaria geothermal fields have progressively increased their power contribution to the national grid.

The study has established that the proposed power plant site is an area within KenGen land that is currently inhabited by Maasai local community that has been earmarked for resettlement. However, a number of negative environmental consequences are likely to accompany the project that include site vegetation clearing, interference with avian migrant pathways, habitat disturbance and increase in water demand from Lake Naivasha. Possible to mitigation measures for the impacts have been recommended in the environmental management and monitoring plans. Possible social impacts for the Projected Affected Persons (PAPs) in the affected villages (Olonongot and Olosinyat) have been adressedted through resettlement action plan for Olkaria IV, which is under construction. The resettlement site for the PAPs is close to completion.

The Project should comply with all local laws and regulations, which seek to ensure that the construction work does not adversely affect the environment and social community resources.

Any adverse impacts that arise will be mitigated on an on-going basis. These shall be included in an updated ESMP. At the operation phase, the monitoring plan shall ensure the project complies with the best environmental practices.

In conclusion, therefore, provided the recommended mitigation and environmental management measures are effectively implemented during the construction and operation phases of the proposed Olkaria V Power Plant, the anticipated environmental and social impacts will, for the most part, have low significance.

1 ENVIRONMENTAL AND SOCIAL IMPACTS AND MITIGATION MEASURES

1.1 Potential Impacts

Any development has the capacity to bring about change in the economic, social and environmental settings. Development is motivated by a positive change; however it can result in conflicts. In the past, the promotion of economic growth to propel improved increased well being was the central to the development agenda with less focus on the adverse social or environmental impacts. The need to avoid adverse impacts and to ensure long term benefits led to the concept of sustainability. This has become accepted as essential feature of development if the aim of increased well being and greater equity in fulfilling basic needs is to be met for this and future generations.

Therefore this ESIA is a formal process to predict the environmental consequences of the proposed developments and to plan appropriate measures to eliminate or reduce adverse effects and to augment positive impacts.

The ESIA thus has three main functions:

- To predict problems/ impacts;
- To avoid or minimize;
- To enhance positive effects / impacts;
- To propose mitigation measures for the adverse impacts.

Power generation and development projects like the one covered in this study induce and generate a wide range of physical, biological and social changes with consequences to the environment. On one hand the activities generate positive impacts; while on the other hand, they generate negative environmental and social impacts on the site and the surrounding areas.

This chapter will highlight significant impacts which will be induced by the proposed geothermal power station at the Olkaria V.

To this end, the focus of this chapter will be:

- To identify and analyze the extent of the environmental and social impacts from the project;
- To assess the environmental impacts of the operation and maintenance activities;
- To assess the social impacts from the project;
- To discuss the decommissioning of the project.

1.2 Definition and Classification of Environmental Impacts

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

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

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

1.2.1 Impact Significance

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

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

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

1.2.2 Impact identification

The study has predicted and evaluated anticipated impacts using acceptable standard methods of impact prediction and evaluation. Constant reference to a checklist of project activities was made and scores were assigned in an assessment table in order to make an objective assessment of how each of the project activities would impact on a particular environmental and social medium. The significance of impacts is subjective, but the value judgments required were best arrived at by consensus. The study team used several approaches such as brainstorming and use of checklists and matrices, to identify the main sources and establish the potential impacts from the proposed main project activities. Public participation and consultation with a wide sector of the community were conducted to reduce uncertainty. Table 7-1 overleaf summarizes the anticipated environmental problems observed which may be created by the project.

Table 1-1 **Summary of environmental Impacts in Olkaria**

ENVIRONMENTAL COMPONENTS / PROJECT ACTIVITY	Climate	Geology	Soils	Surface water resources	Surface water quality	Groundwater abstraction	Topography and geomorphology	Archaeology	Flora	Terrestrial fauna	Aquatic fauna	Air quality	Noise and vibration	Cultural heritage and sites	Local communities	Rural livelihoods	Current land use	Future land use options	Local economy	Regional and national economy	Local infrastructure and services	Health and safety	Aesthetic and amenity values
CONSTRUCTION																							
Power Plant			X	x	x		X		X	X	X	x	X	x	x	X	x	x	X	X	X	X	X
Cooling Towers							X				x	x					x	x				x	x
Pipeline Route				x	x		X		X	X	X						x	x	X			x	x
Steam line			X	x	x		x										x	x	X			X	X
Hot re-injection line										X							x	x				X	X
Cold-re-injection line									X	X	X						x	x				X	X
Switch yard and Transmission Line			X	x			X								x		x	x	X	X	X	X	x
Infrastructure Roads and Buildings.			X	x	x		X						X		x	X	x	x	X	X	X	X	X
OPERATION AND MAINTENANCE																							
Power Generation	x	X	x			X			X	X	X	X	X		x		x		x			X	
Water abstraction				x	x	X			X	X	X				x	x	x			x			
Infrastructure management							X		x	X	X				X	X	X	X	X		X		
DECOMMISSIONING AND CLOSURE																							
Plant closure				x	x										x	x		x	x	x		x	x
Decommissioning of construction site															x	x		x	x			x	x

1.2.3 Impact assessment scoring

The impacts were evaluated using the parameters of magnitude, significance, probability and duration of occurrence. Evaluation of the identified impacts was guided by careful assessment and judgment of anticipated consequences with regard to set standards or pre-development environmental situation of the site. The score of each of the impacts is an average value of scores from at least three study team members. The assessment and assignment of values to each identified impact was based on the values developed in Table 7-2 below which is adapted from the International good practices. Positive impacts were evaluated by assigning positive scores.

Table 1-2 Scale for Evaluation of Project Impacts

Score	***-1 (+1)***	***-2 (+2)***	***-3 (+3)***	***-4 (+4)***	***-5 (+5)***
Magnitude or extent	Impacts will occur only on site		Impacts will occur within a 3-5km radius of site		Impacts will occur regionally
Significance	Low. *Small changes which are hardly detectable*	Moderate. *Impact measurable, but does not alter processes*	High. *Many people, animals, plants affected. Major disruption of ecosystem processes*	Very high. *Loss of people, bio-diversity, property, loss of local livelihood systems*.	Unknown. *Insufficient information is available– apply pre-cautionary principle*
Probability of occurrence	Possible. *impact can occur but controllable*		Probable. *The impact is likely to occur but Can be controlled by effective Measures.*		Definitely to occur.
Duration of occurrence	Short term. *During construction phase only*	Medium term. *During early operations*		Long term. *For the entire operational phase*	Very long term. *For the entire operational phase and after closure*

Project activities in the Olkaria V area will involve construction of power station and related facilities. The impacts generated from these works therefore, will generally be incremental in nature.

1.3 Positive Impacts

1.3.1 Background

The proposed project will have significant positive impacts when compared to other forms of power production especially thermal power which involves the burning of fossil fuel. The positive impacts will be experienced at both construction and operation phases. In addition, the proposed project is likely to have the potential for carbon trade among other positive benefits.

Table 1-3 Impact scoring for positive impacts

Aspect	Score
Aspect/Impact: Income Generating Opportunities for Local Community	
Occurrence	**Score**
Magnitude or extent	3
Significance	2
Probability of occurrence	3
Duration of occurrence	5
Aspect/Impact: Improved Local Economy	
Occurrence	**Score**
Magnitude or extent	3
Significance	3
Probability of occurrence	3
Aspect/Impact: Create Employment Opportunities	
Occurrence	**Score**
Magnitude or extent	3
Significance	5
Probability of occurrence	5
Aspect/Impact: Local Market Opportunities	
Occurrence	**Score**
Magnitude or extent	3
Significance	3
Probability of occurrence	3
Aspect/Impact: Improved infrastructure and Social Services	
Occurrence	**Score**
Magnitude or extent	5
Significance	5
Probability of occurrence	5
Duration of occurrence	5
Aspect / Impact: Information, Education and Communication	
Occurrence	**Score**
Magnitude or extent	5
Significance	5
Probability of occurrence	5
Duration of occurrence	5
Aspect/Impact: Employment Creation	
Occurrence	**Score**
Magnitude or extent	5
Significance	4
Probability of occurrence	5
Aspect/Impact: Improved Infrastructure	

Occurrence	Score
Magnitude or extent	5
Significance	5
Probability of occurrence	5
Aspect/Impact: Urbanisation	
Occurrence	**Score**
Magnitude or extent	5
Significance	5
Probability of occurrence	5
Aspect/Impact: Social change	
Occurrence	**Score**
Magnitude or extent	5
Significance	5
Probability of occurrence	5
Aspect/Impact: Increase power supply to the national grid and thereby stabilization of electricity	
Occurrence	**Score**
Magnitude or extent	5
Significance	5
Probability of occurrence	5
Aspect/Impact: Potential for Carbon Market	
Occurrence	**Score**
Magnitude or extent	3
Significance	4
Probability of occurrence	5

1.3.2 Positive Impacts during Construction

(a) Income Generating Opportunities for local community

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

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

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

Enhancement

- It is proposed that water should be provided at the catering area through a Water Tank or stand pipe to improve hygienic conditions.

(b) Increase power supply to the national grid

The objective of this project is to construct a 140MW geothermal power plant with associated infrastructure to be known as Olkaria V to contribute towards meeting the ever increasing demand for electric power in the country. The project is part of the vision 2030 power projects that are supposed to power the country.

(c) Improved Local Economy

With project increased earnings of both the local population and the new population coming in search for labour, the amount of monies in circulation will increase. With the increased earnings, purchases of local goods and services by the construction labour force will positively impact the local economy. Similarly, increase in imports of construction and process equipment and in the supply of local construction materials will change economic dynamics of the area. This will therefore have a positive impact in terms of economic development.

Improvement of the quality of life of the local community during construction is anticipated to arise from improved local socio-economy.

(d) Create Employment Opportunities

The construction phase of the project will be characterised by recruitment of significant numbers of people to work with the contractor. There will also be an influx of new people into the project area. The projected number of construction staff is 900 persons. An increase in population of this magnitude will create a corresponding increase in demand for goods and services such as food for construction workers, housing, healthcare and need for transport. These needs will be satisfied by people living within the project area where local women will provide food vending services, homes will rent out spaces for the new population and shops will also benefit from increase of sales. All these avenues are bound to create new employment opportunities.

Enhancement measures

In order to improve employment opportunities and make the project attractive to the people living in the area, the following are vital:

- Capacity building and training of men, women and youth on specialised labour that will be required during construction;
- Gender mainstreaming during the recruitment process of workers to work in the construction process;
- Spreading administrative units to areas that are not going to benefit directly from the construction works so as to facilitate distribution of economic activities;
- Establishment of a strong quota system of allocation of jobs for persons living in the Olkaria villages even after relocation to a new place and the neighbouring community to facilitate equal spread of opportunities.

(e) Local Market Opportunities

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

(f) Improved infrastructure and Social Services

The development of access roads to be used during the construction process will boost access across villages and open up areas that have been lacking efficient access such as the Narasha and Inkorienito.

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

Enhancement measures

To improve the above benefits the following will need to be done:

- In liaison with the Sub-county Public Health and Sub-County Medical Officer of Health KenGen should facilitate the development of hospitals in accessible locations for the community and in locations where the workers settle. This can be in Kamere and Kongoni areas;
- Through the Community Liaisons Office consult the provincial administration, community both resettlers and the neighbouring villages to the project area suitable water supply initiatives that can be supported by KenGen.

(g) Potential for Carbon Market

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

For the case of Olkaria II 3rd unit power plant, the CDCF was used to construct a 10km domestic water supply line in Maiella location, class rooms at Olorouwa and Ngaambani primary schools and digging of a community water pan at Olosingate. This implies that both the local community and KenGen will benefit as a result of CDM.

(h) Information, Education and Communication

There will be development of additional skills for those taking advantage of new opportunities. There will also be diffusion of know-how from the more qualified personnel towards the local personnel.

1.3.3 Positive Impacts during Operation

(a) Employment Creation

The project will create direct and indirect employment opportunities. Direct employment opportunities will include worker in the geothermal plant, labour force employed in supporting business such as transportation, increase in trade therefore development of new businesses

(b) Urbanisation

Currently, most urban centres in the project area are located along the major roads. With the operationalisation of the additional geothermal plant project it is expected that urban centres are going to proliferate further, especially on neighbouring settlements i.e Kamere, Kongoni and Moi Ndabibi.

The increase in urban centres will lead to:

- Improvement in provision of social services by the Government e.g. construction of new schools and hospitals;
- Improved revenue collection used in the development of the immediate locations;
- Increased allocation resources from the exchequer;

(c) Social change

With the anticipation of coming of new people from varied cultures into the project area, it is projected that there will be cultural exchange which will lead to adoption of new ways of life, system of beliefs and shedding off of traditional way of living that have stagnated development in the local area.

To boost the positive change, sensitization workshops should be held within the project area to explain to the community the importance of provision of equal chances to both sexes in management of land and agriculture.

1.4 Negative Impacts during Construction

Table 1-4 Negative Impacts during construction

Aspect/Impact: Impact on Flora	
Occurrence	Score
Magnitude or extent	-1
Significance	-2
Probability of occurrence	-3
Duration of occurrence	-4
Aspect/Impact: Impact on Fauna	
Occurrence	Score
Magnitude or extent	-3, -5
Significance	-3
Probability of occurrence	-3
Duration of occurrence	-4
Aspect/Impact: Landscape Character Impacts	
Occurrence	Score
Magnitude or extent	-3
Significance	-3
Probability of occurrence	-3
Duration of occurrence	-4
Aspect/Impact: Soil Erosion	
Occurrence	Score
Magnitude or extent	-5
Significance	-3
Probability of occurrence	-2
Duration of occurrence	-5
Aspect/Impact: Impact on Quarry sites	
Occurrence	Score
Magnitude or extent	-3
Significance	-3
Probability of occurrence	-3
Duration of occurrence	-2
Aspect/Impact: Landslides and soils Creep	
Occurrence	Score
Magnitude or extent	-3
Significance	-2
Probability of occurrence	-3
Duration of occurrence	-2
Aspect/Impact: Water Resources	
Occurrence	Score
Magnitude or extent	-3
Significance	-3
Probability of occurrence	-3
Duration of occurrence	-5
Aspect/Impact: Impact on Air Quality and Dust	
Occurrence	Score
Magnitude or extent	-3
Significance	-3
Probability of occurrence	-3
Duration of occurrence	-4
Aspect/Impact: Impact on Noise and Vibrations	
Occurrence	Score
Magnitude or extent	-3

Significance	-2
Probability of occurrence	-3
Duration of occurrence	-4
Aspect/Impact: Impact on solid wastes	
Occurrence	Score
Magnitude or extent	-3
Significance	-4
Probability of occurrence	-3
Duration of occurrence	-2
Aspect/Impact: Septic Waste and Accidental Spillage Resulting in Contamination of Chemicals and Soils	
Occurrence	Score
Magnitude or extent	-3
Significance	-1
Probability of occurrence	-3
Duration of occurrence	-2
Aspect/Impact: Loss of Land and Resettlement	
Occurrence	Score
Magnitude or extent	-3
Significance	-1
Probability of occurrence	-1
Duration of occurrence	-1
Aspect/Impact: Economic Displacement of Persons	
Occurrence	Score
Magnitude or extent	-3
Significance	-1
Probability of occurrence	-3
Duration of occurrence	-1
Aspect/Impact: Spread of Communicable Diseases	
Occurrence	Score
Magnitude or extent	-3
Significance	-3
Probability of occurrence	-4
Duration of occurrence	-2
Aspect/Impact: Increase in Amount and Tonnage of Traffic	
Occurrence	Score
Magnitude or extent	-5
Significance	-2
Probability of occurrence	-3
Duration of occurrence	-1
Aspect/Impact: Occupation Health and Safety	
Occurrence	Score
Magnitude or extent	-5
Significance	-3
Probability of occurrence	-3
Duration of occurrence	-4
Aspect/Impact: HIV/ AIDS and Sexually Transmitted Infections	
Occurrence	Score
Magnitude or extent	-3
Significance	-2
Probability of occurrence	-4
Duration of occurrence	-5
Aspect/Impact: Housing of Staff	
Occurrence	Score
Magnitude or extent	-2
Significance	-3
Probability of occurrence	-1
Aspect/Impact: Insecurity	

Occurrence	Score
Magnitude or extent	-1
Significance	-3
Probability of occurrence	-1

1.4.1 Impact on Flora

(a) Loss of Migratory Corridors or Prime Dispersal Areas

The major impacts on flora will be the loss of migratory corridors or prime dispersal areas as follows:

- During the construction phase for roads, well drilling and power plants selective and minimal clearing and removal of natural vegetation will be done at the project area which includes the ecologically sensitive areas such as gorges, valley vegetation, thickets, along ridges;
- Invasive plant species *Nicotianum glauca* and *Solanum incanum*, which was recorded in the area, may gain opportunity to proliferate after native vegetation has been cleared during construction.

Mitigation measures

- Map out ecologically sensitive area at the site and make them known to the engineers and contractor e.g. valley thicket, hills, and gorges
- Ensure there is selective clearing of the vegetation this allows future re-growth and regeneration. This will ensure minimal disruption of wild fauna's natural movement, territoriality, and other ecological processes;
- It is desirable to re-vegetate disturbed areas along roads, pipelines and steam lines and other construction sites. While *Nicotianum glauca* will rapidly colonize the disturbed bare grounds and still act as surrogate habitat for some faun species, it is still desirable to minimize/discourage it's dominance by planting native trees such as *Tarconunthu*s and *A. drepanolobium*. Additionally, *Hyparrhenia dregeana* a native tussocks grass commonly growing at the site can be very used in checking soil erosion especially on loose soil dumps or bare slopes created during construction.
- The water and steam pipe lines should be laid across (perpendicular to) the valleys rather than running along them – as this will mean destroying large patch of this ecologically sensitive keystone habitat for many species this will reduce loss of habitat.
- There is need to create awareness among the local communities and discourage them from engaging in charcoal burning which is evidently on the increase in this area.
- KenGen GRD Environmental and community liaison section should monitor regeneration of natural vegetation as well as the appearance/spread of invasive or opportunistic species within the disturbed areas. Monitoring should include spotting and uprooting of unwanted germinating plants.

1.4.2 Impact on Fauna

(a) Impacts on Macrofauna (mainly Mammals)

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

- Loss and disturbance of habitat may lead to disappearance of some rare wildlife such as leopards known to occur in the area today. Other animals such Giraffes may temporarily stop using the area;
- Increased vehicle and human traffic in this area may result in many resident species leaving the area. Many forms of human-wildlife conflicts may occur e.g. poaching and accidents due to the high human and vehicle traffic in the area.
- Dust during the construction phase may cause poor visibility which may result to wild animals being knocked by vehicles;

- Steam Pipelines may block migratory route for the larger mammals. Blocking migration routes and corridors may result in isolation of some populations in 'island like' spaces which could interfere with their breeding patterns and genetic variability. Visible pipelines may not only deter animals from going near them as they follow their corridors but also reduces the aesthetic value of the landscape.

Mitigation measures

- KWS and KenGen should monitor wildlife abundance, distribution and movement in relation to this infrastructural development during construction and operation stages to aid in decision making.
- Erect bumps in wildlife crossing zones;
- Vehicular disturbances such as hooting should be discouraged accordingly;
- Incident records (of poaching, accidents and other human wildlife conflicts etc) should be kept by monitoring and taking of corrective measures;
- Roads feeding into the park area should be maintained as routes for tourist's activities and wildlife management;
- Access for earthmoving machines should be regulated;
- Park rules should be enforced within the park;
- Brine ponds should be located close to the source. Distant flow should be piped to prevent animal or vegetation contact;
- At known animal migration corridors pipes should be elevated or buried under the ground surface. Modify pipe loop designs to minimize hindrance to wildlife movement as well as scaring them away. Other design options like pipe burying, wider loops or concave ones should be explored for habitat suitability and to ensure big game can still move along their routine corridors and routes.

(b) Impact on Avifauna

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

- Fugitive dust from roads settling on perching and nesting sites may push some birds from the site;
- As a result of vegetation clearing habitat for birds that occur in thickets will be lost. The loss may create habitats for species associated with more open areas especially along the pipelines;
- Certain birds such as pipits, wagtails and ant eater chats are typically grassland species and occur only within the open grassland at Olo Sinyat and Olo Nongot targeted for power plant construction respectively. These species will be displaced during construction activities in the area. However they may find other habitats closer to the area;
- Migrating bird's species may be affected by transmission lines erected across their fly ways where they are either electrocuted or collides with transmission lines. For instance vultures that travel long distances during the day return to Vulture cliff to roost.

Mitigation measures

- KenGen together with KWS should develop and implement an avifauna monitoring scheme, assessing bird population trends and direct hazards relating to the project;
- The project site has gorges, valleys and hillsides which form some of the keystone habitat features for raptors (Vultures and Eagles) as they enable them to soar high using thermal currents while in search of prey. These should therefore be retained as intact as possible;
- High voltage transmission lines should be fitted with wire markers and flappers to alert birds on flight;
- High heat points and emission vents within the project area should be sheltered or fitted with inhibitors to deter birds which may get killed as a result of using such areas;

- As the project will draw much water from Lake Naivasha, KenGen should join hands with other stakeholders in supporting the ongoing bi-annual waterbird counts – which is a long term monitoring activity aimed at assessing the effects of various activities around the lake.

(c) Impacts on Herpetofauna

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

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

Mitigation measures

- KenGen should liaise with KWS to capture reptiles hiding under rocks and sheltered terrains such as Pythons and House snakes and safely release them in suitable habitats.

(d) Impacts on Invertebrates

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

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

Mitigation measures

- Re-vegetation of the cleared vegetation.

1.4.3 Landscape Character Impacts

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

This landscape character area has been identified as having medium landscape sensitivity. Overall, the predicted magnitude of change in landscape resource is medium. Therefore, the predicted significance of landscape impact is moderate.

(a) Visual Impacts

The assessment of the existing visual environment and the impact of the proposed development and its various components on visual receptors have established that there will be potential visual impacts during construction and operation. The elements that shall intrude/obscure the scenic view are;

- Above-ground steam pipes above the ground from the storm wells to the power station
- Power Station Structures;
- Site Lighting – During construction and operation;
- Construction Equipment – Temporary during construction.

Visual sensitivity for the area has been identified as high sensitivity. Overall, the predicted magnitude of change in visual resource is medium. Therefore, the predicted significance of visual impact is moderate.

Mitigation measures

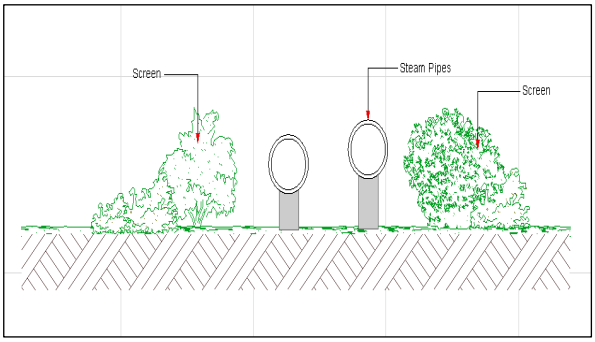
The mitigation measures proposed to deal with the anticipated impacts are shown in the table below:

Impact	Mitigation
Loss of Vegetation Cover 	• Limiting vegetation clearing to construction areas only • Preparation of a landscape planting plan for the entire project area. Planting plan to be comprised of 75% indigenous species and to be rid of any invasive species. • Re-vegetation should target 2 million trees annually until the area is fully re-vegetated.
Topography Change	• Limitation of earthworks to construction areas only
 Soil disturbance: **Plate 1 Visual Impacts**	• Stripped topsoil to be preserved and used during landscaping. • All embankments to be vegetated or stone pitched to prevent soil erosion.

(b) Visual Environment

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

Impact	Mitigation
Visual intrusion by steam pipes from the wells to the station	• Planting a vegetation screen along the steam pipes to reduce visual intrusion across the landscape.

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

(c) Residual Impacts

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

Mitigation measures

- KenGen should undertake holistic studies on cumulative visual impacts to the entire GOGA area, in this coherent mitigation measures should be proposed.

1.4.4 Soil Erosion

This Project will involve earthworks that will have impact on the soils; thus the appropriate and timely erosion control measures will arrest and minimize soil loss and siltation as well as the sedimentation of down slope water courses. The measures will be effected immediately after subsequent construction activities to prevent extended exposure to the agents of erosion and as per the management plan and monitoring recommendations.

The following mitigation measures are recommended for the proposed development:

(a) Site Soil Conservation Measures

Site clearing or disturbance of the natural vegetation will be planned and approved as part of project management process. Among the areas that require immediate restoration, the

Contractor will allow minimal vegetation clearing and disturbance on the slopes to avoid difficulties during restoration.

Areas inevitably disturbed, cleared, excavated, or/and exposed during construction will be re-vegetated using native grass species, preferably of species growing in the immediate pristine environment to allow harmony with the surrounding and minimize duration for watering and care. The restoration period will require monitoring of the re-vegetated sites to assess impacts of heavy foraging, patch growth as well as gulley formation. For instance, tussock grass becomes dominant mid slope up to the valley bottoms hence preferred as the grass cover restoration for such an area.

Isolated sites with installations and frequent human presence that require re-vegetation will be surrounded by less palatable native species to act as plant screens and reduce pressure from wildlife foraging. Presence of well rooted vegetation will act as soil stabilization for the areas. *Taconanthus compharatus* that is locally native and wide spread is recommended among the woody species.

(b) Other Mitigation Measures during Construction

- No grey water runoff or uncontrolled discharges from the site/working areas (including wash down areas) to adjacent watercourses and/or water bodies shall be permitted;
- Water containing pollutants such as cements, concrete, lime, chemicals and fuels shall be discharged into a conservancy tank for removal from site;
- Runoff loaded with sediment and other suspended materials from the site/working areas should be prevented from discharging to adjacent watercourses and/or water bodies must be prevented;
- Potential pollutants of any kind and in any form shall be kept, stored and used in such a manner that any escape can be contained and the water table not endangered;
- Wash areas shall be placed and constructed in such a manner so as to ensure that the surrounding areas (including groundwater) are not polluted.

1.4.5 Impact on Quarry Sites

Materials sites (quarry and other borrow areas) if not reinstated and rehabilitated after project completion, cause landscape scarring, dangers of overhanging cliffs and falling rocks which creates environmental, health and safety hazards.

The following are the mitigation measures proposed during extraction of natural resources for materials:

- Appropriate authorisation to do or use any proposed borrows pits and quarries will be obtained before commencing activities;
- Borrow pits and quarries shall be located more than 100 meters from watercourses in a position that will facilitate the prevention of storm-water runoff from the site from entering the watercourse;
- Notice will be given 14 days to nearby communities of intention to excavate in the borrow pits or quarries;
- Borrow rehabilitation plans, will be prepared prior to use and approved by the local authorities;
- Storm-water and groundwater controls through appropriate drainage shall be implemented to prevent runoff entering streams and the slumping of soil from hillside above;
- The use of borrow pits or quarries for material spoil sites must be approved by the local authorities (and/or with the appropriate consent of the “landowner”). Where this occurs, the materials spoiled in the borrow pit shall be profiled to fit into the surrounding landscape covered with topsoil and revegetated.

In the event that blasting for rock will be done the following mitigation measures are proposed:

- A current and valid authorisation from the Department of Mines prior to any blasting activity shall be obtained;
- A qualified and registered blaster by the Department of Mines and Geology shall supervise all blasting and rock-splitting operations at all times;
- The Contractor shall ensure that appropriate pre blast monitoring records are in place (i.e. photographic and inspection records of structures in close proximity to the blast area);
- KenGen and the Contractor shall ensure that emergency services are notified, in writing, a minimum of 24 hours prior to any blasting activities commencing on Site;
- KenGen and the Contractor shall take necessary precautions to prevent damage to special features and the general environment, which includes the removal of fly-rock. Environmental damage caused by blasting/drilling shall be repaired at the Contractor's expense;
- The Contractor shall ensure that adequate notification is provided to the local communities immediately prior to all blasting. It is preferable that warning / informative signage and billboards be erected at the site indicating operation hours as well as commencement and end of operations. All signals shall also be clearly given;
- KenGen and the Contractor shall use blast mats for cover material during blasting. Topsoil shall not be used as blast cover.
- Precautionary and corrective measures will be taken to avert defacing and deformation of the land features.

1.4.6 Landslides and soil creep

The proposed site has a highly undulating terrain, which will require digging up of the ground levelling and foundation piling during construction; such activities make the ground and soils unstable in sloppy areas that may trigger landslides and soil creep. There is likely going to be reduction of shear strength caused by digging at mid-slope or at the foot of the slope during construction.

The following mitigation measures are proposed

- Retaining walls as alternate for growing vegetation cover restoration along the sloppy ground;
- Benching for cut and fill.
- Baricading unstable sloppy areas with red tape
- Installation of warning signage's

1.4.7 Water Resources

The Olkaria geothermal field has abstracted water from Lake Naivasha before; the Olkaria V project will require water during the construction and operation stage. The project may result to misuse of water resources if conservation measures are not adopted. Incidental oil and chemical spills may result to water pollution. For good practice the following mitigation measures are proposed, which the same are as proposed for the construction of the Olkaria IV power plant:

- Continued monitoring of lake levels;
- Accidental leakages and bursts of water supply pipelines should be reported and repaired immediately;
- Recycle water as much as possible should be encouraged for example water used for curing of concrete can be used for spraying dusty roads;
- Control of the water flows and the water consumption records must be kept and availed to the supervising and KenGen Resident Engineers at the end of working day;
- All employees should be sensitized on water usage practices like discouraging unnecessary opening of taps;
- Monitoring of taps and their efficiency should be done regularly;
- Curing of concrete should be done in conservancy tank to avoid wastage;
- Harvest water during rainfall times;

- KenGen and the Contractor shall arrange for the necessary approvals/permits from the water authorities for the abstraction of water;
- The Contractor will be required to comply with the water quality regulations;
- No grey water runoff or uncontrolled discharges from the site/working areas (including wash-down areas) to adjacent watercourses and/or water bodies shall be permitted;
- Water containing pollutants such as cements, concrete, lime, chemicals and fuels shall be discharged into a conservancy tank for removal from site;
- The Contractor shall instruct their staff and sub-contractors that they must use toilet provided and not the bush or watercourses;
- Reduction of baseline water quality through construction actions/activities shall be prevented (for example coffer dams, silt traps or plastic lining).
- Reinjection of brine from the separator and the condenser is recommended

1.4.8 Air Quality and Dust

Air quality will be affected by the construction of the proposed geothermal power plants both during construction and operation. During construction the main emission sources include dust from earthworks and batching plants and tail gases from construction equipment and vehicles. The dust will settle on flora, and can cause respiratory problems and nuisance for local residents. The following mitigation measures will be implemented to minimize or reduce impact on air quality for proposed projects:

- Olkaria is a fragile ecosystem; thus mobile machinery or vehicle maintenance and services should be undertaken away from project site in a yard set aside for this or by an approved garage or service station to prevent any incident of oil and fuel spills that could contaminate soils and possibly ground water quality.
- Daily monitoring of air quality standards;
- All construction machinery shall be maintained and serviced in accordance with the manufactures specifications;
- Workers shall be trained / sensitized on dust minimization techniques and management of air pollution from vehicles and machinery;
- The removal of vegetation shall be avoided until such time as clearance is required and exposed surfaces shall be re-vegetated or stabilized as soon as practically possible;
- Frequent watering of exposed surfaces and piles of soil to prevent airborne dust emissions;
- Unless inevitable, vehicles shall avoid earth roads susceptible to fugitive dust until dust management routines are done.
- Incorporate dust/fumes arrestors in the batching plant e.g use of dust nets
- Provision of appropriate protective personal equipment including respirators and aprons

1.4.9 Noise and vibration

There are several sources of noise during construction and operation. During construction the main sources will include blasting, heavy equipment, batching plant, generators and transportation vehicles. During operation the main noise source is the operation of the plant itself. Noise levels have been monitored in connection to the operation of the Olkaria geothermal power plants for several years. According to measurements the general noise levels have been within acceptable noise levels. New measurements also indicate the same results. In rare cases where the limit is exceeded, the use of personal protective equipment was recommended.

Noise levels in residential areas did not exceed the limits set by the Kenyan National Environment Management Authority -45 dB(A) during day time and 35 dB(A) during night time respectively.

During construction it is proposed that personal protective equipment will be provided to workers. Encourage the adoption of low noise technology and practice for machines during construction.

Daily monitoring of noise levels will need to be made during operation as per current practice.

1.4.10 Solid wastes

The construction phase will generate two types of solid wastes: spoils and household refuse.

Construction waste will be generated while the works are ongoing. This will consist of building materials, concrete, paper and plastic (for example from packaging materials and lagging), timber, scrap metal, etc. Apart from visual impacts, debris can affect water quality.

During construction the Contractors will construct various facilities for temporary accumulation, which have to be removed and dismantled on completion of the works. Adopt recycle and reuse measures for some of the spoils generated such as woody spoils generated from construction work will be stock piled to manageable size on regular intervals, valued and given to surrounding community as fuel wood as a cost effective measure. This will require a strategic and mutual understanding between the involved parties that is the local community, KenGen and the Contractor. All waste shall be removed from the site for appropriate disposal through licensed waste handlers.

Other solid waste measures adopted from construction of existing Olkaria power plant sites include:

Identifying environmentally acceptable spoil sites for spoil materials and approval by KenGen taking into consideration the following:

- Preferably to be located on land already cleared wherever possible.
- Diligence on the part of the Contractors during construction activities will minimise the amount of debris, and also will ensure that debris is disposed of in a sensible manner, at a specified and approved dump site.
- The tender documents should specify the proper disposal of waste during construction.
- The tender documents should also ensure that the Contractors leaves the site in a clean condition on completion of works. The Contractors should be required to restore and landscape all areas to the satisfaction of the KenGen.
- All solid waste generated during construction and operation should be carefully monitored, collected, stored, and taken out of the park for disposal.
- Waste generated during the operation of the plant must be segregated at source, inventorised and appropriate methods of disposal determined.
- The development and rehabilitation of spoil areas shall include the following activities:

    - Stripping and stockpiling of topsoil;
    - Removal (to a nominal depth of 500mm) and stockpiling of subsoil;
    - Placement of spoil material;
    - Contouring of spoil site to approximate natural topography and drainage and/or reduce erosion impacts on the site;
    - Placement of excavated subsoil and then topsoil over spoil material;
    - Contouring and re-vegetation;
    - The Contractor shall ensure that the placement of spoil is done in such a manner to minimise the spread of materials and the impact on surrounding vegetation and that no materials ‘creep’ into ‘no-go’ areas.

1.4.11 Loss of land and resettlement

Loss of Land in Olo Nongot, Olo sinyat, Maasai Cultural Center and Olo Mayiana Ndogo belonging to individuals and institutions i.e., churches and schools, will be affected in various

degrees within the project area where the project is to be sited. Resettlement will be accompanied with mental and psychological torture experienced by the locals on speculation of land loss.

A Resettlement Action Plan study was undertaken in the year 2009 under the Olkaria IV power plant project to develop a proposal of how to relocate the community. The study was finalised and subsequently a Memorandum of Understanding signed on 1st July 2013 to that effect. Therefore the land loss and displacement of persons associated with Olkaria V power plant will be compensated under the later mentioned project before construction works begin.

Recommendations

- Relocation and compensation should be done before commencement of the construction works.

1.4.12 Economic displacement of persons

Economically Displaced People are defined here as people whose livelihoods are affected by the project land acquisition to such an extent that even if they are not physically displaced they will have to move to regain similar economic opportunities. This category of persons includes persons selling their artwork works in Maasai Cultural Center who will loss trading site and subsequently loss revenue.

Recommendations

- It is proposed that KenGen in liaison with Kenya Wildlife Service's establish a site that will be accessible to the traders and the tourists who buy their merchandise, especially within Hells Gate National Park.

1.4.13 Spread of communicable diseases

During the construction phase there is a risk of spread of communicable diseases such as tuberculosis, diarrhoea, Upper respiratory tract infections and pulmonary infections. Aspects of the physical environment that promote transmission of diseases include: inadequate housing, disposal of wastes and ventilation which are likely to occur during the construction phase of the project.

In addition to the above, most of the areas within the project area and neighbouring villages do not have proper sanitation facilities. From the baseline survey it was found that only 27.8% of the population in the nucleus of the project area have toilet facilities in their compounds and 72.2% of the population in the neighbouring communities have the same facilities. This means that with the influx of people, there will be a likelihood of increase in diseases such as typhoid, tuberculosis, diarrhoeal diseases, malaria, respiratory diseases, dysentery and cholera. The project area of influence is already affected by these pandemic diseases.

Recommendations

- The Community Liaison Office should organize for community and workers training and sensitization programs in conjunction with the Sub-County Public Health Officer under the government led Community Led Total Sanitation (CLTS) initiative. This will facilitate development of more sanitation facilities within the community and also increase usage;
- Covering and / rehabilitation of borrow pits to prevent breeding of mosquitoes that spread malaria;
- Dust proofing of earth roads within the construction site through three (3) times watering a day. This can be done in the Morning, Noon and Afternoon or through spreading of grave/ballast or temporary tarmacking.

1.4.14 Increase in Amount and Tonnage of Traffic

Construction traffic is bound to increase with the commencement of development of Olkaria V power plant. This traffic will vary from fast, light vehicles used for transport of supervisors, minibuses transporting workers to site, pickups, tracked excavators, fuel tankers, and tipping trucks (dump trucks).

Within the park, most of the roads to the production wells and exploration sites are murram or of gravel type. This is likely to result in dusty environment and noise pollution within the area as a result of the anticipated heavy traffic along the roads during construction phase. The negative health and aesthetic effects will be on residents and the natural environment respectively.

The impact of increased traffic will be felt past the project site level to the neighbouring community. This will be through increase in the number of fast moving vehicles in these areas. Secondly, the design criteria for the existing roads did not factor in the current usage which they are subjected to and are thus bound to be dilapidated within a short duration. These can also lead to frequent accidents involving materials, vehicles, people and animals.

Recommendations

- Erection of proper signage along all roads exploited the construction process;
- Construction of bumps along speed bumps along Maili Mbili – Kongoni road and the roads within the park;
- In conjunction with other stakeholders conduct a traffic survey to establish the current usage of the roads, both within and outside the park. Following the results, construct a road with the capacity to handle current traffic and projected traffic to be injected by the proposed Olkaria V power plant.
- Sensitization and training of drivers.
- Monitoring, enforcement and disciplinary action of offenders.
- Use of escort and chase vehicles.

1.4.15 Occupation health and safety

The construction process is estimated to take 2-3 years. These activities may involve employment of hundreds of workers in site, increasing chances of workplace accidents, injuries and illnesses. Health and safety of workers at the work place is a sure motivator to enhance productivity. It will thus be paramount that the contractor adheres to best practices in occupational health and safety.

Recommendation / Mitigation

- Provide and enforce all ranges of required PPEs
- Contractors to establish a comprehensive Health and Safety Policy which should be in compliance with KenGen's Occupation Health and Safety Policies and be approved by Environment, Health and Occupation Manager from KenGen.
- Ensure compliance with all standards and legally required health and safety regulations;
- Include standard best practice health and safety provisions in the construction contract. The provisions should include insurance to enable the contractor to pay for any and all treatments required by his workers including those of all sub-contractors, together with any subsequent lifelong disability payments;
- Employ a full time qualified Health and safety Officer;
- Establish and enforce a strict code of conduct for all project drivers including outside suppliers delivering materials. The code should focus on safety, especially speed, and loading, especially banning all carriage of staff, workers and passengers except in seats;
- Implement the specified H&S programme throughout the construction period;
- Establish an emergency response procedure and display on all work areas. This is likely to require one vehicle on site equipped as an ambulance and a paramedic on site at all times during construction activities;

- Provision of a standard first aid kit at the site office at all times;
- Provision of fire-fighting equipment available at the workers camp;
- Provision of medical facilities for staff;
- Install appropriate safety signages for all work sites;
- Registration of the work place;
- Maintain an accident register;
- carry out accident and incidents investigations and implement corrective actions;
- Establish Occupational Health and Safety Committee;
- Staff and visitor induction;
- Toolbox and monthly safety meetings;
- Routine inspections.

1.4.16 HIV / AIDs and Sexually Transmitted Infections

During construction, the project is likely to bring in a significant population of new people in the project area. Chances are high that new infection rates will increase. This is due to the fact that the traders, workers and business people will have money to spend and some may use it to attract resident from the project area in a bid to solicit for sex, thereby creating avenues for spread of HIV/AIDS.

Recommendation / Mitigation

- The Contractor should ensure that prevention and management of sexually transmitted diseases as a result of social interaction between immigrant workers and local populations is conducted through:
    - Selecting appropriate locations away from concentration of human settlements for construction camps;
    - Education and sensitisation of workers and the local communities on HIV/AIDs and STIs in conjunction with Public Health Office;
    - Provision of condoms to the construction workers, project team and the public. This should be kept in places that are not locked and are accessible to the above persons;
    - Where possible conduct regular sensitisation campaigns and monitoring and evaluation of the modes used during course of the project;
    - Formation of peer groups from among the project staff to ensure continuity in training and awareness raising;
    - The contractor has to institute HIV/AIDS awareness and prevention campaign amongst workers for the duration of the contract e.g. erect and maintain HIV/AIDS information posters at prominent locations as specified by the Resident Engineer in consultation with the KenGen Community Liaison Office;
    - The contractor has to ensure that staff are made aware of the risks of contracting or spreading sexually transmitted diseases;
    - The contractor should ensure that the project workers are sensitised on the local culture;

1.4.17 Housing of staff

The proposed project is projected to directly inject 900 skilled and unskilled professionals in during its construction. Associated with these employments is the indirect workforce in support systems that are going to be further injected into the area.

From consultations with both the stakeholders and local community, they noted that one of the biggest problems in the area is overpopulation in the neighbouring settlements which has caused a strain on the social amenities. Increase in population has also resulted in increase in insecurity.

Recommendation / Mitigation

To mitigate on the above it is therefore proposed that:

- The contractor develops or makes necessary arrangements for construction camp for staff with related social amenities outside the Project area.

1.4.18 Insecurity

Due to the problems in 7.4.17 above Increase in population has also resulted in increase in insecurity.

Recommendation / Mitigation

To mitigate on the above it is therefore proposed that:

- Ensure that the contractor develops staff code of conduct;
- Liaise with the National Police Service to promote community policing;
- Liaise with the County Commissioners office to promote the proposed 'Nyumba Kumi' initiative;
- The Contractor to make security arrangement at the Project site in consultation with Kongoni Police Station, KWS, KenGen and Sub-County Administration.

1.5 Negative Impacts during Operations

Table 1-5 Negative Impacts during operations

Aspect/Impact : Impact on Flora	
Occurrence	Score
Magnitude or extent	-1
Significance	-2
Probability of occurrence	-3
Duration of occurrence	-4
Aspect/Impact : Impacts on Fauna	
Occurrence	Score
Magnitude or extent	-3
Significance	-3
Probability of occurrence	-3
Duration of occurrence	-4
Aspect/Impact : Soil Erosion and Sedimentation	
Occurrence	Score
Magnitude or extent	-3
Significance	-2
Probability of occurrence	-3
Duration of occurrence	2
Aspect/Impact : Solid Waste and Wastewater Disposal	
Occurrence	Score
Magnitude or extent	-3
Significance	-2
Probability of occurrence	-3
Duration of occurrence	-1
Aspect/Impact : Brine Disposal	
Occurrence	Score
Magnitude or extent	-3
Significance	-2
Probability of occurrence	-3
Duration of occurrence	2
Aspect/Impact : Lake Naivasha	
Occurrence	Score
Magnitude or extent	-3

Significance	-2
Probability of occurrence	-3
Duration of occurrence	2
Aspect/Impact : Impact on Air Quality	
Occurrence	Score
Magnitude or extent	-3
Significance	-2
Probability of occurrence	-3
Duration of occurrence	-4
Aspect/Impact : Impact on Noise Levels	
Occurrence	Score
Magnitude or extent	-1
Significance	-2
Probability of occurrence	-3
Duration of occurrence	-2
Aspect/Impact : Accidental Spillage Resulting in Chemical and Soil Contamination	
Occurrence	Score
Magnitude or extent	-3
Significance	-2
Probability of occurrence	-3
Duration of occurrence	-3
Aspect/Impact: Oil / Hazardous Pollution	
Occurrence	Score
Magnitude or extent	-2
Significance	-1
Probability of occurrence	-1
Duration of occurrence	-1
Aspect/Impact : Occupational Health and Safety	
Occurrence	Score
Magnitude or extent	-1
Significance	-1
Probability of occurrence	-1
Duration of occurrence	-1

1.5.1 Impact on Flora

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

- Invasive species such as *Nicotiana glauca, Solanum incanum* and opportunistic weed plants *Datura stramonium, Tagetes minuta, Ricinus communis, Portulaca oleracea* may encroach on the cleared areas including road sides. This may alter the physiognomy and the aesthetic appeal of the original area;
- Non-condensable Gases such as hydrogen sulphide (H_2S), sulphur dioxide (SO_2), ammonia (NH_3) and carbon dioxide (CO_2) released in escaping steam are known to have some impacts on the vegetation of the area in the long term especially when produced in high concentrations (Thompson and Kats 1978) though some plants have been shown to be more tolerant (EPA, 1977; El-Hinnawi, 1981);
- High levels of H_2S, SO_2, NH_3 and CO_2 may result to the formation of acid rains although this has not been recorded in existing KenGen Olkaria plants (Marani 1995)
- Brine may have deleterious effects on plants due to its chemical composition and the fact that it is usually at high temperature. Brine flows and ponds should be located close to the source. Distant flow should be piped to prevent animal or vegetation contact.

Mitigation measures

- Monitor invasive plant species at the project area and uproot unwanted germinating plants;

- Assess concentration geothermal gaseous effluents such as H_2S, SO_2, NH_3 and CO_2 (e.g. by use of automatic sensors) and continually test for any evidence of acid rain
- Plant soil-erosion preventing grass species such as *Cynodon dactylon, Digitaria abyssinica, Pennisetum clandestinum* and *Hyparrhenia dregeana* at bare sloppy grounds or loose soil dumps;
- Steam pipe insulations should have a well camouflaged colours that are maintained so that animals don't perceive pipelines as barriers
- Brine flows and ponds should be located close to the source. Distant flow should be transmitted through closed pipes
- Rehabilitate disturbed areas along roads, pipelines and abandoned campsites etc by planting native plant species such as T*arconunthus* and *A. drepanolobium* – this should be done as soon as practicable to avoid colonization by invasive and opportunistic pioneer species;
- Exotic plants species should not be introduced into this area;
- Create awareness among the local communities on the importance of vegetation cover and discourage them from engaging in charcoal burning.

1.5.2 Impacts on Macrofauna

The major impacts on Macrofauna (Mammals) during the operation phase include (but not limited to) the following:

- The increased traffic to this new area may result in accidents involving wildlife and also may force mammals to alter their routine ecological and movement patterns;
- Due to the high human and vehicle traffic in the area, there may be incidences of wildlife poaching;
- The noise from emission power plant installations will scare away many animal species;
- Brine flowing into open surfaces may lead to contamination of the animal's drinking water;
- Powerful flood lights if covering a large area may interfere with natural behaviour of both diurnal and nocturnal animals.

Recommendation / Mitigation

- KWS and KenGen should monitor wildlife abundance, distribution and movement in relation to this infrastructural development during construction and operation stages to aid in decision making;
- Erect bumps in wildlife crossing zones;
- Vehicular disturbances such as hooting should be discouraged accordingly;
- Incident records (of poaching, accidents and other human wildlife conflicts etc) should be kept by monitoring and taking of corrective measures;
- Roads feeding into the park area should be maintained as routes for tourist's activities and wildlife management;
- Access for earthmoving machines should be regulated;
- Park rules should be enforced within the park;
- Brine ponds should be located close to the source. Distant flow should be piped to prevent animal or vegetation contact;
- At known animal migration corridors pipes should be elevated or buried under the ground surface. Modify pipe loop designs to minimize hindrance to wildlife movement as well as scaring them away. Other design options like pipe burying, wider loops or concave ones should be explored for habitat suitability and to ensure big game can still move along their routine corridors and routes.

1.5.3 Impact on Avifauna

The major impacts on bird during the operation phase may include but not limited to the following:

- High-voltage transmission lines may cause death to birds through electrocution or as a result of direct collision;
- Also when visible e.g. during the day, the swaying of the lines in the wind, their reflective properties and the humming sounds may probably scare away many birds – resulting in a huge area devoid of the flying creatures.
- Powerful flood lights that are directed/shining upwards or covering a large area may interfere with birds that migrate by night.

Recommendation / Mitigation

- High heat points and emission vents should be sheltered or fitted with inhibitors to deter birds from perching or hovering around.
- KenGen together with KWS should develop and implement an avifauna monitoring scheme, assessing bird population trends and direct hazards relating to the project;
- The project site has gorges, valleys and hillsides which form some of the keystone habitat features for raptors (Vultures and Eagles) as they enable them to soar high using thermal currents while in search of prey. These should therefore be retained as intact as possible;
- High voltage transmission lines should be fitted with wire markers and flappers to alert birds on flight;
- High heat points and emission vents within the project area should be sheltered or fitted with inhibitors to deter birds which may get killed as a result of using such areas;
- As the project will draw much water from Lake Naivasha, KenGen should join hands with other stakeholders in supporting the ongoing bi-annual waterbird counts – which is a long term monitoring activity aimed at assessing the effects of various activities around the lake.

1.5.4 Impacts on Herpetofauna

The major foreseen impacts of this project on herpetofauna during operation phase include:

- Brine flows should be piped to the brine ponds rather than being let to freely flow on open channels as this negatively affects herpetofauna in the area e.g. direct burning of slow moving species or alteration of water quality;
- Brine ponds and cold re-injection sites should be monitored to ascertain their utilization as suitable habitat by amphibians like toads and frogs.

Recommendation / Mitigation

- Water and steam pipe lines should be laid across (perpendicular to) the valleys rather than running along them – as this will mean destroying large patch of this ecologically sensitive keystone habitat for many species;
- It is desirable to re-vegetate disturbed areas along roads, pipelines and steam lines and other construction sites;
- Create awareness among the local communities and discourage them from engaging in charcoal burning which is evidently on the increase in this area.

1.5.5 Soil erosion and sedimentation

Wildlife use, livestock grazing, human settlement and tourist traffic in the fragile ecosystem around Olkaria Domes may expose the ground surface to agents of soil erosion during torrential rains. The steam fields are also vulnerable considering the steep slopes along the gathering system corridors. This necessitates soil conservation and erosion control measures for slope protection (such as maintaining vegetation cover) and drainage infrastructure to control the run off within the project area.

Soil erosion is caused by practices which (by action or inaction) either permit intense rainfall to strike the unprotected soil surface, or encourage the accumulation of large volumes of runoff,

or allow runoff to flow rapidly across the soil surface thereby removing the surface layers of the soil.

Runoff from earth roads has the potential to cause erosion problems as already witnessed in operational areas of the power plant, however if the road surfaces are properly maintained and runoff can be diverted at regular intervals to avoid build up of water, erosion problems will be minimised.

It is recommended that effectiveness of the erosion control measures be monitored. A soils expert should review soil conditions, at monthly intervals during construction and at yearly intervals during operation. Finally, it is recommended that KenGen nominates an officer to take responsibility for the day to day control of all activities that could lead to soil erosion. The officer should be briefed by a soils expert as to the nature of risks and should be provided with sufficient authority to direct contractors concerning day to day activities that could lead to erosion.

The design in nutshell should consider the following mitigation measures during operation of the project:

- Proper designs and layout of field to avoid steep gradients should be done, budget for and presented in the Engineering Report;
- The design should consider appropriate terracing due to the nature of topography of the area;
- Planting of trees along the gullies and areas susceptible to erosion is proposed;
- Prepare a restoration scheme to guide re-forestation or re vegetation of areas cleared during construction should be done.

1.5.6 Solid waste and wastewater disposal

The proposed development will require safe handling and disposal of wastewater generated. The release of wastewater (from earlier plants) via gullies and natural drainage lines has resulted in erosion effects.

The chemical concentration of brine (the wastewater from geothermal plants) has the potential to harm flora and fauna; thus, the disposal mechanism should allow reduce chances of harmful contact. The chemical composition of brine shall be monitored. A 140MW development produces a substantial volume of wastewater, all of which needs to be disposed of safely.

The proposed long-term method of wastewater disposal is by deep re-injection into a number of purpose drilled or unused production wells, which should have minimal surface impact as well as minimize contact with ground flora and fauna.
The level of re-injection will be below lake level and there is little possibility of surface or groundwater pollution. The problem of pipe blockages due to precipitation of dissolved silica will be overcome by the use of conditioning ponds. The proposed development will mean about 1400 t/h will need to be re-injected. The large ponds adjacent to the station will probably attract wildlife during extended dry periods and therefore need to be securely fenced.

One advantage of the fact that the brine will have been cooled is that the re-injection line can be buried. This is recommended so that the pipeline does not become a barrier to wildlife movement, particularly since the proposed re-injection wells lie some distance from the production field wells.

1.5.7 Brine Disposal

Brine in the existing plants should be re-injected back to the sub-surface however; there are areas where the brine overflows to the surface.

Mitigation measures

- Brine ponds should be sited close to the source;
- Brine re-injection through re-injection wells into underground reservoir;
- Chemical composition and parameters of the brine should be routinely monitored.

1.5.8 Lake Naivasha

Due to the fact during operation water will be abstracted from the lake and due to historical lake levels fluctuations.

Mitigation measures

- Monitoring of Lake Naivasha water levels should be done regularly as per is currently done.

1.5.9 Impact on Air Quality

Geothermal power station release carbon dioxide and methane known to be greenhouse gases; nevertheless, this development is expected to result in no impact on the local climate.

The emission levels for carbon dioxide generated by geothermal stations are relatively low compared to coal fired power plant. An equivalent amount of electrical energy delivered by a coal-fired power station, with 37 per cent efficiency burning black coal with calorific value of 23 MJ/kg and carbon content of 65 per cent, would result in the emission of approximately eleven times as much (964 027 tonnes) of carbon dioxide. Nevertheless, the quantities of these gases emitted will be substantially less than from a fuel-burning power station of a similar capacity. The amount of methane emitted is estimated to be 119 tonnes per year for the two power stations generating 150MW for one year.

(a) Air Dispersion assessment of effects

To assess the effects of the developments a number of operating cases have been modelled. Four development cases (Cases 1 to 4) have been modeled for Olkaria. These shows the expected air pollution effects of each case for 1-hour, 24-hour and one-year averaging periods. Each case represents the cumulative effects of all power stations expected to be operating for the particular case.

The modelling cases are as follows:

- Case 1 – Operations include Olkaria I, Units 1, 2, 3, 4, 5 and 6 plus Olkaria II, Units 1, 2 and 3 plus the 4.7 MWe well-head power plant at OW37. The total installed capacity is 364.7 MWe.;

- Case 2 – operations include all emission sources that apply for Case 1; but with the following assumptions:

    a) Olkaria I has been refurbished with new Units 1, 2 and 3 rated at 15 MWe each;
    b) The non-condensable gases are released in new cooling towers with similar characteristics to those used for Olkaria II;
    c) Olkaria IV, Units 1 and 2 are operating as new well-head power plants at OW43 and OW914 and have an installed capacity of 545.3 MWe.

- Case 3 – makes the assumption that all Case 2 emissions are operating and that Olkaria V, Units 1 and 2 are operational. The total installed capacity is 685.3 MWe.
- Case 4 – makes the assumption that all Case 3 emissions are operating and that Olkaria VI, Units 1 and 2 are operating. The total installed capacity is 825.3 MWe.

Note that the actual emission rate figures will depend on the chemistry of the well-fields and should be reviewed as this information becomes available.

The results are presented in Figures 7-2 to 7-14 as follows

- Predicted maximum 1-hour average hydrogen sulphide concentrations for Case 1 operations - ppm;

The maximum predicted 1-hour average hydrogen sulphide concentrations was 4.78 ppm, which was predicted to occur at 200.450 km East and 9900.612 km North (Arc 1960 coordinates).

- Predicted maximum 24-hour average hydrogen sulphide concentrations for Case 1 operations - ppm;

It can be seen that the WHO 24-hour guideline of 0.1 ppm is predicted to be exceeded in the high ground to the northwest of Olkaria I and northeast of Olkaria II. There are no residential areas located within the 0.1 ppm 24-hour average contour.

- Predicted annual average hydrogen sulphide concentrations for Case 1 operations - ppm;

It is suggested that an assessment criterion of 0.03 ppm should be used to assess annual average hydrogen sulphide concentrations.

- Predicted maximum 1-hour average hydrogen sulphide concentrations for Case 2 operations - ppm;

The maximum predicted 1-hour average hydrogen sulphide concentrations was 6.39 ppm which was predicted to occur 201.116 km East and 9903.609 km North (Arc 1960 coordinates). This is in the area close to the well-head power station at OW43. It seems likely that this is due to the proximity of the elevated terrain that rises steeply to the north of this emission source.

- Predicted maximum 24-hour average hydrogen sulphide concentrations for Case 2 operations - ppm;

It can be seen that the WHO 24-hour guideline of 0.1 ppm is predicted to be exceeded in several disconnected areas. Most of these are associated with the high ground to the northwest of Olkaria I and northeast of Olkaria II and around OW914. There are no residential areas located within the 0.1 ppm 24-hour average contours. It is interesting that the relative small well-head power station makes a disproportionate contribution to ground-level concentrations of hydrogen sulphide. This is a result of the less buoyant plumes from these sources compared with the larger power stations.

- Predicted annual average hydrogen sulphide concentrations for Case 2 operations - ppm;

No commercial agricultural enterprises areas are predicted to experience annual average concentrations above the 0.03 ppm level.

- Predicted maximum 1-hour average hydrogen sulphide concentrations for Case 3 operations - ppm;

- Predicted maximum 24-hour average hydrogen sulphide concentrations for Case 3 operations - ppm;

This appears to be caused by the emissions from OW914 impinging on the elevated terrain that rises steeply to the north of this emission source.

- Predicted annual average hydrogen sulphide concentrations for Case 3 operations – ppm;

In this model, the WHO 24-hour guideline of 0.1 ppm is predicted to be exceeded in several disconnected areas. Most of these are associated with the high ground to the northwest of Olkaria I and northeast of Olkaria II and around OW914 and Olkaria IV. There are no residential areas located within the 0.1 ppm 24-hour average contours.

- Predicted maximum 1-hour average hydrogen sulphide concentrations for Case 4 operations – ppm;

- Predicted maximum 24-hour average hydrogen sulphide concentrations for Case 4 operations – ppm;

In this model, the WHO 24-hour guideline of 0.1 ppm is predicted to be exceeded in several disconnected areas around power stations. There are no residential areas located within the 0.1 ppm 24-hour average contours.

- Predicted annual average hydrogen sulphide concentrations for Case 4 operations – ppm.

No agricultural enterprises are predicted to experience annual average concentrations above the 0.03 ppm level.

Many of the power plants have multiple emission points and the total number of points modeled in each case and the total estimated emission rate of hydrogen sulphide is shown below:

- Case 1– 28 emission points, 120 g/s
- Case 2– 51 emission points, 193 g/s
- Case 3–59 emission points, 250 g/s
- Case 4 – 67 emission point, 307 g/s.

Figure 1-1 Predicted maximum 1-hour average H2S concentrations for Case 1

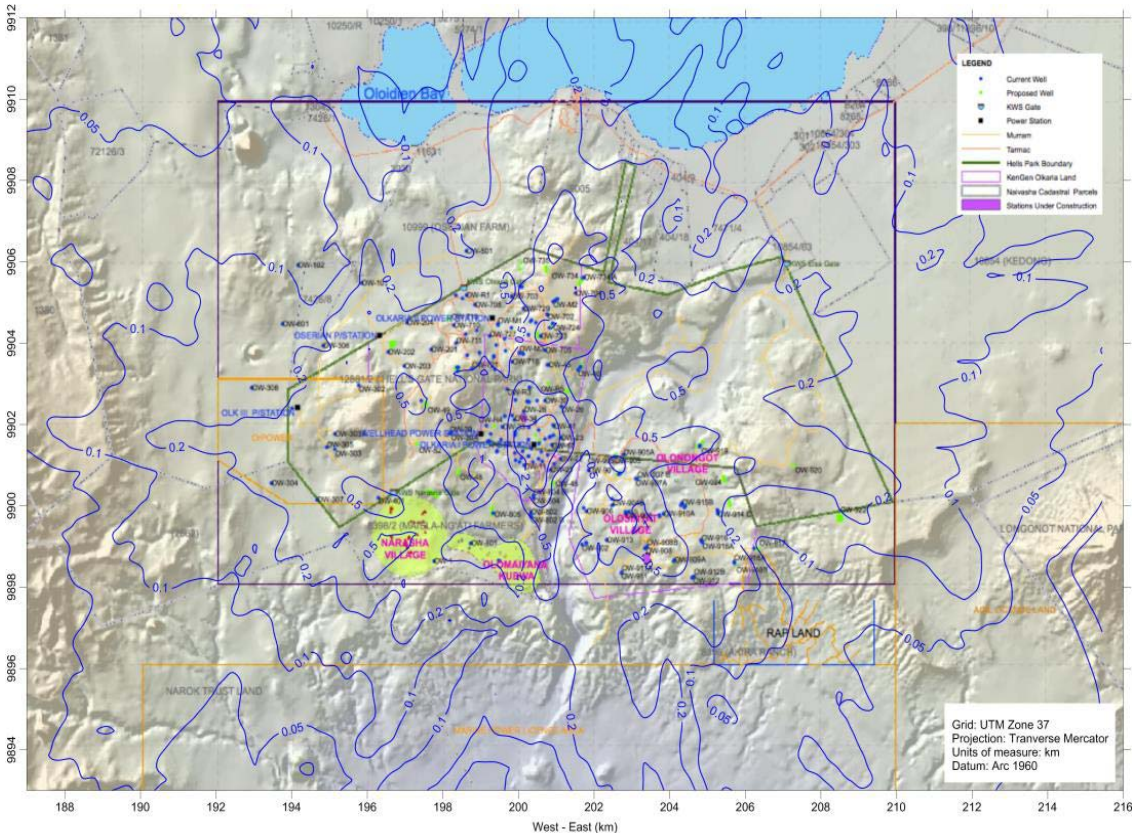


Figure 1-2 Predicted maximum 24-hour average H_2S concentrations for Case 1

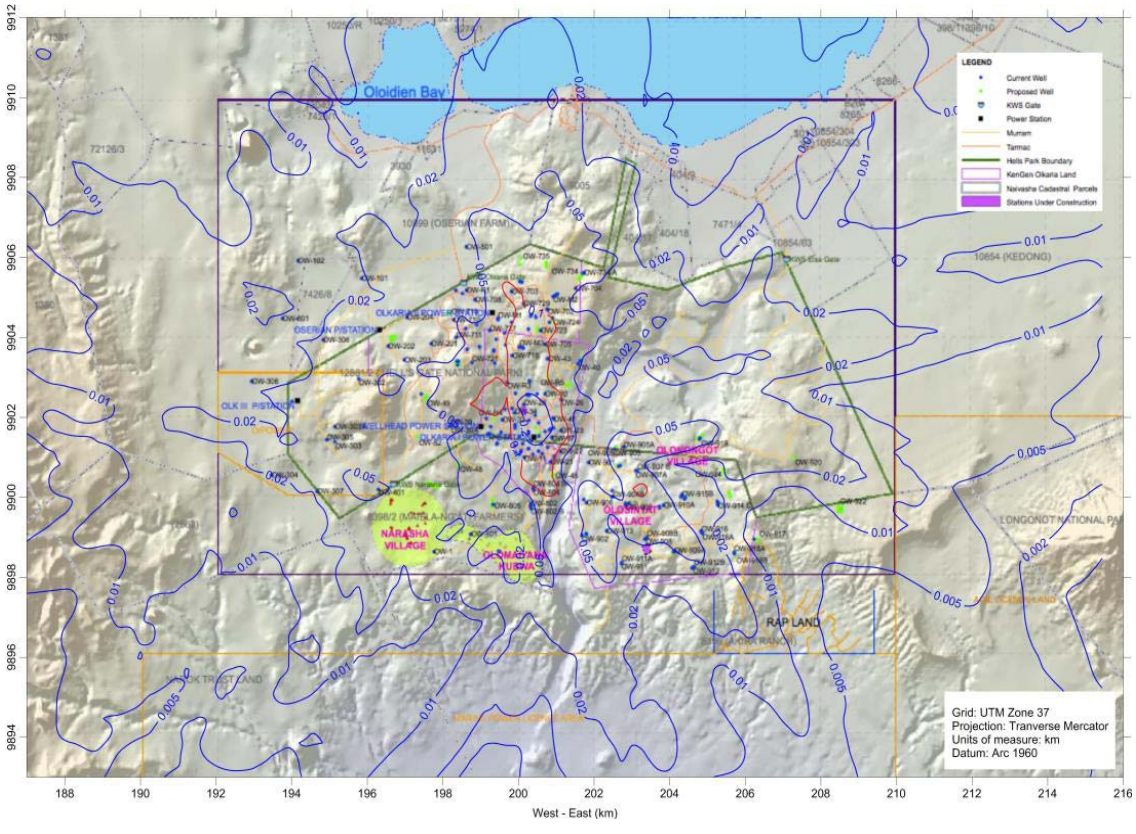


Figure 1-3 Predicted annual average H_2S concentrations for Case 1

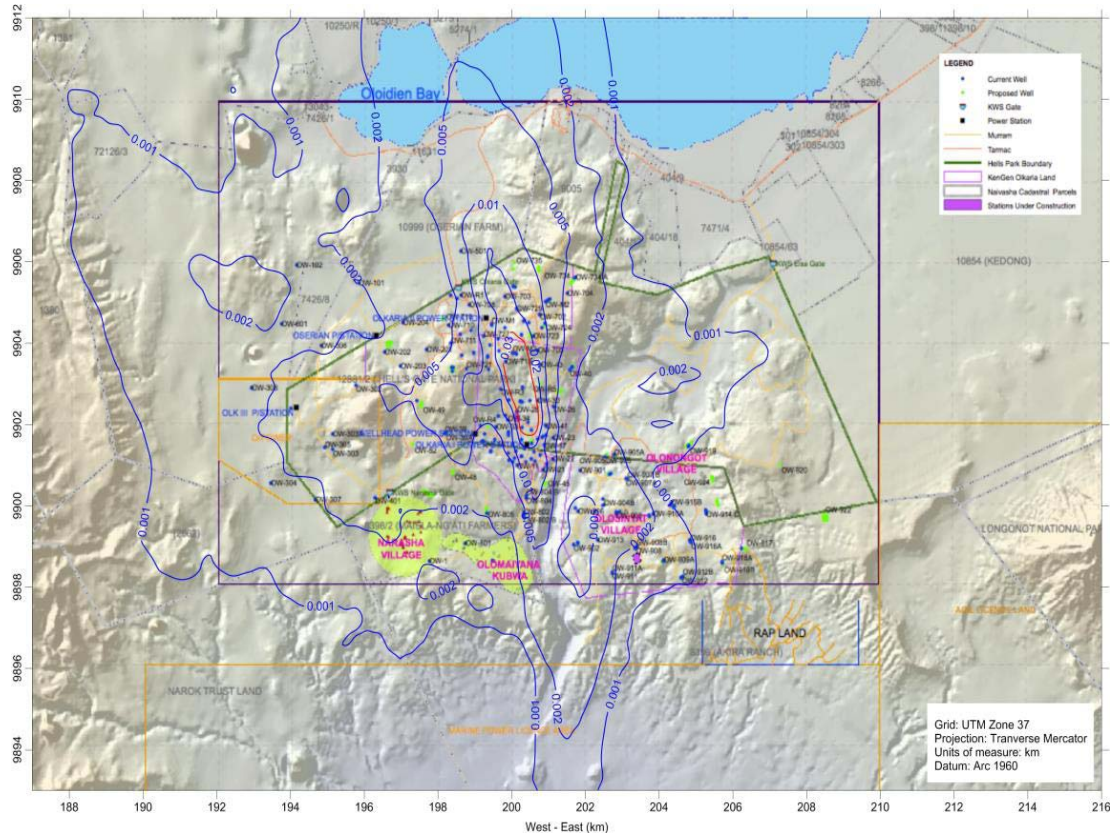


Figure 1-4 Predicted maximum 1-hour average H_2S concentrations for Case 2

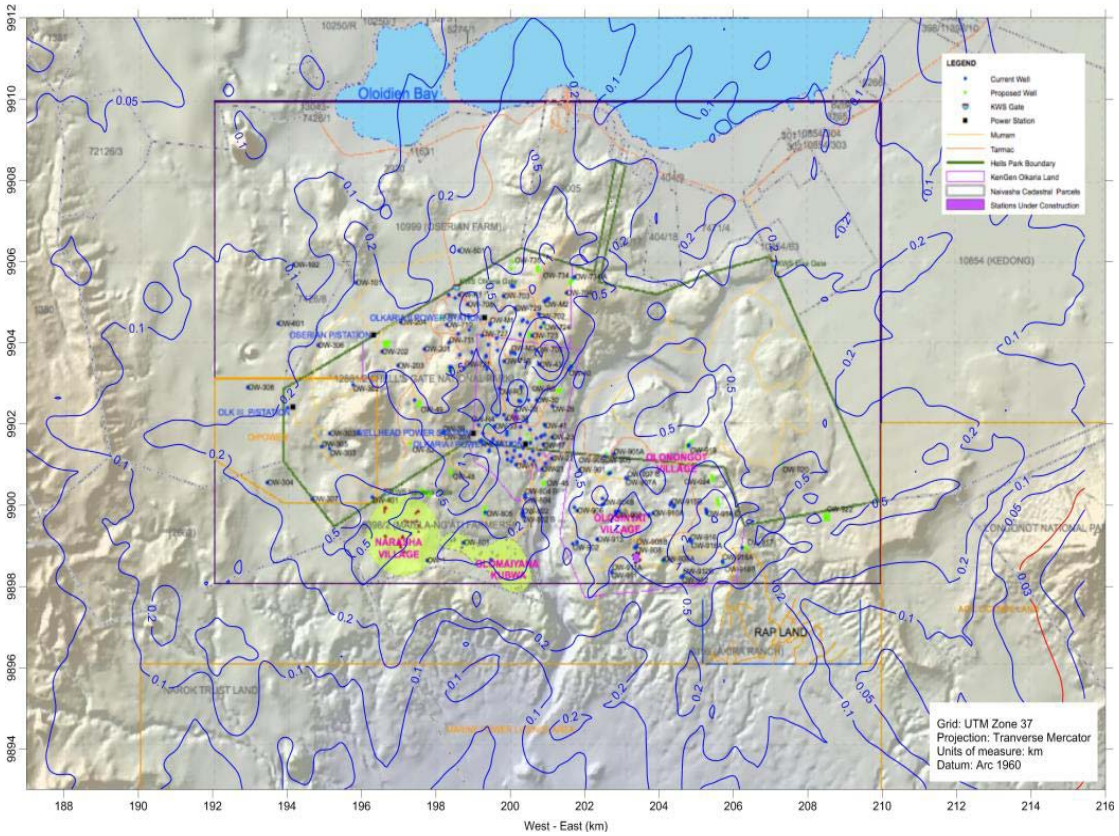


Figure 1-5 Predicted maximum 24-hour average H_2S concentrations for Case 2

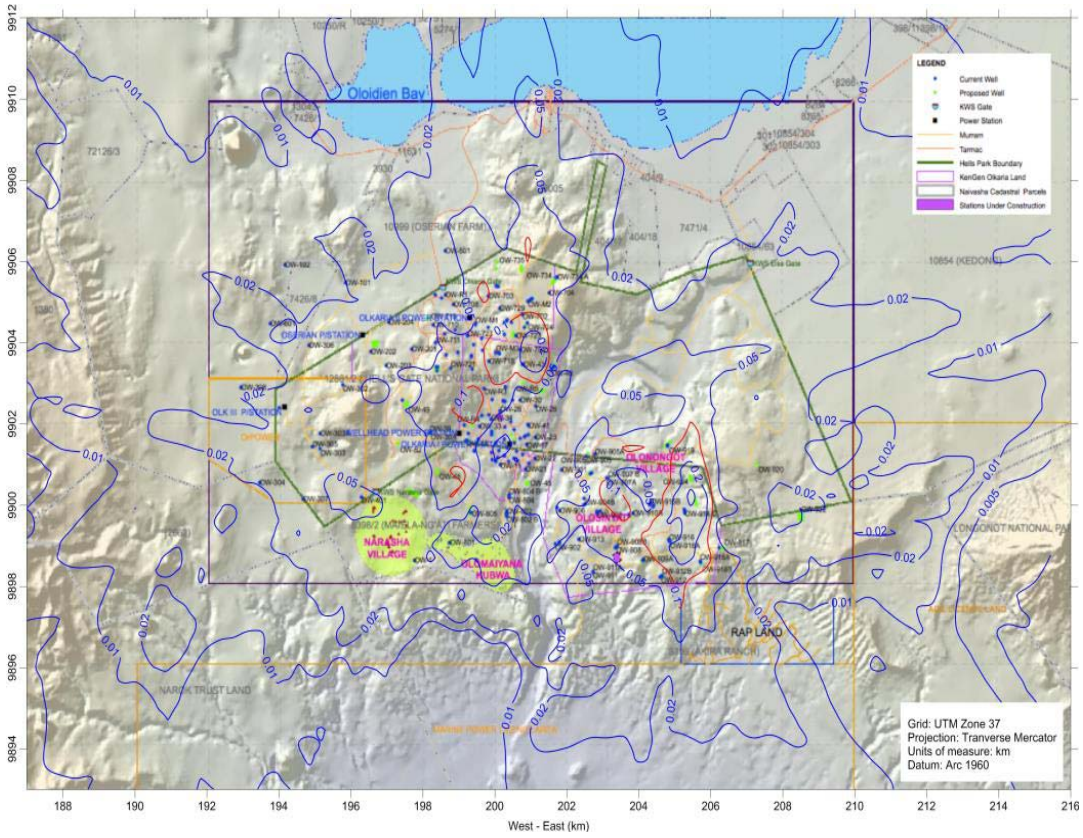


Figure 1-6 Predicted annual average H_2S concentrations for Case 2

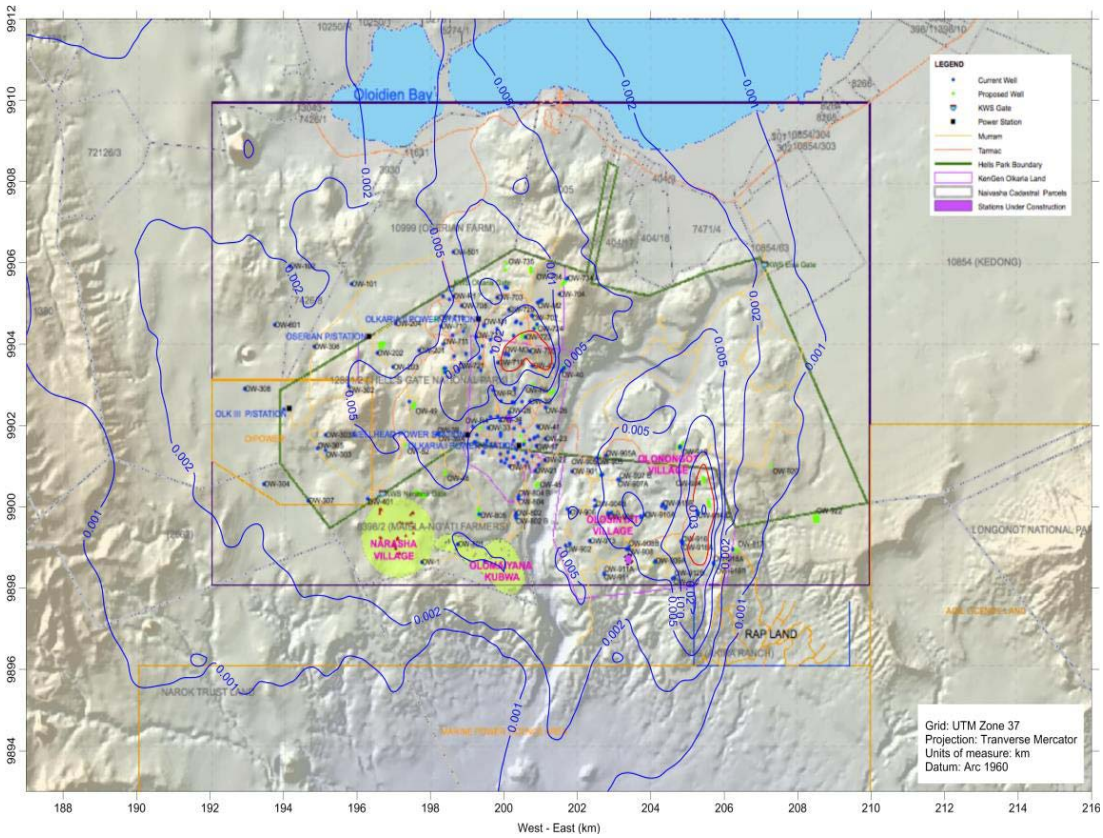


Figure 1-7 Predicted maximum 1-hour average H_2S concentrations for Case 3

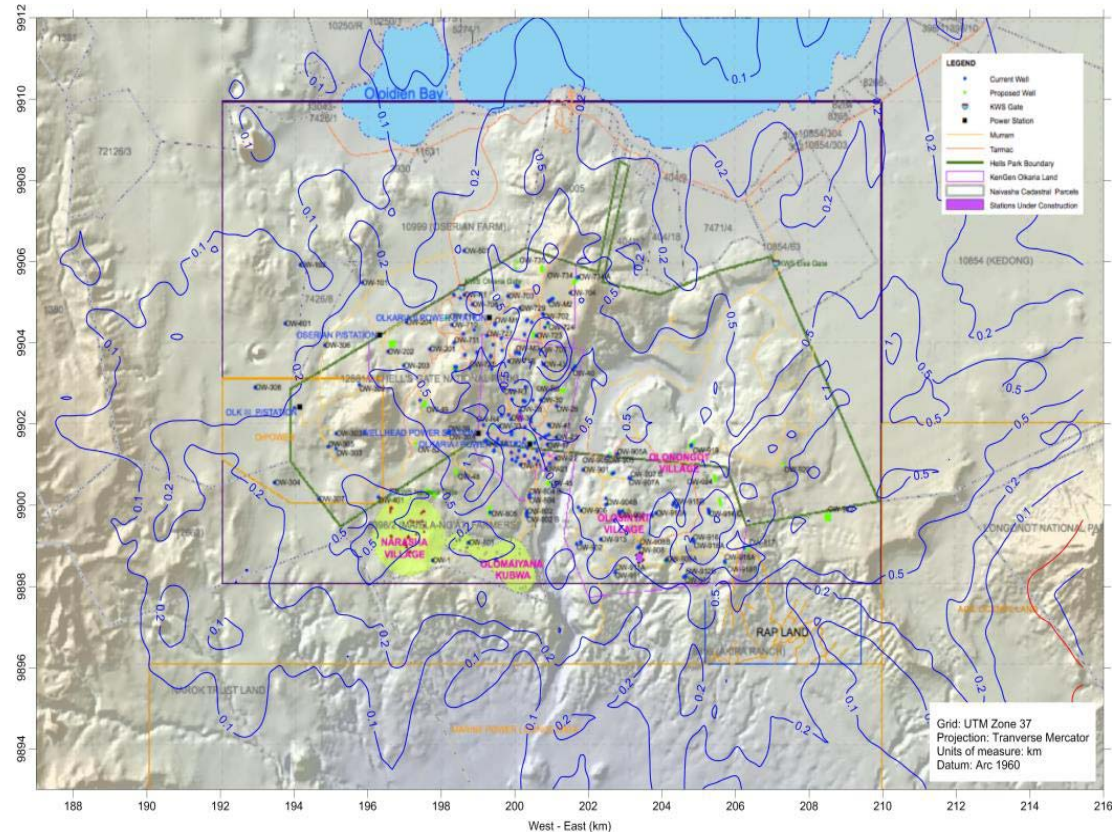


Figure 1-8 Predicted maximum 24-hour average H_2S concentrations for Case 3

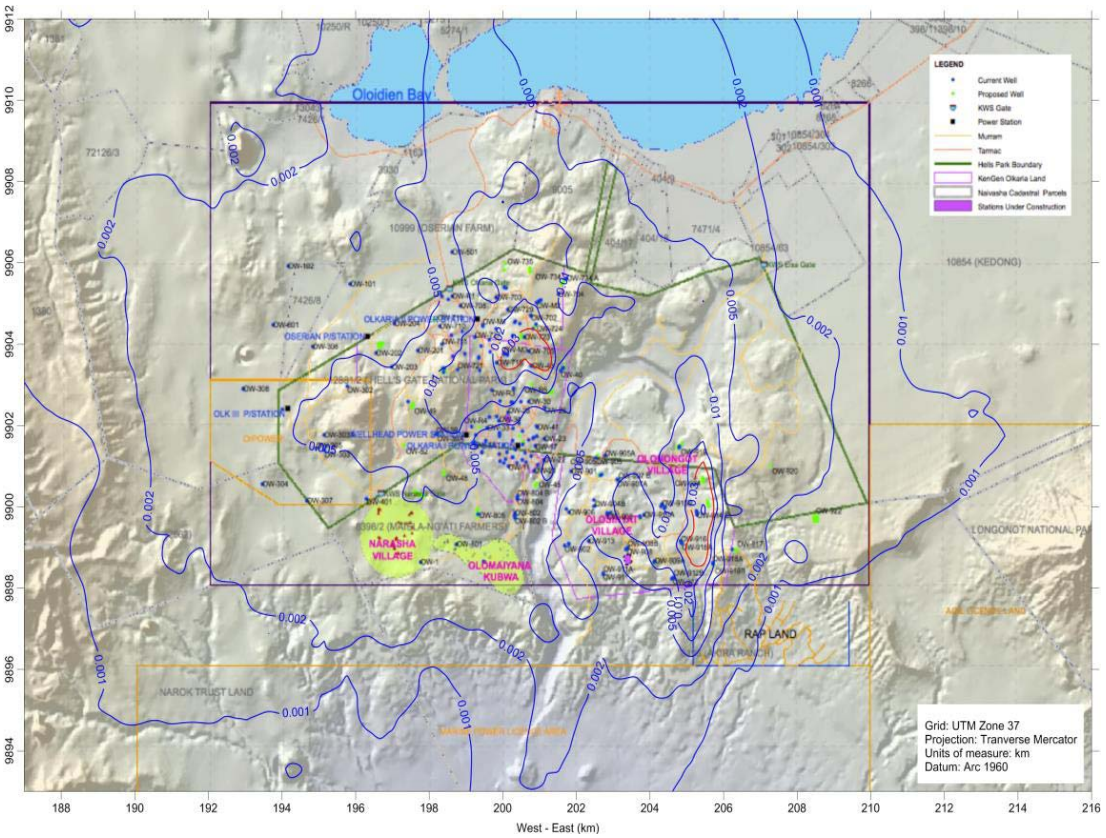


Figure 1-9 Predicted annual average H_2S concentrations for Case 3

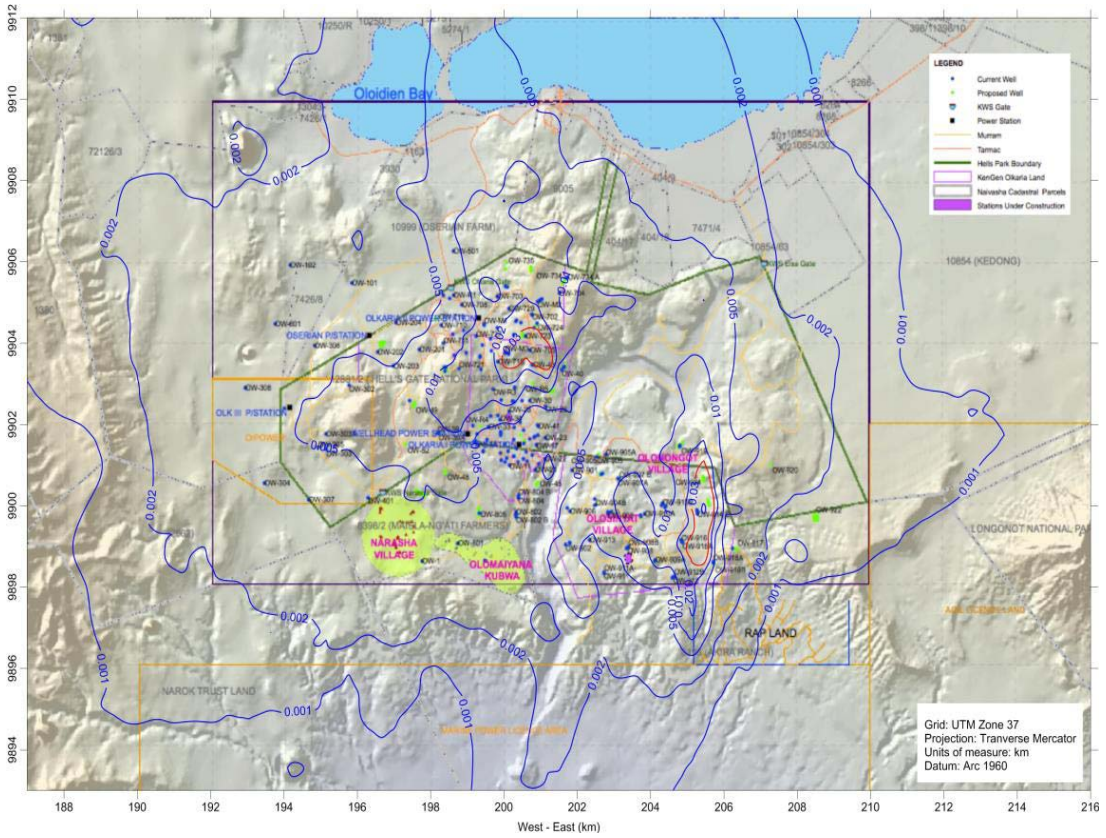


Figure 1-10 Predicted maximum 1-hour average H_2S concentrations for Case 4

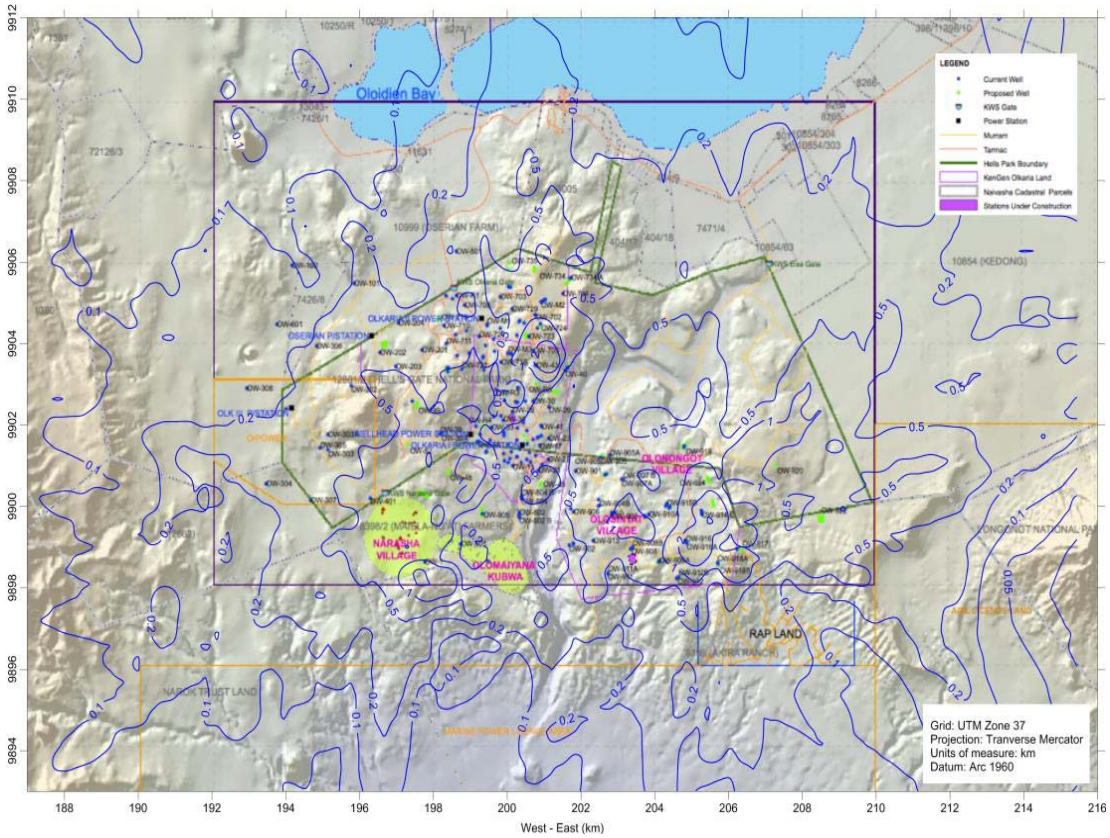


Figure 1-11 Predicted maximum 24-hour average H_2S concentrations for Case 4

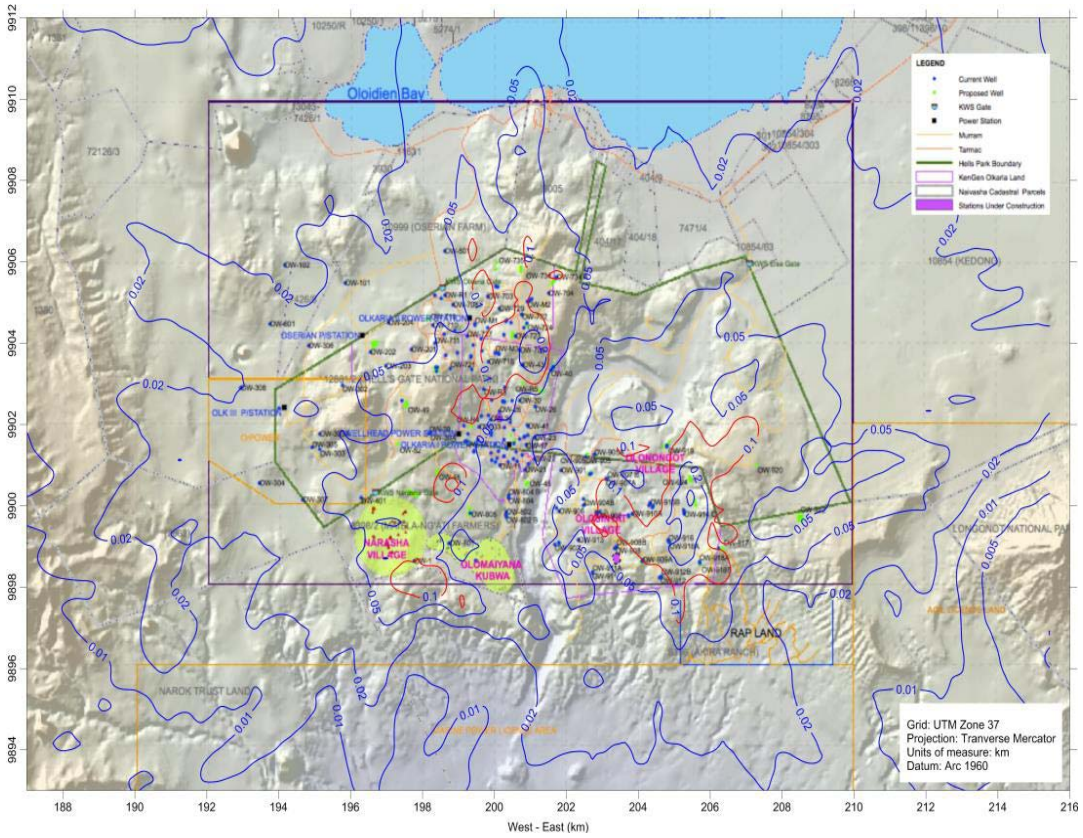


Figure 1-12 Predicted annual average H_2S concentrations for Case 4

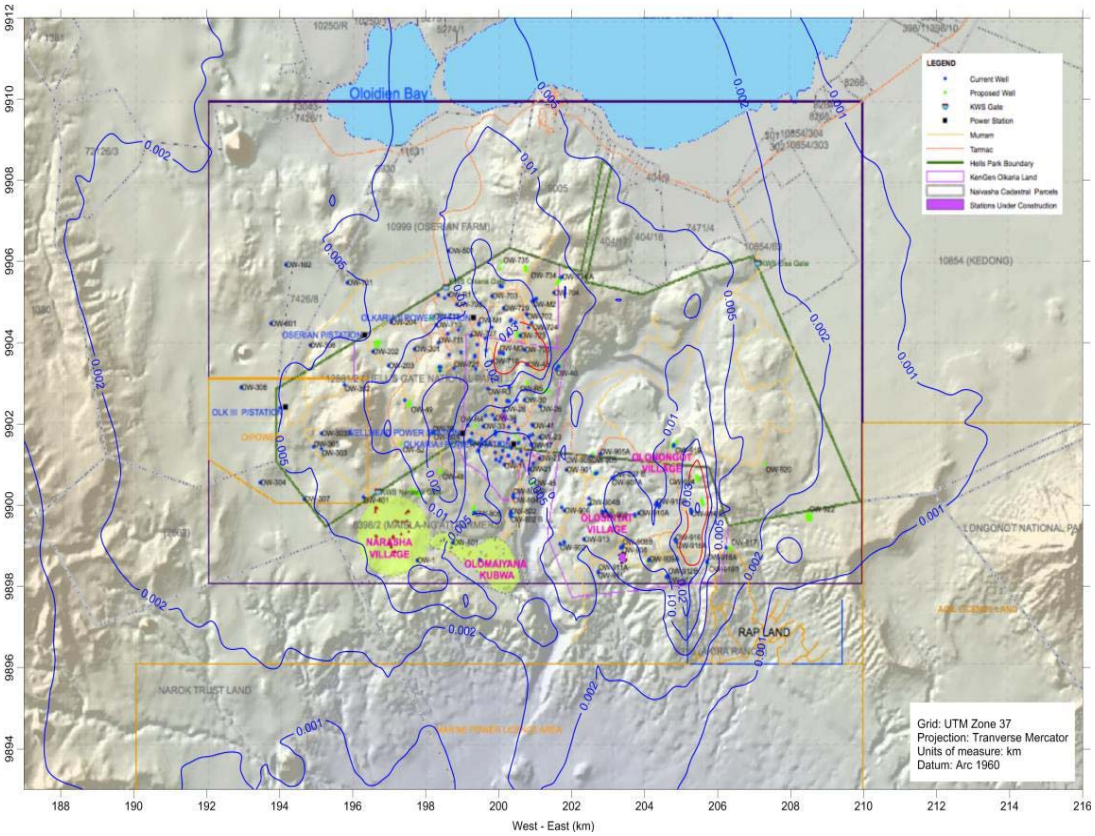
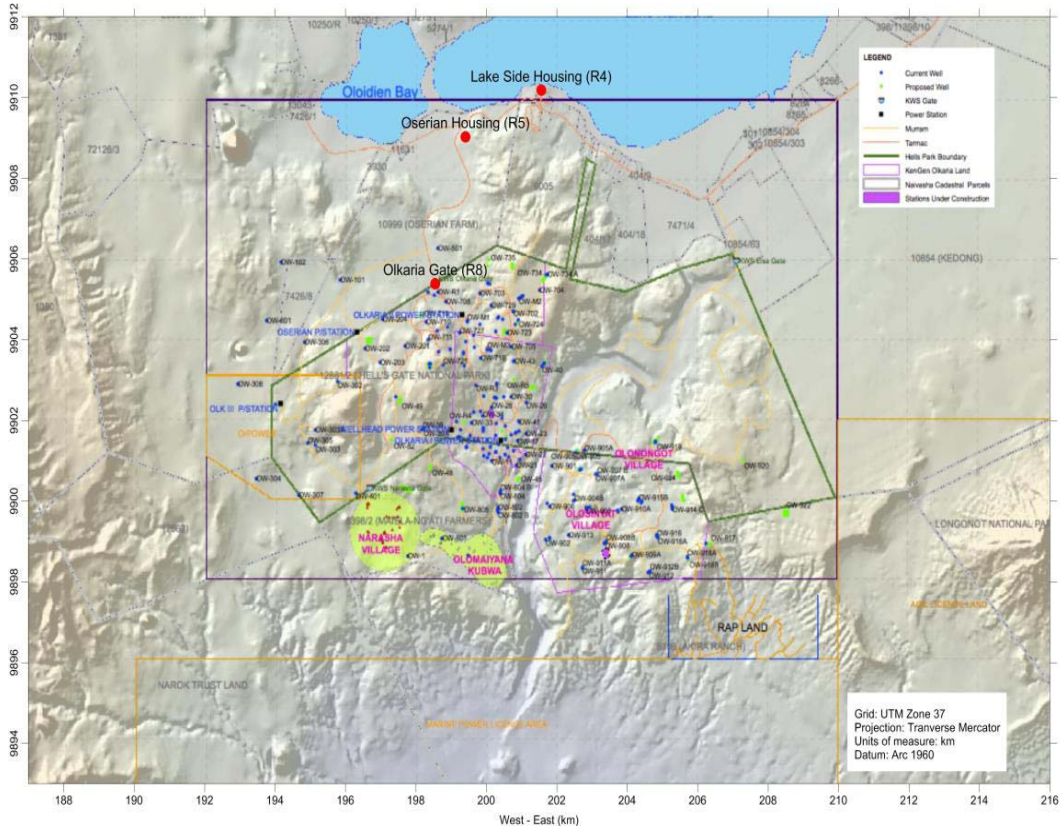


Figure 1-13 Location of sites selected to show cumulative frequency distribution



Mitigation measures

- Situate automatic H_2S sensors around the plant;
- Ensure cooling towers are sited properly;
- Put up additional monitoring stations for precipitation chemistry;
- Monitor changes in geothermal development technology and adopt, if necessary;
- Daily Monitoring of H_2S will be carried out;
- Educate workers on the dangers of exposure to H_2S.

1.5.10 Impact of Noise Levels

To assess the effects of the developments a number of emission scenarios have been described, as follows:

Case 1 - noise emissions for operations from:

- the existing Olkaria I, Units 1, 2 and 3
- Olkaria I, Units 4 and 5 (which are under construction at the time of writing)
- the proposed Olkaria I, Unit 6
- the existing Olkaria II, Units 1, 2 and 3
- the existing 4.7 MWe well-head power plant at OW37.

The red 35 dB(A) contour on Figure 7-14 show the area where the noise levels exceed the NEMA nighttime noise limit. The modeling shows that there are residential areas the noise level is predicted to exceed 35 dB(A).

Case 2 - the operations include all the noise sources that occurring in Case 1, but assumes that:

- Olkaria I has been refurbished with new Units 1, 2 and 3 rated at 15 MWe each.

- Olkaria IV, Units 1 and 2 are operating as are new well-head power plants at OW43 and OW914.

It is interesting that the area affected by noise levels above 35 dB(A) is slightly reduced, because the gas ejector noise is reduced. There are still some residential areas affected by LAeq-10h above 35 dB(A).

Case 3 - Assumes that all Case 2 emissions are operating and that Olkaria V, Units 1 and 2 are operational.

Eight residential areas are affected by noise levels above 35 dB(A).

Case 4 - Assumes that all Case 3 emissions are operating and that Olkaria VI, Units 1 and 2 are operating.

Eleven residential areas are predicted to be affected by noise levels above the NEMA nighttime 35 dB(A) limit.

Figure 1-14 Predicted LAeq-10h noise levels due to power stations in Case 1

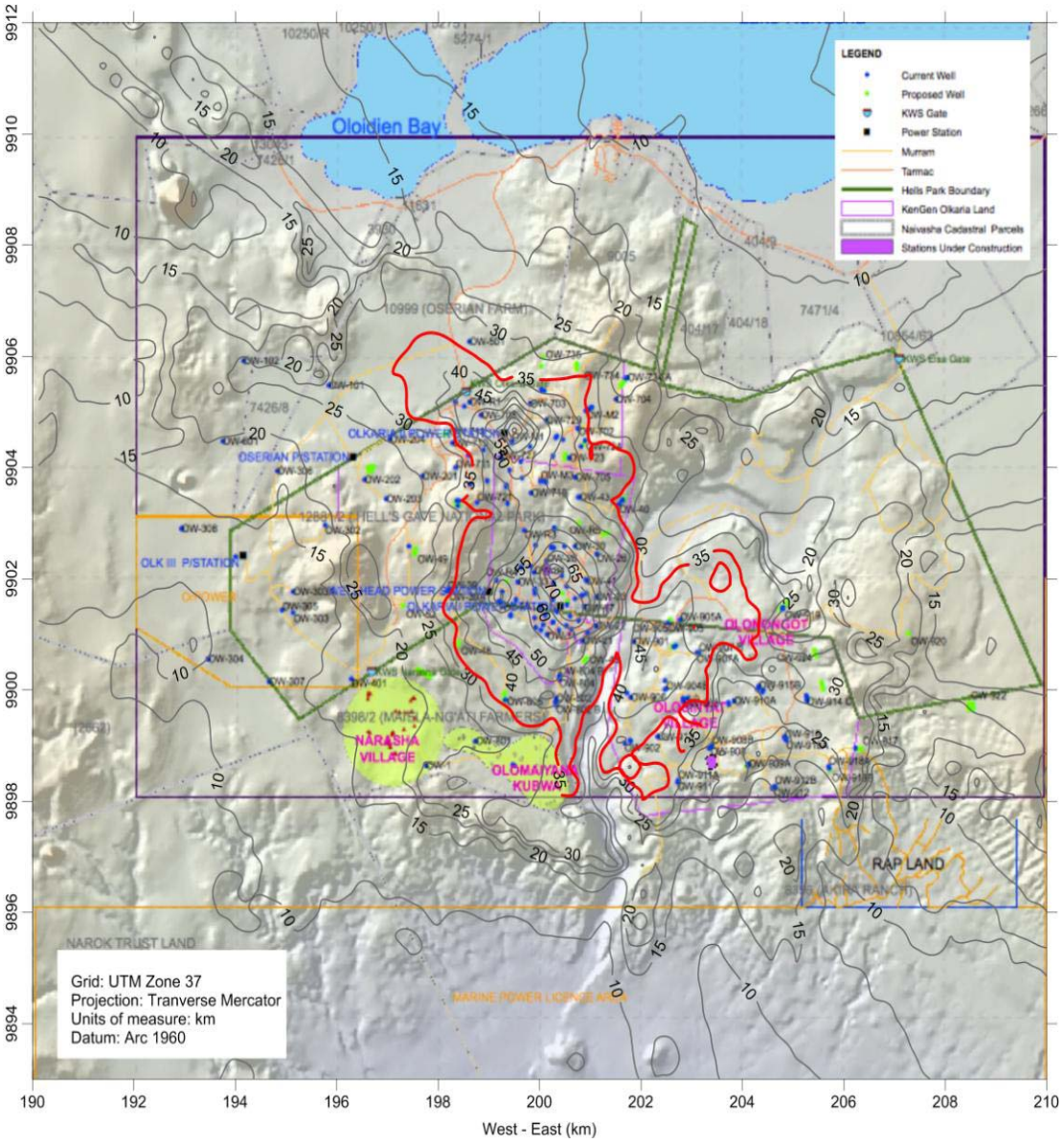


Figure 1-15 Predicted LAeq-10h noise levels due to power stations in Case 2

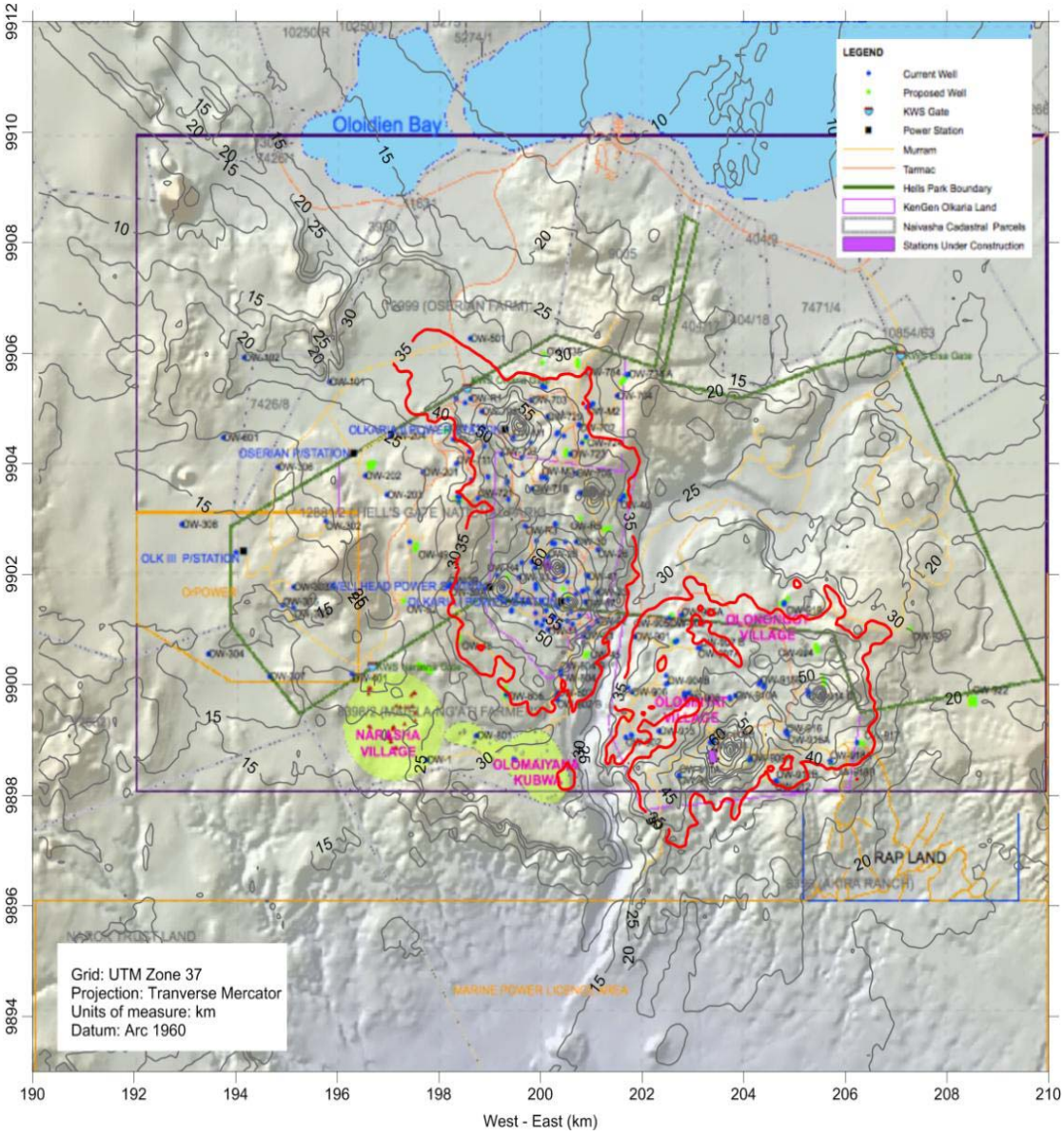


Figure 1-16 Predicted LAeq-10h noise levels due to power stations in Case 3

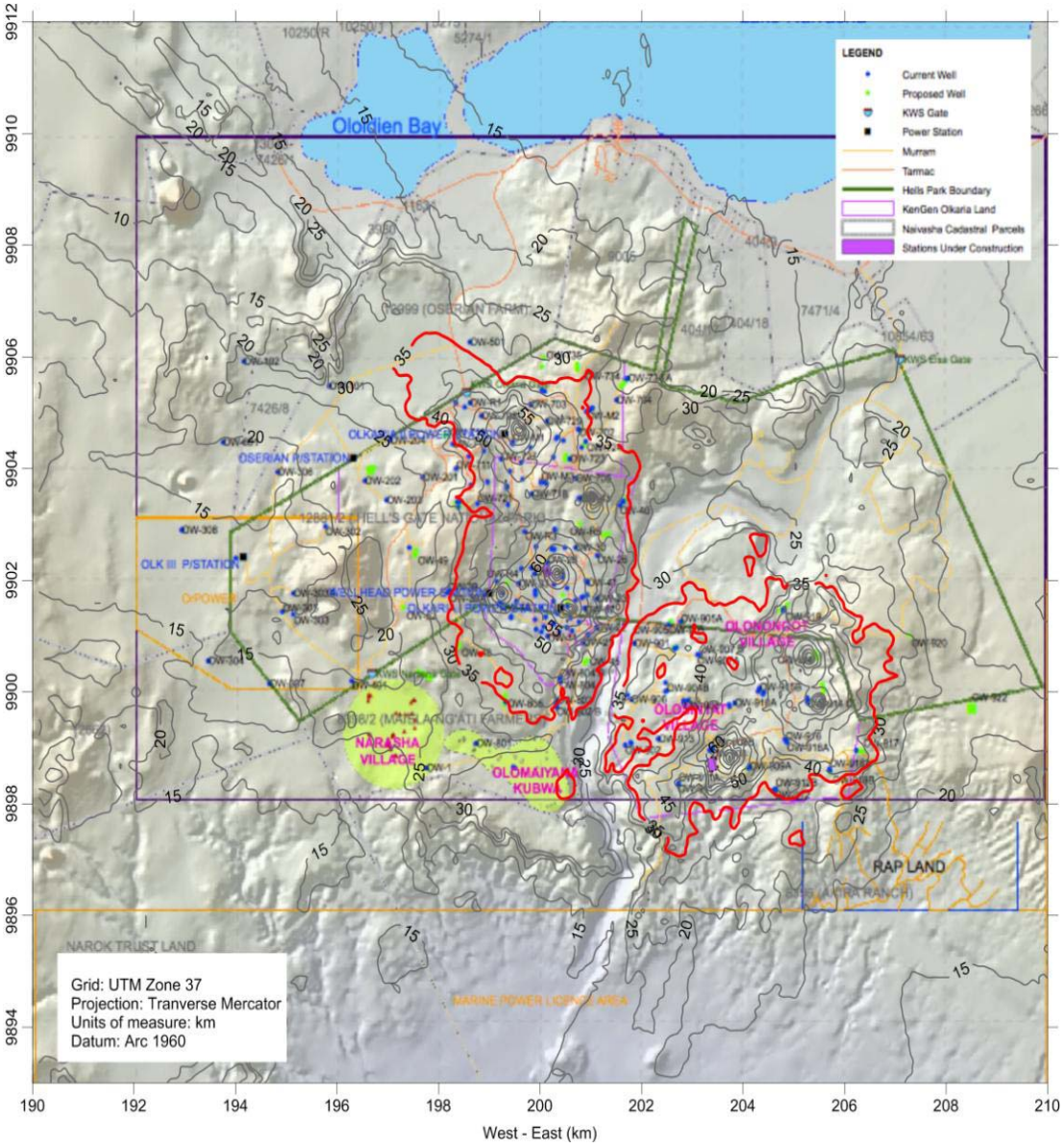


Figure 1-17 Predicted LAeq-10h noise levels due to power stations Case 4

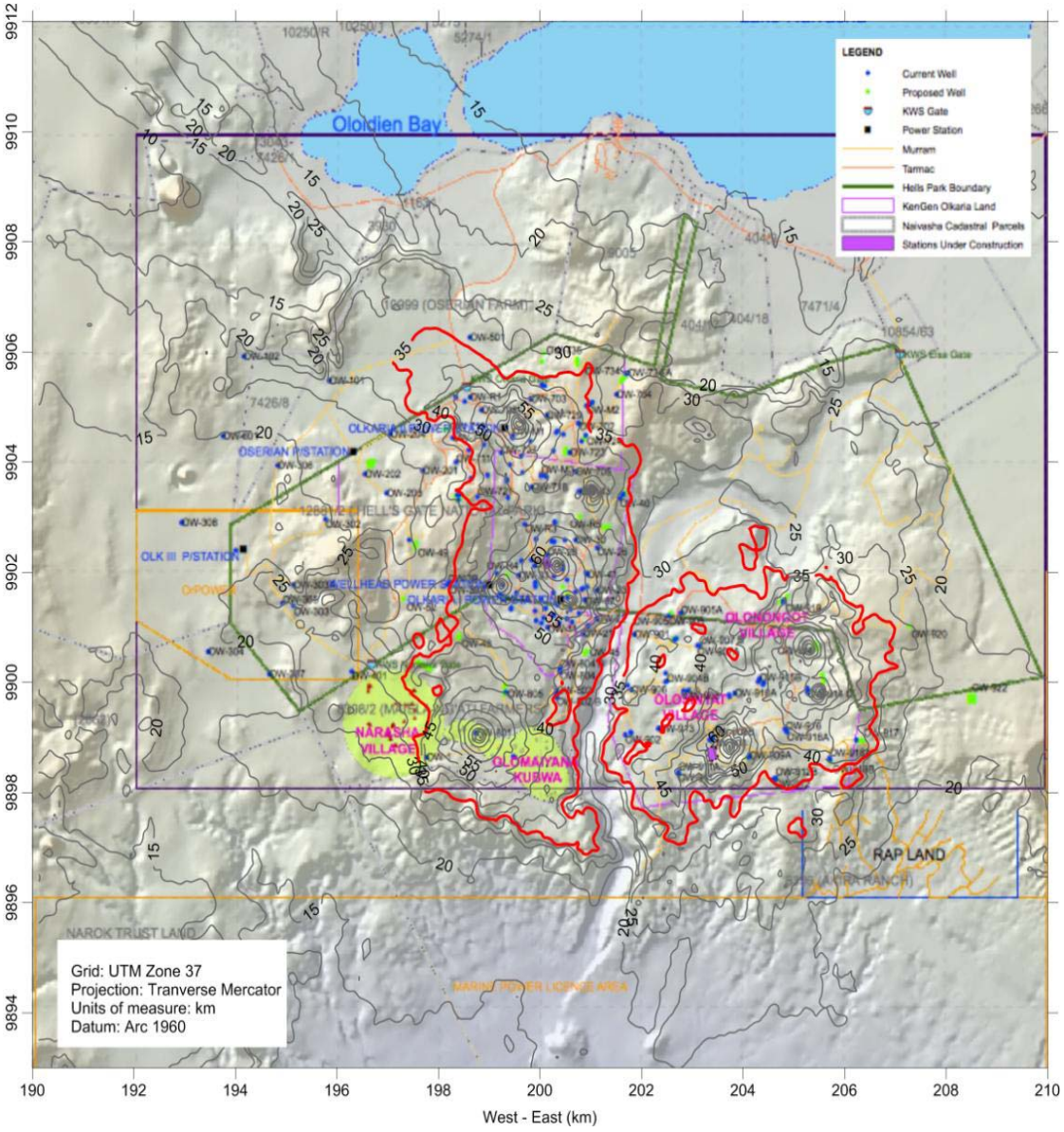
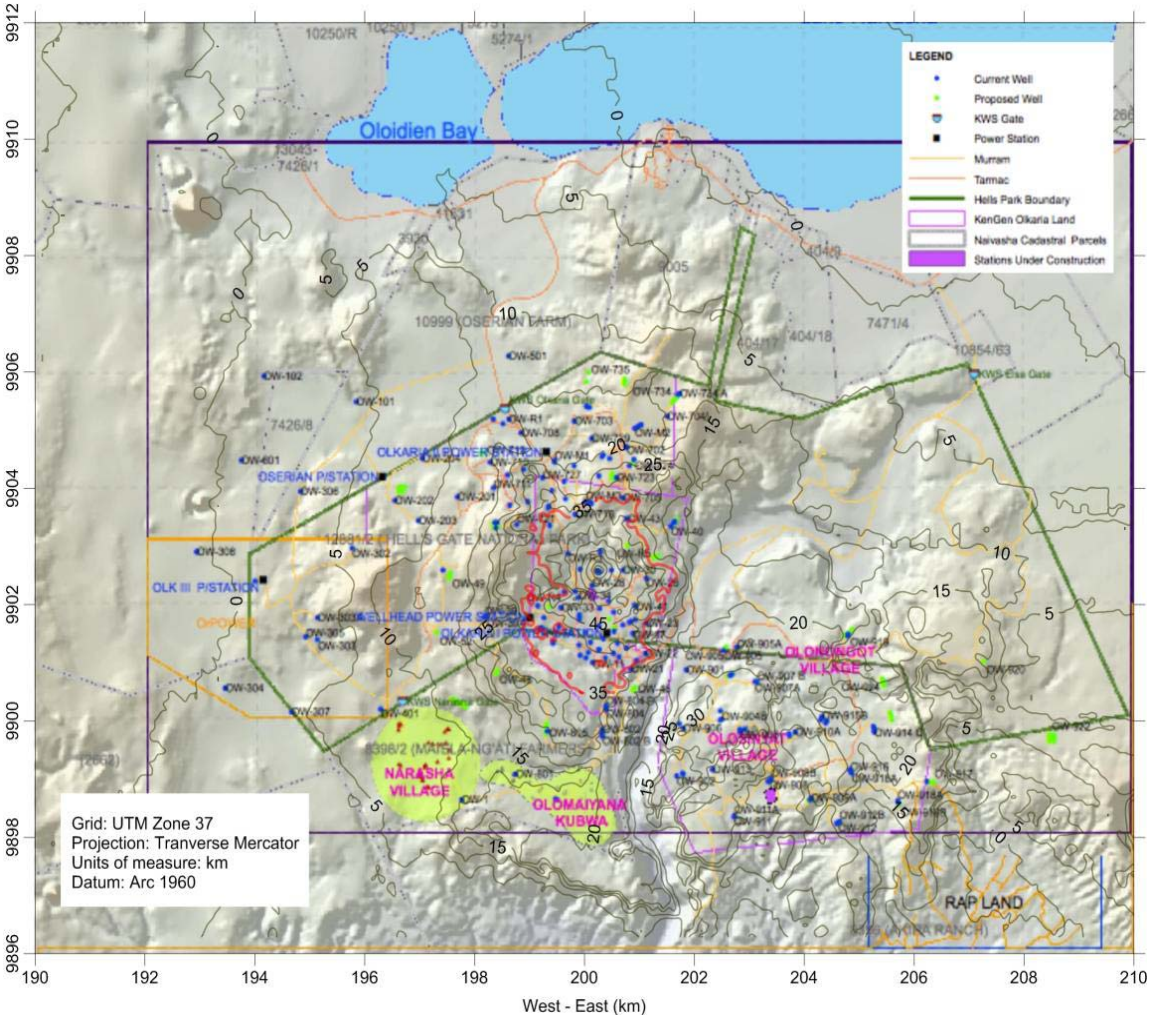


Figure 1-18 Predicted noise effects of a well under test (based on OW28) - dB(A)



The red contour shows the 35 dB(A) LAeq-10h noise level. Land within this contour is affected by noise levels above the 35 dB(A) maximum permissible nighttime limit. It can be seen that the local topography around the well would affect the shape but broadly speaking the affected land extends up to approximately 1.5 km from the well.

Mitigation measures

- Provision of appropriate PPE's to the workers including ear plugs and ear muffs;
- Daily noise level monitoring will be conducted.
- Conduct health surveillance of workers which shall include audiometric test for the power plant operators at least once in a year.
- Post at strategic positions signage's in identified noise hazardous areas.
- Ruptured ejectors in the power plant should be reinstated as soon as possible.
- Sensitization and education of workers and visitors on the need to use PPE provided

1.5.11 Fire Risk

With the installation of the power plant and related substations and transmission lines, there is likely to be a fire risk.

Mitigation measures

- A fire protection system of fire water tanks, fire extinguishers, fire hydrants, hose reels, fire alarms and sprinklers;
- Formulate a fire emergency response plan;
- Ensure no smoking signage is put up in the necessary areas;
- Train some staff to be fire marshals;
- Carry out fire drills -Inspect fire fighting equipment.

1.5.12 Oil / Hazardous pollution

During plant operation, hydrocarbons such as solvents, coolants, acids, and, alkalis will be used.

Mitigation measures

- Spill and drip trays used during servicing of machinery
- Use septic tanks while ensuring doesn't flow to the surface
- Response plans for accidental spills to be formulated and routinely tested
- Bunded storage areas and secondary containment for oil and chemicals
- Use of an oil interceptor in the plant
- Place hazardous materials up to 2 kilometres away from the top water level of public water supply reservoirs such as Lake Naivasha. Also avoid placing within flood levels;
- Storage of fuel and other flammable materials shall comply with standard fire safety regulations;
- A secured compound shall be provided for storage tanks for chemicals and fuel. All chemicals and fuels shall be stored with manufacturer's instructions in mind as per the material safety data sheets;
- Storage areas or secondary containment shall be constructed of waterproof reinforced concrete or approved equivalent, which is not adversely affected by contact with chemicals captured within them;
- The minimum volume for secondary containment shall be 110% of the capacity of the largest tank system, plus 10% of the total capacity of all other separate tanks and containers within the bund wall with closed valves for controlled draining during rains;
- Pipe-work carrying product from the tank to facilities outside the containment shall be provided with secondary containment;
- Tank equipment such as dispensing hoses, valves, meters, pumps, and gauges shall be located within the containment or provided with own containment.

1.5.13 Impacts of Fuel and Chemical Storage on Site from the substation

Spilled chemicals can contaminate soil as well as pollute inshore waters and hazardous and flammable substances (e.g. diesel oil, paints, thinner, solvents, etc.) when improperly stored and handled on the site become potential health hazards for construction workers. It is anticipated that refueling and maintenance of large vehicles will take place on the construction site and that, correspondingly, there will be storage of fuel and lubricants on the site.

During the construction period for the Olkaria Substation and transmission line, oil spills may occur.

Mitigation measures

- KenGen should ensure that the employees on site are aware of the company procedures for dealing with spills and leaks from oil storage tanks for the construction machinery though induction and safety training;
- In case of spillage the KenGen should isolate the source of oil spill and contain the spillage using sandbags, sawdust, absorbent material and/or other materials approved by NEMA;
- KenGen should ensure that there is always a supply of absorbent material such as

saw dust on site during construction, readily available to absorb/breakdown spill from machinery or oil storage;

- All vehicles and equipment should be kept in good working order, serviced regularly and stored in an area approved site by KenGen;
- The KenGen should ensure that filling areas, Oil storage drums / products storage areas have a smooth impermeable (concrete or thick plastic covered in gravel) floor. The floor should be bunded and sloped towards a sump to contain any spillages of substances in accordance with *The Kenya Bureau of Standards (KEBS) KS 1969: 2006 The Petroleum Industry -The installation of underground storage tanks, pumps/dispensers and pipe work at service stations and consumer installations - Code of Practice.*

1.5.14 Occupation health and safety

Due to the fact that there are going to be staff working in different areas of the plant accidents may likely to occur within the plant area.

Mitigation measures

- Carry out Occupational Health and Safety audits
- Equip employees with necessary Personal Protective Equipment (PPE)
- Regular and induction training, of members of the safety committee and new staff respectively, on First Aid
- Ensure the plant and office blocks have adequate supply of First Aid Kits
- Location of safety signs around the plant
- Inspections on conditions of machinery and equipment -Register the plant as a workplace with DOSH

1.6 Negative Impacts during Decommissioning

Decommissioning will involve take out of the power plans and associated infrastructures after useful life. The notable adverse impact at this phase is leaving abandoned plant, equipment and buildings without any attempt to rehabilitate leading to the deterioration of habitat. Unplanned, careless and disorganised site decommissioning can result in interference of habitat. Site decommissioning will involve closure and removal of facilities and wells, including linear infrastructures such as roads and pipelines and finally vegetation restoration and landscaping. Vegetation can restore naturally through succession or intervened rehabilitation to achieve average status with the neighbouring area.

An additional problem is the abandoned wells (holes) which can be fall off for wildlife and human.

Negative impacts can be reduced by consideration in the planning stage of the design of some of the physical facilities and roads with the aim of transferring them to tourism and wildlife viewing circuits once the project is abandoned. Professional removal of plant and building will also ensure that no further loss of habitat and unnecessary disturbance of wild animals, which may have learnt ways of living alongside the project during its operation period. After the removal of plant, revegetation should be encouraged to increase the rate of recovery. Landscaping should be integral of the revegetation to allow spatial continuity and harmony - monitoring should be done to avoid invasive and opportunistic species from taking over.

It is not easy to underscore the severity of the negative impacts during decommissioning however it is safe to anticipate that all the impacts will be severe and to the scale of 5.

2 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The Environmental Social Management Plan (ESMP) is developed to demonstrate how site specific concerns and mitigation measures are managed through the detailed design, pre-construction, construction and post-construction / operation phase of the Project.

The ESMP has been prepared based on the information collected and/or collated to date. The proposed site for construction, material disposal and management have been identified; while exploration of production wells is on going to achieve the sufficient steam capacity.

As a progressive approach, the components of the ESMP may require updating throughout the initiation and scheduling of plans for the project. Thus, this is a working document subject to amendments whenever new information is received or site conditions change.

To ensure that the negative environmental impacts can be controlled and mitigated effectively, a stringent and scientific management and monitoring plan has been prepared. The ESIA proposes that KenGen enhances its capacity of the Geothermal Resource Development (GRD) Environment, Safety and Liaison Section at Olkaria both during the construction and operation phases of the project to be able to cope up with additional challenges emanating from this project. This will ensure that all the targets are achieved and that the environmental responsibilities and obligations of ESIA and the respective geothermal stations and sections are satisfied during project implementation. The Section will principally be charged with the responsibility for monitoring implementation of the environmental management and monitoring plan in conjunction with consultants, contractors and sub-contractors.

2.1 Auditing of the ESMP

To ensure that the ESMP implementation is effective, daily inspections and predefined audits will be undertaken by the Geothermal Resource Development - Environment, Safety and Liaison Section at Olkaria. The Inspection and audits shall check that a procedure is in place to ensure that:

- Site incident register (on spills, injuries, complaints, legal transgressions, spot fines and penalties etc) is maintained in keeping with the ESMP;
- Document deviations, non-conformance and corrective actions on the ESMP;
- The updated version of the ESMP is used;
- Site personnel are equipped with appropriate training;
- Emergency procedures are in place and effectively communicated to personnel;
- Ensure that appropriate corrective and preventive action is taken by the Contractor once instructions have been issued.

2.2 Responsibilities of the ESMP

2.2.1 Responsibilities

In order to ensure the sound development and effective implementation of the ESMP, it will be necessary to identify and define the responsibilities and authority of the various persons and Organizations, who will be associated with the project. The following entities should be involved in the implementation of this ESMP:

- KenGen's top management;
- GRD Environment Safety and Liaison Section;
- Contractor and Subcontractors;

- Nakuru County Government
- NEMA
- Project Consultant.

(a) KenGen

It will be the responsibility of KenGen to oversee or appoint qualified and competent team to oversee the construction and operational phases of the Project. This team shall form part of the project implementation team (PIT)

An ecologist staff with an environmental background is recommended to strengthen the oversight functions of the project.

(b) The GRD Environment, Safety and Liaison Section

The GRD Environment, Safety and Liaison Section will be required to oversee the construction programme and construction activities performed by the Contractor and SubContractor, in compliance with the ESMP.

The PIT should co-ordinate all aspects of the environment during project implementation and operations. This should include following the construction to monitor, review and verify the implementation of the project's ESMP.

(c) The Contractor and Sub Contractors

The contractor and Sub Contractors will be required to comply with the requirements of the ESIA, the ESMP within this report and other relevant legislations.

(d) Line Government organs

The relevant departmental officers in the Government should be called upon where necessary during project implementation to provide the necessary permits and advisory services to the project implementers.

(e) NEMA

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

2.3 Environmental and Social Management during construction phase

2.3.1 Environmental and Social Management Plan

An Environmental and Social Management Plan (ESMP) is prepared as a logical framework within which the identified negative environmental and social impacts will be mitigated and monitored during the construction process of the development project.

The ESMP would identify means of verifications (reference documentation), objectively verifiable indicator (the approval required to complete that activity and the verification documentation to be produced as evidence of satisfactory completion). The ESMP would also identify where "hold points" would be required. These are where continuation of subsequent activity is prohibited unless a former activity has been signed-off. The ESMP would be broken down into various activities as listed in Chapter 4 will be undertaken.

2.3.2 Method Statements

Method statements would be completed on behalf of the Main Contractor or Sub Contractor by trained engineers or other appropriate experienced personnel, in consultation with on-site environmental and safety staff with input from environmental specialists (project consultants and environmental and safety manager). Their production would include a review of the environmental risks and commitments, as identified in the ESMP and risk assessment, so that appropriate control measures are developed and included within the construction process.

Method statements would be reviewed by the KenGen's Environmental Manager, the Main or Sub Contractor's appointed environmental manager and, where necessary, by an appropriate environmental specialist. Where necessary, all method statements would be submitted to the enforcement agencies (NEMA, KWS, Naivasha Municipal Council.) as appropriate. Method statements would contain as a minimum:

- Location of the activity and access/egress arrangements.
- Work to be undertaken and methods of construction.
- Plant and materials to be used.
- Labour and supervision requirements.
- Health, safety and environmental considerations.
- Any permit or consent requirements.

2.3.3 Site Environmental Standards

These would be agreed with the Olkaria Environment, Safety and Liaison Section and would detail the minimum measures that should be achieved for general operations that would fall outside the risk assessment/method statement procedure designed to cover the majority of construction activities. They would cover issues such as storage of materials, management of waste, water pollution, noise and vibration, and water pollution control. The standards would be printed on A3 posters, placed on site notice boards and used as a briefing tool on site.

2.3.4 Control of Construction Processes

(a) Training, Awareness and Competence

The raising of environmental and Safety awareness is viewed as a crucial element in the appreciation and implementation of the Environmental and Social Management Plan. As a consequence, all staff would undergo environmental and safety awareness training, initially by way of the pre-start induction process. A project specific training plan that identifies the competency requirements for all personnel allocated with environmental responsibilities would be produced and would be contained within the CEMP. Training for all personnel identified in the training plan would be completed before commencement of the associated construction activities. Line managers and supervisors would ensure that all personnel engaged in activities that may have an impact on the environment and safety are competent to carry out their duties or, where necessary, arrange for suitable training to be undertaken.

(b) Supervision of Construction Activities

All construction and installation activities including those carried out by subcontractors and suppliers would be supervised, or regularly checked through the completion of site inspections by the Contractors Environmental and safety personnel, in conjunction with environment safety and liaison team to ensure that requirements identified in risk assessments or method statements have been implemented. The frequency and extent of this supervision would vary according to the degree of competence displayed by the workforce and the level of risk to the environment.

(c) Inspection of Other Operational Impacts

Appointed environmental and safety representatives would carry out daily inspections of their respective construction areas, to verify that housekeeping or supporting controls are being

implemented effectively. These inspections would utilise the site environmental and safety standards as the minimum standards that should be achieved, with necessary actions being recorded and raised at weekly progress meetings. Subsequent inspections would commence with a review of all outstanding actions from previous reports to verify that they have been completed. The generated reports should be shared with KenGen for follow up of closure items.

(d) Inspections by the Environmental and Safety Team

Environmental and Safety deliverables required by the CEMP would be subject to regular independent inspections by either the Environmental and Safety personnel or the relevant line ministries. These inspections would be used to confirm that:

- Construction works are progressing in accordance with the agreed method statements';
- Agreed protection or mitigation measures are in place, prior to or during the implementation of construction activities;
- Construction works have been completed in accordance with the design and;
- Commitments made during the statutory process.

(e) Environmental and Safety Inspection and Reporting

The Contractors Environmental and Safety personnel would carry out an assessment of the Project's environmental performance, based upon the reports from the environmental management representatives during the period, reports from the environmental specialists and from his own site inspections. This would be carried out at a frequency at no greater than monthly intervals but could be held more regularly depending on the nature of the construction activity. An assessment of the performance over the month would be made and quantified. A monthly report detailing performance for the period would be provided to the KenGen's Project Manager and would include a summary of environmental inspections completed, audits undertaken, complaints and incidents.

(f) Environmental Monitoring

Monitoring of noise, vibration, dust and water quality would be carried out in accordance with the specialist environmental procedures and environmental commitments made. The GRD Environment and Safety Section would maintain a register of all environmental monitoring.

(g) Control of non-conformance

Non-conforming products or processes would initiate a Non-Conformance Report, which would identify the nature of the problem, the proposed corrective action, action taken to prevent recurrence of the problem and verification that the agreed actions have been carried out.

(h) Communication and Co-ordination

Internal project communications would be via two processes:

- Weekly team meetings;
- A monthly Project Environmental Review;

i. Weekly team meetings

Weekly meetings chaired by the Client's Environmental Manager would be held by each of the construction teams to review performance and co-ordinate short-term planning of forthcoming activities. Environmental management representatives would use these meetings to report on the findings of their inspections together with any systematic or recurring issues. Actions from these meetings would be recorded via minutes and reviewed by the Contract Manager.

ii. Monthly Project Environmental Review

Environmental issues would be primarily discussed at a monthly Project Environmental Review, chaired by the Contract Manager and attended by the Contractors Environmental Manager, the Clients Environmental Manager, relevant sub contractors environmental representatives and, when necessary, environment specialists and representatives from statutory consultees. The Project Environmental Review would:

- Consider past performance from inspections, audit reports and monitoring data.
- Plan actions required to mitigate forthcoming risks.
- Disseminate best practice.

2.3.5 Environmental due diligence during construction

During the construction phase, environmental due diligence will be incorporated into the Project implementation mainly to:

- Control the residual risk of accidental environmental damage;
- Prevent the negative environmental impacts during construction.

The contractor(s) and supervising Engineer will have the primary responsibility for the due diligence. The supervising Engineer will be required to include environmental considerations in the monthly progress reports and indicate progress in the implementation of mitigation measures as outlined in the ESMP.

The Construction risks to be monitored will include, but not be limited to the following issues:

- Handling of hazardous materials as part of construction activities;
- Movement of machinery;
- Management of borrow areas;
- Sedimentation of watercourses
- Collection and disposal of wastes;
- Management of pollution incidents.

Tables 8-1, gives a summary of the Environmental and Social Management Plans during Construction, phases of the project.

Table 2-1 ESMP Olkaria V during Construction

Environmental / social aspect	Recommended mitigation, monitoring and/ or management measure	Goals	Responsibility for implementation	Frequency of monitoring	Cost (*include* Objectively Verifiable Indicator, OVI)
Impact on Flora	• Map out ecologically sensitive area at the site and make them known to the engineers and contractor e.g. valley thicket, hills, and gorges • Ensure there is selective clearing of the vegetation this allows future re-growth and regeneration. This will ensure minimal disruption of wild fauna's natural movement, territoriality, and other ecological processes; • It is desirable to re-vegetate disturbed areas along roads, pipelines and steam lines and other construction sites. While *Nicotianum glauca* will rapidly colonize the disturbed bare grounds and still act as surrogate habitat for some faun species, it is still desirable to minimize/discourage it's dominance by planting native trees such as *Tarconunthu*s and *A. drepanolobium*. Additionally, *Hyparrhenia dregeana* a native tussocks grass commonly growing at the site can be very used in checking soil erosion especially on loose soil dumps or bare slopes created during construction. • The water and steam pipe lines should be laid across (perpendicular to) the valleys rather than running along them – as this will mean destroying large patch of this ecologically sensitive keystone habitat for many species this will reduce loss of habitat. • There is need to create awareness among the local communities and discourage them from engaging in charcoal burning which is evidently on the increase in this area. • KenGen GRD Environmental and community liaison section should monitor regeneration of natural vegetation as well as the appearance/spread of invasive or opportunistic species within the disturbed areas. Monitoring should include spotting and uprooting of unwanted germinating plants.	To ensure minimal habitat destruction	KENGEN / KWS/ Contractor	From Before, onset and during the construction	**Cost:** 20,000,000.00 for re-vegetation of approximately 2 million trees. Pipeline status reports, evidence of camouflaged; Baseline reports; Minutes of awareness meetings, Ecological monitoring data/reports; Aerial photos.
Impact on	• KWS and KenGen should monitor wildlife abundance,	Reduce impact on	KenGen /	At	**Cost:** 1,000,000

Environmental / social aspect	Recommended mitigation, monitoring and/ or management measure	Goals	Responsibility for implementation	Frequency of monitoring	Cost (*include* Objectively Verifiable Indicator, OVI)
microfauna	distribution and movement in relation to this infrastructural development during construction and operation stages to aid in decision making. • Erect bumps in wildlife crossing zones; • Vehicular disturbances such as hooting should be discouraged accordingly; • Incident records (of poaching, accidents and other human wildlife conflicts etc) should be kept by monitoring and taking of corrective measures; • Roads feeding into the park area should be maintained as routes for tourist's activities and wildlife management; • Access for earthmoving machines should be regulated; • Park rules should be enforced within the park; • Brine ponds should be located close to the source. Distant flow should be piped to prevent animal or vegetation contact; • At known animal migration corridors pipes should be elevated or buried under the ground surface. Modify pipe loop designs to minimize hindrance to wildlife movement as well as scaring them away. Other design options like pipe burying, wider loops or concave ones should be explored for habitat suitability and to ensure big game can still move along their routine corridors and routes.	the wild animals. of animal scalding Ensure safety of the animals and retain biodiversity	KenGen / contractor / KWS	construction Daily	annually **OVI:** Proper signage in place, incident reports Ecological monitoring reports/ incident reports/ visible markers and metal flappers on transmission cables Ecological monitoring reports / Incident reports
Avifauna	• KenGen together with KWS should develop and implement an avifauna monitoring scheme, assessing bird population trends and direct hazards relating to the project; • The project site has gorges, valleys and hillsides which form some of the keystone habitat features for raptors (Vultures and Eagles) as they enable them to soar high using thermal currents while in search of prey. These should therefore be retained as intact as possible; • High voltage transmission lines should be fitted with wire markers and flappers to alert birds on flight; • High heat points and emission vents within the project area should be sheltered or fitted with inhibitors to deter birds	Reduce impact on the wild animals.	KenGen / KenGen / contractor / KWS	Daily	**Cost:** 1,000,000 annually **OVI:** Proper signage in place, incident reports Ecological monitoring reports.

Environmental / social aspect	Recommended mitigation, monitoring and/ or management measure	Goals	Responsibility for implementation	Frequency of monitoring	Cost (*include* Objectively Verifiable Indicator, OVI)
	which may get killed as a result of using such areas; • As the project will draw much water from Lake Naivasha, KenGen should join hands with other stakeholders in supporting the ongoing bi-annual waterbird counts – which is a long term monitoring activity aimed at assessing the effects of various activities around the lake.				

Environmental / social aspect	Recommended mitigation, monitoring and/ or management measure	Goals	Responsibility for implementation	Frequency of monitoring	Cost (*include* Objectively Verifiable Indicator, OVI)
Impact on Herpetofauna	• KenGen should liaise with KWS to capture reptiles hiding under rocks and sheltered terrains such as Pythons and House snakes and safely release them in suitable habitats.	Reduce impact on the wild animals.	KenGen / KenGen / contractor / KWS	Daily	**Cost:** included above **OVI:** Ecological monitoring reports.
Impact on vertebrates	• Re-vegetation of the cleared vegetation.	Reduce impact on vegetation	KenGen / KenGen / contractor / KWS	Daily	**Cost:** included above **OVI:** Ecological monitoring reports.
Landscape Character Impacts	• Limiting vegetation clearing to construction areas; • Limiting vegetation clearing to construction areas; • Preparation of a landscape planting plan for the entire project area. Planting plan to be comprised of 75% indigenous species and to be rid of any invasive species; • Re-vegetation should target 2 million trees annually until the area is fully re-vegetated; • All embankments to be vegetated or stone pitched to prevent soil erosion; • Planting a vegetation screen along the steam pipes to reduce visual intrusion across the landscape. • Lighting to be switched off when not required; • Lighting of temporary working areas and site compounds during periods of darkness to be minimised where possible. • Prepare a proper post construction planting plan	Lower the loss of vegetation cover Reduce topography change Lower Visual intrusion by steam pipes Minimize residual impacts	Kengen / Contractor	Routine	**Cost:** included in the BOQ Construction designs and drawings / drawings Camouflage of the pipelines
Soil erosion	• Proper planning of site clearing or disturbance of the natural vegetation. • Isolated sites with installations and frequent human presence that require re-vegetation will be surrounded by less palatable native species to act as plant screens and reduce pressure from wildlife foraging. • No grey water runoff or uncontrolled discharges from the site/working areas (including wash down areas)	Measures for soil conservation Retain soil through soil conservation measures	KenGen / Contractor and KWS	During	No additional cost, based on sound engineering practise.

Environmental / social aspect	Recommended mitigation, monitoring and/ or management measure	Goals	Responsibility for implementation	Frequency of monitoring	Cost (*include* Objectively Verifiable Indicator, OVI)
	• Water containing pollutants such as cements, concrete, lime, chemicals and fuels shall be discharged into a conservancy tank for removal from site; • Runoff loaded with sediment and other suspended materials from the site/working areas should be prevented from discharging to adjacent watercourses and/or water bodies must be prevented; • Potential pollutants of any kind and in any form shall be kept, stored and used in such a manner that any escape can be contained and the water table not endangered; • Wash areas shall be placed and constructed in such a manner so as to ensure that the surrounding areas (including groundwater) are not polluted.				

Environmental / social aspect	Recommended mitigation, monitoring and/ or management measure	Goals	Responsibility for implementation	Frequency of monitoring	Cost (*include* Objectively Verifiable Indicator, OVI)
Impact on quarry sites	• A current and valid authorisation from the Department of Mines prior to any blasting activity shall be obtained; • A qualified and registered blaster by the Department of Mines and Geology shall supervise all blasting and rock-splitting operations at all times; • KenGen and the Contractor shall ensure that appropriate pre blast monitoring records are in place (i.e. photographic and inspection records of structures in close proximity to the blast area); • KenGen and the Contractor shall ensure that emergency services are notified, in writing, a minimum of 24 hours prior to any blasting activities commencing on Site; • The Contractor shall take necessary precautions to prevent damage to special features and the general environment, which includes the removal of fly-rock. Environmental damage caused by blasting/drilling shall be repaired at the Contractor's expense; • KenGen and the Contractor shall ensure that adequate notification is provided to the local communities immediately prior to all blasting. It is preferable that warning / informative signage and billboards be erected at the site indicating operation hours as well as commencement and end of operations. All signals shall also be clearly given; • The Contractor shall use blast mats for cover material during blasting. Topsoil shall not be used as blast cover. • Precautionary and corrective measures will be taken to avert defacing and deformation of the land features.	Avoid scarring, dangers of overhanging cliffs and falling rocks which creates environmental, health and safety hazards:	KenGen / Contractor	Routine	KES 10,000,000.00 Rehabilitation of quaries.
Landslides and soil creep	• Retaining walls as alternate for growing vegetation cover restoration along the sloppy ground; • Benching for cut and fill. • Baricading unstable sloppy areas with red tape • Installation of warning signage's	Stabilizing soil on sloppy areas	KenGen / Contractor	Routine	No additional cost based on sound engineering practise.
Water resources	• Continued monitoring of lake levels;	To conserve water resources	KenGen / Contractor	Daily / Quarterly	No additional cost based on sound

Environmental / social aspect	Recommended mitigation, monitoring and/ or management measure	Goals	Responsibility for implementation	Frequency of monitoring	Cost (*include* Objectively Verifiable Indicator, OVI)
	• Accidental leakages and bursts of water supply pipelines should be reported and repaired immediately; • Recycle water as much as possible should be encouraged for example water used for curing of concrete can be used for spraying dusty roads; • Control of the water flows and the water consumption records must be kept and availed to the supervising and KenGen Resident Engineers at the end of working day; • All employees should be sensitized on water usage practices like discouraging unnecessary opening of taps; • Monitoring of taps and their efficiency should be done regularly; • Curing of concrete should be done in conservancy tank to avoid wastage; • Harvest water during rainfall times; • KenGen and the Contractor shall arrange for the necessary approvals/permits from the water authorities for the abstraction of water; • No grey water runoff or uncontrolled discharges from the site/working areas (including wash-down areas) to adjacent watercourses and/or water bodies shall be permitted; • Reinjection of brine from the separator and the condenser is recommended • Usage of air cooling systems as opposed to water ones.			Reports	engineering practise

Environmental / social aspect	Recommended mitigation, monitoring and/ or management measure	Goals	Responsibility for implementation	Frequency of monitoring	Cost (*include* Objectively Verifiable Indicator, OVI)
Air quality and dust	• Olkaria is a fragile ecosystem; thus mobile machinery or vehicle maintenance and services should be undertaken away from project site in a yard set aside for this or by an approved garage or service station to prevent any incident of oil and fuel spills that could contaminate soils and possibly ground water quality. • Daily monitoring of air quality standards; • All construction machinery shall be maintained and serviced in accordance with the manufactures specifications; • Workers shall be trained / sensitized on dust minimization techniques and management of air pollution from vehicles and machinery; • The removal of vegetation shall be avoided until such time as clearance is required and exposed surfaces shall be re-vegetated or stabilized as soon as practically possible; • Frequent watering of exposed surfaces and piles of soil to prevent airborne dust emissions; • Unless inevitable, vehicles shall avoid earth roads susceptible to fugitive dust until dust management routines are done. • Incorporate dust/fumes arrestors in the batching plant e.g use of dust nets • Provision of appropriate protective personal equipment including respirators and aprons	To reduce pollution of ambient air	KenGen / Contractor	Daily; Quarterly Reports	Cost: 500,000.00 Annually for air and dust sampling; 2,000,000.00 annually for watering OVI: Monitoring reports
Noise and Vibration	• Keep machines and vehicles in good working condition as per manufacturer's instructions; • Site and other operational workforce be provided with personal protective equipments (PPEs). The same should undergo audio metric screening on prescribed bases • Provide signage on high noise levels and adequate notice to any local community to be potentially affected • Daily monitoring of noise levels will need to be made during operation as per current practice	Mitigate noise and vibration pollution	Contractor, Supervising engineer and KenGen	Immediately after commencement of construction (daily and quarterly reports)	Cost: 500,000 annual noise monitoring
Solid Waste	- Identifying environmentally acceptable spoil sites for spoil materials and approval by the Resident Engineer.	Solid waste disposal management	KenGen / contractor	Routine	Cost: Part of the project

Environmental / social aspect	Recommended mitigation, monitoring and/ or management measure	Goals	Responsibility for implementation	Frequency of monitoring	Cost (*include* Objectively Verifiable Indicator, OVI)
	- Encourage segregation by providing labelled collection and separation bins - Encourage recycle and reuse measures for some of the spoils generated such as woody spoils generated from construction work will be stock piled to manageable size, valued and given to surrounding community as fuel wood as a cost effective measure. Other reusable materials are scrap metal and paper. - Waste disposal should be done by licensed collectors and handlers.				OVI: Presence of a waste segregation procedures and a licensed waste handler
Loss of land and resettlement	Resettlement done before construction of Power Plant	Implement the MoU between KenGen and the PAPs	KenGen	Quarterly	Cost: Part of the project cost under
Economic displacement of persons	It is proposed that KenGen in liaison with Kenya Wildlife Service's establish a site that will be accessible to the traders and the tourists who buy their merchandise, especially within Hells Gate National Park.	Restore income streams	KenGen / KWS	Quarterly	Cost: Part of the project cost under
Spread of communicable diseases	- The Community Liaison Office should organize for community and workers training and sensitization programs in conjunction with the Sub-County Public Health Officer under the government led Community Led Total Sanitation (CLTS) initiative. This will facilitate development of more sanitation facilities within the community and also increase usage;	Curb prevalence of communicable diseases	KenGen / Sub-County Public Health Officer	Weekly / Quarterly	KenGen CSR; MoH Services OVI: indicators of prevalence
Increase in Amount and Tonnage of Traffic	- Erection of proper signage along all roads exploited the construction process; - Construction of speed bumps along Maili Mbili – Olkaria – Kongoni road and the roads within the park; - In conjunction with other stakeholders conduct a traffic survey to establish the current usage of the roads, both within and outside the park. Following the results, construct a road with the capacity to handle current traffic and projected traffic to be injected by the proposed Olkaria V power plant. - Sensitization and training of drivers. - Monitoring, enforcement and disciplinary action of offenders. - Use of escort and chase vehicles.	Minimize road traffic impact on the environment	KenGen / Contractor	Daily	Cost part of the project OVI: Presence of proper signage
Occupation	- Contractors to establish a comprehensive Health and Safety	Ensure occupation	KenGen /	Quarterly	Cost part of the

Environmental / social aspect	Recommended mitigation, monitoring and/ or management measure	Goals	Responsibility for implementation	Frequency of monitoring	Cost (*include* Objectively Verifiable Indicator, OVI)
health and safety	Policy which should be in compliance with KenGen's Occupation Health and Safety Policies and be approved by Environment, Health and Occupation Manager from KenGen. - Ensure compliance with all standards and legally required health and safety regulations; - Include standard best practice health and safety provisions in the construction contract. The provisions should include insurance to enable the contractor to pay for any and all treatments required by his workers including those of all sub-contractors, together with any subsequent lifelong disability payments; - Establish and enforce a strict code of conduct for all project drivers including outside suppliers delivering materials. The code should focus on safety, especially speed, and loading, especially banning all carriage of staff, workers and passengers except in seats; - Implement the specified H&S programme throughout the construction period; - Provide fire fighting and first aid kits; - Establish an emergency response procedure and display on all work areas. This is likely to require one vehicle on site equipped as an ambulance and a paramedic on site at all times during construction activities	health and safety	Contractor		project OVI: Safety records
HIV / AIDs and Sexually Transmitted Infections	The Contractor should ensure that prevention and management of sexually transmitted diseases as a result of social interaction between immigrant workers and local populations	Prevent spread of sexually transmitted diseases	KenGen / Contractor / Line ministry	Quarterly	2,000,000.00 Annually for campaign and awareness and provision of condoms. OVI: Prevalence rates indicators
Housing of staff	Develop a construction camp at site	Provide affordable amenities for lower economy staff	KenGen / Contractor	Quarterly	Part of the project cost
Insecurity	- Ensure that the contractor develops staff code of conduct;	Manage theft at site	Kengen /	Quarterly	No additional cost.

Environmental / social aspect	Recommended mitigation, monitoring and/ or management measure	Goals	Responsibility for implementation	Frequency of monitoring	Cost (*include* Objectively Verifiable Indicator, OVI)
	- Liaise with the National Police Service to promote community policing - Liaise with the County Commissioners office to promote the proposed 'Nyumba Kumi' initiative.		Contractor		

2.4 Environmental Management during operation phase

The Environmental Management of the project relies on the project proponent KenGen and it is anticipated that KenGen will increase its current Capacity of Environmental section to deal with new development.

Tables 8-2, gives a summary of the Environmental and Social Management Plans during Operation, phases of the project.

Table 2-2 ESMP Olkaria V during Operation Phase

Environmental aspect	Recommended mitigation, monitoring and/ or management measure	Goals	Responsibility for implementation	Frequency of monitoring	Cost
Impact on Flora	- Monitor invasive plant species at the project area and uproot unwanted germinating plants; - Assess concentration geothermal gaseous effluents such as H2S, SO2, NH3 and CO2 (e.g. by use of automatic sensors) and continually test for any evidence of acid rain - Plant soil-erosion preventing grass species such as Cynodon dactylon, Digitaria abyssinica, Pennisetum clandestinum and Hyparrhenia dregeana at bare sloppy grounds or loose soil dumps; - Steam pipe insulations should have a well camouflaged colours that are maintained so that animals don't perceive pipelines as barriers - Brine flows and ponds should be located close to the source. Distant flow should be transmitted through closed pipes - Rehabilitate disturbed areas along roads, pipelines and abandoned campsites etc by planting native plant species such as Tarconunthus and A. drepanolobium – this should be done as soon as practicable to avoid colonization by invasive and opportunistic pioneer species; - Exotic plants species should not be introduced into this area; - Create awareness among the local communities on the importance of vegetation cover and discourage them from engaging in charcoal burning.	A baseline for monitoring invasive plant species To ensure tolerable levels for plants, animal and humans To curb soil erosion Ensure steam pipes blend with natural environments To prevent animal or vegetation contact with brine To restore natural habitats To retain natural integrity of the area	KenGen	Weekly and quarterly Daily / Weekly Routinely Routinely Routinely Routinely Routinely	KES 1,000,000 annually for 5years target of 100,000 trees annually. OVI: Ecological monitoring reports Aerial Photos / Ecological Monitoring reports Ecological Monitoring reports Ecological Monitoring reports Ecological Monitoring reports
Impact on Fauna	- KWS and KenGen should monitor wildlife abundance, distribution and movement in	To reduce vehicle-wildlife accidents	KenGen	Routinely	Part of the project cost OVI: Ecological Monitoring

Environmental aspect	Recommended mitigation, monitoring and/ or management measure	Goals	Responsibility for implementation	Frequency of monitoring	Cost
	relation to this infrastructural development during construction and operation stages to aid in decision making; - Erect bumps in wildlife crossing zones; - Vehicular disturbances such as hooting should be discouraged accordingly; - Incident records (of poaching, accidents and other human wildlife conflicts etc) should be kept by monitoring and taking of corrective measures; - Roads feeding into the park area should be maintained as routes for tourist's activities and wildlife management; - Access for earthmoving machines should be regulated; - Park rules should be enforced within the park; - Brine ponds should be located close to the source. Distant flow should be piped to prevent animal or vegetation contact; - At known animal migration corridors pipes should be elevated or buried under the ground surface. Modify pipe loop designs to minimize hindrance to wildlife movement as well as scaring them away. Other design options like pipe burying, wider loops or concave ones should be explored for habitat suitability and to ensure big game can still move along their routine corridors and routes	To curb wildlife poaching To reduce noise disturbance to animals. To prevent contamination of animals' drinking water and habitats. To ensure tolerable levels for plants, animal and humans. To safeguards animal welfare and ecological integrity. To prevent bird death incidences.	KenGen / KETRACO / Kenya Power KenGen / Contractor / KWS KenGen / Contractor KenGen / Contractor	Routinely Routinely Routinely Routinely Routinely Routinely	reports Security OB/ incident records Ecological monitoring reports Maintenance/ Ecological monitoring reports Environmental health/ Ecological monitoring reports Ecological monitoring reports Ecological monitoring reports
Soil erosion and sedimentation	- The design should considered appropriate terracing due to the nature of topography of the area; - Planting of trees along the gullies and areas susceptible to erosion is proposed; - Re-forestation or re vegetation of areas cleared during construction should be done.	To conserve soil and avoid stripping of top soil	KWS, Contractor and KenGen.	Daily; Quarterly Reports	Part of the project cost OVI: re-forestation reports
Solid waste and wastewater	- Discharge sewage into septic tanks with maintenance ensuring the sewage doesn't flow	Effective management of solid waste	KenGen/ Contractors	Weekly and Quarterly	Cost: Part of the project cost

Environmental aspect	Recommended mitigation, monitoring and/ or management measure	Goals	Responsibility for implementation	Frequency of monitoring	Cost
disposal	to the surface - For solid waste collection and disposal from the plant ensure a NEMA licensed company is used				OVI: Waste management reports)
Brine disposal	- Brine ponds should be sited close to the source - Brine re-injection through re-injection wells into underground reservoir - Chemical composition and parameters of the brine should be routinely monitored	Avoid water and soil pollution	KenGen	Daily, weekly and Quarterly	Cost: Part of the project cost OVI: Waste management reports
Impact on Air Quality	- Situate automatic H_2S sensors around the plant - Ensure cooling towers are sited properly - Put up additional monitoring stations for precipitation chemistry - Monitor changes in geothermal development technology and adopt if necessary. - Daily Monitoring of H2S will be carried out; - Educate workers on the dangers of exposure to H_2S.	Sustain H_2S and other gases at/ below set standards	KenGen	Daily, weekly and Quarterly	Cost: Part of the project cost OVI: Presence of automatic sensors Reports on H_2S and other gas emission levels
Impact of noise and vibration	- Appropriate signage in sensitive areas - Provide PPE for operational staff and visitors - Annual audio metric test for operational staff - Monitoring of noise quality and abiding by NEMA quality guidelines. - Monitor changes in geothermal development technology and adopt if necessary.	To mitigate noise pollution.	KenGen	Daily monitoring of noise and vibration	Cost: Part of the project cost OVI: Monitoring Reports
Accidental spillage resulting in contamination of chemicals and soil	- Spill and drip trays used during servicing of machinery - Response plans for accidental spills to be formulated and routinely tested - Bunded storage areas and secondary containment for oil and chemicals - Use of an oil interceptor in the plant	Manage spills	KenGen / Contractor	Quarterly	Part of the project cost OVI: Safety Reports

Environmental aspect	Recommended mitigation, monitoring and/ or management measure	Goals	Responsibility for implementation	Frequency of monitoring	Cost
Fire risk	- A fire protection system of fire water tanks, fire extinguishers, fire hydrants, hose reels, fire alarms and sprinklers - Formulate a fire emergency response plan - Ensure no smoking signage is put up in the necessary areas - Train some staff to be fire marshals - Carry out fire drills -Inspect fire fighting equipment	- Mitigate fire risks	Kengen	Quarterly	Cost: Part of the project cost OVI: Report on status of fire fighting equipment Report on training of fire marshals Fire emergency response plan
Oil / Hazardous pollution	- Hazardous materials shall not be stored within 2 kilometres of the top water level of public water supply reservoirs; - Hazardous materials shall be stored above flood level; - Areas for the storage of fuel and other flammable materials shall comply with standard fire safety regulations; - Chemicals and fuel shall be stored in storage tanks within a secure compound. All chemicals and fuels shall be stored in accordance with manufacturer's instructions; - Storage areas or secondary containment shall be constructed of waterproof reinforced concrete or approved equivalent, which is not adversely affected by contact with chemicals captured within them; - The minimum volume for secondary containment shall be 110% of the capacity of the largest tank system, plus 10% of the total capacity of all other separate tanks and containers within the bund wall with closed valves for controlled draining during rains; - Pipe-work carrying product from the tank to facilities outside the containment shall be provided with secondary containment;	- To maintain sound waste management practice.	Supervising Engineer and the Contractor.	Daily; Quarterly Reports	Cost: No additional cost. OVI: Performance is dependent on sound supervision and environmental practices.

Environmental aspect	Recommended mitigation, monitoring and/ or management measure	Goals	Responsibility for implementation	Frequency of monitoring	Cost
	- Tank equipment such as dispensing hoses, valves, meters, pumps, and gauges shall be located within the containment or provided with own containment.				
Occupational Health and safety	- Carry out Occupational Health and Safety audits - Equip employees with necessary Personal Protective Equipment (PPE) - Regular and induction training, of members of the safety committee and new staff respectively, on First Aid - Ensure the plant and office blocks have adequate supply of First Aid Kits - Location of safety signs around the plant - Inspections on conditions of machinery and equipment -Register the plant as a workplace with DOSH	- Avoid accidents and ensure safety in the workplace	KenGen	Quarterly	Cost: KES 500,000 anually. OVI: Safety audit report, Inspection report and Presence of signage

2.5 Environmental and Social Monitoring

2.5.1 Monitoring during construction and operation

Not all impacts on the environment can be foreseen during the design and construction phases. For this reason, it is proposed that a component of environmental auditing and monitoring be included in both the construction and operation phases of the Projects. Monitoring and auditing will essentially serve the following purposes:

- Measure the attainment (success or failure) of mitigation measures to ameliorate foreseen impacts;
- To spot unforeseen impacts, especially the ones related to the Park Management;
- Assist in assessing whether the designs and technologies are suitable and satisfactory;
- Facilitate better management of the Power Station.

During the construction phase, it is particularly important to ensure that all the features of the designs as presented in the design reports and drawings are implemented.

During the operation period there is need to ensure that the operating and performance standards of Geothermal Power Station are followed and achieved.

Environmental and social monitoring during construction and operation helps to predict unforeseen environmental and social impacts and allows measures to prevent or avert adverse impacts to be developed or introduced in a timely manner.

Maintenance of infrastructure during construction and operation is also important in contributing towards environmental conservation by for example, preventing soil erosion along the road and its upstream and downstream catchments and ensuring proper drainage of run-off, away from the road.

During the construction and operation phase, monitoring will be undertaken to ensure that proposed mitigation measures for negative impacts and enhancement measures for positive impacts are implemented.

Tables 8-3, gives a summary of the Environmental and Social Monitoring Plans during Operation phase of the project.

Table 2-3 ESMP during Construction and Operation phase

Monitoring Scope	Parameter	Location	Frequency		Responsibility
			Construction	Operation	
Air	TSP, SO_2, CO, H_2S, CO_2, CH_4	Populated areas	Daily	Daily	GRD Environment and community liaison officer, KenGen, NEMA.
Wastewater and surface water	TSS, COD, BOD, DO, pH, oil, phenol	Effluent outlets; local drinking water supply sources; important water bodies	Monthly for 3 consecutive days	Monthly	GRD Environment and community liaison officer, KenGen, NEMA.
Noise	dB	Sensitive spots	Daily	Daily	GRD Environment and community liaison officer, KenGen, NEMA.
Solid waste	Slag, domestic refuse, metallic scraps, sludge	Disposal sites	Quarterly	Daily	GRD Environment and community liaison officer, KenGen, NEMA.
Spoils	Visual inspection	Entire site	Daily	Daily	GRD Environment and community liaison officer, KenGen, NEMA.
Soil erosion	Visual inspection	Entire site	Biweekly	Monthly	GRD Environment and community liaison officer, KenGen, NEMA.
Public safety	Accident and Incident Register.	Entire site	Biweekly	Monthly	GRD Environment and community liaison officer, KenGen, NEMA.
Hells Gate National Park	Regular monitoring of wildlife numbers	Entire site	Biweekly	Monthly	GRD Environment and community liaison officer, KenGen, NEMA.
Induced socio-economic benefits	Household surveys	Entire site	Annual	Annual	GRD Environment and community liaison officer, KenGen, NEMA.
Community participation and performance of CSR	Visual inspection	Entire site	Biweekly	Monthly	GRD Environment and community liaison officer, KenGen, NEMA.

BOD = Biochemical oxygen demand, CO = Carbon monoxide, COD = chemical oxygen demand, dB = decibel, DO= Dissolved oxygen,, pH measure of acidity/alkalinity, SO_2 = Sulfur dioxide, TSP = Total suspended particles, TSS = Total suspended solids.

3 CONCLUSION

As the country seeks to realize the Vision 2030 blueprint; this is spurring a rise in economic investments and a demand for energy generation from different forms. It is against this background, that the proposed 140 MWe Olkaria V has great economic significance. Nonetheless, the dwindling and erratic rainfall patterns as well as rising population are adding more pressure to the current generation capacity creating the need to diversify so as to sustainably rationalize the demand and supply sides.

The potential for perpetual steam production has given geothermal resources development a strong basis for renewable energy generation through massive green projects in Kenya. Since 1981, the Olkaria geothermal fields have progressively increased their power contribution to the national grid.

The study has established that the proposed power plant site is an area within KenGen Land that is currently inhabited by Maasai community that has been earmarked for relocation. However, a number of negative environmental consequences are likely to accompany the project that include site vegetation clearing, interference with avian migrant pathways, habitat disturbance and increase in water demand from Lake Naivasha. Possible to mitigation measures for the impacts have been recommended in the environmental management and monitoring plans. Possible social impacts for the Project Affected Persons (PAPs) in the affected villages (Olonongot and Olosinyat) have been addressed through resettlement action plans for Olkaria IV, which is under construction. The resettlement site for the PAPs is almost nearly complete.

It is therefore imperative that the proposed mitigation measures and monitoring strategies be strictly adhered to. This is especially important since the project sits in a fragile ecosystem, adjacent to the Hell's gate National Park. The park has a national importance as a tourist attraction site, being home to rare and endangered wild flora and fauna. Some key biodiversity of particular significance include the rare and endangered Chanler's Mountain Reedbuck, a major roosting site for Vultures (on Vulture Cliff) and the fact that the site is within the Rift Valley a major flyway for migratory birds. It ought therefore, to be the commitment of all stakeholders to strive to ensure harmonious co-existence of the power plant and the ecosystem where biodiversity conservation and environmental sustainability are safeguarded.

The Project should comply with all local laws and regulations, which seek to ensure that the construction work does not adversely affect the environment and social community resources. Any adverse impacts that arise will be mitigated on an on-going basis. These shall be included in an updated ESMP. At the operation phase, the monitoring plan shall ensure the project complies with the best environmental practices.

In conclusion, therefore, provided the recommended mitigation and environmental management measures are effectively implemented during the construction and operation phases of the proposed Olkaria V Power Plant, the anticipated environmental and social negative impacts will, for the most part, have low significance.

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