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Environmental Impact Mitigation Considerations in Geothermal Drilling: A Case Study of Menengai Geothermal Drilling Project

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ABSTRACT

Geothermal drilling is one of the most important activities in geothermal development. This development stage is preceded by surface exploration studies and production drilling. The key objective of geothermal drilling is to verify geoscientific surface exploration studies in order to prove existence of a geothermal resource. For that reason the evaluation of impacts arising at this stage of geothermal energy development is important in order to have an environmentally viable geothermal project. This paper focuses on the need for sound environmental management in geothermal drilling by analyzing the different environmental aspects and environmental legislation related to geothermal drilling. An environmental model of drilling geothermal wells which adheres to the concept of environmental sustainability as prescribed in the environmental management plan (EMP) is described. The study show that geothermal well drilling with key consideration of environmental sustainability concept not only as a tool for protection and conservation of the environment, helps to enhance acceptability of the geothermal project due to various environmental consideration that go with the drilling process.

1.0 INTRODUCTION

Menengai geothermal project is located within the Eastern sector of the African Rift system on the outskirts of Nakuru Town, about 180 Km Northwest of Nairobi, Kenya. The area is bound by UTM Co-ordinates 157000E to 180000 E and 997000 N to 0 (Equator, Figure 1). To harness the geothermal energy resource, Geothermal Development Company (GDC) has made progress in drilling and testing of explorations, appraisals and production geothermal wells using two rigs within the Caldera

The main aim is to prove the availability of geothermal steam for construction of geothermal power plants. This is to meet the increasing demand for electricity in Kenya using geothermal, which is an indigenous, reliable, environmentally benign source of energy. The geothermal field will be developed in four phases of 400MW each with the 400 MWe Menengai Phase I ready for commissioning by 2016. The total field capacity is estimated at over 1,650MW.

Before commencement of the project an Environmental and Social Impact Asessment (ESIA) study was carried out which developed an Environmental Management Plan (EMP) to address both positive and negative environmental impacts that arise from the project.

Its implementation ensures that adverse project impacts are prevented and positive impacts are enhanced. The plan identifies impacts, proposes mitigation measures and assigns responsibility for its implementation. Review of the plan is equally carried out routinely. It important to note, that the plan bears a comprehensive approach, addressing each and every aspect of the project in an effort to address all impacts that might be forthcoming.

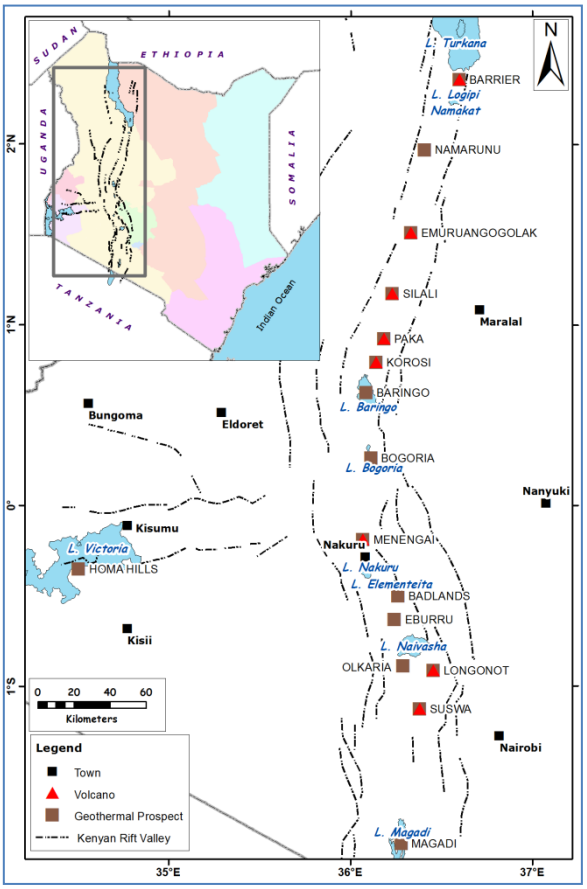

Figure 1: Menengai geothermal project area

1.1 Environmental Management Plan (EMP)

An EMP is sometimes referred to as a 'Pollution Prevention Plan' as the main focus is preventing pollution, as opposed to managing all environmental issues. However, developing an EMP may also help businesses address a variety of environmental issues such as managing air contaminant discharges, wastewater and energy consumption. Once a business has an EMP, it has an advantage as far as managing pollution risks according to best practice. EMPs can also help businesses increase efficiencies (e.g. moving risky activities into covered areas will minimize pollution risks and can increase productivity) and reduce costs (e.g. managing hazardous substances properly will reduce the likelihood of spills and can therefore minimize the associated costs of spill clean-up and potential fines).

In Kenya, Projects under the 2nd Schedule of EMCA 1999 must come up with environmental management plan to address their impacts on the environment in developing the ESIA study report.

1.2 OTHER ENVIRONMENTAL MANAGEMENT TOOLS

There exist other environmental management tools. These include among others cleaner production, environmental accounting, environmental management systems and environmental performance evaluation.

1.2.1 CLEANER PRODUCTION

Cleaner production is a preventive, company specific environmental protection initiative. It is intended to minimize waste and emissions and maximize product output by analyzing the flow of materials and energy in a company, and identify options to minimize waste/emissions out of industrial processes through source reduction strategies. Improvement of organization and technology help to reduce or suggest better choices in use of materials and energy, and to avoid waste, wastewater generation, gases emissions and noise. .

1.2.2 ENVIRONMENTAL ACCOUNTING

Environmental accounting also called social accounting, measures both the social and environmental impacts of business decision. It takes into account all costs, rather than just company expenses, when making production and pricing decisions. The depletion of natural resources involves more cost than the monetary ones that appear on company financial statement. Examining our use of and effect on natural resources and the environment increases awareness of the way in which the environment is treated. This awareness allows sound decision making that will keep our water and air cleaner and manage dwindling natural resources base.

2.0 ENVIRONMENTAL LEGAL FRAMEWORK

Before implementation of any project, the national and international environmental legislation relevant to its implementation must be understood. In geothermal energy development, it is important to understand these legislations in relation to exploration, drilling, power plant construction operations and decomissioning.These legislations often specify standards with which the project must comply and may delay implementation due to lengthy licensing process or public consultation requirements. Implementing agencies should guard against any environmental liabilities as they may have adverse financial implication on the total project cost. Some of the legislation that must be understood includes:

- National Environmental and any related legislations, associated regulations and guidelines,
- Multilateral Financiers Safeguards Policies and Guidelines (World Bank, African Development Bank, JIBIC, AFD),
- International environmental convention/treaties and associated protocols and guidelines.

3.0 PREPARATION OF AN EMP FOR GEOTHERMAL PROJECTS

Preparation of a typical Environmental Management Plan starts with conducting an environmental baseline studies. This is a stock taking exercise to establish existing environmental status and resources. Acquisition of baseline data will enable an environmental and social impact assessment to be carried out which ultimately gives an environmental management plan for implementation. Geothermal projects are developed in various phases. The first phase involves civil works which include opening of access roads, development of water infrastructure for the much needed drilling water and setting up of drilling sites. Upon setting up of the project site, drilling of geothermal wells commences and later well testing is done to determine the average output of a well.

The wells are normally drilled to economical depths of approximately 3000 m to access geothermal fluids (steam and water), which is transmitted through pipelines to the turbines of the proposed geothermal power station for electricity generation. These activities bear social and environmental impacts though of low significance given that geothermal energy is clean.

Noted effects include issues relating to land access rights, gaseous emission (H_2S) emission, noise during drilling and well testing around the well, dust emissions and vegetation clearing which occur during site preparation and road construction and oil pollution. Drilling activities encourages an influx of people into the project area, comprising the workforce as well as people seeking employment. A number of environmental and social impacts can result due the presence of the workforce. This revolves around the availability of housing and living conditions, sanitation and wastewater and solid waste disposal all of which have implications on public health hence appropriate mitigation measures have to be proposed. Other issues relate to visual intrusion, solid and drilling waste may equally arise. These activities together with their effects to the environment are included in an EMP, their mitigation measures defined and responsibility for implementation assigned.

4.0 EMP FOR MENENGAI GEOTHERMAL PROJECT

The Menengai geothermal project has all its social, environmental and safety concerns addressed in well developed EMP. The EMP activities broadly seek to address social issues, personal safety, waste management, water quality, air quality, and rehabilitation and social afforestation program. Implementation of this EMP is executed by well trained and competent Environmental Scientists Community Liaison Officers and Safety officers. The EMP is instituted through regularly environmental monitoring programs as discussed in subsequent sections.

4.1 Meteorological Monitoring

Meteorological parameters monitoring is one of the key environmental activities in the Menenngai project area.The monitoring aids in quantifying the effects of its operations in terms of weather and emission dispersion levels at the project site and its environs. This can only be acheived by real time meteorological data collection, analysis, interpretation and reporting. This is especially aided by the use of two (2) Automatic Weather station (AWS) that are installed in Menengai caldera.

Plate 1: Automatic weather station at Menengai project site

The stations collects data, on an hourly basis, of key parameters such as wind speed, wind direction, total rainfall, relative humidity, barometric pressure, air temperature and solar radiation.

4.2 Air Quality Characterization and H_2S Monitoring

The visible plumes seen rising from some geothermal energy installations are actually water vapor emissions (steam) and not smoke. Because geothermal power plants do not burn fuel like fossil fuel plants, they release virtually no air emissions.

Air quality in Menengai Geothermal Project has been characterized in terms of H_2S, CO, CO_2, CH_4, SO_2, Cl_2, O_2 and non combustible gases (LEL) concentrations. The aforementioned gases are monitored on daily basis at specified time at designated monitoring points within the Menengai project area and its environs by use of gas detectors. Analysis of the same is carried out, where recorded levels are compared with existing national Occupational Safety and Health Act (OSHA) standards and other International standards such as World Health Organisation (WHO) and World Bank (WB) for health and safety purposes.

Of concern among the monitored gases is Hydrogen sulfide (H_2S) due to its distinctive rotten-egg smell and potential toxicity in high doses. The effect of this gas is however now effectively abated due to improved geothermal power generation technologies such as steam scrubbing/extraction and venting through cooling towers hence it is dissolved in the cooling water.

4.3 Waste Management

The waste generated from Menengai geothermal project mostly comes from the rig operations and drillers' camp. It consists of plastic containers, cartons, scrap metals and other food/domestic refuse (paper, food remains) generated from the drillers camp and staff canteen. Best waste management practices have been adopted in dealing with all kinds of waste generated. Dustbins and refuse bags are provided for waste collection (Plate 2).Waste is segregated at the source (Plate 3). A temporary waste collection site has been developed for proper and safe disposal of recyclable waste while food/biodegradable waste is composite for use at Menengai Project Tree Nursery as composite soil for raising tree seedlings towards GDC's social Afforestation program.

Plate 2: Solid waste management

Plate 3: Solid waste segregation at source in Menengai project

4.4 Rehabilitation

This is carried out in an effort to restore the project biophysical environment after project operations. The rehabilitation program involves putting back to near original state of sites that have been disturbed by civil works activities (Plate 4) such as murram/laterite burrow pit or quarries. GDC has showcased how a quarry can be rehabilitated after decommissioning (Plates 5 and Plate 6). In this exercise the farmer whose land GDC has lease to obtain murram for access roads reported a 60% increase in crop yield in the decommissioned and rehabilitated quarry area (Plate 6).

Plate 4: Planting of native grass at disturbed areas

Plate 5: Menengai quarry during rehabilitation at the project site

Plate 6: Menengai quarry after rehabilitation

4.5 Social Afforestation

Social afforestation is a program specially designed by project environmental management team to reach out to the project surrounding communities. The program targets to raise tree seedlings while partnering with local communities organized groups tree nurseries in promoting environmental conservation initiative. An average of two hundred thousand tree seedlings are donated and planted (Plate 7) every year, this is done in collaboration with local communities organized groups tree nurseries who get paid by GDC to raise the tree seedlings.GDC equally operates its own tree nursery within the project site (Plate 8). Ultimately the planted trees will help conserve the water towers which supply drilling water to GDC for instant the Mau complex.

Plate 7: GDC staff planting trees in Menengai project area

Plate 8: GDC Menengai project tree nursery

4.6 Noise Level Assessment

Noise monitoring is carried out on a weekly basis during drilling. Noise levels over the monitoring period evaluated has been within acceptable World Bank/WHO limits and NEMA Maximum Permissible Noise Level Limits for Construction Sites.

In areas where noise levels are high especially for wells under discharge and testing and where noise gives rise to difficulties in verbal or sound communication, signs have been posted clearly and prominently marked "DANGER, HEARING PROTECTION MUST BE WORN in compliance with The Factories and Other Places of Work (Noise Prevention and Control) Rules 2005 and suitable hearing protection (Ear Mufflers and Ear Plugs) are provided to the affected workers and visitors as stipulated in the same Rules.

4.7 Water, Soil and Vegetation Quality Monitoring

Waste products from the drilling process will include brine and drill fluids. Constituents of the brine may contain chemical constituents that may surpass the wastewater quality criteria for surface disposal in any environment as recommended by Environmental management and coordination (water quality) regulations of 2006.

Wastewater reinjection has been adopted as this method of disposal of wastewater eliminates flow of surface waters and the subsequent development of the deep gullies in this area. It also ensures that soil, water resources, humans and animals in and beyond the project site are not exposed to the wastewater. Means of containing wastewater from drilling has been developed so that they are not released directly to the ground and on to vegetation. This has been through redirecting the wastewater from drilling and well discharge to a conditioning pond, from where the wastewater will be re-injected into some deep well.

The geothermal wastewater analysis results indicated that all elements conformed to NEMA standards. The ongoing on-going water quality monitoring by the GDC Environment Section in the stream and spring in Menengai project area show no significant change in the water quality of the Wanyororo Spring and Kandutura River compared to the baseline data.

4.8 Stakeholder and Local Community Engagement

GDC has on a continueous basis engaged its key stakeholders and the local community in the Menengai project area. This has been achieved through stakeholder and public meetings for community and stakeholder participation, to ensure they fully understand the project and are incorporated in its day to day implementations. In such meetings the corporate activities and future plans for the project are highlighted to ensure they are all on board.

4.9 Environmental Management Systems

GDC has started working towards ISO 14001 (Environmental management system) certification. This system will facilitate management of the current environmental monitoring programs in a comprehensive, systematic, planned and documented manner.

5.0 CONCLUSIONS

The Environmental Management Plan (EMP) usually improves mitigation of potential impacts in a continuous way over time due to its regular review to take care of new or non-anticipated impacts. Its full implementation has ensured that geothermal drilling project in Menengai proceeds with all potential environmental and socio-economic impacts as predicted in the ESIA study report being effectively managed and mitigated hence ensuring environmental, social and economic sustainability of Menengai geothermal project.

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