Presented at "Short Course on Geothermal Drilling, Resource Development and Power Plants", organized by UNU-GTP and LaGeo, in Santa Tecla, El Salvador, January 16-22, 2011.

UNITED NATIONS UNIVERSITY
GEOTHERMAL TRAINING PROGRAMME

LaGeo S.A. de C.V.

ENVIRONMENTAL IMPACT CONSIDERATIONS FOR GEOTHERMAL DRILLING

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ABSTRACT

Geothermal drilling is one of the most important activities in the geothermal development. For that reason the evaluation of the impacts during this process is important in order to obtain an environmental friendly geothermal project. This report analyzes the different environmental aspects related with geothermal drilling, the environmental legislation regarding the construction of a geothermal well, and the geothermal field development process. A model of the geothermal well construction process which adheres to the concept of environmental sustainability is achieved. The results show the feasibility of the construction under the sustainability concept not only as a tool for the protection and conservation of the environment but also as an improvement of the construction process in terms of competitiveness.

1. INTRODUCTION

The Miravalles Geothermal Field is located at the Miravalles Volcano in Bagaces, Guanacaste, between the Blanco and Cuipilapa rivers basins. The Miravalles I and Miravalles II power plants are located at the coordinates 298 000 N-405 700 E at 610 m a.s.l and the Miravalles III power plant at the coordinates 300 150 N-407 050 (Vallejos, 1996).

The Miravalles Environmental Impact Assessment (EIA) was done in 1988. Since it was the first EIA ever done in Costa Rica it changed the way of creating models for future large projects. However, this study includes all the environmental aspects considered in the modern methodology for the EIA, even the social aspects.

In Costa Rica the laws clearly protect the environment but also the right of the inhabitants to well-being.

The National Constitution indicates that "All the people have the right to enjoy a healthy and ecologically balanced environment" and also the government has the responsibility to ensure this right.

The most important environmental law (1995) indicates that:

- The environment is national heritage for all of its inhabitants. This implies the obligation to protect it but also the right to use it in order to provide well-being.
- The government has to ensure the sustainable use of the natural resources.

- The damage to the environment is a social, economic and cultural offense.

All the projects in Costa Rica need to obtain permission from the Ministry of Environment and Energy (maximum environmental authority). The methodology to evaluate the impacts are established in the legislation DE-31849 "Reglamento General sobre los Procedimientos de Evaluación de Impacto Ambiental" (General Regulations on the Procedures for Environmental Impact Assessment). Before any development is done an organization needs to present a preliminary environmental study that is a detailed description of the project and the environment where the project will be inserted. Based on this information the authority decides the environmental impact significance of the project and then if the EIA is necessary.

There are three significance categories:

- Low environmental impact significance;
- Moderate environmental impact significance; and
- High environmental impact significance.

If the impacts are considered as low significance the developer only needs to present an environmental declaration. If the significance are moderated the developer need to present a environmental management program, and if the significance is high, depending on the importance of the impacts the authority could require a partial or full EIA, and it is necessary to make a money deposit as a guarantee in case of non-conformance. If any non-compliance occurs the company can lose its money. And if the impacts are considered to be extensive, the project can be stopped.

2. THE GEOTHERMAL ENVIRONMENTAL MANAGEMENT IN COSTA RICA

The environmental geothermal management is focused in the EIA requirements. One important tool to ensure a systematic way to accomplish the EIA requirements is using an Environmental Management System. The ISO 14001 Environmental Management System implementation at geothermal projects in Cost Rica began in 2002, due to the new ICE environmental policies. Before 2002 Miravalles has an environmental monitoring system, it was mainly focused in the monitoring of different environmental parameters established at the Environmental Impact Assessment, and does not include the management system of the ISO 14001.

In March 2002, the ICE directive council established the environmental policy for the organization and ten principles to define it. The ICE policy is as follows: The Instituto Costarricense de Electricidad (ICE) plans and develops its activities with the principle of sustainable development; the management is done according with the attitude of conservation, protection, recovering and adequate use of the environment.

In Miravalles, the Environmental Management System is used as a tool of continual improvement to administrate environmental issues and can be used successfully to ensure the EIA requirements. The Environmental Management System improves the EIA programs because ensure the continual actions' reviewing, and allow the detection of new impacts. The Environmental Management System that has been used in Miravalles (Figure 1) has eight main topics to ensure adequate environmental management and additional procedures to control the system.

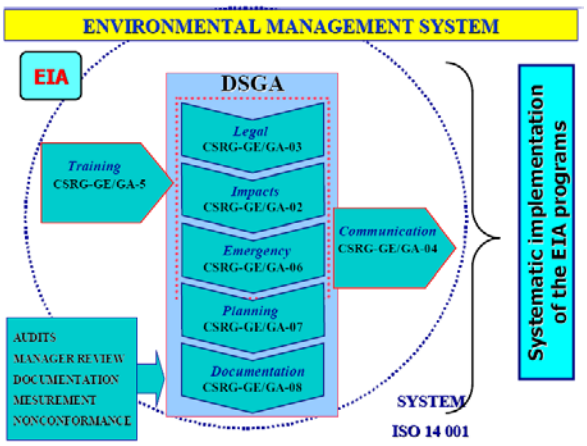

FIGURE 1: Environmental management system

With the Environmental Management System it is possible to systemize and improve the control of impacts in a continuous way (continuous improvement). Figure 2 shows the model of continuous improvement in the geothermal environmental management. It is necessary because the process changes as well as the organization, the environmental conditions and legal requirements change. And this means that the environmental programs and the actions also need to change continually.

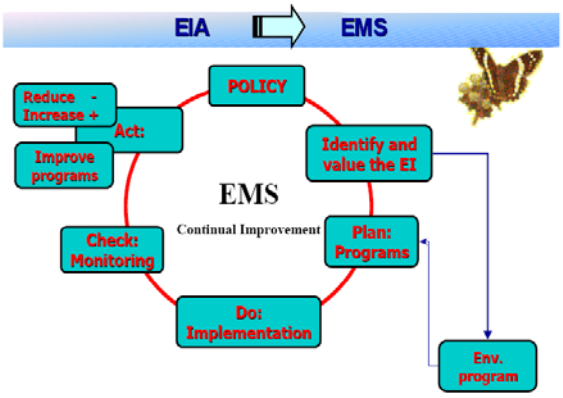

FIGURE 2: Environmental Management System and continual improvement

The main objective of any Environmental Management System is to improve the environmental performance of the organizations to protect the environment, improve their public image and reduce costs.

The main purpose of the Environmental Management System is to prevent all kind of negative impacts. If it is not possible it will try to reduce the negative impacts and if any of these solutions are possible, then it will focus on to mitigate the impacts. But as is shown in Figure 3, there are other aspects associated with the implementation of the Environmental Management System. The organization can reduce the costs if it teaches the people about the importance of reduce the unnecessary use of material, electricity, water, paper, etc. It will represent a high efficiency and less production costs.

The actual laws in Costa Rica and in most of the other countries penalize environmental pollution, in most of the cases it means high quantities of money to pay and use of time and resources reversing the damage. All these problems can be prevented if the organization implements an adequate Environmental Management System. Finally, it has to be taken into account that the communities have a lot of power. If they are against the project it will mean a lot of problems that can be prevented and solved by a correct Environmental Management System implementation.

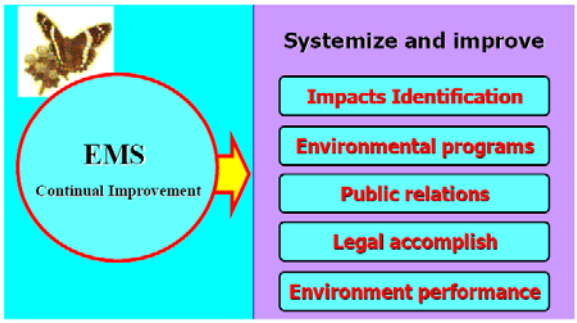

FIGURE 3: Environmental Management System helps to improve the environment's protection

The Environmental Management System also increases the sense of responsibility with nature and thereby improves the personal satisfaction among all of the members of the organizations.

The environmental management in the geothermal projects in Costa Rica is focused on six main aspects: air and water quality, evolution of the rainwater pH, environmental education, field management and communities' relationships. The monitoring is done using a system of control stations located around all the influenced area. Also the meteorological conditions have been monitored.

3. ENVIRONMENTAL MANAGEMENT DURING GEOTHERMAL DRILLING

Figure 4 shows the main activities during the geothermal drilling and the main monitoring activities to control the possible environmental impacts.

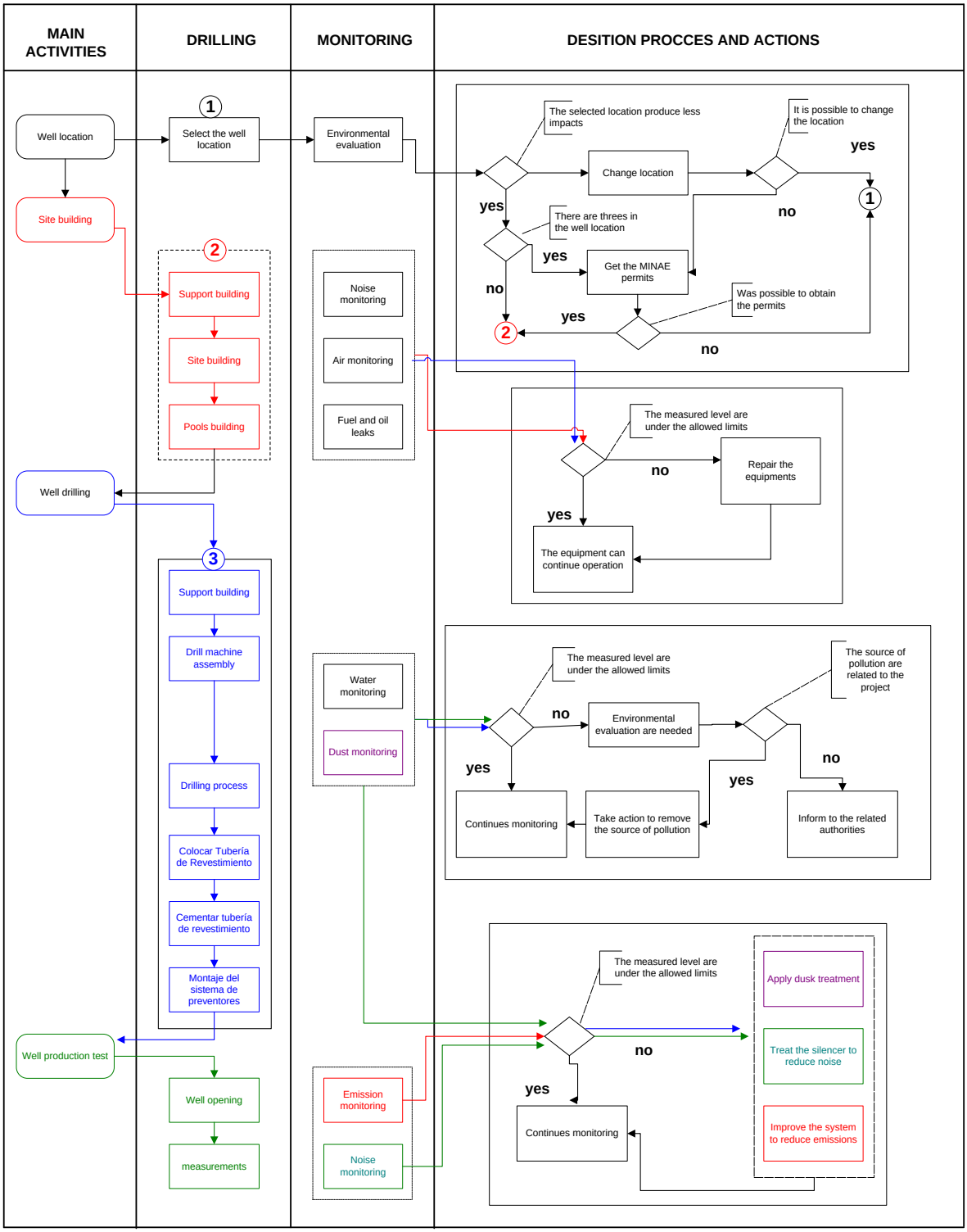

FIGURE 4: Drilling and monitoring system

Due to the Environmental Management System requirements it is necessary to analyze all the project activities to determinate possible changes in the environmental conditions that can produce new environmental impacts. To monitor the changes the matrix shown in Figure 5 is used. The matrix considers different environmental parameters, the legal aspects and the frequency of the activities monitored.

Continuous studies are quite important because they involve the persons working directly at the project activities. It means that the analyses will considerer all the small details, potential problems probably not detected during the EIA process. This detailed analysis allows reviewing and valorised the process and then classify the impacts by relevance as is shown on the left in Figure 6 and also what environmental parameters are the most affected by the different processes as is shown on the right.

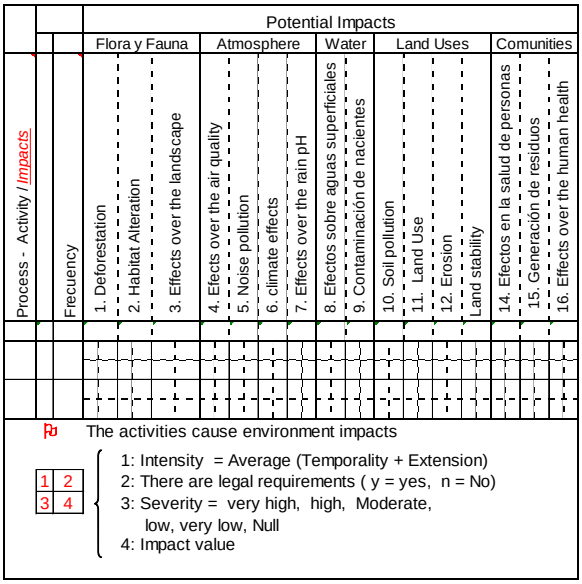

FIGURE 5: Matrix of identifying environmental impacts

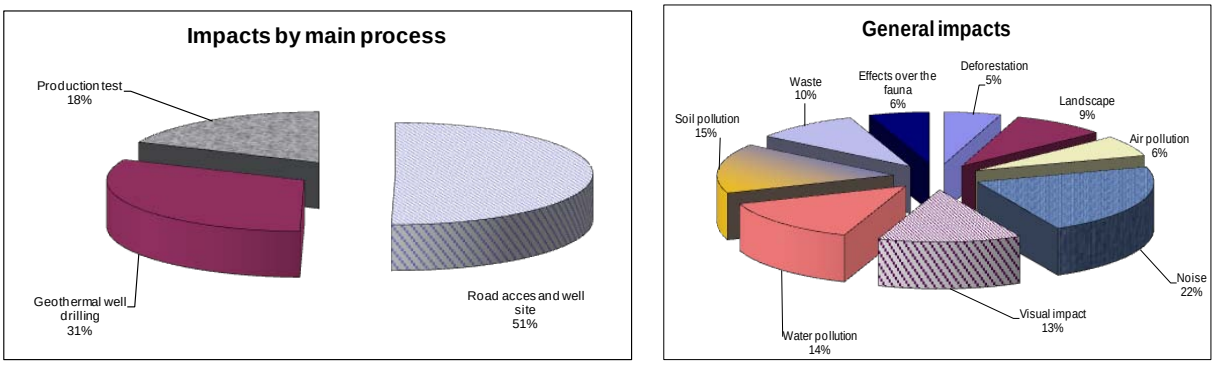

FIGURE 6: Impacts at the productive process

PGP - 11

Fecha del recorrido: PGP-11	01/09/2010	08/09/2010	28/09/2010	30/10/2010	15/11/2010	29/11/2010
Reporte	NI	SI	SI	SI	SI	SI
Lagunas impermeabilizadas						
Existencia de Basura						
Aceites						
Ruptura en la geomembrana						
Fugas por rebalse						
Otros						
Plataforma						
Basura en la plataforma						
Presencia de derrames de aceite						
Presencia de derrames de lodos						
Derrames de combustibles						
Otros						
Niveles de ruido						
No Med. / Punto						
A			76.7	70.5	67.1	54.2
B			74.1	76.5	70.4	60.7
C			71.2	73.2	69.6	64.5
D			83.3	68.2	64.8	43.2

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FIGURE 7: Impacts at the productive process

This information allows attending first to the impacts with more significance and then reduces the negative impacts of the projects. It is showed that the build of roads and the well site produce the main impacts. And also noise, soil and water pollution are the main potential impacts over the environment. For these reason the environmental monitoring during the geothermal drilling include mainly these aspects.

Figure 7 shows an example of a simple tool to follow some environmental aspect during the drilling, the monitoring include the main environmental aspects and try to control them.

As is shown in Figure 8 during the drilling and production well tests the noise and the air pollution are monitored, there are no impacts in the air quality; the only concerns are the noise during the production test, the sound level can be over the 85 dBA and this

PRUEBAS DE POZOS			CO_2				H_2S				Hg				Ruido			
POZO	FECHA	MEDICION	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
PGP-24	22-ene-10	1	300	290	280	290	0.004	0.004	0.003	0.004	0.000	0.000	0.000	0.000	77.2	71.8	75.1	73.9
		2	290	310	300	320	0.004	0.004	0.004	0.004	0.000	0.000	0.000	0.000	77.1	70.1	74.4	73.3
		3	280	300	290	300	0.003	0.004	0.004	0.004	0.000	0.000	0.000	0.000	77.3	71.3	74.7	73.6
		4	290	280	290	300	0.004	0.005	0.003	0.004	0.000	0.000	0.000	0.000	76.9	70.8	75.5	74.1

FIGURE 8: Air quality monitoring

problem is worst when the geothermal well are near to populated areas where the maximum levels are 60 dBA during the day and 40 dBA in night times.

One of the most important activities is the environmental education (Figure 9). The change of the environmental culture is quite difficult and only with constancy is possible to obtain positive result, but it is necessary to be patient.

FIGURE 9: Environmental education

There are simple actions that can prevent large environmental problems, but if the people are not compromised and not take the prevention to reduce the impact, a simple bottle with small residues of dangerous chemicals or fuel can become a big problem and can mean large impacts in the company image. If the people in clear about it they will easily prevent potential problems.

During the last two years the ICE's environmental group has been working in environmental education and has been implementing a solid waste management program to control the way to process mainly the hazardous waste produced in the geothermal field.

The management is focused in this aspect because the potential pollution over the soil and water that can be generated due to leaks or bad management of hazardous products; it means that if you can control in an adequate way the dangerous material, so the risks of environmental impacts are also controlled.

The main idea of the program is to show to the people the importance of a good management of the hazardous materials and also the importance of separate the waste and recover or recycle part of it (Figure 10).

The obtained results are impressive and evident, the amount of the recover materials is big and the aspect of the work sites is better.

FIGURE 10: Environmental waste management

Figures 11 and 12 compare the working site condition before the program start and after working for two years in these programs. Also shows the conditions in two different drilling sites, geothermal drilling and superficial drilling for gradients wells.

FIGURE 11: Management before environmental education and monitoring

FIGURE 12: Management after environmental education and monitoring

4. CONCLUSIONS

- The Environmental Management System allows systemisation and improvement of control of impacts in a continuous way over time. It also improves the EIA programs in itself because it ensures continuous reviewing and allows the detection of new or non-considered impacts.

- Due to the environmentally friendly of the geothermal energy, is during the complex drill activities where the main impacts can occur and this is because the equipment is in constant movement and there are more probabilities of accident and it's more difficult to control other impacts like noise, dust and visual impacts.

- The main impacts during the geothermal well drilling are the noise and the risk of soil and water pollution due to leaks of hazardous materials like oil gas or chemical products. But all these impacts can be controlled in an easy way wit the adequate people's training and activities monitoring.

- The adequate waste management is important to prevent potential pollution over the environment. Impacts over the soil, water and air can be controlled using and efficient control of the ordinary and hazardous waste.