Summary Environmental and Social Management Plan

Project Title : **Geothermal Exploration Project**
Project Number : P-DJ-FA0-001
Country : Djibouti
Department : ONEC Division : ONEC2

1. Brief Description of Project and Main Environmental and Social Components

Project Description

Geothermal resource utilisation activities have a 36-year long history in Djibouti. The first exploration campaign was conducted in 1975 by BRGM. A second drilling programme, partly financed by the World Bank, was conducted in the late 1980s in Lake Assal region (4 boreholes) and Hanlé region (2 boreholes). After the drilling of two boreholes in Hanlé region, the drilling platform was moved towards Lake Assal, where 4 boreholes were drilled. Two of the boreholes in Assal turned out to be productive, but donor disagreement on the need to conduct more exploration activities, as well as civil strife in Djibouti in the early 1990s hampered the development of a geothermal power production plant. In the 2000s, cooperation agreements between Djibouti and Iceland revived the geothermal programme before Iceland's 2008 financial crisis hamstrung its capacity to fund a drilling programme. The concession awarded to the Icelandic exploration company (REI) expired in May 2009. Recently, the Government of Djibouti requested donors (the African Development Bank and the World Bank) to help it implement a geothermal exploration drilling project.

The objective of the geothermal project is to quantify the technical and financial feasibility of using the geothermal resources of Assal Rift for mass production of electricity. The project comprises an exploration drilling programme of 4 production wells in Fialé region and more precisely to the North of Lava Lake.

This zone is located on the southern fringe of Tadjoura region, about 70 km West of Djibouti City. The primary objective of each of these four drilling exercises will be to reach and test the intermediate (surface) reservoir. During the 6 drilling exercises conducted at Assal, this intermediate reservoir was reached at depths of 240 to 600 metres. The temperatures of the intermediate reservoir recorded during previous drilling programmes ranged from 140°C to 190°C, high enough to generate electricity for commercial purposes using a binary cycle power plant.

The geothermal resource evaluation project will be implemented under three primary contracts comprising:

a. The selection of a geothermal expert to support the project team in structuring the programme and preparing the Request for Proposals for the drilling consultant;

b. The selection of a drilling consultant to:

   (i) prepare a specific drilling plan in the form of an invitation to bid used to select the drilling company;

   (ii) supervise implementation of the drilling programme by the drilling company;

   (iii) produce the results of the drilling programme; and

(iv) correlate and analyse the results of the drilling programme in order to validate the geothermal resource and prepare the basic data that will be used for any bidding process to recruit the developer for the second phase.

c. The award of a services contract for the conduct of exploratory drilling.

The following works will be necessary under the proposed project:

- construction of an access road from the Djibouti-Tadjoura RN9 highway to the drilling sites;

- opening of one or more quarries to obtain backfill material;

- construction of 4 drilling platforms, each having a surface area of 6,000 to 10,000 m^2. To each platform will be added two watertight tanks, one for mud (1,000 m^3), and the other for collecting geothermal fluids produced during production tests (2,000m^3). In event of a positive drilling result, the equipment needed to conduct various tests, such as a separator and a silencer, as well as fluid processing equipment, will also be installed on these platforms.

- preparation of the land at least for storage of equipment and/or temporary premises for the drilling team;

- drilling works (4 boreholes created through rotary directional drilling with an initial diameter of 23 inches, a final diameter of 9 inches, and a target depth 2000 to 2,500 metres).

- laying of discharge pipes for geothermal fluids, and a water intake pipe for preparation of drilling mud;

- establishment of a camp for workers and security officers.

The drilling platforms will be installed near former borehole A5 situated to the north-west of Lava Lake. The works will be implemented in the following stages:

1. Design and studies phase, including preparation of bidding documents for the drilling contractor (4 months);

2. Preparatory phase / installation of project site (construction of access roads, development of platforms, installation of tanks, construction of infrastructure, etc.);

3. Drilling works and production testing phase (duration of approximately 12 months: 1.5 to 2 months for drilling, 3 months for production testing).

4. Completion (abandonment or preparation of operational follow-up of the project).

Main Environmental and Social Components

The study area of this environmental and social impact assessment comprises the land between Lake Assal and the Gulf of Ghoubbet (see map below). It is located in Tadjoura prefecture, 120 km from Djibouti and 70 km from Tadjoura. Daba le Gahar, Ardoukoba (Carrefour) and Laïta villages are located within the project area.

Geology

From the geological standpoint, the Republic of Djibouti is located at the confluence of three major rifts: the Red Sea, the Arden Gulf, and the East African Rift. Its territorial relief, which is essentially volcanic in origin, was formed by a series of successive volcanic activities caused by tectonic movements. The Assal Rift, which was discovered in the 1960s, shows tectono-magnetic structures crisscrossing the ocean bed. It is an active plate frontier where it is possible to observe the birth and monitor the evolution of an ocean. Such oceanisation stems from the NNE displacement of the Arabian plate as it separates from the African plate. The separation is not yet final since the Arabian plate remains attached to Africa through the Afar Depression that comprises the territory of Djibouti. This huge depression, which extends into Ethiopia and Eritrea, is crisscrossed by a complex system of large cracks and faults of which the most active lie between Ghoubbet-Kharab Basin and Lake Assal (Assal Rift).

On account of this geological situation, the geothermal gradient is particularly high in the Assal Rift region. That is why this region was chosen for the implementation of geothermal energy projects. The Assal Rift region is dominated by very recent volcanic rocks. From the geological standpoint, starting from the uppermost strata right down to the innermost depths, there are:

- recent basaltic flows (Asal series);
- hyaloclastites (Asal series);
- basalts (Gulf series);
- basalts (stratoid series, aged 1 to 3 MY);
- rhyolites (aged 1 MY); and
- basalts of the Dalha series (aged 4 to 7 MY).

Figure 1
Study Area

The most remarkable signs of recent and current volcanic activity in the Asal Rift are the presence of hot springs, fumaroles, various craters and the Ardoukoba volcano that started in November 1978. Because of this peculiar tectonic situation, the Asal Rift is a very seismically active region. Earthquakes are quite frequent although their intensity is low (generally imperceptible to man). The region was hit by an earthquake in March 1992 that rippled through the Gulf of Tadjoura, with its epicentre located at sea, 2 km off the coast of Arta, and seismic tremors that exceeded 4 on the Richter scale. These earthquakes did not cause much damage. The average period of occurrence of an earthquake with a magnitude exceeding 5 in a given region is estimated at 16 years (± 5 years). A magnitude of 6 on the Richter scale is the estimated maximum for the Gulf of Tadjoura (Didier, 2001).

Soils in the project area are generally under-developed. It is only in the wadis that lithosols are sometimes found.

Climate and Water Resources:

Humidity ranges between 40% and 90%, while average air temperature is 25°C in winter and 35°C in summer. Annual rainfall is normally 50 mm to 215 mm, with an average of 130 mm, but can be highly variable in certain years. The climate, which is far from uniform all over the national territory, varies over time and with each region. Generally, the climate in the coastal regions is characterized by a cold season (from October to April) and a hot and dry season (from May to September). The quantity of fresh water resources in the project area is very limited because of low rainfall.

The nearest groundwater resource is located in Kussur-Kussur, 10 km towards the South West, where the RN9 highway crosses As Dan'aou wadi (located 5 km North-East as the crow flies). The groundwater resources map of the Republic of Djibouti (BGR 1982) shows that the groundwater in the Lake Assal region is of poor quality, with a salinity of >2.000 mg/l. CERD (2009) has indicated the presence of brackish groundwater in the study area.

In the coastal regions, where the project is located, climatic conditions are harsh and inhospitable. Limited and even total lack of rainfall (drought in 1980 and currently), and the consequent lack of perennial watercourses, expose plant and animal resources to a high risk of degradation. That is why agriculture is less developed and the main activity in rural areas remains pastoral nomadism.

Ecosystems / Protected Areas

Djibouti currently has 7 protected areas comprising 4 on land (Day and Mabla forests, Lake Abbé and Lake Asal) and 3 at sea (the Islands of Musha and Maskali, Sept-Frères-Khor Angar-Godoria and Harramous). They are all classified as protected areas under Djibouti law, but do not directly match the categories of the IUCN. The terrestrial ecosystem of the Republic of Djibouti is divided into mountainous regions and plains, plateaux and depressions. These low-lying lands are characterised by steppes and grassland savannah. The plant life, such as acacias, is adapted to dry climates.

Lake Assal

Lake Assal, considered to be one of the geological wonders of the country (situated 155 m below sea level in a volcanic area, the third deepest depression in the world) is surrounded by an expanse of solid salt of variable thickness that exceeds 60 metres at certain points with a surface area of 60 km^2. This briny body of water, which is saturated with mineral salts (up to 340 g/l), has a surface area of 50 km^2 and a maximum depth of 25 m. Its reserves are deemed to be inexhaustible, since 6 million tonnes of salt flow in each year (filtering in from Ghoubbet sea and from brackish hot springs).

From time immemorial, this lake has always been a focus of interest to the nomadic peoples of the region whose main livelihood is small-scale mining of salt that is exported by caravan to Ethiopia where it is used in chemical industries (tannery, fertilizer) and for human consumption. However, this salt is not iodized and the Government of Djibouti has banned its consumption all over the national territory (to prevent thyroid disorders in the population) (Source: MHUE (2005); Coastal Area Integrated Management Plan).

Lake Assal has been declared a protected area under Articles 1 and 7 of Law No. 45/AN/04/5L. Nevertheless, the exact boundaries of the protected areas and their managerial measures have not yet been defined. There is no accurate map of protected areas in the country. The statute determining the protection boundaries of Lake Assal has not been adopted, but provision is made for protecting the lake itself and its salt banks (solid salt expanse). The distance between the drilling site and the banks of Lake Assal is approximately 8 km. The proposed drilling site is located (maximum 1 km) close to the area where water from Ghoubbet sea filters into Lake Assal.

Ghoubbet-Kharab:

Ghoubbet is a sensitive ecological area separated from the Gulf of Tadjoura by a narrow strait that is 40 m wide and 40 m deep. Ghoubbet sea is more than 200 metres deep. Sea water salinity ranges from 39.3 g/l at a depth of 125 m in November to 37.7 g/l at the surface in June. Surface temperatures fluctuate between 28°C and 30.5°C. Ghoubbet is a potential marine protected area according to MHUE.

Coastal Area:

On its continental part, Djibouti's coastal area boundary is set 15 km from the coastline. The project area is located in the coastal region of the Republic of Djibouti. The distance between the drilling site and Ghoubbet-Kharab is approximately 2 km as the crow flies and 5 km by road.

The Coastal Region Integrated Management Plan (GIZC) provides that one of its key concerns is to promote economic development which includes preservation of the coastal environment in various sectors (heavy infrastructure, transport, industry, agriculture and stockbreeding, fisheries and tourism).

Vegetation

In general, the vegetation of Assal-Ghoubet region is grass (especially in the wadis) and shrub steppe with *Dracaenae ombet*, *Acacias tortilis* and *mellifera* as well as *Acacia asak* in the more humid areas. Acacia leaves are the main food for herds of goats.

The land around the proposed drilling site and around "Lava Lake" is uneven terrain, covered mainly by basaltic lava with very little vegetation in general.

Nevertheless, one of the specific characteristics of the site is the presence of mainly herbaceous vegetation that grows thanks to vapour emissions from the fumaroles in the caldera and its environs. The name *Fialé* in the Afar language refers to this vegetation, which is generally found along the fissures open towards the rift. There are no shrubs within the landed strip of over 1 km surrounding Lava Lake. The herbaceous plants that flourish around the faults and fissures are also less abundant than in neighbouring regions. Furthermore, they are of little grazing value, as confirmed by the local population.

Wildlife

On account of the extreme salinity of the water in Lake Assal, wildlife presence is limited to the confluence of springs flowing into the lake where the water is less saline. The presence of small fish (*Cyprinodon* sp.) has been confirmed.

Ghoubet marine basin is a spawning area for most pelagic fish and coral reef fish of Djibouti (National Monograph 2000). Although corals are relatively less numerous and less developed, the permeable species composed of barnacles, sponges, molluscs etc., are very diverse. Fish are the most studied species, and there are at least 454 species living in Djiboutian seas, some of which are endemic. There are also 27 shark species, including the whale shark. The marine and coastal waters are home to 4 turtle species, 13 marine bird species and (among the marine mammals) dugongs and dolphins (Source: MHUE 2005). The dugong (*Dugong dugong*) and the whale shark (*Rhincodon typus)* feature on the IUCN's (International Union for the Conservation of Nature) list of endangered species.

Ghoubbet is the habitat of several species mentioned in Decree No. 2004-0065/PR/MHUE on the protection of biodiversity, especially dugongs, dolphins, turtles, sharks and whale sharks *(Rhincodon typus)* which deserve special protection.

Proposed Drilling Area / Caldeira de Fialé:

Caldeira de Fialé (located near the scheduled drilling area) is used as pastureland by the local community and transhumant herds. At the same time, the site is also traversed by the access road leading to the Ardoukoba volcano and Lava Lake which are sites of touristic interest. Because of the frequent passage of tourists, gazelles and other mammals are rare in the project area, although the presence of gazelles has been confirmed.

Human and Socio-Economic Environment:

According to preliminary statistics of the 2nd General Population and Housing Census (GPHC) of 2009, Djibouti's population is estimated at 818,159 inhabitants. The geographical distribution of the population remains relatively balanced between the capital region of Djibouti City (58.1%) and the hinterland regions (41.9%).

Until very recently, Djibouti's rural population was a pastoral society with a subsistence nomadic way of life and close ties with neighbouring countries. The Afars of Northern Djibouti followed the transhumance routes running through the Afar zones of Eritrea and Ethiopia, while the Issa/Somali groups moved with their herds through the Somali zone. Although most of them have long become sedentary, they have maintained their pastoral and transhumance traditions, albeit on a much smaller scale, to this day.

The country's official languages are French and Arabic, while Somali and Afar, which belong to the Cushitic group of languages, are the main mother tongues. At the national level, the country's two main ethnic groups are the Afars and Issas, both of which have a nomadic tradition and share the Muslim faith. Obock, Tadjoura and Dikhil regions are mainly inhabited by the Afars, while Ali Sabieh, Arta and Djibouti regions are mainly inhabited by Somalis belonging to the Issa group.

Pastoral organisation, which is determined by the status of resources, is predicated first and foremost on livestock survival. During normal (non-drought) periods, pastureland usage is strictly regulated to ensure its sustainable management. In times of crisis, herders may roam the land without any restrictions to ensure livestock survival. However, a person's animals may range in a neighbour's pastureland only if they have common reciprocity agreements.

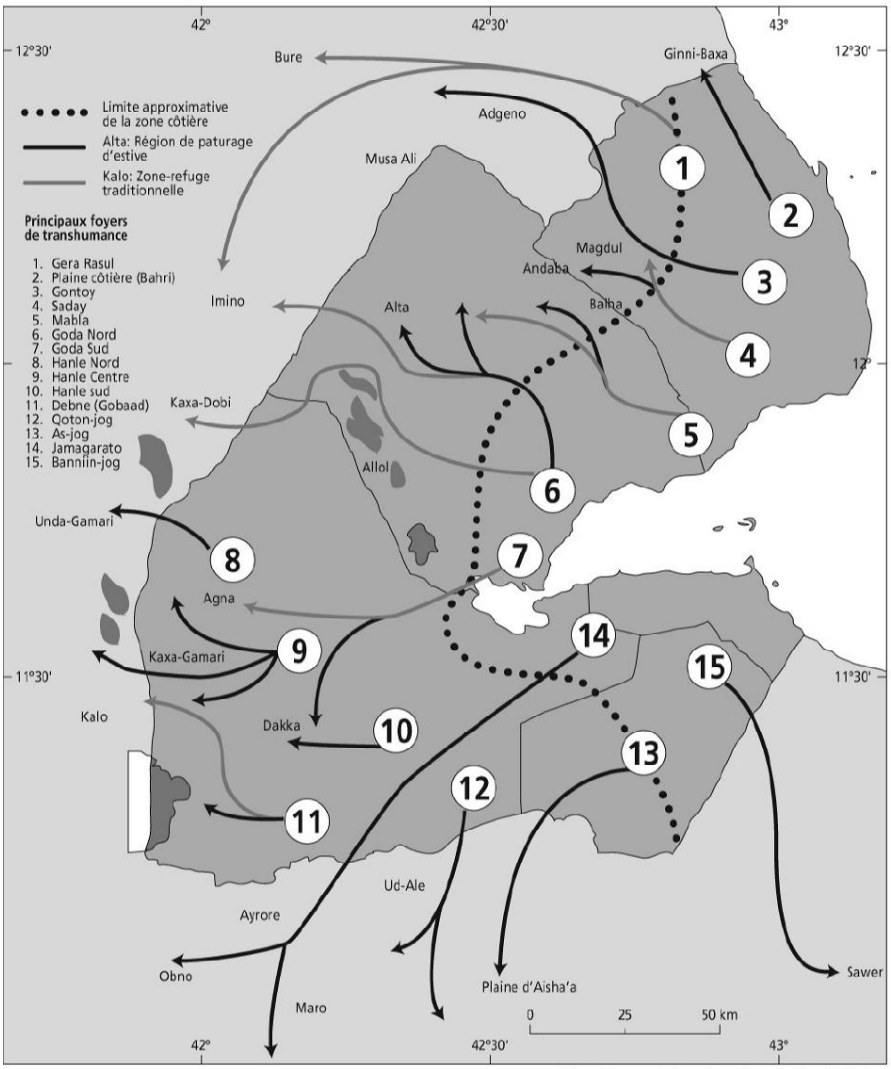
Both societies follow the traditional transhumance routes. Route No. 7 transits directly through the project area over a distance of approximately 5 km with a breadth of 5 m to 1 km, depending on the geographical location (narrow route through lava blocks or more open terrain).

The Issas are not present in the project area. Rather, it is a traditional zone of activity for Afar nomads who have been mining salt from Lake Assal for centuries. Camel trains have been the means of transport to destinations located in the Ethiopian mountains or to the Djiboutian port of Tadjoura.

The project is located in Tadjoura region, 79 km from Tadjoura town and 127 km from the capital. It is 7 km away from the border of Arta region and 25 km away from Karta village (Arta region), where the nearest school is found. The closest community is currently located at Daba le Gahar (76 households) on the former camp site of the Yugoslavian company that built the RN9 highway, situated approximately 5 km from the proposed drilling site. The total population in the villages of Daba le

Gahar, Laïta and Ardoukoba (called Carrefour) is 298 "sedentary" households who still mine salt using caravans. In addition to the settled population, 248 "semi-nomadic" households (practicing transhumance) live in the area. The population in the study area is 546 households, the closest of which live in Daba le Gahar, 5 km from the proposed drilling site.

Figure 2
Transhumance Corridors in Djibouti



Source: National Monograph on Biodiversity (MHUE, 2000), taken from ISERST (Guedda/Godet)

The camps of the drilling and geothermal energy workers will probably be established jointly with those of the Lake Assal salt mining workers (Saltinvest) in Daba le Gahar. Traditionally, the Assal zone is not recognized as a permanent settlement site because of its harsh climatic conditions, lack of drinking water and scanty vegetation.

In the past, it used to be a periodic transit area between two seasons (cold season and hot season) used by transhumant herders as they moved from North to South or from South to North. There are no basic services, no basic infrastructure, no health post or school. However, it was also the area that experienced the first intensive salt extraction activities. The region had the greatest number of caravans travelling from the salt banks of Lake Assal to Ethiopia.

Due to closure of the salt mining project, the decline in economic options and prevalent poverty, a high number of households has left the sub-prefecture. There are no homes in the proposed drilling area.

According to Djiboutian archaeologists, there are no signs of prehistoric settlement in the environs of the proposed drilling area and the existing access road. The important sites within the region are concentrated along the Ghoubbet coast, South-East of the study area.

Djibouti remains on the list of least developed countries, ranked 155th out of 182 countries under the 2009 Human Development Index of the United Nations Development Programme (UNDP). Poverty is widespread, affecting close to 75% of the population, including 42% living in extreme poverty. It is particularly acute in rural areas where close to 96% of the population is considered poor, compared to 66% in small towns and 35% in Djibouti City.

Agriculture is poorly developed because of harsh conditions. Stockbreeding, which is more adapted to such conditions, remains the dominant activity in rural areas. It is practised in two ways: nomadic and sedentary. Approximately 90% of stockbreeding is nomadic, while the rest is sedentary. Transhumant stockbreeding is the main activity of rural communities, and is very often their sole livelihood. It involves close to 1/3 of the country's population, and is practised extensively along routes depending on availability of water and pastureland. Pastureland is essentially found in hilly regions and grabens.
The livestock population is mainly composed of goats and sheep. The rearing of camels and cattle is also widespread, although the latter is reared on a more limited basis in the Northern region. Cattle-rearing has, more or less, been sedentarized in order to ensure milk supply to Djibouti City. Donkey rearing is practised by a minority.

In the project area, there are several tourist attractions of varied potential:

- Lake Assal and the salt caravans;
- "Lava Lake";
- Ardoukoba volcano with its peculiar geology;
- Ghoubbet-el-Kharab, the shark pool, Devil Island;
- the camps of "Dankalêlo / Ghoubbet" and "Afar Rift".

The project region's potential is mainly geared towards the sector niche of nature-culture tourism and adventure and geological tourism. Infrastructure in Assal region is rudimentary, and the tourist camp of Dankalêlo Plage operates below capacity. In 2011, the camp received approximately 50 local and zero European tourists (according to a guard at Dankalêlo Plage).

Gender Aspects

The Ministry of Women's Advancement has a local office in each region to implement and monitor its activities and programmes. Its main initiatives include literacy programmes, child health centres, support to vulnerable women, construction of wells, data collection on women and capacity-building.
In general, the economic situation of women in Lake Assal region is very difficult. The same applies to men, most of whom have been unemployed since the closure of salt mining companies. The women's situation is characterised by their role of fetching water and energy, two resources that are rare in the region. Fetching water and fuel wood takes up most of the day without any corresponding reduction in women's other responsibilities like child upbringing, housework, cooking, etc. Changing traditional roles is difficult. Girls have to accompany their mothers when they go to fetch water or fuel wood, and consequently cannot attend school. With the current community structures and women's associations, the situation is changing and women "leaders" are quick to speak out openly and address the lack of income-generating activities.

Drinking Water

The leading priority for the local population is drinking water. There is no drinking water source, since groundwater is saline. It has been announced that the situation of the people will be improved and that a source which is closer (in Kusur Kusur village) but located in another region (Dikhil) and not under the administration of Tadjoura, will be tapped. Daba Legahar village (the closest to the site and comprising 90 families), which belongs to Tajoura region, is supplied with water only once a week by tank truck from *Saltinvest company* which distributes 60 litres of water per household per week. The other two villages, Laita and Carrefour, are supplied by ARTA Region to which they belong administratively.

Education

There is no school in Assal sub-prefecture. Children from the villages concerned attend the nearest school in Karta (15 km). 59 children out of 170 in the communities attend school. Since there is no school bus, the children trek to and from school.

Health

There are no statistics on the health situation of Assal region. Public health is not developed. There is no dispensary/health centre in Assal sub-prefecture. In theory, an ambulance service exists in Tadjoura town, but because of the long distance, it is expensive and *de facto* unavailable.

Electricity

The villages have electricity only when there is gasoil for an existing generator (at least for some households). The project for building interconnection lines from the future geothermal power station will not improve the situation in the villages unless a low-tension line for rural electrification is constructed.

2. Main Environmental and Social Impacts

2.1 Positive impacts

Recruitment of Local Labour

It will be necessary to recruit local labour for the project. Skilled labour will surely come from the capital and from abroad, while the local population will have the opportunity to be recruited for manual work (unskilled labour) such as construction of an access road to the drilling site. Men and women have requested to be recruited on an equal basis. Priority in recruitment will be given to persons living near the project site. The positive impact on demand for labour will benefit relatively few people, and will only be in the short term. Demand for unskilled labour is estimated at 10-20 persons to build the access road for an estimated period of one month, and 2 to 4 persons (site surveillance, night watchmen) for an approximate period of 6 months. According to the PMU, about fifty people are likely to be employed on the drilling project site, including about 20 persons who could be recruited locally (watchmen, labourers, domestic help, kitchen staff, etc.). An exact figure will be obtained during the technical study of the project.

Development of Services for Camp Workers

The workers will probably use the camp of *Saltinvest SA* during the drilling phase. Unskilled labour will be recruited from the neighbouring villages in order to raise local incomes. Contrary to the massive and disorganized settlement of workers and their families during the salt mining boom of the

2000s which led to problems of hygiene, prostitution, security, etc., the use of the camp within the Saltinvest compound will help to prevent these problems. Despite the project's limited scope and short duration, its impact on the population, in terms of income generation, is deemed to be slightly positive.

Impact on Gender Aspects

The situation of women within the local population will not deteriorate as a result of the project. A positive impact may be produced through the creation of local jobs and attendant socio-economic measures. During the consultations, women requested to be employed on an equal basis with men and to receive the same salaries. An improvement in water supply and a contribution for the women's association could reduce gender inequality and help to curb poverty in project area villages.
The creation and management of a revolving fund (*tontine)* could constitute viable support for breaking out of the poverty cycle. Guidance by a women's association (OSC) or ADDS is recommended to ensure proper selection of business ventures and support for the initiative through a training programme.

2.2 Negative Impacts

Potential Impacts on Local Ecosystems

The geothermal project is not located directly within Lake Assal area or on the salt bank, and will consequently not have a direct impact on the Lake Assal protected area given its current scope. However, the geothermal drilling project could indirectly affect the waters of Lake Assal. In case of negligent treatment, muddy waters from drilling and geothermal fluids generated during the trial phase could potentially flow over the land's surface or through shallow faults into the lake. Given the probability that the heavy metal content (or other dangerous substances) of these fluids exceed that of the receiving waters of Lake Assal, it is imperative to ensure that such fluids, other waste or dangerous substances do not reach Lake Assal. Leaving fluids to drain away, as practiced during the drilling tests on Assal 3, is not acceptable. The drilling project could have a high negative impact on protected areas, the sensitive ecosystems and the coastal areas, especially if drilling sludge and geothermal fluids are dumped into the waters of Lake Assal or Ghoubbet el Kharab. Although the latter has not yet been declared a protected area, it is the habitat of several vulnerable species that feature on the red list of the International Union for the Conservation of Nature (IUCN), such as the whale shark and the dugong.

Cumulative Impacts on Protected Areas and the Coastal Zone

The Saltinvest Project left a considerable environmental impact on the Lake Assal Area and the Ghoubbet seashore by:

- mining salt in a protected area (salt bank);*
- developing a salt storage site on Ghoubbet seashore (potential marine protected area); and
- building a port on Ghoubet sea for maritime transportation of salt.

Any additional impact caused by the geothermal drilling project appears to be limited if mitigation measures are effectively taken.

Impacts of Project Infrastructure:

Project site preparation works will comprise various civil engineering works, especially:

- construction of an access road; and
- development of the drilling site itself.

The access road will be approximately 4,800 m long. So far, there are no specifications on the access road development. The road must be able to withstand heavy traffic, the transportation of drilling equipment and materials, etc.

Initial site development works will include the construction of four drilling platforms. The assumption is that the surface of these drilling platforms will be made of gravel. The space needed for such a platform is approximately 6,000 to 10,000 m^2.

Crushed aggregate needs are estimated as follows:

- access road (4,800 m): 5,000 m^3
- drilling platform (4 x 8,000 m^2): 10,000 m^3.

Developing the drilling platform sites and building the access road will have a limited impact on the area's:

- geology;
- topography;
- wildlife, vegetation and ecosystems;
- air quality (dust production);
- noise level (construction noise); and
- landscape (visual impact).

The impact on air quality and noise level is temporary, while the other impacts are permanent.

Quarry Management

The materials required are estimated at 15,000 m^3. There is a quarry near the site that could provide the needed materials. It is situated near the RN9 highway; approximately 300 metres south of the junction where the highway crosses the road leading to the tourist attraction called "Pool of Sharks". Furthermore, while conducting the engineering design study, the drilling contractor could investigate whether the numerous faults and recent volcanic scoria could provide the necessary material without any degradation of the landscape.

Operating the existing quarry located near the RN9 highway will have an impact on the area's:

- geology;
- topography;
- wildlife and vegetation (noise, destruction of biotopes);
- air quality (dust production);
- noise level (machinery, use of explosives); and
- landscape (visual impact).

The overall impact of the mine operation is rated as average. The impact on air quality and noise level is generally temporary, while the other impacts are permanent.

A mining permit and an environmental permit are needed to open a quarry.

Drilling Works and Production Testing

One significant impact of drilling works and production testing is the increase in noise levels. This increase is caused by drilling machines and geothermal blow wells. Drilling noise is approximately 75 dB(A) at a distance of 25 m from the noise source and falls to 30 dB(A) at a distance of 400 m. When drilling is successful, the noise from discharge wells could reach 100 dB(A) or more. A silencer will be installed to reduce the noise of production drilling. Since there are no residential areas near the site, the impact on the population is nil, although the noise will have some impact on wildlife. The noise near the drilling site exceeds the World Bank's threshold value of 85 dB(A) for heavy industry installations. Consequently, onsite workers will have to wear the requisite protective gear.

Another potential impact lies in the use of various machines, like drilling machinery or generators that consume fuels. In this case, there is always the risk of accidental contamination by fuels, oils and other fluids. The total quantity of fuels used for the entire project is estimated at 500,000 litres (order of magnitude).

The impact is classified as temporary and limited, and could be rated zero if the contractor uses only equipment that is in good condition and does adequate maintenance. On the whole, the environmental impact of drilling works and testing is classified as low and limited to the project duration.

Impacts on Water Resources

With regard to water supply, a distinction should be made between:

- drinking water for workers' needs; and
- water for drilling purposes, which is not required to be of the same quality.

The drinking water requirement for workers' camps is approximately 5 m^3 per day (assumption: 50 workers, consuming 100 litres per day and per person). Where necessary, the needs of the local population will also have to be factored into the calculation.

For drinking water supply to the workers' camps in Daba le Gahar, the options are to bring in water by tank truck or build a water supply system (for instance, from Kusur-Kusur village). If the chosen option is to bring water by tank truck, the impact will be negligible (very small increase in traffic: one truck every 3 days).

Water used for drilling purposes, especially for the production of drilling mud, may be tapped from the sea (pipes, pressure pumps) or from shallow boreholes (150 m) near the drilling site. The volume of water needed for drilling could reach 25 m^3/h, or 6,000 m^3/d.

Supplying the drilling project with water from Ghoubbet-Kharab sea would imply:

- building a temporary water intake connection on the Ghoubet;
- building a pumping station;
- building a pressure pipe that is approximately 4 km long.

Even if the above required facilities are temporary, they (especially the pipe) would still have a considerable impact on:

- soils and topography (pipe);
- landscape (pipe); and the
- Ghoubbet ecosystem (water intake structure).

The alternative of supplying water using tank trucks will cause a significant increase in traffic. It will require 400 trips by 15 m^3 tank trucks to transport 6,000 m^3 per day.

The option of supplying the drilling works with water from shallow boreholes located near the exploration drilling site will create only a very limited impact. That is why this option is the most preferable solution from the environmental standpoint. However, the technical feasibility of this solution is yet to be determined through hydro-geological studies conducted by the drilling consultant (investigation of the presence of a surface water table). This study also has to investigate the effects of water extraction on the level of the water table.

Air Emissions

Geothermal power station emissions are generally negligible compared to emissions from electric power stations that run on fossil fuels. Emissions may be produced during drilling and testing. The gases contained in Assal 3 drilling fluids include carbon dioxide (CO_2), with traces of hydrogen sulphide (H_2S) and Methane (CH4). Hydrogen sulphide is toxic to organisms at concentrations of about 20 ppm. The WHO standard provides that at a value of 10 ppm, protective measures should be taken for workers. Experience from the Assal 3 and 6 drillings shows that the expected concentrations are very probably lower, and the gas from the drilling site will disperse and be diluted because of the strong dominant winds in Assal region. Nevertheless, hydrogen sulphide is heavier than air, and this may in theory lead to accumulation within enclosed structures (buildings, etc.). For this reason, the H_2S parameter will be monitored and, where necessary, safety measures will have to be taken for workers. The gas from drilling activities will disperse and be diluted because of the strong dominant winds in Assal region.

Use of Drilling Fluids

All drilling methods use drilling fluids whose main function is to:

- evacuate drilling debris;
- cool the drilling bit;
- reinforce borehole walls;
- control fluid loss in permeable formations;
- control water inflow in the case of artesian water tables.

Choice of the fluid depends mainly on the nature of the terrain to be drilled, the features of the equipment, input supply possibilities and the qualifications of the drilling team. Generally, drilling can be done with foam or mud. The foam is produced from detergents and frothing agents. The mud is composed of fragments from rocks perforated during the drilling process (cuttings or spoils) as well as adjuvants that lubricate the drill bit and flush out the excavated material.

The type of fluid (foam or mud) to be used in Fialé will be determined during the engineering design studies to be conducted by the drilling contractor. These studies will also determine the precise chemical composition and volume needed. The mud flushed out during drilling is cooled, sifted,

partially recycled, and the spoils are dumped into vats kept for that purpose, together with some residual sludge. The solid particles settle at the bottom of the vat through decantation, and the clear water at the surface can be recycled or disposed of.

The filtered water should preferably be reused. For its final disposal, evaporation is the preferred solution, although the feasibility of this solution depends on the amount of water to be disposed of. This solution should be explored by the drilling contractor. Disposal must be done preferably near the exploration drilling site in shallow injection wells. In that case, the chemical composition of the water should be controlled. Contaminants could be chemical additives or pollutants such as heavy metals from the geothermal reservoir.

The criteria for this decision are the same as those applied to determine the quality of geothermal fluids. Furthermore, the drilling contractor needs to specify the additives to be used, as well as their contamination potential. If there is need to treat this water, the simplest solution would be to treat it in the geothermal fluids treatment plant. Indiscriminate disposal of drilling fluids may have a negative impact on the environment, especially on ecosystems. Regardless of the drilling method chosen, drilling muds must be treated. The method adopted for the drilling of Assal 1 to 6, which is to let the drilling muds and excavated material drain into the environment, is not acceptable from the environmental standpoint.

Generation of Geothermal Fluids

During the trial phase, a separator will be used to pump the vapour into the atmosphere and channel the residual water into a vat kept for that purpose. A silencer will be installed to reduce production drilling noise. A large quantity of geothermal fluids will be generated that will have to be disposed of properly. The total quantity produced during the trial phase of 90 days was estimated at 43,200 to 108,000 tonnes per test well. The test results of geothermal fluids from the deep geothermal reservoir boreholes A3 and A6 (Aquater, 1989) show very high salinity with a significant heavy metal content. By analogy with the results of previous campaigns, it is highly probable that the geothermal fluids from new boreholes will contain heavy metals (lead, zinc, copper, etc.) in quantities that are probably at variance with the quality of their receiving environment. It is obvious that indiscriminate disposal of these fluids would have a significant impact on the environment, especially water resources and ecosystems. Lead, for instance, is highly toxic to fish and other aquatic organisms. For this reason, it is necessary to treat geothermal fluids.

Based this assumption, there are, in principle, two disposal options for geothermal fluids, namely:

- reinjection into the original reservoir through an injection well; and
- disposal of treated fluids.

If the option of **reinjection into the original reservoir** is retained, then water-tight casing must be used to line the injection wells. Otherwise the water table above the original reservoir may be contaminated. It is also likely that the water from such water tables could flow into Lake Assal. Consequently, disposing of the water in this water table would contaminate the lake's ecosystem. Besides, the reinjection of (relatively cold) geothermal fluids into the original reservoir may have long-term negative consequences on the temperature of the reservoir.

If the option of **geothermal fluid disposal** is retained, the condition still remains that the fluid's quality should be in conformity with environmental standards. Consequently, fluid treatment is indispensable.

The most preferable solution from the environmental standpoint is to inject treated fluids into the fissures and shallow wells located near the drilling sites for the following reasons:

- the need to build a pipeline to the receiving waters (Gulf of Ghoubbet or Lake Assal) if the direct disposal option is chosen;

- the sensitivity of ecosystems, especially the Gulf of Ghoubbet, and the risk that would be posed by direct disposal of fluids, even when treated.

Generation of Potentially Dangerous Solid Waste

Potentially dangerous solid waste produced during the drilling programme comprises:

- Spoils and mud from the treatment of drilling mud, estimated at 8,000 tonnes or 3,200 m^3 for the 4 boreholes.

- Precipitates of Mineral Products Generated During Production Tests: Precipitates of sulphur, silicate, carbonate or other elements generally collected on cooling towers and vapour separators. These precipitates can be classified as dangerous, depending on their concentration of chloride compounds, heavy metals and other elements, as well as their lixiviation potential. At the Assal 3 borehole, where a scaling test was conducted in 1990 (Virkir-Orkint, 1990), the precipitates contained significant quantities of galena (PbS) and sphalerite (ZnS). The expected quantity of precipitates is hard to determine. Experience from the test conducted in the Assal 3 borehole shows that the quantity may be several tonnes per borehole. The total quantity for the four boreholes is estimated to be below 10 tonnes.

- Treatment residues, if the retained option is to treat geothermal and/or drilling fluids: The expected volume of residue is about 1 kilogramme per cubic metre of water treated. If calculated with a (very approximate) maximum quantity of 400,000 m^3 of geothermal fluids to be treated, the quantity of residue generated in the treatment station would be about 400 tonnes. The main pollutants expected to be found in mud coming from the treatment station are heavy metals that are ecotoxic. The heavy metals present in the mud will be in the form of hydroxides, which are more stable than sulphites. Nevertheless, hydroxides will, in the long term, dissolve in an acidic medium and have an impact on the environment, especially ecosystems and water resources. Toxicity does not only depend on absolute values, but also on factors like the build-up factor and the nature of the chemical compound (silicate, sulphur, hydroxide, etc.). The risk analysis should consider these factors. The parameter to be analysed in the laboratory to assess this risk is the concentration of heavy metals in the eluate, representing the collectable part of the heavy metal content of the solid.

Generation of Household Waste and Wastewater

Household garbage and wastewater will be generated on the drilling site during the works phase. The expected quantity of household garbage is estimated at 0.25 tonnes per day and that of wastewater at 5 m^3 per day.

Road Traffic

Lava Lake area is currently frequented by tourists and technicians who carry out maintenance on the seismograph station. It is estimated that the daily number of vehicles will not exceed ten. The exploration phase will generate some increase in road traffic that will be limited to the access road leading to the project site. This increase will stem from:

- transportation of staff to the project site;
- land development works and reinforcement of the access road;
- possible operation of a quarry;
- transportation of machines and material for drilling and testing;
- tank-trucks, if the option of trucking in drinking water is retained.

Traffic is estimated to increase by a factor of 3 to 5 during the works phase, representing 30 to 50 vehicles per day. Considering its limited impact on the environment, no provision is made for mitigation measures in this domain. Where there is need to reduce the amount of dust or noise generated, a speed limit could be imposed along the access road.

Environmental Risks of the Project

Well Blowouts

Well blowouts may occur during drilling of wells, leading to the emission of drilling and geothermal fluids. Rising drilling fluids may attain high temperatures with risks of burning for workers. The risk of an induced phreatic or volcanic eruption is low, but the impact on staff is potentially strong and provision should be made for mitigation measures.

Accidental Fluid Emissions

Pipes may break during well drilling or testing, causing emissions of geothermal fluids and hydrogen sulphide from the geothermal reservoir. The potential impact of a broken pipe on staff and the environment is deemed to be high, and provision should be made for mitigation measures.

Seismic and Volcanic Events

Considering that the project is located in a zone of intense seismic and volcanic activities, there is a certain risk of seismic (earthquakes) and volcanic incidents. The consequences of such an incident are potentially catastrophic for the staff and local population.

Socio-economic Impacts

Potential Loss of Part of the Transhumance Corridor

Part of the transhumance corridor runs over the drilling project area. The length of the corridor in the potentially affected drilling area is approximately 2-3 km, starting from the seismograph station up to the great fault behind the former Assal 5 drilling site. The passage of animals requires a corridor that has a minimum breadth of 2 m (when limited to a short distance); on flat land, animals need a larger corridor that is 1 to 2 km wide. The herds pass along the current access road and its environs where the land so permits. Herders from the northern part of Tadjoura region and from the south of Dikhil region use the transhumance corridor regularly, at least twice (and often 3 to 4 times) a year, depending on the abundance of rainfall, which has remained irregular in recent years. Route No. 7 transits directly

through the project area. During consultations with the affected population, the sub-prefect of the region stated that several thousands of animals indeed transit regularly through the project area and pass through the drilling project site.

Closure of the transhumance corridor would imply that the population will no longer have access to this important transhumance resource. Under the customary law of the Afars, right of passage is defined by the Sultan of Tadjoura. If the transhumance corridor along the current route is effectively closed, an alternative route will need to be constructed.

Visual Impacts

The drilling facilities and pipes for channelling sea water to the drilling sites will leave an enormous visual impact on the area.

Impacts Related to STDs/HIV-AIDS

Workers' camps are often a potential source of negative impacts on local women: sexual harassment, prostitution and sexually-transmitted diseases (AIDS, etc.). Women are often vulnerable to single workers living without their families in the camps and have to be protected against all forms of abuse. Given the drilling project's limited number of workers, short duration of construction activities, and recruitment of local labour, this impact is evaluated as low. An awareness-raising drive on sexually-transmitted diseases will be conducted by a local NGO to be jointly selected with the Ministry of Women's Advancement/ADDS.

No Displacement of Communities

The selected drilling site is an uninhabited area. The nearest houses and camps are located 5 km away. The drilling site is located on land belonging to the State. Consequently, it will not be necessary to acquire land for the drilling project during the exploration phase. For the proposed drilling activities, there is no need to resettle communities, construct an access road or build a workers' camp. Since the site is unsuitable for settlement, it is improbable that local peoples will settle on the selected drilling site and have to be relocated and compensated. Representatives of the various villages and social groups were informed of the project location during the consultations.

3. Development and Mitigation Programme

Protective Measures for Local Ecosystems

In order to protect the area's ecosystems, it is recommended that the sensitive ecosystem of the Bay of Ghoubbet should not be affected and that water for drilling purposes should rather be pumped from a well near the drilling site, and to reinject fluids into their reservoir of origin or dispose of/inject treated fluids into shallow wells.

Specific Measures for the Development of Drilling Infrastructure

With regard to reinforcement of the access road, the following mitigation measures should be envisaged:

- design the road alignment in such a way as to limit impact on the landscape and geology to a strict minimum;

- carry out minimum excavation works to protect the geology, soils, topography, landscape and vegetation;

- take appropriate erosion-control measures and avoid vegetation areas;

- follow the alignment of the existing road where possible. For the areas where the current road crosses over Lava Lake, there are plans to change the alignment and avoid the lava area.

- alignments of the current road that have been replaced should be closed.

Before and during operation of the quarry, the following mitigation measures should be taken:

- establish a general safety and health plan (GSHP) for the operation of the quarry;

- optimize the planning of proposed extractions to minimize impacts on geology, topography, vegetation, etc.;

- choose adequate extraction equipment and techniques to minimize impacts on noise levels and air quality and reduce the risk of accidents;

- accurately plan extraction works to avoid all types of accidents caused by rockslides, landslides, etc. especially after the use of explosives;

- regulate access of quarry trucks to national highways (road signs, speed limits, etc.).

- reduce noise by using appropriate equipment;

- provide for noise protection gear;

- reduce dust generation;

- provide protective respiratory masks for workers;

- ensure proper transportation and storage of explosives;

- secure the quarry site against all types of accidents or subsequent damage, and rehabilitate the site upon completion of the works.

Specific Measures for Drilling Operations

Management of Drilling Fluids

Mitigation measures for drilling fluid management include the following:

- use of storage tanks or special basins lined with a water-tight membrane for collection and storage of fluids, mud and spoils;

- re-utilisation of drilling fluids to the extent possible;

- use of water-tight casing to line the walls right down to the appropriate depth of the geological formation to avoid leakage of drilling fluids at levels far above the geothermal reservoir;

- preference for biodegradable products when manufacturing drilling mud;

- where a decision has been taken to dispose of the liquid resulting from separation, the quality of effluents must be up to standards; this could imply treating fluids prior to disposal;

- the quality of liquids to be disposed of must be controlled regularly;

- where foam would be used, special measures must be taken to protect against wind;

- the drilling mud treatment facilities and water intake and/or drilling fluid disposal pipes must be dismantled upon completion of works.

Management of Geothermal Fluids

The option to dispose of geothermal fluids into the Gulf of Ghoubbet or Lake Assal, even when treated, is not entertained. It is recommended that the technical study should investigate whether the Assal 5 well can be used for reinjection of treated fluids.

The treatment method to be adopted very much depends on the chemical composition of the geothermal fluids, and should be determined by the drilling contractor once the geothermal drilling fluids have been analysed through laboratory tests.

- If all the geothermal fluids are not re-injected into their reservoir of origin, the quality of effluents must be up to standard. This may imply bringing the temperature and concentrations of effluent down to the prescribed limits. The quality of water that is disposed of must be controlled regularly.

- Where it is decided that the fluids be re-injected into their reservoir of origin, the groundwater contamination potential must be reduced to a minimum by lining the injection wells with water-tight case right down to the level where the geological formation containing the geothermal reservoir is located.

- Where applicable, the temporary treatment facilities and pipes for disposal of geothermal fluids produced during the tests must be dismantled after completion of works.

Protective Measures against Risk of Water and Soil Contamination

- Regular maintenance of machines;

- Proper transportation and storage of fuels;

- Collection and proper disposal of used and potentially polluting fluids (oils, break fluids, etc.).

Solid Waste Management

The drilling contractor should present a **Waste Management Plan** that includes dangerous waste, prior to commencement of drilling works.

In case of dangerous waste, adequate management must include its proper onsite storage and confinement prior to its final treatment and disposal in an appropriate waste management facility. Waste treatment essentially includes dewatering of sludge. Assuming that the waste contains heavy metals mainly composed of sulphides and hydroxides, any waste stabilized in this manner may be disposed of in a household waste treatment facility, so long as it is protected from rain water. Given the low rainfall in Djibouti, the risk of heavy metal build-up is generally deemed to be low.

The decision on the final destination of dangerous waste must be taken by the Djiboutian authorities. The main options are landfilling or export. Considering that there is no controlled landfilling in Djibouti to date, the export of small quantities of potentially dangerous waste is probably the preferred option.

Mitigation measures on household waste management comprise at least:

- onsite waste collection;
- transportation of the waste to a household garbage dump.

With regard to wastewater, the measures to be envisaged are:

- the installation of mobile toilets on the project site;
- regular evacuation to a wastewater treatment plant.

General Safety and Health Plan (GSHP)

After preparing the technical study and selecting the drilling methods, the drilling Consultant should prepare a **General Safety and Health Plan (GSHP)** prior to commencement of works.

The role of the GSHP is to highlight the general risks on the project site. It comprises a detailed analysis of the risks, and defines safety and health measures, covering aspects related to drilling machinery, external companies, work equipment, individual protection gear, noise, explosives, vehicles, surface traffic, asbestos, ionizing radiation, electricity, protection against corrosion, protection against explosions, evacuation and rescue means, safety drills, drilling programme, installation and dismantling, casings and general safety of the site.

The specific health and safety problems of geothermal products could result from exposure to:

- gas coming from the geothermal reservoir;
- heat; and
- noise.

The problems could also be caused by exceptional accidents (breakage of pipes, well blowouts, volcanic eruptions, earthquakes, etc.).

Exposure to Gas

As regards the risk of exposure to dangerously high concentrations of hydrogen sulphide, it is necessary to envisage the following measures:

- install a non-stop surveillance and early-warning system; where the H_2S concentration exceeds the WHO guideline value of 10 ppm, the drilling works or testing should be halted;

- prepare an **emergency intervention plan** in case of accidental hydrogen sulphide emission, covering all the necessary aspects from evacuation to resumption of normal operations;

- install hydrogen sulphide detectors or distribute personal detectors, and also install autonomous respiratory equipment in areas with high risk of exposure;

- install adequate ventilation mechanisms to prevent a build-up of hydrogen sulphide;

- distribute brochures or any other information medium to workers on the chemical composition of liquid and gaseous phases, explaining their potential risks to health and safety.

Exposure to Heat

Accidental exposure to heat may occur during drilling in case of well blowouts and malfunction of heat confinement and conveyance mechanisms. Recommendations on controlling exposure to heat include the following:

- reduce work time in high temperature environments and provide access to drinking water points;

- establish protective surfaces in areas where workers work near hot equipment, especially pipes;

- use appropriate individual protection gear, especially insulated gloves and shoes;

- follow appropriate safety procedures during drilling works.

Exposure to Noise

Noise is usually generated by well drilling works and vapour expulsion. The noise level can temporarily exceed 100 dB(A) during certain drilling and vapour expulsion operations. Workers operating in the drilling area should use individual protective gear such as ear defenders if the noise level exceeds 85 dB (A).

Well Blowouts

The drilling consultant should cover these risks in his **emergency intervention plan (EIP).** The plan should specify the following:

- define measures for controlling a blowout; using a blowout preventer stack; and stocking of material for quelling the blowout (water, baryta);

- define personal safety measures;

- define other emergency measures;

- the staff working on the drilling site should be trained on the measures to be adopted.

Volcanic Eruptions and Earthquakes

The following mitigation measures should be taken:

- establish an evacuation plan;
- develop emergency measures;
- train staff on the risks and the measures to be adopted.

The GSHP, including the EIP, should be included in the Bidding Documents for the drilling contractor.

Socio-economic Measures

Compensate for/avoid the Transhumance and Tourist Routes

Two alternatives were discussed in the impact assessment: constructing a new route (recommended by the local population); and leaving the current road open to herders during the project.

It is recommended that the technical drilling study should select drilling sites in such a way as to maintain a safe distance without closing the route used by transhumant livestock. Where possible, the transhumance route should be slightly modified, but it must still pass through Fialé in order to guarantee access to pastureland and the traditional right to the transhumance route. The specific ESMP of the drilling contractor should specify mitigation measures, where necessary.

Although the impact assessment recommends that the current route should be left open, the matter has not yet been concluded and requires closer consultation with the PMU, the local population and the Directorate for the Environment.

Similarly, the project should not block the route that leads to Lava Lake and Ardoukoba Volcano. The passage should remain open, but a safe distance must be maintained during construction of the drilling platforms. If this is not possible, an alternative route should be constructed. It would be appropriate to install display and information panels.

Prior to implementation of the project, it is mandatory to display a detailed plan of the project sites and consult the local population and local administrative authorities. It should be explained that landowners newly settled on the proposed drilling sites will not be compensated.

Institution of a Procedure for "Chance Finds" of Cultural Monuments

There are no historical sites or cultural monuments in the project area (access roads, drilling area). However, a procedure for “chance finds” has been suggested for use during the eventual modification of the current alignment of the access road, the selection of a quarry, etc. The proposed sites should be

inspected by an archaeologist from CERD prior to commencement of construction works. In case of a chance find during the project, all works should be suspended and an archaeologist called in.

Temporary Abandonment

In case of temporary abandonment of the site, the following measures should be envisaged:

- installation of a blowout preventer to reduce the risk of blowout;
- regular surveillance of temporarily abandoned wells;
- construction of a fence around the drilling site to prevent access by unauthorized persons or animals.

Temporary abandonment is possible only when:

- the casings are properly installed;
- cementation between the casing and the soil ensures the insulation of the permeable levels.
- the duration of temporary abandonment should be agreed upon with the competent authorities.

Permanent Abandonment

Where a well turns out to be unproductive or where the risk of blowout is too high, the geothermal well should be abandoned permanently.

Once such a decision is taken, the products needed to insulate the permeable levels should be used to cover the entire initially drilled section of the well.

After complete closure of the well, a closure file should be prepared by the drilling consultant giving an exhaustive and precise description of the status of the well and all details of the closure procedure. After completion of the works, the drilling site should be rehabilitated.

4. Monitoring Programme and Additional Initiatives

Monitoring Programme

1. Planning phase (prior to the works):
   - The PMU should ensure that the technical solution proposed by the drilling consultant is in conformity with environmental and social standards. A detailed ESMP, a GHSP, an EIP and a Solid Waste Management Plan should be prepared and validated.
   - Commencement of the institution of support projects for the local population.
2. Preparatory works phase
   - Monitoring of the application of health and safety standards and measures;

- Consultation with the local population to verify whether the problem of the transhumance corridor and the tourist route has been solved;

- Consultation with village communities of Assal area (Daba le Gahar, Laïta, Carrefour) and local authorities, traditional institutions and women/men's associations to find out whether mitigation measures have been implemented.

3. Drilling works phase

- Control of the application of the best technology, control of the application of the environmental precautions (works, storage of chemical substances, treatment of drilling mud and geothermal fluids, storage of materials, etc.);

- Control of the implementation of safety measures at work: noise, heat, geothermal gas emissions, etc.;

- Regular analysis of the chemical composition of emitted gases;

- Quality control when disposing of fluids resulting from treatment of drilling mud;

- Analysis of generated waste (drilling spoils) to determine means of disposal;

- Visual control of the drilling site and storage and/or treatment facilities;

- Control of protective measures for wells, in case of temporary or permanent abandonment of the drilling site.

4. Testing phase

- Control of the implementation of safety measures at work; noise, heat, geothermal gas emissions;

- Quality analysis of geothermal fluids prior to commencement of testing;

- Regular visual control of the processing facilities, pipes, etc.;

- Regular quality control for treated fluids prior to disposal (where applicable);

- Regular analysis of the chemical composition of emitted gases;

- Analysis of the waste generated (precipitates, residue from geothermal fluid treatment) to determine means of disposal;

- Consultation of the population concerned to verify whether the mitigation and support measures have effectively been implemented and whether the implementation process was transparent.

5. Completion phase

- Control of site rehabilitation (quarry, drilling, etc.);
- Project appraisal;
- Planning of subsequent stages.

Additional Initiatives

1. Under the drilling project, a small-scale NGO programme has been suggested to promote the organisation of women:

- Support for the women's association, including a receipt of registration of the organisation at the Ministry of the Interior. Stakeholders responsible: MI, ADDS, UNFD. No cost.

- Organisation of training for the women's association on the development of income-generating activities conducted by the NGO. 15 days, 2 facilitators, USD 7,500.

- Awareness-raising drive for workers on sexually-transmitted diseases conducted by an NGO (5 days, 3 facilitators = USD 6,000, including material and transport costs), to be specified during preparation of the specific ESMP (changes depending on the number of workers).

The two potential NGOs for this programme will be the National Union of Djibouti Women (UNFD) and Atuyofan, the association of Afar women. Cooperation with ADDS and the Ministry of Women's Advancement is encouraged.

2. Sea Water Desalination Structure:

In order to propose a more sustainable solution, it is suggested that a pilot project for the desalination of saline waters (appropriate simple technology such as "Water Pyramid") be implemented to produce drinking water for the local population. It will be set up in Dankalêlo on the shores of Ghoubbet sea, whose waters will be tapped. The structure is estimated to cost USD 120,000 (including transport costs). This measure is considered to be a local development priority and is consistent with the priorities of the local population. For the local population in the study area, this structure will provide approximately 25 litres per household per day. At Daba le Gahar, this will double the daily ration of water that SALTINVEST currently supplies by tank truck.

Although the initial investment will be paid for by the project, the maintenance and operational costs incurred by a local contractor can be defrayed through user contributions. A contribution of approximately DJF 0.05 to DJF 0.1 per litre will be enough to ensure maintenance (USD 700 to USD 1,400 per year). Maintenance costs will be clearly cheaper than the cost of gasoil for the tank truck. The capacity to pay largely depends on salt mining and other economic activities available. At the moment, the population is waiting for the commencement of activities; in the present uncertain situation, no one was ready to express an opinion on the willingness to pay. This measure remains dependent on relentless public consultation of the local populations throughout the project.

3. Community Funds for Women and Men's Associations

A revolving fund ("tontine") for the women's association will provide considerable support to women in the project area. One woman is selected to receive a sum of money (initially a grant to the association) for a business venture and will repay the money to the next beneficiary, plus a small interest rate of 2 to 3% maximum (for the association). Micro-credits are not recommended because of high monthly interest rates of 2% (degressive model, 18% per year) and the resulting vicious circle of debt that is generated in many cases. Traditionally, this collective savings mechanism exists under the appellation "hagba" or "tontine". These are groups of ten persons (mostly women) who take turns to

receive and repay micro-credits (at 0% interest). Guidance of the women's association by ADDS or by an NGO is recommended to ensure selection of sound business ventures and support for the programme with training in "business planning" and management of repayments to the association. A similar measure could be tried with other associations that are not necessarily women's associations. The fund may also be used for community activities. The suggested endowment for this fund is DFJ 2,666,000 per year (or USD 15,000).

4. Health Provisions for Workers and the Local Population

Instead of establishing a dispensary solely for workers, it is recommended to extend the new healthcare facilities to the local population and ensure transfer of emergency cases by ambulance. Discussions can be held on whether to use the Saltinvest health centre (once it becomes operational) or Karta health centre (which is in the final construction phase). Under the drilling project, it will not be viable in the long-term to build a health centre near the site because it will not be possible to finance the operating costs on a sustainable basis. Cooperation mechanisms between the regions (for example, the ambulance service of the nearest hospital) should be developed. The policy decision to include the project area in the ambulance service of Karta instead of Tadjoura (longer distance for Tadjoura) must be promoted. ADDS and the Ministry of Interior could facilitate this task.

From various consultations with the local population, three priorities have been retained:

1. Water desalinisation infrastructure ("Drink with the Wind"), to be implemented by CERD, costing USD 100,000.

2. Organisation of the ambulance service (facilitate a policy decision); under the responsibility of the Ministry of the Interior; to make project health facilities available to the local population. Stakeholders responsible: ADDS and drilling contractor. No specific additional cost.

3. *Tontine* Fund for associations / communities, to be implemented by ADDS or an NGO to be selected by the PMU, costing USD 15,000.

5. Institutional Arrangements and Capacity Building Needs

The Project Management Unit will comprise:

- a project manager (international consultant);
- a local project coordinator;
- an assistant local project coordinator;
- **an expert on environmental and social aspects;**
- a seasoned accountant; and
- a secretary.

The PMU will be directly attached to the Ministry of Energy and Water, in charge of Natural Resources (MEERN) and should be considered as an autonomous unit responsible for the planning, execution and monitoring of project activities.

The PMU will operate under the supervision of the Steering Committee (SC) whose role is to guide and coordinate activities. The SC is chaired by the MEERN and composed of representatives from the following institutions:

- Ministry of Energy and Water, in charge of Natural Resources (MEERN);
- Ministry of the Economy and Finance, in charge of Industry and Planning (MEFIP);
- Ministry of Higher Education and Research (MESR); represented by the
- Djibouti Studies and Research Centre (CERD);
- Ministry of Town Planning, Housing and the Environment (MHUE);
- Ministry of Transport and Equipment (MTE);
- Ministry of the Interior (MI);
- *Electricité de Djibouti* (EDD).

The project is placed under the supervision of the PMU, which ensures technical oversight, while the Ministry of the Economy and Finance, in charge of Industry and Planning (MEFIP) ensures administrative and financial oversight.

The Scientific and Technical Council (S&T Council) was set up by the MEERN. It comprises international geothermal experts who will be called upon to advise on key project decisions relating to science (priority sites for developing geothermal energy in Djibouti, additional exploration strategy, selection of drilling sites, opinion on types of drilling, testing procedures, interpretation of results, etc.).

The company in charge of drilling and production tests will be responsible for implementing the project's ESMP and the General Environment, Health and Safety Plan. The PMU should monitor/evaluate ESMP implementation, and periodical monitoring reports will be submitted to donors (African Development Bank and World Bank).

At the beginning of his/her mission, a drilling consultant recruited by the PMU will organize training for the PMU and its national partners on the environmental impact of the project, mitigation measures, and monitoring/evaluation of the implementation of safeguard measures.

6. Public Consultations and Information Dissemination Requirements

A public consultation workshop organized by the PMU was held on 12 May 2012 to discuss the preliminary ESIA. Approximately 50 representatives of various stakeholders were in attendance. Most participants' comments focused on potential project benefits for the local population. Representatives of the local population emphasized the fact that the project should bring some improvements; for instance, in the areas of health and drinking water supply. Community expectations as regards job creation under the project were discussed. According to the PMU, about fifty people are likely to be employed on the drilling project site, including about 20 persons who could be recruited locally (watchmen, labourers, domestic help, kitchen staff, etc.). An exact figure will be obtained during the technical study of the project. Priority should be given to local recruitment, especially affected persons.

The future approach for consultations with stakeholders in the preparatory and execution phases of the project will focus on the following activities:

- Regular briefing of the local community on project progress;
- Institution of a complaints resolution mechanism/response to complaints, designation of an ombudsman for future complaints. It should be explained that landowners newly settled on the proposed drilling sites will not be compensated.
- Periodical consultations with stakeholders at the national and local levels;
- Briefing of the media;
- Consultations with other economic operators (Saltinvest);
- Display of a detailed plan of project sites; and
- Consultation of the local population and local administrative authorities.

The project's summary Environmental and Social Management Plan will be posted on the website of the African Development Bank for at least 30 days prior to approval by the ADB Board of Directors.

7. Cost Estimates

All the costs of mitigation measures should be included in the total budget of the project. These mitigation measures will be specified in the bid submitted by the drilling contractor. The total estimated cost of the ESMP is USD 555,200, including USD 385,000 for the geothermal fluid treatment plant, USD 120,000 for the desalting plant, USD 10,000 for training, and USD 15,000 for the *tontine* fund.

8. Implementation Schedule and Reporting

The project will present the status of its environmental and social component in an environmental and social monitoring report to be submitted once a year to the Bank.