Japan International Cooperation Agency (JICA)

Comision Ejecutiva Hidroelectrica del Rio Lempa (CEL)

FEASIBILITY STUDY
ON
THE HYDROELECTRIC COMPLEX
OVER
THE TOROLA RIVER
IN
THE REPUBLIC OF EL SALVADOR
(El Chaparral Project)

ENVIRONMENTAL IMPACT ASSESSMENT

MARCH 2004

ELECTRIC POWER DEVELOPMENT CO., LTD.
(J-POWER)
TOKYO-JAPAN

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Symbols utilized in the text

Abbreviation	Definition
MARN	Ministerio de Medio Ambiente y Recursos Naturales
MAG	Ministerio de Agricultura y Ganadería
MSPAS	Ministerio de Salud Pública y Asistencia Social
MOP	Ministerio de Obras Públicas
MTPS	Ministerio de Trabajo y Previsión Social
CEL	Comisión Ejecutiva Hidroeléctrica del Río Lempa
SIGET	Superintendencia General de Electricidad y Telecomunicaciones
CESSA	Cemento de El Salvador, S.A. de C.V.
JICA	Japan International Cooperation Agency
EIA	Environmental impact assessment
EMP	Environmental management program
mm	millimeter
cm	centimeter
cm^2	square centimeter
cm^3	cubic centimeter
cm^3/s	cubic centimeter per second
m	meter
m^2	square meter
m^3	cubic meter
km	kilometer
km^2	square kilometer
mz	manzana
ha	hectar
mg/L	Miligram per litter
µmhos/cm	Microohms per centimeter
NMP/100ml	Number more probable in 100 mililiters
NUT	Nephelometric unit of turbidity
JTU	Jackson turbidity unit
gal	Unit of acceleration (d/t^2: distance by squre time)
l	liter
g	gram
kg	kilogram
s	second
min	minute
h	hour
d	day
m	month
°C	degree centigrade
V	Volt
kV	kilovolt
W	Watt
kW	kilowatt

Abbreviation	Definition
MW	Megawatt
GW	Gigawatt
kWh	kilowatt hour
MWh	Megawatt
GWh	Gigawatt hour
kVA	kilovolt ampere
%	perecntage
pH	hydrogen potential
GDP	Gross domestic product
B/C	Benefit costo ratio
IRR	Internal rate of return
EIRR	Economic internal rate of return
FIRR	Financial internal rate of return
US$ o $	United States dollar
NGO(s)	Non governmental organization(s)
EP/UICN	In danger of extinction / International union for conservation of nature
A/CITES	Threatened to extinction / International treaty for traffic of silvester life species
CMC (EPA)	Maximum concentration criteria / US Environmental Protection Agency
EEC	European Economic Community
CONACYT	Consejo Nacional de Ciencia y Tecnología
FAO	Food and Agriculture Organization of the United Nations

EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

1. General Aspects

As a component of the El Chaparral Hydroelectric Project Feasibility Study, and to meet the proposed guidelines by the Ministerio de Medio Ambiente y Recursos Naturales, the Environmental Impact Assessment of the Project has been performed. The Project consists of the construction and start of operation of a hydroelectric plant on the Torola River that is located between the 13° 50' and 13° 53' northern latitudes and the 88° 22' and 88° 16' western longitudes. The Project is located in the northeast region of the Republic of El Salvador, and the dam site is located 300 m east to the region where the Torola River forms a natural border with the Republic of Honduras, between the municipalities of San Luis de La Reina and Carolina. The reservoir extends upstream to the San Antonio del Mosco municipality, in the department of San Miguel.

The dam site can be reached by traveling through the Pan American Highway (CA-1) on the San Salvador-San Miguel route, then taking the turn-off to the Moncagua city at the 122 km, continuing up to the Barrios city, San Luis de La Reina and the dam site. It can also be reached by traveling by the CA-1 at the 105 km, at the El Triunfo city turn-off, crossing through Sesori, toward San Luis de La Reina and the dam site.

The project owner and holder is the Comisión Ejecutiva Hidroeléctrica del Río Lempa (CEL), an autonomous institution dependant from the Ministerio de Economía, and its development constitutes an institutional effort oriented toward the improvement of the electric energy sector by increasing the electric energy supply at a national level. The hydrologic potential of the Torola River will be exploited, with an average flow of 100 m^3/s to obtain a maximum capacity of 64.4 MW that will have an annual average generation of 220.6 GWh.

This study is being performed with the technical and financial assistance of the Japan International Cooperation Agency (JICA), who entrusted the feasibility study development to the Japanese company Electric Power Development Co, Ltd. (J-POWER), who subcontracted the Salvadorian company ECO Ingenieros, S. A. de C. V. to perform the field investigations for the following: Flora and fauna, Water quality, Aquatic life, Socioeconomy, Archeology and historical and cultural heritage elements. Aspects related to the Paleontology investigation, were the responsibility of specialists from the Consejo Nacional para la Cultura y el Arte (CONCULTURA). To coordinate the development of the Environmental Impact Assessment, J-POWER subcontracted the North American Company Harza Engineering Company International L.P. The geologic, hydrologic and seismicity studies, as well as the topographical surveys of the project area were performed by J-POWER.

Once the Feasibility Study is finished, the Final Design phase of the Project will be performed for a period of one or two years, on which the works to be constructed will be defined in detail, as well as the environmental measures that must be implemented to mitigate or compensate the negative impacts that would occur.

The construction time is estimated to be three years and four months, and during construction approximately 500 people of different skills and specialties will be employed. For the operation and maintenance activities of the plant a total of 40 people will be employed.

2. Project Main Components

The project development involves the construction of a 405 m long dam, with a 90 m long and 87.5 m high spillway, which will reach an elevation of 214.5 m above sea level. The spillway will be

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The intake works will be located on the left side of the spillway. The intake will be bell-shaped and controlled by gate 7 m wide and 7 m high, at the point where the water will enter the penstock. It will have a gross head of 74 m. The penstock will be 144.5 m long and have 5 m of internal diameter, and a valve will be installed at its end to allow the passage of a 2 m^3/s ecological flow that will be permanent during the dry season, while the plant is not operating.

The powerhouse will be located on the left bank of the river; it will be of reinforced concrete with 36 m of length, 26 m of width and 16 m of height, and it will house a main turbine with a capacity of 65,900 kW, and a 1,420 kW secondary turbine driven with the ecological flow. There will be a main generator with a standard capacity of 71,600 kVA and a 1,510kVA secondary generator, and all the necessary equipment for the control of the generation operations.In thdry season, the reservoir will be operated during the peak hours, approximately from 6 to 9 p.m.

The main works will be sited in the river. While the works are being constructed, a 385 m long and 8 m in diameter tunnel will be drilled on the right bank, where the river flow will be temporarily diverted. A maximum flood of 728 m^3/s with a return period of one year has been considered for the design of the diversion works.

Two kilometers upstream from the dam site, there is an area of approximately 120,000 m^2, where the availability of 360,000 m^3 of materials has been estimated for use as concrete aggregates. The rock from the required excavations will also be used for this purpose.

The substation to transform the energy, which will be transported to the 15 de Septiembre Plant for its integration into the national network, will be constructed on the right bank, in an area of 1,200 m^2 located 60 m downstream from the powerhouse. The corresponding Environmental Impact Assessment will be performed for the construction of the transmission line.

Once the civil works are completed, the river flow will be retained to form the reservoir, which will stretch 11 km upstream from the dam site; it will have a maximum area of 8.6 km^2 and reach an elevation of 212 m above sea level. The maximum storage capacity will be 189 millions of cubic meters of water.

The reservoir filling involves the relocation of 79 houses, two churches, and one school located in the area to be flooded. Therefore in the Final Design phase, a detailed resettling program for the population that chooses this option will be prepared. The construction of a housing complex in the proximities of the Carolina city with all the necessary basic services has been contemplated for the population directly affected by the Project..

The residential camp for the Contractor's construction and office personnel will be constructed in an area of 57,500 m^2. These structures will be able to be used during the operation phase. The construction of 3 km of new roads will be undertaken and 6 km of access roads to the project sites will be expanded and improved.

3. Natural Environment Characterization

The project area is located in the lower hydrographic basin area of the Torola River. The basin area is 1,575 km^2; of which 557 km^2 belong to the Honduras Republic and 1,018 km^2 to El Salvador. The approximate length of the river is 77 km, of which 58 km are located inside the Salvadorian territory; the rest of the riverbed is the natural border of the two countries.

An area of direct influence that comprises the areas directly affected by the works, was established for the natural environment characterization, and it is the area where the detailed environmental study was performed. The indirect influence area consists, in general, of the Torola River basin,

and specifically, of the three municipalities that contain areas affected by the Project, as well as the Torola River downstream from the dam to its discharge point into the Lempa River and to the 15 de Septiembre plant reservoir.

A large team of professionals and technicians with specialties in each study area participated in the investigation and characterization of the natural environment, applying appropriate methodologies for each particular study area.

1) Physical

a) Land Use

In the land use component, the geological, hydrologic, topographical, seismic, types and land use capacity, sedimentation and erosion problems and slopes stability aspects where investigated.

Regarding the geological aspect, it was determined that, in the future reservoir area, the Morazan, which consists of tuffaceous breccias and basalt, is the main formation. The rock outcrops in the area where the dam will be built are of the andesitic-basaltic type and, given their quality; they constitute an adequate material for structure foundations.

Regarding seismicity, an evaluation for seismic events from 1915 to 2001 in the project area was performed and a value of 220 gal was established as the maximum seismic acceleration for any return period in the site.

For the land use capacity, the soil classification system establishes that most of the project area is Class VII, which are soils with severe use restrictions, not for farming, but only for forest exploitation. Regarding the current land use, in the entire area, the use is for natural pastures and basic grains farming.

As for erosion problems, the photo geologic analysis and dam site reconnaissance does not reveal significant erosive risks, neither from slides or slope instability. However, due to agricultural and livestock activities in the basin, erosive processes are being observed in the soil cover of specific areas.

b) Water

The surface hydrography is formed by the Torola River and its tributaries, which according to data from the Osicala station form an annual average flow of 30 m^3/s and an annual minimum flow of 0.9 m^3/s. However, to guarantee the stability of the river water uses and the preservation of the aquatic life downstream from the Plant during the dry season months, an ecological flow of 2 m^3/s has been established, for when the Plant is not operating.

c) Torola River Water Quality

The water quality is affected by the different river uses, which include washing clothes, personal hygiene and toxic products use for fishing. Water quality is also affected by the activities that are performed in the basin, mainly agricultural activities where chemical products are used, which are incorporated in the river by superficial dragging, as well as the indirect spill of sewage, like in the case of Carolina city, that pours them at the El Rastro creek which finally reaches the Torola River.

To determine the river water quality, water samples were taken on the three sites for the aquatic life, and during five different dates, between the months from October to December of 2001. Physical, chemical, and microbiological parameters were analyzed.

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Regarding the water quality requirements for the aquatic life development, from 16 analyzed parameters, it was found that in the Carolina site slightly exceeded, the established limits for: pH, manganese, mercury and selenium. In reference to the watercolor, this parameter was exceeded with 33 units in the Carolina site.

d) Weather

Climatically, the project influence area is classified as hot tropical savannah, where the temperature does not vary much throughout the year, because in the lower areas the variation goes from 25° C to 30° C and in the higher areas from 19°C to 23° C, with an annual average of 26.4° C.

The maximum precipitation appear during the months of June and September, with a monthly average between 363 and 401 mm respectively and an annual variation of 1,200 to 2,900 mm. The annual relative humidity is 66 % and the annual average evaporation is 186 mm.

2) Biological

In the biologic environment, aspects associated to the composition, abundance and vegetation cover diversity present in the project area, as well as the diversity and abundance of terrestrial fauna were investigated, determining its ecological classification based on its threatened or endangered condition. In the same way, the presence of aquatic organisms at the micro and macroscopic level was investigated, giving particular attention to determining the fish species used as food by the population. The water quality was also investigated in the Torola River, which has importance in the preservation aquatic life.

a) Vegetation

For the vegetation study, 36 plots of 625 m^2 each were established, distributed in the future reservoir area, to survey species diversity. A total of 60 species of the trees belonging to 32 families were found; 61 species were registered in the bush and shrubs groups. Of these species, 3 were classified as threatened and 3 endangered. In addition, 10 species classified as agricultural were identified. The diameter at the chest height was measured, indicating that the largest number of units presented a diameter less than 40 cm. Three units were found with a diameter larger than a meter.

In the Final Design phase, the exploitation plan for the biomass extracted from the direct influence area will be prepared. The cost for the exploitation will be determined in this plan, which fundamentally depends on the species quality and of their growth; as well as the wood's main use; extraction facilities; timber price in the market and wood volume to be extracted for sawmill processing.

b) Fauna

The fauna investigation was performed with direct observation and consultation with local inhabitants.

In the mammals group, 19 species were identified, of which 6 were classified as threatened species and 5 as endangered. This is a group very vulnerable due to the constant reduction of the natural habitat because of agricultural and livestock activities, as well as hunting activities for consumption, commercialization and domestic use.

A total of 54 species of birds were registered, of which 19 were classified as threatened and 5 as endangered. The reason for the threat to birds is similar to the mammals.

20 species of reptiles were reported, where the main group is snakes. 5 species are classified as threatened and 4 as endangered. In the amphibians group, 7 species were reported, which are not identified as to their condition of threatened or endangered.

In general, the flora and fauna species are present in the entire area, so that they are well established outside the project direct influence area.

c) Aquatic Life

For the aquatic life investigation, three sampling sites were established, known as: Carolina, located in the mid section of the river that will be affected by the project development; Vado Nuevo, located 1.5 km downstream from the dam site and Nuevo Edén de San Juan, located approximately 21 km downstream from the dam site. On these sites, during five different dates during the months from October to December of 2001, and using appropriate instruments, samples were taken of microscopic organisms that compose the phytoplankton and zooplankton; of benthonic organisms mainly constituted by insects; and nektonic organisms composed by fishes and crustaceans.

In general, the river presents rapids or stream environments, established by strong currents and the presence of rocks of different sizes, as well as ponds or areas with relatively slow speed in the water flow. These environments determined different habitats for the aquatic organisms.

Of the microscopic organisms or plankton, 71 species were reported as phytoplankton, composed of 5 groups of algae, of which the more abundant correspond to the Chrysophyta division or diatoms, with 36 species and the Chlorophyita division or green algae, with 19 species. The zooplankton presented 33 species, of which the more abundant belong to the Phyla Ciliophora or protozoa with 14 species and the Phyila Sarcodinos with 10 species.

The benthonic organisms were scarce, with 7 groups being registered, of which the more abundant was the Dipteral order with 4 families.

Among the nektonic organisms, 8 fish species were registered, of which 7 are used as food for the population; among these are the "mojarra", the "tilapia", the "guapote", and the catfish. The average size was 21 cm; the average size of the larger organisms of different species was 28.5 cm. Regarding the crustaceans only a 7 by 5 cm "cangrejo de río" was captured. In the mollusk group, small snails with an average size of 1 cm were observed.

In general, the fish population, regardless of its wide distribution, is very scarce and does not represent a significant resource for the people's nutritional diet, because the capture of the representative specimens required the combined effort of fishermen groups for a relatively long period of time with the use of different fishing implements.

3) Socioeconomical

Field activities were performed to determine the socioeconomical environment, which consisted of visits and interviews with authorities and local leaders in the three municipalities with affected areas affected by the Project, and a ground reconnaissance was performed with direct surveys of 80 % of the families located in the future reservoir area, and the remaining 20 % was done indirectly. This activity allowed informing the inhabitants about the project development and at the same time obtaining specific information about the population. Economic and social indicators like education, health, housing, and job opportunities were also studied which allowed understanding the level of development of the area.

The investigation shows a low level in those indicators, because the inhabitants of these areas must travel to nearby cities and department centers to gain access to specific basic services.

With the Project, 1.3 km^2 of the San Luis de La Reina, 6.78 km^2 of the Carolina and 0.52 km^2 of the San Antonio del Mosco municipalities areas are affected, for a total of 8.6 km^2, where 89.4 % of the lands are used mainly for natural pasture and basic grains farming, the rest of the land presents small areas with natural vegetation and abandoned farm fields.

a) Population

The municipalities with affected areas by the Project have a total population of 24,091 inhabitants, where Carolina has 9,122 inhabitants, San Luis de La Reina 7,312 and San Antonio del Mosco 7,657. From this population 4,129 inhabitants are located in the urban area and 19,962 in the rural area.

The Project affects the habited areas of eight caseríos of the Carolina municipality and three caseríos of San Antonio del Mosco, where there are a total of 409 houses, of which 79 are located in the affected area by the reservoir, 69 in the Carolina municipality and 10 in the San Antonio del Mosco municipality. Of the 79 houses, 9 are uninhabited. Considering one family per house and estimating an average of 6 persons per family, a total of 420 persons would be directly affected by the project development. The San Luis de La Reina municipality does not have a population in the direct influence area.

It was determined that in 50% of the cases, the area used by the houses is 96 m^2 and the average area of the lot is one block, which is equal to 7000 m^2. Regarding the materials that are use for constructing the house walls it was found that 12 % are of the mixed system, 42 % are sun dried brick, 40 % is bahareque and 6 % are prepared with crude materials, which can be wood, plates, cardboard and plastic. The roofs are generally tiled.

A total of 430 plots were found in the reservoir area belonging to 340 owners, which means that some people have more than one plot. These properties will be acquired by the project owner, who is purchasing them at a real cost, plus an economic incentive that motivates and compensates the owner for inconveniences that may occur when he is asked to sell his property.

b) Education

In the urban area of the three municipalities, there is a high school education level. In the rural area, the education level reaches the ninth grade.

c) Health

On each of the area municipalities, there is a Health Unit with a physician, one nurse, and auxiliary personnel consisting of promoters, health inspectors, and administrative personnel working full time. Complex health cases that cannot be treated in the Health Units are transferred to the hospitals of Barrios, San Francisco or to San Miguel City.

Regarding the diseases for which the population requests medical attention, it was found that the more frequent are the intestinal parasites, acute respiratory infections, intestinal infections and acute pharynx tonsillitis.

As far as vector carried diseases like malaria, in 2002, 6 cases were registered in Carolina and 3 in San Antonio del Mosco.

d) Economical Activities

The economical activities are related to the basic grains farming, as well as sugar cane for the traditional preparation of brown sugar loaf. There is also noticeable livestock development. In the

urban area, small activities related to the sale of necessity products are observed; two families produce mats from tule fibers, there is an establishment that makes women clothes; there is an establishment where tile and sun dried bricks are prepared, and there is a barge or boat in the Torola River, west from Carolina city, used for the crossing of people and pack animals. There are no industrial installations.

e) Road Infrastructure

There is an extensive system of highways, streets, and roads, being the most important the road that leads from Barrios to Carolina city, which was recently paved. The rest of the roads are difficult to access during most of the rainy season.

As part of the highway system, there is an overhanging pedestrian bridge above the Torola River located to the north of Carolina city, 135 m long, 1.5 m wide, and 20 m high. This structure is located in the future reservoir area. In addition, distributed along the river, there are 7 steel cables. This is a relatively simple system, but requiring skill and effort, and it is used to cross the river, mainly during the rainy season.

At specific months of the dry season, when the river flow decreases, it is possible to travel to the north section using three crossings located in the Carolina municipality and one in San Antonio del Mosco. The rest of the year, when the river is too wide, this section remains relatively isolated to the south.

f) Touristic and Recreational Sites

There are no properly conditioned touristic installations. However, there are natural sites used by the population for amusement and recreation; among these are the hot springs located in the right side of the river, downstream and near the overhanging bridge. In the left side of the river near the bridge a pier type concrete structure has been constructed which facilitates the congregation of people that visit the river for touristic purposes. Also, besides a normal number of ponds located in the Torola River, there is a seasonal pond in the Riachuelo River, located southeast of Carolina that in the rainy season is frequently visited by local inhabitants for bathing and amusement. All these sites will be affected by reservoir filling.

g) Services

Thanks to the road system that interconnects the municipalities, there is a bus transportation service that travels from San Miguel city to the area and vice versa. There is also a merchandise and agricultural products transportation service.

Regarding electricity service, the municipalities are interconnected with a 13.2 kV distribution line, of which 7.6 kV lines derive to rural areas. In the direct influence area, 15 % of the population has electric service.

In the urban areas of these municipalities, there is a fixed telephone communication system, as well as a cellular telephone system. There are also post offices, municipal services, security by the Policía Nacional Civil and Juzgados de Paz.

h) Disclosure and Public Information Activities

Starting in 2002, CEL personnel performed public consultation activities, to inform about the project development process, as well as the advantages involved. For this, activities are being performed with the representatives of the different population sectors, as well as members of families that live in the direct influence area. Numerous communal meetings have been held in the area, informative meetings in San Miguel city and demonstrative visits to the 15 de Septiembre

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Hydroelectric Plant have been carried out, where tours across the Plant facilities and the Lempa-Acahuapa irrigation district, established from a water intake of the Plant reservoir, are performed. Sites where their productive activities from the construction of the Cerrón Grande Plant are also visited, consisting of the intensive use of the lands near the reservoir shore with a high agricultural production diversity, as well as fishing, touristic and recreational activities. Besides, the relocation center of this Plant is also visited, where the communication with center inhabitants is promoted, so that it provides of first hand knowledge of the experiences of these persons that lived in a similar situation.

During the development of this study visits to municipal authorities, to religious and communal leaders and to the population living in the direct influence area were performed, in order to present them the project scope, the expected benefits with its development and gather their opinions.

i) Archaeology

To determine the archeology and historical and cultural heritage resources, inspections were performed along both riverbanks, from the dam site to the Agua Caliente crossing. And finally, the sites at Agua Caliente, in the San Antonio del Mosco municipality and the Carolina site, at Carolina where investigated in detail. In both sites, excavations of 1 m by 1 m were performed with depths going from 0.40 to 1 m.

In the Carolina site, traces of objects belonging to the Arcaic period, which goes from the 6,000 to the 2,000 year before Christ, were found. The findings consisted of small obsidian pieces and rock fragments that could have been used in human activities and that were also usually found outside the project influence area. There are no structures or elements that need preservation or prevent the project development.

j) Paleontological Resources

Regarding the paleontological resources, the work was oriented toward investigating and documenting the existence of fossils in the project direct influence area, by performing detailed inspections in both riverbanks.

In the Vado Ancho site, a fossil outcrop was found consisting of limestone, diatoms and lime that in its interior had fossilized invertebrate agglomerations, in some cases with a saturation of up 30 individuals by every 20 square centimeters. The material in question breaks with ease showing a materials superior stratum with gastropod incrustations.

Due to the relatively long period of time required for these activities and the rough terrain, it is advisable that, in the Final Design phase, a detailed investigation is carried out to identify the type of material observed.

The site is in the area to be flooded in the future. However, it has been determined that it does not represent an obstacle for the project development, but it has to be guaranteed that it will not be disturbed by man, unless it is for scientific purposes. In case future excavations are performed, the corresponding authority has to be notified.

4) Landscape

In the landscape analysis it was found that some specific project structures like the powerhouse and substation will be located in the lower area of the river canyon, therefore they will not represent a significant visual impact. However the dike, spillway and camp structures will be located at a height that exposes them to the sight of potential observers. With the revegetation works that will be performed it is expected that the trees will hide a part of the structures, integrating them as

much as possible in the natural environment. Besides, the reservoir, as a superficial body of water, will contribute to increasing the scenic beauty of the area that in the dry season presents arid characteristics.

4. Environmental Impacts Identification

A procedure known as MEL-ENEL Method, whose application leads to the preparation of cause-effect interactive matrices through which the environmental importance of each impact is evaluated, by giving it a number known as Relative Significance Coefficient, was used for the identification, analysis and evaluation of the potential environmental impacts.

The application of the method requires the participation of a multi and interdisciplinary team that has a comprehensive knowledge of the different project components and of its construction characteristics, as well of the environment where the works are being constructed. Through this knowledge, the existing relation between a specific project activity and the environmental factors is determined, after which a matrix is generated, on which, the main project activities are placed on the columns and the environmental factors vulnerable to the works development are placed on the rows.

15 main activities that cause 84 impacts were identified, of which 52 are negative and 32 positive, 54 direct and 30 indirect. Once they were identified, the impacts that were common to specific environmental factors, like soil, water, weather, vegetation, fauna, human population, health, and landscape, were grouped together.

The evaluation process involves assigning a value to each impact, considering for each the concepts of: Magnitude, Importance, Extension, Duration, and Reversibility, which represent an integral evaluation of the impact that a specific activity may cause in the environment.

As a result of the evaluation process it was found out that, in a descending order, the most affected environment components were: the soil, the vegetation, the human population, the water, the fauna, the population health, the landscape and the weather.

It is concluded that, with project development, the electric energy availability will be improved at a national level, which will bring a series of economical and social benefits, and the development of the area. On the other hand, if the project were not implemented, the opportunity to improve the living conditions of a population located in an area would be lost.

5. Mitigation Measures

To mitigate and compensate the identified potential negative impacts, an Environmental Management Program (EMP) was prepared, which contains the measures that will have to be undertaken to avoid, reduce or compensate the effects of such impacts, with the purpose of protecting and improving the natural resource quality, as well as the population living conditions located in the project direct influence area.

The measures will be applied according to the activities that are performed in the different project phases and will be related to preventing soil erosion, as well as preventing contamination due to the spillage of solid and liquid wastes; prevent the superficial and underground water contamination due to the inadequate final disposal of solid and liquid wastes; revegetation or planting of vegetation species; wildlife fauna protection; workers and population health protection; and mitigate the significant alterations of the natural landscape.

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However, most of measures with an environmental character will be performed as activities inherent to the Project, some specific actions have been considered strictly environmental measures and their development cost has been established. Among these measures are the revegetation of the areas in the vicinity of the works, as well as the reforestation of 114 hectares in the reservoir perimeter; adaptation of a site to compensate the loss of the hot springs in Carolina and the development of activities to increase the fish population in the future reservoir. The established cost for the EMP development amounts to US$ 192,000 and constitutes the amount for meeting the bond that has to be deposited in favor of MARN.

Among the actions of an environmental nature closely related to the project development and Plant operation are: design and development of a program for the resettling of the population located in the future reservoir area, which includes the delivery of basic services and communal infrastructure, as well as social activities of training the resettled population in the acquisition of skills and abilities that promote a better life style; assignment of a monetary compensation for the head of each relocated family, equal to a monthly minimum wage during the first six months and half of a minimum wage for the next six months as a help to stabilization to new situation; extraction of the vegetation in the area to be flooded with the reservoir filling; construction of two bridges in narrow sections of the reservoir to enable passages for the persons along the reservoir shore; enabling the dam as a vehicular bridge to allow traffic across the river; improvement of 33 km and construction of 11 km of public roads along the reservoir perimeter; relocation of a elementary school and two churches; institutional support for the environmental activities during the project phases; contribution to the improvement of the area municipalities specifically during the construction and operation activities; establish and operate an integrated system for solid and liquid waste management; perform works to prevent the environmental contamination with hydrocarbons; establishment of hygiene and occupational safety programs, as well as environmental education; and establishment of an Environmental Management System during the operation phase, which incorporates into the every day activities of the personnel the risk management philosophy. For these activities, an amount of US$ 7,228,000 has been established, which is included in the project direct costs.

A Monitoring Program to follow up the EMP development has been prepared, where it was determined which measures are to be supervised, the purpose and monitoring frequency, the observation method and results interpretation and the preparation of the corresponding reports. After which the corresponding environmental Audits will be performed.

6. Risk Identification and Contingency Plan

Although significant risks are not expected, an analysis of the potential risks that could present themselves during the construction phase was performed. These risks would be related mainly to accidents due to management and maintenance of machinery and equipment; storage and management of dangerous materials; generation of solid and liquid wastes; work accidents; workers negligence or lack of awareness; and the presence of extraordinary natural phenomena.

During the operation phase, specific risks can occur due to potential spills of chemical substances or residual waters that contaminate the soil and water; the presence of extraordinary meteorological events that could cause floods downstream from the facilities; seismic events that could damage the infrastructures and population; work accidents; and workers negligence or lack of awareness in the Plant operation.

A series of contingency measures are proposed to support the Contractor and the responsible of the Plant operation in the planning of appropriate answers, with the purpose of preventing or minimizing the damages that could arise with the presence of the identified risks. These measures consist fundamentally in maintaining hygiene and occupational safety regulations in the work areas; an appropriate solid and liquid waste management; adequate management of dangerous

substances adequate management; receiving timely meteorological forecasts; establishing permanent training programs; having emergency equipment available; establishing an effective early warning system; and maintaining adequate coordination with institutions such as SNET and COEN to confront threats related to extraordinary natural phenomena.

7. Conclusion

Based on the different works and analysis, the professional team which participated in the preparation of the EIA concludes that the Project is environmentally and socially feasible. With the execution of the project, it will improve the availability of electricity at the national level, which will lead to a series of economic and social benefits, and promote the development of the region. On the other hand, if an option of not to construct the project, it would be less convenient to the communities of influenced area, to the environment, and to the country in general.

Work Team

The following persons participated in the preparation of the El Chaparral Hydroelectric Project EIA:

Name	Participation	No. RPSEA *
	By J-POWER	
Nobuo Hashimoto Walter Hernández	Geological study	
Ken Mizoue	Hydrological study	
Sadaaki Kato	Seismicity study	
Shun Takagi	Topographical survey	
Tetsuya Hirahara	Economic-financial evaluation	
Nobuo Hashimoto Ms.C	General coordination	
	By Independent Consultants	
Juan José Medrano	EIA report preparation	127
Federico I. Castellanos	Impacts evaluation, EMP, maps and figures preparation	006
	By Harza Engineering Company	
Peter Saunders Ms.C	EIA coordinator (up to 20 01 03)	
Dr. Charles Russell Ph.D	EIA coordinator (up to 30 12 03)	488
Dr. Peter Ames Ph.D	Final report review and observations	
	By ECO Ingenieros	
Ofelia Gonzáles Ms.C	Flora, terrestrial fauna and birds fauna	
Dr. Vianney Castañeda	Terrestrial biology	002
Jeannette Monterrosa Ms.C	Aquatic life	263
Jeannette Monterrosa Ms.C Carolina Bendek	Water quality	
Roberto Aguilar Leonora Ferrer	Socioeconomy	011
Dr. Frederic W. Lange Ph.D Leonora Ferrer	Archeology and historical and cultural heritage	011
Rodolfo Montúfar	General coordination	025
	By CONCULTURA	
Dr. Daniel Aguilar Dr. Mario Romero	Paleontology	

* Registration number to provide environmental services for the Ministerio de Medio Ambiente y Recursos Naturales.

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By CEL, as an institutional counterpart, the following individuals participated:

Name	Participation
Jaime Contreras	Project Manager
Jorge Luis García	Construction aspects
José Orlando Argueta Lazo	Environmental Management Unit Chief
Leonel Letona	Socio economical aspects, Revision and general observations
Roberto Artiga	Water quality, effects of green house gases, Economic-financial evaluation, Revision and general observations
José Eugenio López	Socio economical aspects

CHAPTER 1

INTRODUCTION

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Chapter 1.

INTRODUCTION

This document contains the Environmental Impact Assessment of El Chaparral Hydroelectric Project, which presents information with the principal construction characteristics different components of the project, as well as information related to the area where the project will be constructed. Therefore it facilitates understanding of the required activities, as well as the characteristics of the environment affected with the works.

The environmental impact assessments of a project, is an analysis process through which the construction aspects of a project are related with its environment. It offers advantages that result in significant savings in the investments costs and fundamentally in environment protection. The analysis and evaluation process of environmental impacts encourages the development of designs more technically adequate and integrated with the environment, which leads to a greater social acceptance, guaranteeing their sustainability.

The project consists in the construction and start of operations of a hydroelectric plant that will be located in a lower reach of the Torola River basin. This basin is located in the northeast region of El Salvador, and the project area is located between the 13° 50' and 13° 53' of northern latitude and between the 88° 22' and 88° 16' of western longitude. The project affects areas of the San Luis de La Reina, Carolina and San Antonio del Mosco municipalities, in the department of San Miguel.

In the prefeasibility study performed from December 1997 to March 1999, the potential for the hydroelectric development of the Torola River, which length is approximately 50 km, was investigated identifying seven potential sites for the construction, which from the upper to lower area are the following: Las Cruces, Maroma, Cerro Pando, Las Marías, Las Mesas, La Honda, Carolina and El Chaparral. From an economical and environmental point of view, the La Honda and El Chaparral were determined as the more feasible.

In the preliminary phase of the feasibility study initiated in March 2001, the last two sites were analyzed, finding out that the most promising for the hydroelectric project development was the El Chaparral site that is the object of this study.

The Environmental Impact Assessment (EIA) is contained within the Feasibility Study that is being performed through the technical and financial assistance of the Japan International Cooperation Agency (JICA), who entrusted its development to the Japanese company Electric Power Development Co., Ltd. (J-POWER). To support the preparation of the EIA, J-POWER subcontracted the Salvadorian company ECO Ingenieros, S.A. of C.V., which performed investigations in the project area such as: Flora and fauna, Water quality, Aquatic life, Socio-economy and Anthropology. The research regarding the historical and cultural heritage resources was performed by specialists of the Consejo Nacional para la Cultura y el Arte (CONCULTURA). For the coordination and development of the EIA, J-POWER subcontracted the North American company Harza Engineering Company International L.P. J-POWER performed the topographical surveys, as well as the geological, hydrological and seismicity studies in the project area.

The Project is property of the Comisión Ejecutiva Hidroeléctrica del Río Lempa (CEL), an autonomous institution dependant of the Ministerio de Economía, with head offices in the city of San Salvador, and the work constitutes an institutional effort oriented toward the improvement of electric energy supply at a national level because, although there has been an increase in the demand, CEL, as a generating company has not undertaken any new developments in this field over the last 20 years.

The construction time is estimated in three years and four months, during which approximately 500 people of different skills and specialties will be employed. During the operation phase, a total of

40 people will be employed that will have under their responsibility the operation and maintenance activities of the plant.

Based on 2003 prices, the development cost has been estimated in 136 millions of US Dollars and the project development general program consists of:

- Feasibility Study: March of 2001- February 2004
- Environmental Study Approval and Financing Proceedings: Dec. 2004 - May 2005
- Detailed Design: Dec. 2004 - May 2006
- Construction Tender: July 2006 - February 2007
- Construction: April 2007 - July 2010
- Start of Operations: August 2010

The project development contemplates the construction and expansion of access roads to the work sites and improvement of public roads, as well as the construction infrastructure comprised of: camp and offices for the contractor; dike and spillway construction, powerhouse and substation construction, assembly and installation of mechanical and electrical equipment, construction and installation of the transmission line, house constructions for the relocation of the families living in the reservoir area, reservoir filling, generation equipment operational testing and Plant start-up.

The dam will be concrete gravity with an approximate volume of 370,000 m^3, with a height of 87.5 m and will regulate the annual average flow of 1,489 millions of cubic meters through a reservoir with an area of 8.6 km^2 and a maximum storage capacity of 106 millions of cubic meters.

Through the use of a maximum flow of 100 m^3/s, 220 GWh per year will be generated with a main generator with a nominal capacity of 71,600 kVA. To guarantee the continuity of the different river uses downstream from the dam, a secondary generator with a nominal capacity of 1,510 kVA will be installed, driven by an ecological flow of 2 m^3/s that will be permanent during the dry season months, where values of even 0.9 m^3/s have been recorded.

The fundamental purpose of the EIA is to give a description and an appreciation of the magnitude of the works to be performed and of the environment where these will be located, which enables identifying and evaluating the possible negative impacts that may be caused with its development and proposing the corresponding environmental measures designed to mitigate and compensate such impacts.

As a result of a detailed analysis, it has been concluded that the project is technically and financially feasible. With its development a series of economical and social benefits derived mainly from the use of the available water resources are expected and thereby strengthening the energy sector.

Through this analysis, it has also been determined that hydroelectric plants represent the best option terms of a cost benefit, compared to other sources of energy generation, mainly due to the low on contamination known as green house effect gases, such as carbon dioxide. However, like every engineering works, a series of significant alterations will be introduced in the natural ecosystems. Therefore, the importance of monitoring the environment protection and complying with the current legal regulation this Environmental Impact Assessment has been considered.

A team of professionals and technicians with multi and interdisciplinary skills have participated in this report, and the Terms of Reference proposed by the Ministerio de Medio Ambiente y Recursos Naturales were taken as a guide, having at all times the participation of a team of professionals, in charge of the project engineering, and the Unidad de Gestión Ambiental de CEL, with whom office work and numerous technical inspections were performed in the Project area, discussing and analyzing the construction aspects of the different works, as well as their effort on the different components of the natural environment.

The analysis and appraisal of the potential environmental impacts were performed through the application of an evaluation instrument known as MEL-ENEL Method, which has been develop by the Engineer Manuel Enrique Lopez, of Costa Rican nationality, and consists in the elaboration of cause-effect interactive matrices through which the environmental importance of each impact is evaluated, by using a number known as Relative Significance Coefficient (Coeficiente de Significancia Relativa), which represents an integral evaluation of the effect that a specific activity can generate on the environment.

The evaluation process proved that the main negative impacts due to the development of the works will be related to the permanent change in the current use of land in an area of 8.6 km^2 because of the formation of a reservoir; with the removal of significant volumes of soil for the works foundation; loss in the vegetation cover and in the wildlife habitat in the area; relocation of 79 households, a rural school and two churches located in the project area and loss of areas with cultural and touristic importance, such as the Carolina hot springs.

To prevent, avoid and compensate the presence of potential environmental impacts, a series of specific actions are proposed for each component of the affected environment, which fundamentally consist in the planting of vegetation species in the areas adjacent to the works, as well as the reforestation of 114 ha in a protection strip around the reservoir perimeter; establishment of a site to compensate the loss of hot springs in Carolina and the performance of activities for the increase of the fish population in the future reservoir. The cost of these measures has been established in US$ 192,000, which constitutes the bond amount that should be deposited in favor of MARN.

Besides the indicated measures, other actions of environmental nature have been identified that are connected with project development, like the development of a program for the resettling of the families located in the future reservoir area, which contemplates the construction of a residential complex with basic services; delivery of a monetary compensation during a year for each head of a relocated family; construction of two bridges in narrow sections of the reservoir enabling access for the persons in the reservoir shore lines; enabling the dike as a vehicle bridge to communicate the sectors located at the north and south side of the river; improvement of 33 km and construction of 11 km of public roads in the reservoir perimeter; relocation of an elementary school and two churches; and support for the area municipalities. Specifically for the construction and operation activities: establish and operate an integrated solid and liquid waste management program; training for the development of environmental education programs; establishment of a Environmental Management System, that enables performing the work in harmony with the environment, in a continuous improvement process. An amount of US$ 7,228,00 is available for the development of these works, included as direct costs of the project.

A monitoring program was prepared to verify the performance of the proposed environmental measures. A risk Study is also presented with its respective contingencies and accident prevention measures for the construction and operation phases, and for the hypothetical closure of operations or plant abandonment.

Regardless of the negative impacts that the project development may cause to the environment, these can be compensated with the increase in the local and national development due to the strengthening of the energy sector when the plant starts operations, which implies improving significantly the life conditions of the population that has been affected by the project development. Besides, with the proper application of the mitigation measures and proposed compensation, the negative impacts to the environment will be mitigated or compensated, so that once construction is completed, the ecosystems will be able to recover in the short to medium term, allowing a gradual integration of the infrastructures to the affected natural environment.

Therefore it is concluded that the project is feasible from a social and environmental point of view.

CHAPTER 2

ENVIRONMENTAL LEGISLATION AND REGULATION APPLICABLE TO THE PROJECT

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CHAPTER 2

ENVIRONMENTAL LEGISLATION AND REGULATION APPLICABLE TO THE PROJECT

2.1 General Aspects

Passed by the Legislative Assembly in April 1998 and its later publication in the Tomo No. 339 of the Diario Oficial in May of that same year, the Ley del Medio Ambiente became the main judicial tool that regulates all the environmental aspects in the country, and the institution responsible of for application is the Ministerio de Medio Ambiente y Recursos Naturales (MARN).

The fundamental procedures to regulate the environmental protection and control are established in this Law, and within the MARN structure this, mission is under the responsibility of the Direccion de Gestion Ambiental, that has among its functions the regulation, planning and inspection of the environmental aspect in development activities. One of the most important objectives of this Dirección is to achieve the participation of the different sectors of society in environment protection policies.

The legal regulation related to the project will be discussed starting with the Constitucion Politica de la Republica, and continuing with the Ley del Medio Ambiente, its Reglamento General and Reglamentos Especiales, where everything related to the environment is regulated, as well as other secondary laws related to the particular activities. Agreements to regulate the use of bi-national waters will also be addressed. A summary of the content of this legislation is presented on Table 2.1.

Table 2.1 Environmental Regulations Applicable to the Project

Institution	Regulation	Description	Specific Regulation
2.1.1 Salvadorian Regulation			
Asamblea Legislativa	**Constitución de la República de El Salvador (1983)**	Background for any legal disposition that is emitted in the country.	**Art. 65.** "The health of the inhabitants of the Republic constitutes a public asset ..." **Art. 117.** "It is declared of social interest, the protection, development and exploitation of the natural resources" and defines as a State responsibility, "to supply the economic incentives and technical assistance necessary for the conservation and exploitation". Also it states that the regulation, conservation, and improvement of the environment resources are ruled by Special Laws.
Ministerio de Medio Ambiente	**Ley del Medio Ambiente,** Legislative Decree No.233 (1998)	The Law has as its purpose the development of the Dispositions for the protection, conservation and recovery of the environment.	**Art. 1** It takes the dispositions from the Constitución Política of El Salvador and declares that it is an "State, municipalities and inhabitants in general basic obligation" the environment protection and the application of the international treaties and agreements held by El Salvador in environmental matters. **Art. 3.** It states that the national policy on the environment will be established by the Ministerio de Medio Ambiente y Recursos Naturales (MARN) and by the Sistema Nacional de Gestión del Medio Ambiente. **Art. 9.** Establishes that the inhabitants have the right of being informed of the policies, plans and programs related to the health and quality of life, as well as participating in the consultations when concessions are granted for the exploitation of natural resources.

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Institution	Regulation	Description	Specific Regulation
			Art. 15. Establishes that the energy, communication, transportation works and exploitation of the natural resources, must include an environmental component.
			Art. 19. It states that for the start-up and operation of activities, works or projects established by the Law, an Environmental Permit (EP) must be acquired, being MARN, responsible of issuing the permit, with previous approval of the Environmental Impact Assessment (EIA) of the work or project. Regarding the scope of the EP, the Law makes reference to the necessity of including the established elements in the Environmental Management Program (EMP) as components of the EIA, which is a condition for granting the EP. **Art. 20.** It states that the environmental permit will force the owner of the project to perform the entire preventive, attenuating or compensating activities for the negative environmental impacts, established in the EMP contained in the EIA, which will be approved as a condition for granting the EP. **Art. 21 h.** Establishes the need to perform an EIA for activities such as construction of a dam, reservoir and hydraulic systems. **Art. 21 n.** Establishes the need to perform the irrigation study. **Art. 22** The owner of any activity, work, or project must request a permission of the Ministerial de Medio Ambiente, so that it classifies the work or project according to the size and nature of the potential impact. **Art. 24** It regulates the preparation, evaluation and approval of the Environmental Impact Assessments. **Art. 25** It determines the public consulting tool as well as the ten days term for any person that considers itself affected by the project to express his opinions or make written observations
Ministerio de Medio Ambiente	**Reglamento General de la Ley del Medio Ambiente** Legislative Decree No. 17 (2000)	Its purpose is to develop the rules and precepts contained in the Law, which is attached to, as its main execution instrument.	**Chapter I.** It makes reference to the Sistema Nacional de Gestión del Medio Ambiente. **Chapter II.** Regulates all the related to the Environment Evaluation, establishing that its purpose is developing and making operational everything concerning the Environmental Evaluation System at the sustainable development framework. **Art. 28** It refers to the necessity of including on the EIA the corresponding risks study, and some guidelines for its preparation are presented. The Articles 64 to 75 refer to the environmental protection, understood as the development of activities oriented to preventing and controlling contamination.
Ministerio de Medio Ambiente	**Reglamento Especial regarding dangerous**	Its purpose is to regulate the Ley del Medio Ambiente on	**Art. 2** Establishes that the authority responsible for the application of the Regulation is the MARN, in coordination with the other institutions that have responsibility, according to their laws, regarding the subject that is regulated by this Regulation.

Institution	Regulation	Description	Specific Regulation
	substances, *residues* and wastes.	the activities related to dangerous substances, residue and waste.	The following chapters regulate all the related to the identification, registration and transportation of dangerous substances, so that the protection of the human health and the environment are guaranteed.
			It also regulates all the related to the generation of residues and dangerous wastes (Chapters III and IV). The following chapters refer to the regulations for transportation, storage and management of dangerous waste; the transportation and final disposal of dangerous wastes and the international transportation of dangerous wastes, and include a series of common arrangements related to substances, residues and dangerous wastes.
Ministerio de Medio Ambiente	**Reglamento Especial for effluents**	Its purpose is to ensure that effluents waters do not alter the quality of the receiving streams.	**Art. 1** Establishes that its objective is to regulate the Ley del Medio Ambiente concerning activities related to dangerous substances, residues and wastes. **Art. 4** Establishes that the proper authority for the application of the *Regulation is the MARN, in coordination with the other* institutions that have responsibility, according to their laws, regarding the subject that is regulated by these Regulation. **Art. 5.** The owners of works and projects must consider on their EMP the application of attenuating and compensation measures for the negative impact caused on the water resource. The following chapters regulate all the related to the necessity of installing sewage treatment systems and final disposal of sludge from the treatment systems, as well as performing the analysis of the water characteristics in laboratories credited by the CONACYT. It also regulates the aspects related to quality water samples, parameters to consider, sampling frequency and results recording.
Ministerio de Medio Ambiente	**Reglamento Especial regarding the control of substances that exhaust the ozone layer**	Its purpose is to regulate in the country the importation and consumption of substances that exhaust the ozone layer.	**Art. 1.** Establishes that its purpose is to regulate in the country the importation and consumption of substances that exhaust the ozone layer. **Art. 2.** It defines that the Regulation will be applied to all natural and judicial persons that import and consume substances that exhaust the ozone layer and its mixtures. **Art. 5.** The MARN is the authority responsible for the application of the present Regulation. **Art. 6.** Identifies a series of compounds with their formula, common name, commercial name and customs code. The following articles regulate the related to the forms for the importation of this type of compounds and the importation license validation.
Ministerio de Medio Ambiente	**Reglamento *Especial* of technical regulations for environmental *quality***	Its purpose is to determine the guidelines for the establishment of environmental quality regulations.	**Art. 2.** The MARN in coordination with CONACYT will be the authorities responsible for applying this Regulation. **Art. 3.** The CONACYT will be the authority responsible for establishing the environmental quality technical regulations. **Art. 9.** It lists a series of air pollutants and establishes the maximum allowable values.

Institution	Regulation	Description	Specific Regulation
			The following articles regulate the related to fixed sources of emissions, chimneys and ducts, incinerators and the corrective measures. Establishes the allowable limits for mobile sources, regulations for the fuel quality, noise control, of smell pollutants, water quality as a receiver establishing limits for specific parameters, as well as soil quality.
Ministerio de Medio Ambiente	**Reglamento Especial about the solid wastes integral management.**	Its purpose is to regulate the solid waste management of residential commercial, from services or institutional origin.	**Art. 1.** The Regulation dispositions will apply in all the national territory and will be monitor and of mandatory compliance for every natural or judicial individual. **Art.4.** Establishes the MARN responsibility to determine the site selection criteria for transfer stations, treatment, and final disposal of solid waste, as well as emitting the permits for every solid waste management program. **Art. 5 al 9.**It regulates the related with municipal waste management. The following chapters regulate the related with the waste treatment, final disposal, sanitary landfills and vigilance regarding the sanitary landfill operation.
Ministerio de Agricultura y Ganadería	**Ley Forestal** Legislative Decree No. 852 (2002)	Protection, increase, management and sustainable use of the forest resources.	**Art. 23.** It declares restricted use Areas, the land surfaces on which the owners will have the obligation of managing in a sustainable manner the existing vegetation: lands within a 50 m zone measured horizontally starting from their highest flood during normal season on lakes, natural lagoons and in the shores of the artificial reservoirs constructed by the State, which have to be permanently covered with vegetation.
	Ley de Conservación de Vida Silvestre Legislative Decree No. 844 (1994)	Purpose of the Law: protection, restoration, management, use and conservation of wild life.	**Art. 1.** Protection, restoration, management, use and conservation of wild life. **Art. 3.** Classify wild life as part of the Nation's natural heritage. **Art. 9.–** The wild life species included on threatened or endangered species listings, which are registered in such categories, will be subjected to specific regulations regarding their protection. Includes the regulation of activities such as hunting, collection and commercialization and other forms of use and exploitation of this resource.
	Ley de Riego y Avenamiento Legislative Decree No. 153 (1970)	Exploitation and distribution of the water resource.	**Art. 11.–**The concessions are granted according to the Acuerdo del Poder Ejecutivo at the Ramo de Agricultura y Ganadería, for a term not longer than fifty years. The Estate must answer for the damages that come to the license holder for the lack or decrease of flow stated in the concession, except when this lack or decrease is due to natural flows or third party actions. The concessions could be renewed for equal successive periods. **Art. 12.** – The water right use granted through permit or concession is for the exclusive benefit of the real property that the permit or concession is granted to.
	Ley General de las Actividades Pesqueras	The purpose of this Law is to promote and regulate the	**Art. 11.** The Dirección General de Recursos Pesqueros will be the institution of the Ministerio de Agricultura y Ganadería in charge of the administration and application of this Law and will have among other responsibilities:

Institution	Regulation	Description	Specific Regulation
	Decree No 799 (1981)	fishing and aquiculture for a better use of the resources and fish products.	▪ Perform the plans and section programs of the fishing activities; ▪ Regulate the fishing resource extraction activities according to their stock; ▪ The investigation and promotion of fishing activities and the related with these; ▪ Training, assistance and technical advice to the participants in fishing activities; ▪ Contribute with other institutions in the promotion of the industrialization and consumption of fishing products; ▪ Process and settle the requests for fishing and aquiculture permits and license granting.
Municipalities	**Código Municipal** Legislative Decree No.274 (1986)	Development of the organization and municipal *independence* constitutional principles	**Art. 4.** Determines the municipalities' responsibilities. **Art. 10** Increase to the Protection of renewable and non renewable resources The faculty to establish decrees for regulating the activities in the municipality.
CEL	**Ley de Expropiación y de Ocupación de Bienes por el Estado** Legislative Decree No.33 (1939)	Determine possibility, for the State, of expropriating the possessions for public utility projects.	**Art. 3.** An agreement on the price must be achieved first. **Art. 4.** Requirements to perform forced expropriation.
Superintendencia de Electricidad y Telecomunicaciones	**Ley General de Electricidad** Legislative Decree No.843 (1996)	The State is responsible of promoting the economic development and the rational use of resources	**Art. 2 c** Rational and efficient use of the resources **2 d** Promoting the access to electric energy distribution for all population sectors. **Art. 5.** The concession requirement granted by SIGET for the use of hydraulic resources **Art. 13** Among the requirements for obtaining hydraulic resources exploitation concession **b)** The project feasibility study including a descriptive report and the corresponding drawings **c)** The EIA previously approved by the proper authorities containing a systematic evaluation of effects of the project its appurtenant works, on its construction, operation and abandonment phases, the comparison of the different existing operations and the decision-making for preventive measures and the actions designed to mitigate the adverse effects.
		Of the *disciplinary* measures	**Art. 104** **Severe** violations: **b)** Perform studies of the State properties without the SIGET authorization, with the purpose of establishing electric energy generation installations **Art. 105** **Very** severe violations: **b)** Use hydraulic or geothermic resources for electric energy generation without having the concession for such; **i)** Interconnecting transmission or distribution installations *without an agreement with the grid owner;*

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Institution	Regulation	Description	Specific Regulation
	Electricidad. Executive Decree 70. Diario Oficial tomo 336 July 25, 1997	Procedures development in the Ley General de Electricidad	**Art. 8** The entities interested in performing studies for the development of electric energy generation projects using hydraulic or geothermic resources in national properties of public or Estate use, must present to the SIGET **b)** A geographic area detail on which the study will be performed, including the national or public Ownership list on which these will be performed.
			c) Nature, type and detail of the studied resource, and **d)** Description of the study to be performed, and the estimated time that this will take
			Art. 11 In the permit, it will be clearly stated that it is not exclusive for performing the studies of the resource. Also this permit does not allow the introduction of private property into lands without the owner's previous approval. **Art. 12** Concession is the act granted by the SIGET, on which authority is given to an individual to exploit a specific hydraulic or geothermic resource, with the purpose of generating electric energy.
CONCUL-TURA	**Ley Especial de Protección al Patrimonio Cultural y su Reglamento.** Decree No. 29 (1998)	Protection of the cultural Heritage of El Salvador..	**Art. 9** Public and private properties. **Art. 13** Authorizations are required for investigations and excavations of archeological or historical interest. **Art. 27** Authorization of the Ministerio to perform investigations, studies and interventions of cultural properties, by national or foreign entities. **Art.30** Protection measures when the cultural property is in imminent danger of being damaged or destroyed.
2.1.2 International Regulation			
Ministerio de Relaciones Exteriores	**Convención para la protección y uso de aguas transfronterizas y lagos internacionales** (Helsinki, 1992)	Guidelines for the use of international waters and rivers.	**Chapter 1, articles 1 to 3** provide the information for the basin's limits of international drainages. **Chapter 2, articles 4 to 8,** deals with the fair use of waters from an international drainage basin. **Chapter 3, articles 9, and 11,** state the responsibility of controlling and preventing contamination of the river. **Chapter 6, articles 26 to 33,** it presents the procedures for the avoidance and settling of conflicts.
	Convenio para la protección de humedales de Importancia Internacional, especialmente Aves Acuáticas (RAMSAR/UNESCO, 1971)	It is an intergovernmental treaty, known as Convención Relativa a los Humedales of international importance especially for the habitat of aquatic life.	**Wetland is define as:** "extensions of marshes, swamps and turfs or surfaces covered with water, may these be of natural or artificial state, permanent or temporary, stagnant or running, fresh, salted, including the sea water extensions whose depth in low tide does not exceed six meters" **Artificial wetlands:** are those constructed by the human being which posses the structural and functional characteristics of an ecosystem. They may achieve ecological functions without human intervention. Examples: reservoirs, lakes, lagoons, canals systems, among others.

Institution	Regulation	Description	Specific Regulation
	Corredor Biológico Mesoameri-cano (CBM)	Differentiated territorial zones.	Definitions of differentiated zones: **Core zone** The core zones are places designated as "protected areas". Their purpose is to ensures that the forests, wetlands, coastal estuaries, coral reefs and other wild habitats maintain their biodiversity and generating environmental services for the people that live within them or their nearby areas and farther away. Typically these zones will include the river springs that provide water to the towns, the irrigation, the hydroelectric projects and the industry. **Buffer zones** The second type of land designation within the CBM initiative is established by the geographical zones that surround the protected areas and that are known as buffer zones. Their purpose is to create a physical space between these protected zones that mainly contain wild lands, and the adjacent areas that are used for farming, forest harvesting, farms, and other human activities. These lands surrounding the core zones are supervised with the purpose that they will filter or absorb the negative effects from in any direction.
	Convenio sobre la Diversidad Biológica Legislative Decree No.833 (1994)	Agreement subscribed in Río de Janeiro on 1992, to give protection to the life forms on the planet.	In this convention, it was recognized that the biological diversity conservation is of common interest to all humanity. **Art. 3** It recognizes that the States are responsible of the conservation of their biological diversity and the sustainable use of their biological resources. **Art. 8 and 9** provides the tools for the conservation In Situ and ex situ
	Política Centroamericana para la conservación y el uso racional de los Humedales CCAD Ministry council. XXXIII ordinary meeting (Nicaragua, July 2002)	It proposes that the Central America States increase their joint action as a region, with the purpose of conserving and rationally using the wetlands and fulfilling the commitments of the Ramsar Convention.	The political goal is to strengthen the conservation and rational use of the region wetlands through the action and cooperation between countries for the good of present and future generations of the Central America population. The population and States action are presented regarding the wetlands and non-governmental agencies, a description of the benefits that these ecosystems provide, as well as their main directors. Establishes objectives as: Encouraging the economic value of the wetlands with regional applicability, as an effective instrument to facilitate political decision-making. Support the implementation of the resolutions in the region from the Ramsar Convention, Convenio de lucha contra la Desertificación y Sequía, Convenio de Cambio Climático, Convención Interamericana para la Protección de Tortugas Marinas, Cartagena Convention, and others related to the conservation and rational management of wetlands. Encourage the informed and timely participation of the local communities and indigenous people in the conservation and rational use of the wetlands.

CHAPTER 3

PROJECT DESCRIPTION

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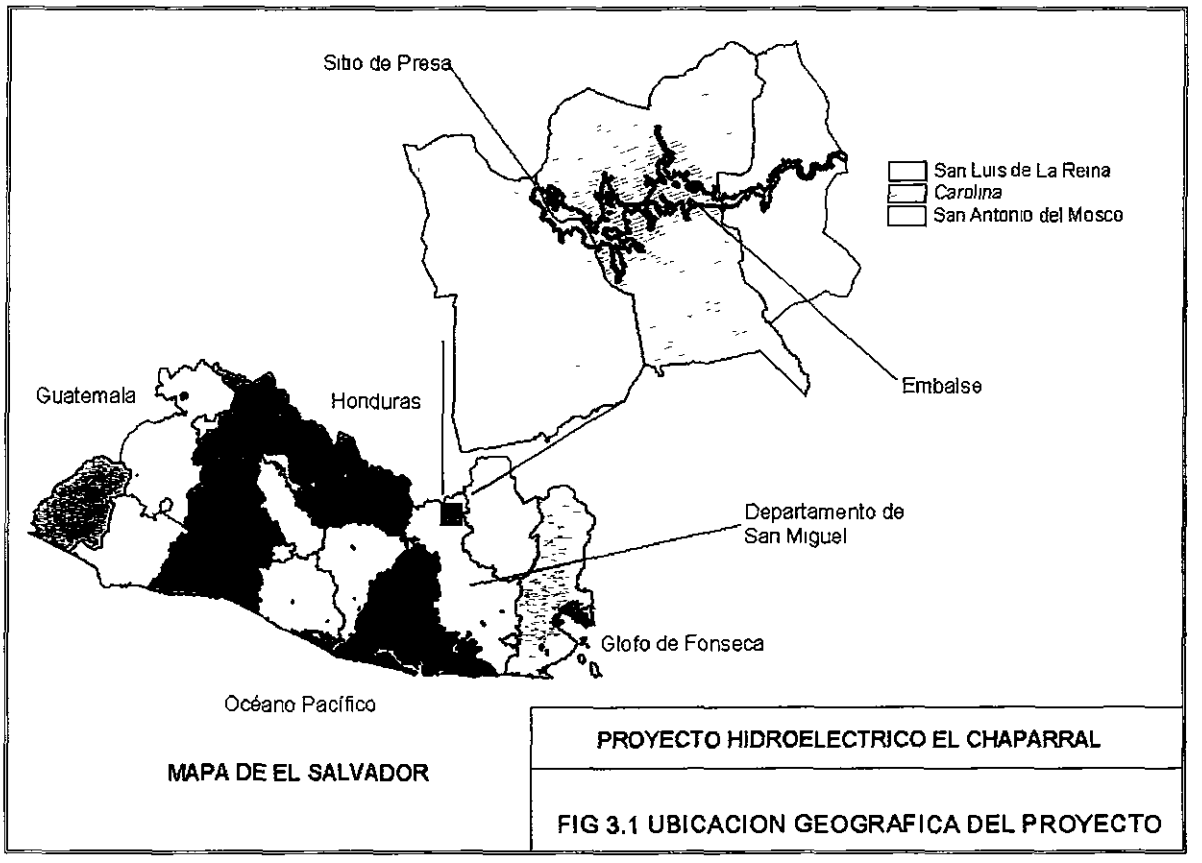
Chapter 3

PROJECT DESCRIPTION

El Chaparral Hydroelectric Project consists of the construction and start up of a hydroelectric plant, that will be located in the lower portion of the hydrographic basin of the Torola river, between the municipalities of San Luis de La Reina and Carolina, which and whose reservoir extends to the San Antonio del Mosco municipality in the Department of San Miguel. The Torola River basin is located in the northeast region of El Salvador and the dam site is located between the 13°50' and 13°53' parallels of northern latitude and between the 88°22' and 88°16' meridians of western longitude. The purpose of the project is to exploit the maximum river flow of 100 m^3/s to obtain a maximum power of 64.4 MW, for an average annual generation of 231.26 GWh, which includes the generation obtained from the use of an ecological flow of 2 m^3/s that will flow permanently while the plant is not operating.

The dam axis will be located 300 m upstream from the Honduran border providing adequate topographical and geological conditions, such as narrow valleys, on the selected site, (the riverbed has about 30 m of width and on both banks there are very steep slopes, which result in a relatively crest length), a strong foundation with impervious that inhibit seepage.

Access to the dam site can be achieved by traveling along the Pan American Highway (CA-1) on the San Salvador-San Miguel route, taking the EL Triunfo-Sesori- San Luis de La Reina turn-off and from there to the dam site. Also, by traveling along the CA-1 at km 105, onto the turn-off for the cities of El Triunfo-San Luis de la Reina and from there, to the dam site. The turn-off location of the project site is shown on Figure 3.1.



3.1 Construction Phase

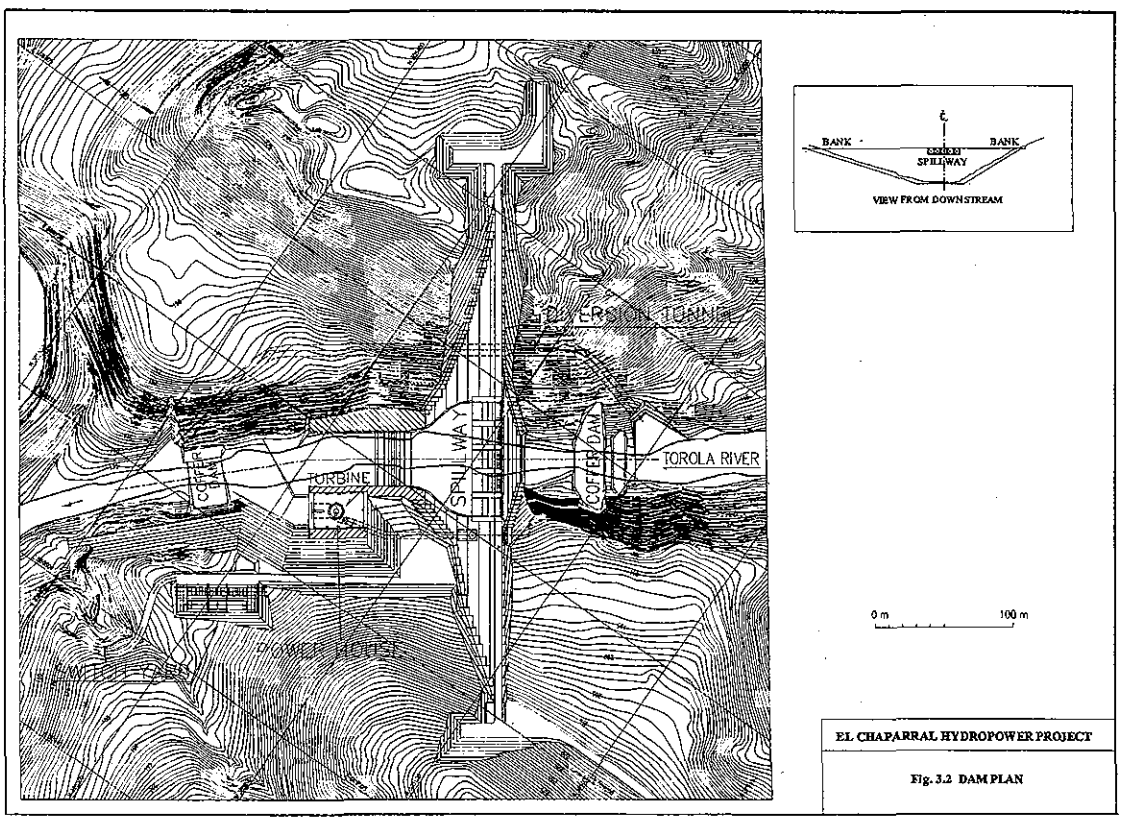
Below are described the project main components and their construction aspects.

3.1.1 Civil Works

The main civil works are described below:

a) Dam

The dam is comprised of three sections: a) in the middle section, there will be a gravity concrete structure that forms the 90 m long spillway, with 5 gates; and b) two closure dams sections faced towards the right and left abutment which will be constructed with roller compacted concrete to an elevation of 214.5 meters above sea level (masl). The total crest length of the dam will be 405 m and from the foundation to the crest it will have 87.5 m of height and an approximate volume of 370,000 m^3. For its foundation, an excavation of 5 m in depth will be performed in the riverbed, 15 m on the left bank and 30 m on the right bank, at an excavation rate of 2,500 m^3/day. Preliminary studies have determined that the volume of materials volume coming from the excavations will be 311,200 m^3. The concrete placement on the closure dams will be accomplished continuously, 24 hours a day. On Figure 3.2, the dam design and appurtenant works are shown.

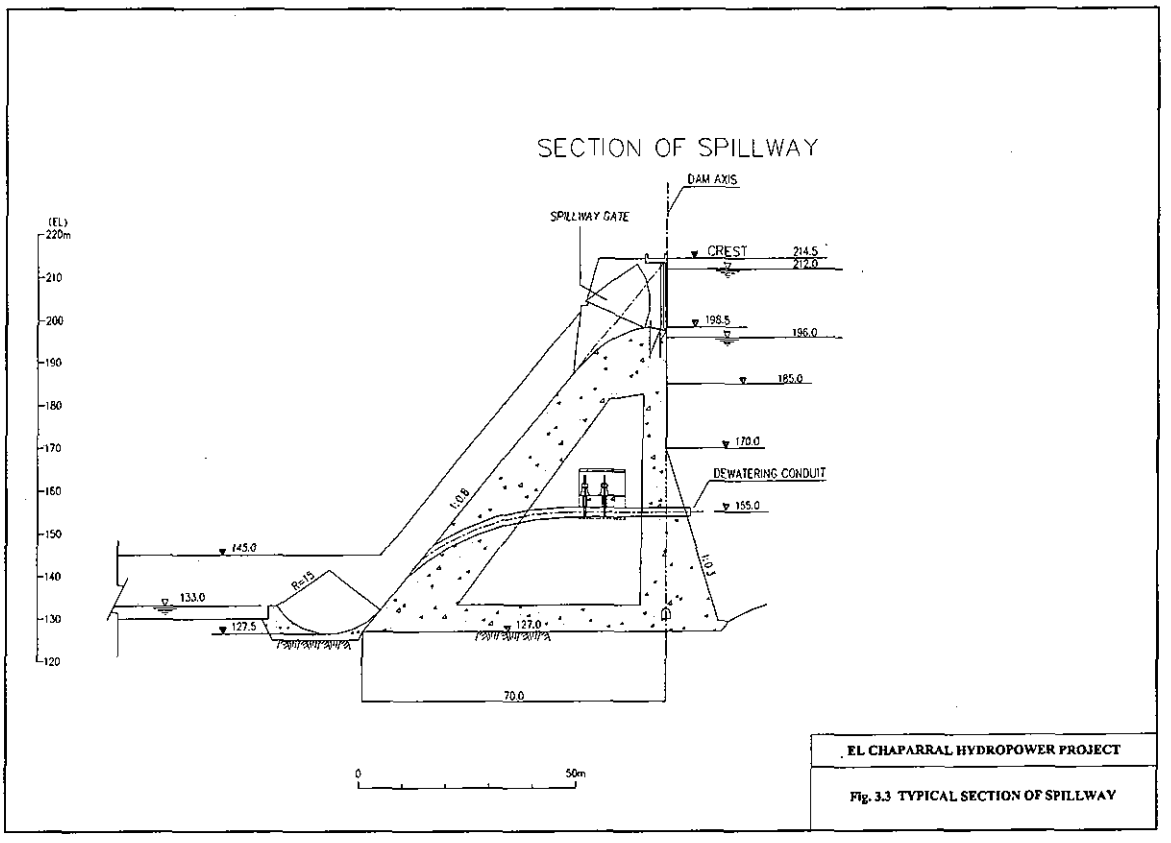


b) Spillway

The spillway will have 5 radial steel gates 13.2 m wide and 15.2 m high with a hydraulic operating mechanism. The spillway will be 90 m wide and lateral covering walls that reduce flow width to

the downstream riverbed width. To dissipate the energy there will be a flip bucket and stilling pool structure. On Figure 3.3, a typical section of the spillway is shown along with the operation levels.

To determine the spillway design flow, two criteria were analyzed: first is directly applying the maximum probable flood of 6,484 m^3/s and the second is reducing the design flood peak because of the attenuating effects of the reservoir and using a smaller flow than the probable maximum flood. To avoid problems related to the surplus water storage due to the topographic restrictions, the first criteria was selected.

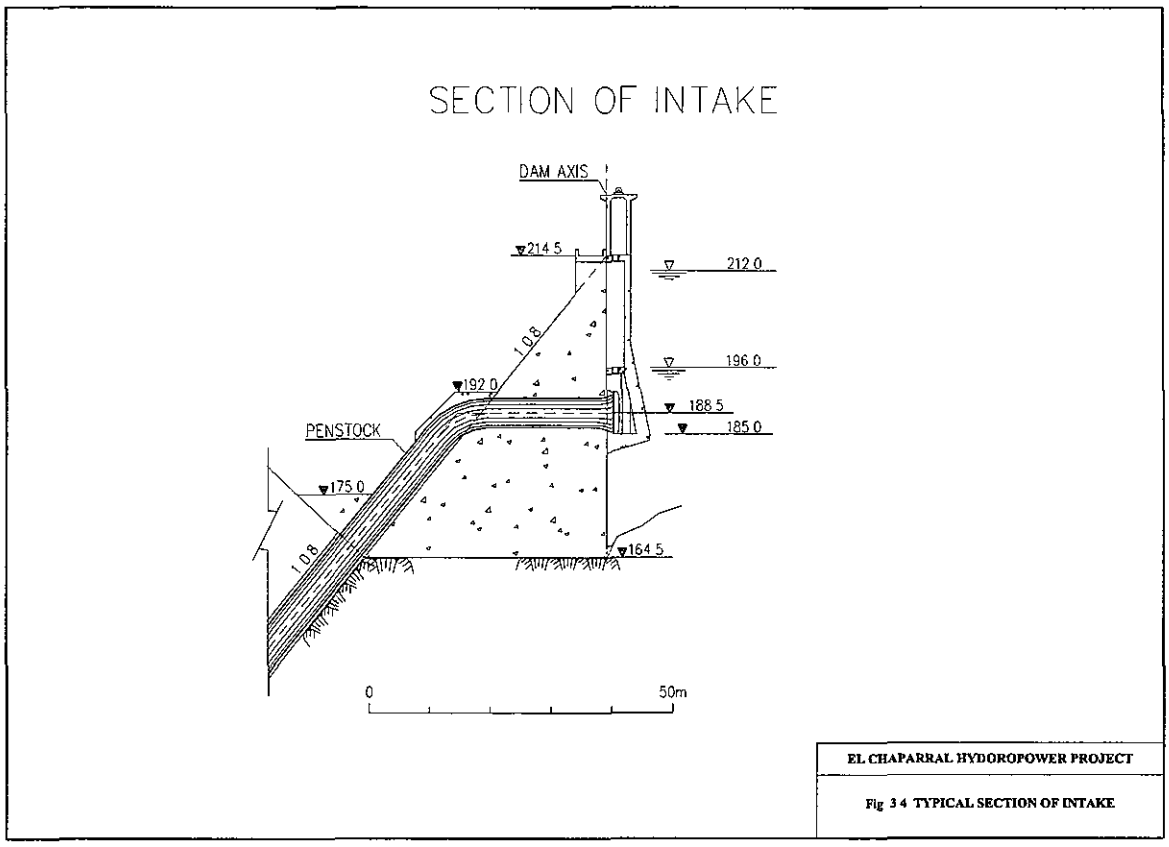


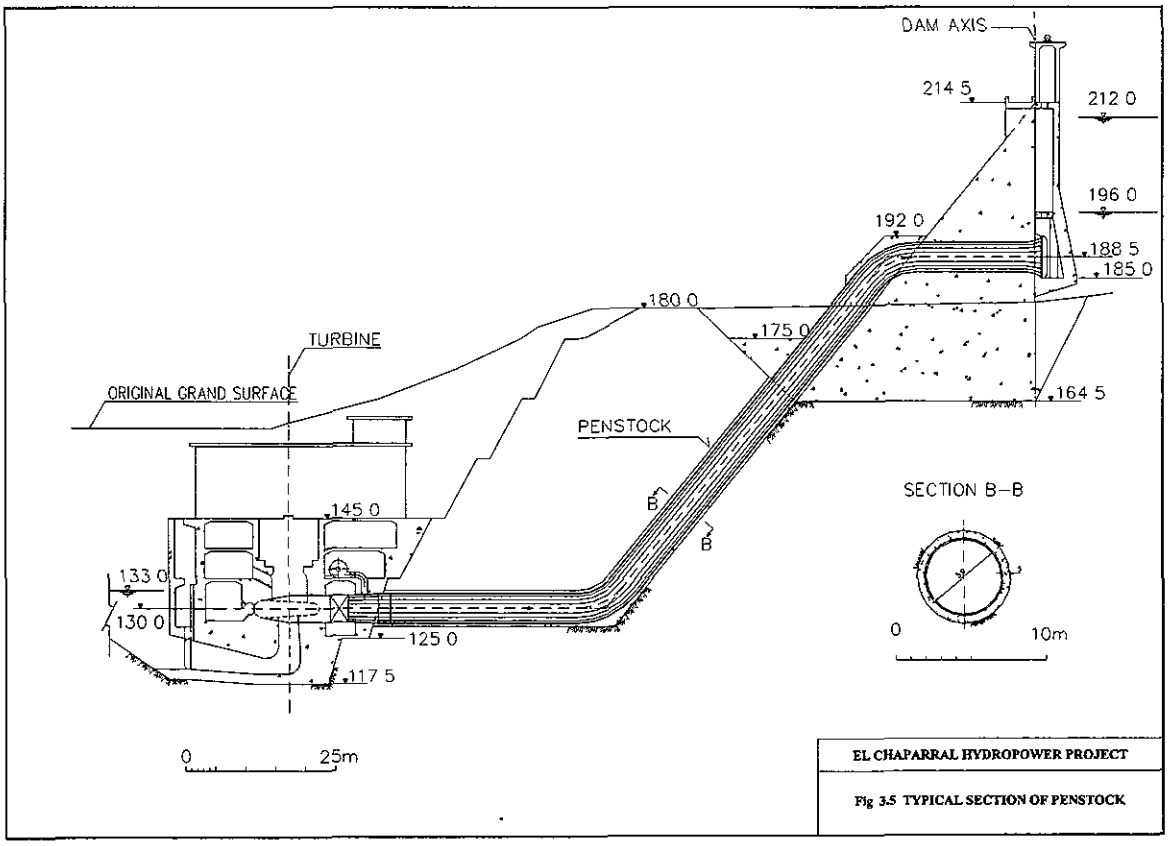
c) Intake Work and Penstock

The intake will be integrated into the dam and located on the left bank, and will be 10 m wide and 10 m high, with a 7 m wide and 7 m high gate. The intake structure will be shaped like a bell that allows water-reaching velocities of 1 m/s at the trash racks. The water intake will be equipped with a gate that will permit dewatering of the intake.

The penstock begins at the intake, crosses the dam body horizontally, until it reaches the turbine, (gross head of 74 m). The penstock will be embedded steel and have a total length of 144.5 m and an optimum internal diameter of 5 m.

The 2 m^3/s ecological flow valve will be located at the end of the penstock. The ecological flow will run permanently throughout the dry season. The spillway and penstock details are presented on Figures 3.4 and 3.5.


SECTION OF INTAKE
DAM AXIS
214 5
212 0
196 0
192 0
188 5
185 0
PENSTOCK
175 0
164 5
1 0.8
1 0.8
0
50m
EL CHAPARRAL HYDOROPOWER PROJECT
Fig 3 4 TYPICAL SECTION OF INTAKE


DAM AXIS
214 5
212 0
196 0
192 0
188 5
185 0
180 0
175 0
164 5
TURBINE
ORIGINAL GRAND SURFACE
PENSTOCK
145 0
133 0
130 0
125 0
117 5
B
B
SECTION B–B
0
10m
0
25m
EL CHAPARRAL HYDROPOWER PROJECT
Fig 3.5 TYPICAL SECTION OF PENSTOCK

d) Powerhouse and Headrace

The powerhouse consists of a reinforced concrete structure, 36 m long by 26 m wide and 16 m high. Due to the favorable geological conditions and ease of access, the powerhouse will be located at the dam toe, on the left riverbank. A pit powerhouse has been considered, requiring an excavation of about 40 m deep, and the entire structure will be below ground level.

A main turbine with a capacity of 65,900 kW and a secondary turbine, with a capacity of 1,420 kW utilizing the ecological flow, will be installed in the powerhouse. The main turbine will be coupled to a main generator with a capacity of 71,600 kVA. The secondary turbine will be coupled to a 1,510 kVA generator. Additionally, all the equipment and systems required for the proper plant operation will be installed.

e) Diversion Tunnel

For the dam and powerhouse construction, it will be necessary to divert the river flow. On the right bank, a 383.5 m long and 8 m diameter diversion tunnel will be constructed. To divert the water into the diversion tunnel, a small dike a called cofferdam will be constructed across the valley and will be 77 m long and 19 m high. Overtopping of the cofferdam during the rainy season, could affect construction of the dam, but it would be possible to dewater the are and resume construction after the flood season. To design the river diversion works, a flood of 728 m^3/s with a return period of one year, has been considered.

Tunnel construction will be continuous and will require the use of dynamite to perform controlled blasting. The tunnel construction will be accomplished at a rate of 6 m a day.

In similar manner, for the protection of the construction area from waters discharged through the tunnel, a concrete cofferdam 43.5 m long and 5 m high will be built immediately upstream of the tunnel exit. The layout of these works is shown on Figure 3.2.

f) Borrow Area

An area of approximately 120,000 m^2 has been identified as an aggregates source for concrete, and is located 2 km upstream from the dam site. The availability of aggregates has been to be in 360,000 m^3. Figure 3.6 shows the borrow areas and the area for temporary facilities that will be used during the construction period.

g) Administrative and Camp Area

On the left bank, approximately 600 m from the dam site, temporary installations will be built to be used by CEL and the Contractor and will include administrative offices, as well as warehouses, campsite and a cafeteria. These installations will occupy two adjacent areas, one with 37,500 m^2 area and another with 20,000 m^2 area, which will be served by a septic tank system. In other transitory worker areas where workers are staying for short periods of time, pit latrines will be built.

Regarding basic services, the local municipalities will provide the main services, such as electric energy and telephone. Water will be supplied through a drilled wells or from nearby streams.

The administrative and camp installations that the Contractor will use during construction will be conditioned for use as an operator's residence during the operation phase.

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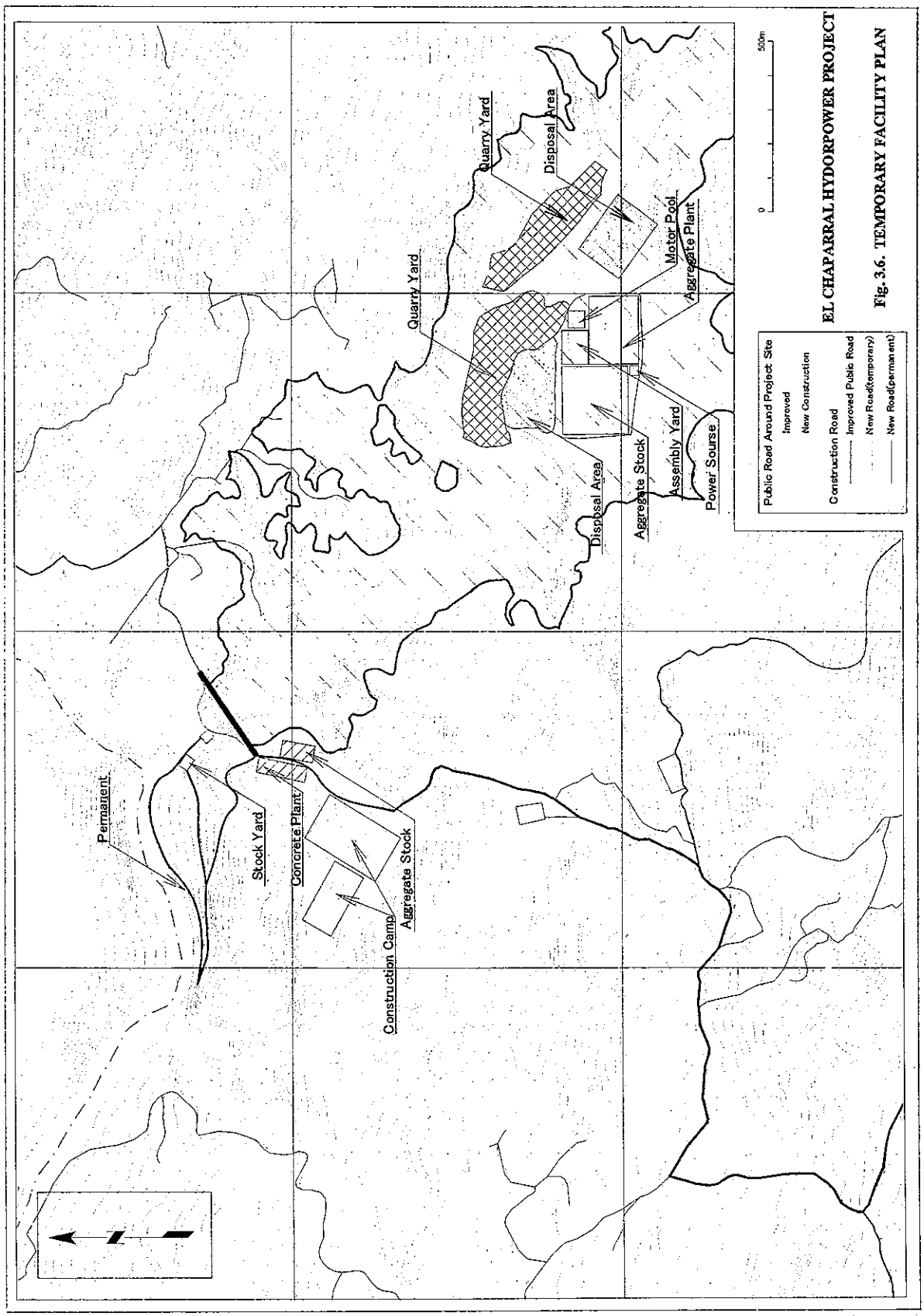
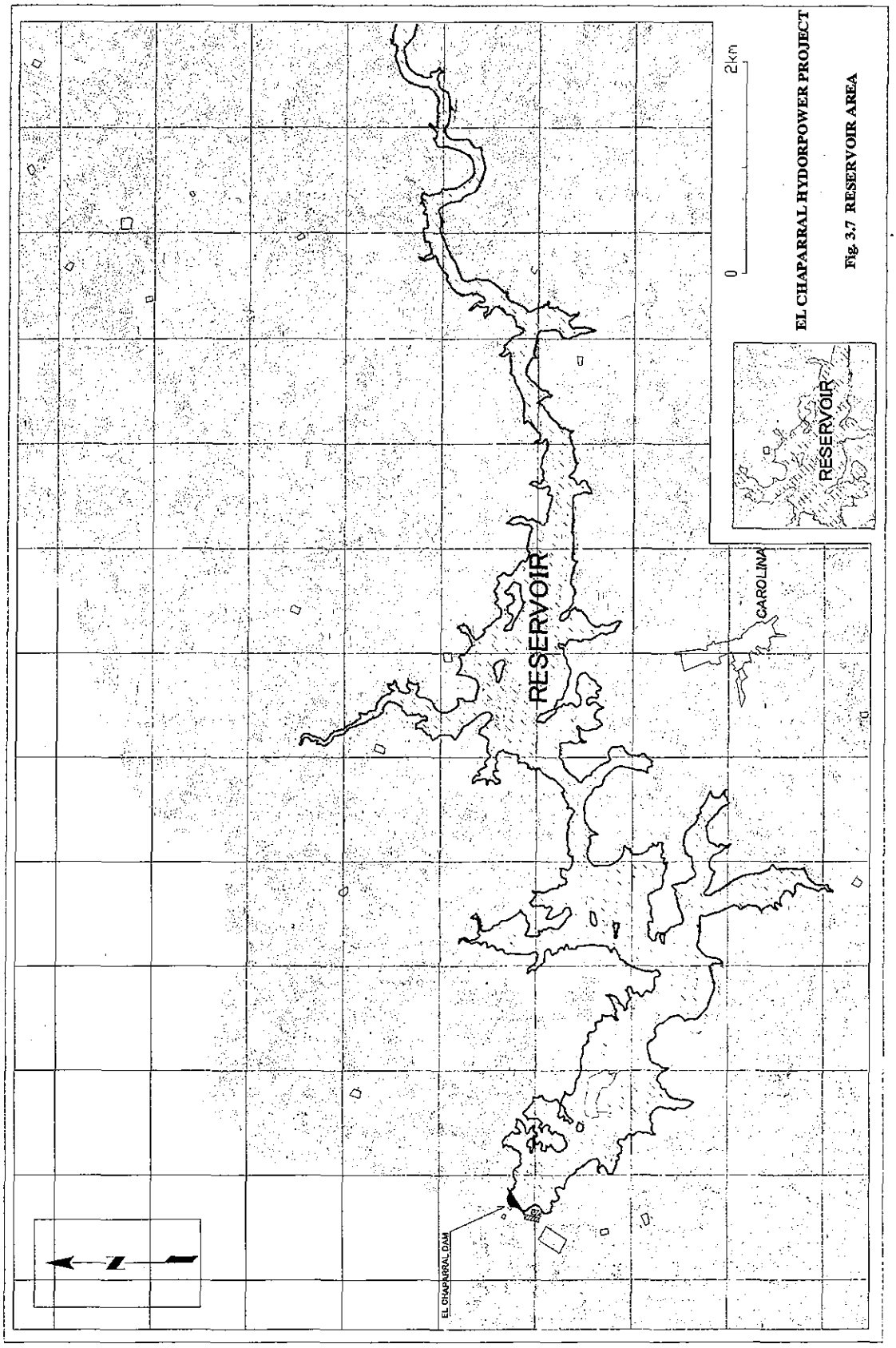


EL CHAPARRAL HYDORPOWER PROJECT

Fig. 3.6. TEMPORARY FACILITY PLAN


EL CHAPARRAL HYDORPOWER PROJECT
Fig. 3.7 RESERVOIR AREA
0
2km
RESERVOIR
RESERVOIR
CAROLINA
EL CHAPARRAL DAM

h) Site Access Roads

There are existent roads that provide access to different locations within the Torola river basin. For site access it will be necessary to expand, improve and extend the roads. A total of 3 km of roads (6 m wide), including cross drainage works will be provided for permanent site access, along with 2 km of temporary roads (6 m wide) during the construction, and the improvement of 6 km of existing roads (11 m wide) from San Luis de La Reina to the dam site. The dam crest will be used for access for the people located in both sides of the Torola River.

i) Reservoir Formation

As designed, the constructed works will lead to the formation of a reservoir that will extend 11 km upstream from the dam site near a place known as Paso de la Honda. The reservoir area will be 8.6 km^2 at the maximum level. The reservoir minimum level will be at the El. 196 masl and the maximum at the El. 212 masl, with a storage capacity of 189 million m^3 of water. The reservoir will affect areas from the San Luis de la Reina, Carolina and San Antonio del Mosco municipalities. The reservoir area is shown on Figure 3.7.

During the dry season, the plant will principally operate during peak hours, approximately from 6 to 9 pm, with a flow of about 70 m^3/s. During the rainy season, it could also operate during non-peak hours, with a maximum flow of 102 m^3/s (100 m^3/s for the main turbine and 2 m^3/s for the ecological flow turbine).

j) Substation

The substation will occupy an area of 1,200 m^2, and will be located on the left bank, approximately 60 m from the powerhouse; it will consist of interrupters, metal towers and the necessary equipment for connection with the transmission line that will transport the energy.

k) Transmission Line

A 115 kV transmission line will start from the substation and continue along a 43 km corridor to the 15 de Septiembre substation located in the southeast. From there, the generated energy will be integrated into the national network. The conductors will be supported by steel lattice towers. For the construction of the transmission line, a specific Environmental Impact Assessment will be prepared.

Generally, the equipment and materials to be used for the installation and start up of the plant and its components will be manufactured according to established technical specifications.

l) Reservoir Filling

Once the works are completed, the closure of the diversion tunnel will be performed so that the filling of the reservoir can begin. To close the diversion tunnel, the tunnel entrance will be closed and a concrete plug will be constructed in the tunnel to prevent leakage. The reservoir filling will proceed at a controlled rate, utilizing the low-level discharge works incorporated into the body of the dam. It is scheduled to initiate the reservoir filling in February and complete the filling by reaching the maximum reservoir level (212 msnm) in May.

m) Relocation

For the relocation of families directly affected by the project, a public information campaign is being developed to explain the alternatives. One alternative being considered is the construction of houses for the families to relocate.

3.1.2 Revegetation

The Contractor will plant vegetations mainly where the administrative offices and camp areas will be established. The specifications for this activity will be detailed in the detailed design phase.

3.1.3 Transportation Routes for Imported Machinery and Equipment

There are the two existing ports in the country where the project machinery and equipment could be unloaded. An analysis of the possible inland routes that could be used to transport machinery and equipment identified two possible routes, depending whether the unloading is done on the Acajutla Port or the La Union Port.

a) Acajutla Port Route

The Acajutla Port is located on the Sonsonete Department, 85 kilometers to the southwest of San Salvador city. It is currently the only international port of El Salvador and it possesses adequate infrastructure for the unloading and maneuvering of the imported machinery, because it has 30, 40, 45 and 60-ton cranes, as well as freight elevators and towing trucks. This route includes the following: Acajutla-San Salvador-Moncagua detour-Barrios city-San Luis de La Reina-dam site.

If this route was used, the option of going through the road that starts from the El Triunfo city, at the 105 km on the Pan-American Highway, to San Luis de La Reina and the dam site, with a distance of 320 km could be considered. To use this route, a detailed study of the conditions of the road and the capacity of 2 or 3 bridges must be performed.

b) La Unión Port Route

The La Union port is located on the southeast of the country, and the port infrastructure is planned on being improved within a short term, so that there will be the capacity to perform heavy machinery unloading operations. If this port was used for that purpose, the overland distance will be approximately 100 km and will offer advantages regarding the transportation time, cost and security compared to the Acajutla route. This route extends from La Union Port-San Miguel city-Moncagua city detour-Barrios city-San Luis de La Reina-dam site and it involve satisfactory road conditions for machinery transportation, except within the La Union city, which has narrow roads.

3.1.4 Electrical and Mechanical Equipment

For the main generation unit the following equipment will be installed:

a) A main Francis hydraulic turbine, with a vertical axis, a capacity of 65.9 MW, with 72.8 m of standard effective head and 100 % gate opening. Plus, inside the powerhouse, a secondary turbine will be installed with a horizontal axis and a 1.42 MVA capacity, that will be driven by the ecological flow.

b) A synchronous three phase main generator with a vertical axis, 71.6 MVA of capacity and a 90 % power factor. The rotor and stator winding will have Class F insulation. The cooling system will be closed air with a water heat exchanger and fans. The principal data are shown on the next page:

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- Rotation direction : clockwise
- Synchronous speed : 200 rpm
- Capacity : 71.6 MVA
- Current : 3,000 A
- Power factor : 0.9
- Voltage : 13.8 kV
- Frequency : 60 Hz

There will be a synchronous three phase secondary generator with a 1.51 MVA capacity, with characteristics similar to the main unit. The principal data of the specifications is shown below:

- Rotation direction : clockwise
- Synchronous speed : 900 rpm
- Capacity : 1.51 MVA
- Current : 1,820 A
- Power factor : 0.9
- Voltage : 0.48 kV
- Frequency : 60 Hz

c) A main transformer will be provided outside the powerhouse. It will be a three-phase transformer and designed considering transportation limitations, efficiency and installation space. The maximum allowable weight for ground transportation to the project site is 100 tons, including the weight of the transportation vehicle. There will be a water spray fire protection system for the transformer.

d) Penstock and inlet valve. There will be a steel pipe coupled with a main inlet valve, of 4.3 m diameter. Another penstock for the small turbine will join the main pipe at a section upstream of the inlet valve.

e) Switchyard Equipment. The 115 kV line will originate at the high voltage side of the transformer and will reach the switchyard that is 60 m away with the 115 kV transmission line.

3.1.5 General Testing and Function

Once the installation of generation, control and transformation equipment is complete, water and performance tests will be undertaken, prior to start-up of the plant.

3.1.6 Development Cost

As of January 2003, the total development cost was estimated (by calculation) in millions of US dollars, distributed in the following manner:

i. Preparatory works, which consist of expansion and improvement of existing roads for both temporary and permanent use, on the project site.

ii. Civil works, including the diversion tunnel; cofferdam; dam, spillway, and powerhouse.

iii. Hydro mechanical equipment procurement including the gates.

iv. Electrical equipment procurement: turbines, generators, transformers, generation and substation equipment.

v. Transmission equipment: breakers and materials for the transmission lines.

vi Environmental aspects: expansion and improvement of public roads, construction of two bridges and development of environmental impact mitigation measurements.

vii. Land acquisition: for reservoir, for access roads, temporary installations, powerhouse, substation and transmission lines. Costs for relocation.

viii. Contingencies for preparatory works, civil works, fixing of nearby roads and electrical hydromechanical and transmission equipment. A summary of the costs is presented on Table 3.1

xv. Costs for administration and engineering of the construction.

Table 3.1 Summary of Costs for Project Construction

No.	Activity	Cost US Dollars
1	Preparatory Works	4,471,800
2	Civil Works	57,114,110
3	Hydromechanical Equipment	11,720,000
4	Electrical Equipment	17,786,000
5	Transmission Equipment	2,597,000
6	Environmental Costs	7,420,000
7	Land Acquisition and Relocation	9,823,700
	Total direct costs	**110,932,610**
8	Contingencies	7,763,750
9	Administration and Engineering Costs	16,639,900
	Total indirect costs	**24,403,650**
	Total costs for project construction	**135,336,260**

3.1.7 Construction Period

This project has been planned to be constructed in 3 years and 4 months and it has been determined that the critical aspect will be related to the construction of the powerhouse. It is estimated that the project construction will require the participation of 500 workers of diverse specialties for the execution of different activities, who, except for the tunnel and cofferdam works will have a standard workday of 8 hours. During the construction of the works, different machines will be used such as: power shovels, drills, dragshovels, cranes, roller and vibration compactors, and dump trucks. On Figure 3.8, the project construction schedule is presented.

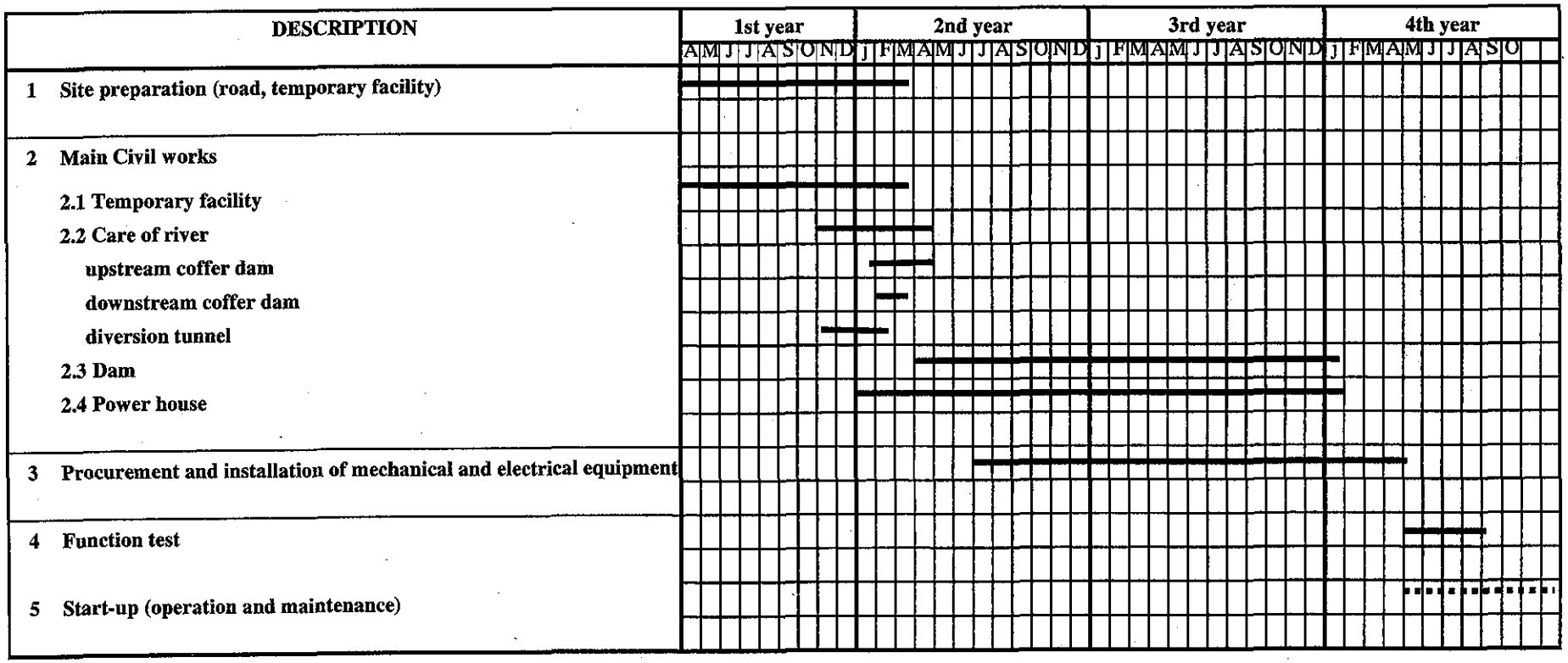

Fig.3.8 Construction Schedule

3.2 Operation Phase

The operation of the hydroelectric plant consists of a series of controlled and coordinated actions from the powerhouse that determine normal plant operation, including routine activities such as: periodic inspections, programmed cleaning and preventive maintenance, and emergency repairs, with the purpose of maintaining the equipment in a perfect working condition.

The principal activity is related to the electric energy generation through operating the hydraulic turbines. For proper plant operation, it is necessary to perform activities such as the described below:

- Recovery of oil and lubricants at the powerhouse.
- Equipment and metering panels maintenance.
- Cleaning the intake trash racks.
- Cleaning and washing of the structure.
- Maintenance of retaining walls for the different structures, to avoid deterioration and possible land slides.
- Maintenance activities of the vegetation cover in the direct area of influence.
- Maintenance of the access roads to the different components of the plant.
- Substation and transmission line maintenance.
- Reservoir operation, according to the energy requirements.
- Early warning system of sudden large volumes of water discharges.
- Internal radio communication systems.
- *Operations regulations.*
- Signals

3.3 *Abandonment Phase*

It has been taken into consideration the activities that have to be performed to dismantle the provisional installations used by the Constructor once the construction activities are completed, as well as the closure of the plant operations or plant abandonment.

Once the construction works are finished, the Contractor will remove all the remaining materials. He will perform an orderly dismantling of the provisional installations such as: offices, warehouses and shops, and will deliver the Plant operator areas, free of all types of waste.

As for the hydroelectrical plant installations, there is no near term planning of operations termination because the useful life is estimated to be 50 years. With proper maintenance, even after this period and if the corresponding evaluations so indicate, it could continue operating.
However, for any hypothetical abandonment plan, first of all, the proper authorities have to be informed, such as SIGET, the MARN and the Municipalities, (or their equivalents at that moment), institutions that will have a specific regulatory authority such as providing the Environmental Form to obtain the proper dismantling permits.

On the practical aspects, the natural river flow would have to be diverted back to the riverbed, removing the spillway gates, and also dismantling the remaining structures, so that they do not become a real or potential risk for the population or for the fauna. The rehabilitation of all the affected areas must be achieved, to facilitate the recovery of the natural resources.

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3.4 Economic and Financial Evaluation

3.4.1 Economic Evaluation

The purpose of the economic evaluation is to determine the economic impact produced by the development of the project from the national economic point of view. A comparison between costs and benefits of the project development is presented below.

1) Basic Conditions

Based on the existing reports regarding other projects in El Salvador, the following basic conditions have been adopted:

- **Capital Opportunity Cost:** The capital opportunity cost refers to an interest rate that can be used to justify the worthiness of the investment. An interest rate of 10 % has been applied, considering the rates for other projects in El Salvador.

- **Discount Rate:** A discount rate of 10 %, adopted by the World Bank, has been used.

- **Shadow Price:** The standard conversion factor adopted by the Banco Interamericano de Desarrollo to calculate the shadow price of the domestic price portion was used.

- **Useful Life:** The useful life of each installation, according to the experience of the Consultant, is shown below:

  50 years for civil works
  35 years for hydromechanical and electromechanical equipment.
  30 years for the transmission line

- **Project Life (calculation period):** The calculation period for the evaluation is 53 years, in other words, 50 years of useful life for the works and 3 years of construction.

- **Cost Estimation:** The cost estimation has been performed using the price level of 2003.

2) Project Economical Cost

The project economical cost has been calculated based in the market price presented in the Project Feasibility Study. The construction, operation and maintenance cost has been included in the flow of costs.

Basically, the generation and substation equipment in El Salvador are exempt from the import tax. Therefore, the cost estimation does not include the taxes, and the foreign currency portion has been used as an economical price without conversion.

a) Initial Investment Costs (Economic Price)

The initial investment costs for the different installations are presented in Table 3.2. The annual investments has been totaled for the main items; including the engineering and administration cost, and also the contingency (the fourth year includes the payment of the retention):

Table 3.2 Initial Investment Costs at Economic Price

(Unit: 1000US$)

	Environment and land acquisision cost	Civil and preparatory works	Hydromechanical and electromechanical equipment	Transmission lines	Total Cost
1st year	12,305	11,618	4,183	455	28,561
2nd year	2,037	18,317	8,074	1,061	29,490
3rd year	2,037	33,075	14,412	1,212	50,737
4th year	2,037	9,409	8,213	303	19,962
Total	18,418	72,418	34,883	3,030	128,749

b) Operation and Maintenance Cost

The operation and maintenance costs (O & M) has been calculated multiplying the construction cost of each work by a specific rate, according to the Consultant's experience in similar projects, that are shown in Table 3.3.

Table 3.3 Cost of Operation and Maintenance

(Unit: 1000US$)

Item	Construction Cost	Rate	Amount
Civil Works	729,418	0.5%	362
Equipment	34,883	1.5%	523
Transmission Line	3,030	1.5%	46
Total			931

3) Project Economical Benefit

The following benefits were taken for the Project; one is the cost savings for the alternative thermal plant from the "with project" and "without project" point of view, and the other is the income due to the sale of electric energy at the marginal cost. The complete analysis is found in the Project Feasibility Study.

a) Thermal Generation Alternative Cost

The economic benefit can be measured from the "with project" and "without project" point of view. In this case, instead of constructing a hydroelectric plant, it will be possible to a thermal plant to generate the energy with the quality and quantity equal to the El Chaparral Project. With the purpose of calculating the required cost of such an alternative plant, the following process was applied in two phases: the first phase to study the annual cost of several plants with different generation systems and the second to select a plant with the minimum annual cost to estimate its construction cost and cost of O & M, including fuel.
Having these conditions the annual cost for each plant and the single generation cost for different installation usage factors were calculated. As a result of the comparison with the usage factor of

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40 %, which will correspond to the El Chaparral Project, the lowest cost plant was that of a low speed Diesel engine. For the present case, the low speed Diesel engine was selected considering the technologies available in El Salvador and the fuel available.

The alternative thermal plant installed capacity was calculated, based on the El Chaparral Project effective reliable capacity. In this project, due to a large flow difference between the climatic seasons, the effective capacity is very low, compared with the installed capacity. Therefore, from a conservative point of view, and with the purpose of avoiding an over-estimation of benefits the alternative thermal plant capacity has not covered the El Chaparral Project capacity.

The total construction cost of the alternative thermal plant is US$ 46,000,000; the total O & M cost for the thermal alternative is US$ 2,440,000 and the fuel cost is US$ 9,112,000/year.

b) Incomes Due to the Sale of Electric Energy

Due to the energy sector in El Salvador, the wholesale market regulated by the Unidad de Transacciones, has been working since its establishment in 1998. All the energy, is offered, and commercialized with a specific price by the market. The average of the monthly energy cost during the last five years is US$ 67.65/MWh. This price can be considered close to the electric energy marginal cost. Therefore, this average price is used as the price for energy sales. If it is multiplied by the estimated average annual energy of 233.21 GWh that includes the increase in the energy generation of 2 GWh of the 15 de Septiembre plant, to obtain the estimated annual income (US$ 15,776,000), which the benefit.

4) Economic Indicators

The net present value (NPV) of the costs of the Project reaches US$ 109,614,000 (with a discount rate of 10 %; the same rate has been applied to the following calculations). The total present value of the economical benefit with the alternative thermal plant is US$120,294,000. The NPV calculated is US$ 10,680,000 and the benefit cost (B/C) ratio is 1.12. The calculated economic internal rate of return (TIRE) is 11.3 %, as shown in Table 3.4.

On the other hand, the total present value of the economical benefit with the incomes from energy sale is US$ 111,237,000. The calculated NPV is US$ 1,623,000 and the calculated benefit-cost (B/C) ratio is 1.02. The calculated economic internal rate of return (TIRE) is 10.2%, as shown in Table 3.4.

The evaluation indexes or economic indicators, such as net present value (NPV) and benefit-cost ratio (B/C) with several discount rates, as well are summarized in the Table 3.4:

Table 3.4 Economic Indicators

	Benefit		Criteria	Discount rate
	Alternative thermal	Power sales		
NPV	72,822	74,637	> 0	6 %
	34,388	29,323	> 0	8 %
	10,680	1,623	> 0	10 %
B/C	1.57	1.59	> 1	6 %
	1.29	1.25	> 1	8 %
	1.10	1.01	> 1	10 %
EIRR	11.3%	10.2%	> costo de oportunidad de capital	

It has been concluded that the evaluation that uses the energy sales as the benefit turn out to be lower than the ones from the thermal alternative. Despite this, any evaluation index, including these lower values, meet the evaluation criteria, and the Project can be considered feasible from an economic point of view.

The Feasibility Study includes an analysis where the sensitivity of the economic evaluation indexes is analyzed for cases where the basic conditions have been changed.

However, it is obvious that the economical indicators are lower than the evaluation criteria in the sensitivity analysis for the worst conditions. Generally, a small value of the TIRE does not necessarily reject the project, and a few per cents lower than the capital opportunity cost is considered to be within the "marginal" range. The sensitivity analysis results for the worst conditions fall within the mentioned range. In case that a development agency decides to perform projects with such a risk, it will be necessary to take a political decision, considering the cost difference of the capital opportunity cost as a subsidiary cost destined to promote clean energy development and/or rural development.

3.4.2 Financial Evaluation

The purpose of the financial evaluation is to establish the recovery of the investments, as expected by developing agencies.

1) Methodology

In the study the discount of cash flow method was used. The basic approach of this method is indicated below. First of all, the expenses and expenditures flow and the income and benefits flow for each year during the life of the project are developed and secondly, the amounts in the different years are discounted to the initial year of the Project and expressed as an accumulated present value of that same year. Later, a comparison between costs and benefits is performed. The evaluation index obtained is the internal rate of financial return (TIRF) on the investments. The TIRF on the investments is not affected by financial conditions; therefore, it is appropriate to evaluate the profitability of the Project.

2) Financial Cost and Project Benefit

a) Financial Cost

The project financial cost includes the initial investment cost, the equipment replacement cost and the operation and maintenance cost, indicated at market prices. These values are shown in Table 3.5.

Table 3.5 Financial Project Cost

(Unit: 1000 US$)

	Environment and land acquisition cost	Civil and preparatory works	Hidromechanical/ electromechanical equipment	Transmission Line	Total Cost
1st year	13,431	12,432	4,244	468	30,574
2nd year	2,133	19,463	8,205	1,091	30,892
3rd year	2,133	35,090	14,632	1,247	53,102
4th year	2,133	9,997	8,326	312	20,769
Total	19,830	76,982	35,407	3,117	135,336

The O&M cost has been calculated by multiplying the construction cost of each work by a specific rate, according to the experiences of the Consultant in similar projects, these values are presented in Table 3.6.

Table 3.6 O&M Cost

(Unit: 1000US$)

Item	Construction Cost	Rate	Amount
Civil Works	76,982	0.5 %	385
Equipment	35,407	1.5 %	531
Transmission Line	3,117	1.5 %	47
Total			963

b) Financial Benefit

The financial benefit of the Project is the income obtained from the sale of electric energy. The Unidad de Comercio and the Departamento de Estudios of CEL prepared a report "Proyecciones de Generación e ingresos corrientes de la Central Hidroeléctrica El Chaparral, período 2009 – 2024", using the SDDP optimization dispatch model. According to this report, the annual energy that can be sold was estimated at 180.2 GWh, and the average sale price was US$ 58.08 MWh. In this evaluation, the annual income was calculated at US$ 10,466,000.

c) Internal Rate of Financial Return (TIRF)

The TIRF for the investment was calculated based on the financial income that is shown in Table 3.7. The conclusion is that the development of the project requires softer loan conditions.

Table 3.7 Result of FIRR

Item	Result	Criteria
FIRR	6.4 %	> interest rate

d) Period of Investiment Recovery

Three financing conditions are considered. These conditions are shown in Table 3.8.

Table 3.8 Financial Condition

	Case A Comm. Bank	Case B Int'l Financing	Case C Bilateral loan
(1) Interest rate	8 %	6 %	1.5%
(2) Commitment fee	0.75 %	0.75%	0.75%
(3) Loan period	10 years	15 years	25 years
(4) Repayment period	7 years	12 years	18 years
(5) Grace period	3 years	3 years	7 years
(6) Debt/Capital	70/30	70/30	70/30

Under these above conditions, Period of Investment Recovery is calculated. In this case, Period of Investment Recovery means that the period a cash follow will turn in surplus after Start-Up. A result of the calculation is presented on Table 3.9.

Table 3.9 Period of Investment Recovery

	Case A	Case B	Case C
Recover Period	20 years	21 years	2 years