Japan International Cooperation Agency (JICA)

Comisión Ejecutiva Hidroeléctrica del Río Lempa (CEL)

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

FINAL REPORT

MARCH 2004

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

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PREFACE

In response to a request from the Government of the Republic of El Salvador, the Government of Japan decided to conduct the Feasibility Study on the Hydroelectric Complex over the Torola River and entrusted the Study to Japan International Cooperation Agency (JICA).

JICA sent a study team led by Mr. Nobuo HASHIMOTO of Electric Power Development Co., Ltd. (J-POWER) to the Republic of El Salvador eight times from May 2001 to December 2003.

The study team held discussions with the officials concerned of the Government of the Republic of El Salvador and conducted related field surveys. After returning to Japan, the study team carried out further studies and compiled the final results in this report.

I hope this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of El Salvador for their close cooperation throughout the study.

March 2004

Tadashi IZAWA
Vice President
Japan International Cooperation Agency

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March 2004

Mr. Tadashi IZAWA
Vice President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Izawa,

Letter of Transmittal

We are pleased to submit to you the feasibility report on the Hydroelectric Complex over the Torola River in the Republic of El Salvador. This report contains the advice and suggestions of the authorities concerned of the Government of Japan and your Agency, as well as the formulation of the above mentioned project. Also included are comments made by the Comisión Ejecutiva Hidroeléctrica del Río Lempa of the Republic of El Salvador during technical discussions on the draft final report which were held in San Salvador.

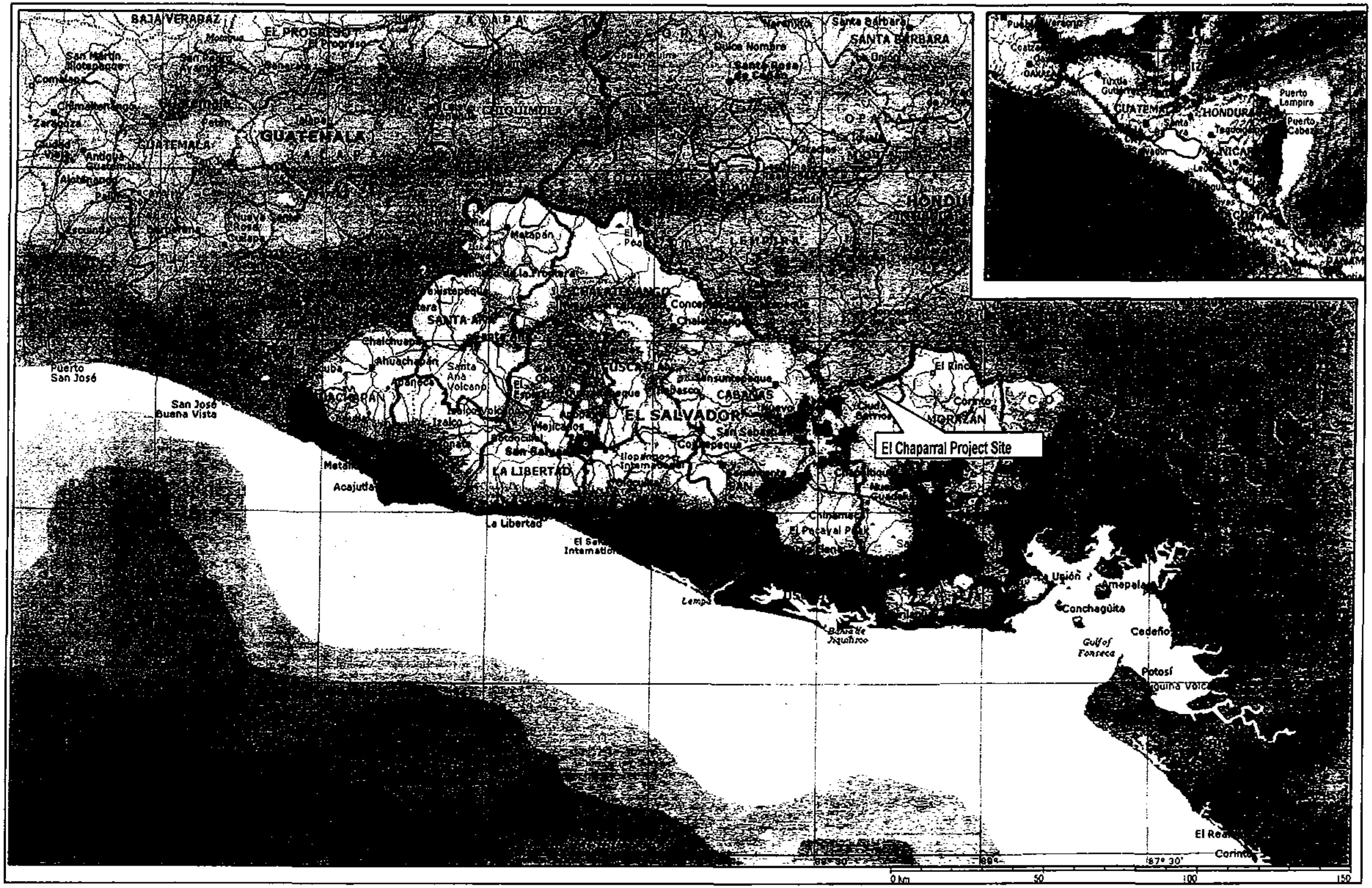
This report presents a development of El Chaparral Hydropower Project with an installed capacity of 65.7 MW and annual energy generation of 233.2 GWh. After completion of the project, the domestic water resources can be effectively used to supply stable energy in order to cope with the increasing power demand as well as problem of global warming.

In view of the importance of power development and of the need for socio-economic development of the Republic of El Salvador, we recommend that the El Salvadorian Government implement this Project as a top priority.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Economy, Trade and Industry. We also wish to express our deep gratitude to the Comisión Ejecutiva Hidroeléctrica del Río Lempa and other authorities concerned of the Government of El Salvador for their close cooperation and assistance extended to us during our study.

Very truly yours,

Nobuo HASHIMOTO
Team Leader
Hydropower Complex over the Torola River Project



El Salvador Location Map

El Chaparral Dam Site (View from Downstream)

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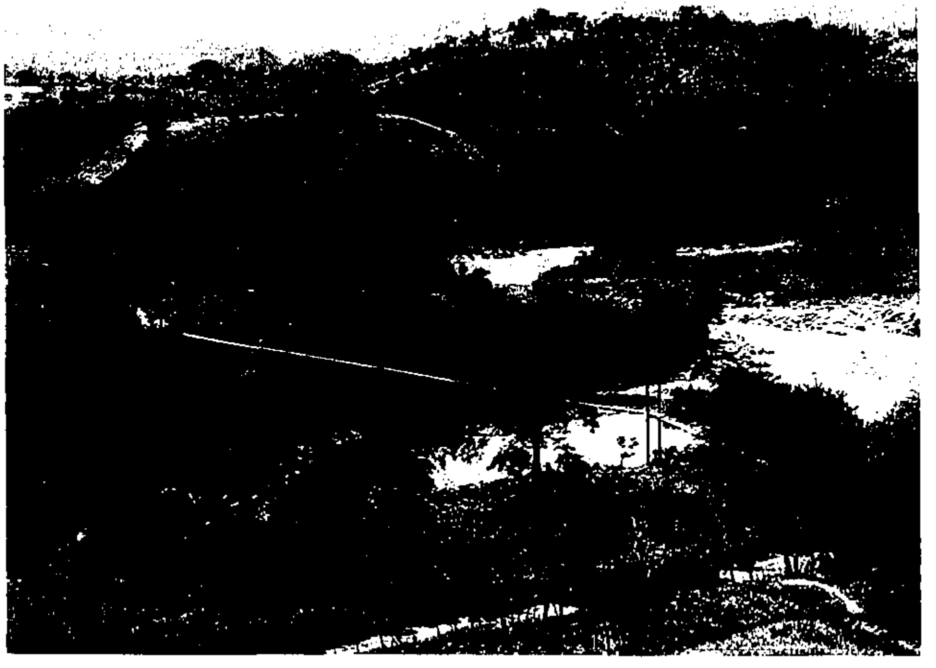
Road Condition (El Trinfo, Turning Point from Pan-American Highway)

Road Condition (San Luis de La Reina ~ Dam Site)

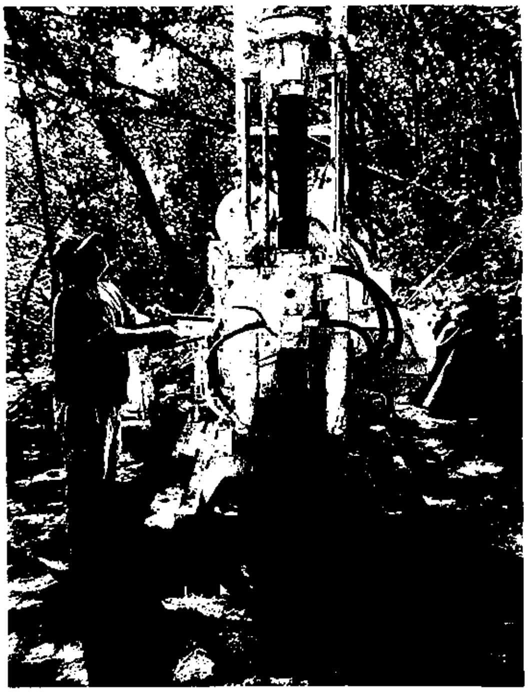
Upstream View from El Chaparral Dam Site

Downstream View from El Chaparral Dam Site



Suspension Bridge in Carolina

Osicala Hydrological Gauging Station

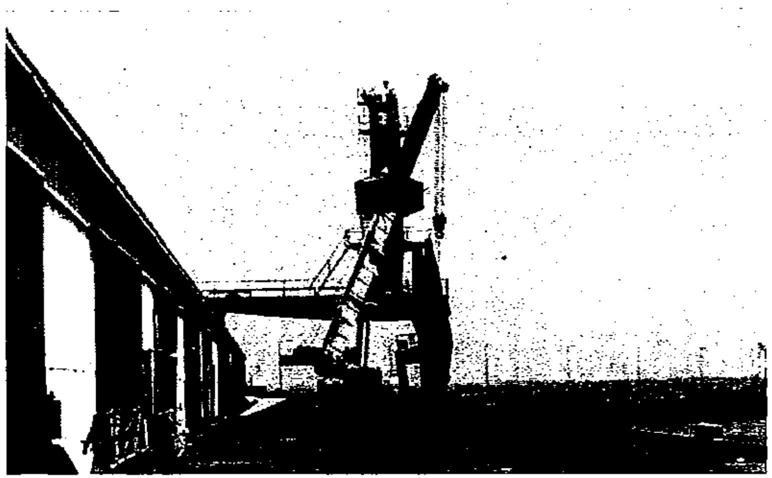


Geological Investigation

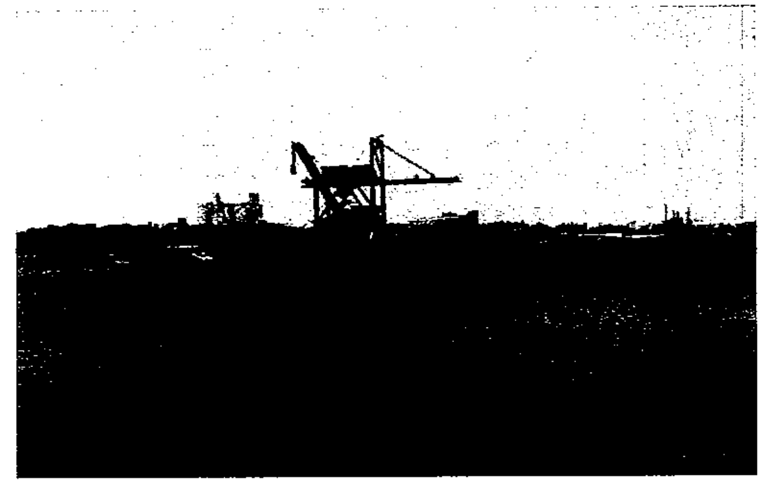
Environmental Investigation

1st Public Hearing (June, 2003)

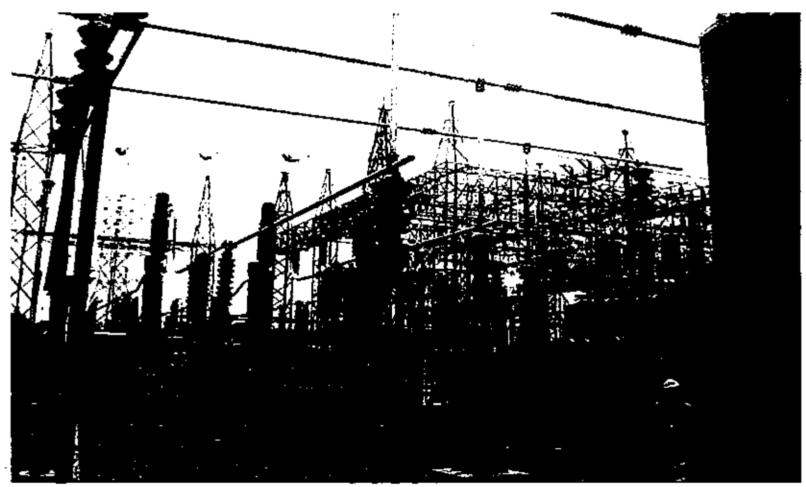
2nd Public Hearing (December, 2003)



Acajutla Port Facility

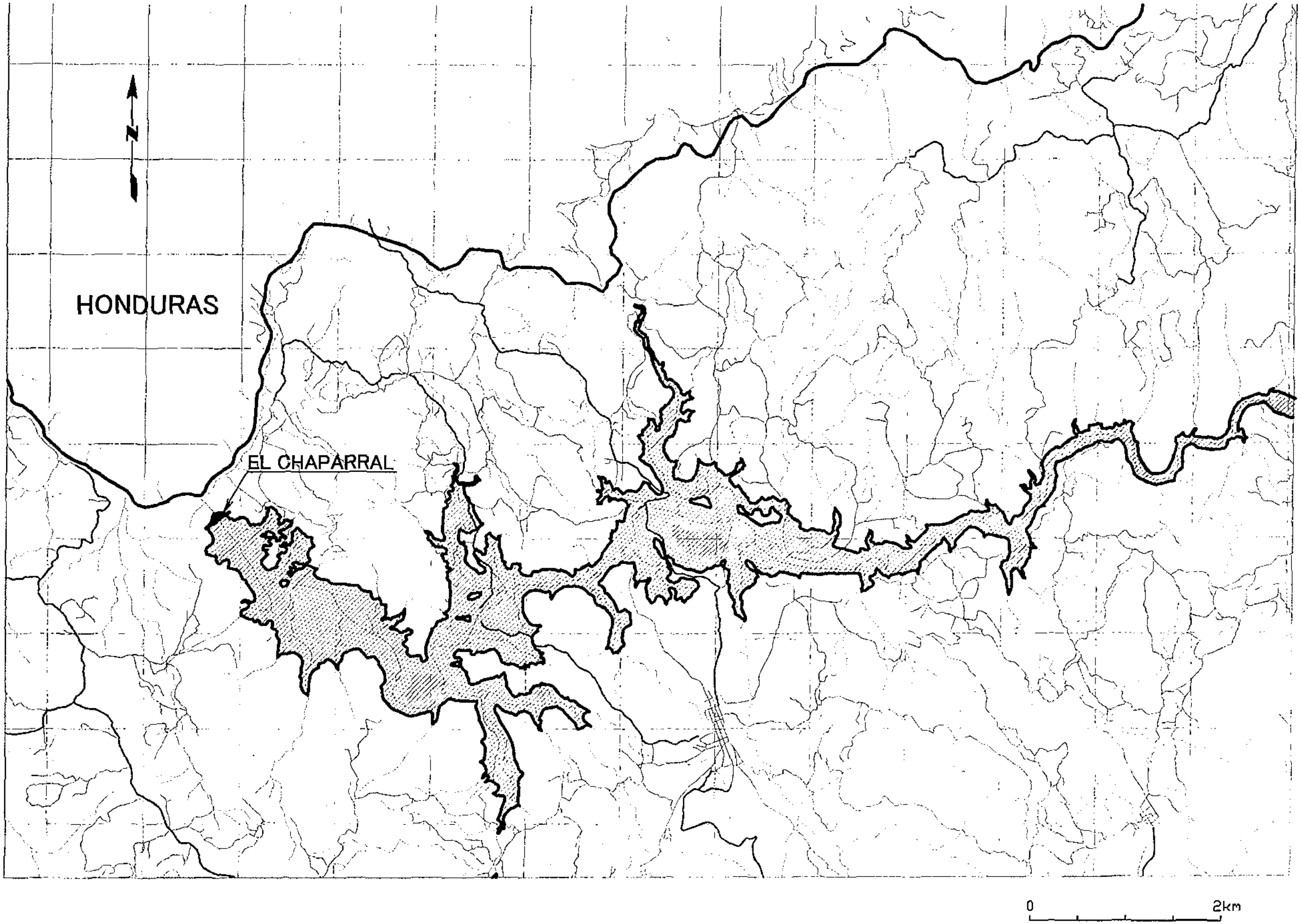


Acajutla Port Facility



15 de Septiembre Sub Station

15 De Septiembre Sub Station



El Chaparral Development Plan

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ABBREVIATION

1. Domestic and Regional Organizations

CIG	Centro de Invertigaciones Geotécicas
MARN	Ministry of Environment and Natural Resources
COEN	Comité de Emergencia Nacional
CONACYT	Consejo Nacional para la Ciencia y la Tecnología
CONCULTURA	Consejo Nacional para la Culatura y el Arte
CEL	Comisión Ejecutiva Hidroeléctrica del Río Lempa
SIEPAC	Sistema de Interconexión Eléctrica para los Países de América Central
UT	Unidad de Transacciones
SIGET	Superintendencia General de Electricidad y Telecomunicaciones
GESAL	Geotérmica Salvadoreña, S.A. de C.V.
CESSA	Cemento de El Salvador S.A de C.V.
CAESS	Compañía de Alumbrado Eléctrico de San Salvador de S.A de C.V.
CLESA	Compañía de Alumbrado Eléctrico de Santa Ana de S.A de C.V.
DELSUR	Distribuidora Eléctrica del Sur, S.A. de C.V.
DEUSEM	Distribuidora Eléctrica de Usulután, Sociedad de Economía Mixta
ETESAL	Empresa Transmisora de Energía Eléctrica Salvadoreña, S.A
EEO	Empresa Eléctrica de Oriente S.A de C.V
CEAC	Consejo de Electrificación de América Central
ITIC	Instituto Tropical de Investigaciones Científicas
SNET	Servicio Nacional de Estudios Territoriales

2. International and Foreign Organizations

JICA	Japan International Cooperation Agency
BCIE	Central American Bank for Economic Integration (CABEI)
NWS	National Weather Service (USA)
NOAA	National Oceanic and Atmospheric Administration (USA)
USGS	United States Geological Survey
JSCE	Japan Society of Civil Engineers
EPDC	Electric Power Development Co., Ltd.(J-POWER) of Japan
ASTM	American Society for Testing and Materials
ANSI	American National Standards Institute

3. Technical Terms

CA	Catchment area
PMF	Probable maximum flood
PMP	Probable maximum precipitation

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HWL	High water level
LWL	Low water level
NWL	Normal water level
IWL	Intake water level
TWL	Tail water level
Hd	Draw down depth
SL	Sedimentation level
EL.m	Elevation (m) above sea level
HPP	Hydropower plant (or project)
GPP	Geothermal power plant
PS or P/S	Power station
GS	Gauging station
S/T or S/S	Substation
T/G	Turbine and generator
L/T	Transmission line
D/L	Distribution line
AC	Alternating current
DC	Direct current
p.f	Power factor
PF	Plant Factor
cct	Circuit
S/Y	Switchyard
GIS	SF6-Gas insulated switch gear
O&M or O/M	Operation and maintenance
E.H.S	Extra high strength
RMS	Root mean square
ROW	Right of way
ACSR	Aluminum cable steel reinforced
RCC	Roller compacted concrete
CRF	Capital recovery factor

4. Environmental Terms

EIA	Environmental impact assessment
AAU	Assigned amount unit
ERU	Emission reduction unit
ET	Emission trading
EsIA	Estudio de impacto ambiental
JI	Joint implementation
RMU	Removal unit

I.E.E	Initial environmental examination
CDM	Clean development mechanism
CER	Certificate of emission reduction
PMA	Environmental Management Program'
NMP/100	More probable number in 100ml

5. Economic Terms

GDP	Gross domestic product
B/C	Benefit cost ratio
B-C	Net benefit (Net present value: NPV)
OCC	Opportunity cost of capital
IRR	Internal rate of return
EIRR	Economic internal rate of return
FIRR	Financial internal rate of return
F/C	Foreign currency
L/C	Local currency
CDM	Clean development mechanism
ET	Emission trading
CER	Certified emission reduction
US$ or $	US dollar
MUS$	Million US dollar
USC or c	US cent
SDDP	Stochastic dynamic dual program

6. Others

MC	Contract market
MM	Wholesale market
PM	Power market
MRS	System adjustment market
NGO	Non governmental organization
ODA	Official development aid
F/S	Feasibility study
DD	Definite design
S/W	Scope of work
M/M	Minutes of meeting
IPP	Independent power producer
HDWiz	Hydro design wizard
OFAF	Forced oil, air cooled type
JIS	Japanese Industrial Standards

28'

UNIT

No.	Measurement	
1	**Length**	
	mm	Millimeter
	cm	Centimeter
	m	Meter
	km	Kilometer
2	**Area**	
	cm^2	Square centimeter
	m^2	Square meter
	ha	Hectare
	km^2	Square kilometer
	MCM	Mil circular mil
3	**Volume**	
	cm^3	Cubic centimeter
	l	Liter
	Kl	Kiloliter
	m^3	Cubic meter
	MCM	Million cubic meter
4	**Weight**	
	g	Gram
	kg	Kilogram
	ton or t	Metric ton
	tC	Carbon ton
	gC	Carbon gram
	CO_2.ton / t- CO_2.	Carbon dioxide ton
5	**Time**	
	s / sec	Second
	ms	Millisecond
	min	Minute
	h / hr	Hour
	d	Day

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No.	Measurement	
	mth	Month
	yr	Year
	gal	Acceleration value
6	**Meteorology**	
	°C	Degree in centigrade (Celcius)
	K	Degree in Kelvin-grade
	mb	Milibar
7	**Electrical Measures**	
	V	Volt
	kV	Kilovolt
	A	Ampere
	kA	Kiloampere
	Hz	Hertz (cycle)
	W	Watt
	kW	Kilowatt
	MW	Megawatt
	GW	Gigawatt
	kWh	Kilowatt hour
	MWh	Megawatt hour
	GWh	Gigawatt hour
	kVA	Kilovolt ampere
	MVA	Megavolt ampere
	MVAR/MVar	Megavar
	m-kW	Meter-kilowatt
8	**Others**	
	Btu	British thermal unit
	rpm / RPM	Revolutions per minute
	%	Percentage (or Percent)
	Lu	Lugeon
	cm^3/s	Cubic centimeter per second
	m^3/s	Cubic meter per second
	pH	Hydrogen power

CONCLUSION AND RECOMMENDATIONS

Conclusion and Recommendations

This feasibility study was implemented with respect to the Torola River Hydroelectric Project from March 2001, and the Project was judged feasible from technological, economical, financial and environmental points of view for the following reasons as a result of the study. The details of the conclusion will be discussed below.

Conclusion

(1) Necessity of Hydroelectric Development

This project conforms to the following basic policies on the hydroelectric development of the government of El Salvador:

1) To meet the increased demand for electric power by using competitive and sustainable hydropower resources;
2) To contribute to a reduction in petroleum resources consumption; and,
3) To effectively utilize the underused hydroelectric resources of the Torola River.

While the new development of thermal power stations by private companies and an increase in imported electric power from other countries are also considered as alternatives for the introduction of new power source, in addition to new hydroelectric developments such as this project, it is considered necessary to place higher priority on the hydroelectric development from the following points of view:

- It is necessary to coordinate with national energy policies such as measures taken in response to global environmental problems and the development and promotion of alternative energy to oil; and,
- A power source with load adjustability features against fluctuations of the system such as frequency change is necessary, and quick response is required in the operation.

From the above, this hydroelectric project is positioned as a valuable power source development from the perspective of securing a power source that allows sustainable reliability amidst the need for non-oil power sources on the backdrop of rising concern over global environment problems relating to CO_2, the deregulation of electric utilities, and the widespread power exchanges through SIEPAC.

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(2) Projection of electric power demand

The electric power demand in El Salvador has risen steadily as evidenced in the annual average increase rates in electric energy and in the maximum electric power for the last 10 years of approximately 4.9% and 4.7% respectively. With regard to the electric power demand and supply balance, the deregulation of electric utilities has allowed the electric power imported from Guatemala and Honduras and the power received from independent power producers (IPP) to be incorporated into the overall electricity. As a result, the electricity generated from domestic sources, which stood at about 3,981 GWh in 2002, accounted for approximately 91.2% of the total generation, while approximately 8.8% of the total generation came from imported sources, amounting to approximately 384 GWh.

Meanwhile, the current power source development plan projects that the reserve margin will fall below 10% both in terms of kWh and kW in 2008 and demand and supply are expected to be increasingly out of balance after 2009. Thus, the development of new power sources will become essential for 2008 and onward.

While the daily load curve of El Salvador reaches its peak during the night time from 18:00 to 22:00, this power station is planned as a hydroelectric power station which, along with the existing hydro-electric power stations , will be able to meet the electric power demand during the peak hours including the discharge for the river maintenance and to supply electric power targeting the three-to-four peak hours throughout the year (and also the power for the base hours during the rainy season).

(3) Study Processes and Development Scheme

In reference to the hydroelectric development project of the Torola River, various development schemes were examined on eight projects in total through a Pre-Feasibility study conducted from December 1997 to March 1999.

As a result, the La Honda Project and the El Chaparral Project in the downstream parts of the Torola River were selected as projects feasible for the development to be launched within the near future from the standpoints of economy and environment of the surrounding areas. Since results of the Pre-Feasibility study that began in March 2001 revealed questionable cost efficiency for the La Honda Project, the subsequent detailed study focused only on the El Chaparral Project.

During the detailed study stage, a follow-up field study (on topographic features, geological features, and environment) was commissioned and carried out, and a proposed plan for the sole development of the El Chaparral Project was prepared based on its results.

(4) Topography and Natural Conditions

The Torola River watershed is surrounded by relatively gentle mountains, with few flatlands. Since the river gradient is not very steep (approximately 1/100 - 1/200) and the river does not have many large sharp curves, securing of drops by water conveyance through water channels is not effective, and the topography is suited for the dam type power generation method.

The Torola River watershed is composed of volcanic rocks and volcanic detritus rocks formed by volcanic activities in the Tertiary Era to Quaternary Era and the soil of the El Chaparral project area is composed of tuff breccia and basalt. While the surface deposit is generally thin including the riverbed gravel part, the bedrock is highly permeable and the groundwater level is low.

The Torola River watershed has two distinct seasons: a dry season from November to April and a wet season from May to October. While it receives little rainfall during the driest period from December to February, it receives rainfall amounting to 300 m to 500 m in June and September. The annual rainfall varies from 1,200 m to 2,900 m in the watershed.

(5) Optimum Development Scale

In the study of power generation planning scale, cost efficiency was compared to the effective capacities at several high water levels (HWL) on the assumption that the peak hours required in terms of demand and supply is three to four hours.

In the study, it was planned that the water required to maintain a minimum ecological flow (2m ^{3}/s) would be diverted from the dam at the end of the penstock and discharged to the area immediately downstream from the dam via small hydraulic turbines placed at the end.

Based on the above, several cases with different combinations of maximum discharges and high water levels were compared for the power generation scale. The comparison revealed that, because the topography of El Chaparral dam site is relatively steep, the upsizing of the dam height was found to little increase the total construction expense. Thus, the upsizing of the dam height was found to be economical for the purpose of securing of the effective capacity of the reservoir. The case with the highest water level (HWL 212 m Qmax=100 m^3/s) showed the best result in terms of cost efficiency, and it was determined as the optimum scale.

(6) Overview of the Development Project

This project is a dam type power station project located in the downstream part of the Torola River and immediately upstream above the international border with Honduras. The dam will be a concrete gravity dam 87.5 m in height and approximately 370,000 m^3 in volume, which will regulate an annual average inflow of 1,489 × $10^6 m^3$ by the reservoir with an effective storage capacity of 106 × $10^6 m^3$.

With regard to the water for power generation, a maximum discharge of 100 m^3/s will be taken from the intake attached to the dam and will be conveyed to the power station located on the left bank immediately downstream from the dam through the penstock of approximately 145 m in extension. Electricity with an annual energy production of 220.6 GWh will be generated at the maximum output (one unit) of 64.4 MW and delivered to the existing 15 de Septiembre Substation on the 115 kV transmission line.

In the meantime, the total electric energy amounts to 233.2 GWh including the electric energy generated by the small hydraulic turbines (1.3 MW) attached to the dam which use the water released from the storage to maintain a minimum ecological flow, and the increase in the power generation in the downstream of the dam by the existing 15 de Septiembre Power Station through the operation of the reservoir.

(7) Feasibility Designing

The axis of the dam was placed in the location approximately 300 m upstream from the confluence of the Torola River and the border with Honduras. Both banks of the location are relatively narrow. The soil of the dam site is composed mainly of basalt and no large faults have been identified. The surface deposit is generally thin except the thick decomposed rocks on the right bank, and the bedrock of the riverbed is adequate for the construction of the concrete gravity dam with 80 – 90 m in height. The basic shape of the dam was decided by calculating the dam stability against the design seismic ground motion expected to occur at the dam site. The dam height as measured from the bedrock to the dam crest is 87.5 m at maximum and the volume of the dam body is approximately 370,000 m^3. The gravel on the riverbed approximately 2 km upstream above the axis of the dam will be primarily used for the dam concrete aggregate.

Because the permeability of the dam bedrock is generally high, in the neighborhood of 20 Lu in some zones according to a bore hole permeability test conducted along the dam axis, while the groundwater level was extremely low, curtain grouting for the purpose of controlling the penetration of reservoir water through the bedrock and consolidation grouting for improving the surface of the dam bedrock will included in the foundation treatment scheme of the dam.

The type of spillway will be the central overflow type with gates to release a design spillway flow of 6,484 m^3/s (PMF) at HWL.

The power station will be placed on the left bank for easier accessibility and because of the distribution of relatively favorable soil, and the outlet will be integrated with the power station. The type of the power station will be semi-underground type in consideration of less complicated construction and economic efficiency, and the main transformer will be installed outdoors adjacent to the mountain side of the power station. The switchyard will be placed in an area of a gently sloped land on the left bank downstream of the power station.

(8) Construction Costs and Construction Schedule

The amount of funds required for this project is approximately US$135.3 million in total based on the price index of FY2003, including the direct construction cost for preparatory works, civil works, hydro-mechanical equipment, electronic and mechanical equipment, land and compensations, environmental expenditures, among others, as well as overhead such as construction administrative costs and contingency for quantity fluctuations. The transmission line expense included in the construction costs includes the costs for the installation of 43 km-long transmission line from this power station to the existing 15 de Septiembre substation.

The construction period from the start of preparatory works to the start of operation is approximately three years and four months, and this covers permanent works such as preparatory works, civil engineering works and electric work. The schedule through the start of construction is outlined below:

Feasibility Study by JICA (Mar. 2001 to Feb. 2004)
Clearance of EIA / Loan Procedure (2004)
Additional Topographical & Geological Investigation (Dec. 2004 to May. 2005)
Detailed Design Work (Dec. 2004 to May. 2006)
Tendering (2006 to 2007)
Construction Period (Apr. 2007 to July. 2010)
Start of Operation (Aug. 2010)

(9) Environmental Impacts

Although a small reservoir of approximately 8.6 km^2 will come into existence and the implementation of this project will submerge the terrestrial ecosystem and the aquatic

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ecosystem, no environmental problem is expected to impair the feasibility of the project. Factors that will adversely affect the environment can be mitigated by appropriate compensation, measures to alleviate environmental impacts and implementation of monitoring/management during the construction and after the start of operation.

For the positive side, the socioeconomic level of the local inhabitants will be enhanced by the implementation of this project, as a result of an increase in public service offering and employment opportunity, as well as improved social infrastructure, including roads to the region, which is one of the most underdeveloped in the nation.

The vegetation indigenous to the project region has already been overexploited. Most of the land in the region is used for pasture and agriculture, while the terrestrial and aquatic ecosystems including wildlife and aquatic life such as fish are poor. The composition of the natural habitat of the species found in the project site is not confined to the surroundings of the reservoir only but the area is a reflection of the diversity of the natural habitat found throughout the watershed. Archeological research confirmed that there are no relics or fossil-containing strata to be affected by the reservoir.

According to the result of a household survey in the project region conducted in association with a social environmental research, 79 houses will be affected by the submersion caused by the reservoir and need to relocate. Of the 79 houses, 9 are uninhabited. Two churches and one school are also located in the area of inundation.

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. 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.

(10) Economic and Financial Evaluations

Cost efficiency of this project was evaluated based on the cost of alternative thermal power (low-speed diesel) and the benefits of electricity sales income (at the unit price of the average electricity sales income for the past five years of US$67.65/MWh). From this evaluation, the Economic Internal Rates of Return (EIRR) were derived to be 11.3 % and 10.2 % respectively. Both exceeded the opportunity cost of capital of 10 %. Thus it was evaluated to be economically feasible. In addition, a study with emission trade introduced as an additional benefit factor was conducted for three assumed unit prices: US$3, US$5 and US$10. This study revealed positive impact on economic efficiency when the unit price exceeds US\$10/CO_2-ton, resulted in nearly 11 % of EIRR even with the benefit of electricity sales income.

On the other hand, in the financial evaluation based on CEL's projected electric power generation and income (electric energy of 180.2 GWh, average unit price for electricity sales income of US$ 58.08/MWh) as financial benefits, the financial internal rate of return (FIRR) is 6.4%, and thus, softer financial conditions will be required for the implementation of this project.

In addition, a cash flow analysis was conducted based on various financing terms (8 % for private fund, 6 % for international financial institution, 1.5 % for bilateral fund) including a sensibility analysis against fluctuations of the electricity sales price and the construction cost. As a result, the IRR for the project's cash flow is 2.9 % - 3.4 % for the base case condition.

Thus, developing this project using private funding was judged too difficult, and it will be necessary to seek funding with the softest terms and conditions as much as possible.

Recommendations

In light of the electric power conditions of El Salvador, where the reserve margin will fall short of 10% from 2008 and onward, the El Chaparral Hydroelectric Power Generation Project that provides response to peak hours should be promoted as a candidate for the next hydropower project.

This power generation project is feasible from technical, economic/financial and environmental viewpoints and can be developed as a power generation project which will also contribute to the advancement, through development, of underdeveloped regions. The operation can begin as early as around 2010, given the time required for tasks to take place subsequent to this Feasibility Study, including topographical/geological survey, detailed designing, fund raising and construction work, among others. The following will have to be completed before implementing this project:

(1) In the detailed design, the results of additional surveys as shown in Chapter 15 "Future Research" of this report should be sufficiently incorporated to optimize the layout and structure of the power generating unit and at the same time to prepare documents and for contracting construction works with higher accuracy of construction cost estimation.

(2) The preparation of construction fund, bidding for construction contracts, and the selection of contractors will have to be performed before the construction of this project. In addition, construction of new roads and repair work of existing roads leading to the dam and the power station will have to be completed before the construction launch of this project.

(3) While the area contains no objects that may potentially raise environmental issues relating to the vegetation, aquatic/terrestrial animals, relics/cultural assets in the region affected by the implementation of this project, appropriate compensation such as relocation measures must be provided to those whose houses will be affected by the immersion for the reservoir, and at the same time sufficient mutual understanding must be secured through public hearings and other means.

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El Chaparral Hydropower Project

River

Name of River	Torola River
Catchment Area	1,233 km^2
Annual Inflow	1,489.1 × $10^6 m^3$

Reservoir

High Water Level	212 m
Low Water Level	196 m
Drawdown Depth	16 m
Normal Water Level	207 m
Sedimentation Level	185 m
Gross Storage Capacity	189 × $10^6 m^3$
Effective Storage Capacity	106 × $10^6 m^3$
Reservoir Area	8.6 km^2

Dam

Type	Concrete Gravity Dam
Elevation of Dam Crest	214.5 m
Height of Dam	87.5 m
Length of Dam Crest	405 m
Volume of Dam	370 × $10^3 m^3$

Diversion Tunnel

Design Flood	728 m^3/s
Type	Half Circle Half Rectangular, Pressure
Number	One (1) Line
Inner Height	8.0 m
Length	383.5 m

Outlet Equipment

Type	Service	Jet Flow Gate
	Auxiliary	High Pressure Slide Gate

Spillway

Design Flood	6,484 m^3/s
Type	Shute with Gates
Elevation of Overflow Crest	198.5 m
Width of Overflow Crest	66 m (excluding pier width)

	Energy Dissipator	Bucket Type
	Type of Gate	Radial Gate
	Number of Gate	Five (5)
	Size of Gate	Width 13.2 m × Height 15.2 m
Intake		
	Type	Incorporated in dam
	Number	One (1)
	Elevation of Inlet Sill	185 m
	Size	Width 10.0 m × Height 10.0 m
	Type of Gate	Roller Gate
	Number of Gate	One (1)
	Size of Gate	Width 7.0 m × Height 7.0 m
Penstock		
	Type	Steel Embedded
	Number	One (1) Line
	Inner Diameter	4.2 m~5.0 m
	Total length	144.5 m
Powerhouse		
	Type	Semi-Under Ground
	Size (Control Building)	Width 26.0m × Height 16.0 m × Length 36.0 m
Development Plan		
	Intake Water Level	207 m
	Tail Water Level	133 m
	Gross Head	74 m
	Effective Head	72.8 m
	Maximum Discharge	100 m^3/s + 2 m^3/s
	Number of Unit	Two (2)
	Installed Capacity	65.7 (64.4[*1] + 1.3[*2]) MW
	Dependable Capacity	39.5 (38.4[*1] + 1.1[*2]) MW
Turbine		
	Type	Vertical Shaft, Francis Turbine
	Number	One (1)
	Max. Discharge	100 m^3/s per unit
	Turbine Output	65,900 kW
	Revolving Speed	200 rpm

Generator

	Type	Three phases Alternating Current Synchronous
	Number	One (1)
	Rated Output	71,600 kVA
	Revolving Speed	200 rpm
	Frequency	60 Hz
	Voltage	13.8 kV
	Power Factor	0.9 lag

Sub Turbine

	Type	Horizontal Shaft, Francis Turbine
	Number	One (1)
	Max. Discharge	2.0 m^3/s per unit
	Turbine Output	1,420 kW
	Revolving Speed	900 rpm

Sub Generator

	Type	Three phases Alternating Current Synchronous
	Number	One (1)
	Rated Output	1,510 kVA
	Revolving Speed	900 rpm
	Frequency	60 Hz
	Voltage	480 V
	Power Factor	0.9 lag

Main Transformer

	Type	Outdoor three phases, Forced-oil-forced-air Cooled type
	Number	One (1)
	Capacity	73,000 kVA
	Voltage	(Primary) 13.8 kV (Secondary) 115 kV

Switchyard

	Bus System	One and Half Circuit Breaker Buses

Bus Conductor Type	ACSR
Number of Lines Connected	One (1) cct Transmission Line
Voltage	115 kV
Conductor Type	ACSR

Transmission Line

Length	43 km
Type of Transmission Tower	Steel lattice tower
Number of Circuit	One (1),
Voltage	115kV
Conductor Type	477 MCM ACSR (Flicker)

Information Transmission System

Transmission System	Microwave Multiplex Radio (and / or Power Line Carrier (PLC))
Length	Less than 43 km,

Annual Energy Production

Average Energy	233.2 (220.6*1 + 10.6*2 + 2.0*3) GWh

Construction Period 3 years and 4 months

Project Cost 135.3×10^6 US$

Unit Construction Cost

Per kW	2,073 US$/kW (with sub turbine-generator)

Economic/Financial Evaluation

Benefit	Power Sale	Alternative thermal
Benefit-Cost Ratio (Financial)	1.01	1.10
EIRR	10.2 %	11.3 %
FIRR	6.4 %	---

Note:
*1 : main turbine *2 : sub turbine *3 : incremental energy at 15 de Septiembre Power Station

1. PREFACE

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1. PREFACE

1.1 Antecedents

A Feasibility Study (hereinafter referred to as "FS") on the Hydroelectric Complex over the Torola River is to be carried out under the Scope of Work (S/W) and the Minutes of Meeting (M/M) concluded in December 2000 between Japan International Cooperation Agency (hereinafter referred to as "JICA") and Comisi6n Ejecutiva Hidroeléctrica del Río Lempa (hereinafter referred to as "CEL") and Ministerio de Relaci6nes Exteriores.

The Government of El Salvador and CEL accomplished pre-FS of a hydropower potential study over the Torola River in March 1999. It called for a FS to be performed on the implementation of hydropower development plans at the most promising sites of El Chaparral and La Honda through the technical assistance of the Government of Japan. For the said purpose, both governments concluded the S/W for the execution of FS in December 2000.

JICA, the executing organization of technical assistance for the Government of Japan, decided to entrust the implementation of the said FS to Electric Power Development Co., Ltd. (hereinafter referred to as "J-POWER"), which started the study in March, 2001. Fig.1.1 shows the flow chart of the study. During the stage of the preliminary investigation, a preliminary study of the development scheme was prepared and summarized in Progress Report 1. From this study, the La Honda site was found to be uneconomical, and it was decided that the detailed investigation would be made only for the El Chaparral site.

During the stage of detailed investigations, site survey works (topography/geology/environment) started in October 2001 by subcontractors, but the works were interrupted halfway in December 2001 because some local people did not grant the workers access to the area needed for the site surveys. As a result, the survey works were aborted and subsequently canceled in March 2002 without completing the remaining works. In September 2002, the local people agreed to permit the implementation of the site survey works, and the contract for the remaining works was signed again. The works restarted in November 2002 and completed in March 2003.

Based on the investigation results so far, the reviews development plan such as the optimization of scale examination for the Chaparral site have been conducted since April 2003, with the start of the FS-grade design stage. This interim report is the summary of the investigation results and the study results so far.

1.2 Study Items

The study schedule is roughly divided into 3 stages (preliminary investigation, detailed investigation and FS-grade design). The study items are summarized below.

1.2.1 Preliminary Investigation Stage

(1) Preparatory Works in Japan (No.1)

1) Collection and Review of Existing Data, Information and Documents

2) Preparation of an Inception Report

(2) Preparatory Works in Japan (No.2)

1) Preparation of Specifications for Works to be Subcontracted Locally (Topographical, Geological and Environmental Surveys) and Domestically (Aerial Photograph Mapping)

(3) The First Round of Site Works in El Salvador

1) Explanation and Discussion of Inception Report

2) Topographical Survey (Subcontracted locally)

3) Site Reconnaissance

4) Power Sector Survey

5) Collection of Cost Estimate Data

6) Initial Environmental Examination (I.E.E.)

7) Preparation for Subcontracting (Specifications and Others)

8) Procurement of Equipment (Telephone, Fax and others)

(4) The First Round of Works in Japan

1) Review and Study on the Results of the First Round of Site Works

2) Topographic Mapping (Subcontracted in Japan)

3) Hydrological Analysis

4) Flood Analysis

5) Study on the Development Plan

6) Planning for Subcontracted Works on Site to be Performed during Detailed Investigation Stage

7) Preparation of Progress Report 1

1.2.2 Detailed Investigation Stage

(5) The Second Round of Site Works in El Salvador

1) Explanation and Discussion of Progress Report 1

2) Contract to be Concluded for Locally Subcontracted Works, including:

- Ground Survey and Topographic Mapping,
- Geological Survey and Material Test, and
- Environmental Survey

(6) The Second Round of Works in Japan

1) Preparation of Progress Report 2

(7) The Third Round of Site Works in El Salvador

1) Supervision and Certification of Subcontracted Works, including:

- Ground Survey and Topographic Mapping,
- Geological Survey and Material Test, and
- Environmental Survey

2) Explanation and Discussion of Progress Report 2

(8) The Third Round of Works in Japan

1) Review of Contracts and Specifications for Subcontracting for the Remaining Portion of the Works Subcontracted Locally

(9) The Fourth Round of Site Works in El Salvador

1) Contract for the Remaining Portion of Works Subcontracted Locally (Topographical, Geological and Environmental Surveys)

(10) The Fourth Round of Works in Japan

1) Preparation of Progress Report 3

2) Preparation for the First Public Consultation

(11) The Fifth round of Site Works in El Salvador

1) Supervision and Certification of Subcontracted Works, including:

- Topographic Mapping,
- Geological Survey and Material Test, and
- Environmental Survey

2) Additional Data Collection for the FS-grade Design

3) Explanation and Discussion of Progress Report 3

1.2.3 FS-grade Design Stage

(12) The Sixth Round of Site Works in El Salvador

1) Assistance for the First Public Consultation

(13) The Fifth Round of Work in Japan

1) Analysis on the Collected Data and the Results of Investigation

2) Optimization Study on the Development Plan and Design of the Layout

3) FS-grade Design for the Main Structure and Cost Estimate

4) Power Demand Forecasts, and Review of Demand and Supply Balance

5) Environmental Impact Assessment (E.I.A.)

6) Preparation of Interim Report

(14) The Seventh Round of Site Works in El Salvador

1) Explanation and Discussion of Interim Report

2) Review and Study of the collected Data and Information

3) Optimization of Financing Plan

(15) The Sixth Round of Works in Japan

1) FS-grade Design for Civil Structures and Electrical Equipment

2) Construction Planning and Construction Schedule

3) Estimate for Project Cost

4) Preparation of E.I.A Report

5) Economic and Financial Estimation

6) Conclusions and Recommendations

7) Preparation of Draft Final Report

8) Preparation for the Second Public Consultation

(16) The 8th Site Work in El Salvador

1) Submission of Draft Final Report

2) Participation in the Second Public Consultation

(17) Submission of Final Report

1) Submission of Final Report

1.3 Outline of Site Works Subcontracted Locally

An outline of completed works by local subcontractors is as follows.

1.3.1 Topographical Survey

Detailed investigations were performed at sites selected near the locations of the major civil structures such as the dam and powerhouse of El Chaparral, where topographical survey works were made to prepare a 1/1,000 topographical map and river cross sections.

The subcontracted topographical survey works are summarized below. Fig. 1.2 shows the investigation results so far.

- Preparation of a 1/1,000 topographical map of the major civil structure sites
- River cross-section survey works at the dam and powerhouse site
- Setting of survey control points at dam abutments

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1.3.2 Geological Survey

At the locations of the major civil structures such as the dam and powerhouse of the El Chaparral site and of planned rock quarry site for concrete aggregate, a geological survey and a laboratory test of the collected samples were carried out.

The subcontracted geological survey works are as follows. Fig.1.3, 1.4 shows the investigation results so far.

- Core drilling and permeability test
- Seismic prospecting
- Laboratory test of materials (Construction material test, Physical and dynamic test of rock)
- Field geological reconnaissance

1.3.3 Environmental Survey

The distribution and activity of the terrestrial fauna, flora and aquatic life in the river basin around the reservoir of El Chaparral dam as well as its upstream and downstream zones were surveyed. Impact on the ecosystem and other natural environments as well as the existence of scarce species was also studied.

Additionally, issues relating to the resettlement of inhabitants who now live in the areas to be submerged at the completion of the dam and the relocation of cultural and historical heritages to be affected were investigated.

Measures for the reduction and/or mitigation of negative impacts on natural and social environment as well as environmental management and/or the monitoring system were studied.

The subcontracted environmental survey works are as follows.

- Survey of living conditions of the people
- Survey of ecological systems of flora and fauna
- Survey of cultural heritage etc
- Survey of water quality

1.4 The Record of Dispatched Mission

In March 2001, JICA began its work based on the S/W and dispatched the following survey missions for site surveys concerning the project.

- First site survey mission May 27, 2001 ~ Jun. 25, 2001
- Second site survey mission Sep. 9, 2001 ~ Oct. 4, 2001
- Third site survey mission Jan. 18, 2002 ~ Mar. 21, 2002
- Fourth site survey mission Oct. 27, 2002 ~ Nov. 10, 2002
- Fifth site survey mission Feb. 13, 2003 ~ Mar. 10, 2003
- Sixth site survey mission May 26, 2003 ~ Jun. 8, 2003
- Seventh site survey mission Sep. 4, 2003 ~ Sep. 28, 2003
- Eighth site survey mission Dec. 1, 2003 ~ Dec. 22, 2003

In this period, the survey mission teams submitted the following reports to CEL.

- Inception Report May 2001
- Progress Report 1 September 2001
- Progress Report 2 February 2002
- Progress Report 3 February 2003
- Interim Report September 2003
- Draft Final Report December 2003

1.5 Member List of CEL and JICA related to the Feasibility Study

(CEL)

	Name	Title	
1	Mr. Guillermo A. Sol	Presidente	Head Office
2	Mr. José Oscar Medina	Director Ejecutivo	Head Office
3	Mr. Gregorio Antonio Avila Castillo	Coordinador Técnico	Head Office
4	Mr. Salvador Novellino	Unidad de Gestión y Control de Proyectos	Head Office
5	Mrs. Gladis Artiga de Valencia	Jefe Unidad de Gestión y Control de Proyectos	Head Office
6	Mrs. Marlene de Estevez	Unidad de Gestión y Control de Proyectos	Head Office

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	Name	Title	
7	Mr. Miguel Domínguez	Unidad de Gestión y Control de Proyectos	Head Office
8	Mr. Manuel Rivera Castro	Gerente de Ingeniería	Head Office
9	Mr. Jaime Eduardo Contreras	Director del Proyecto Torola	Head Office
10	Mr. José Orlando Argueta	Jefe Unidad de Gestión Ambiental.	Head Office
11	Mr. Roberto Adolfo Cerón Pineda	Ingeniero Hidrólogo	Head Office
12	Mr. Jorge Luis García	Ingeniero Hidrólogo	Head Office
13	Mr. Ignacio Gavidia	Ingeniero Civil	Head Office
14	Mr. Oscar Guillén	Ingeniero Civil	Head Office
15	Mr. Saúl Enrique Lino	Ingeniero Electricista	Head Office
16	Mr. Omar Medrano	Ingeniero Electricista	Head Office
17	Mr. Mario Campos	Ingeniero Hidrólogo	Head Office
18	Mr. Nelson Villegas	Ingeniero Agrónomo	Head Office
19	Mr. César Morales	Ingeniero Civil	Head Office
20	Mr. Jose Orlando Martínez Martir	Unidad de Proyectos Especiales	Head Office
21	Mr. Manuel Atilio Escobar	Jefe Departamento de Evaluación Técnica	Head Office
22	Mr. Luis Fernando Arévalo	Ingeniero Asistente Subestaciones	Head Office
23	Mr. Angel Arturo Díaz	Departamento de Estudios	Head Office
24	Mr. Ludwing Macdonal Valdez Grande	Departamento de Estudios	Head Office
25	Mr. Luis Ardon	Jefe, Departamento Electrico	15 de Septiembre Hydro Power Station
26	Mr. Jorge Gutiérrez	Supervisor Operación	15 de Septiembre Hydro Power Station
27	Mr. Douglas González	Superintendente	5 de Noviembre Hydro Power Station
28	Mr. César Emilio Torres	Ingeniero Civil	5 de Noviembre Hydro Power Station
29	Mr. Jose Sánchez Orellana	Jefe de Operaciones	5 de Noviembre Hydro Power Station
30	Mr. Armando Preza Castro	Superintendente	Cerrón Grande Hydro Power Station
31	Mr. Elmer Ulises González	Jefe de Departamento Mecánico	Cerrón Grande Hydro Power Station

(JICA Study Team Member)

	Name	Title	Organization
1	Mr. Nobuo Hashimoto	Team Leader / hydropower planning	Electric Power Development Co., Ltd.
2	Mr. Sadaaki Kato	Civil Design A	Electric Power Development Co., Ltd.
3	Mr. Katsu Hagihara	Civil Design A	Electric Power Development Co., Ltd
4	Mr. Hitoshi Shimokoshi	Civil Design B	Electric Power Development Co., Ltd.
5	Mr. Mototaro Okada	Electro-mechanics	Electric Power Development Co., Ltd.
6	Mr. Hirotaka Kosaka	Power transmission	Electric Power Development Co., Ltd.
7	Mr. Takahiro Imaizumi	Power transmission	Electric Power Development Co., Ltd.
8	Mr. Ken Mizoue	Hydrology	Electric Power Development Co., Ltd.
9	Mr. Nobuo Hoshino	Geology A	Electric Power Development Co., Ltd.
10	Mr. Walter Hernandez	Geology B	---
11	Mr. Shun Takagi	Topographic Survey	PASCO CORPORATION
12	Mr. William P. Saunders	Environment	Harza Engineering Company Int'l L.P.
13	Mr. Charles E. Russell	Environment	Harza Engineering Company Int'l L.P.
14	Mr. Tetsuya Hirahara	Economic/Financial Evaluation	Electric Power Development Co., Ltd.
15	Mr. Yoshimi Sugano	Interpreter	Translation Center Pioneer
16	Mr. Kiyotoshi Yamakawa	Interpreter	Translation Center Pioneer
17	Mr. Mamoru Sasa	Coordinator	Electric Power Development Co., Ltd.
18	Mr. Koji Tabata	Coordinator	Electric Power Development Co., Ltd
19	Mr. Toru Ishihata	Coordinator	Electric Power Development Co., Ltd
20	Mr. Go Orukawa	Coordinator	Electric Power Development Co., Ltd.

54'

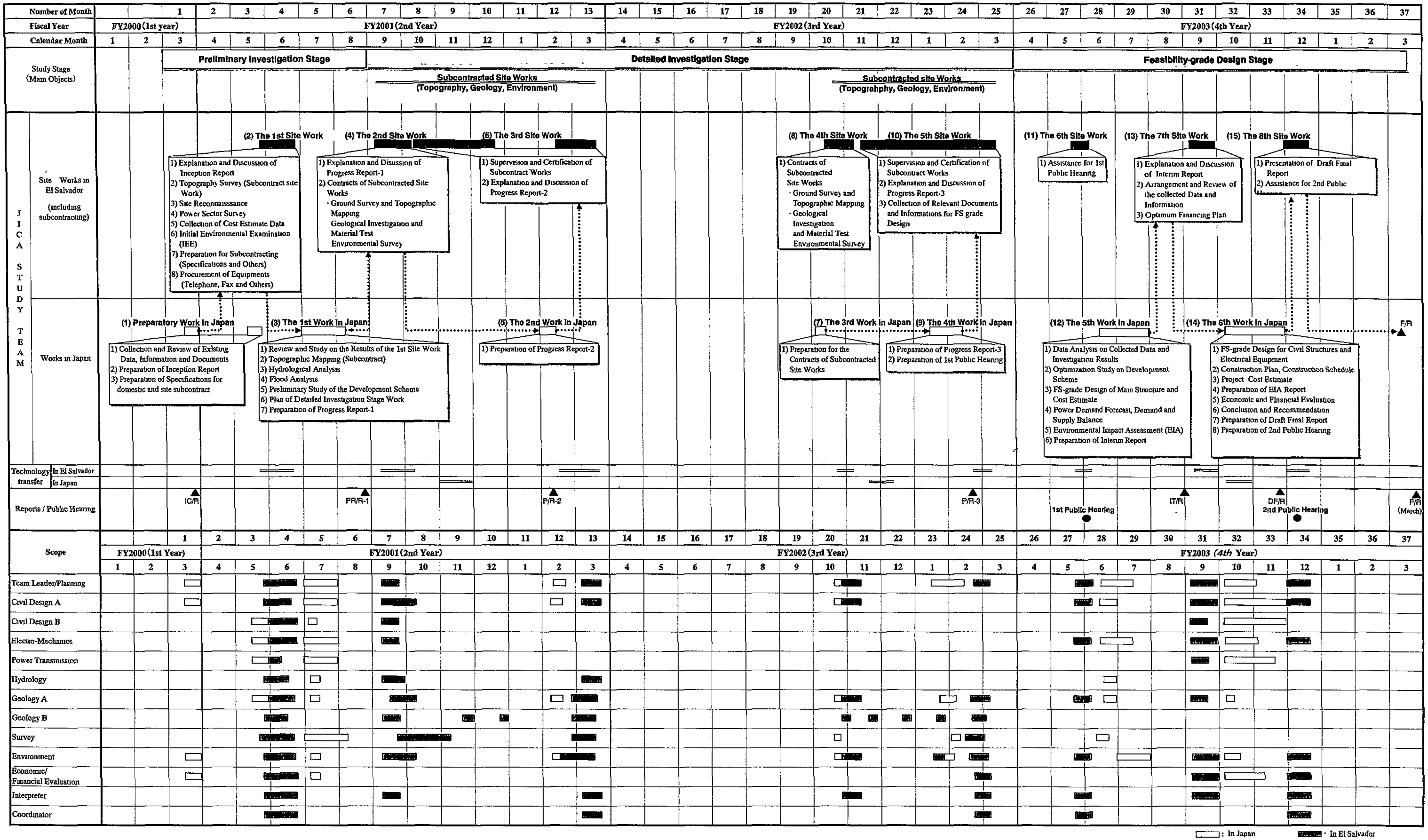

Fig. 1.1 Flow Chart of Study Work for Torola Hydropower Project

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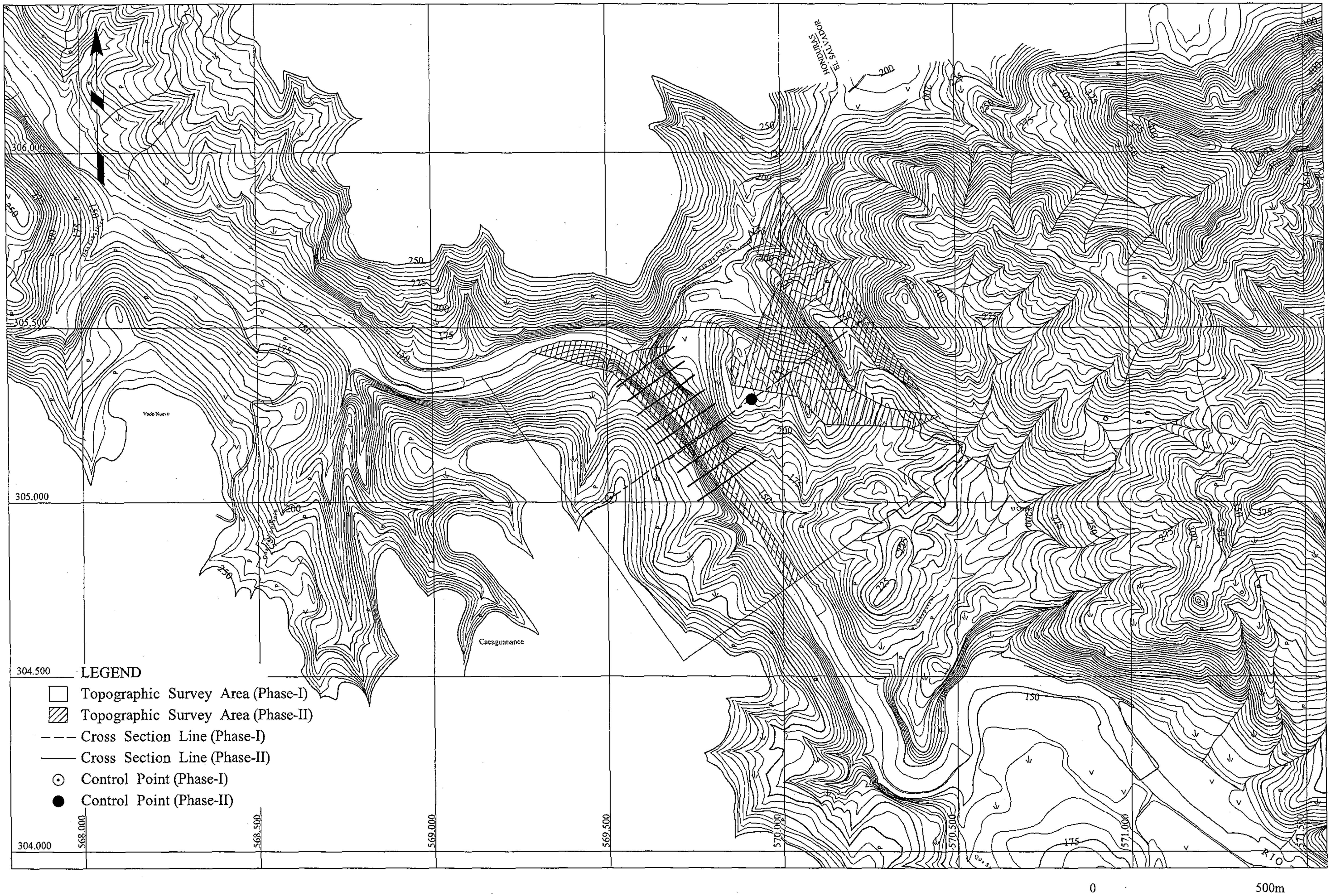

Fig.1.2 Location of Topographic Survey

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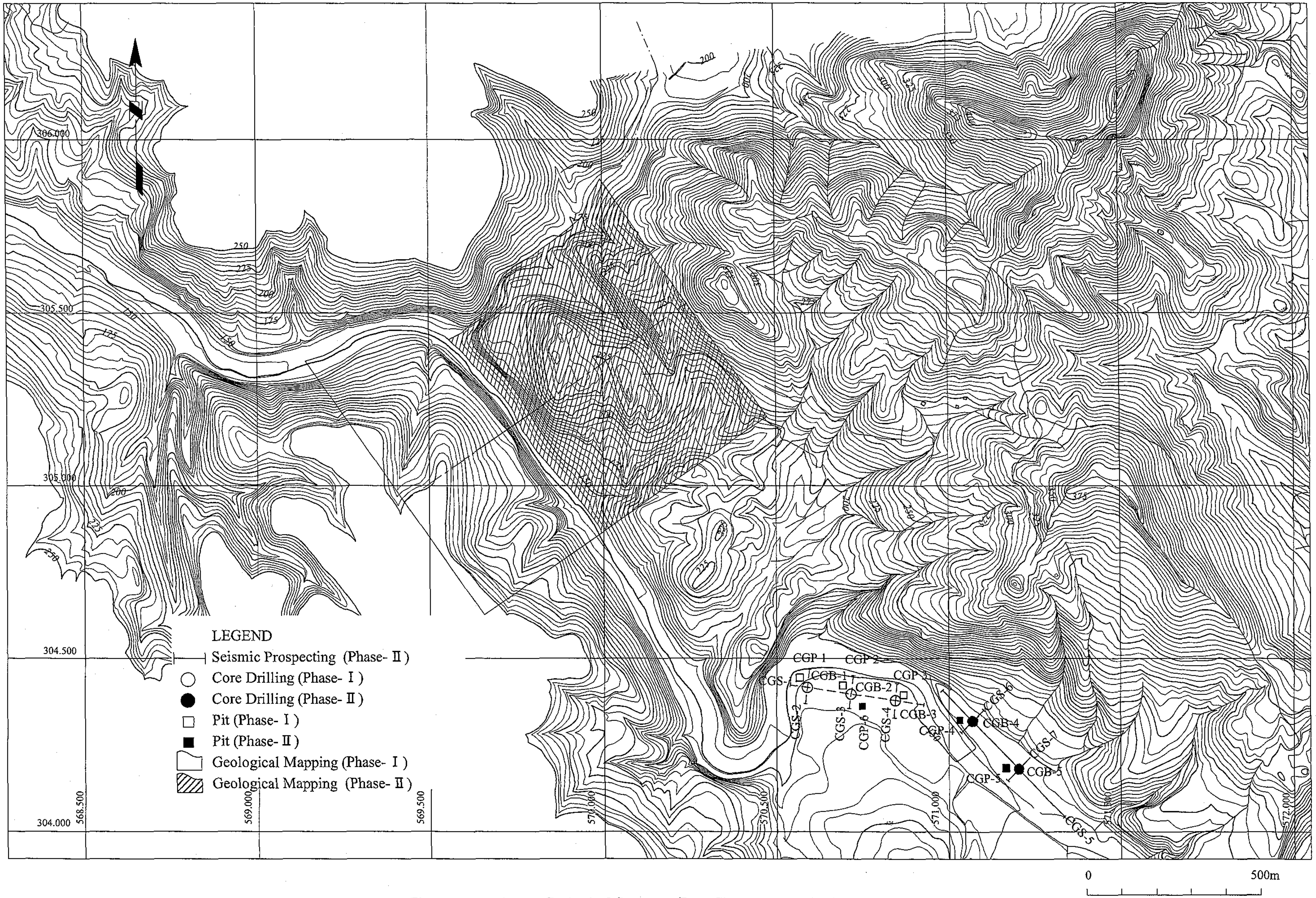
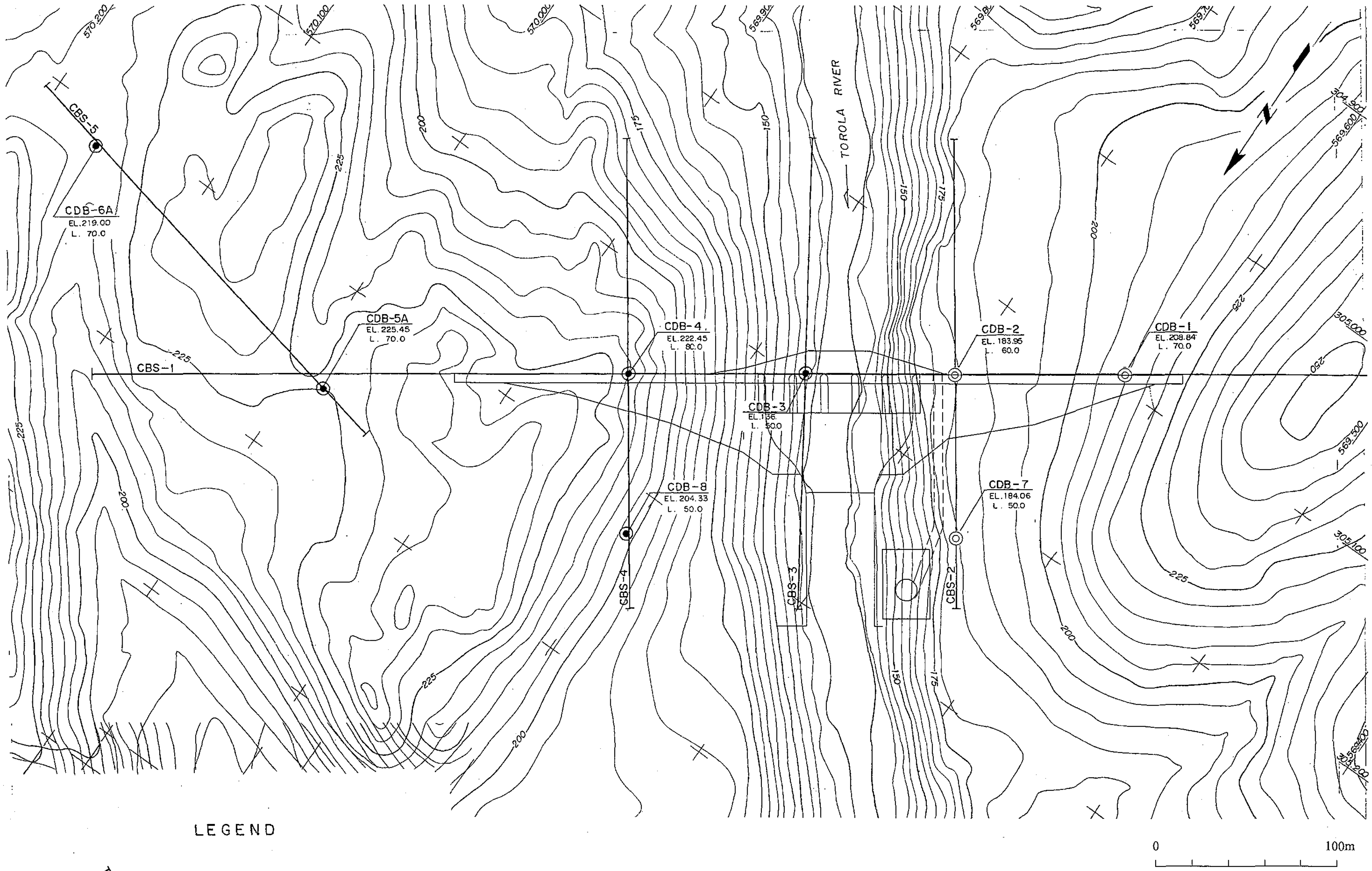


Fig. 1.3 Location of Geological Survey at Dam Site and Material Site



LEGEND

Seismic Prospecting Line (phase II)

Core Boring (phase I)

Core Boring (phase II)

Fig. 1.4. Location of Geological Survey at El Chaparral Dam Site

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2. GENERAL CONDITIONS OF EL SALVADOR

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2. GENERAL CONDITIONS OF EL SALVADOR

2.1 Geography

The Republic of El Salvador is located at Longitude 87°39'~90°8'W, Latitude 13°24'~14°24'N, in Central America, bordering Honduras on the northeast , Guatemala on the northwest and the Pacific Ocean on the south. The country area of about 21,000 km^2 is comparable to the size of Shikoku in Japan and is the smallest among the countries of Central America.

The nation's land contains massive topographical ups and downs and a mountain range that stretches east to west across the Honduras border of the Pacific ocean and along the coastal zone. Its tourist attractions include the Izalco Volcano (1,985 m), which was active until recent years.

Most of its volcanoes are classified as the Conide (a composite volcano) type, and they include San Vicente (2,181 m), Santa Ana (2,365 m), Chaparasteike (2,130 m), and San Salvador (1,959 m), and more. The basin of the coastal central area is an agricultural region consisting of flat and fertile lands. More than 150 rivers mostly run through the nation to the Pacific Ocean, but none of them is suited for sailing due to the rapid flows of the current.

About 101km in length, the River Lempa is the largest river in El Salvador and runssouth to north connecting the northwest and central parts. The river basins contain many lakes, including such famous ones as , the Apasutepeke Lake, the Guipa Lake, and the Suchitlan lake, to name a few..

2.2 Climate

2.2.1 Temperature

El Salvador boasts a warm climate despite its low latitude, as most of its land is situated in the areas high above the sea levels. Climate zones are divided broadly into three (3) levels according to the elevation. The zone with the altitude of 0~600 meters is called the tropics, with average temperatures of 23 ~ 28 °C. The plateau area with the altitude of 600~1,800 meters is called the warm zone, with average temperatures of 17 ~ 20 °C, while the highland zone with the altitude of more than 1,800 meters is called the cold area with average temperatures of 10 ~ 17 °C.

2.2.2 Precipitation

The annual average precipitation level of El Salvador is 1,850 millimeters, with the maximum rain zone receiving 2,292 mm of rains and the minimum rainfall zone getting only 1,419 millimeters..

Although, the capital city of San Salvador experiences a rainfall of about 1,800 mm, the amounts fluctuate widely in recent years as a result of abnormal weather. Seasons are divided into a May-to-October wet season and a November-to-April dry season. The precipitation during the dry season is extremely low, while a daily squall, which does not last long, hits the area almost everyday during the wet season.

The following table shows the average annual precipitation (mm) and temperatures (^{0}C) between during 1961 and 1985 in San Salvador, Santa Ana and San Miguel.

Observation Point: San Salvador (ITIC)

(Longitude 89°12.4'W, Latitude 13°43.3'N, El.710m)

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave./ Total
mm	5	4	12	63	161	292	347	328	334	214	32	9	1,801
℃	22.2	22,6	23.8	24.6	24.0	23.5	23.1	23.1	22.6	22.6	22.4	22.0	23.0

Observation Point: Santa Ana (El Palmar)

(Longitude 89°34.2'W, Latitude 13°58.6'N, El.725m)

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave./ Total
mm	4	4	13	67	203	332	300	299	327	188	34	8	1,779
℃	21.6	22,2	23.6	24.4	23.9	23.0	23.1	23.0	22.6	23.0	22.2	21.6	22.8

Observation Point: San Miguel

(Longitude 88°7.4W, Latitude 13°26.6'N, Elevation.140m)

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave./ Total
mm	2	3	5	28	194	329	235	264	350	238	39	6	1,693
℃	26.3	27.0	28.3	29.0	28.2	26.9	26.8	26.7	25.9	25.8	25.8	25.8	26.9

2.3 Population

According to the General Directorate of Statistics and Census of the Ministry of Economy, El Salvador's population stands at 6.517 million and is growing at the rate of 1 .9 % annually.

Given the size of the land, El Salvador's population is large. The population density of 310 people per square kilos is considered high. The following is the population summary of major cities as of 2001:
San Salvador: 486,000

Santa Ana: 253,000
San Miguel: 245,00.

Ethnically, El Salvador is 84% mixed race (i.e., half-white (of Spanish descents), half-indigenous), 5.6% aborigines, 10% white, and 0.4% others. The mixed race (Mestizoes), which accounts for the largest ethnic group, has completely lost the language and lifestyle traditions of the Indios. In contrast, the Indios form their own communities and live in such areas as Panchimalco, Izalco, and Nahuizalco.

2.4 Economy

GDP of El Salvador in 2002 was US$ 14,284 million, or the per capita GDP of US$2,192.
In 2002 23.5% of the country's GDP was contributed by its manufacturing sector, while the contributions by the distribution and service sector and the agriculture and fishing sector stood at 19.2% and 8.7% respectively. Therefore, the figures imply El Salvador's fundamental reliance on the manufacturing and service sectors. Table 2.1 shows GDP of each industrial sector.

The monetary values of production by the manufacturing sector and the distribution and the service industry stand at US$3,351.8 million and US$2,727.8 million respectively.

Major export items are limited, to a large extent, to coffee and apparel, and it is their urgent task to develop new industries. Its trade deficits is financed mainly by the remittance of funds to families in El Salvador from individuals living in the United States, which amounts annually to over USD1.9 billion in total. Thus, reforms in its industrial structure are called for to correct the trade financing mechanism. The following Table shows changes in GDP over years.

Macroeconomic Statistics

Year	1997	1998	1999	2000	2001	2002
CPI Inflation (%)	1.90	4.20	4.25	4.30	1.40	2.80
Nominal GDP (MUS$)	11,192	12,008	12,465	13,134	13,803.7	14,283.9
Real GDP Growth (%)	4.00	3.70	3.40	2.20	1.70	2.50
Deflector (2002 base) (%)	78.4	84.1	87.3	92.0	96.6	100.0

2.5 Energy Resource

El Salvador, which is not an oil-producing county, depends on imported oil, which accounts for 44% of the country's primary energy consumption (2002 figure). Table 2.2 shows the energy consumption by electricity tariff. According to the table, the nation's power consumption is equivalent to 0.16 million tons of oil and accounts for a significant proportion in the energy

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consumption. Therefore, the utilization of domestic energy resources, energy saving and a more efficient utilization of energy resources are crucial policy issues for El Salvador.

The hydropower potential in 1998 was estimated to be about 2,165 MW, and since then, about 19%(or about 410.8MW) of the potential has been realized up to this moment (2002). Looking ahead, the development of alternative energies for oil, such as geothermal, wind power, solar energies is expected. Additional plans calling for an international connection of power transmission lines are also under progress.

2.6 Road Infrastructure

The major means of transportation in El Salvador is via road. The total length of the national roads is about 1,200 km, of which about 700 km runs east to south and 500 km runs north to south.

Two routes serve as the major roads. They are the Pan American High Way running across the central section and another route running closer to the coastal line. Both roads serve Acajutla, an international port, the capital city of San Salvador, and the local city of San Miguel in that order. The two roads meet at two points along the way (i.e., the San Salvador-Comalapa corridor and the Sanvicante-Zacatecoluca corridor) for improved efficiency of transportation routes. Upgrades have been performed on these mainstay roads annually including road widening work, better curves and road paving.

Table 2.1 Real Indicators Quarterly Gross Domestic Product

(Unit: Million of US$)

No.	Main Divisions	2001 2/					2002 2/				
		Q1	Q2	Q3	Q4	Annual	Q1	Q2	Q3	Q4	Annual
1	Agriculture, Cattle, Forestry and Fishing	326	331	327	318	1,301	315	316	306	304	1,242
2	Manufacturingndustry and Mining	807	805	810	826	3,248	843	854	860	858	3,414
3	Construction	150	159	168	171	647	170	166	168	171	675
4	Total Service	2,030	2,053	2,063	2,085	8,231	2,118	2,147	2,153	2,144	8,562
4.1	Service excluding government services	1,785	1,807	1,817	1,839	7,248	1,873	1,903	1,911	1,906	7,594
4.2	Government Services	245	246	246	246	983	245	244	241	238	968
5	Less: Imputed banking services	145	145	144	144	577	147	148	147	146	588
6	Plus: Other GDP Items 1/	231	236	141	245	953	242	242	245	251	980
	Total Gross Domestic Product	3,399	3,439	3,365	3,501	13,804	3,541	3,577	3,584	3,581	14,284

1/ Include Value Add Tax and Customs Duties

2/ Preliminary figures for 2001 and 2002

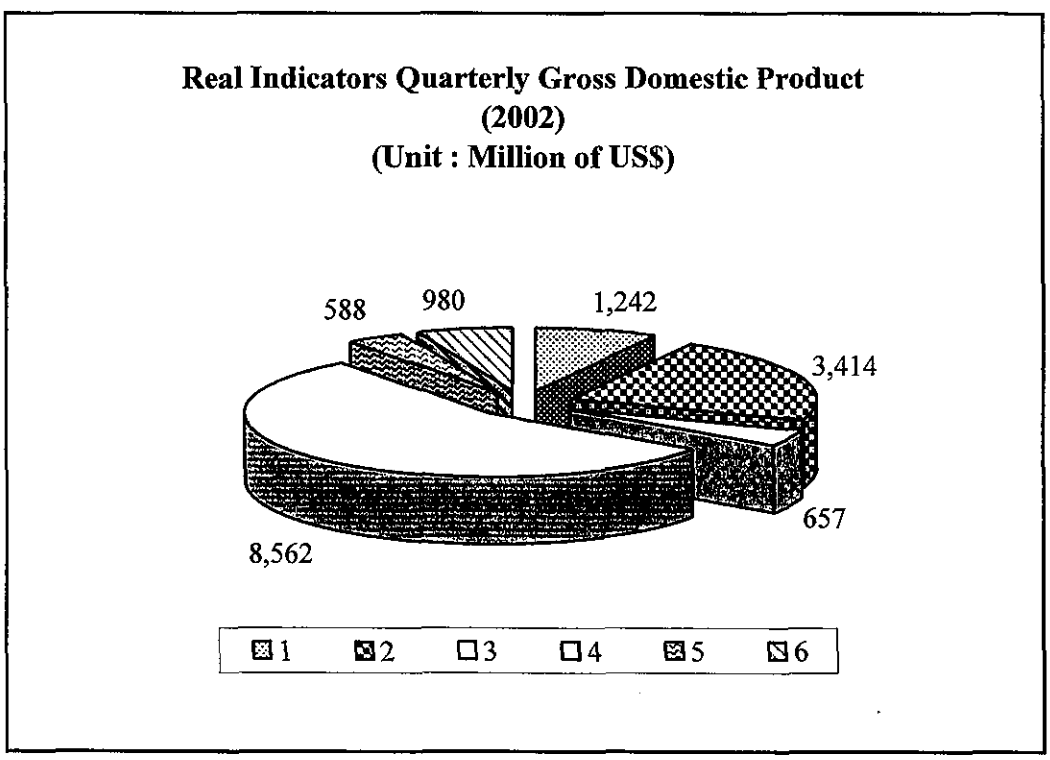

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Table 2.2 Consumption of Energy (2002)

No.	CATEGORY			GWh	%
1	Low Voltage	SMALL DEMAND	(0 < kW < 10)	1,776.4	50.0
2		MIDDLE DEMAND	(10 < kW < 50)	100.7	2.8
3		LARGE DEMAND	(> 50 kW)	8.1	0.3
4	High Voltage	SMALL DEMAND	(10 < kW < 50)	167.9	4.7
5		LARGE DEMNS	(> 50 kW)	1,499.2	42.2
Total				3,552.3	100.0