12. CONSTRUCTION PLAN AND COST OF CONSTRUCTION

3K9 (750K)

CONTENTS

12. CONSTRUCTION PLAN AND COST OF CONSTRUCTION

12.1 General

12.1.1 Access to the Plan Point

(1) Airport

Comalapa International Airport of El Salvador is located about 44 km south of the capital of San Salvador on the Pacific Ocean shore. It takes one hour from San Salvador to reach Comalapa by car. There is no regular domestic air service.

(2) Road

The El Chaparral Project site is located about 300 m upstream from the point at which the Torola River becomes the boundary line between Honduras and El Salvador, and the straight distance from San Salvador is about 90 km. The distance from San Salvador to San Luis De La Reina, which is near the project site, is about 130 km, and it is possible to reach there by car.

Alternative transportation routes for the construction machinery and materials, which will be imported from foreign countries, are available, including the sea routes by way of Akaftra Harbor and La Union Harbor, and the American Highway route. The domestic transportation route, which branches from the American Highway at El Triunto and stretches about 47 km to the construction site through Sesori and San Luis De La Reina, is recommended. The route has ten bridges of various sizes before San Luis De La Reina. These bridges are 6 m or wider, and the road before San Luis De La Reina is scheduled to be asphalted very soon. Therefore, no problem is expected for heavy load transportation. The existing road of about 6 km length that stretches from San Luis De La Reina to the construction site is narrow and rough; therefore, repairs must be made in order to transport the heavy machinery and materials.

The new road construction is necessary to approach the construction site.

12.1.2 Electric Power for Construction

A distribution substation of 46/13.2 kV, 2 MVA is located at Ciudad Barrios approximately 5 km off the construction site. The substation is owned by the local distribution company, E.E.O. (Empresa Electrica de Oriente S.A de C.V.)

12.2 Construction Plan and Construction Schedule

12.2.1 Basic Assumptions

(1) Meteorology

The Torola River basin is noted for heavy annual rainfall compared to other localities within El Salvador, having two distinct seasons, a dry season from November to April and a rainy season from May to October. The rainfall in December to February, the season with the least rainfall throughout the year, is almost zero. In June and September, the peak of the rainy season, the monthly rainfall reaches the range of 300 - 500 mm.

Temperature fluctuations are small throughout the year. The daily average temperature in the lowlands (250 m asl) varies generally from 25°C to 30°C. An outline of weather phenomena as observed for the recent ten years (1991-2000) at the point located near Osicala gauging station is as follows.

Annual average precipitation:	2,090 mm
Maximum precipitation of the month:	544 mm (October, 1999)
Annual normal temperature:	24.6°C
Maximum temperature:	42.2°C
Lowest temperature:	12.5°C
Annual rainy days:	About 90 days (precipitation of more than 1 mm/day)

A construction schedule was set up on the assumption that construction work can be performed full year (effective work days per year: approx. 280 days). The days for dam concrete placing and other works, which are affected even by scant rainfalls, are deducted (20 days/month).

(2) Design Discharge for Diversion Tunnel at the Dam site

One diversion tunnel was planned at the site in order to execute the dam construction. Flood discharge with a return period of one year, i.e., 728 m^3/sec, was adopted as the diversion tunnel design discharge.

(3) Construction Materials

Cement is available from a plant inside El Salvador (production capacity: 4,500 t/day). Since a large quantity of cement must be procured in a short period, cement (including fly ash), as well as reinforcements and steel materials will be procured from offshore sources.

The construction site's riverbed gravel, deposits on the terrace, and excavated materials from the dam and powerhouse will be diverted and used for the aggregate for concrete. The total concrete quantity is approximately 430,000 m^3, broken down into approximately 390,000 m^3 for the dam body (including the upstream cofferdam) and approximately 40,000 m^3 for the other structures. The rude materials required for the concrete quantity is approximately 520,000 m^3, consisting of approximately 380,000 m^3 of rough aggregate and approximately 140,000 m^2 of fine aggregate.

Unit aggregate volume	Dam concrete: 0.8 m^3/m^3	Concrete for general structures: 0.7 m^3/m^3
Rate of fine aggregate	Dam concrete: 25%	Concrete for general structures: 45%

Required rude material extra rate to aggregate product quantity: 1.5 (for riverbed gravel)

Required rough aggregate quantity
$(390{,}000 \times 0.8 \times 0.75 + 40{,}000 \times 0.7 \times 0.55) \times 1.5 =$ Approximately 380,000 m^3

Required fine aggregate quantity
$(390{,}000 \times 0.8 \times 0.25 + 40{,}000 \times 0.7 \times 0.45) \times 1.5 =$ Approximately 140,000 m^3

Total Approximately 520,000 m^3

Since the quantity of riverbed gravel available approximately 2 km upstream from the dam is approximately 320,000 m^3 (refer to Chapter 7 Geology), excavated materials must be diverted to compensate for the deficient amount of approx. 200,000 m^3.

Since the quantity of the excavated rock (dam, powerhouse, etc.) is approximately 370,000 m^3, the usable aggregate quantity is 185,000 m^3 (= 370,000 × (1/2) = 185,000 m^3), based on the assumption that the required rude material extra rate to the aggregate product quantity is 2.0. This falls short of the required amount; thus it is necessary to expand the investigation area to confirm the quantity of riverbed materials that could compensate for the shortfall.

(4) Construction Power

For the power for construction works, an exclusive power receiving facilities determined in the construction plan will be placed in the work area (temporary site to be planned at 2 km upstream

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from the dam), and the local power distribution company, E.E.O., which is designated to supply power to this region, will distribute power from the substation near the construction site. The power receiving facilities must be constructed before the start of dam construction works.

Inside the construction area, 4.16 kV or 480 V construction work power supply distribution line will be laid from the exclusive power receiving facilities, for feeding power to each temporary facility.

(5) The Temporary Road and Yard for Construction

Improvement of public roads around the construction site, and the construction of temporary roads and yards for construction works must be completed as part of preparatory works.

12.2.2 Construction Plan

The construction plan and the construction schedule have been proposed based on the above basic assumptions and construction quantities. Powerhouse construction works comprise the critical path under the Project construction schedule. The project construction schedule is shown in Table 12.1.

The main structures to be constructed under the Project are the following:

Diversion Tunnel:	Inner height: H= 8.0m; Length: L=360m; 1 line
Dam:	Concrete gravity type; Height: H=87.5m; Crest length: L=405.0m
Intake:	The Type that allows incorporation into the dam
Penstock:	Embedded penstock; Inner diameter: D=5.0m-4.2m; Length: 144.5m
Powerhouse:	Semi underground type; Length: L=36.0m; Width: W= 26.0m; Height: H=16.0m
Switchyard:	25.0m x 65.0m

The major civil work volumes are as follows:

Structure	Unit	Excavation volume	Concrete volume
Care of river	m^3	42,600	16,500
Dam	m^3	311,200	392,200
Waterway	m^3	2,400	2,500
Powerhouse	m^3	209,500	11,800
Total	m^3	565,700	423,000

(1) Preparatory Works

Preparatory works prior to the main works comprise improvement of existing public roads, construction of access roads (involving temporary roads for construction), preparation of temporary yards, and construction of temporary facilities such as electric receiving facilities, office and lodging facilities. Such preparatory works will be included in the scope of work to be handled the contractor for the major civil structures and will be carried out accordingly. The office and lodging facilities for the contractors to be implemented by the contractors are not included within the scope of the preparatory works.

The following outlines preparatory works. Fig. 12.1 shows the location plan of preparatory works.

1) Improvement of existing public roads
2) Temporary roads for construction
   - Access road to the dam
   - Access road to the powerhouse
   - Access road to the switchyard
   - Aggregate the conveyance road
3) Temporary yards
   - Materials storage yard
   - Concrete batching plant and aggregate stock yard
   - Aggregate plant yard
   - Reinforcement workshop and penstock tube assembly yard
   - Parking lot
4) Electric power for construction
   - Receiving facilities for electric power
   - Power distribution line in the construction area
5) Office and lodging facilities
6) Temporary facilities

The following outlines the temporary facilities.

Fixed type cable crane	2 units
Fixed type tower crane	1 unit
Aggregate crushing plant	1 unit
Concrete batching plant	1 unit

Aggregate, cement stock equipment	1 set
Turbid water treatment plant	2 units
Temporary bridge	1 unit

(2) Civil Works

1) Diversion tunnel

A diversion tunnel will be excavated from the outfall to the inlet. The access road to the powerhouse and the temporary bridge will be used for fording to reach the outfall. The inlet should be constructed during the dry season. The daily and monthly tunnel excavation rates are estimated to be 6.0 m (1.5m/blast × 3 or 4 cycle/day) and 144 m, respectively, on an around-the-clock basis. The concrete lining is planned to be placed once every two days, and its monthly placing rate is estimated at 120 m (10 m/cycle × 24 days/month / 2 days/cycle). The invert lining is planned to once every two days, and its monthly placing rate is estimated at 360 m (30 m/cycle × 24 days/month / 2 days/cycle).

The primary and secondary upstream cofferdams (RCC to be applied) and the downstream cofferdam will be constructed during the dry season after the completion of diversion tunnel works. Flow diversion will be executed after the completion of the cofferdams.

2) Dam

a) Foundation excavation

The excavation of the dam foundation will start from the high elevation part of the left bank before the completion of the flow diversion works. After the flow diversion works, the excavation of both banks will start. Excavated material will be dumped down to the riverbed and transported to the disposal area upstream by dump truck.

The excavation will be carried out only during daytime. The daily and monthly excavation rates are 2,500 m^3/day and 50,000 m^3/month (2,500 m^3/day × 20day/month), respectively.

b) Concrete placing

The dam's concrete volume is approximately 390,000 m^3 (including upstream cofferdams). The RCC method will be applied for the dome construction. Generally, the following items compose of the transporting equipment for the RCC dam construction.

- Dump truck for transportation
- Fixed type cable crane
- Fixed type tower crane
- Incline
- Tower type belt conveyor

The length of the dam crest is long and the moving range of the concrete placing site is wide against the dam volume (concrete placing amount). Because there is a spillway with five gates at the center of the dam, the concrete placing site will be completely separated into two sections, one on the left side and the other on the right, after the concrete placing on the piers for the spillway. In addition, it is necessary to transport both RCC and normal concrete for the dam construction. For the above reason, a fixed type cable crane will be used for the project.

In the event that two units of the fixed type cable crane (suspended load capacity: 20 t, bucket capacity: 6.0 m^3) will be installed at site and concrete placing work will be carried out on an around-the-clock basis, the monthly transporting capacity of dam concrete will be 57,600 m^3/month (20 days/month × 20 h/day × 20 cycles/h × 6.0m^3 × 0.8 (working efficiency) × 1.5). The concrete placing period is estimated to be 8.0 months (390,000 m^3 / 57,600 m^3/month × 1.15 (extra rate)).

A concrete batching plant and two mixers with a capacity of 3.0m^3 will be installed in the vicinity of the dam crest on the left bank. Concrete aggregates will be transported by dump truck from the aggregate crushing plant and stored in the aggregate stock equipment bin adjacent to the concrete batching plant.

3) Intake

The intake will be constructed in parallel with the concrete placing for the dam.

4) Penstock

The penstock consists of an upper horizontal part (crossing part in the dam body), an inclined shaft (open-pit part, underground part), and a lower horizontal part (powerhouse part). Iron pipes will be fabricated in the temporary yard adjacent to the upstream disposal area and then transported to the powerhouse.

The excavation will be performed downward from the inclined shaft top. The excavated materials will be lifted by a winch and transported to the disposal area along with the excavated materials from the dam.

The penstock will be lifted and carried by a tower crane set in the temporary yard of EL. 180.0 m from the inclined shaft top and then installed sequentially from the

powerhouse side. The open part of the inclined shaft and the embedded part of the dam body will be installed in step with the dam body concrete placing.

5) Powerhouse

The powerhouse will be excavated using the bench cut method. After reaching EL. 125.0 m, the penstock tunnel will be completed and then the powerhouse will be excavated again to the bottom.

The base concrete will be placed sequentially from the bottom in line with the progress of installation of the generator.

(3) *Hydroelectric Works*

1) Turbine and Electric Facilities

The installation of electric facilities will begin during the ninth month following the commencement of civil works and be completed during the thirtieth month. Commercial operation of the unit will start during the thirty-fourth month subsequent to the commencement of civil works after a dry test and a wet test.

The draft tube installation will start after the completion of the powerhouse excavation. The Installation of casings, turbines and generators will be completed in one year using an overhead traveling crane.

2) *115 kV Transmission Line*

The construction of the 43-km long, one circuit 115 kV-transmission line under the project is to begin during the first year and be completed during the third year after the start of the civil works.

12.2.3 Construction Schedule

The construction period was estimated to be three years and four months, in light of the scale of the construction. The critical path of the construction schedule includes the works relating to the powerhouse. Table 12.1 shows the construction schedule and the outline of the construction for each year:

The First Year (rainy season: May to October)

(1) Preparatory Works

- Office and lodging facilities
- Access roads to each construction area (improvement of existing roads and construction of new roads for the construction works)
- Development of temporary land and preparation of temporary facilities (concrete plant,

aggregate plant and electric facilities for the construction works)

The First Year (dry season: November to April)

(2) Care of river
- Diversion tunnel (tunnel excavation, lining with concrete, etc.)
- Upstream coffer dams (dewatering, foundation excavation, dam concrete placing, etc.)
- Downstream coffer dam (dewatering, foundation excavation, dam embankment, etc.)

(3) Dam
- Excavation (high elevation part)

(4) Penstock
- Inclined shaft excavation

(5) Powerhouse
- Excavation (high elevation part)

The Second Year (rainy season)

(6) Dam
- Foundation excavation

(7) Penstock
- Inclined shaft excavation
- Penstock tube installation
- Filling concrete

(8) Powerhouse
- Foundation excavation (low elevation part)
- Concrete placement (foundation, wall, slab and others)

(9) Outlet
- Riverbed excavation

(10) Electric Equipment
- Draft tube installation
- Installation of turbine's auxiliary parts, etc.

The Second Year (dry season)

(11) Dam

- RCC dam concrete placement (inner concrete)
- Conventional dam concrete placement (outer concrete)
- Consolidation grouting (boring, cement injection)
- Curtain grouting (boring, cement injection)
- Gallery installation

(12) Spillway

- Concrete placement (pier, guide wall, stilling basin wall and others)

(13) Intake

- Concrete placement (pier and others)

(14) Penstock

- Penstock tube installation

(15) Powerhouse

- Concrete placement (foundation, slab and others)
- Building construction (overhead crane installation, wall, ceiling and others)

(16) Electric equipment

- Turbine-related equipment installation

The Third Year (rainy season)

(17) Dam

- RCC dam concrete placement (inner concrete)
- Conventional dam concrete placement (outer concrete)
- Consolidation grouting (boring, cement injection)
- Curtain grouting (boring, cement injection)
- Gallery installation

(18) Spillway

- Concrete placement (pier, guide wall, stilling basin wall and others)
- Gate installation

(19) Intake

- Concrete placement (pier and others)
- Gate and screen installation

(20) Powerhouse

- Concrete placement (foundation, slab and others)
- Building construction (interior finish work and others)

(21) Switch yard

- Excavation, foundation concrete placement

(22) Electric equipment

- Turbine-related equipment installation and others
- Generator-related equipment installation

The Third Year (dry season)

(23) Care of river

- Diversion tunnel closing (plug concrete, consolidation grouting and others)

(24) Spillway

- Gate installation

(25) Powerhouse

- Concrete placement (slab and others)

(26) Electric equipment

- Turbine-related equipment installation
- Powerhouse-related equipment installation
- Main transformer and switchyard-related equipment installation
- Sub-turbine generator-related equipment installation
- Power plant equipment, information transmission equipment (with microwave transmission system or power line carrier equipment) and accessory equipment installation and others
- Dry and wet test

(27) Transmission line

- The First Year (dry season) to the Third Year (dry season)

12.3 Construction Cost

Construction cost has been calculated by applying the following basic criteria and reflecting the site's meteorology and geology, general area conditions and the construction scale.

12.3.1 Basic Criteria for Cost Estimate

(1) Unit prices of materials, labor and equipment, which constitute the unit costs of the work items are based on the price level of 2003.

(2) All costs are expressed in US Dollars and are assorted into the Local Currency and a Foreign Currency.

(3) For imported materials or equipment, local taxes and customs duties are not included.

(4) Price escalation is not included in the project cost.

(5) Interest during the construction period is not included in the project cost.

12.3.2 Constitution of Project Cost

The project cost consists of the following cost items.

(1)	Preparatory Construction Cost:	Existing road improvement works, access roads, temporary yards, supply facilities for construction power, office and camp facilities.
(2)	Civil Works Construction Cost:	
	Care of River	Diversion tunnel, upstream and downstream cofferdams
	Dam	Main dam body, foundation treatment, spillway main body, stilling basin wall
	Waterway	Intake, inclined shaft, filling concrete
	Powerhouse	Powerhouse foundation, building and control room, outlet main body, switchyard foundation
(3)	Hydromechanical Equipment:	Gates, Penstock, Screen, Bottom outlet
(4)	Hydroelectric Equipment:	Turbine, inlet valve, speed governor and related auxiliary equipment, generator, exciter and related auxiliary equipment, sub turbine-generator, inlet valve and related auxiliary equipment, overhead travelling crane, transformer

	& fire extinguisher (with a inter-connecting line between transformer and switchyard), generator main circuit buses, protective relay including distribution panel switches & information transmission system (with equipment to be installed a relay station), auxiliary equipment attached to powerhouse, etc.
(5) Transmission Line:	Transmission equipment, Electrical equipment in switchyard (with switching equipment to be installed a 15 de Septiembre substation)
(6) Environmental spending:	Repairs of neighboring roads, new roads, bridges (cf. Fig.12.2), environmental spending
(7) Land acquisition and indemnity cost	Cost of land acquisition, indemnity for trial flooding, and right of way for the transmission line
(8) Physical Contingency:	10% for preparatory works, civil works and roads, 5% for hydromechanical equipment, 5% for hydroelectric equipment and transmission line
(9) Administrative and Engineering Costs:	Administrative/management and engineering costs on detailed design and construction supervision (15% of direct cost)

The direct construction cost comprises the total of Items (1) through (7) above. The project cost comprises the total for direct construction cost and Items (8) and (9) above.

12.3.3 Project Cost

(1) Preparatory Work Cost

The work unit prices proposed by CEL were applied to the roads (existing road improvement and new road construction). The costs for the construction work of the power receiving facilities and the temporary office and loading facilities were calculated based on the results of projects in neighboring countries (local currency 90%, foreign currency 10%).

(2) Civil Work Cost

Work unit prices and the proportion of local and foreign currencies for the work were set by referring to the work unit prices for the projects being constructed in neighboring Central and South American countries and by considering the differences in labor cost and the material unit price.

(3) Hydromechanical Equipment

All the hydromechanical equipment such as gates and penstocks will be imported. Work unit prices and the proportion of local and foreign currencies were set by referring to the work unit prices for other projects in neighboring Central and South American countries as well as civil works.

(4) Electric Equipment

All the hydroelectric equipment-related items will be imported. Work unit prices were set by referring to the international prices recorded thus far. Transportation and installation costs (16% of the total) are set in the local currency.

(5) Transmission Line

The transmission equipment construction cost has been set by referring to the international prices recorded thus far. The construction cost (28%) was allocated in the local currency, and the materials cost (72%) was allocated in the foreign currency.

(6) Environmental Spending

The cost was set based on the results of a field environmental survey. 90% of the cost is set in the local currency excluding the cost for the bridges (90% is in the foreign currency), and 10% in the foreign currency.

(7) Land Acquisition Cost and Indemnity Cost

The work unit prices proposed by CEL were applied. 100% of the costs was set in the local currency.

(8) Physical contingency

As a quantitative reserve fund, 10% was allocated to the preparatory works, civil works and roads, 5% to the hydromechanical equipment, and 5% to the hydroelectric equipment and the transmission line.

(9) Administrative and Engineering Costs

15% of the direct cost (2% for administrative/management cost and 13% for engineering cost) was set by referring to the costs in other projects.

The project cost as estimated based on the optimum development scheme selected in "9.3 Selection of Development Scheme" is tabulated in Table 12.2.

12.3.4 Disbursement Schedule

The annual required funding (disbursement schedule) is indicated in Table 12.3.

An advance payment will be made to contractors according to the type of works. The retention money will be released to the contractors after the acceptance inspections during the final year of works.

Tabla 12.1 Cronograma de Construcción del Proyecto El Chaparral

item		unidad	cantidad	1er. año	2do. año	3er. año	4to. año	notas
				A M J J A S O N D	E F M A M J J A S O N D	E F M A M J J A S O N D	E F M A M J J A S O N D	
1 Obras preparatorias								
Camino de acceso 1 (ancho: 6 m)	mejora de camino existente	km	6					
Camino de acceso 2 (ancho: 6 m)	camino nuevo (permanente)	km	3					
Camino de acceso 3 (ancho: 11 m)	camino nuevo (temporal)	km	2					
Campamento y oficinas		SG	1					
Desarrollo de terrenos temporales		SG	1					
Instalaciones temporales	suministro de agua y electricidad	SG	1					
	planta de agregado / concreto	SG	1					
	grúa de cable y otros	SG	1					
2 Obras civiles principales								
Cambio del curso de agua					desviació			
Ataguía aguas arriba	excavación	m^3	5,400					
	concreto de presa	m^3	14,400					15,360 m^3/mes (24 días/mes × 20 horas/día × 20 veces /hora × 2.0 m^3 × 0.8)
Ataguía aguas abajo	excavación	m^3	5,000					
	apilado de ataguía	m^3	3,000					
Túnel de desviación	excavación	m^3	8,200					
	excavación de túnel (L = 380m)	m^3	24,000					144 m/mes (24 días/mes × 1.5 m/ciclo × 4 ciclos/día)
	concreto de revestimiento(L=80m)	m^3	2,100					120 m/mes (24 días/mes ÷ 2 días/ciclo × 10 m/ciclo)
	cierre (concreto de obturación)	SG	1					
Presa								
Presa								
excavación		m^3	311,200					50,000 m^3/mes (20 días/mes × 2,500 m^3/día)
concreto de presa RCC	concreto del interior	m^3	247,600					57,600 m^3/mes (20 días/mes × 20 horas/día × 20 veces/hora × 6.0m^3 × 0.8 × 1.5)
concreto de presa convencional	concreto del exterior	m^3	121,600					
cortina de inyecciones	perforación (inyección de cemento)	m	46,800					
inyecciones de consolidación	perforación (inyección de cemento)	m	4,400					
Vertedero								
concreto de estructura	pilas, muros de canal y otros	m^3	23,000					
instalación de compuertas	compuertas	SG	1					

Tabla 12.1 Cronograma de Construcción del Proyecto El Chaparral

item		unidad	cantidad	1er. año	2do. año	3er. año	4to. año	notas
				A M J J A S O N D	E F M A M J J A S O N D	E F M A M J J A S O N D	E F M A M J J A S O N D	
Conducto de agua								
Obra de toma								
concreto de estructura	pilas y otros	m^3	1,200					
instalación de compuertas	compuerta y rejilla	SG	1					
Tubería forzada								
excavación del túnel inclinado		m^3	2,400					L = 91m, 60 m/mes (20 días/mes × 1.5 m/ciclo × 2 ciclos/día)
instalación de tubería forzada		m	145					L = 89m, 30 m/mes (20 días/mes ÷ 12 días/ciclo × 18 m/ciclo)
relleno de concreto		m^3	800					
Casa de máquinas								~EL145 m 166,100 m^3, EL145 m ~ 31,100 m^3
Casa de máquinas								
excavación		m^3	179,400					50,000 m^3/mes (20 días/mes × 2,500 m^3/día)
concreto de estructura	fundación, losa y otros	m^3	11,700					2,400 m^3/mes (120 m^3/día × 20 días/mes)
Edificio de control								
edificio de control	35 × 27 × 13	SG	1					
Canal de descarga								
excavación		m^3	16,200					
Patio de llaves								
concreto de fundación		m^3	100					
3. Equipo eléctrico	instalación de equipos	SG	1				inundació	
tubo de aspiración principal y grúa puente								
turbina principal y sus equipos auxiliares								
generador principal y sus equipos auxiliares								
pequeña turbina y generador y sus equipos auxiliares								
equipo de la central								
equipos de patio de llaves y trasformador principal								
pruebas sinagua y con agua							operación	
línea de transmisión		km	43					

Tabla 12.2 Proyecto El Chaparral
Resumen del Costo del Proyecto
(precio a enero de 2003)

Item	Cantidad	Unidad	Precio Unitario	Costo Total	Moneda Extranjera	Moneda Local	Subtotal
COSTO DEL PROYECTO							
1 Obras Preparatorias							$ 4,471,800
Construcción del camino 1 (existente mejorado, A=6m)	6.0	km	$ 15,400	$ 92,400	$ 9,240	$ 83,160	
Construcción del camino 2 (nuevo permanente pavimentado, A=6m	3.0	km	$ 185,000	$ 555,000	$ 55,500	$ 499,500	
Construcción del camino 3 (nuevo temporal, A=11m)	2.0	km	$ 37,200	$ 74,400	$ 7,440	$ 66,960	
Campamento y oficinas	1	SG	$ 1,800,000	$ 1,800,000	$ 180,000	$ 1,620,000	
Instalaciones temporales de construcción	1	SG	$ 1,100,000	$ 1,100,000	$ 110,000	$ 990,000	
Desarrollo de terrenos temporales de construcción	1	SG	$ 850,000	$ 850,000	$ 85,000	$ 765,000	
2 Obras Civiles							$ 57,114,110
Cambio del Curso de Agua							$ 6,210,450
Ataguía Aguas Arriba							
Excavación Común	3,800	m³	$ 4	$ 15,200	$ 7,600	$ 7,600	
Excavación de Rocas	1,600	m³	$ 10	$ 16,000	$ 9,600	$ 6,400	
Concreto Compactado con Rodillo	14,400	m³	$ 55	$ 792,000	$ 316,800	$ 475,200	
Otros	1	SG	40000	$ 40,000	$ 20,000	$ 20,000	
Ataguía Aguas Abajo							
Excavación Común	3,500	m³	$ 4	$ 14,000	$ 7,000	$ 7,000	
Excavación de Rocas	1,500	m³	$ 10	$ 15,000	$ 9,000	$ 6,000	
Apilado	3,000	m³	$ 7	$ 21,000	$ 16,800	$ 4,200	
Otros	1	SG	40000	$ 40,000	$ 20,000	$ 20,000	
Túnel de Desviación							
Excavación Común	8,200	m³	$ 4	$ 32,800	$ 16,400	$ 16,400	
Excavación de Túnel	24,000	m³	$ 150	$ 3,600,000	$ 2,880,000	$ 720,000	
Concreto de Revestimiento de Túnel	2,100	m³	$ 230	$ 483,000	$ 241,500	$ 241,500	
Varillas de Refuezo	60	t	$ 1,500	$ 90,000	$ 54,000	$ 36,000	
Otros	1	SG	25%	$ 1,051,450	$ 630,870	$ 420,580	
Presa							$ 44,048,400
Presa							
Excavación Común	124,500	m³	$ 4	$ 498,000	$ 249,000	$ 249,000	
Excavación de Rocas	186,700	m³	$ 10	$ 1,867,000	$ 1,120,200	$ 746,800	
Concreto Compactado con Rodillo (Concreto de Interior)	247,600	m³	$ 55	$ 13,618,000	$ 5,447,200	$ 8,170,800	
Concreto Conventional (Cresta de la Presa + Exterior)	121,600	m³	$ 100	$ 12,160,000	$ 4,864,000	$ 7,296,000	
Perforación para Inyecciones de Consolidación	4,400	m	$ 60	$ 264,000	$ 52,800	$ 211,200	
Cemento para Inyecciones de Consolidación	90	t	$ 700	$ 63,000	$ 12,600	$ 50,400	
Perforación para Cortina de Inyecciones	46,800	m	$ 130	$ 6,084,000	$ 1,216,800	$ 4,867,200	
Cemento para Cortina de Inyecciones	2,200	t	$ 700	$ 1,540,000	$ 308,000	$ 1,232,000	
Otros	1	SG	10%	$ 3,609,400	$ 180,470	$ 3,428,930	
Vertedero							
Concreto de Estructura (Pilas, Canales, Muros, etc.)	23,000	m³	$ 130	$ 2,990,000	$ 897,000	$ 2,093,000	
Varillas de Refuerzo	640	t	$ 1,500	$ 960,000	$ 576,000	$ 384,000	
Otros	1	SG	10%	$ 395,000	$ 19,750	$ 375,250	

Tabla 12.2 Proyecto El Chaparral
Resumen del Costo del Proyecto
(precio a enero de 2003)

Item	Cantidad	Unidad	Precio Unitario	Costo Total	Moneda Extranjera	Moneda Local	Subtotal
Conducto de Agua							$ 1,070,300
Bocatoma							
Concreto de Estructura (Pilas, etc.)	1,200	m³	$ 130	$ 156,000	$ 46,800	$ 109,200	
Varillas de Refuerzo	60	t	$ 1,500	$ 90,000	$ 54,000	$ 36,000	
Otros	1	SG	10%	$ 24,600	$ 7,380	$ 17,220	
Tubería Forzada							
Excavación del Túnel Inclinado	2,400	m³	$ 200	$ 480,000	$ 384,000	$ 96,000	
Concrete de Relleno	800	m³	$ 190	$ 152,000	$ 60,800	$ 91,200	
Concreto de Estructura (Bloque de Anclaje)	500	m³	$ 130	$ 65,000	$ 19,500	$ 45,500	
Varillas de Refuerzo	20	t	$ 1,500	$ 30,000	$ 18,000	$ 12,000	
Otros	1	SG	10%	$ 72,700	$ 21,810	$ 50,890	
Casa de Máquinas							$ 5,784,960
Casa de Máquinas							
Excavación Común	35,900	m³	$ 4	$ 143,600	$ 71,800	$ 71,800	
Excavación de Rocas	143,500	m³	$ 10	$ 1,435,000	$ 861,000	$ 574,000	
Concreto de Estructura (Losa, Bóveda)	11,700	m³	$ 130	$ 1,521,000	$ 456,300	$ 1,064,700	
Varillas de Refuerzo	740	t	$ 1,500	$ 1,110,000	$ 666,000	$ 444,000	
Otros	1	SG	20%	$ 841,920	$ 336,770	$ 505,150	
Edificio de Control							
Edificio de Control	12,300	interno m³	$ 40	$ 492,000	$ -	$ 492,000	
Canal de Descarga							
Excavación Común	4,900	m³	$ 4	$ 19,600	$ 9,800	$ 9,800	
Excavación de Rocas	11,300	m³	$ 10	$ 113,000	$ 67,800	$ 45,200	
Otros	1	SG	20%	$ 26,520	$ 10,610	$ 15,910	
Patio de Llaves							
Excavación Común	13,900	m³	$ 4	$ 55,600	$ 27,800	$ 27,800	
Concreto de Estructura (Fundación)	100	m³	$ 130	$ 13,000	$ 3,900	$ 9,100	
Otros	1	SG	20%	$ 13,720	$ 5,490	$ 8,230	
3 Equipos Hidromecánicos							$ 11,720,000
Compuertas de Vertedero	1,130	t	$ 7,000	$ 7,910,000	$ 7,119,000	$ 791,000	
Compuerta de la Obra de Toma	90	t	$ 6,000	$ 540,000	$ 486,000	$ 54,000	
Rejilla de la Obra de Toma	20	t	$ 3,000	$ 60,000	$ 54,000	$ 6,000	
Tubería Forzada	350	t	$ 5,000	$ 1,750,000	$ 1,575,000	$ 175,000	
Compuerta de Descarga	70	t	$ 6,000	$ 420,000	$ 378,000	$ 42,000	
Compuerta de Descargador de Fondo y Placa de Acero	1	SG	$ 1,040,000	$ 1,040,000	$ 936,000	$ 104,000	

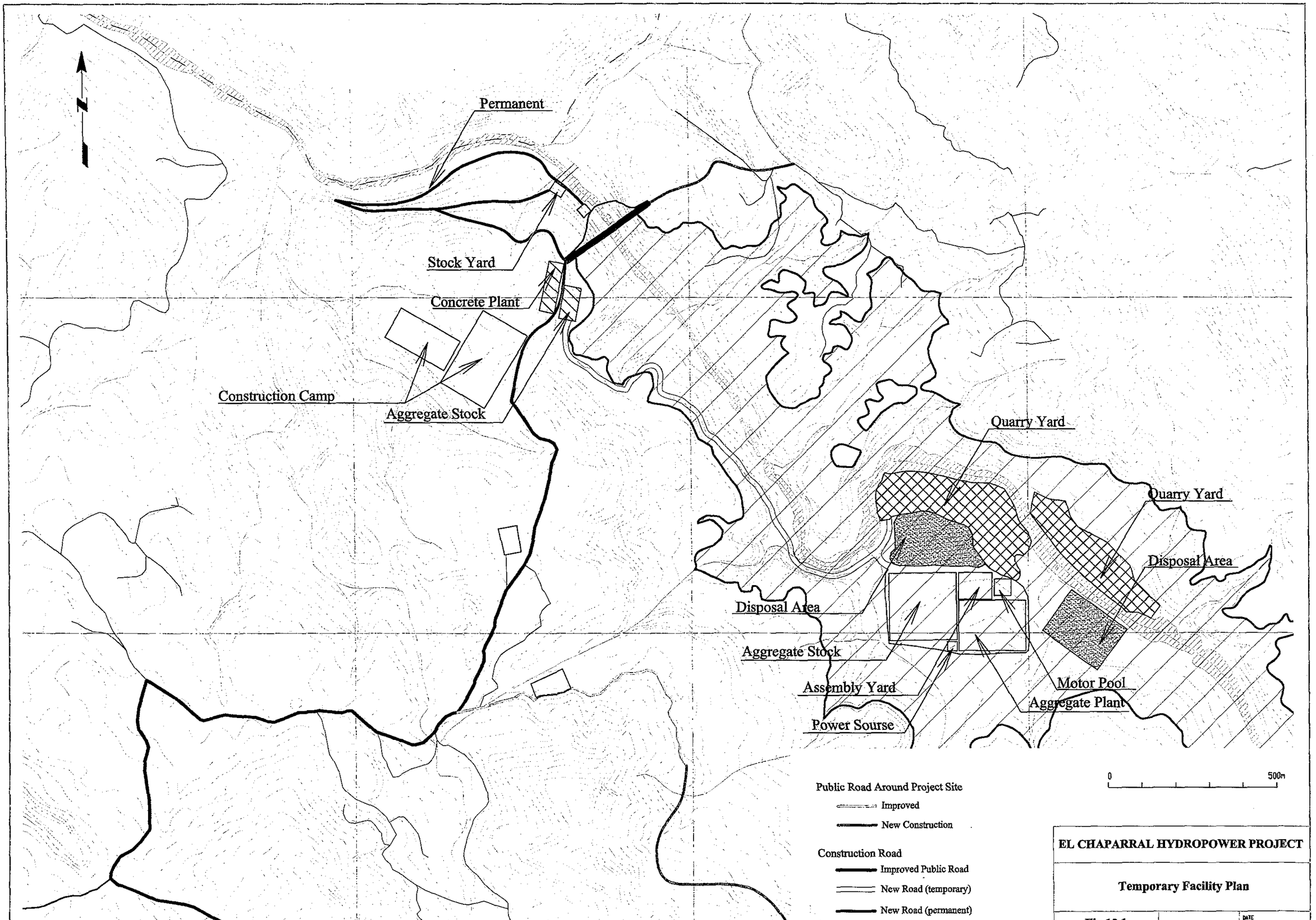
Tabla 12.2 Proyecto El Chaparral
Resumen del Costo del Proyecto
(precio a enero de 2003)

Item	Cantidad	Unidad	Precio Unitario	Costo Total	Moneda Extranjera	Moneda Local	Subtotal
4 Equipos Eléctricos							$ 17,786,000
Turbina Principal y Sistema de Gobernación de Velocidad	1	SG	$ 5,466,000	$ 5,466,000	$ 4,700,760	$ 765,240	
Generador Principal y Sistema de Excitación	1	SG	$ 4,328,000	$ 4,328,000	$ 3,722,080	$ 605,920	
Transformador de Potencia Principal	1	SG	$ 1,043,000	$ 1,043,000	$ 896,980	$ 146,020	
Turbina Pequeña y Sistema de Gobernación de Velocidad	1	SG	$ 425,000	$ 425,000	$ 365,500	$ 59,500	
Generador Pequeño y Sistema de Excitación	1	SG	$ 387,000	$ 387,000	$ 332,820	$ 54,180	
Grúa Puente	1	SG	$ 857,000	$ 857,000	$ 737,020	$ 119,980	
Equipos de Patio de Llaves	1	SG	$ 502,000	$ 502,000	$ 431,720	$ 70,280	
Equipos de Casa de Máquinas	1	SG	$ 4,778,000	$ 4,778,000	$ 4,109,080	$ 668,920	
5 Equipos de Transmisión							$ 2,597,000
Interruptor de Recepción	1	SG	$ 177,000	$ 177,000	$ 152,220	$ 24,780	
Línea de Transmisión	1	SG	$ 2,420,000	$ 2,420,000	$ 1,742,400	$ 677,600	
6 Costo del Medio Ambiente							$ 7,420,000
Infraestructura							
Camino Público Nuevo	11	km	$ 25,000	$ 275,000	$ 27,500	$ 247,500	
Camino Público Mejorado	33	km	$ 15,000	$ 495,000	$ 49,500	$ 445,500	
Puente Nuevo (dos puentes)	2	SG	$ 2,000,000	$ 4,000,000	$ 3,600,000	$ 400,000	
Mitigación Medioambiental							
Mitigación Medioambiental	1	SG	$ 192,000	$ 192,000	$ 19,200	$ 172,800	
Mitigación Medioambiental inherente al Proyecto	1	SG	$ 2,458,000	$ 2,458,000	$ 245,800	$ 2,212,200	
7 Adquisición de Terreno y Reubicación							$ 9,823,700
Adquisición de Terreno para el Reservorio (apto para agricultura	234	ha	$ 8,000	$ 1,872,000	$ -	$ 1,872,000	
Adquisición de Terreno para el Reservorio (no apto para agricult	645	ha	$ 5,900	$ 3,805,500	$ -	$ 3,805,500	
Adquisición de Terreno para el Reservorio (terreno escarpado)	81	ha	$ 4,200	$ 340,200	$ -	$ 340,200	
Adquisición de Terreno para los Caminos de Acceso	23	ha	$ 5,000	$ 115,000	$ -	$ 115,000	
Adquisición de Terreno para el Campamento y Terreno Tempo	7	ha	$ 5,000	$ 35,000	$ -	$ 35,000	
Adq. de Terreno para Presa, Casa de Máquinas y Patio de Llav	6	ha	$ 5,000	$ 30,000	$ -	$ 30,000	
Derecho de Vía par Línea de Transmisión	43	km	$ 32,000	$ 1,376,000	$ -	$ 1,376,000	
Cosot de Reubicación y Reasentamiento	75	familia	$ 30,000	$ 2,250,000	$ -	$ 2,250,000	
COSTO DIRECTO TOTAL				**$ 110,932,610**	**$ 54,430,710**	**$ 56,501,900**	
8 Contingencia							$ 7,763,750
Obras Preparatorias + Obras Civiles			10%	$ 6,158,600	2,275,020	$ 3,883,580	
Equipos Hidromecánicos			5%	$ 586,000	527,400	$ 58,600	
Equipos Eléctricos + Equipos de Transmisión			5%	$ 1,019,150	859,530	$ 159,620	
9 Costo de Administración e Ingeniería							$ 16,639,900
Costo de Administración e Ingeniería	1	SG	15%	$ 16,639,900	$ 11,370,600	$ 5,269,300	
COSTO INDIRECTO TOTAL				**$ 24,403,650**	**$ 15,032,550**	**$ 9,371,100**	
COSTO TOTAL DE CONSTRUCCION DEL PROYECTO				**$ 135,336,260**	**$ 69,463,260**	**$ 65,873,000**	

Tabla 12.3 Cronograma de Distribución del Costo del Proyecto

(Unidad:US$ mil)

Año	1	2	3	4	Total
Obras Preparatorias	3,130	894	0	447	4,472
ME	313	89	0	45	447
ML	2,817	805	0	402	4,025
Obras Civiles	6,815	14,676	28,072	7,551	57,114
ME	2,661	5,731	10,962	2,948	22,303
ML	4,154	8,945	17,110	4,602	34,811
Equipo Hidromecánico	1,758	613	4,190	5,160	11,720
ME	1,582	551	3,771	4,644	10,548
ML	176	61	419	516	1,172
Equipo Electromecánico	1,779	6,225	8,004	1,779	17,786
ME	1,530	5,354	6,883	1,530	15,296
ML	249	872	1,121	249	2,490
Línea de Transmisión	390	909	1,039	260	2,597
ME	284	663	758	189	1,895
ML	105	246	281	70	702
Cost del Medioambiente	1,855	1,855	1,855	1,855	7,420
ME	986	986	986	986	3,942
ML	870	870	870	870	3,478
Adquisición de Terrno y Reubicación	9,824	0	0	0	9,824
ME	0	0	0	0	0
ML	9,824	0	0	0	9,824
Costo Total Directo	25,551	25,172	43,159	17,051	110,933
ME	7,356	13,374	23,359	10,342	54,431
ML	18,195	11,798	19,800	6,709	56,502
Contingencia	1,191	1,944	3,469	1,160	7,764
ME	467	910	1,667	617	3,662
ML	724	1,034	1,802	542	4,102
Costo de Administración e ingeniería	3,833	3,776	6,474	2,558	16,640
ME	2,619	2,580	4,424	1,748	11,371
ML	1,214	1,196	2,050	810	5,269
Cost Total Indirecto	5,024	5,720	9,943	3,717	24,404
ME	3,086	3,491	6,091	2,365	15,033
ML	1,937	2,230	3,852	1,352	9,371
Cost Total de Construcción	30,574	30,892	53,102	20,769	135,337
ME	10,442	16,864	29,450	12,707	69,463
ML	20,132	14,028	23,652	8,061	65,873



EL CHAPARRAL HYDROPOWER PROJECT

Temporary Facility Plan

Fig.12.1

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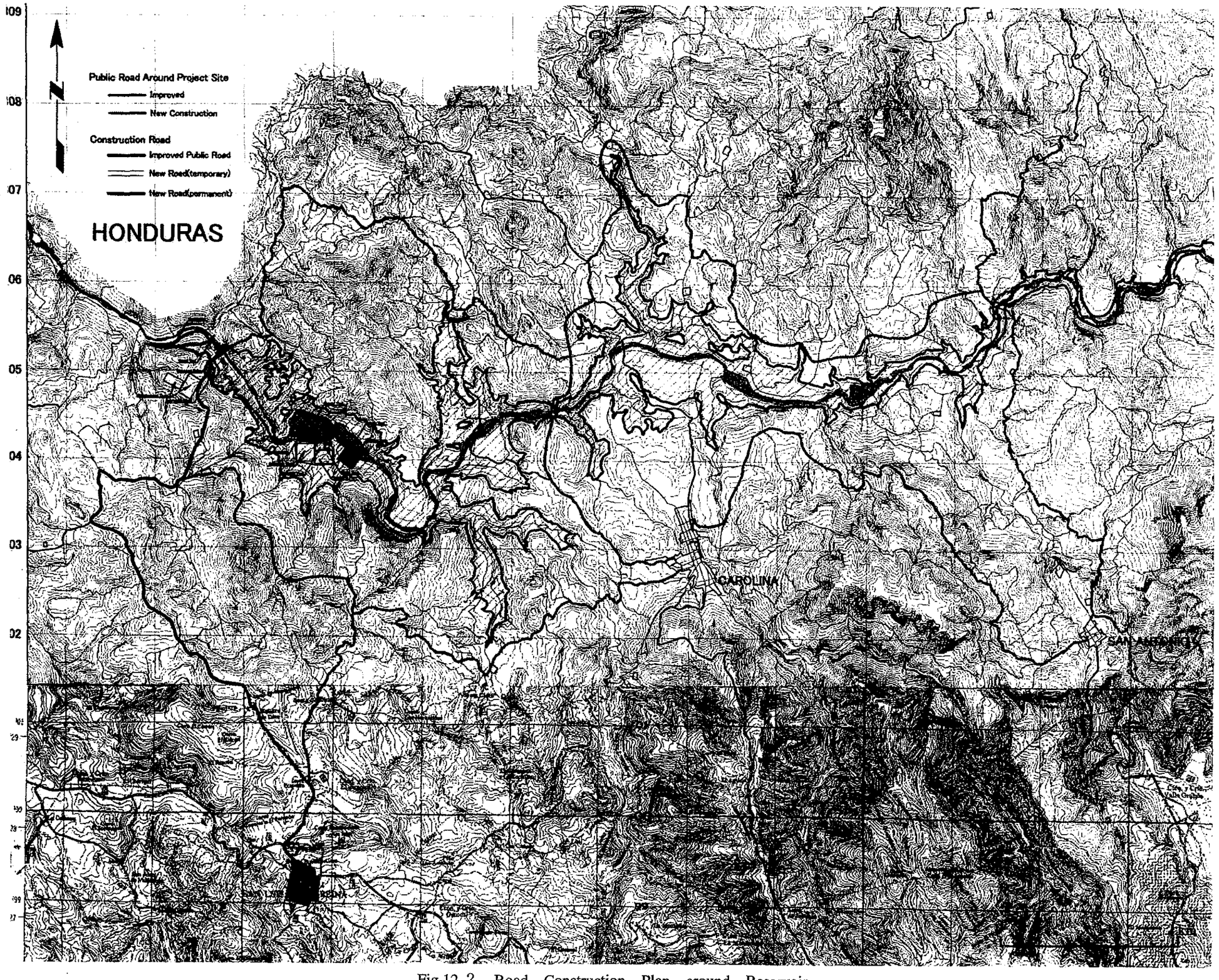

Fig.12. 2 Road Construction Plan around Reservoir

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13. ENVIRONMENT

CONTENTS

13. Environment

13.1 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 m3/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 hired 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 hired the North American company Harza Engineering Company International L.P. The geological, hydrological 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.

13.2 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 located in the middle part of the dam and will have 5 radial metallic gates with 13.5 m of width and 15.2 m of height.

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 1,510-kVA secondary generator, and all the necessary equipment for the control of the generation operations.

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 Substation 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.

13.3 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.

13.3.1 Physical Environment

(1) 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.

(2) 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.

(3) 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.

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.

(4) 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.

13.3.2 Biological Environment

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.

(1) 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.

(2) 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.

(3) 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.

13.3.3 Socio-economical Environment

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.

(1) 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.

(2) 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.

(3) 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.

(4) 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.

(5) 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.

(6) 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.

(7) 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.

(8) 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 Hydropower 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.

(9) Archeology and historical and cultural heritage resources

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.

(10) 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.

13.3.4 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.

13.4 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.

13.5 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.

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: extraction of the vegetation in the area to be flooded with the reservoir filling; 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, 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 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.

13.6 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.