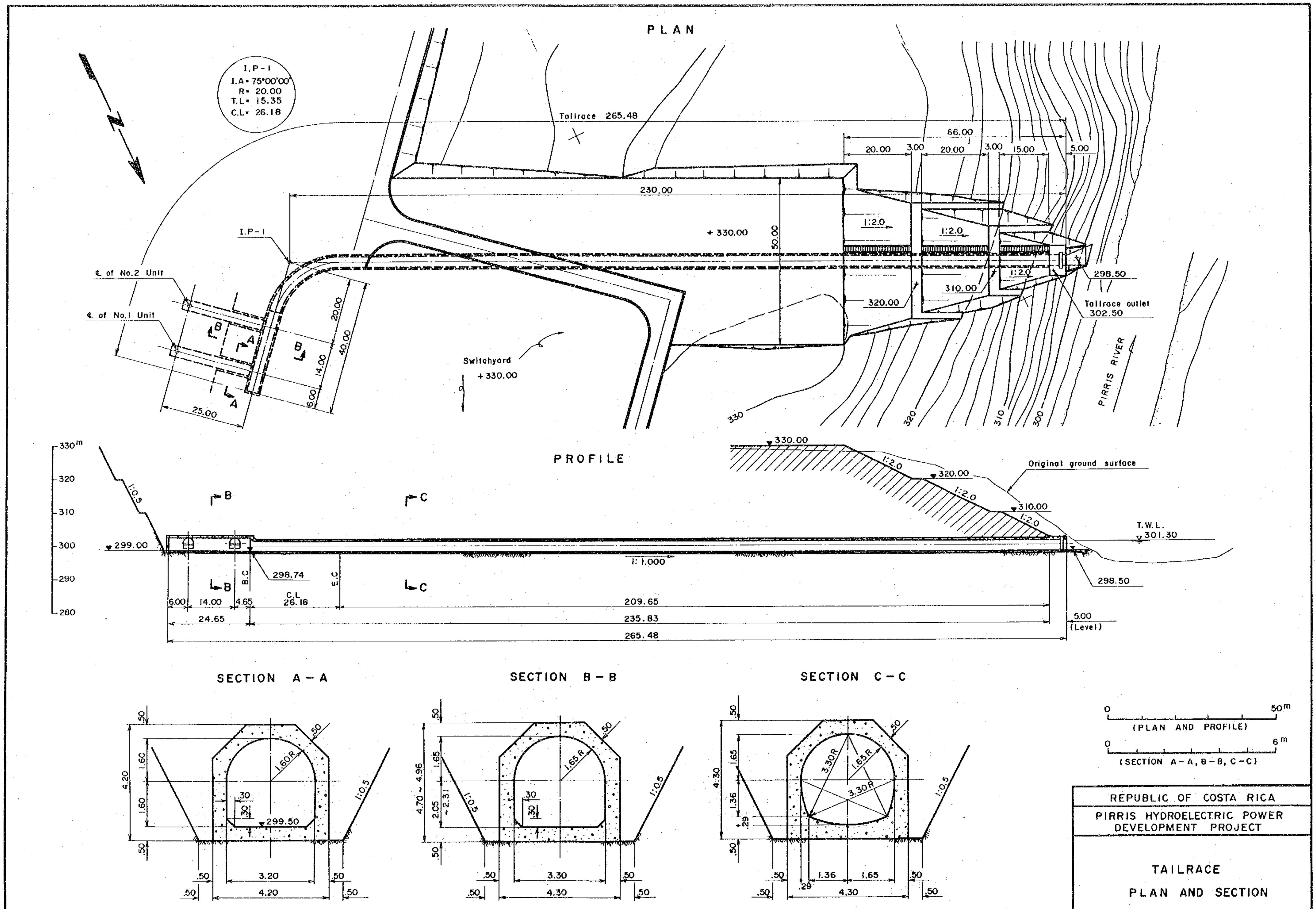
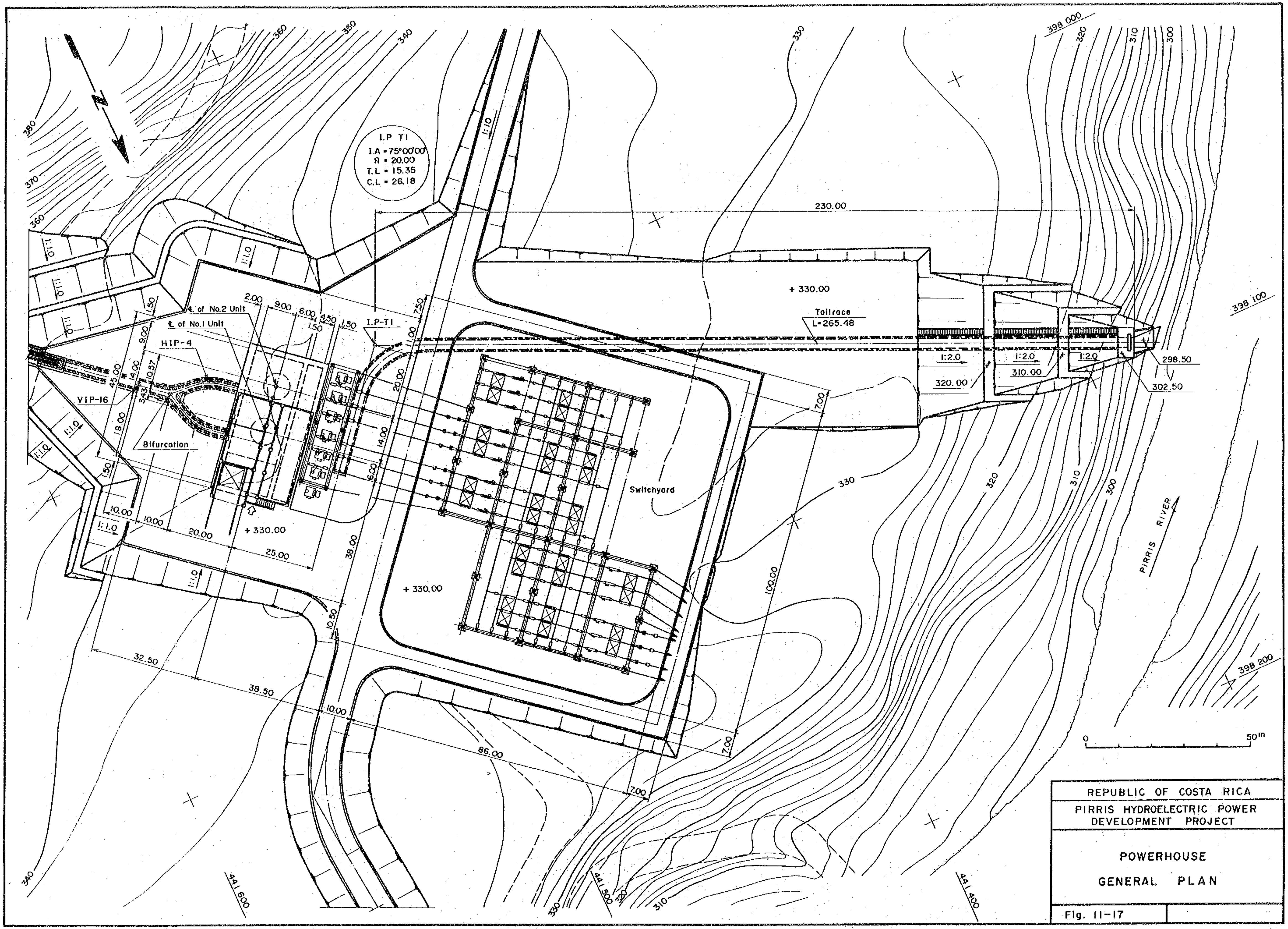


REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

TAILRACE
PLAN AND SECTION

Fig. 11-16

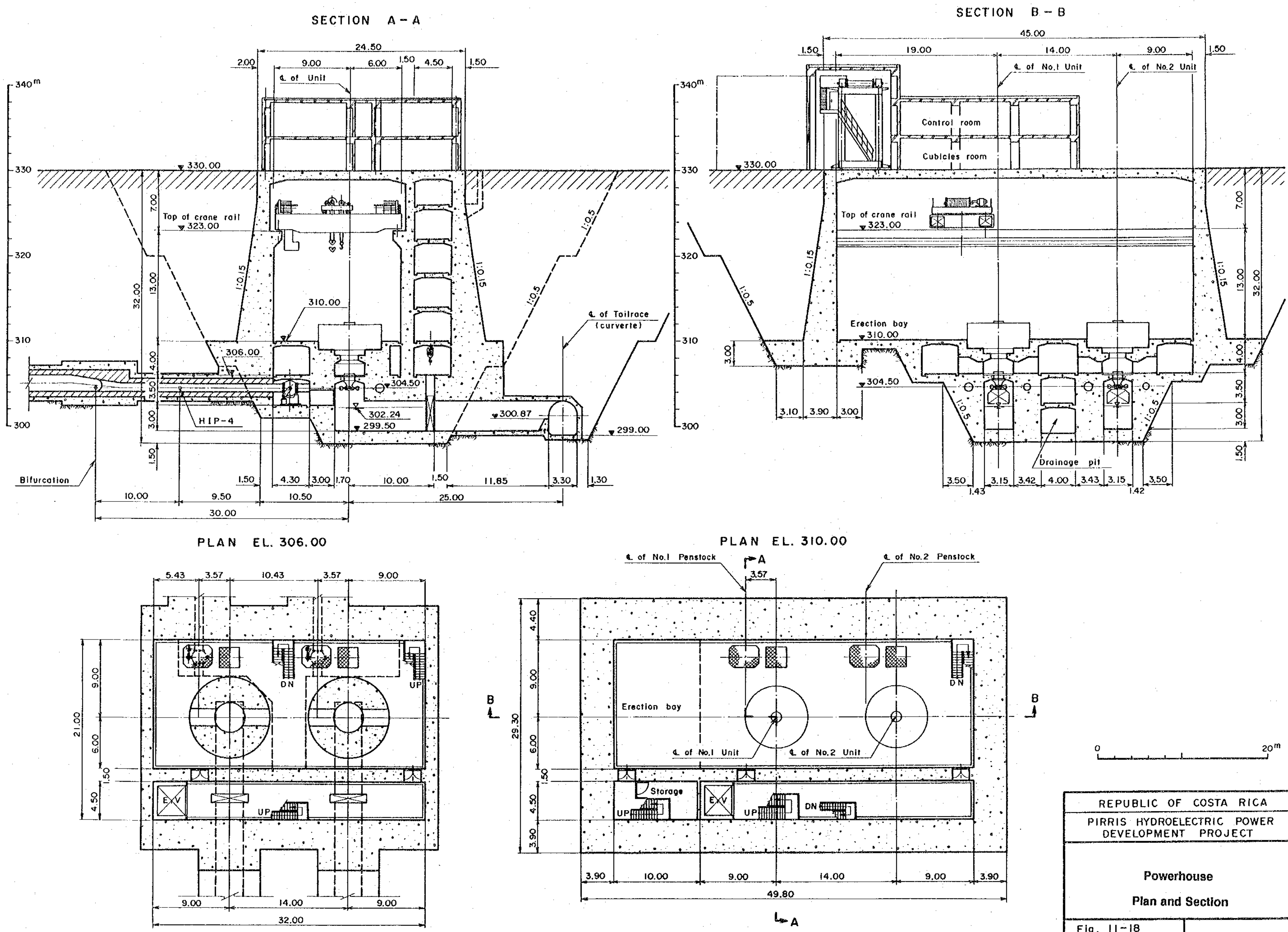


REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

POWERHOUSE GENERAL PLAN

Fig. 11-17



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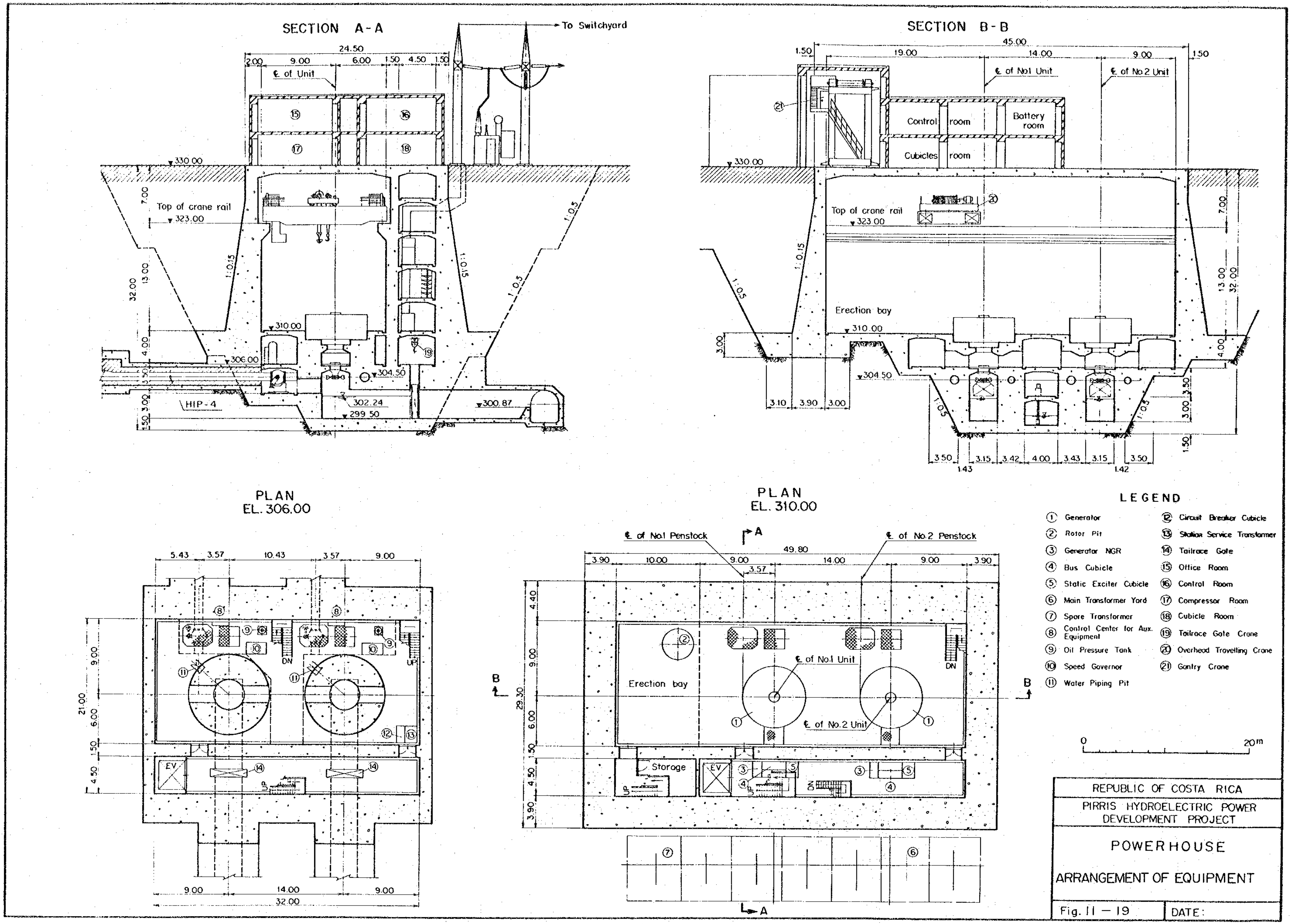
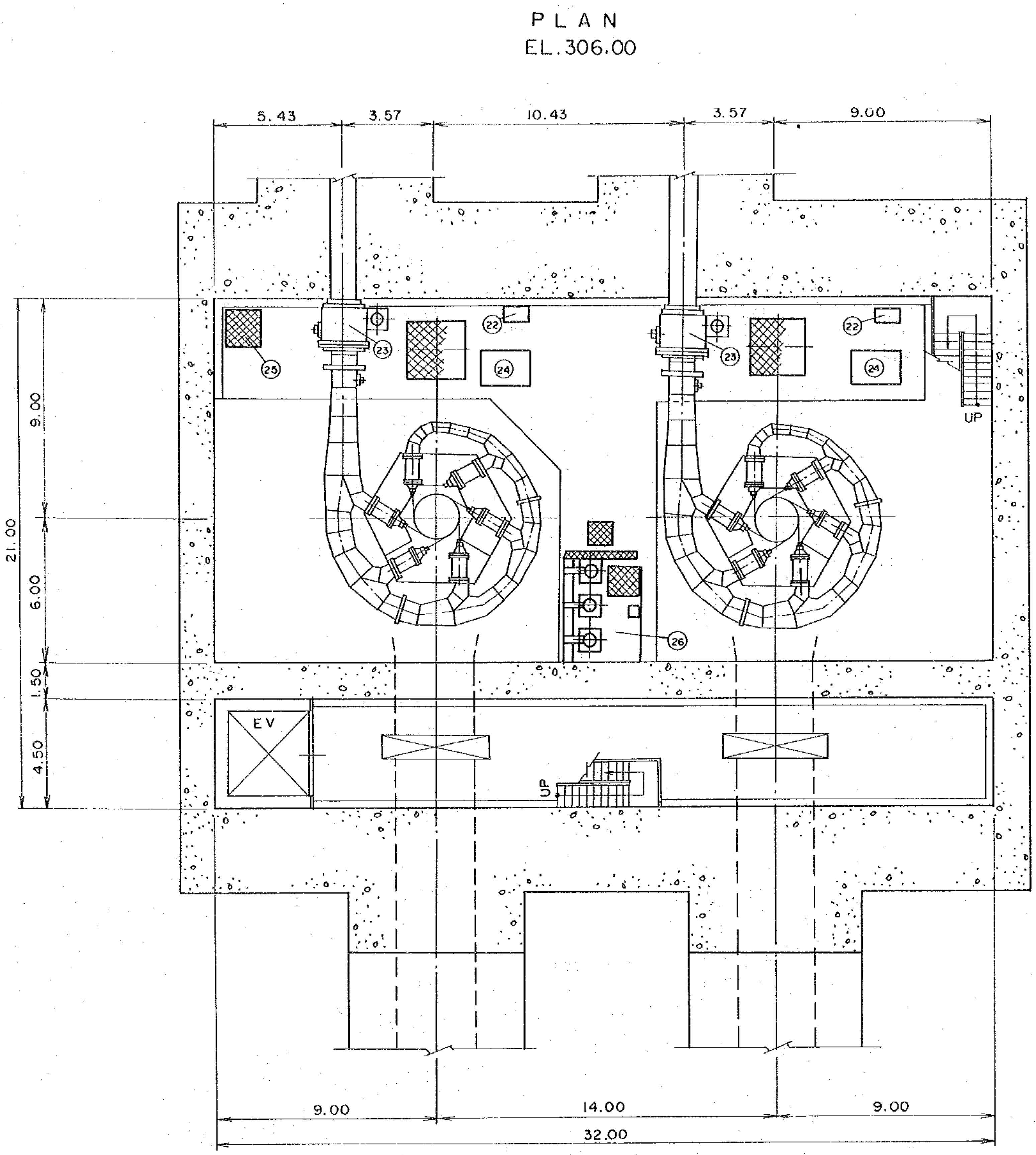
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

Powerhouse

Plan and Section

Fig. 11-18


SECTION A-A
To Switchyard
€ of Unit
Top of crane rail
HIP-4
SECTION B-B
€ of No.1 Unit
€ of No.2 Unit
Control room
Battery room
Cubicles room
Top of crane rail
Erection bay
PLAN
EL. 306.00
PLAN
EL. 310.00
€ of No.1 Penstock
€ of No.2 Penstock
€ of No.1 Unit
€ of No.2 Unit
Erection bay
Storage
LEGEND
① Generator
② Rotor Pit
③ Generator NGR
④ Bus Cubicle
⑤ Static Exciter Cubicle
⑥ Main Transformer Yard
⑦ Spare Transformer
⑧ Control Center for Aux. Equipment
⑨ Oil Pressure Tank
⑩ Speed Governor
⑪ Water Piping Pit
⑫ Circuit Breaker Cubicle
⑬ Station Service Transformer
⑭ Tailrace Gate
⑮ Office Room
⑯ Control Room
⑰ Compressor Room
⑱ Cubicle Room
⑲ Tailrace Gate Crane
⑳ Overhead Travelling Crane
㉑ Gantry Crane
REPUBLIC OF COSTA RICA
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT
POWERHOUSE
ARRANGEMENT OF EQUIPMENT
Fig. II — 19
DATE:



LEGEND

(22) Oil Drainage Tank with Pump

(23) Inlet Valve

(24) Oil Sump Pump with Oilpressure Pump

(25) Drainage Pit

(26) Cooling Water Pump

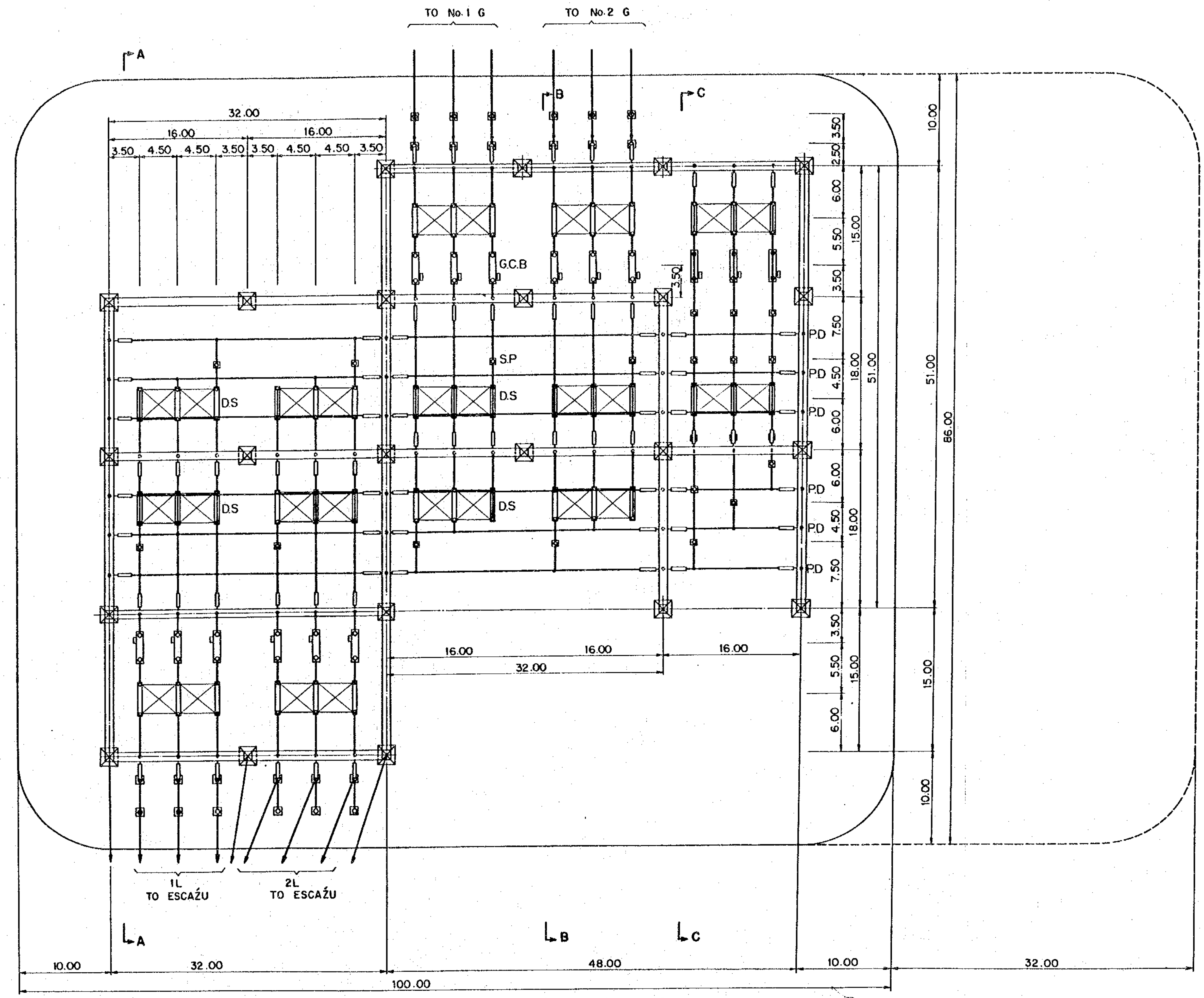
REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

POWERHOUSE

TURBINE FLOOR PLAN

Fig. II - 20 | DATE :



TO No.1 G
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C
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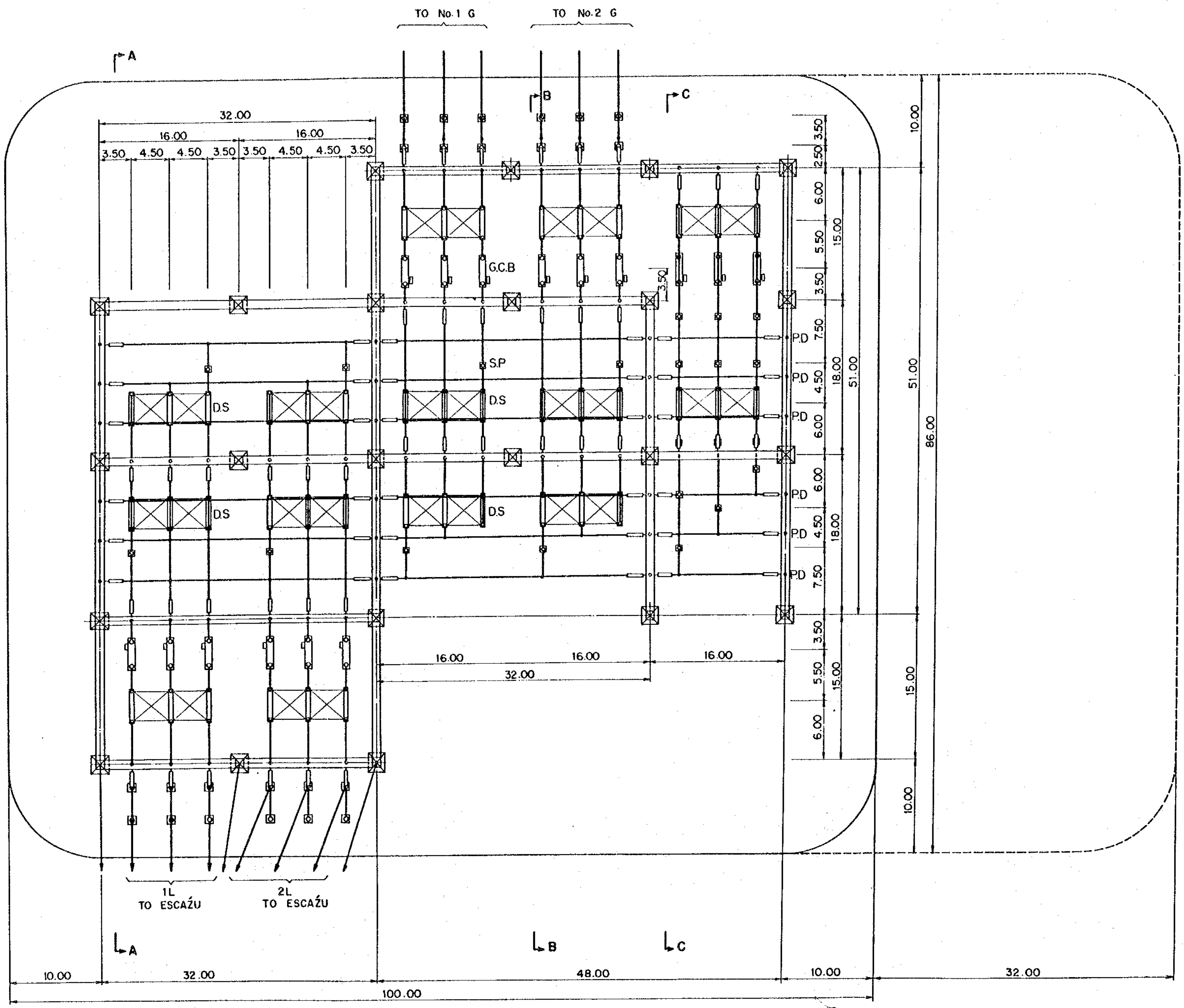
英文(本文)



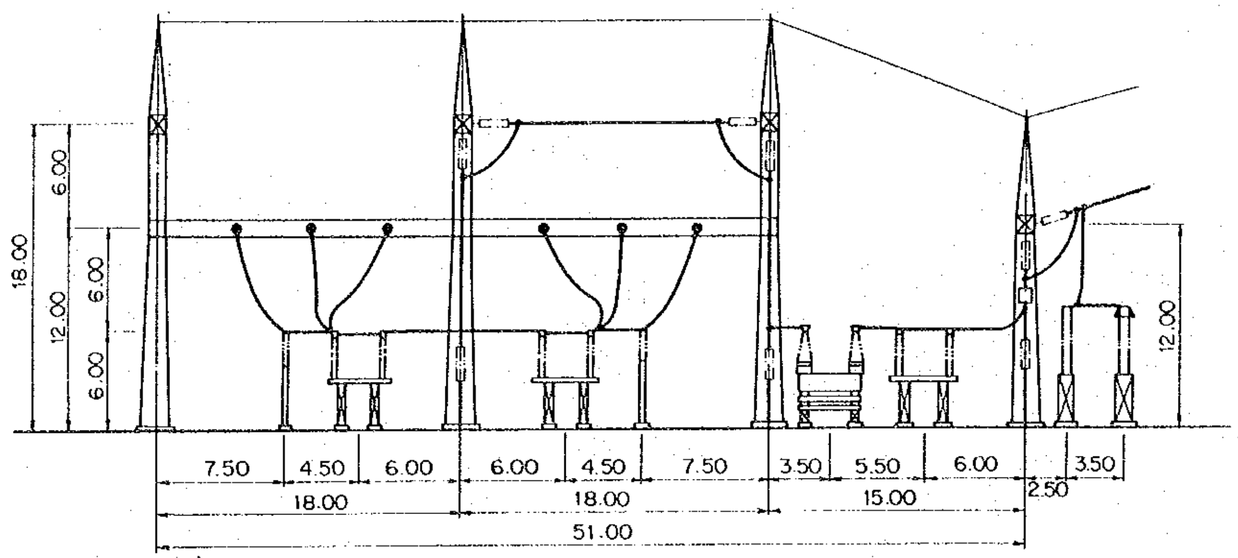
REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

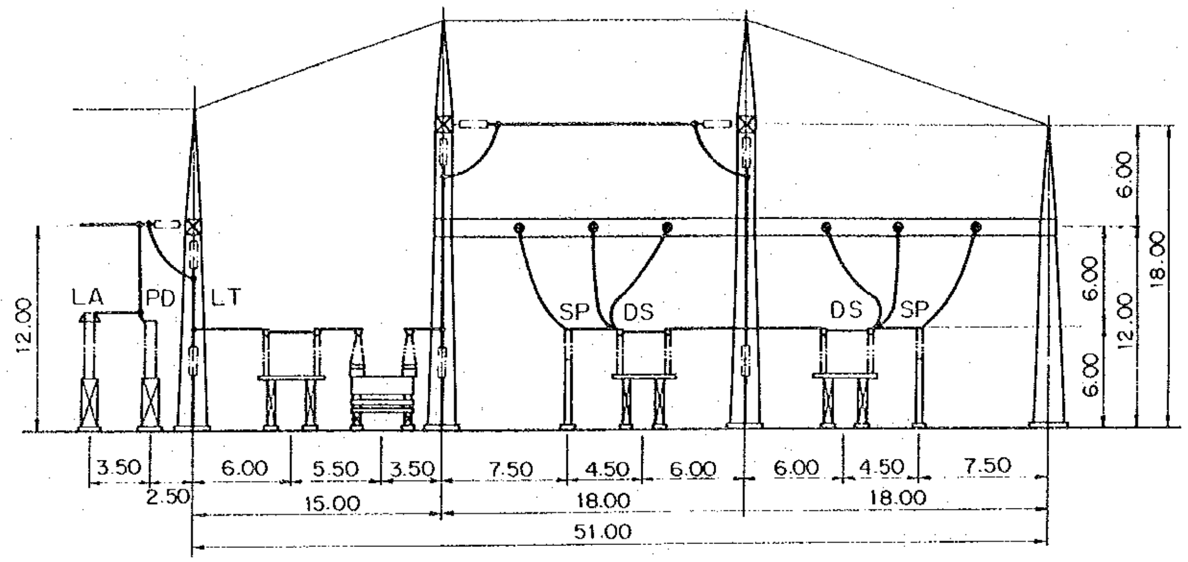
SWITCHYARD PLAN

Fig. 11 – 21 | DATE:

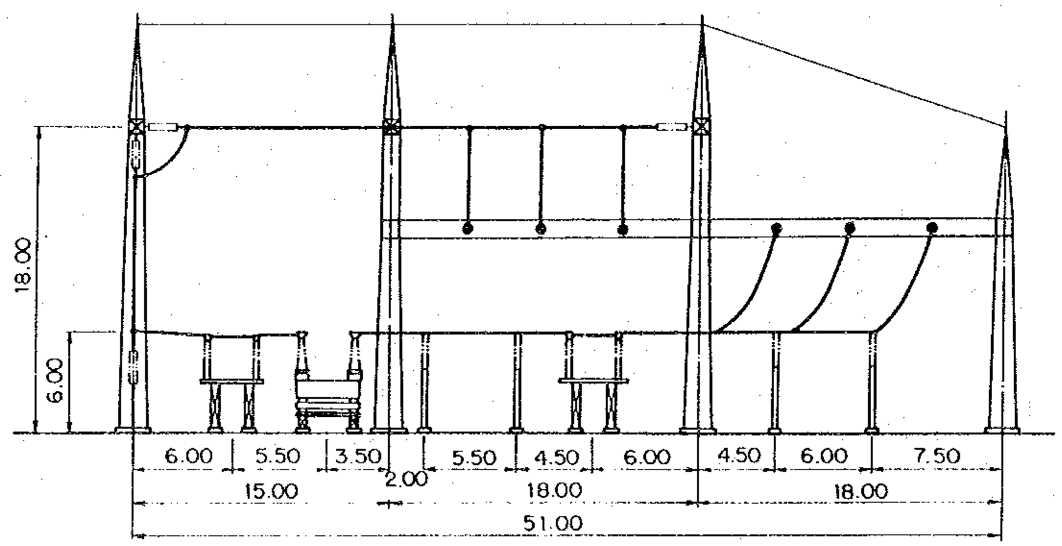
SECTION A - A



SECTION B - B

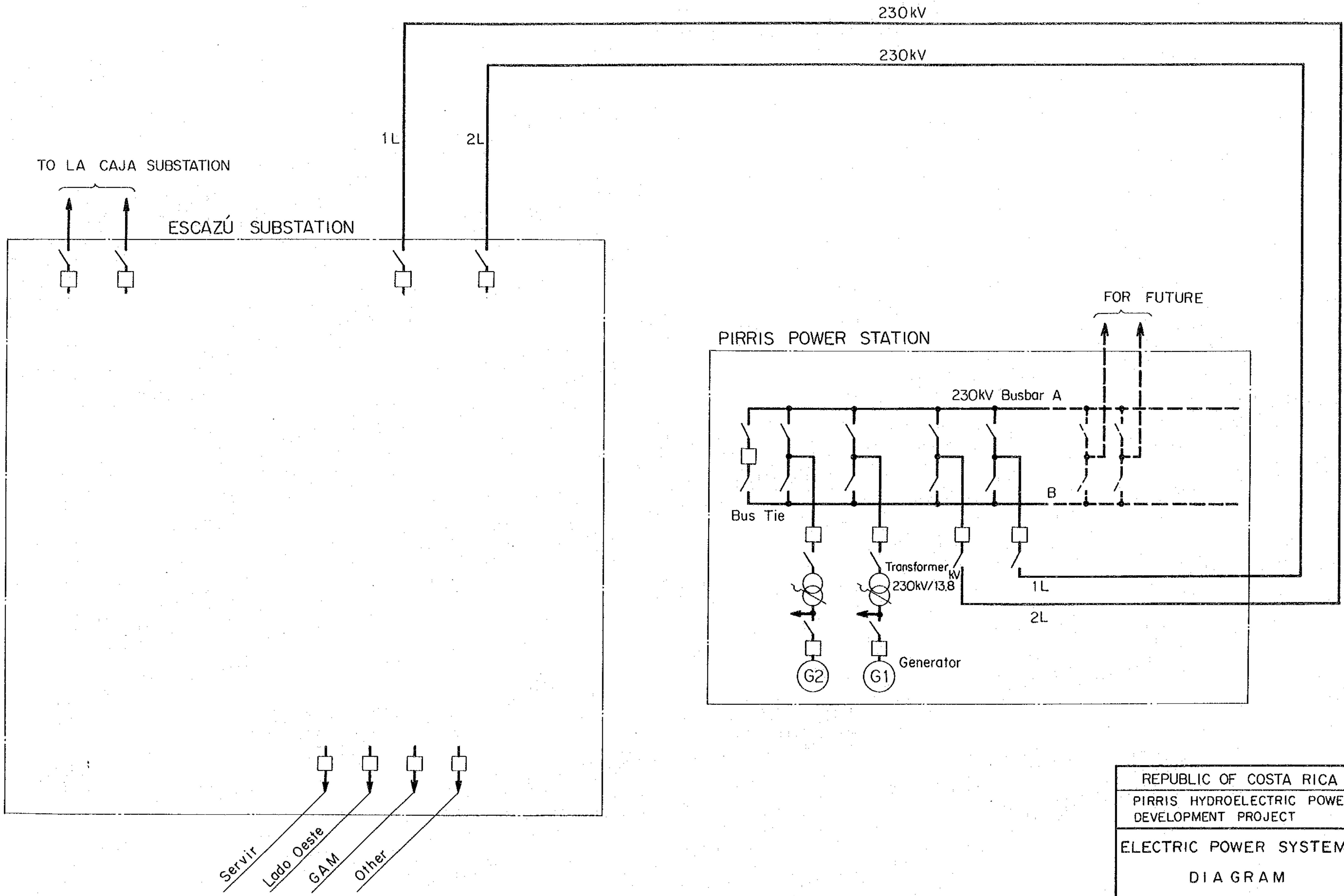


SECTION C - C

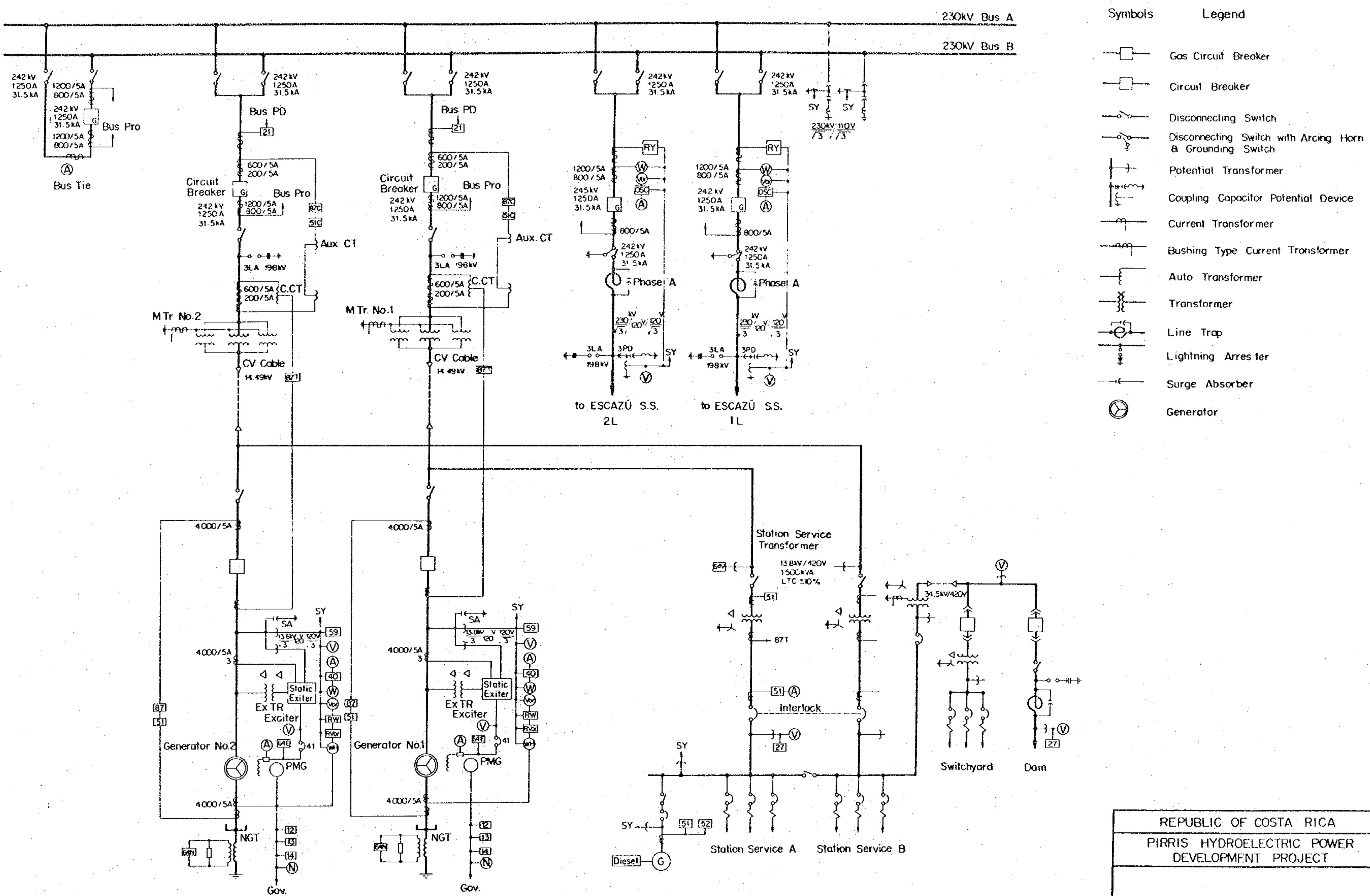


REPUBLIC OF COSTA RICA	
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT	
SWITCHYARD SECTION	
Fig. 11 - 22	DATE:

PIRRIS PROJECT



REPUBLIC OF COSTA RICA
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT
ELECTRIC POWER SYSTEM DIAGRAM
Fig. II – 23 | DATE:



REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

SINGLE LINE DIAGRAM

Fig. 11 – 24 | DATE:

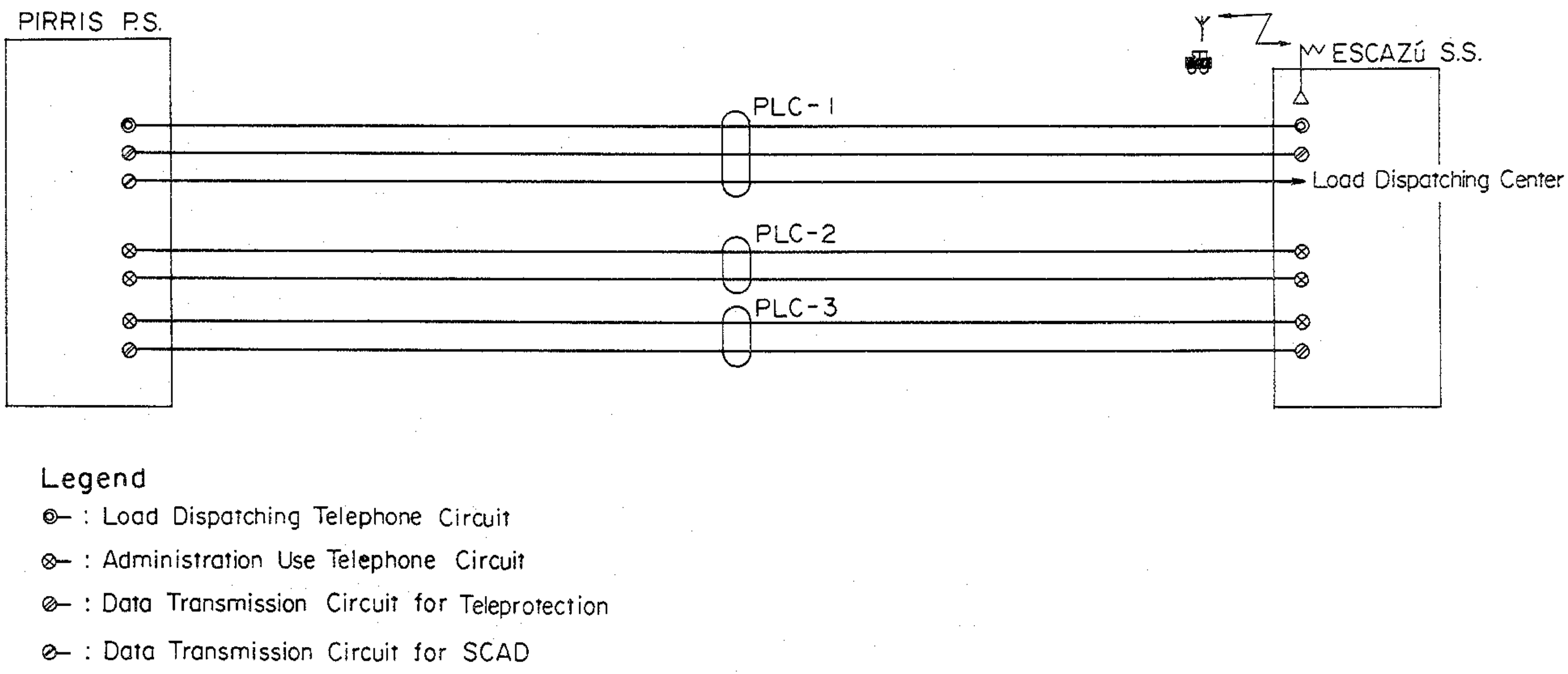


Fig. 11-25 Telecommunication System (1)

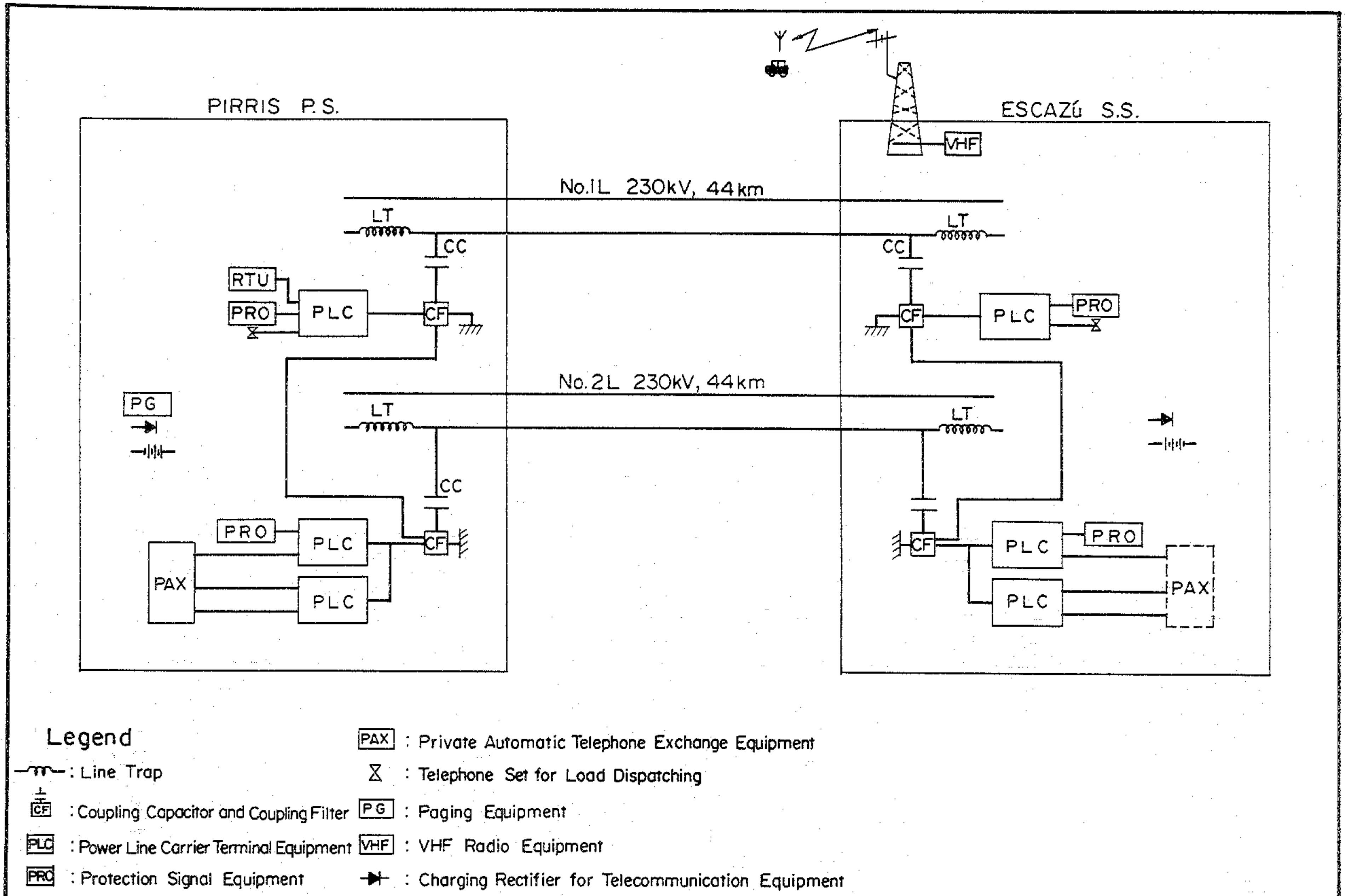


Fig.11-26 Telecommunication System (2)

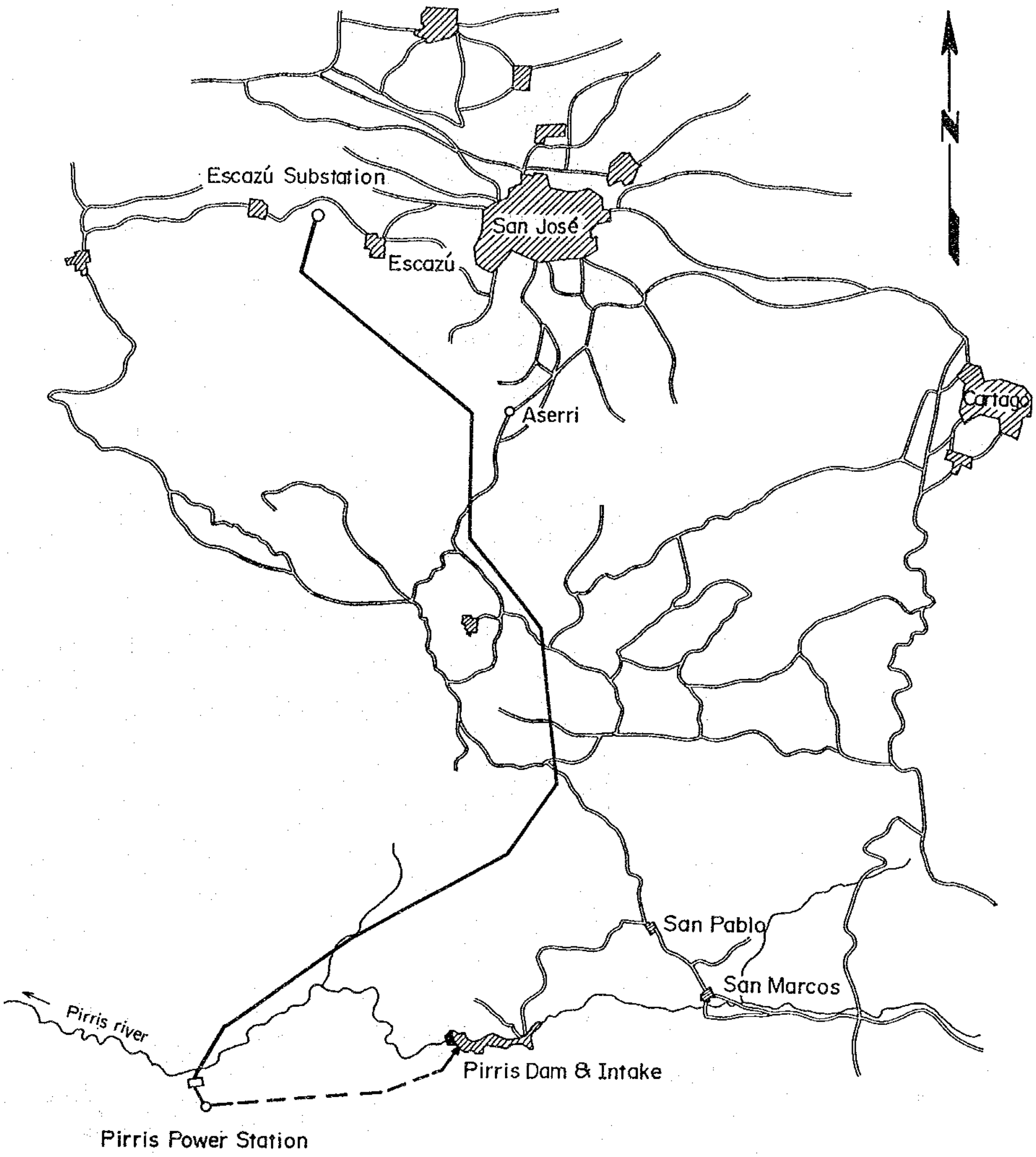
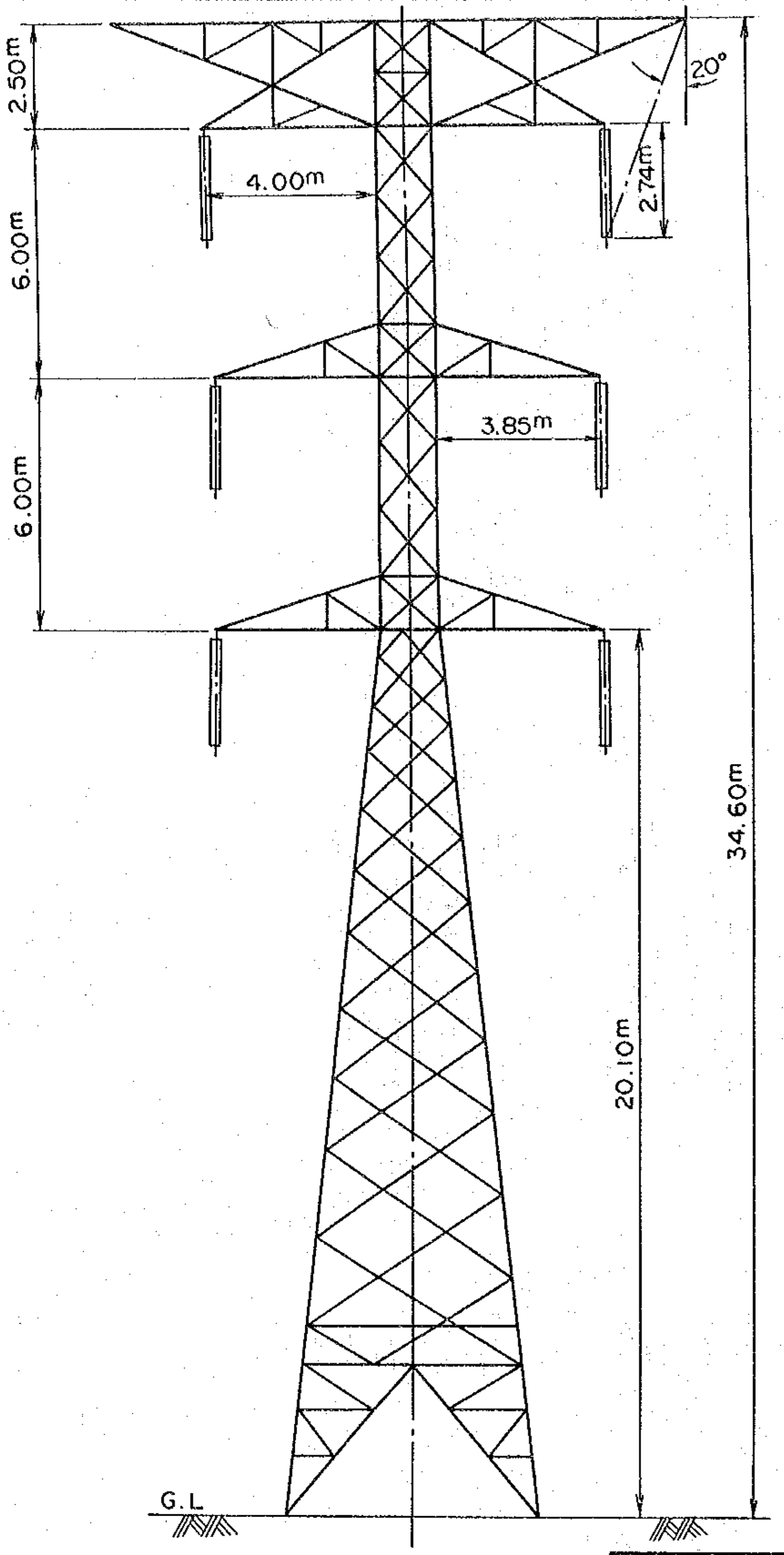


Fig. 11-27 Transmission Line Route



REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

STANDARD SUSPENSION TOWER

Fig. 11 - 28 | DATE :

CHAPTER 12 CONSTRUCTION PLANNING AND COST ESTIMATION

CHAPTER 12 CONSTRUCTION PLANNING AND COST ESTIMATION

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CHAPTER 12 CONSTRUCTION PLANNING AND COST ESTIMATION

12.1 Construction Planning and Construction Schedule

12.1.1 Fundamental Matters

The principal structures scheduled to be constructed in the Project are as follows:

Item	Type	Particulars
Dam	Concrete arch gravity dam	Height 120.00 m Volume 390,000 m^3
Water way		
Intake	Inclined reinforcement concrete structure	Height 55.50 m Width 8.50 m
Headrace	Pressure tunnel Circular cross-section	Inner diameter 2.80 m Length 8,686 m
Surge tank	Restricted orifice	Upper chamber Inner dia. 10.00 m Height 15.00 m Shaft Inner dia. 5.00 m Height 88.50 m
Penstock	Open type and embedded in tunnel partially	Inner diameter 2.80 m ~ 1.00 m Length 2,601 m - 1 line 23 m - 2 lines
Powerhouse	Semi-underground	Width 24.50 m Length 45.00 m Height 32.60 m
Tailrace	Culvert reinforcement concrete structure	Inner diameter 3.30 m, 3.2 m Length 315.00 m

In formulation of the construction schedule of the Project, the fundamental matters such as of meteorology and transportation necessary for the study are as described below.

(1) Meteorology

The meteorological conditions in connection with the Project are as described in Chapter 6.

The construction schedule was set up assuming that the work is possible throughout the year (with 276 days effective for construction).

(2) Transportation of Construction Materials and Equipment

(i) Transportation Route

It is considered economical to adopt separate routes to the dam site and to the powerhouse site for transportation of materials and equipment. The reason is that the actual route from the dam site to the powerhouse site is barely passable by jeep during the dry season. It will require an enormous expense to improve this into a road where transporting of heavy articles is possible.

For delivery of materials and equipment to the dam site, in case the city of San Jose is made the starting point, the two routes of Cartago City-San Marcos-San Pablo and Aserri-San Pablo would be available. Whichever route is taken, the road from San Jose to San Pablo would have nothing to hinder transportation of heavy articles with regard to width, cross-grade, pavement, etc. However, it will be necessary to make a resurvey on bridges.

The section from San Pablo to the dam site is in a mountainous area and has parts of steep grades and sharp curves, so that improvements of the existing road and construction of new roads at parts will be required.

Especially, at the section from the site where the Queb. San Rafael is crossed to the dam site, the existing road would be utilized at parts by making improvements such as widening, but mostly, a new road would be constructed along the Pirris River.

Regarding access to the powerhouse site, the existing road from the dam site is bad as mentioned previously. Therefore, it is necessary to make an access over local road No. 143 on the Pacific Ocean side, going in via Parrita. The sections from San Jose or Caldera Port to Parrita pose no problems in transportation of materials and equipment. However, since it is estimated that the allowable load on the N-type truss bridge crossing the Pirris River at Parrita is about 25 tons, it is thought necessary to reinforce the bridge or to construct a new bridge.

The section from Parrita to the powerhouse site is narrow as a whole, while the subgrade is soft. Particularly, in the mountainous area, there are many parts forming steep grades. Because of this situation, it will be necessary to make improvements on the existing road, such as widening and subgrade reinforcement. Also it will be necessary to construct a new road at parts of steep grades, in order to secure cross-grades.

The transportation routes are shown in Fig. 12-1.

(ii) Port and Harbor Facilities

The main ports for landing materials and equipment from foreign countries are Caldera Port (Pacific Ocean side) and Limon Port (Caribbean Sea side). In the case of the Project, it is thought Caldera Port would be the main landing port in view of location.

Caldera Port is located approximately 123 km northwest from the Pirris Power Station site and 92 km to the west of San Jose.

The port of Caldera was completed in the 1980s, and it is possible for freighters of 20,000-ton, 10,000-ton, and 5,000-ton class to berth simultaneously at the pier of total length approximately 400 m. As to cargo unloading facilities, the port has a 120-ton mobile crane and 5-ton floating cranes. It has a lot of 9,600 m^2 as a freight yard, as well as 12,600 m^2 of warehouse space. These facilities have adequate functions for a port for importation of the materials and equipment required for the Project.

The materials and equipment landed would be hauled by trailer, those for the dam via San Jose, and those for the powerhouse south down the local road No. 143 along the Pacific Ocean coast and via Parrita, for delivery to the respective project sites.

Meanwhile, there is Moin Port, located at a place approximately 162 km east from San Jose. This is being used mainly as a port for export of bananas. As for the loading facilities, it has a 45 ton crane, 59,800 m^2 of stockyard and 5,280 m^2 of warehouse at Aleman pier.

(3) Construction Materials and Equipment

The principal materials required for construction work are as described below.

(i) Cement

Cement is being produced in Costa Rica. There are two main cement plants in Costa Rica, located at Cartago and at Guanacaste. Ordinary portland cement is being manufactured here. The manufacturing capacities are 50,000 t/mo and 35,000 t/mo, respectively. The amount of cement required for the Project can be supplied. Fly ash has never been used, and if necessary, it will have to be imported.

(ii) Concrete Aggregates

Natural materials suitable for concrete aggregates are not available in the Pirris River Basin, and they will need to be manufactured at each job site. For the dam, intake, and headrace upstream side work, material would be collected from a quarry located at the right bank of the Pirris River immediately upstream of the dam, and coarse and fine aggregates manufactured at an aggregate plant.

Concrete aggregates used for care-of-river work would be manufactured with a portable aggregate plant using excavation muck from the diversion tunnel. Concrete aggregates for headrace downstream side work, surge tank, and powerhouse are planned to be manufactured from excavation muck from the powerhouse site since it is located on a river terrace. In the event that the deposits at this terrace are composed of large boulders, much expense would be required for crushing. Therefore it would be necessary to consider manufacture using material from a separate quarry and tunnel excavation muck.

(iii) Steel

Costa Rica does not have any steel works, but only steel fabrication plants. Accordingly, most steel materials would be imported.

(4) Electric Power Supply for Construction

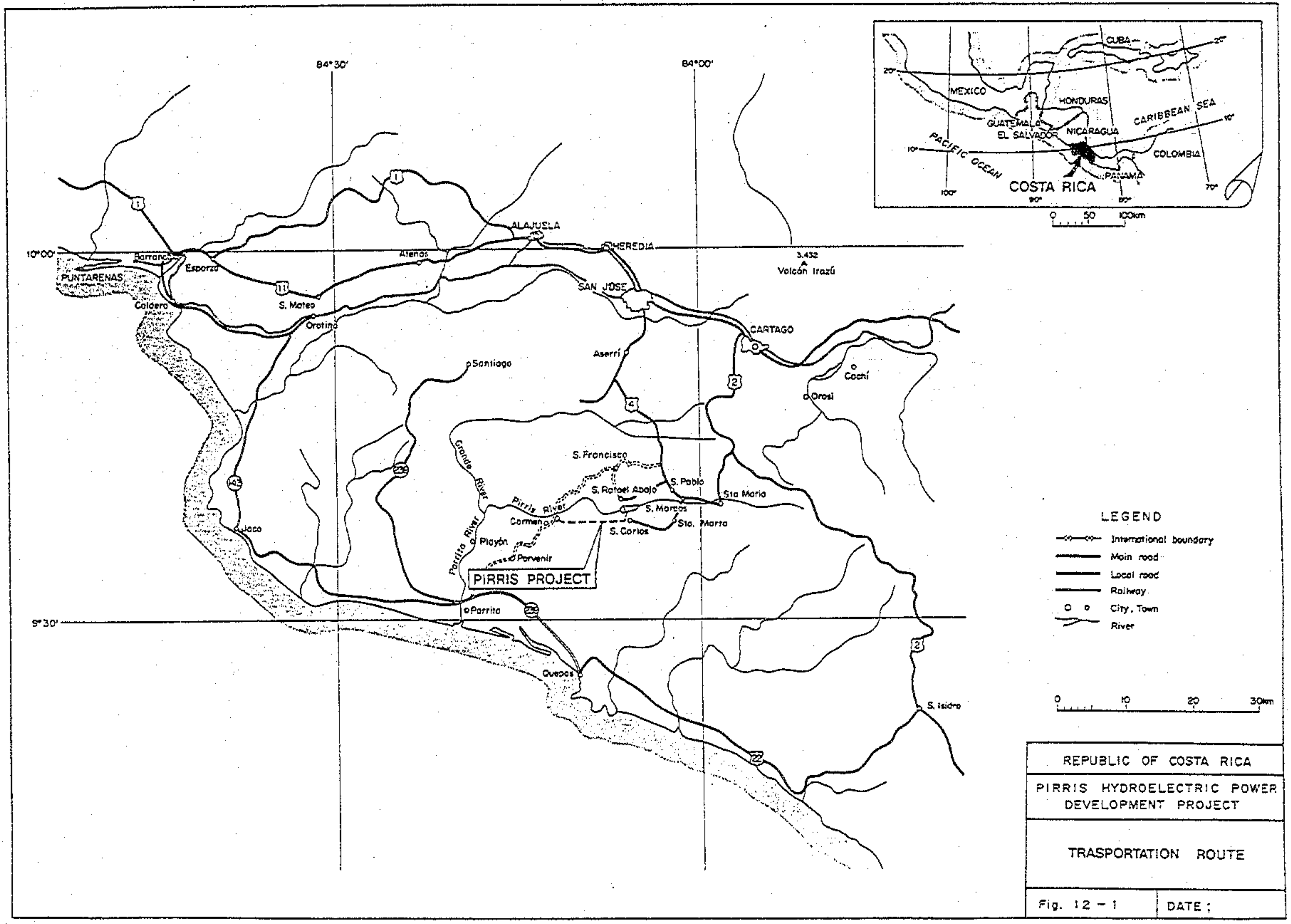
As a result of investigations, points for supplying electric power required for the Pirris power station and dam construction works are as described below. Distribution lines of ICE or ICE-related power distribution companies closest to the powerhouse site were investigated, but there were no suitable sites within ranges possible for supply. Particularly, there is a 34.5 kV distribution line extending a great distance along the coast on the Pacific Ocean side from Barranca Substation at Puntarenas. There are no substations in any of the towns, and supply to customers is made using only pole transformers. Accordingly, it is not technically possible to lead a distribution line to the Pirris powerhouse site branching from the Parrita site.

An investigation of electric power supply from the side of the dam site revealed the existence of La Lucha Substation owned by Coopesantos Electric Power Distribution Company located near San Pablo, as shown in Fig. 12-2. The power source of this substation is a single-circuit 34.5 kV wood pole facility stepped down from 138 kV from Concavas Substation of ICE. The receiving capacity of the substation is for motive power required for harvesting and processing coffee berries, and there is no allowance for supplying the approximately 6,000 kVA required for construction.

Therefore, as shown in Fig. 12-2, another circuit is to be added parallel to the existing distribution line between Concavas Substation and La Lucha Substation for construction of the Project. The distance of this line would be roughly 20 km. Supply of electric power for construction from La Lucha Substation to the Pirris project area would be achieved by construction of a new 3-phase, 1-cct distribution line of 34.5 kV.

The length of the newly constructed power distribution line for construction is 20 km between La Lucha Substation and the dam site, and approximately 20 km between the dam site and the powerhouse site, a total of 40 km. Further, supply of electric power to the individual job sites in the dam area would be by distribution with newly installed transformers and distribution lines from the dam site to the camp site, dam, intake, and upstream-side headrace tunnel work adit. From the powerhouse site, transformers and distribution lines would be provided to the downstream-side headrace tunnel work adit, surge tank, and powerhouse job sites similarly to the case of the dam site.

After construction has been completed, these distribution line facilities are to be diverted to use for distribution of power for management of the sector between the powerhouse and the dam.



REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

TRASPORTATION ROUTE

Fig. 12 - 1 | DATE ;

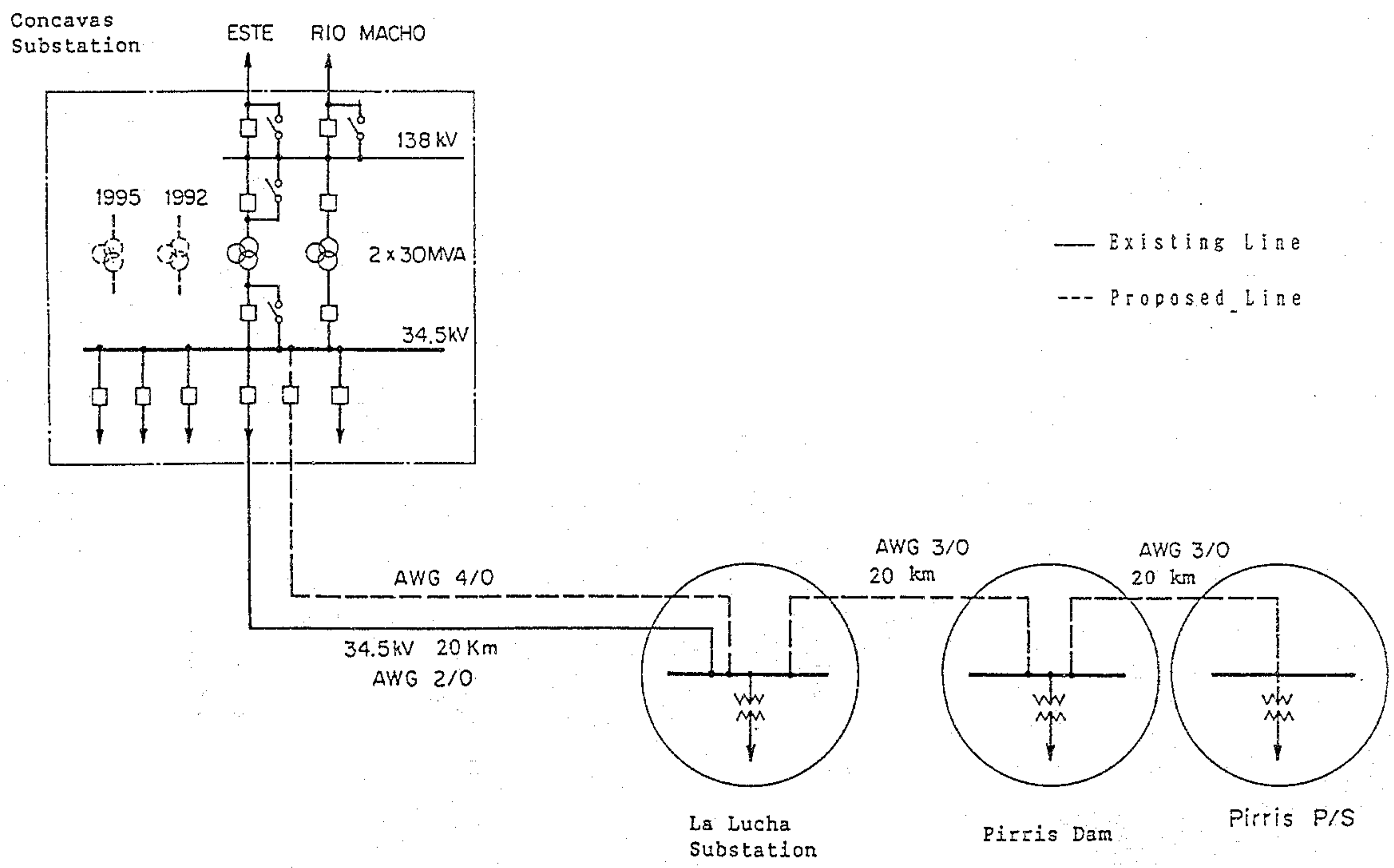


Fig. 12-2 Distribution Line for Construction

12.1.2 Construction Planning and Construction Schedule

Assuming that the year of commissioning of the Project is to be 2001, it will be necessary to carry out the various preparatory works such as further geological investigations and detailed design which are necessary for award of contract and construction works in accordance with the schedule given below.

Item	Period
1. Feasibility Study	Dec. 1989 - Sep. 1992
2. Further Investigation Works	Oct. 1991 - Apr. 1993
3. Final Design	Oct. 1992 - Sep. 1994
4. Request ICE to MIDEPLAN	Jun. 1992 - Dec. 1992
5. Finance Formalities	Oct. 1993 - Sep. 1994
6. Approval Congress	Sep. 1994 - Sep. 1995
7. Bidding and Award of Contract for Construction	Oct. 1994 - Apr. 1996
8. Construction	May 1996 - Apr. 2001

The quantities of the principal civil works of the Project are given in Table 12-1. The construction machines which will be used at the peak of dam and headrace tunnel works are listed in Table 12-2.

The construction period of the Project was examined, considering the scale of work and layout of structures. It was estimated to be 5 years under the condition that access road work and construction power transmission line work would be done separately prior to commencement of the main works.

The locations of temporary facilities for construction are shown in Fig. 12-3, and the construction schedule in Fig. 12-4.

The outlines of the construction planning and the construction schedule are as described below.

It should be noted that this construction planning was set up assuming that temporary facilities such as quarters, offices, and power supply for construction, and access roads (permanent roads) to the dam and powerhouse will have been completed at the time of starting on the main works.

Table 12-1 Principal Civil Works

Item	Description	Civil Works		
Care of River				
Diversion Tunnel	D = 6.5 m, L = 330 m	Tunnel Ex.	15,900	m^3
		Lining Con.	3,300	m^3
Coffer Dam	Upstream H = 20 m	Concrete	3,300	m^3
	Downstream H = 5 m	Concrete	600	m^3
Dam	Arch gravity dam	Excavation	350,000	m^3
	H = 120 m	Concrete	390,000	m^3
Power Intake	Inclined type	Ex.	63,000	m^3
	Qmax. 18 m^3/sec	Con.	5,100	m^3
Headrace Tunnel	Pressure tunnel Qmax. 18 m^3/sec	Tunnel ex.	84,000	m^3
	D = 2.8 m, L = 8,690 m	Lining con.	30,300	m^3
Surge Tank	Orifice type Upper chamber D = 10 m	Shaft ex.	4,800	m^3
	Shaft D = 5 m	Lining con.	1,700	m^3
Penstock	Exposure and embedded in the tunnel partially			
	D = 2.8 m ~ 2.1 m 2,600 m x 1 line	Ex. in open Ex. in tunnel	131,500 10,400	m^3 m^3
	D = 1.0 m 23 m x 2 lines	Con.	11,000	m^3
Powerhouse	Semiunderground type	Ex.	232,000	m^3
	W = 24.5 m x L = 45.0 m	Con.	24,000	m^3
	H = 32.6 m			
Tailrace	Culvert D = 3.3 m, 3.2 m	Ex.	164,000	m^3
	L = 320 m	Con.	2,400	m^3
Switchyard	Outdoor type	Ex.	31,100	m^3
	100 m x 86 m	Con.	500	m^3

Table 12-2 Principal Machinery

1. Equipment for Dam Construction

Name	Specification	Power (ps)	Weight (ton)	Number
Excavation Works				
Bulldozer	26 ~ 36 ton class	230 ~ 290	30 ~ 40	4
Wheel loader	Bucket 2 m^3	155	12.4	4
Dump truck	20 ~ 30 ton class	290 ~ 470	20 ~ 30	25
Crawler drill	Drifter 180 kg Air consump. 17 m^3/min		5.1	4
Leg drill	Jack 40 kg class Air consump. 3 m^3/min		0.04	8
Compressor	Discharge 9 m^3/min	75 kW	2.6	8
Water pump	Discharge 0.5 m^3/m	3.7 kW	0.2	2
Concrete Works				
(1) Quarry				
Bulldozer	26 ~ 36 ton class	230 ~ 290	30 ~ 40	4
Wheel loader	Bucket 2 m^3	155	12.4	4
Dump truck	30 ton class	470	27	11
Crawler drill	Drifter 180 kg Air consump. 17 m^3/min		5.1	2
Compressor	Discharge 9 m^3/min	75 kW	2.6	4
Water pump	Discharge 0.5 m^3/m	3.7 kW	0.2	1
(2) Crushing Plant (160 ~ 190 ton/hr)				
Joe crusher	Entrance 100 x 120 cm	130 kW	90	1
Corn crusher	Mantle 130 cm	95 kW	29	2
Rod mill	Drum 240 x 360 cm	260	71	1
Vib. feeder	220 ton/hr	5	3	2
Apron feeder	150 x 400 cm	8	21	1
Belt-conveyer, others	(L.S.)			1
Water pump	q = 4 m^3/min h = 30 m	37	0.75	3

Name	Specification	Power (ps)	Weight (ton)	Number
(3) Batching Plant (120 ~ 150 m^3/hr)				
Mixer	Automation, Forced mixing type 1.5 m^3, 75 m^3/hr	72 kW	44	2
Cement silo	1,000 ton, 60 t/hr	1.5 kW	69	2
Water pump	q = 4 m^3/min h = 30 m	37 kW	0.75	2
(4) Transportation (120 m^3/hr)				
Truck mixer	4.5 m^3	290	9.2	8
(5) Placing (120 m^3/hr)				
Diesel car	6 ton class	78	6	2
Dolly	Capa. 6 m^3	-	6.7	2
Cable crane	One tower swing Capa. 20 ton	890 kW	440	1
	Fixed type Capa. 9 ton	175 kW	77	1
Bucket	Capa. 6 m^3	-	4.2	2
	Capa. 3 m^3	-		2
Vibrator	(L.S)			
Water pump	Capa. 2 m^3/min	110 kW	1	2
Cooling Works				
Cooling plant	Refrigerating pla Capa. 200 JRT	180 kW	5.4	1
Grouting Works				
Boring machine	KT-1 (KOUKEN) Capa. 27 m/min	5 kW	0.3	2
Grout pump	Capa. 30-70 1/min	3.7 kW	0.2	2
Grout mixer	Mixer 200 liter	2	0.2	2

2. Equipment for Headrace Tunnel (For half section of the tunnel between Adit-B and Adit-C)

Name	Specification	Power (ps)	Weight (ton)	Number
Tunnel Excavation Works				
(1) Drilling Works				
Drill jumbo, 2 booms, Rail type Air driving	Drifter 90 kg class	49.30	7.00	1.00
Compressor	Stationary type 22 m^3/hr	125 kW	-	1.00
(2) Mucking Works				
Tractor loader, Rail type Air driving	Bucket .35 m^3	18.00	8.50	1.00
Shuttle car	Capa. 20 m^3 Gauge 762 or	18 pc/or 22 kW	23.00	1.00
Cherry picker				1.00
(3) Transportation Works (Inside the tunnel)				
Battery car	6 ton car	24.00 kW	7.10	2.00
Trolley	Capa. 4.5 m^3	-	3.00	5.00
Chiplar				1.00
(4) Supporting Works				
Shotcrete and Rockbolt method will be applied.				
Shotcrete	Capa. 4 m^3/hr	30.00	0.60	1.00
Concrete pump (NATM)	Portable type kW Capa. 10 m^3/hr	20.4 kW	7.50	1.00
(5) Transportation Works (Outside the tunnel)				
Dump truck	Capa. 11 ton	240.00	11.00	2.00
(6) Disposal area				
Bull dozer	Capa. 20 ton	160.00	16.20	1.00
Lining Concrete Works				
Concrete plant	Capa. 10 m^3/hr Tilting mixer	7.5 kW	1.40	1.00
Cement silo	Capa. 50 ton	.75 kW	6.20	1.00
Concrete pump	Capa. 10 m^3/h	22 kW	1.40	1.00

Name	Specification	Power (ps)	Weight (ton)	Number
Agitator car	Capa. 3 m^3	11 kW	4.00	2.00
Crushing plant	Capa. 120 m^3/hr Common use			1.00
Consolidation Grouting Works (Around Tunnel)				
Drilling	Boring machine	10.00	0.44	1.00
Grout pump				1.00
Grout mixer				1.00
Mortar Injection Works (Gap between lining conc. and rock)				
Grout pump	0.8-1.2 m^3/hr	25.00	3.10	1.00
Grout mixer				1.00

First Year

(i) Temporary Facilities

Before starting on the various works, quarters and offices for the contractor himself and various facilities necessary for construction - access roads to the various work areas, for example, roads from the existing road to the individual work adits for the headrace tunnel, concrete plant, aggregate plant, and distribution facilities for power supply for construction - are to be constructed.

(ii) Care of River

River diversion work would be done for construction of the dam. Diversion is to be done with a diversion tunnel (inside diameter 6.5 m, length 330 m, 1 line). Excavation of the diversion tunnel would be started immediately after completion of the access road to the tunnel portal and the Pirris River crossing facilities (temporary bridge) have been completed. Muck from excavation of this tunnel is to be hauled to the designated place and stored in order that it can be used as aggregate for concrete. Excavation of this tunnel would be done for completion within the first year. During this time, work on an aggregate plant and a concrete plant for tunnel lining concrete work in the following year is to be carried out.

(iii) Headrace Tunnel

What will govern the construction period of the Project is the headrace tunnel work. Consequently, it is desirable for this work to be started as early as possible. For this purpose, work adits at three places would be started at the time access becomes possible to the portal locations. The cross sections of work adit tunnels are to be of 3.5 m inside diameters for convenience of mucking from the upstream and downstream tunnel sections and to provide space for facilities for ventilation (ventilation ducts) inside the tunnel. The length would be 470 m for the longest work adit. Excavation of these work adits is to be completed within 3 to 4 months.

Excavation of the headrace tunnel would be done in succession to completion of work adit excavation.

Part of the excavation muck from the tunnel would be utilized as concrete aggregate.

(iv) Surge Tank

Since an access road (permanent road) would have been completed beforehand, work can be commenced immediately. Open excavation of the upper part of the vertical shaft would be done in the first year.

(v) Penstock

The penstock may be divided into tunnel and surface portions. The work will be started from the upper penstock tunnel excavation (D = 3.1 m, L = 330 m) upon completion of surface facilities such as compressors and water supply facilities necessary for tunnel excavation. The reason for this early start is that this tunnel would have high value as a route for hauling out excavation muck from the vertical shaft of the surge tank.

On the other hand, open work would be started after the various facilities (repair shop, warehouse, disposal area, etc.) necessary for the access road and the tunnel work have been completed.

(vi) Powerhouse and Tailrace

Since there is an existing road, the main work can be started immediately.

During this year, excavation (open) and work on the aggregate and concrete plants would be performed.

Excavation muck, after placing of concrete (powerhouse side walls, trailrace culvert), would be used as backfill material.

Second Year

(i) Care of River

Concrete lining work is to be done on the diversion tunnel.

As soon as the tunnel concrete lining has been completed, primary coffer dam is to be done and the river flow diverted. The primary cofferdam is to be made using natural soil and rock. After diversion, construction of the upstream and downstream cofferdams is to be started immediately. The cofferdams are both to be of concrete gravity type.

(ii) Dam

Excavation for the dam is to be started immediately after diversion of the river flow.

Excavation muck is to be hauled to a disposal area downstream of the dam and discarded.

(iii) Intake

Open excavation is to be done for the intake after completion of the upstream cofferdam.

(iv) Headrace Tunnel

Tunnel excavation would be continued.

(v) Surge Tank

Excavation of the vertical shaft would be done. In excavation of the vertical shaft, a vertical shaft for mucking (1.5 m x 1.5 m) is to be excavated down to the top of the headrace tunnel, and after this mucking shaft has been completed the main surge tank vertical shaft is to be excavated by widening, with digging performed downward in succession.

(vi) Penstock

Open excavation would continue to be done, along with which concrete work for anchor blocks and saddles would be started.

(vii) Powerhouse and Tailrace

Open excavation would continue to be done.

Third Year

(i) Dam

Excavation for the dam would continue to be carried out. After excavation of the river bed in the area of the dam has been completed, treatment of foundation (consolidation grouting or fault replacement concrete) would be done and placement of concrete of the dam proper started. Pipe cooling would be carried out on the dam concrete to hold down temperature rise after placement and to perform joint grouting.

(ii) Intake

Open excavation would be carried out. After completion of this open excavation, driving of the intake tunnel (D = 2.8 m, L = 30 m) would be started. The inclined potion (approximately 30 m) continuing from this tunnel would be dug upward from the downstream side.

When all of the excavation has been completed, concrete placement of the intake proper and surrounding retaining walls would be started.

(iii) Headrace Tunnel

Excavation of the tunnel would be continued. After completion of tunnel excavation, concrete lining of the tunnel would be commenced. The forms used are to be traveling steel forms.

Concrete is to be manufactured providing small portable batching plants at the individual portals.

(iv) Surge Tank

Excavation of the vertical shaft would continue. The excavation muck would be passed down the mucking shaft and be hauled outside through the upper penstock tunnel.

(v) Penstock

Placing of concrete for saddles and anchor blocks for steel pipes is to be continued.

(vi) Powerhouse and Tailrace

Placing of concrete would be started after waiting for excavation to be completed.

At the powerhouse, concrete for equipment bases and surrounding walls would be placed.

At the tailrace, placement of concrete for the culvert (inside diameter 3.3 m, length 270 m) would be done. Placement of culvert concrete of the tailrace has been completed and backfilling is to be started.

(vi) Transmission Line

Construction of the transmission line would be begun.

Fourth Year

(i) Dam

Foundation treatment and placement of dam concrete would be continued.

When the dam block at which outlet facilities are to be provided has reached the prescribed height, an outlet conduit (width 1.70 m, height 1.85 m for typical section) would be embedded and work on a gate chamber and radial gate installation would be started.

(ii) Intake

Placing of concrete would continue to be done. After completion of the concrete work, installation of the slot metals of the intake gate and screen would be done.

(iii) Headrace Tunnel

Placement of lining concrete for the headrace tunnel would be continued.

(iv) Surge Tank

Lining of the vertical shaft with concrete would continue to be done.

(v) Penstock

Installation of penstock steel pipe is to be commenced.

Installation of the pipe is to be divided into 5 or 6 blocks in consideration of the center line configuration of the penstock and of topography, and these blocks are to be worked on separately. The steel pipe fabricating plant would be provided at the location indicated in Fig. 12-4. The steel pipes are to be hauled by trailer from the penstock yard to the individual work blocks, from where they are to be transported to the specified locations by incline facilities and fixed in place.

(vi) Powerhouse and Tailrace

Placement of the side walls of the powerhouse would be continued. After completing this wall concrete placement work, backfilling at the exteriors of the powerhouse walls would be started. The interior finish work of the powerhouse would begin.

Upon completing the above work, installation of a gantry crane (EL. 330 m) for hoisting of turbines, generators, etc. to the powerhouse assembly hall, and an overhead traveling crane (EL. 323 m) for assembly and installation of electrical equipment would be started,

After these crane facilities have been completed, delivery, assembly, and installation of the No. 1 turbine and generator units are to be commenced.

Foundation concrete work and electrical equipment installation at the outdoor switchyard would be started.

(vii) Transmission Line

Construction of the transmission line would be continued.

Fifth Year

(i) Care of River

Plugging of the diversion tunnel would be done. The timing of plugging is to be decided giving consideration to the timing of test operation of the electrical equipment and the flow condition of the Pirris River.

(ii) Dam

Placing of dam concrete and grouting would continue to be done.

In preparation for start of reservoir water impoundment, installation of a outlet conduit, gate (width 1.70 m, height 2.5 m) and spillway gates (width 10 m, height 11.3 m, 2 units) would be done.

Impoundment of water in the reservoir is to begin.

(iii) Headrace Tunnel

Placing of tunnel lining concrete is to be continued.

After completion of the lining concrete, grouting would be done to consolidate the rock around the tunnel.

After completion of grouting, the various work adits are to be plugged.

(iv) Penstock

Installation of the penstock steel pipe would be continued. After completing installation, gaps between steel pipe and surrounding rock at the upper tunnel portion are to be filled with concrete. Further, at the starting point of the penstock, curtain grouting is to be done on the surrounding rock of the penstock tunnel to prevent water leaked from along the headrace tunnel from flowing out to the penstock side.

(v) Powerhouse and Switchyard

Interior finish work in the powerhouse would be continued.

Various tests of power generating equipment would be conducted.

(vi) Transmission Line

Transmission line construction would continue to be done. Inspections would also be made, and upon completion, line charging and other tests would be conducted.

12.2 Cost Estimation

The construction cost of the Project is to be estimated based on the designs, construction methods, and materials according to technological levels at the present time, and further, considering the geographical conditions of the Project and geological conditions of the sites. Construction cost was estimated based on the following conditions:

- A part of civil works (access road and camping facilities) will be carried out by ICE.

- Other civil works, hydraulic equipment and electromechanical works (including transmission line), etc. will be carried out by contractor.

The time of estimation is to be as of January 1991, with the exchange rate between local and foreign currency being US$1 = 105 Colones. The construction cost shows in US dollars.

12.2.1 Fundamental Matters

(1) Cost Estimation Items

(a) Civil Works

Care of river	:	Diversion tunnel, upstream and downstream cofferdams
Dam	:	Dam proper and foundation treatment (including spillway and outlet works)
Waterway	:	Intake, headrace tunnel, surge tank, penstock, tailrace
Powerhouse and switchyard	:	Civil and architectural works

	Access road (permanent road)	: Access roads to dam site, powerhouse and surge tank site
	Camp facilities	: Offices and lodging facilities
	Electric power for construction	: Transmission line for construction
(b)	Hydraulic Equipment	: Gates, penstock steel pipe, outlet facilities, etc.
(c)	Electrical equipment	: Turbine-generator, appurtenant equipment, switchyard equipment, etc.
(d)	Transmission line	: All costs related to transmission line construction
(e)	Engineering and administration cost	: Project management cost, engineering fee, others
(f)	Compensation cost	: Land, houses, road relocation, etc.
(g)	Contingency	:
(h)	Interest during construction	:

(2) Estimating Criteria

(a) Civil Works

Unit prices were decided on with wages of laborers and prices of materials and equipment as of January 1991 as bases upon comparisons and studies of unit construction costs of projects similar to the Project under study and hydroelectric power stations under construction presently in Costa Rica, and referring to unit construction costs for similar sites in Japan.

(i) Laborer Wages and Unit Materials Prices

Unit costs in Costa Rica were applied for wages of laborers and unit prices of materials for the Project. However, for materials, international unit prices were used for imported items such as steel. Unit costs of labor and materials are given in Tables 12-3 and 12-4.

Transportation costs from manufacturing plants of materials or cargo landing ports to construction sites were calculated by unit prices furnished by ICE.

Table 12-3 Labor Cost

Unit: Colones/hr.

Name	Unit Cost
Foreman	256.0
Miner	235.9
Heavy Machine Ope. (A)	217.6
Light Machine Ope. (B)	124.3
Crane Operator	188.1
Mechanic	164.7
Steel Fixer Welder	139.6
Plumber	195.4
Electrician	195.4
Carpenter	177.6
Driller	161.6
Ditto, Assist.	157.2
Groutman	218.0
Labor	113.7

Table 12-4 Material Unit Price

Unit: Colones

Name	Specification	Unit	Home Production	Importation
Cement				
	Portland	ton	6,570.0	
	Extra fine	ton	7,220.0	
Flyash		ton		8,800.0
Admixture				
	AE agent	kg		520.0
	Water reducing agent	kg		250.0
Shape Steel				
	Angle	ton		82,000.0
	H-beem	ton		66,500.0
	Carbon steel pipe	ton		73,000.0
	Seam welded pipe	ton		81,000.00
Rolled Steel				
	t = 17 mm	ton		57,750.0
	t = 8 to 10 mm	ton		82,950.0
	t = 5 to 7 mm	ton		90,830.0
Steel Bar				
	Round bar (13-44 mm)	ton		50,000.0
	Deformed bar (13-44 mm)	ton		50,000.0
Rock Bolt				
	Deformed bar (22*3,000 mm)	p.c		1,400.0
	Deformed bar (25*3,000 mm)	p.c		1,800.0
Welded Metal Mesh				
	3.2*100*100	m^2		160.0
	4*100*100	m^2		220.0

Unit: Colones

Name	Specification	Unit	Home Production	Importation
Fuel and Oil				
	Gasoline	liter	46.2	
	Light oil	liter	41.2	
	Lubrication	liter	127.0	
	Grease	kg	240.0	
Blasting				
	Dynamite	kg		254.0
	ANFO	kg		73.0
	Elec. detona	piece		186.0
	Elec. leads	m		
	Detonating	m		
Bit and Rod				
General	Bit (30-44 mm)	p.c		5,100.0
	Rod (22 mm*2 m)	p.c		7,000.0
Rock-bolt	Bit (36-38 mm)	p.c		11,600.0
	Rod (25 mm* 2.3 m)	p.c		12,400.0
Boring-machine	Metal crawn	p.c		3,100.0
	Rod 3 m (33.5-50 mm)	p.c		12,300.0
Wood		m^3	15,000.0	
Metal Form (for Form work)				
	Flat type (150*1,800 mm)	p.c		1,600.0
	Flat type (300*1,800 mm)	p.c		2,200.0

(ii) Construction Machinery

Principal construction machinery, for example, items such as dump truck, bulldozer, large truck crane, cable crane, batching plant, aggregate plant, freezing plant, and boring machine would all be imported. The unit prices of these items, with domestic market prices in Japan as bases, were calculated assuming CIF prices at Caldera Port.

In estimation of construction costs, depreciation costs of machinery were used upon comparing the value based on the above calculated prices and depreciation cost of machinery estimated by ICE and making adjustments.

(iii) Access Roads

The roads to the dam site and the powerhouse site are to be used permanently. They require constructions capable of withstanding traffic of heavy articles, and constructions corresponding to expressways were adopted. Construction cost estimations were made based on the unit construction cost of ICE.

The road from the powerhouse site to the surge tank will not have much hauling in or out of heavy articles and so was estimated as a road of simple pavement.

(b) Hydraulic Equipment

Gates, valves, and penstock steel pipes would all be imported. The unit prices of these items of hydraulic equipment were estimated based on unit prices in similar projects under construction in Costa Rica and actual cases in Japan.

(c) Electrical Equipment

All electrical equipment would be imported. Unit construction costs were estimated referring to actual cases of international prices.

(d) Transmission Line

All materials and equipment would be imported. Unit construction costs were calculated referring to unit prices estimated by ICE and taking into consideration the topographical conditions of the Project.

(e) Camp Facilities

For camp facilities, 6% of direct costs of civil works is to be calculated.

(f) Engineering and Administrative Cost

As engineering and administrative cost, 18% of direct construction costs would be allocated.

(g) Compensation Cost

Compensation costs would include compensation for objects to be submerged with water impoundment in the reservoir such as houses, land, roads, etc., costs of relocation works such as of roads and land for transmission line. These would be examined and estimated based on the estimates of ICE.

(h) Contingency Costs

As contingency costs, 10% of civil works costs, 5% of hydraulic equipment, electromechanical equipment and transmission construction cost, and 10% of engineering and administrative costs are to be allocated.

(i) Interest during Construction

Interest during construction is to be 8.5% for the foreign currency portion and none for the local currency portion.

(3) Division of Local Currency and Foreign Currency Portions

(a) Civil Works Costs

Only cement, lumber, and fuel for motive power such as gasoline are to be from domestic sources, and these are to come under local currency requirements. All materials other than the above would be imported, and come under foreign currency requirements.

All construction machinery would be imported and come under foreign currency requirements.

(b) Hydraulic Equipment

All hydraulic equipment would be paid for with foreign currency, but overland transportation costs from cargo unloading port to construction site and installation costs would come under local currency requirements.

(c) Electrical Equipment and Transmission Line

Electrical equipment and transmission line steel towers and cable are to be listed in the foreign currency portion. Domestic transportation costs and equipment assembly and installation costs are to be in the local currency portion.

(d) Engineering and Administrative Cost

The engineering and administrative cost is to be 89% local currency and 11% foreign currency.

(e) Compensation Cost

Excluding the substitute bridge (length approximately 60 m) to be constructed immediately upstream of the confluence of the Pirris River and the San Rafael River, all costs would be paid for with local currency.

The main part of the substitute bridge would be foreign currency and bridge abutments and bridge piers would be local currency.

(f) Interest during Construction

Interest during construction would be calculated only for the foreign currency portion since the local currency portion is to be free of interest.

12.2.2 Construction Cost

The domestic and foreign currency portions of construction costs and the construction costs by year are respectively given in tables 12-5 and 12-6 for the Project.

Table 12-5 Estimated Construction Cost

As of Jan. 1991
US$ = 105 Colones
Unit;10^3 US$

Items	Description	Total	Foreign Currency	Local Currency
1. Civil Works		99,806.6	54,618.2	45,188.3
	Care of River	2,235.0	1,189.6	1,045.5
	Dam	39,090.3	18,905.5	20,184.7
	Water way	30,472.4	18,805.0	11,667.4
	Power intake	1,114.9	577.6	537.3
	Headrace tunnel	23,770.2	15,055.9	8,714.3
	Surge tank	926.5	496.1	430.4
	Penstock	3,470.9	1,982.3	1,488.6
	Tailrace	1,189.9	693.2	496.7
	Powerhouse,Switchyard	7,041.3	3,676.2	3,365.1
	Powerhouse	5,538.5	2,780.4	2,758.1
	Control building	1,210.0	726.0	484.0
	Switchyard	292.8	169.8	123.0
	Disposal Area	2,182.9	1,515.2	667.8
	Preparatory Works	18,784.7	10,526.7	8,257.9
	Access road	12,028.1	6,336.4	5,691.7
	Camp facility	4,861.3	2,645.5	2,215.8
	Power supply	1,895.2	1,544.8	350.4
2. Hydraulic Equipment		18,457.6	15,145.6	3,312.0
	Gate & Valve	1,394.2	1,180.7	213.5
	Penstock & S.Liner	16,940.3	13,891.0	3,049.3
	Bridge	123.0	73.8	49.2

Items	Description	Total	Foreign Currency	Local Currency
3.	Electromechanical Equipment	22,597.0	20,188.0	2,409.0
	Turbine	6,650.0	5,890.0	760.0
	Generator	6,150.0	5,450.0	700.0
	Transformer	1,680.0	1,490.0	190.0
	Crane etc	3,150.0	2,860.0	290.0
	Control equip.	1,995.0	1,830.0	165.0
	Switchyard	2,260.0	2,080.0	180.0
	Communication equip.	712.0	588.0	124.0
4.	Transmission Line	9,714.0	7,571.0	2,143.0
5.	Total Direct Cost (1+2+3+4)	150,575.1	97,522.7	53,052.3
6	Project Control (Direct cost x 18%)	27,103.5	2,981.4	24,122.1
7.	Compensation	1,522.1	140.6	1,381.5
	House, 4 houses	85.7	0.0	85.7
	Land, reservoir 125 ha	595.2	0.0	595.2
	Land, access road 52 ha	99.0	0.0	99.0
	Land, temporary 30 ha	142.9	0.0	142.9
	Relocation road 4.1 km	117.1	0.0	117.1
	ditto, Bridge 60 m	234.3	140.6	93.7
	Transmission Line 118 ha	247.8	0.0	247.8

Items	Description	Total	Foreign Currency	Local Currency
8. Contingency		15,229.4	7,905.2	7,324.2
	Civil works x 10 %	9,980.7	5,461.8	4,518.8
	Hydraulic equipment x 5 %	922.9	757.3	165.6
	Electromechanical equipment x 5 %	1,129.9	1,009.4	120.5
	Transmission Line x 5 %	485.7	378.6	107.2
	Project controlling x 10 %	2,710.4	298.1	2,412.2
9. Total Indirect Cost		43,855.0	11,027.1	32,827.9
10. Total Construction Cost (Total direct cost + Total indirect cost)		194,430.2	108,549.9	85,880.2
11. Interest During Construction		24,485.3	24,485.3	0.0
12. TOTAL PROJECT COST (Investment Cost)		218,915.5	133,035.2	85,880.2

Table 12-6 Fund Requirement in Each Year

As of Jan. 1991
US$ = 105 Colones
Unit;10^3 US$

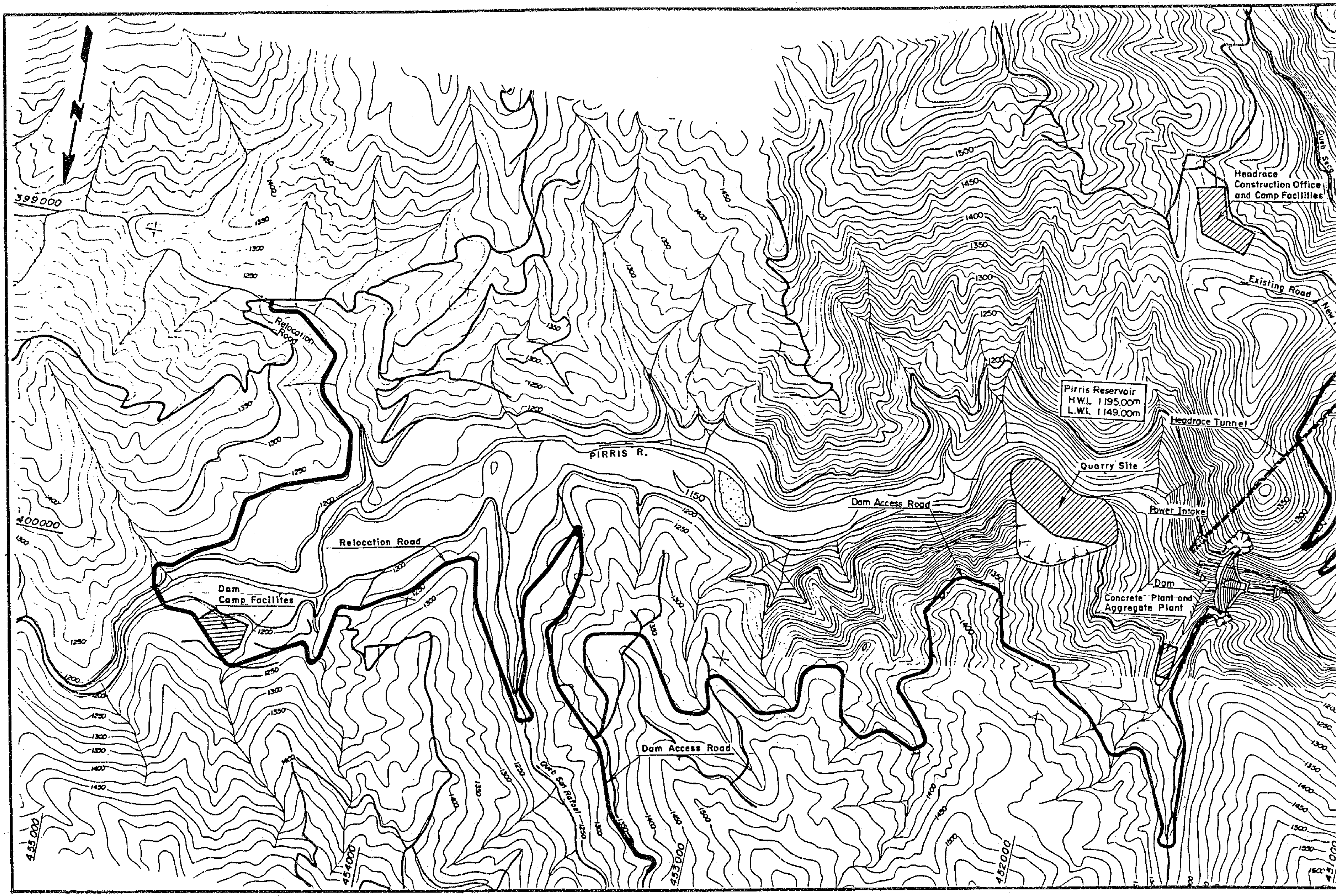
F.C; Foreign currency, L.C; Local currency, T; Total

Item		-1st year	1st year	2nd year	3rd year	4th year	5th year	6th year	Total	Remarks
1. Civil Works										
Care of River	F.C		639.6	491.6			58.4		1,189.6	Coffer dam and
	L.C		379.5	570.7			95.3		1,045.5	Diversion tunnel
	T		1,019.1	1,062.2			153.8		2,235.0	
Dam	F.C			1,026.0	5,525.2	8,090.5	4,263.8		18,905.5	Dam,Spillway and
	L.C			483.5	5,760.0	9,210.6	4,730.7		20,184.7	Outlet works
	T			1,509.5	11,285.2	17,301.2	8,994.5		39,090.3	
Waterway	F.C		2,561.5	4,807.8	6,937.1	3,080.1	1,418.5		18,805.0	Intake,Headrace
	L.C		1,099.2	2,278.5	4,165.7	2,992.5	1,131.4		11,667.4	tunnel,Surge
	T		3,660.8	7,086.2	11,102.8	6,072.6	2,550.0		30,472.4	tank & Penstock
Powerhouse & Switchyard	F.C		249.1	638.0	1,365.8	1,241.8	181.5		3,676.2	
	L.C		132.8	471.3	1,513.3	1,126.7	121.0		3,365.1	
	T		382.0	1,109.3	2,879.0	2,368.5	302.5		7,041.3	
Disposal Area	F.C		331.9	580.2	582.4	20.7	0.0		1,515.2	Dam,Waterway and
	L.C		153.5	258.6	247.4	8.3	0.0		667.8	Powerhouse
	T		485.4	838.8	829.7	29.0	0.0		2,182.9	
Preparatory Works	F.C	7,002.6	2,944.6	144.9	144.9	144.9	144.9		10,526.7	Access rord,
	L.C	5,436.4	2,242.1	144.9	144.9	144.9	144.9		8,258.0	Camp facilities,
	T	12,439.0	5,186.8	289.7	289.7	289.7	289.7		18,784.7	T.L for Const.
Civil Works Total	F.C	7,002.6	6,726.8	7,688.4	14,555.2	12,578.0	6,067.1	0.0	54,618.2	
	L.C	5,436.4	4,007.1	4,207.4	11,831.2	13,483.0	6,223.3	0.0	45,188.4	
	T	12,439.0	10,734.0	11,895.7	26,386.4	26,061.0	12,290.4	0.0	99,806.6	
2. Hydraulic Equipment	F.C				1,365.6	7,479.3	6,300.7		15,145.6	Gates & Penstock
	L.C				0.0	1,766.1	1,545.8		3,312.0	
	T				1,365.6	9,245.4	7,846.6		18,457.6	

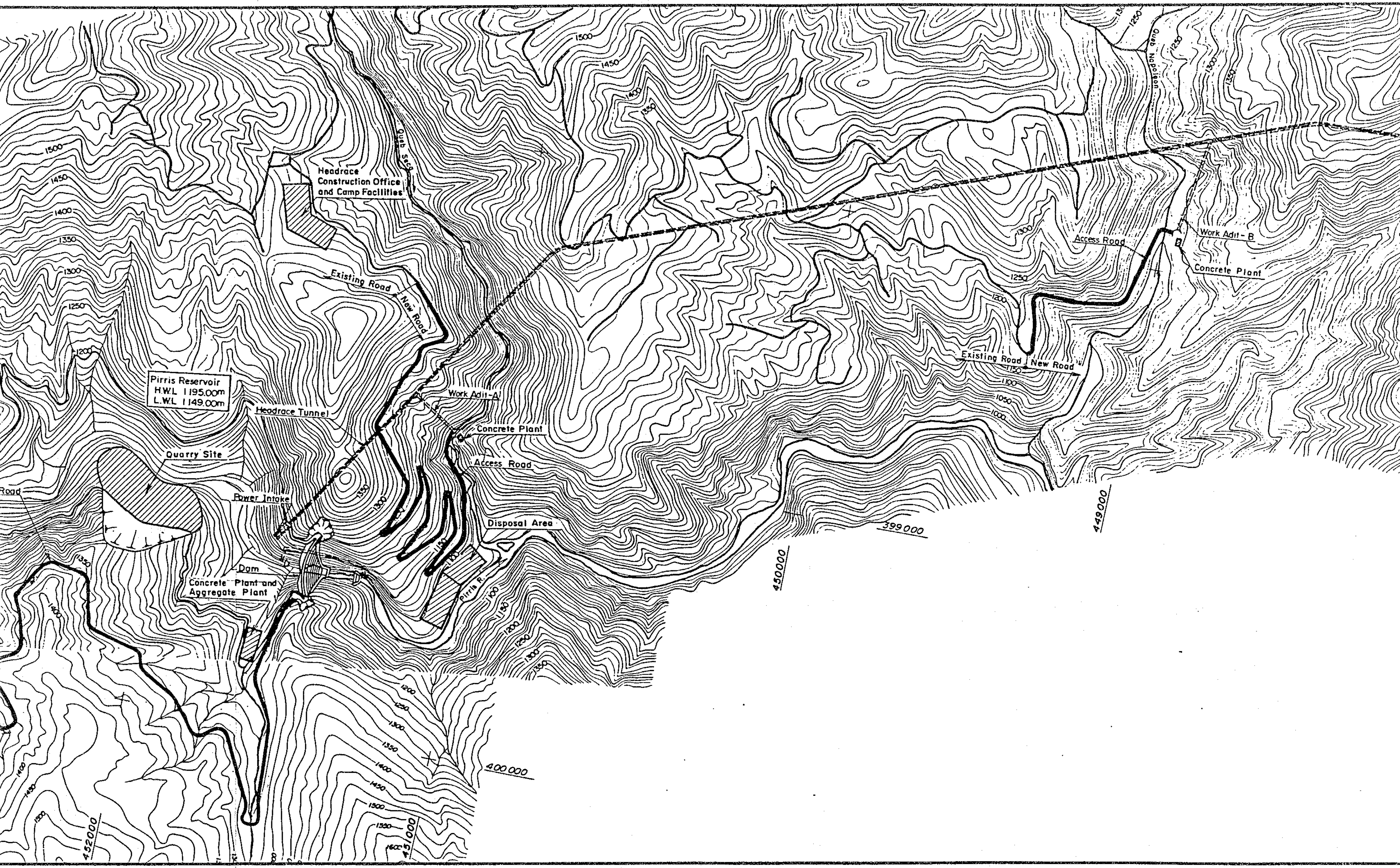
Item		-1st year	1st year	2nd year	3rd year	4th year	5th year	6th year	Total	Remarks
3. Electromechanical Equipment	F.C			3,200.0	838.0	15,680.0	470.0	0.0	20,188.0	
	L.C			0.0	0.0	525.0	1,719.0	165.0	2,409.0	
	T			3,200.0	838.0	16,205.0	2,189.0	165.0	22,597.0	
4. Transmission Line	F.C			1,090.0	4,995.0	849.0	637.0		7,571.0	
	L.C			0.0	643.0	857.0	643.0		2,143.0	
	T			1,090.0	5,638.0	1,706.0	1,280.0		9,714.0	
5. Total Direct Cost (1+2+3+4)	F.C	7,002.6	6,726.8	11,978.4	21,753.9	36,586.3	13,474.8	0.0	97,522.7	
	L.C	5,436.4	4,007.1	4,207.4	12,474.2	16,631.1	10,131.1	165.0	53,052.4	
	T	12,439.0	10,734.0	16,185.7	34,228.0	53,217.4	23,605.9	165.0	150,575.1	
6. Project Control (T.D.C x 18 %)	F.C	246.3	212.5	320.5	677.7	1,053.7	467.4	3.3	2,981.4	
	L.C	1,992.7	1,719.6	2,593.0	5,483.3	8,525.4	3,781.7	26.4	24,122.1	
	T	2,239.0	1,932.1	2,913.4	6,161.0	9,579.1	4,249.1	29.7	27,103.5	
7. Compensation	F.C	0.0	140.6	0.0					140.6	
	L.C	1,077.2	304.3	0.0					1,381.5	
	T	1,077.2	444.9	0.0					1,522.1	
8. Contingency										
Civil	F.C	700.3	672.7	768.8	1,455.5	1,257.8	606.7	0.0	5,461.8	
	L.C	543.6	400.7	420.7	1,183.1	1,348.3	622.3	0.0	4,518.8	
	T	1,243.9	1,073.4	1,189.6	2,638.6	2,606.1	1,229.0	0.0	9,980.7	
Hydraulic Equipment	F.C				68.3	374.0	315.0	0.0	757.3	
	L.C				0.0	88.3	77.3	0.0	165.6	
	T				68.3	462.3	392.3	0.0	922.9	
Electromecha. Equipment	F.C			160.0	41.9	784.0	23.5	0.0	1,009.4	
	L.C			0.0	0.0	26.3	86.0	8.3	120.5	
	T			160.0	41.9	810.3	109.5	8.3	1,129.9	
Transmission Line	F.C			54.5	249.8	42.5	31.9	0.0	378.6	
	L.C			0.0	32.2	42.9	32.2	0.0	107.2	
	T			54.5	281.9	85.3	64.0	0.0	485.7	
Project Controlling	F.C	24.6	21.3	32.0	67.8	105.4	46.7	0.3	298.1	
	L.C	199.3	172.0	259.3	548.3	852.5	378.2	2.6	2,412.2	
	T	223.9	193.2	291.3	616.1	957.9	424.9	3.0	2,710.4	
Total Contingency	F.C	724.9	693.9	1,015.4	1,883.2	2,563.6	1,023.8	0.3	7,905.2	
	L.C	742.9	572.7	680.0	1,763.6	2,358.2	1,195.9	10.9	7,324.3	
	T	1,467.8	1,266.6	1,695.4	3,646.8	4,921.8	2,219.7	11.2	15,229.4	

Item		-1st year	1st year	2nd year	3rd year	4th year	5th year	6th year	Total	Remarks
9. Total Indirect Cost (6+7+8)	F.C	971.2	1,047.0	1,335.9	2,560.9	3,617.3	1,491.2	3.6	11,027.1	
	L.C	3,812.9	2,596.5	3,273.0	7,246.9	10,883.7	4,977.6	37.3	32,827.9	
	T	4,784.1	3,643.6	4,608.8	9,807.9	14,501.0	6,468.8	40.9	43,855.0	
10. Total Construction Cost (5+9)	F.C	7,973.8	7,773.9	13,314.2	24,314.8	40,203.6	14,966.0	3.6	108,549.9	
	L.C	9,249.3	6,603.7	7,480.4	19,721.1	27,514.8	15,108.7	202.3	85,880.3	
	T	17,223.1	14,377.5	20,794.6	44,035.9	67,718.4	30,074.7	205.9	194,430.2	
11. Interest During Construction (R=8.5 %)	F.C	338.9	826.7	1,904.4	3,503.6	6,245.7	8,590.4	3,075.6	24,485.3	
	L.C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	T	338.9	826.7	1,904.4	3,503.6	6,245.7	8,590.4	3,075.6	24,485.3	
12. Grand Total (Investment Cost)	F.C	8,312.7	8,600.6	15,218.6	27,818.4	46,449.3	23,556.4	3,079.2	133,035.2	
	L.C	9,249.3	6,603.7	7,480.4	19,721.1	27,514.8	15,108.7	202.3	85,880.3	
	T	17,562.0	15,204.3	22,699.0	47,539.6	73,964.0	38,665.1	3,281.6	218,915.5	

Remarks: Figures in total and grand total do not necessarily correspond to the respective sum because fractions have been rounded off in the course of calculation.



399000
400000
455000
454000
453000
452000
Headrace Construction Office and Camp Facilities
Existing Road
Relocation Road
Pirris Reservoir
H.W.L 1195.00m
L.W.L 1149.00m
Headrace Tunnel
PIRRIS R.
Quarry Site
Dam Access Road
Power Intake
Dam
Concrete Plant and Aggregate Plant
Dam Camp Facilites
Queb San Rafael


Headrace
Construction Office
and Camp Facilities
Existing Road
New Road
Pirris Reservoir
H.W.L 1195.00m
L.W.L 1149.00m
Headrace Tunnel
Work Adit-A
Concrete Plant
Access Road
Quarry Site
Power Intake
Disposal Area
Dam
Concrete Plant and
Aggregate Plant
Pirris R.
Quebrada Seca
Quebrada Napoleón
Access Road
Work Adit-B
Concrete Plant
Existing Road
New Road
399 000
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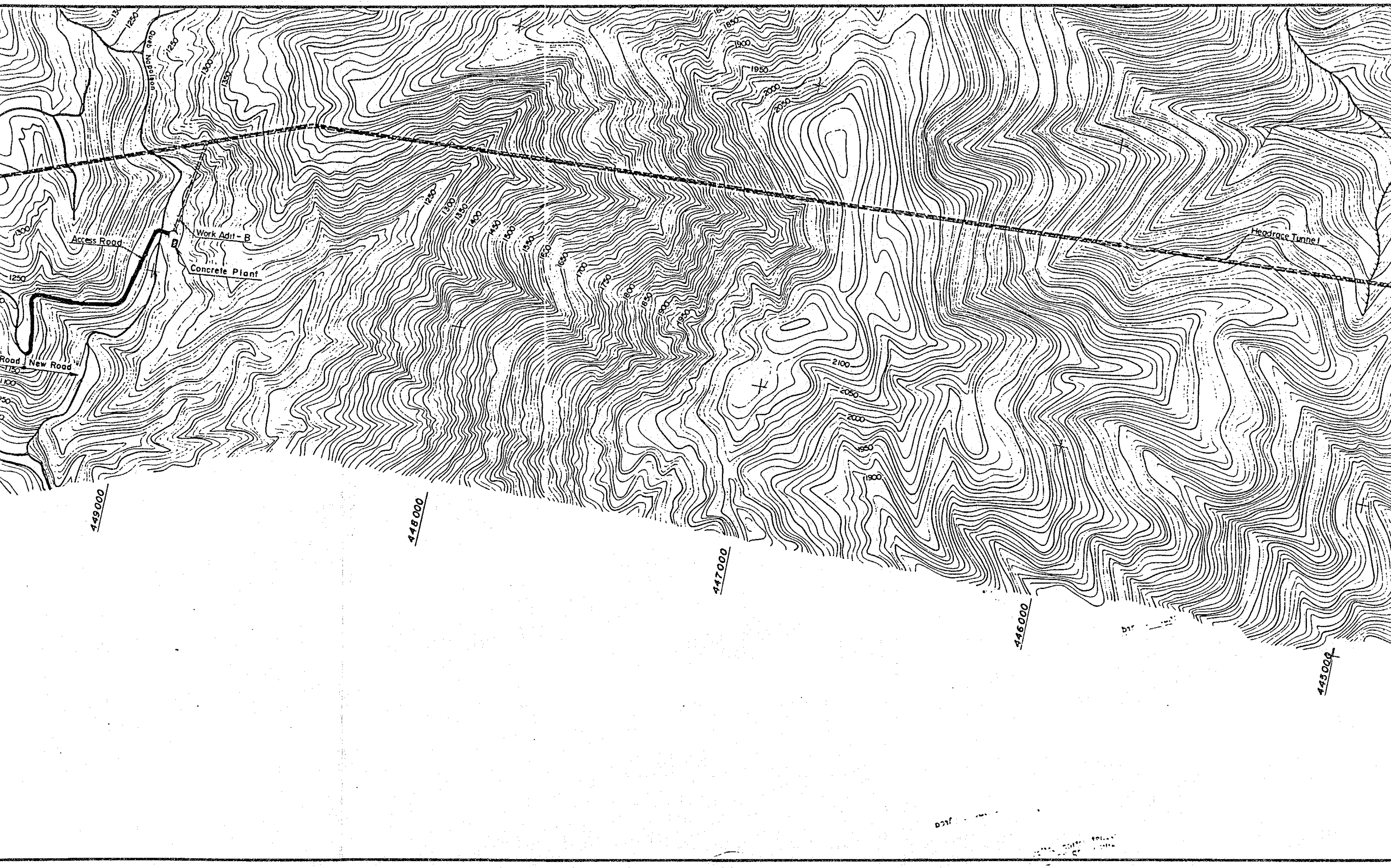
449000
450000
451000
452000



Access Road
Work Adit - B
Concrete Plant
Road
New Road
Headrace Tunnel
449000
448000
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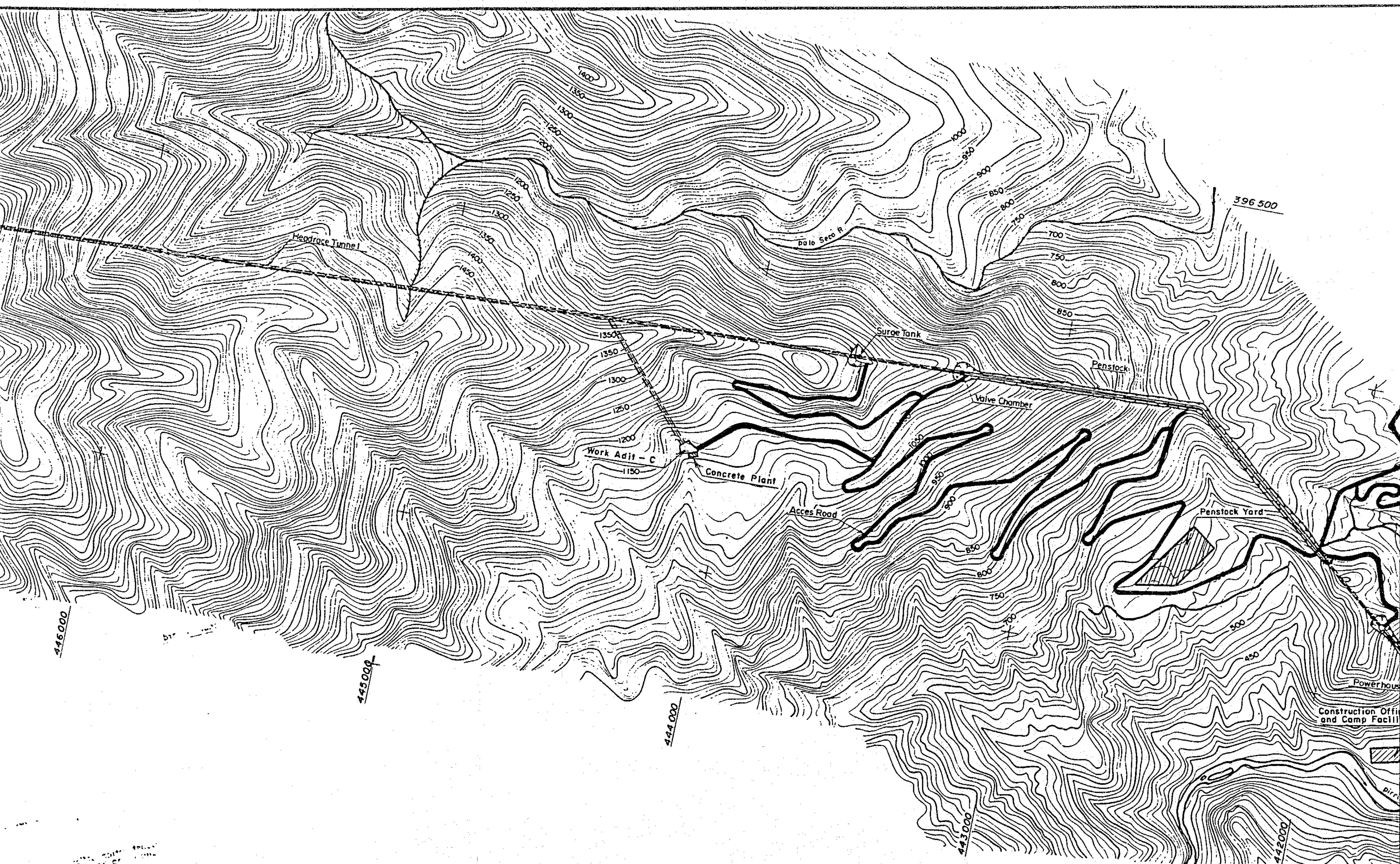
446000
445000



Headrace Tunnel
Palo Seco R.
396 500
Surge Tank
Penstock
Valve Chamber
Work Adit - C
Concrete Plant
Acces Road
Penstock Yard
Powerhous
Construction Offi
and Camp Facili
446000
445000
444000
443000
442000

REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

LOCATION OF TEMPORARY FACILITIES

Fig. 12-3 | DATE:

Nationality :	
Name of Project :	Pirris

Fig. 12-4 Construction Schedule

Revisions
Rev. 1
Rev. 2
Rev. 3

Item	Quantity	Remarks
Preparatory works and Camp Facilities		
Road of Construction	Dam 6.5km, Power plant 15km	
Care of River		
Diversion Tunnel	D=6.5m L=330m	
Coffer-dam	Upsteam h=20m conc. 3,300m³	
	Downstream h= 5m conc. 600m³	
Dam (H=120.0m)	Ex. = 350,000 m³	
	Conc. = 390,400 m³	
	Drilling & Grouting 14,600m	
Power Intake	Ex. = 63,000 m³	
	Conc. = 5,100 m³	
Headrace Tunnel	D. =2.8m EL= 8,690m	Grouting 13,000m
	(Max. Length 4,150m)	
Surge Tank	Upper Chamber D_1=10m h_1=15.00m	
	Shaft D_2= 5m h_2=88.50m	
Penstock	Tunnel D=2.8m L=334m D=3.6m L=290m	
	Open D=2.8m L=1.0m L=2,024m	
Power-house	Ex. 232,000 m³	
	Conc. 24,000 m³	
Tailrace	Ex. 164,000 m³	Backfill 151,300m³
	Conc. 2,400 m³	L = 265m
Hydraulic Equipments	Spillway Gate 11m×11.5m×2	
	Outlet Gate & Conduit	
	Intake Gate 4.2m×3.9m×1	
	Penstock Valve ϕ2.8m	
	Draft Gate 3.2m×3.20m×2	
	Penstock D=2.8~1.0m L=2,650m	
Electromechanical Equipment	No.1 Unit	
	No.2 Unit	
Switchyard		
Transmission Line		
Telecommunication