iii) Aggregates for Concrete

Aggregates would be collected and/or manufactured from river sand-gravel deposit in the vicinity of the confluence of the Oltu and Tortum rivers, the river sand-gravel deposit distributed downstream in the vicinity of the Artvin dam site, rock produced in excavation, and rock obtained from quarries.

iv) Embankment Materials

Core material would be collected from the landslide area at the left bank of the Tortum River, while filter and rock materials would be supplied from the abovementioned sand-gravel deposits, rock from excavation, and quarries.

(4) Electric Power for Construction

Electric power for construction can be supplied by branching off from the transmission line (154 kV) which passes by the construction sites.

(5) Temporary Construction Facilities

Large-sized equipment for hauling, embanking, and compacting in construction of the fill dam, the large-sized crane, cooling plant, and other special equipment to be used in connection with construction of the concrete dam, and special equipment such as boring machines and grout plant would be imported from abroad.

11.1.2 Construction Planning and Construction Schedule

Assuming that the Yusufeli and Artvin projects are to be commissioned in the year 2000, it would be necessary for preparations and start of construction to be roughly in accordance with the schedule below.

	Yusufeli Project	Artvin Project
Mar. '85 - Dec. '86	Feasibility Study	
Jan. '87 - Dec. '87	Financial Arrangement for Detailed Design	
Jan. '88 - Jun. '89	Detailed Design (1.5 Yr)	
Jul. '89 - Dec. '90	Financial Arrangement for Construction (1.5 Yr)	
Jan. '91 - Dec. '91	Bidding and Award of Contract for Construction	
Jan. '92 -	Start of Construction (Yusufeli)	
Jan. '95		Start of Construction (Artvin)
	(9 Yr)	(6 Yr)
... Dec. 2000	End of Construction	End of Construction

The construction planning and construction schedules of the two projects would be as described below.

(1) Yusufeli Project

The structures to be constructed in this Project are a rock-fill dam 270 m in height, a power intake, penstock, powerhouse and tailrace tunnel. The quantities of the principal civil works are as given in Table 11-1.

The machinery expected to be mainly required for dam construction are as given in Table 11-2.

It is thought that a construction period of about 9 years including preparatory works will be required for the Yusufeli Project as a result of study taking into account the project scale and layout of structures.

The layout of temporary facilities for construction and the construction schedule are shown in Fig. 11-1 and 11-2, respectively.

Outlines of the construction plan and the construction schedule are given below.

Table 11–1 Principal Civil Works for Yusufeli Project

Item	Description	Civil Works
Diversion Tunnel	D=9.2m ℓ=1,258m	Tunnel ex. 134,000 m^3 Lining con. 41,000 m^3
Cofferdam (Upstream)		Embankment 616,000 m^3
Dam	H=270 m	Ex. in open 1,080,000 m^3 Em. Core 2,720,000 m^3 Filter 2,580,000 m^3 Rock 14,940,000 m^3 Riplap 190,000 m^3 Total: 21,510,000 m^3
Spillway		Ex. in open 7,880,000 m^3 Concrete 151,000 m^3
Power Intake		Ex. in open 790,000 m^3 Concrete 11,000 m^3
Penstock	D=4.2 - 9.0m ℓ=366m (No.2)	Tunnel ex. 35,000 m^3 Filling con. 12,500 m^3
Power House		Power House Ex. in underground 90,000 m^3 Concrete 35,300 m^3
Tailrace Tunnel	D=5.7 - 10.0m ℓ=403m (No.2)	Tunnel ex. 54,000 m^3 Lining con. 17,100 m^3

Table 11–2 Principal Machinery for Yusufeli Dam Construction

Item	Machinery		No.
Core	Wheel loader	8.5 m^3 class	1
	Dump truck	25 t class	30
	Bulldozer	40 t class	2
	Vibratory roller	15 t class	2
Filter & Rock	Wheel loader	8.5 m^3 class	6
	Dump truck	45 t class	50
	Bulldozer	50 t class	8
	Vibratory roller	15 t class	3

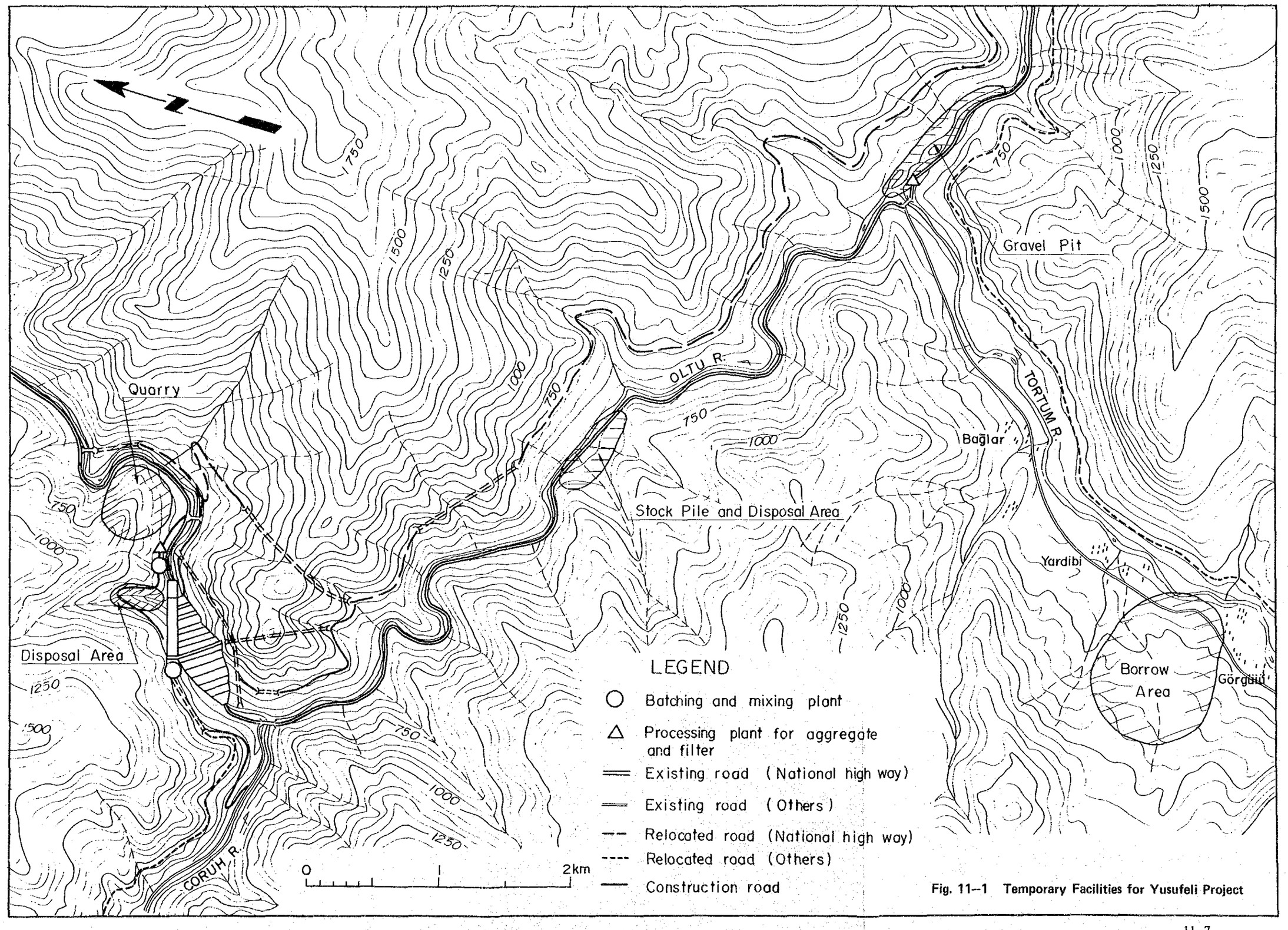

Fig. 11–1 Temporary Facilities for Yusufeli Project

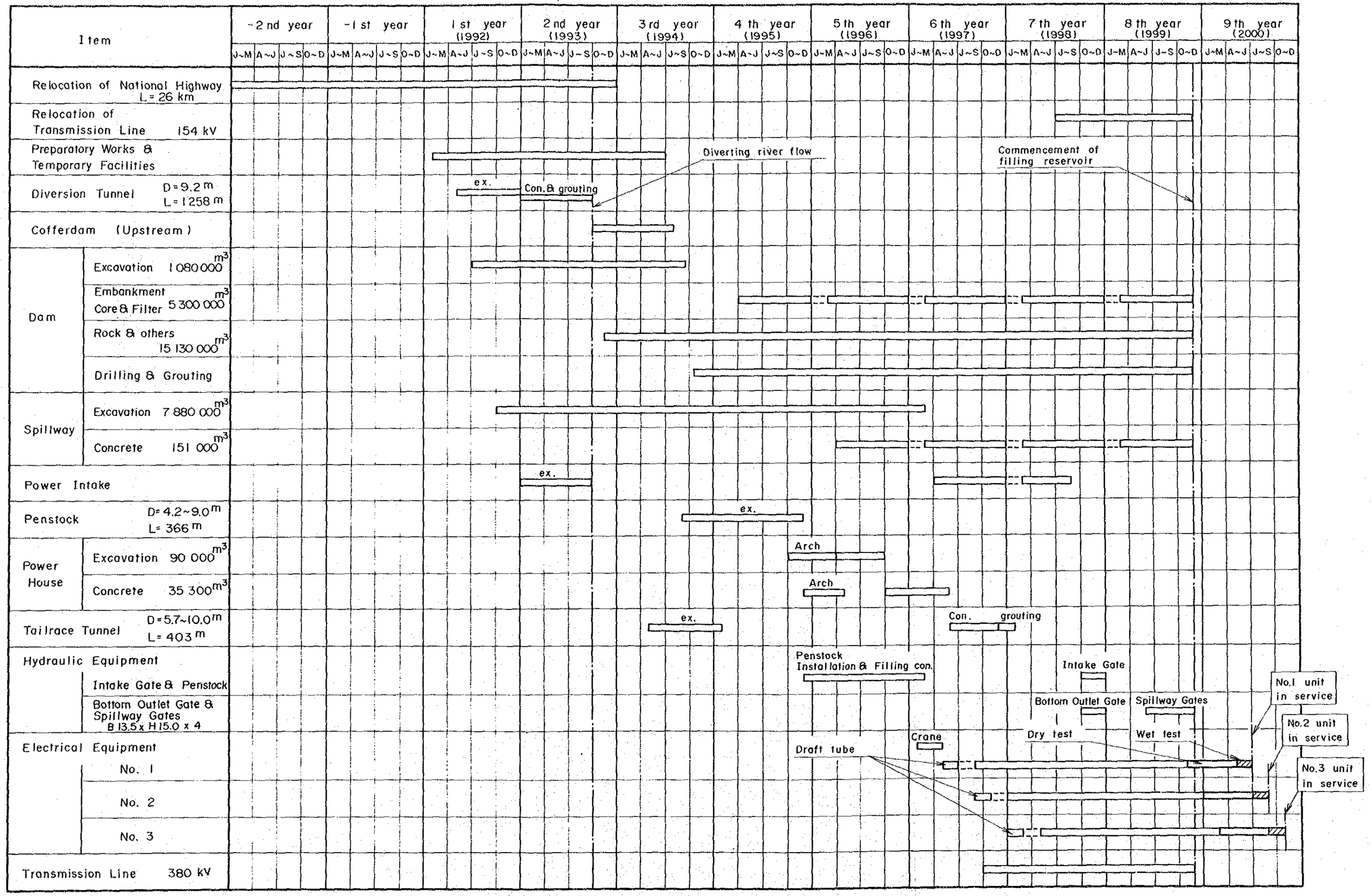

Fig. 11--2 Construction Schedule for Yusufeli Project

First Year

It will be imperative in order to carry out construction smoothly that prior to start of construction, relocation of the national highway in the vicinity of the dam site will have been completed, and traffic on the national highway throughout the construction period will not be interrupted so that constraints will not be placed on the construction work of the Yusufeli Project.

Simultaneously with start of construction, work is to be started on materials procurement and construction of access roads, temporary bridges, camps for the owner and engineer, quarters for contractors and laborers, materials stockyards, etc., preparation of sites for temporary facilities such as concrete and aggregate plants, and erection of such equipment.

After completion of the access roads and temporary bridges required for the diversion tunnel work, excavation for the diversion tunnel and bottom outlet tunnel is to be started immediately. Surface excavation for the dam and spillway is to be started. Materials from excavation that can be utilized is to be hauled to stockpiles and used as dam embankment material and aggregates.

Since these excavation works would be carried out at a multiple number of places within the project area, work must be performed paying thorough attention to assurance of safety in the work.

Second Year

Surface excavation for the intake is to be started parallel with the diversion tunnel work, excavation for the dam and spillway, and temporary facilities work.

The diversion tunnel is to be completed by the dry season in the autumn and the river is to be diverted through the diversion tunnel.

After completion of diversion, embankment of the upstream and downstream cofferdams and excavation of the dam foundation and foundation treatment corresponding to the progress in the embankment of the cofferdams are to be carried out. Embankment of rock for the dam is also to be started where possible.

Third Year

Embankment of coffer dams, excavation for the dam and spillway, etc. are to be continued.

After completion of the cofferdams, deep excavation at the dam foundation and foundation treatment work are to be continued, and preparations made for core embankment.

On completion of the right-bank surface excavation, underground work is to be started in the second half of the year which are excavation for tailrace tunnel, access tunnel, etc. After excavation of the tailrace tunnel, excavation for the penstock is to be started. Muck is to be hauled out through the tailrace tunnel.

Fourth Year

Core embankment is to be started after completion of foundation treatment of the river-bed. Work on the filter zones is to proceed in step with the core embankment, and embanked surfaces of roughly the same elevations are to be maintained at all times.

Since excavation for the spillway will be performed at an elevation higher than the dam embankment, the work must be carried out exercising thorough care regarding execution methods and safety. Excavated material that can be utilized is to be used as much as possible as embankment material.

Excavation and concrete lining of the arch portion of the powerhouse is to be started. Since the powerhouse work is a large cavern, careful studies will be required concerning the construction method and safety.

After excavation for the penstock, installation of penstock pipe and placement of filling concrete are to be started.

Fifth Year

Dam embankment and foundation treatment are to be continued. Concrete placement is to be started for the spillway corresponding to progress made in excavation.

For the powerhouse, excavation of the cavern is to be performed following completion of the arch portion. Excavated muck is to be dropped down a morning glory hole and hauled out through the tailrace and other tunnels. Placement of concrete in the walls is to be started after completing excavation of the cavern.

Work on transformer hall and gate chamber are also to be performed at the same time.

Sixth Year

Embankment of the dam, foundation treatment, and concrete placement of the spillway are to be continued. Concrete placement at the intake is to be started.

The crane for installing electromechanical equipment is to be installed corresponding to the progress in the work on powerhouse wall concrete. After completing installation of the crane, the draft tubes of the turbine units are to be installed in succession and installation, and assembly of electromechanical equipment are to be started.

As the final items of underground civil works, concrete lining and grouting of the tailrace tunnels are to be done.

Construction of the transmission line (Yusufeli-Hopa, 380 kV) for transporting the electric power generated at Yusufeli Power Plant and Artvin Power Plant is to be started.

Seventh Year

Dam embankment, foundation treatment, spillway concrete placement, intake concrete placement, electromechanical equipment installation, and transmission line (380 kV) construction are to be continued.

Relocation work on the transmission line (154 kV) to be submerged by reservoir impoundment is to be started.

After completion of intake concrete placement, intake gate and tailrace gate installation is to be started.

Eighth Year

This is to be the final year of the principal civil works as dam embankment, foundation treatment, and spillway concrete placement.

After spillway gates have been installed and all works related to the dam completed, the diversion tunnel is to be plugged and impoundment of the reservoir started.

Assembly of electromechanical equipment is to be continued and after completing assembly, dry tests of each unit are to be started in succession.

The relocated transmission line (154 kV) is to be completed before water impoundment and switching is to be done immediately.

Ninth Year

Water impoundment is to be continued. Observations of behavior of dam body and ground in the surroundings of the reservoir must be carried out with the utmost care.

The transmission line (380 kV) is to be completed within the previous year, following which preparations would be made for start of operation which would include adjustment of power generating equipment and other works.

Electromechanical equipment is to be subjected to wet tests after dry tests. Commercial operation is to be started after the wet tests.

(2) Artvin Project

The structures to be built in this Project would consist of a concrete arch dam 160 m in height, a power intake, penstock, powerhouse and tailrace tunnels.

The quantities of the major civil works are as given in Table 11-3. The principal machinery and equipment to be mainly required for dam construction are as given in Table 11-4.

It is thought that a construction period of about 6 years including preparatory works will be required for the Artvin Project as a result of study taking into account the project scale and layout of structures.

The layout of the temporary facilities for construction and the construction schedule are shown in Figs. 11-3 and 11-4, respectively.

Outlines of construction planning and the construction schedule are given below.

Table 11–3 Principal Civil Works for Artvin Project

Item	Description	Civil Works
Diversion Tunnel	D=10.0m ℓ=549m	Tunnel ex. 68,000 m^3 Lining con. 19,600 m^3
Cofferdam (Upstream)		Embankment 94,000 m^3
Dam	H=160 m	Ex. in open 1,151,000 m^3 Dam concrete 500,000 m^3
Power Intake		Ex. in open 55,000 m^3 Concrete 11,600 m^3
Penstock	D=5.2 - 6.5m ℓ=213m x 1 ℓ=239m x 1	Tunnel ex. 27,600 m^3 Filling con. 12,100 m^3
Power House		Power House Ex. in underground 80,400 m^3 Concrete 28,500 m^3
Tailrace Tunnel	D=7.5m ℓ=184m x 1 ℓ=207m x 1	Tunnel ex. 27,400 m^3 Lining con. 9,700 m^3

Table 11–4 Principal Equipment for Artvin Dam Construction

Equipment	Specification	No.
Cable crane (One tower travelling type)	20t (6 m^3 bucket)	1
Concrete plant	1.75 m^3 x 1 Forced action type	1
Aggregate plant	200 t/hour	1
Cooling plant	300 RT	1

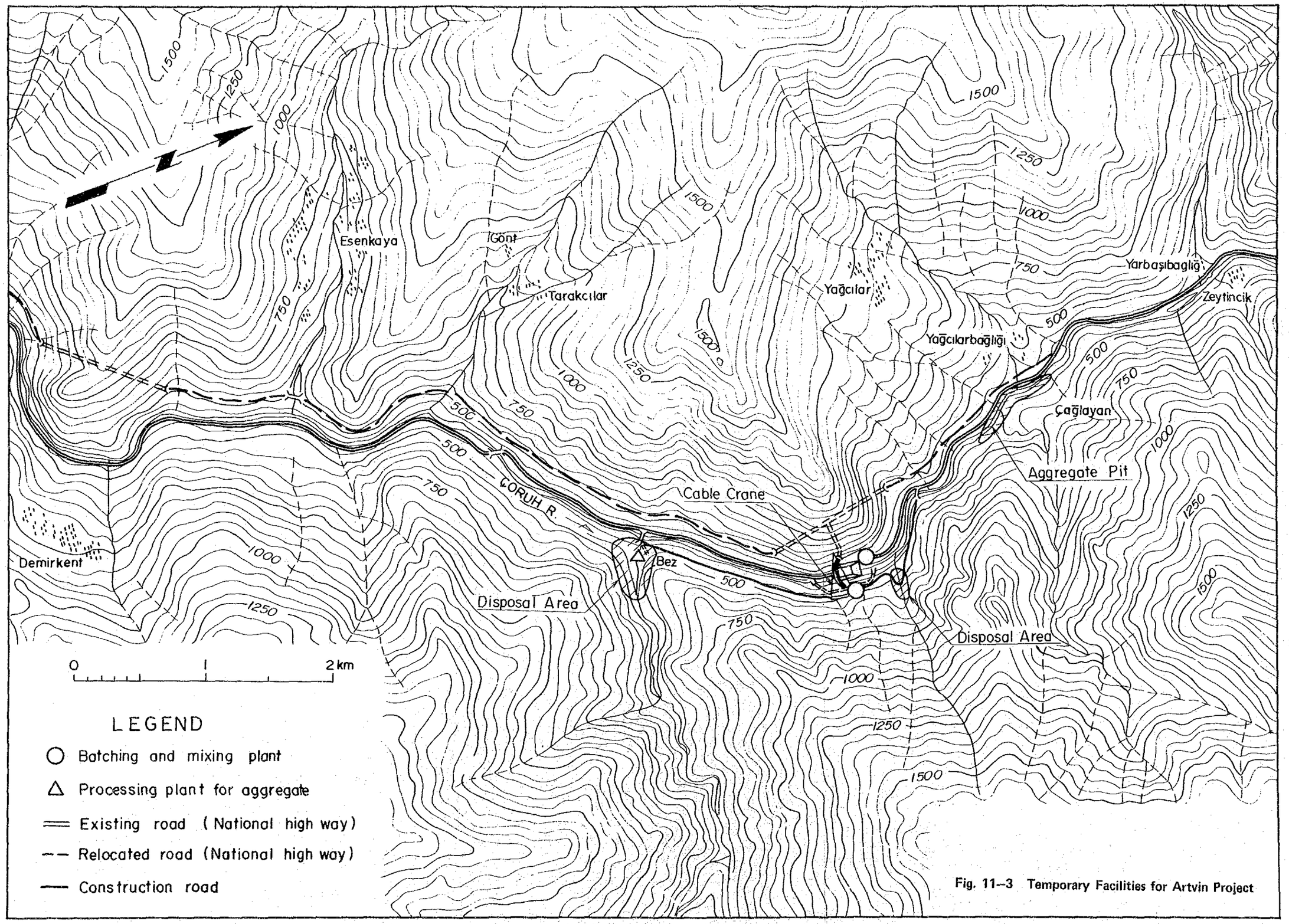

Fig. 11–3 Temporary Facilities for Artvin Project

Item		-2 nd year				-1 st year				1st year (1995)				2 nd year (1996)				3 rd year (1997)				4 th year (1998)				5 th year (1999)				6 th year (2000)			
		J~M	A~J	J~S	O~D	J~M	A~J	J~S	O~D	J~M	A~J	J~S	O~D	J~M	A~J	J~S	O~D	J~M	A~J	J~S	O~D	J~M	A~J	J~S	O~D	J~M	A~J	J~S	O~D	J~M	A~J	J~S	O~D
Relocation of National Highway L=17 km																																	
Relocation of Transmission Line 154 kv																																	
Preparatory Works & Temporary Facilities																																	
Diversion Tunnel D=10.0 m L=549 m												ex.			con.& grouting			Direrting river flow											Commencement of filling rerervoir				
Cofferdam (Upstream)																																	
Dam	Excavation 1151 000 m3																																
	Concrete 500 000 m3																																
	Drilling & Grouting																																
Power Intake															ex.					Con.													
Penstock D=5.2~6.5 m L=213 m x1 L=239 m x1																ex.																	
Power House	Excavation 80 400 m3																		Arch														
	Concrete 28 500 m3																		Arch														
Tailrace Tunnel D=7.5 m L=184 m x1 L=207 m x1															ex.					Con.	grouting												
Hydraulic Equipment	Intake Gates & Penstock																	Penstock Installation & Filling con.				Intake Gates											
	Outlet Gate & Spillway Gates B 13.0 H 15.0 x4																					Outlet Gate				Spillway Gates							
Electrical Equipment																				Crane		Dry test				Wet test				No.1 unit in service			
	No. 1																																
	No. 2																			Draft tube										No.2 unit in service			
Transmission Line 380 kv																																	

Fig. 11—4 Construction Schedule for Artvin Project

First Year

It will be imperative in order to carry out construction smoothly that, prior to start of construction, relocation of the national highway near the dam site will have been completed, and traffic on the national highway throughout the construction period of the Artvin Project will be assured so that constraints will not be placed on the construction work of the Artvin Project.

Simultaneously with start of construction, work is to be started on materials procurement and construction of access roads, temporary bridges, quarters for contractors and laborers, materials stockyards, preparation of sites for temporary facilities such as concrete and aggregate plants, and assembly of such equipment.

After completion of the access road and temporary bridges required for the diversion tunnel work, excavation for the diversion tunnel is to be started immediately.

Surface excavation for the dam is also to be started.

Materials from excavation that can be utilized is to be stockpiled and used as aggregates.

Since these excavation works will be carried out at a multiple number of places within the project area, work must be performed exercising thorough care concerning assurance of safety in the work.

Second Year

Surface excavation for the intake is to be started parallel with the diversion tunnel work, excavation for the dam, and temporary facilities work.

The diversion tunnel is to be completed by the low-water season in the autumn and the river is to be diverted through the diversion tunnel.

After completion of diversion, construction of the upstream and downstream cofferdams and excavation of the dam foundation and foundation treatment corresponding to the progress in the cofferdam work are to be carried out.

Underground work is to be started with excavation for the tailraces, access tunnel, etc.

After completion of tailrace excavation, excavation for the penstock tunnels is to be started. Excavation of the vertical shaft portion of the penstock is to be performed by excavating upward from the bottom, and excavated muck is to be hauled out utilizing routes such as the tailrace tunnels.

Excavation and concrete lining of the arch portion of the powerhouse are to be started. Since the powerhouse is a large cavern, careful studies will be required concerning the construction method and safety.

Third Year

After completion of the cofferdams, deep excavation at the dam foundation and foundation treatment work are to be carried out, followed by start of concrete placement of the dam.

For the powerhouse, excavation of the cavern and placing of wall concrete are to be performed after construction of the arch portion.

Work on transformer hall and gate chamber is also to be performed along with the powerhouse work.

After completion of excavation in the underground work, concrete lining of the tailrace tunnels used for hauling out excavated muck is to be started.

The crane for installing electromechanical equipment is to be installed corresponding to the progress in the work on the powerhouse wall concrete. Installation of draft tubes is to be started after completing installation of the crane.

After completion of excavation for the penstock tunnels, installation of steel penstock and placement of filling concrete are to be carried out.

Fourth Year

Dam concrete placement, foundation treatment, and lining concrete and grouting of the tailrace tunnels are to be continued.

Gates of outlet in the dam body and intake gates are to be installed in step with progress in the dam concrete placement.

Electromechanical equipment installation and assembly are to be done following installation of draft tubes.

Fifth Year

This is to be the final year of dam concrete placement. Installation of spillway gates is to be started after completing placement of dam concrete. Foundation treatment of the dam is to be continued from the previous year.

Installation and assembly of electromechanical equipment are to be continued.

Sixth Year

After completion of spillway gates installation and foundation treatment, the diversion tunnel is to be plugged and water impoundment of the reservoir started. Observation of the behavior of the dam body and ground in the surroundings of the reservoir must be carried out with the utmost care.

Electromechanical equipment is to be subjected successively to dry tests after completion of installation and assembly, following which, wet tests are to be performed. Commercial operation is to be started after the wet tests.

11.2 Cost Estimation

The construction cost of the Project was estimated based on the design and construction methods and materials in accordance with the technological level that can be expected at the present time and considering the geological conditions of the project sites, regional conditions, project scale, etc. The cost estimate was based on prices as of July 1985. (1US$=550 TL)

11.2.1 Fundamental Matters

(1) Construction Cost Estimation Items

The items of construction cost estimation were the following:

(a) Civil Works

- Care of River: diversion tunnel, cofferdams
- Dam: main body, spillway, etc.
- Waterway Structures: intake, tailrace tunnel, penstock, etc.
- Powerhouse and Switchyard: civil and architectural works
- Access Roads: powerhouse access tunnel, dam access roads, etc.
- Camp Facilities: office and lodging facilities, etc.
- Preparatory Works: access road, electric power facilities for construction, etc.

(b) Hydraulic Equipment: gate, penstock, etc.

(c) Electromechanical Equipment: turbine, generator, auxiliary equipment, switchgear, etc.

(d) Transmission line: all costs related to transmission line construction

(e) Project Controlling: planning, survey, management, administration costs

(f) Land Acquisition: land, buildings, etc. in water impoundment area

(g) Road Relocation: existing national highway, etc.

(h) Transmission Line Relocation: existing transmission line

(i) Interest during Construction: interest during construction period

(2) Criteria for Cost Estimate

(a) Civil Works (Including hydraulic equipment such as gate and penstock)

Unit prices in 1985 established by DSI, unit prices of existing, under construction and definite study level hydroelectric power development projects in Turkey such as Altinkaya and Kayraktepe, etc. and those of similar hydroelectric power development projects in Japan are examined and compared.

Further, the labor costs, material costs and machinery costs, etc. that are necessary for construction works are estimated on the basis of conditions in Turkey by analysis of each item of work according to the construction procedure.

The labor costs and material costs in Turkey applied to the abovementioned work are given in Tables 11-5 and 11-6.

Table 11–5 Labor Cost

Item	Unit Cost (T.L./day)
Foreman	3,136
Labor	1,432
Operator and Driver	2,480
Carpenter	2,176
Labor for Grouting	2,176
Pit Man	2,176

Table 11–6 Construction Materials Cost

Item	Unit	Unit Cost	Note
Cement	TL/ton	17,100	T.S.19, KPC 325
Reinforcement (Round Steel bar)	TL/ton	150,000	> ϕ 24
Reinforcement (Deformed steel bar)	TL/ton	153,000	
Gasoline	TL/ℓ	240	including Tax
Motorline	TL/ℓ	160	including Tax
Dynamite	TL/kg	860	
ANFO	TL/ton	165,000	including Tax

(b) Electromechanical Equipment

Electromechanical equipment, such as turbines, generators, transformers, etc., are all to be imported.

(c) Transmission Line

Unit prices in transmission line construction costs and existing transmission line relocation costs applied were those made available by TEK (through EIE).

(d) Land Acquisition

Compensation costs such as for land acquisition were calculated based on data furnished by EIE.

(e) Road Relocation

Relocation costs of existing roads were calculated based on unit prices of DSI and the National Highway Department, etc.

(f) Import Duty and Tax

Import duties and various taxes were considered as follows:

- A state tax of 10% was included in costs of materials for construction.
- An import duty without certificate was considered besides the state tax of 10% for equipment to be imported for civil works.
- A state tax of 10% was considered for electromechanical equipment, and import duty was not considered.

(g) Contingency

Contingency costs of 15% for civil works, and 10% for electromechancial equipment including installation costs are considered.

(h) Project Controlling

Project controlling costs of 15% of construction costs including contingencies are considered.

(i) Interest during Construction

Interest during construction is to consist of 9.5% on foreign currency and 9.5% on domestic currency.

(3) Separation of Domestic and Foreign Currency Portion

Cement, steels such as reinforcing bars and structural steel, steel products such as spillway gates, and explosives, which are the main materials for civil works, are to be of domestic origin and are to be calculated in domestic currency.

Heavy equipment such as heavy dump trucks, bulldozers, wheel loaders, vibratory rollers for civil works, and temporary-facility mechanical installations such as concrete plants, aggregate plants, concrete placement cranes, and cooling plant are all to be imported, and costs were calculated under foreign currency requirements.

Special types of equipment such as boring machines, grout pumps, compressors, etc. are to be imported and were calculated under foreign currency requirements.

Electromechanical equipment and transmission line equipment and materials are included under foreign currency while their transportation costs in Turkey and installation costs are in domestic currency.

Import duty on construction equipment for civil works to be imported, and state taxes on electromechanical equipment and materials and equipment are included in domestic currency.

11.2.2 Estimated Construction Cost

The domestic and foreign currency portions of construction costs and the construction costs by year are respectively given in Tables 11-7 and 11-8 for the Yusufeli Project, and Tables 11-9 and 11-10 for the Artvin Project.

Transmission line construction costs were calculated with allocations to the Yusufeli and Artvin projects as described below.

The section between Yusufeli Power Plant and Artvin Power Plant was allocated to the Yusufeli Project, and the section between Artvin Power Plant and Hopa Substation to the two projects based on the ratio of power generation outputs.

Table 11–7 Estimated Construction Cost of Yusufeli Project

(Unit; 10^6 TL)

Item	Foreign Currency	Domestic Currency	Total
Civil Works			
Care of River	1,682	5,307	6,989
Dam	31,235	55,770	87,005
Waterway	1,405	5,118	6,523
Powerhouse & Switchyard	1,476	8,942	10,418
Access Road	273	1,207	1,480
Camp Facility	1,900	8,530	10,430
Preparatory Works	958	716	1,674
Contingency (15%)	5,840	12,839	18,679
Sub-total	44,769	98,429	143,198
Hydraulic Equipment	0	4,877	4,877
Electromechanical Equipment	38,018	8,564	46,582
Transmission Line	3,436	1,144	4,580
Total (Direct Cost)	86,223	113,014	199,237
Project Controlling	8,968	20,918	29,886
Land Acquisition	0	12,511	12,511
Relocation of Road	2,657	10,786	13,443
Relocation of Transmission Line	200	97	297
Total (Project Cost)	98,048	157,326	255,374
Interest during Construction	38,932	79,059	117,991
Grand Total (Investment Cost)	136,980	236,385	373,365

Table 11–8 Fund Requirement in Each Year of Yusufeli Project (1/2)

F; Foreign Currency
D; Domestic Currency
T; Total

(x 10^6 TL)

Item \ Year		-2nd year	-1st year	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	Total	Note
Civil Works														
Care of River	F			323	737	622							1,682	
	D			1,792	2,578	937							5,307	
	T			2,115	3,315	1,559							6,989	
Dam	F			740	2,531	4,279	5,407	5,762	4,474	4,214	3,828		31,235	
	D			1,713	5,342	8,031	9,163	10,487	7,611	7,035	6,388		55,770	
	T			2,453	7,873	12,310	14,570	16,249	12,085	11,249	10,216		87,005	
Waterway	F				685	242	171	66	197	44			1,405	
	D				1,572	1,107	883	263	1,030	263			5,118	
	T				2,257	1,349	1,054	329	1,227	307			6,523	
Powerhouse & Switchyard	F						426	676	374				1,476	
	D						2,271	4,505	2,166				8,942	
	T						2,697	5,181	2,540				10,418	
Access Road	F			273									273	
	D			1,207									1,207	
	T			1,480									1,480	
Preparatory Works	F			958									958	
	D			716									716	
	T			1,674									1,674	
Camp Facility	F			950	950								1,900	
	D			4,265	4,265								8,530	
	T			5,215	5,215								10,430	
Sub-total	F			3,244	4,903	5,143	6,004	6,504	5,045	4,258	3,828		38,929	
	D			9,693	13,757	10,075	12,317	15,255	10,807	7,298	6,388		85,590	
	T			12,937	18,660	15,218	18,321	21,759	15,852	11,556	10,216		124,519	
Contingency	F			487	735	771	901	976	757	639	574		5,840	
	D			1,454	2,064	1,511	1,848	2,288	1,621	1,095	958		12,839	
	T			1,941	2,799	2,282	2,749	3,264	2,378	1,734	1,532		18,679	
Sub-total	F			3,731	5,638	5,914	6,905	7,480	5,802	4,897	4,402		44,769	
	D			11,147	15,821	11,586	14,165	17,543	12,428	8,393	7,346		98,429	
	T			14,878	21,459	17,500	21,070	25,023	18,230	13,290	11,748		143,198	

Table 11–8 Fund Requirement in Each Year of Yusufeli Project (2/2)

F; Foreign Currency
D; Domestic Currency
T; Total

(x 10^6 TL)

Item \ Year		-2nd year	-1st year	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	Total	Note
Hydraulic Equipment	F							0		0	0		0	
	D							2,439		1,219	1,219		4,877	
	T							2,439		1,219	1,219		4,877	
Electromechanical Equipment	F						4,278	6,417	7,604	11,405	4,512	3,802	38,018	
	D						428	642	1,712	2,570	2,356	856	8,564	
	T						4,706	7,059	9,316	13,975	6,868	4,658	46,582	
Transmission Line	F								443	1,672	1,321		3,436	
	D								44	310	790		1,144	
	T								487	1,982	2,111		4,580	
Total (Direct Cost)	F			3,731	5,638	5,914	11,183	13,897	13,849	17,974	10,235	3,802	86,223	
	D			11,147	15,821	11,586	14,593	20,624	14,184	12,492	11,711	856	113,014	
	T			14,878	21,459	17,500	25,776	34,521	28,033	30,466	21,946	4,658	199,237	
Project Controling	F			670	966	788	1,160	1,553	1,262	1,371	988	210	8,968	
	D			1,562	2,253	1,837	2,706	3,625	2,943	3,199	2,304	489	20,918	
	T			2,232	3,219	2,625	3,866	5,178	4,205	4,570	3,292	699	29,886	
Land Acquisition	F			0	0	0	0						0	
	D			3,128	3,128	3,128	3,127						12,511	
	T			3,128	3,128	3,128	3,127						12,511	
Relocation of Road	F	673	672	335	334	107	107	107	107	107	108		2,657	
	D	3,088	3,088	1,037	1,036	423	423	423	423	423	422		10,786	
	T	3,761	3,760	1,372	1,370	530	530	530	530	530	530		13,443	
Relocation of Transmission Line	F									140	60		200	
	D									14	83		97	
	T									154	143		297	
Total (Project Cost)	F	673	672	4,736	6,938	6,809	12,450	15,557	15,218	19,592	11,391	4,012	98,048	
	D	3,088	3,088	16,874	22,238	16,974	20,849	24,672	17,550	16,128	14,520	1,345	157,326	
	T	3,761	3,760	21,610	29,176	23,783	33,299	40,229	32,768	35,720	25,911	5,357	255,374	
Interest during Construction	F	32	96	353	907	1,560	2,475	3,805	5,267	6,921	8,392	9,124	38,932	
	D	147	440	1,388	3,246	5,109	6,905	9,068	11,073	12,672	14,129	14,882	79,059	
	T	179	536	1,741	4,153	6,669	9,380	12,873	16,340	19,593	22,521	24,006	117,991	
Grand Total (Investment Cost)	F	705	768	5,089	7,845	8,369	14,925	19,362	20,485	26,513	19,783	13,136	136,980	
	D	3,235	3,528	18,262	25,484	22,083	27,754	33,740	28,623	28,800	28,649	16,227	236,385	
	T	3,940	4,296	23,351	33,329	30,452	42,679	53,102	49,108	55,313	48,432	29,363	373,365	

Table 11–9 Estimated Construction Cost of Artvin Project

(Unit; 10^6 TL)

Item	Foreign Currency	Domestic Currency	Total
Civil Works			
Care of River	572	2,229	2,801
Dam	7,254	19,071	26,325
Waterway	540	2,519	3,059
Powerhouse & Switchyard	1,111	6,460	7,571
Access Road	120	522	642
Camp Facility	1,120	5,060	6,180
Preparatory Works	534	448	982
Contingency (15%)	1,689	5,447	7,136
Sub-total	12,940	41,756	54,696
Hydraulic Equipment	0	4,374	4,374
Electromechanical Equipment	30,762	7,001	37,763
Transmission Line	1,350	503	1,853
Total (Direct Cost)	45,052	53,634	98,686
Project Controlling	4,441	10,362	14,803
Land Acquisition	0	664	664
Relocation of Road	1,324	5,587	6,911
Relocation of Transmission Line	119	57	176
Total (Project Cost)	50,936	70,304	121,240
Interest during Construction	12,983	22,792	35,775
Grand Total (Investment Cost)	63,919	93,096	157,015

Table 11–10 Fund Requirement in Each Year of Artvin Project (1/2)

F; Foreign Currency
D; Domestic Currency
T; Total

(x 10^6 TL)

Item \ Year		-2nd year	-1st year	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	Total	Note
Civil Works														
Care of River	F			182	390								572	
	D			973	1,256								2,229	
	T			1,155	1,646								2,801	
Dam	F			253	506	2,233	2,357	1,905					7,254	
	D			425	849	6,054	6,511	5,232					19,071	
	T			678	1,355	8,287	8,868	7,137					26,325	
Waterway	F			19	241	95	185						540	
	D			76	1,058	435	950						2,519	
	T			95	1,299	530	1,135						3,059	
Powerhouse & Switchyard	F			129	228	704	50						1,111	
	D			617	1,279	4,468	96						6,460	
	T			746	1,507	5,172	146						7,571	
Access Road	F			100				20					120	
	D			473				49					522	
	T			573				69					642	
Preparatory Works	F			534									534	
	D			448									448	
	T			982									982	
Camp Facility	F			1,120									1,120	
	D			5,060									5,060	
	T			6,180									6,180	
Sub-total	F			2,337	1,365	3,032	2,592	1,925					11,251	
	D			8,072	4,442	10,957	7,557	5,281					36,309	
	T			10,409	5,807	13,989	10,149	7,206					47,560	
Contingency	F			351	205	455	389	289					1,689	
	D			1,211	666	1,644	1,134	792					5,447	
	T			1,562	871	2,099	1,523	1,081					7,136	
Sub-total	F			2,688	1,570	3,487	2,981	2,214					12,940	
	D			9,283	5,108	12,601	8,691	6,073					41,756	
	T			11,971	6,678	16,088	11,672	8,287					54,696	

Table 11–10 Fund Requirement in Each Year of Artvin Project (2/2)

F; Foreign Currency
D; Domestic Currency
T; Total

(x 10^6 TL)

Item \ Year		-2nd year	-1st year	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	Total	Note
Hydraulic Equipment	F					0	0	0	0				0	
	D					1,458	972	972	972				4,374	
	T					1,458	972	972	972				4,374	
Electromechanical Equipment	F				3,076	3,076	9,229	12,305	3,076				30,762	
	D				307	701	2,296	2,996	701				7,001	
	T				3,383	3,777	11,525	15,301	3,777				37,763	
Transmission Line	F					214	778	358					1,350	
	D					22	147	334					503	
	T					236	925	692					1,853	
Total (Direct Cost)	F			2,688	4,646	6,777	12,988	14,877	3,076				45,052	
	D			9,283	5,415	14,782	12,106	10,375	1,673				53,634	
	T			11,971	10,061	21,559	25,094	25,252	4,749				98,686	
Project Controling	F			539	453	970	1,129	1,136	214				4,441	
	D			1,257	1,056	2,264	2,635	2,652	498				10,362	
	T			1,796	1,509	3,234	3,764	3,788	712				14,803	
Land Acquisition	F			0	0								0	
	D			332	332								664	
	T			332	332								664	
Relocation of Road	F	256	255	407	406								1,324	
	D	1,082	1,081	1,712	1,712								5,587	
	T	1,338	1,336	2,119	2,118								6,911	
Relocation of Transmission Line	F						83	36					119	
	D						8	49					57	
	T						91	85					176	
Total (Project Cost)	F	256	255	3,634	5,505	7,747	14,200	16,049	3,290				50,936	
	D	1,082	1,081	12,584	8,515	17,046	14,749	13,076	2,171				70,304	
	T	1,338	1,336	16,218	14,020	24,793	28,949	29,125	5,461				121,240	
Interest during Construction	F	12	36	221	655	1,285	2,327	3,764	4,683				12,983	
	D	52	155	803	1,806	3,019	4,530	5,852	6,575				22,792	
	T	64	191	1,024	2,461	4,304	6,857	9,616	11,258				35,775	
Grand Total (Investment Cost)	F	268	291	3,855	6,160	9,032	16,527	19,813	7,973				63,919	
	D	1,134	1,236	13,387	10,321	20,065	19,279	18,928	8,746				93,096	
	T	1,402	1,527	17,242	16,481	29,097	35,806	38,741	16,719				157,015	

CHAPTER 12 ECONOMIC EVALUATION

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CHAPTER 12. ECONOMIC EVALUATION

12.1 Economic Evaluation

12.1.1 Methodology

(1) Basic Approach

In general, economic evaluation of a development project is designed to measure its socio-economic impacts on the country as a whole by comparing two cases; the project is implemented and the project is not implemented.

The economic evaluation employs indices such as net present value of the project, benefit/cost ratio and economic internal rate of return which are calculated from benefits and costs of the project by using the Discounted Cash Flow method.

To determine benefits and costs of a project, market prices obtained should be converted to real benefits and costs, since these are generally distorted due to taxes, government subsidies, import control, import duties, public charges, minimum wages, and other government intervention and monopolistic pricing.

The World Bank and other international financing organizations employ international market prices to estimate real project costs and benefits. A method of economic evaluation employed by the World Bank and other international financing organizations may be summarized as shown in Fig. 12-1.

Phase 1: To exclude items to be transferred to national income from market prices

Phase 2: To convert market prices for trade goods, non-trade goods, skilled labor, unskilled labor and other items to real (border) prices

Phase 3: To determine the internal rate of return on the basis of real benefits and costs, and compare it with opportunity cost of capital in the country

Phase 4: To carry out socio-economic evaluation in consideration of national saving and income distribution.

For this project, economic evaluation up to Phase 3 is carried out (See Fig. 12-1).

In economic evaluation of hydroelectric power development projects, it is more realistic to measure and compare benefits and costs of the project by using the long-term marginal cost method or the tariff system method, if benefits can be accounted for.

However, if benefits cannot be easily accounted for and the project is incorporated in a long range electric power development program which is a part of national socio-economic development policy to satisfy future power demand (i.e., if the project is not implemented, it will be substituted for by other means of power supply), an alternative plant approach will be employed to measure and evaluate economic costs of the proposed project and the alternative project.

For this project, the alternative plant approach is employed.

(2) Conversion Factors to Determine Economic Costs

When project benefits and costs are evaluated at international market prices, goods and services consumed for the project should be converted to border prices. In simple terms, a border price for imported goods is expressed as CIF price at a unloading port and that for exported goods as FOB price at a shipping port. As for non-trade goods, economic prices for each good and service are determined by using its opportunity cost and evaluated by international market prices. However, this process is very difficult to carry out, so that conversion factors are used instead.

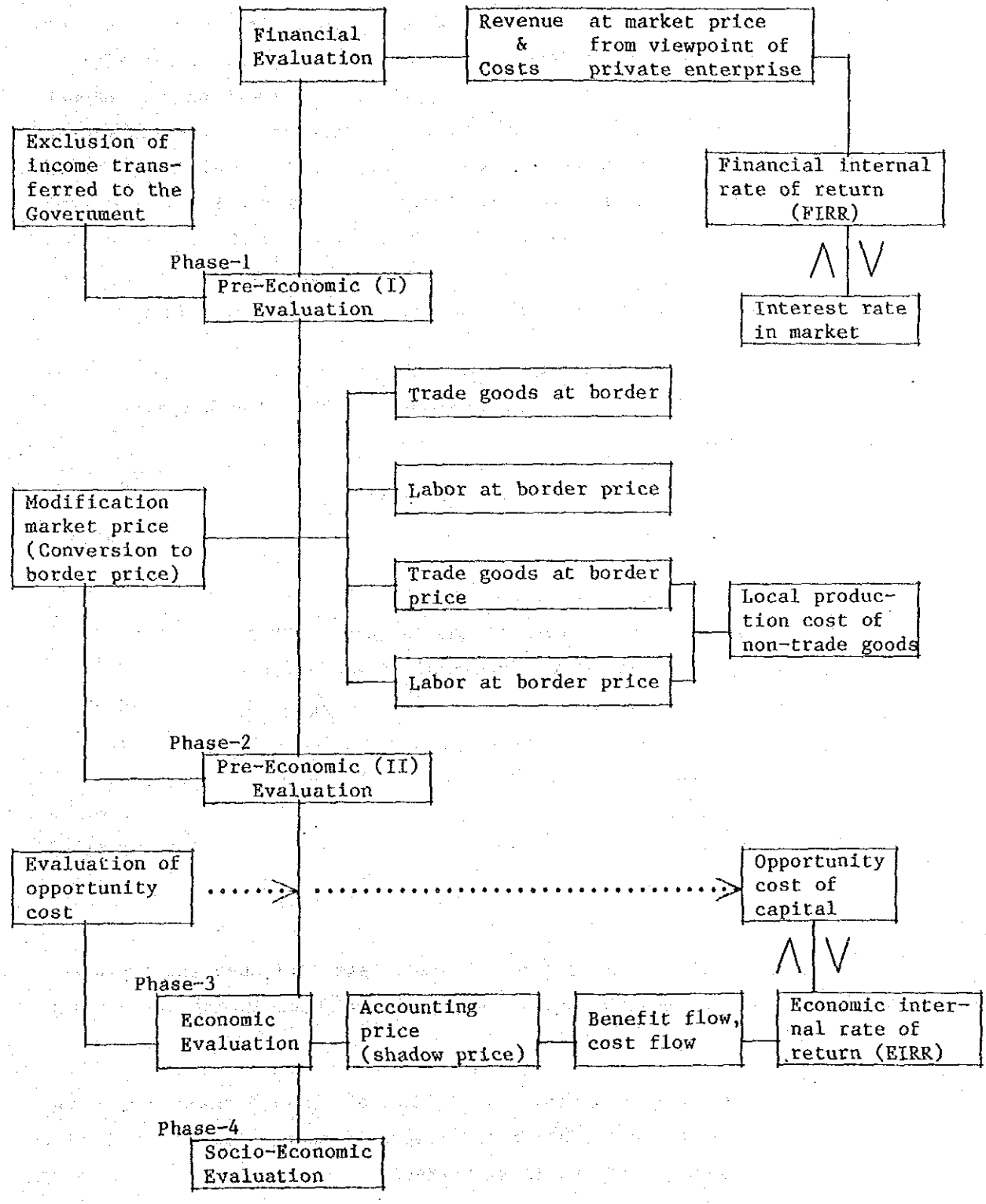

Fig. 12–1 Flow Chart of Economic Evaluation of Project

Skilled and unskilled labors obtained locally are converted to border prices by using shadow wage rates. The conversion factors can be calculated in proportion to weighted averages of values of major export and import items, import duties, export subsidies, and import control. The standard conversion factor determined from total values of major export and import items is used as a general indicator to show distortion of domestic prices from international market prices, and the conversion factor based on values of consumption goods exported and imported is called a consumption goods conversion factor.

Conversion factors applied to Turkey are already published on "Staff Working Paper No.392, May 1980" of the World Bank, as follows:

National Parameters

Parameters	Value
Standard conversion factor (SCF)	0.59
Conversion factor for consumption goods (CF_C)	0.79
Conversion factor for intermediate goods (CF_I)	0.55
Conversion factor for capital goods (CF_K)	0.52
Marginal product of capital	12 %
Shadow wage rates (SPI)	
Rural sector	0.56
Urban informal sector	0.55
Urban formal sector	0.57

Among these parameters, the JICA team estimated the representative standard conversion factor as shown in the table which follows.

In the past ten years, mechanism of Turkish economy has not changed to an extent to significantly change its distortion in relation to international market.

Also, no drastic change in national policy has been made to significantly change the Turkish economy. In view of the fact that there is a small difference, 1 ~ 3%, between standard

conversion factors estimated by the World Bank and the JICA team, for the purpose of economic evaluation of the project the parameters estimated by the World Bank were used.

Item	WB Working Paper	Estimation by JICA Team
CIF Value of Imports (M)	1974-1978 average 4808 x 10^6US$	1979-1983 average 7998 x 10^6US$
FOB Value of Exports (X)	1974-1978 average 1787 x 10^6US$	1979-1983 average 4270 x 10^6US$
Average Duty on Imports Rate (tm)	1484 x 10^6US$ 31%	3174 x 10^6US$ 40% 1/
Average Tax Rebate on Exports Rate (tx)	138 x 10^6US$ 7.6%	299 x 10^6US$ 7% 1/
Standard Conversion Factor (SCFa) Without Premium Rate	0.80	0.81
Standard Conversion Factor (SCFb) With Premium Rate of 60%	0.59	0.61

(1) $SCFa = \frac{M + X}{M(1+tm) + X(1-tx)}$

$SCFb = \frac{M + X}{M(1+tm+TM) + X(1-tx)}$

Note: 1/ Estimated by JICA Team

As a result, conversion factors to determine economic costs of the project are established as follows.

Table 12–1 Conversion Factors to Determine Economic Cost

Currency	Item	Conversion Factor
Domestic	Skilled Labor	0.79
	Unskilled Labor	0.56
	Material Cost (Trade goods)	0.79
	" (Non-trade goods)	0.55
	Transportation Cost	0.59
	Land Cost	0.59
	Project Controlling Cost	0.79
Foreign	Imported Plants (CIF)	1.0
	Expatriate Labor	1.0
	Project Controlling	1.0

(3) Selection of an Alternative Thermal Power Plant

As of 1984, hydropower plants occupy approximately 46% of total electric power capacity in Turkey, while thermal power plants being 54%. The latter is further divided according to type of fuel; 55% by lignite, 39% by fuel oil, and 6% by diesel oil and hard coal.

At present, power demand is not fully satisfied by domestic supply; as of 1984, approximately 8% of power demand depends on import. The Turkish government's immediate target is to solve the shortage of domestic energy supply as early as possible, and for this purpose, the government contemplates to upgrade and expand thermal power generation facilities, to provide base and middle loads, while developing hydropower utilizing abundant water resources available in the country, so as to increase the operation efficiency of hydropower generation. Energy development policies of the government can be summarized as follows:

a) To give priority to utilization of domestic energy sources (particularly, hydropower and lignite), so far as economically feasible.

b) To consider import of energy.

c) To develop alternative energy, such as geothermal, solar, and biomass.

d) To induce funds for development from domestic and foreign private sectors.

Based on these policies, lignite-fired thermal power is considered to be the primary candidate among thermal power facilities to be developed in the future. Lignite is already used as a major energy source in the country's thermal power generation. Estimated reserves of lignite in the country is approximately 13 billion tons. However, a half of the reserve is low-grade coals (950 - 1,000 kcal/kg) which require relatively large capacity plants for combustion, drying and handling facilities as well as high station service use, thereby increasing power generation costs. Although use of lignite offers advantages in saving of foreign currency and incentive to industrial development, after completion of Beysehir and Elbistan B Projects, it is not likely that lignite will continue to play a major role in thermal power generation on an intermediate and long term basis, in consideration of favorable world coal supply.

Therefore, lignite is not considered appropriate for an alternative thermal power plant.

On the other hand, fuel oil used for thermal power generation is all imported. The import accounted for approximately 50% of total export revenues of the country although its share has slightly been decreased in recent years because of drastic drop of price on the international oil market. If the oil price continues to be at present low level, oil fired thermal power can be considered as a main thermal in the electric system in the future. However, international oil market pri-

ces are often affected by political as well as economic or military factors, so that the price is not free from the risk of fluctuation and short supply in the mid and long term. This means, stable supply of fuel oil, which is essential to power generation, is not assured in terms of price and quantity. Thus, oil-fired thermal cannot be considered as an appropriate alternative thermal power plant.

Nuclear power may be considered as a major energy source in the future for the country which does not have natural resources other than lignite and hydropower. However, the country does not have nuclear power technology and human resources required for siting, planning, design, construction, operation, maintenance, fuel transport and loading into reactor. As a result, there is much uncertainty to select it as an alternative thermal power plant.

The most appropriate alternative power plant, for the time being, between lignite-fired thermal power and nuclear power appears to be imported coal-fired thermal power. Coals are widely produced around the world. If power stations are sited along the coast, a wide variety of sources of import can be selected to ensure stable supply in terms of quality, quantity and price. Coal-fired thermal power stations recently constructed have considerably upgraded equipment and technology, with efficient operation and maintenance as well as high combustion efficiency being attained by using computer systems. As a result, these plants are capable of handling diversified fuels in the most efficient way and accomplishing reduction of overall power generation costs.

Based on the above reasoning, a thermal power plant using imported coals is selected as an alternative plant in this economic evaluation.

12.1.2 Economic Cost of the Project

The economic cost of the Project is obtained by applying the economic cost conversion factor of Table 12-1 to the financial cost that was obtained in Chapter 11 "Construction Planning and Cost Estimation", according to the method described in 12.1.1. The economic cost of the Project thus obtained is presented below (cost for substation in Hopa and Ankara is excluded).

The operation and maintenance cost is obtained by applying the following values to the economic construction cost.

Civil facility construction cost	0.3%
Hydraulic equipment cost	1.5%
Electro-Mechanical equipment cost	1.5%
Transmission line cost	1.5%

(1) Economic Cost of Yusufeli Project

As indicated in Table 12-2, the initial investment in the economic cost of this Project is 206,108 x 10^6 TL.

The total cost throughout the project life (369,539 x 10^6 TL) and the flow of economic costs in each year are as presented in Table 12-3.

(2) Economic Cost of Artvin Project

As indicated in Table 12-4, the initial investment in the economic cost of this Project is 103,932 x 10^6 TL.

The total cost throughout the project life (213,712 x 10^6 TL) and the flow of economic costs in each year are as presented in Table 12-5.

Table 12–2 Economic Costs in Initial Stage for Yusufeli Project

Unit: 10^6 TL

Year	-2	-1	1	2	3	4	5	6	7	8	9	Total
Foreign Currency												
(1) Machine and Equipment	673	672	3,266	5,972	6,021	11,290	14,004	13,513	16,549	9,082	0	84,844
(1) Materials			800	0	0	0	0	443	1,672	1,321	3,802	4,236
(1) Engineering Fee	0	0	670	966	788	1,160	1,553	1,262	1,371	988	210	8,968
(1) Sub-total	673	672	4,736	6,938	6,809	12,450	15,557	15,218	19,592	11,391	4,012	98,048
(2) Equipment & Materials							2,965	7,265	3,154	1,845		15,229
(2) Engineering Fee							147	408	252	188		995
(2) Sub-total							3,112	7,673	3,406	2,033		16,224
(3) Total	673	672	4,736	6,938	6,809	12,450	18,669	22,891	22,998	13,424	4,012	114,272
Domestic Currency												
(1) Land Acquisition	0	0	1,783	1,783	1,783	1,782						7,131
(1) Materials (trade goods)	141	141	380	341	162	193	617	734	360	273		3,342
(1) Materials (non-trade goods)	965	965	3,879	5,482	3,636	4,553	6,726	3,912	3,240	2,939		36,315
(1) Transportation	0	0	7	0	0	17	25	34	62	72	17	234
(1) Labour Cost	605	605	2,149	2,874	2,009	2,844	3,741	2,691	2,649	2,307	376	22,817
(1) Administration Cost	0	0	1,234	1,780	1,451	2,138	2,864	2,325	2,527	1,820	386	16,525
(1) Sub-total	1,711	1,711	9,450	12,260	9,013	11,522	13,973	9,696	8,838	7,411	779	86,364
(2) Transportation								63	125	127		315
(2) Labour Cost								658	1,216	1,352		3,226
(2) Administration Cost							270	751	464	346		1,831
(2) Sub-total							270	1,472	1,905	1,825		5,472
(3) Total	1,711	1,711	9,450	12,260	9,013	11,522	14,243	11,168	10,743	9,236	779	91,836
GRAND TOTAL	2,384	2,383	14,186	19,198	15,822	23,972	32,912	34,059	33,741	22,660	4,791	206,108

Note: (1) Cost for Dam, Power Plant & transmission line from Yusufeli to Hopa

(2) Cost for transmission line from Hopa to Ankara

Table 12–3 Economic Cash Flow of Yusufeli Project

Unit: 10^6 TL

Year	Investment Cost			O & M	Total	Transmission Line (Hopa – Ankara)			Grand Total
	Dam and Equipment	Transmission Line (Yusufeli-Hopa)	Sub Total			Investment Cost	O & M	Total	
-2	2,384		2,384		2,384				2,384
-1	2,383		2,383		2,383				2,383
1	14,186		14,186		14,186				14,186
2	19,198		19,198		19,198				19,198
3	15,822		15,822		15,822				15,822
4	23,972		23,972		23,972				23,972
5	29,530		29,530		29,530	3,382		3,382	32,912
6	24,405	509	24,914		24,914	9,145		9,145	34,059
7	26,388	2,042	28,430		28,430	5,311		5,311	33,741
8	16,694	2,108	18,802		18,802	3,858		3,858	22,660
9	4,791		4,791		4,791			0	4,791
10			0	1,391	1,391		325	325	1,716
~38			0	1,391	1,391		325	325	1,716
39	6,888		6,888	1,391	8,279		325	325	8,604
40	8,058		8,058	1,391	9,449	3,382	325	3,707	13,156
41	10,408	509	10,917	1,391	12,308	9,145	325	9,470	21,778
42	15,231	2,042	17,273	1,391	18,664	5,311	325	5,636	24,300
43	5,867	2,108	7,975	1,391	9,366	3,858	325	4,183	13,549
44	4,824		4,824	1,391	6,215		325	325	6,540
~59			0	1,391	1,391		325	325	1,716
Total	231,029	9,318	240,347	12,519	309,897	43,392	16,250	59,642	369,539

Table 12–4 Economic Cost in Initial Stage for Artvin Project

Unit: 10^6 TL

Year	-2	-1	1	2	3	4	5	6	7	8	9	Total
Foreign Currency												
Machine and Equipment	256	255	2,621	5,052	6,563	12,210	14,519	3,076				44,552
(1) Materials			474	0	214	861	394	0				1,943
Engineering Fee			539	453	970	1,129	1,136	214				4,441
Sub-total	256	255	3,634	5,505	7,747	14,200	16,049	3,290				50,936
Equipment & Materials				1,730	4,238	1,840	1,077					8,885
(2) Engineering Fee				86	238	147	110					581
Sub-total				1,816	4,476	1,987	1,187					9,466
(3) Total	256	255	3,634	7,321	12,223	16,187	17,236	3,290				60,402
Domestic Currency												
Land Acquisition			189	189								378
Materials (trade goods)	55	55	279	269	1,265	1,435	902					4,260
Materials (non-trade goods)	321	321	3,614	2,106	4,455	2,875	2,148	429				16,269
(1) Transportation	0	0	4	0	14	54	83	14				169
Labour Cost	553	553	1,512	1,342	2,283	2,149	2,280	406				11,078
Administration Cost		0	993	834	1,789	2,082	2,095	393				8,186
Sub-total	929	929	6,591	4,740	9,806	8,595	7,508	1,242				40,340
Transportation				0	42	84	85					211
(2) Labour Cost				0	378	756	777					1,911
Administration Cost				158	438	270	202					1,068
Sub-total				158	858	1,110	1,064					3,190
(3) Total	929	929	6,591	4,898	10,664	9,705	8,572	1,242				43,530
GRAND TOTAL	1,185	1,184	10,225	12,219	22,887	25,892	25,808	4,532				103,932

Note: (1) Cost for Dam, Power Plant & transmission line from Artvin to Hopa

(2) Cost for transmission line from Hopa to Ankara

Table 12–5 Economic Cash Flow of Artvin Project

Unit: 10^6 TL

Year	Investment Cost			O & M	Total	Transmission Line (Hopa - Ankara)			Grand Total
	Dam and Equipment	Transmission Line (Artvin-Hopa)	Sub Total			Investment Cost	O & M	Total	
-2	1,185		1,185		1,185			0	1,185
-1	1,184		1,184		1,184			0	1,184
1	10,225		10,225		10,225			0	10,225
2	10,245		10,245		10,245	1,974		1,974	12,219
3	17,307	246	17,553		17,553	5,334		5,334	22,887
4	21,844	951	22,795		22,795	3,097		3,097	25,892
5	22,896	661	23,557		23,557	2,251		2,251	25,808
6	4,532		4,532		4,532			0	4,532
7				886	886		190	190	1,076
8				886	886		190	190	1,076
36				886	886		190	190	1,076
37	3,894		3,894	886	4,780	1,974	190	2,164	6,944
38	4,816	246	5,062	886	5,948	5,334	190	5,524	11,472
39	12,344	951	13,295	886	14,181	3,097	190	3,287	17,468
40	16,254	661	16,915	886	17,801	2,251	190	2,441	20,242
41	4,158		4,158	886	5,044		190	190	5,234
42				886	886		190	190	1,076
56				886	886		190	190	1,076
Total	130,884	3,716	134,600	44,300	178,900	25,312	9,500	34,812	213,712

12.1.3 Parameters and Economic Costs of Alternative Thermal Power Plant

As discussed earlier, an imported coal fired thermal power plant was assumed as the alternative facility with which the economic benefit of this Project is calculated.

In this evaluation method, the economic costs of this alternative thermal power plant are regarded as the benefit to be realized by this Project, and they are compared to the economic costs of this Project.

As most of the output of this Project will be transmitted to the large load centers such as Ankara, the alternative thermal power plant which is taken as the basis of the economic evaluation was assumed to be located at the Zonguldak site on the coast of the Black Sea, which is approximately 200 km to the northeast of Ankara, and the output of this thermal power plant was assumed to be transmitted to Ankara.

The alternative thermal power plant was assumed to be capable of supplying power at the same service level as this Project (in terms of effective dependable capacity and annual available energy).

In addition, it was assumed that the reference point at which the Project and the alternative thermal power plant are compared was Ankara to which the output of the Project is to be supplied, as stated above. The basic criteria used in this evaluation are presented in Table 12-6.

The construction cost of a standard thermal power plant (300 MW x 2 units) of 233,600 x 10^6 T.L (excluding tax and interest during construction), which was introduced in "Chapter 9, Development Plan", was used as the construction cost of the standard coal fired thermal power plant (300 MW x 2 units). The construction cost of this standard alternative thermal plant was used as the basis of estimating the construction cost of the alternative thermal power plant having potentials equivalent to this Project. The power generated by this alternative thermal power plant was assumed to be transmitted to Ankara by a single circuit 380 kV transmission line. The constrution cost of this transmission line was assumed to be 6,954 x 10^6 T.L (excluding tax and interest during construction).

Table 12–6 Basic Criteria for Economic Study

Item	Description
Method of Analysis	Discounted Cash Flow Method
Study Period	50 Years plus Construction Period
Discount Rate	9.5%
Escalation	Not Considered
Shadow Price Factor (Conversion Factor)	Considered
Service Life of Facility	
Dam & Reservoir	50 Years
Hydro-power Plant	35 Years
Coal-fired Thermal Plant	25 Years
Substation	25 Years
Transmission Line	35 Years
Conversation Rate of Currency (As of July, 1985)	US$1.00 = 550 T.L

(1) Parameters and Economic Costs of Alternative Thermal Power Plant for Yusufeli Project

(a) Plant Parameters

The plant parameters of the alternative thermal power plant having potentials equivalent to Yusufeli Project are presented in Table 12-7.

(b) Initial Investment Cost

The initial investment cost required for construction of the alternative thermal power plant (617.3 MW) was estimated as shown in the following table.

unit: (10^6 T.L)

	1st Year	2nd Year	3rd Year	4th Year	Total
Financial Cost (excluding tax and interest during construction)					
	64,890	67,295	72,100	36,050	240,355
Economic Cost					
Foreign currency	45,420	47,110	50,470	25,235	168,235
Domestic currency	11,020	11,425	12,245	6,120	40,810
Total	56,440	58,535	62,715	31,355	209,045

The initial investment on the transmission line for the alternative thermal power plant (380 kV x 1 cct. x 200 km) was estimated as below.

unit: (10^6 T.L)

	1st Year	2nd Year	3rd Year	4th Year	Total
Financial Cost (excluding tax and interest during construction)					
	--	1,001	4,278	1,675	6,954
Economic Cost					
Foreign currency	--	900	3,175	494	4,569
Domestic currency	--	80	794	818	1,692
Total	--	980	3,969	1,312	6,261

(c) Annual Operation, Maintenance and Repair Cost

Thermal power plant; $209,045 \times 10^6 \times 0.03 = 6,271 \times 10^6$ T.L

Transmission line ; $6,261 \times 10^6 \times 0.015 = 94 \times 10^6$ T.L

Total $6,365 \times 10^6$ T.L

(d) Fuel Cost

Unit Fuel Cost;

0.86 x 1,000 kCal/kWh x 4,09 T.L/1,000 kCal/0.35

= 10.05 T.L/kWh

Annual Fuel Cost;

10.05 T.L/kWh x $1,847.3 \times 10^6$ kWh

= $18,565 \times 10^6$ T.L

(e) Economic Cost

The economic cost flow of the alternative thermal power plant, which is the benefit of Yusufeli Project, is presented in Table 12-8.

Table 12–7 Alternative Thermal Power Plant for Studying Economic Justification (for Yusufeli Project)

Item	Unit	Coal-fired Thermal Power Plant	Yusufeli Hydroelectric Project
Installed Capacity	MW	617.3	540.0
Dependable Capacity	MW	617.3	505.8
Losses	%	24.2	7.5
Effective Dependable Capacity	MW	467.9	467.9
Annual Energy Production	10^6 kWh	1,847.3	1,704.6
Station Service Use	%	7% for kW,8% for kWh	) 3.3
Transmission Loss	%	3.5% for kW,3% for kWh	
Annual Available Energy	10^6 kWh	1,648.5	1,648.5
Fuel Consumption Rate	kg/kWh	0.406	
Unit Fuel Price 1/	TL/kg	24.75	
Construction cost 2/	10^6 TL	240,360	
Unit Construction cost 2/	TL/kW	389,333	
O&M, Administration Cost	10^6 TL/yr.	6,271	
Fuel Cost	10^6 TL/yr.	18,565	

1/ not including taxes
2/ not including interest during construction & taxes including project controlling cost

Note:

1. 1 Installed Capacity

$$= \frac{\text{Effective Dependable Capacity}}{(1-\text{Station Service Use})\times(1-\text{Failure Loss})\times(1-\text{Repair Loss})\times(1\ \text{Trans. Loss})}$$

$$= \frac{467.9\ \text{MW}}{(1-0.07)\times(1-0.04)\times(1-0.12)\times(1-0.035)} \doteq 617.3\ \text{MW}$$

2 Annual Energy Production

$$= \frac{\text{Annual Available Energy}}{(1-\text{Station Service Use})\times(1-\text{Trans. loss})} = \frac{1,648.5\times10^6\ \text{kWh}}{(1-0.08)\times(1-0.003)}$$

$$= 1,847.3 \times 10^6\ \text{kWh}$$

Table 12–8 Benefit Flow of Yusufeli Project

unit: (10^6 T.L)

Year	Alternative Thermal Power Plant				Transmission Line			Total
	Investment Cost	O&M Cost	Fuel Cost	Sub-Total	Investment Cost	O&M Cost	Sub-Total	
1				-			-	-
5				-			-	-
6	56,440			56,440				56,440
7	58,535			58,535	980		980	59,515
8	62,715			62,715	3,969		3,969	66,684
9	31,355			33,355	1,312		1,312	34,667
10		6,271	18,565	24,836		94	94	24,930
11		6,271	18,565	24,836		94	94	24,930
.		.	.	.		.	.	.
.		.	.	.		.	.	.
.		.	.	.		.	.	.
30		6,271	18,565	24,836		94	94	24,930
31	56,440	6,271	18,565	81,276		94	94	81,370
32	58,535	6,271	18,565	83,371		94	94	83,465
33	62,715	6,271	18,565	87,551		94	94	87,645
34	31,355	6,271	18,565	56,191		94	94	56,285
35		6,271	18,565	24,836		94	94	24,930
.		.	.	.		.	.	.
.		.	.	.		.	.	.
.		.	.	.		.	.	.
41		6,271	18,565	24,836		94	94	24,930
42		6,271	18,565	24,836	980	94	1,074	25,910
43		6,271	18,565	24,836	3,969	94	4,063	28,899
44		6,271	18,565	24,836	1,312	94	1,406	26,242
.		.	.	.		.		
.		.	.	.		.	94	24,930
.		.	.	.		.	.	.
.		.	.	.		.	.	.
.		.	.	.		.	.	.
56		6,271	18,565	24,836		94	94	24,930
57		6,271	18,565	24,836		94	94	24,930
58		6,271	18,565	24,836		94	94	24,930
59		6,271	18,565	24,836		94	94	24,930
Total	418,090	313,550	928,250	1,659,890	12,522	4,700	17,222	1,677,112

(2) Parameters and Economic Costs of Alternative Thermal Power Plant for Artvin Project

(a) Plant Parameters

The plant parameters of an alternative thermal power plant having potentials equivalent to Artvin Project are presented in Table 12-9.

(b) Initial Investment Cost

The initial investment cost for construction of the alternative thermal power plant (361.0 MW) was estimated as given in the table below.

unit: (10^6 T.L)

	1st Year	2nd Year	3rd Year	4th Year	Total
Financial Cost (excluding tax and interest during construction)					
	37,949	39,354	42,165	21,082	140,550
Economic Cost					
Foreign currency	26,564	27,548	29,516	14,757	98,385
Domestic currency	6,444	6,682	7,159	3,580	23,865
Total	33,008	34,230	36,675	18,337	122,250

The initial investment on the transmission line for the alternative thermal power plant (380 kV x 1 cct. x 200 km) was estimated as below. (As discussed before.)

unit: (10^6 T.L)

	1st Year	2nd Year	3rd Year	4th Year	Total
Financial Cost (excluding tax and interest during construction)					
	--	1,001	4,278	1,675	6,954
Economic Cost					
Foreign currency	--	900	3,175	494	4,569
Domestic currency	--	80	794	818	1,692
Total	--	980	3,969	1,312	6,261

(c) Annual Operation, Maintenance and Repair Cost

Thermal power plant; $122,250 \times 10^6 \times 0.03 = 3,668 \times 10^6$ T.L

Transmission line ; $6,261 \times 10^6 \times 0.015 = 94 \times 10^6$ T.L

Total $3,762 \times 10^6$ T.L

(d) Fuel Cost

Unit Fuel Cost;

10.05 T.L/kWh (as calculated before).

Annual Fuel Cost;

10.05 T.L/kWh $\times 1,047.8 \times 10^6$ kWh

$= 10,530 \times 10^6$ T.L

(e) Economic Cost

The economic cost flow of the alternative thermal power plant, which is the benefit of Artvin Project, is presented in Table 12-10.

Table 12–9 Alternative Thermal Power Plant for Studying Economic Justification (for Artvin Project)

Item	Unit	Coal-fired Thermal Power Plant	Artvin Hydroelectric Project
Installed Capacity	MW	361.0	320.0
Dependable Capacity	MW	361.0	303.6
Losses	%	22.2	7.5
Effective Dependable Capacity	MW	280.8	280.8
Annual Energy Production	10^6 kWh	1,047.8	988.8
Station Service Use	%	7% for kW,8% for kWh	) 3.3
Transmission Loss	%	1% for kW,0.8% for kWh	
Annual Available Energy	10^6 kWh	956.2	956.2
Fuel Consumption Rate	kg/kWh	0.406	
Unit Fuel Price 1/	TL/kg	24.75	
Construction Cost 2/	10^6 TL	140,550	
Unit Construction Cost 2/	TL/kW	389,333	
O&M, Administration Cost	10^6 TL/yr.	3,668	
Fuel Cost	10^6 TL/yr.	10,530	

1/ not including taxes
2/ not including interest during construction & taxes including project controlling cost

Note:

1. 1 Installed Capacity

$$= \frac{\text{Effective Dependable Capacity}}{(1\text{-Station Service Use})\times(1\text{-Failure Loss})\times(1\text{-Repair Loss})\times(1\text{ Trans. Loss})}$$

$$= \frac{280.8\text{ MW}}{(1-0.07)\times(1-0.04)\times(1-0.12)\times(1-0.01)} \doteq 361.0\text{ MW}$$

2 Annual Energy Production

$$= \frac{\text{Annual Available Energy}}{(1\text{-Station Service Use})\times(1\text{-Trans. loss})} = \frac{956.2}{(1-0.08)\times(1-0.008)}$$

$$\doteq \frac{956.2}{0.9126} \doteq 1{,}047.8 \times 10^6\text{ kWh}$$

Table 12–10 Benefit Flow of Artvin Project

unit: (10^6 T.L)

Year	Alternative Thermal Power Plant				Transmission Line			Total
	Investment Cost	O&M Cost	Fuel Cost	Sub-Total	Investment Cost	O&M Cost	Sub-Total	
1				-			-	-
2				-			-	-
3	33,008			33,008			-	33,008
4	34,230			34,230	980		980	35,210
5	36,675			36,675	3,969		3,969	40,644
6	18,337			18,337	1,312		1,312	19,649
7		3,668	10,530	14,198		94	94	14,292
.		.	.	.		.	.	.
.		.	.	.		.	.	.
.		.	.	.		.	.	.
27		3,668	10,530	14,198		94	94	14,292
28	33,008	3,668	10,530	47,206		94	94	47,300
29	34,230	3,668	10,530	48,428		94	94	48,522
30	36,675	3,668	10,530	50,873		94	94	50,967
31	18,337	3,668	10,530	32,535		94	94	32,629
32	18,337	3,668	10,530	14,198		94	94	14,292
.		.	.	.		.	.	.
.		.	.	.		.	.	.
.		.	.	.		.	.	.
38		3,668	10,530	14,198		94	94	14,292
39		3,668	10,530	14,198	980	94	1,074	15,272
40		3,668	10,530	14,198	3,969	94	4,063	18,261
41		3,668	10,530	14,198	1,312	94	1,406	15,604
42		3,668	10,530	14,198		94	94	14,292
.		.	.	.		.	.	.
.		.	.	.		.	.	.
.		.	.	.		.	.	.
53		3,668	10,530	14,198		94	94	14,292
54		3,668	10,530	14,198		94	94	14,292
55		3,668	10,530	14,198		94	94	14,292
56		3,668	10,530	14,198		94	94	14,292
Total	244,500	183,400	526,500	954,400	12,522	4,700	17,222	971,622

12.1.4 Economic Evaluation of the Projects

As described in 12.1.1, the economic evaluation of this Project is evaluated by the net present value (NPV), the benefit cost ratio (B/C) and the economic internal rate of return (EIRR) which are calculated by the discounted cash flow method. These indices are obtained by the following methods.

* Net Present Value (NPV) Method

$$NPV = \sum_{t=0}^{n} \frac{B_t - C_t}{(1+r)^t}$$

where: B_t ; the benefit in the "t"th year.

C_t ; the cost in the "t"th year.

r ; the discount rate.

n ; the period of calculation.

* Benefit-Cost Ratio (B/C) Method

$$B/C = \sum_{t=0}^{n} \frac{\frac{B_t}{(1+r)^t}}{\frac{C_t}{(1+r)^t}}$$

where: B_t ; the benefit in the "t"th year.

C_t ; the cost in the "t"th year.

r ; the discount rate.

n ; the period of calculation.

* Economic Internal Rate of Return (EIRR) Method

$$\sum_{t=0}^{n} \frac{B_t - C_t}{(1+r)^t} = 0$$

where: B_t ; the benefit in the "t"th year.

C_t ; the cost in the "t"th year.

r ; the discount rate (the internal rate of return).

n ; the period of calculation.

The amounts of benefit and cost expressed for each year throughout the project life are called the cash flow. In presenting a cash flow, including the project cost incurred during the construction period, the operation, maintenance and fuel costs after the commencement of operation while capital costs such as interest and depreciation are excluded from the flow. The benefits and costs in the cash flow are expressed by the boarder prices. When the benefit of a hydroelectric project is not expressed by the amount of electric tariff which the consumers are willing to pay, but is expressed in the cost of an alternative thermal power plant, the economic internal rate of return of the hydroelectric project is called the equalized discount rate (EDR) as the hydroelectric project cost and the alternative thermal plant cost (benefit) becomes equal at that discount rate.

Together with the EDR method, the evaluation by the economic internal rate of return was also studied where the benefit of the hydroelectric power was the assumed expected revenue from the electricity sales, rather than the amount the customers are willing to pay as discussed above.

(1) Economic Evaluation of Yusufeli Project

(a) Net Present Value (B-C) and Benefit-Cost Ratio (B/C)

The flow of economic costs of this project throughout the project life is presented in Table 12-3, and the net present value in the first year of the project is 144,017 x 10^6 TL (C) at a discount rate of 9.5%.

The net present value (B) of an alternative thermal power plant is 236,972 x 10^6 TL.

Consequently, the net present value (B-C) of the Project is 92,955 x 10^6 TL, and the Benefit-Cost Ratio (B/C) is 1.65.

As indicated by these two indices, the cost of construction and operation of this Project is smaller than those of an alternative thermal plant which can provide equiva-

lent service, and it can be concluded that the Project is superior than the alternative plan.

(b) Economic Internal Rate of Return (EDR and EIRR)

The discount rate at which the present values of the investments on this Project and on the alternative thermal power plant becomes equal in the first year of the projects (that is, EDR), is 17.3% as indicated in Table 12-11. Thus it can be concluded that this Project is superior unless the discount rate does not exceed 17.3%. On the other hand, if the expected electricity sales revenue is to be used in estimating the benefit of this Project for calculation of the economic internal rate of return, the amount of revenue is 44,509.5 x 10^6 TL/year (Refer 12.2.3). The value of the economic internal rate of return based on this revenue is 12.4% as indicated in Table 12-12.

This rate exceeds the capital opportunity cost 12% in Turkey. Thus this Project can be regarded to have sufficient economic value for investment.

(2) Economic Evaluation of Artvin Project

(a) Net Present Value (B-C) and Benefit-Cost Rate (B/C)

The flow of economic costs of this Project throughout the project life is presented in Table 12-5, and the net present value in the first year of the project is 84,594 x 10^6 TL (C) at a discount rate of 9.5%.

The net present value (B) of an alternative thermal power plant is 181,928 10^6 TL.

Consequently the net present value (B-C) of the Project is estimated to be 97,334 x 10^6 TL, and the Benefit-Cost Ratio (B/C) is 2.15.

As indicated by these two indices, the cost of construction and operation of this Project is smaller than those

of an alternative thermal plant which can provide equivalent service, and it can be concluded that the Project is superior than the alternative plan.

(b) Economic Internal Rate of Return (EDR and EIRR)

The discount rate at which the present values of the investments on this Project and on the alternative thermal power plant becomes equal in the first year of the projects (that is, EDR), is 37.7% as indicated in Table 12-13. Thus it can be concluded that this Project is superior unless the discount rate does not exceed 37.7%. On the other hand, if the expected electricity sales revenue is to be used in estimating the benefit of this Project for calculation of the economic internal rate of return, the amount of revenue is 25,817.4 x 10^6 TL/year (Refer 12.2.3). The value of the economic internal rate of return based on this revenue is 15.9% as indicated in Table 12-14.

This rate exceeds the capital opportunity cost 12% in Turkey. Thus this Project can be regarded to have sufficient economic value for investment.

Table 12–11 Estimation of Equalizing Discount Rate of Yusufeli Project

			BENEFIT - COST ANALYSYS				B/C - DISCOUNT RATE
DISCOUNT RATE	HYDRO TOTAL INVEST	ALT TOTAL INVEST	COST	BENEFIT	B-C	B/C RATIO	B/C (*)
(%)	(MIL.TL)	(MIL.TL)	(MIL.TL)	(MIL.TL)	(MIL.TL)		0 1 2 3
5.0	283739.00	430612.00	193292.06	487979.12	294687.06	2.5246	I *
5.5	283739.00	430612.00	185620.56	443889.25	258268.69	2.3914	I *
6.0	283739.00	430612.00	178710.87	405474.31	226763.44	2.2689	I *
6.5	283739.00	430612.00	172445.25	371837.31	199392.06	2.1565	I *
7.0	283739.00	430612.00	166728.00	342249.31	175521.31	2.0527	I*
7.5	283739.00	430612.00	161478.50	316094.37	154615.87	1.9575	I *
8.0	283739.00	430612.00	156633.56	292879.87	136246.31	1.8698	I *
8.5	283739.00	430612.00	152136.31	272175.37	120039.06	1.7890	I *
9.0	283739.00	430612.00	147943.37	253636.19	105692.81	1.7144	I *
9.5	283739.00	430612.00	144016.81	236971.62	92954.81	1.6454	I *
10.0	283739.00	430612.00	140326.50	221934.06	81607.56	1.5816	I *
10.5	283739.00	430612.00	136844.75	208316.87	71472.12	1.5223	I *
11.0	283739.00	430612.00	133549.69	195939.06	62389.37	1.4672	I *
11.5	283739.00	430612.00	130421.94	184652.81	54230.87	1.4158	I *
12.0	283739.00	430612.00	127446.50	174329.31	46882.81	1.3679	I *
12.5	283739.00	430612.00	124608.19	164858.44	40250.25	1.3230	I *
13.0	283739.00	430612.00	121896.19	156146.50	34250.31	1.2810	I *
13.5	283739.00	430612.00	119299.19	148108.06	28808.87	1.2415	I *
14.0	283739.00	430612.00	116808.69	140674.25	23865.56	1.2043	I *
14.5	283739.00	430612.00	114416.87	133782.87	19366.00	1.1693	I *
15.0	283739.00	430612.00	112116.25	127379.50	15263.25	1.1361	I*
15.5	283739.00	430612.00	109901.00	121417.19	11516.19	1.1048	I*
16.0	283739.00	430612.00	107766.44	115855.44	8089.00	1.0751	I*
16.5	283739.00	430612.00	105706.19	110655.25	4949.06	1.0468	I *
17.0	283739.00	430612.00	103717.00	105784.81	2067.81	1.0199	I *
* 17.3	283739.00	430612.00	102555.37	103009.06	453.69	1.0044	I *
* 17.4	283739.00	430612.00	102173.94	102108.31	-65.63	0.9994	I *
17.5	283739.00	430612.00	101794.31	101216.62	-577.69	0.9943	I *
18.0	283739.00	430612.00	99934.25	96924.31	-3009.94	0.9699	I *
18.5	283739.00	430612.00	98135.06	92886.25	-5248.81	0.9465	I *
19.0	283739.00	430612.00	96391.75	89079.87	-7311.87	0.9241	I *
19.5	283739.00	430612.00	94703.12	85488.25	-9214.87	0.9027	I *
20.0	283739.00	430612.00	93065.56	82094.44	-10971.12	0.8821	I *

* --- I.R.R (HYDROPOWER)

Table 12–12 Estimation of Economic Internal Rate of Return (EIRR) of Yusufeli Project

	DISCOUNT RATE (%)	HYDRO TOTAL INVEST (MIL.TL)	ALT TOTAL INVEST (MIL.TL)	BENEFIT - COST ANALYSYS COST (MIL.TL)	BENEFIT (MIL.TL)	B-C (MIL.TL)	B/C RATIO	B/C - DISCOUNT RATE B/C (*) 0 1 2 3
	5.0	283739.00	0.0	193292.06	523796.62	330504.56	2.7099	
	5.5	283739.00	0.0	185620.56	465465.00	279844.44	2.5076	
	6.0	283739.00	0.0	178710.87	415256.19	236545.31	2.3236	
	6.5	283739.00	0.0	172445.25	371835.62	199390.37	2.1563	
	7.0	283739.00	0.0	166728.00	334123.87	167395.87	2.0040	
	7.5	283739.00	0.0	161478.50	301216.69	139738.19	1.8654	
	8.0	283739.00	0.0	156633.56	272395.37	115761.81	1.7391	
	8.5	283739.00	0.0	152136.31	247037.12	94900.81	1.6238	
	9.0	283739.00	0.0	147943.37	224645.12	76701.75	1.5185	
	9.5	283739.00	0.0	144016.81	204802.37	60785.56	1.4221	
	10.0	283739.00	0.0	140326.50	187157.56	46831.06	1.3337	
	10.5	283739.00	0.0	136844.75	171416.62	34571.87	1.2526	
	11.0	283739.00	0.0	133549.69	157326.44	23776.75	1.1780	
	11.5	283739.00	0.0	130421.94	144678.37	14256.44	1.1093	
	12.0	283739.00	0.0	127446.50	133293.37	5846.87	1.0459	
*	12.4	283739.00	0.0	125165.37	124992.12	-173.25	0.9986	
	12.5	283739.00	0.0	124608.19	123018.37	-1589.81	0.9872	
	13.0	283739.00	0.0	121896.19	113722.81	-8173.37	0.9329	
	13.5	283739.00	0.0	119299.19	105290.94	-14008.25	0.8826	
	14.0	283739.00	0.0	116808.69	97626.44	-19182.25	0.8358	
	14.5	283739.00	0.0	114416.87	90645.00	-23771.87	0.7922	
	15.0	283739.00	0.0	112116.25	84272.00	-27844.25	0.7516	
	15.5	283739.00	0.0	109901.00	78444.69	-31456.31	0.7138	
	16.0	283739.00	0.0	107766.44	73106.87	-34659.56	0.6784	
	16.5	283739.00	0.0	105706.19	68207.75	-37498.44	0.6453	
	17.0	283739.00	0.0	103717.00	63704.87	-40012.13	0.6142	
	17.5	283739.00	0.0	101794.31	59558.95	-42235.37	0.5851	
	18.0	283739.00	0.0	99934.25	55736.63	-44197.62	0.5577	
	18.5	283739.00	0.0	98135.06	52208.49	-45926.57	0.5320	
	19.0	283739.00	0.0	96391.75	48946.07	-47445.68	0.5078	
	19.5	283739.00	0.0	94703.12	45926.20	-48776.92	0.4849	
	20.0	283739.00	0.0	93065.56	43127.57	-49938.00	0.4634	

* --- I.R.R (HYDROPOWER)

Table 12–13 Estimation of Equalizing Discount Rate of Artvin Project

	DISCOUNT RATE (%)	HYDRO TOTAL INVEST (MIL.TL)	ALT TOTAL INVEST (MIL.TL)	BENEFIT - COST ANALYSYS COST (MIL.TL)	BENEFIT (MIL.TL)	B-C (MIL.TL)	B/C RATIO	B/C - DISCOUNT RATE B/C (*) 0 1 2 3
	9.5	159912.00	257022.00	84593.37	181927.69	97334.31	2.1506	I *
	30.0	159912.00	257022.00	45937.84	52297.33	6359.50	1.1384	I *
	30.5	159912.00	257022.00	45418.26	51247.67	5829.41	1.1283	I *
	31.0	159912.00	257022.00	44908.99	50230.16	5321.17	1.1185	I *
	31.5	159912.00	257022.00	44409.65	49243.34	4833.69	1.1088	I *
	32.0	159912.00	257022.00	43920.06	48285.84	4365.78	1.0994	I *
	32.5	159912.00	257022.00	43439.98	47356.58	3916.60	1.0902	I *
	33.0	159912.00	257022.00	42969.00	46454.10	3485.10	1.0811	I *
	33.5	159912.00	257022.00	42507.02	45577.39	3070.37	1.0722	I *
	34.0	159912.00	257022.00	42053.71	44725.36	2671.65	1.0635	I *
	34.5	159912.00	257022.00	41608.87	43897.03	2288.16	1.0550	I *
	35.0	159912.00	257022.00	41172.42	43091.64	1919.22	1.0466	I *
	35.5	159912.00	257022.00	40743.96	42307.98	1564.03	1.0384	I *
	36.0	159912.00	257022.00	40323.32	41545.33	1222.00	1.0303	I *
	36.5	159912.00	257022.00	39910.40	40802.92	892.52	1.0224	I *
	37.0	159912.00	257022.00	39504.89	40079.96	575.06	1.0146	I *
	37.5	159912.00	257022.00	39106.72	39375.77	269.05	1.0069	I *
*	37.7	159912.00	257022.00	38949.46	39099.22	149.77	1.0038	I *
*	37.8	159912.00	257022.00	38871.29	38962.07	90.78	1.0023	I *
*	37.9	159912.00	257022.00	38793.34	38825.53	32.19	1.0008	I *
*	38.0	159912.00	257022.00	38715.74	38689.80	-25.95	0.9993	I *
*	38.1	159912.00	257022.00	38638.32	38554.62	-83.69	0.9978	I *
*	38.2	159912.00	257022.00	38561.29	38420.29	-140.99	0.9963	I *
	38.5	159912.00	257022.00	38331.62	38021.10	-310.52	0.9919	I *
	39.0	159912.00	257022.00	37954.24	37369.16	-585.08	0.9846	I *
	39.5	159912.00	257022.00	37583.55	36733.50	-850.04	0.9774	I *
	40.0	159912.00	257022.00	37219.28	36113.43	-1105.85	0.9703	I *
	40.5	159912.00	257022.00	36861.44	35508.62	-1352.81	0.9633	I *
	41.0	159912.00	257022.00	36509.65	34918.29	-1591.36	0.9564	I *
	41.5	159912.00	257022.00	36163.89	34342.06	-1821.83	0.9496	I *I
	42.0	159912.00	257022.00	35824.04	33779.49	-2044.55	0.9429	I *I
	42.5	159912.00	257022.00	35489.96	33230.14	-2259.81	0.9363	I *I
	43.0	159912.00	257022.00	35161.57	32693.66	-2467.91	0.9298	I *I
	43.5	159912.00	257022.00	34838.59	32169.45	-2669.14	0.9234	I *I
	44.0	159912.00	257022.00	34521.02	31657.20	-2863.82	0.9170	I *I
	44.5	159912.00	257022.00	34208.71	31156.59	-3052.12	0.9108	I *I
	45.0	159912.00	257022.00	33901.53	30667.23	-3234.30	0.9046	I *I

* --- I.R.R (HYDROPOWER)

Table 12–14 Estimation of Economic Internal Rate of Return (EIRR) of Artvin Project

DISCOUNT RATE (%)	HYDRO TOTAL INVEST (MIL.TL)	ALT TOTAL INVEST (MIL.TL)	BENEFIT - COST ANALYSYS COST (MIL.TL)	BENEFIT (MIL.TL)	B-C (MIL.TL)	B/C RATIO	B/C - DISCOUNT RATE B/C (*) 0 1 2 3
5.0	159912.00	0.0	110904.81	351712.81	240808.00	3.1713	
5.5	159912.00	0.0	106655.31	317031.37	210376.06	2.9725	
6.0	159912.00	0.0	102870.69	286874.12	184003.44	2.7887	
6.5	159912.00	0.0	99477.69	260530.56	161052.87	2.6190	
7.0	159912.00	0.0	96416.06	237419.56	141003.50	2.4624	
7.5	159912.00	0.0	93635.06	217051.69	123416.62	2.3181	
8.0	159912.00	0.0	91094.44	199034.25	107939.81	2.1849	
8.5	159912.00	0.0	88758.44	183024.25	94265.81	2.0620	
9.0	159912.00	0.0	86599.50	168746.19	82146.69	1.9486	
9.5	159912.00	0.0	84593.37	155967.69	71374.31	1.8437	
10.0	159912.00	0.0	82720.87	144491.69	61770.81	1.7467	
10.5	159912.00	0.0	80964.69	134151.87	53187.19	1.6569	
11.0	159912.00	0.0	79311.06	124803.81	45492.75	1.5736	
11.5	159912.00	0.0	77747.50	116328.25	38580.75	1.4962	
12.0	159912.00	0.0	76264.81	108622.69	32357.87	1.4243	
12.5	159912.00	0.0	74854.00	101597.94	26743.94	1.3573	
13.0	159912.00	0.0	73508.25	95178.81	21670.56	1.2948	
13.5	159912.00	0.0	72220.25	89296.62	17076.37	1.2364	
14.0	159912.00	0.0	70985.62	83895.50	12909.87	1.1819	
14.5	159912.00	0.0	69799.44	78925.37	9125.94	1.1307	
15.0	159912.00	0.0	68657.31	74342.12	5684.81	1.0828	
15.5	159912.00	0.0	67556.69	70108.00	2551.31	1.0378	
* 15.9	159912.00	0.0	66703.25	66949.44	246.19	1.0037	
* 16.0	159912.00	0.0	66493.31	66189.87	-303.44	0.9954	
16.5	159912.00	0.0	65466.35	62556.73	-2909.62	0.9556	
17.0	159912.00	0.0	64470.72	59181.76	-5288.96	0.9180	
17.5	159912.00	0.0	63505.71	56042.61	-7463.10	0.8825	
18.0	159912.00	0.0	62569.46	53118.36	-9451.09	0.8490	
18.5	159912.00	0.0	61660.43	50390.98	-11269.45	0.8172	
19.0	159912.00	0.0	60776.72	47842.68	-12934.04	0.7872	
19.5	159912.00	0.0	59917.20	45459.15	-14458.05	0.7587	
20.0	159912.00	0.0	59080.64	43227.10	-15853.54	0.7317	

* --- I.R.R (HYDROPOWER)

12.2 Financial Evaluation

12.2.1 Method of Financial Evaluation

In conducting the financial evaluation of this Project, the cash flow at market prices was developed for all costs including the capital invested in this Project, taxes, operation and maintenance costs, replacement costs, Project controlling costs, etc. This cost cash flow was compared to the benefit cash flow that was obtained by the expected income from the sales of electricity generated by this Project, and the financial internal rate of return was calculated by the discounted cash flow method (DCF method).

The discount rate for the DCF method was determined as 9.5% in consultation with EIE.

12.2.2 Financial Cost of the Projects

The amount of initial investment and the replacement cost were obtained from Chapter 11, "Construction Planning and Cost Estimation". The following values were selected as the operation and maintenance cost. (The maintenance costs for Substations in Hopa and Ankara are not included.)

Operation and Maintenance Cost:

- Civil facilities construction cost x 0.3%
- Hydraulic equipment cost x 1.5%
- Electro-Mechanical equipment cost x 1.5%
- Transmission line cost x 1.5%

The financial costs of Yusufeli Project and Artvin Project are as shown below.

(1) Financial Cost of Yusufeli Project

The total expenditure (the total of cash outflow) of this Project is 500,505 x 10^6 TL as shown in Table 12-15, of which the amount of initial investment is 280,767 x 10^6 TL (excluding interest during construction). The operation and maintenance cost is as follows:

Civil facilities	291,059 x 10^6 x 0.003	= 873 x 10^6 TL
Hydraulic equipment Electrical equipment Transmission facilities	82,306 x 10^6 x 0.015	= 1,235 x 10^6 TL
Transmission facilities from Hopa to Ankara	32,671 x 10^6 x 0.015	= 490 x 10^6 TL
	Total:	= 2,598 x 10^6 TL

(2) Financial Cost of Artvin Project

The total expenditure (the total of cash outflow) of this Project is 275,960 x 10^6 TL as shown in Table 12-16, of which the amount of initial investment is 136,055 x 10^6 TL (excluding interest during construction). The operation and maintenance cost is as follows:

Civil facilities	95,967 x 10^6 x 0.003	= 288 x 10^6 TL
Hydraulic equipment Electrical equipment Transmission facilities	61,048 x 10^6 x 0.015	= 916 x 10^6 TL
Transmission facilities from Hopa to Ankara	19,060 x 10^6 x 0.015	= 286 x 10^6 TL
	Total:	= 1,490 x 10^6 TL

12.2.3 Financial Evaluation of the Project

The financial income of this Project is the electric sales revenue. The revenue was calculated based on TEK's average tariff of 27 TL/kWh. (This value was obtained by deducting 18% from uniform rate system, 32.8 TL/kWh, as of April, 1985. This percentage was tentative value, which includes radio/TV tax, value added tax, and substation/distribution costs.)

The evaluation was made at the receiving end of Ankara Substation. It was assumed that the average annual available energy of this Project throughout its life is the amount of electricity that can be sold, and the financial income of this project was calculated based on the tariff rate quoted above.

(1) Financial Evaluation of Yusufeli Project

The average annual available energy of Yusufeli Project is estimated to be 1,648.5 x 10^6 kWh. Thus the revenue was calculated at the average rate of 27 TL/kWh which amounts to 44,509.5 x 10^6 TL/year. On the other hand, the financial cost of Yusufeli Project is shown in Table 12-15.

The discount rate at which the financial cost equals the income (that is, the financial internal rate of return) is 9.7% (Refer to Table 12-17). When this rate is compared to the expected average interest rates of 9.5% for borrowings for both domestic and foreign currencies, it can be concluded that this Project is sound from the financial point of view.

(2) Financial Evaluation of Artvin Project

The average annual available energy of Artvin Project is estimated to be 956.2 x 10^6 kWh. Thus the revenue was calculated at the average rate of 27 TL/kWh which amounts to 25,817.4 x 10^6 TL/year. On the other hand, the financial cost of Artvin Project is shown in Table 12-16.

The discount rate at which the financial cost equals the income (that is, the financial internal rate of return) is 12.8% (Refer to Table 12-18). When this rate is compared to the expected average interest rates of 9.5% for borrowings for both domestic and foreign currencies, it can be concluded that this Project is sound from the financial point of view.

Table 12–15 Financial Cash Flow of Yusufeli Project (without Interest during Construction)

Unit: 10^6 TL

Year	Investment Cost			O & M	Total	Transmission Line (Hopa - Ankara)			Grand Total
	Dam and Equipment	Transmission Line (Yusufeli-Hopa)	Sub Total			Investment Cost	O & M	Total	
-2	3,761		3,761		3,761				3,761
-1	3,760		3,760		3,760				3,760
1	21,610		21,610		21,610				21,610
2	29,176		29,176		29,176				29,176
3	23,783		23,783		23,783				23,783
4	33,299		33,299		33,299				33,299
5	40,229		40,229		40,229	3,751		3,751	43,980
6	32,208	560	32,768		32,768	10,414		10,414	43,182
7	33,441	2,279	35,720		35,720	6,429		6,429	42,149
8	23,483	2,428	25,911		25,911	4,799		4,799	30,710
9	5,357		5,357		5,357				5,357
10				2,108	2,108		490	490	2,598
~38				2,108	2,108		490	490	2,598
39	5,412		5,412	2,108	7,520		490	490	8,010
40	10,923		10,923	2,108	13,031	3,751	490	4,241	17,272
41	10,713	560	11,273	2,108	13,381	10,414	490	10,904	24,285
42	17,473	2,279	19,752	2,108	21,860	6,429	490	6,919	28,779
43	9,300	2,428	11,728	2,108	13,836	4,799	490	5,289	19,125
44	5,357		5,357	2,108	7,465		490	490	7,955
~59				2,108	2,108		490	490	2,598
Total	309,285	10,534	319,819	105,400	425,219	50,786	24,500	75,286	500,505

Table 12–16 Financial Cash Flow of Artvin Project (without Interest during Construction)

Unit: 10^6 TL

Year	Investment Cost			O & M	Total	Transmission Line (Hopa - Ankara)			Grand Total
	Dam and Equipment	Transmission Line (Yusufeli-Hopa)	Sub Total			Investment Cost	O & M	Total	
-2	1,338		1,338		1,338				1,338
-1	1,336		1,336		1,336				1,336
1	16,218		16,218		16,218				16,218
2	14,020		14,020		14,020	2,184		2,189	16,209
3	24,522	271	24,793		24,793	6,075		6,075	30,868
4	27,885	1,064	28,949		28,949	3,750		3,750	32,699
5	28,329	796	29,125		29,125	2,801		2,801	31,926
6	5,461		5,461	1,204	5,461				5,461
7				1,204	1,204		286	286	1,490
8				1,204	1,204		286	286	1,490
~36				1,204	1,204		286	286	1,490
37	3,890		3,890	1,204	5,094	2,189	286	2,475	7,569
38	6,021	271	6,292	1,204	7,496	6,075	286	6,361	13,857
39	14,372	1,064	15,436	1,204	16,640	3,750	286	4,036	20,676
40	18,714	796	19,510	1,204	20,714	2,801	286	3,087	23,801
41	5,462		5,462	1,204	6,666		286	286	6,952
42				1,204	1,204		286	286	1,490
~56				1,204	1,204		286	286	1,490
Total	167,568	4,262	171,830	60,200	232,030	29,630	14,300	43,930	275,960

Table 12–17 Estimation of Financial Internal Rate of Return (FIRR) of Yusufeli Project

DISCOUNT RATE (%)	HYDRO TOTAL INVEST (MIL.TL)	ALT TOTAL INVEST (MIL.TL)	BENEFIT - COST ANALYSYS COST (MIL.TL)	BENEFIT (MIL.TL)	B-C (MIL.TL)	B/C RATIO	B/C - DISCOUNT RATE B/C (*) 0 1 2 3
5.0	370605.00	0.0	265995.69	523796.62	257800.94	1.9692	
5.5	370605.00	0.0	255722.06	465465.00	209742.94	1.8202	
6.0	370605.00	0.0	246458.94	415256.19	168797.25	1.6849	
6.5	370605.00	0.0	238050.75	371835.62	133784.87	1.5620	
7.0	370605.00	0.0	230371.19	334123.87	103752.69	1.4504	
7.5	370605.00	0.0	223314.00	301216.69	77902.69	1.3488	
8.0	370605.00	0.0	216795.81	272395.37	55599.56	1.2565	
8.5	370605.00	0.0	210741.44	247037.12	36295.69	1.1722	
9.0	370605.00	0.0	205093.37	224645.12	19551.75	1.0953	
9.5	370605.00	0.0	199801.75	204802.37	5000.62	1.0250	
* 9.7	370605.00	0.0	197776.00	197500.31	-275.69	0.9986	
10.0	370605.00	0.0	194825.56	187157.56	-7668.00	0.9606	
10.5	370605.00	0.0	190130.12	171416.62	-18713.50	0.9016	
11.0	370605.00	0.0	185684.62	157326.44	-28358.19	0.8473	
11.5	370605.00	0.0	181464.19	144678.37	-36785.81	0.7973	
12.0	370605.00	0.0	177447.81	133293.37	-44154.44	0.7512	
12.5	370605.00	0.0	173616.50	123018.37	-50598.12	0.7086	
13.0	370605.00	0.0	169955.25	113722.81	-56232.44	0.6691	
13.5	370605.00	0.0	166449.00	105290.94	-61158.06	0.6326	
14.0	370605.00	0.0	163085.87	97626.44	-65459.44	0.5986	
14.5	370605.00	0.0	159855.62	90645.00	-69210.62	0.5670	
15.0	370605.00	0.0	156748.56	84272.00	-72476.56	0.5376	
15.5	370605.00	0.0	153756.81	78444.69	-75312.12	0.5102	
16.0	370605.00	0.0	150873.19	73106.87	-77766.31	0.4846	
16.5	370605.00	0.0	148090.75	68207.75	-79883.00	0.4606	
17.0	370605.00	0.0	145402.50	63704.87	-81697.62	0.4381	
17.5	370605.00	0.0	142804.87	59558.95	-83245.87	0.4171	
18.0	370605.00	0.0	140292.12	55736.65	-84555.44	0.3973	
18.5	370605.00	0.0	137860.56	52208.49	-85652.06	0.3787	
19.0	370605.00	0.0	135504.56	48946.07	-86558.44	0.3612	
19.5	370605.00	0.0	133221.56	45926.20	-87295.31	0.3447	
20.0	370605.00	0.0	131007.81	43127.57	-87880.19	0.3292	

* --- I.R.R (HYDROPOWER)

Table 12–18 Estimation of Financial Internal Rate of Return (FIRR) of Artvin Project

DISCOUNT RATE	HYDRO TOTAL INVEST	ALT TOTAL INVEST	BENEFIT - COST ANALYSYS				B/C - DISCOUNT RATE
			COST	BENEFIT	B-C	B/C RATIO	B/C (*)
(%)	(MIL.TL)	(MIL.TL)	(MIL.TL)	(MIL.TL)	(MIL.TL)		0 1 2 3
5.0	201460.00	0.0	145548.69	351712.81	206164.12	2.4165	I *
5.5	201460.00	0.0	140112.06	317031.37	176919.31	2.2627	I *
6.0	201460.00	0.0	135262.50	286874.12	151611.62	2.1209	I *
6.5	201460.00	0.0	130907.87	260530.56	129622.69	1.9902	I *
7.0	201460.00	0.0	126972.94	237419.56	110446.62	1.8698	I *
7.5	201460.00	0.0	123393.62	217051.69	93658.06	1.7590	I *
8.0	201460.00	0.0	120118.81	199034.25	78915.44	1.6570	I *
8.5	201460.00	0.0	117104.25	183024.25	65920.00	1.5629	I *
9.0	201460.00	0.0	114314.31	168746.19	54431.87	1.4762	I *
9.5	201460.00	0.0	111719.87	155967.69	44247.81	1.3961	I *
10.0	201460.00	0.0	109295.06	144491.69	35196.62	1.3220	I *
10.5	201460.00	0.0	107019.12	134151.87	27132.75	1.2535	I *
11.0	201460.00	0.0	104874.81	124803.81	19929.00	1.1900	I *
11.5	201460.00	0.0	102845.87	116328.25	13482.37	1.1311	I *
12.0	201460.00	0.0	100920.37	108622.69	7702.31	1.0763	I *
12.5	201460.00	0.0	99087.69	101597.94	2510.25	1.0253	I *
* 12.8	201460.00	0.0	98028.44	97678.50	-349.94	0.9964	I *
13.0	201460.00	0.0	97337.87	95178.81	-2159.06	0.9778	I *
13.5	201460.00	0.0	95663.44	89296.62	-6366.81	0.9334	I *
14.0	201460.00	0.0	94057.56	83895.50	-10162.06	0.8920	I *
14.5	201460.00	0.0	92513.75	78925.37	-13588.37	0.8531	I *
15.0	201460.00	0.0	91027.69	74342.12	-16685.56	0.8167	I *
15.5	201460.00	0.0	89594.25	70108.00	-19486.25	0.7825	I *
16.0	201460.00	0.0	88210.12	66189.87	-22020.25	0.7504	I *
16.5	201460.00	0.0	86871.06	62556.73	-24314.33	0.7201	I *
17.0	201460.00	0.0	85574.19	59181.76	-26392.43	0.6916	I *
17.5	201460.00	0.0	84317.50	56042.61	-28274.89	0.6647	I *
18.0	201460.00	0.0	83097.81	53118.36	-29979.45	0.6392	I *
18.5	201460.00	0.0	81913.19	50390.98	-31522.21	0.6152	I *
19.0	201460.00	0.0	80761.94	47842.68	-32919.25	0.5924	I *
19.5	201460.00	0.0	79641.75	45459.15	-34182.60	0.5708	I *
20.0	201460.00	0.0	78551.50	43227.10	-35324.40	0.5503	I *

* --- I.R.R (HYDROPOWER)

CHAPTER 13 LOAN REPAYMENT SCHEDULE

CHAPTER 13. LOAN REPAYMENT SCHEDULE

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CHAPTER 13. LOAN REPAYMENT SCHEDULE

13.1 Basic Considerations

In general, construction of an electric power facility requires a large amount of initial investment during the construction period, and the return to that investment starts only after the construction is completed. The time required to recover the investment is much longer than that required for production of durable consumer goods. Accordingly, it is quite usual to obtain loans having low interest rate, long grace period and repayment period.

It can be assumed that a large portion of the fund required for implementation of this Project will be supplied by international financing institutions, and the rest by domestic financing agencies. As the proportions of the foreign and domestic funds can not be predicted at this moment, the JICA Team consulted with EIE to assume the following financing conditions, and the repayment schedule was formulated based on these assumptions.

Interest rate: 9.5% for both foreign and domestic funds, with no considerations for commitment charge.

Terms of repayment: Repayment is deferred during the period of construction of the Projects (9 years for Yusufeli and 6 years for Artvin): repayment of principal and interest in equal amounts in 20 years.

13.2 Required Amount of Fund

The required amount of fund is estimated based on the prices as of 1985, though this Project is scheduled to be connected to the power grid in 2000. Thus the escalation of the prices upto and including the construction period must be taken into account as additional cost, however, price escalation in Turkey in the recent years is rather abnormal compared to those in other major countries, and it is difficult for the JICA Team to make any projection of the price escalation in the future. For this reason, the loan repayment schedule

was formulated based on the amount of fund requirement estimated at 1985 prices.

Yusufeli Project (including the construction cost of the transmission line from the project site to Hopa)

Domestic currency: 236,385 x 10^6 TL
Foreign currency : 136,980 x 10^6 TL
Total: 373,365 x 10^6 TL

Artvin Project (including the construction cost of the transmission line from the project site to Hopa)

Domestic currency: 93,096 x 10^6 TL
Foreign currency : 63,919 x 10^6 TL
Total: 157,015 x 10^6 TL

Transmission Line (from Hopa to Ankara)

Portion to be born by Yusufeli Project:
Domestic currency: 11,466 x 10^6 TL
Foreign currency : 21,205 x 10^6 TL
Total: 32,671 x 10^6 TL

Portion to be born by Artvin Project:
Domestic currency: 6,689 x 10^6 TL
Foreign currency : 12,371 x 10^6 TL
Total: 19,060 x 10^6 TL

13.3 Income and Cost

The return on investment is the income from electricity sale. It is assumed that the electric power generated by this Project will be supplied to Ankara area through Hopa Substation. The present tariff system of TEK consists of two types of contracts and the customer has freedom of selecting one of them: The two stage tariff consisting of a fixed charge and energy charge and the uniform rate contract. The tariff rates differ from one supply area to another.

As it was difficult to find out the average tariff rate as of 1985 for the whole TEK power system, the uniform rate of TEK as of April 1985, which is 27 TL/kWh (Refer 12.2.3) was used as the basis of revenue calculation.

The annual operation and maintenance cost of the facilities of this Project was assumed as below. (The cost for substations in Hopa and Ankara was excluded.)

Civil facility construction cost	x 0.3%
Hydraulic equipment cost	x 1.5%
Electro-Mechanical equipment cost	x 1.5%
Transmission facility cost	x 1.5%

The depreciations are calculated by the straight line method with zero residual values and the facility lives assumed as below.

Civil facilities;	50 years
Hydraulic equipment;	35 years
Electro-Mechanical equipment;	35 years
Transmission facilities;	35 years

13.4 Loan Repayment Schedule

The source of funds for loan repayment is to be the operating income (the electricity sales revenue minus operation and maintenance cost, depreciation, interest, etc.) and the reserve for depreciation.

The yearly projections of the income statements of this Project are presented in Tables 13-2 and 13-5.

The yearly projections of loan repayment schedule (cash flow statement) are presented in Tables 13-1 and 13-3 for Yusufeli Project and Tables 13-4 and 13-6 for Artvin Project.

As indicated in the tables, the capital costs are recovered from revenues in the 13 years after the commencement of operation in case of Yusufeli Project, and in the 5 years in case of Artvin Project, and thereafter revenues exceed capital costs producing profits. Thus it is judged that the capital investment on this Project can be safely recovered.

Table 13-1 Funds Procurement and Repayment Schedule for Yusufeli Project

No.	Year	Yusufeli Project			Transmission Line (Hopa - Ankara)			Funds Procurement (Total)			Repayment Schedule								
											Foreign Currency				Local Currency				
		Foreign	Local	Total	Foreign	Local	Total	Foreign Currency	Local Currency	Total	Interest	Principal	Total	Outstanding Balance	Interest	Principal	Total	Outstanding Balance	
-2	1990	673	3,088	3,761				673	3,088	3,761	(32)				(147)				Repayment
-1	1991	672	3,088	3,760				672	3,088	3,760	(96)				(440)				FC and
1	1992	4,736	16,874	21,610				4,736	16,874	21,610	(353)				(1,388)				
2	1993	6,938	22,238	29,176				6,938	22,238	29,176	(907)				(3,246)				
3	1994	6,809	16,974	23,783				6,809	16,974	23,783	(1,560)				(5,109)				
4	1995	12,450	20,849	33,299				12,450	20,849	33,299	(2,475)				(6,905)				Commitme
5	1996	15,557	24,672	40,229	3,112	639	3,751	18,669	25,311	43,980	(3,953)				(9,098)				
6	1997	15,218	17,550	32,768	7,673	2,741	10,414	22,891	20,291	43,182	(5,927)				(11,264)				Grace Pe
7	1998	19,592	16,128	35,720	3,406	3,023	6,429	22,998	19,151	42,149	(8,108)				(13,137)				
8	1999	11,391	14,520	25,911	2,033	2,766	4,799	13,424	17,286	30,710	(9,837)				(14,869)				Repayment
9	2000	4,012	1,345	5,357				4,012	1,345	5,357	(10,665)			114,272	(15,753)			166,495	
10	2001										10,855	2,112	12,967	112,160	15,817	3,076	18,893	163,419	20 years
11	2002										10,654	2,313	12,967	109,847	15,525	3,368	18,893	160,051	interest
12	2003										10,434	2,533	12,967	107,314	15,205	3,688	18,893	156,363	
13	2004										10,194	2,773	12,967	104,541	14,854	4,039	18,893	152,324	Capital
14	2005										9,931	3,036	12,967	101,505	14,471	4,422	18,893	147,902	
15	2006										9,643	3,324	12,967	98,181	14,050	4,843	18,893	143,059	Note: Figu
16	2007										9,328	3,639	12,967	94,542	13,590	5,303	18,893	137,756	inte
17	2008										8,982	3,985	12,967	90,557	13,087	5,806	18,893	131,950	perio
18	2009										8,603	4,364	12,967	86,193	12,535	6,358	18,893	125,592	
19	2010										8,189	4,778	12,967	81,415	11,931	6,962	18,893	118,630	
20	2011										7,735	5,232	12,967	76,183	11,269	7,624	18,893	111,006	
21	2012										7,238	5,729	12,967	70,454	10,544	8,349	18,893	102,657	
22	2013										6,693	6,274	12,967	64,180	9,750	9,143	18,893	93,514	
23	2014										6,097	6,870	12,967	57,310	8,883	10,010	18,893	83,504	
24	2015										5,445	7,522	12,967	49,788	7,932	10,961	18,893	72,543	
25	2016										4,730	8,237	12,967	41,551	6,892	12,001	18,893	60,542	
26	2017										3,948	9,019	12,967	32,532	5,752	13,141	18,893	47,401	
27	2018										3,091	9,876	12,967	22,656	4,503	14,390	18,893	33,011	
28	2019										2,153	10,814	12,967	11,842	3,136	15,757	18,893	17,254	
29	2020										1,125	11,842	12,967	0	1,639	17,254	18,893	0	
Total		98,048	157,326	255,374	16,224	9,169	25,393	114,272	166,495	280,767	145,068	114,272	259,340	0	211,365	166,495	377,860	0	

Table 13–1 Funds Procurement and Repayment Schedule for Yusufeli Project

(Unit: 10^6TL)

Project		Transmission Line (Hopa - Ankara)			Funds Procurement (Total)			Repayment Schedule								Remarks
								Foreign Currency				Local Currency				
al	Total	Foreign	Local	Total	Foreign Currency	Local Currency	Total	Interest	Principal	Total	Outstanding Balance	Interest	Principal	Total	Outstanding Balance	
88	3,761				673	3,088	3,761	(32)				(147)				Repayment Conditions:
88	3,760				672	3,088	3,760	(96)				(440)				
74	21,610				4,736	16,874	21,610	(353)				(1,388)				FC and LC Interest rate: 9.5% per annum
38	29,176				6,938	22,238	29,176	(907)				(3,246)				
74	23,783				6,809	16,974	23,783	(1,560)				(5,109)				
49	33,299				12,450	20,849	33,299	(2,475)				(6,905)				Commitment charge: not considered
72	40,229	3,112	639	3,751	18,669	25,311	43,980	(3,953)				(9,098)				
50	32,768	7,673	2,741	10,414	22,891	20,291	43,182	(5,927)				(11,264)				Grace Period: 9 years
28	35,720	3,406	3,023	6,429	22,998	19,151	42,149	(8,108)				(13,137)				
20	25,911	2,033	2,766	4,799	13,424	17,286	30,710	(9,837)				(14,869)				Repayment Method:
45	5,357				4,012	1,345	5,357	(10,665)			114,272	(15,753)			166,495	
								10,855	2,112	12,967	112,160	15,817	3,076	18,893	163,419	20 years with principal and interest in equal installment
								10,654	2,313	12,967	109,847	15,525	3,368	18,893	160,051	
								10,434	2,533	12,967	107,314	15,205	3,688	18,893	156,363	
								10,194	2,773	12,967	104,541	14,854	4,039	18,893	152,324	Capital recovery factor: 0.113476
								9,931	3,036	12,967	101,505	14,471	4,422	18,893	147,902	
								9,643	3,324	12,967	98,181	14,050	4,843	18,893	143,059	Note: Figures in parentheses are interest during construction period.
								9,328	3,639	12,967	94,542	13,590	5,303	18,893	137,756	
								8,982	3,985	12,967	90,557	13,087	5,806	18,893	131,950	
								8,603	4,364	12,967	86,193	12,535	6,358	18,893	125,592	
								8,189	4,778	12,967	81,415	11,931	6,962	18,893	118,630	
								7,735	5,232	12,967	76,183	11,269	7,624	18,893	111,006	
								7,238	5,729	12,967	70,454	10,544	8,349	18,893	102,657	
								6,693	6,274	12,967	64,180	9,750	9,143	18,893	93,514	
								6,097	6,870	12,967	57,310	8,883	10,010	18,893	83,504	
								5,445	7,522	12,967	49,788	7,932	10,961	18,893	72,543	
								4,730	8,237	12,967	41,551	6,892	12,001	18,893	60,542	
								3,948	9,019	12,967	32,532	5,752	13,141	18,893	47,401	
								3,091	9,876	12,967	22,656	4,503	14,390	18,893	33,011	
								2,153	10,814	12,967	11,842	3,136	15,757	18,893	17,254	
								1,125	11,842	12,967	0	1,639	17,254	18,893	0	
26	255,374	16,224	9,169	25,393	114,272	166,495	280,767	145,068	114,272	259,340	0	211,365	166,495	377,860	0	

Table 13–2 Income Statement for Yusufeli Project

(unit: 10^6TL)

No.	Year	Operating Revenue (A)	Operating Expenses			Operating Income (A)-(B)=(C)	Financial Expenses			Net Income (C)-(D)=(E)	Remarks
			OMA	Depre-ciation	Total (B)		FC	LC	Total (D)		
-2	1990						(32)	(147)	(179)		Operating Revenue:
-1	1991						(96)	(440)	(536)		
1	1992						(353)	(1,388)	(1,741)		Energy sold : 1,648.5 x 10^6 KWh
2	1993						(907)	(3,246)	(4,153)		Unit Price : 27 TL/kWh
3	1994						(1,560)	(5,109)	(6,669)		Total : 44,509.5 x 10^6 TL
4	1995						(2,475)	(6,905)	(9,380)		
5	1996						(3,953)	(9,098)	(13,051)		OMA: Operation maintenance and
6	1997						(5,927)	(11,264)	(17,191)		Administration Expenses
7	1998						(8,108)	(13,137)	(21,245)		
8	1999						(9,837)	(14,869)	(24,706)		Project proper : 2,108 x 10^6 TL/year
9	2000						(10,665)	(15,753)	(26,418)		Related Trans.L.: 490 "
10	2001	44,509.5	2,598	9,106	11,704	32,805.5	10,855	15,817	26,672	6,133.5	Total : 2,598 "
11	2002	44,509.5	2,598	9,106	11,704	32,805.5	10,654	15,525	26,179	6,626.5	
12	2003	44,509.5	2,598	9,106	11,704	32,805.5	10,434	15,205	25,639	7,166.5	Depreciation:
13	2004	44,509.5	2,598	9,106	11,704	32,805.5	10,194	14,854	25,048	7,757.5	
14	2005	44,509.5	2,598	9,106	11,704	32,805.5	9,931	14,471	24,402	8,403.5	Project proper : 8,173 x 10^6 TL/year
15	2006	44,509.5	2,598	9,106	11,704	32,805.5	9,643	14,050	23,693	9,112.5	Related Trans.L.: 933 "
16	2007	44,509.5	2,598	9,106	11,704	32,805.5	9,328	13,590	22,918	9,887.5	Total : 9,106 "
17	2008	44,509.5	2,598	9,106	11,704	32,805.5	8,982	13,087	22,069	10,736.5	
18	2009	44,509.5	2,598	9,106	11,704	32,805.5	8,603	12,535	21,138	11,667.5	
19	2010	44,509.5	2,598	9,106	11,704	32,805.5	8,189	11,931	20,120	17,685.5	Note: Figures in parentheses are
20	2011	44,509.5	2,598	9,106	11,704	32,805.5	7,735	11,269	19,004	13,801.5	interest during construction
21	2012	44,509.5	2,598	9,106	11,704	32,805.5	7,238	10,544	17,782	15,023.5	period.
22	2013	44,509.5	2,598	9,106	11,704	32,805.5	6,693	9,750	16,443	16,362.5	
23	2014	44,509.5	2,598	9,106	11,704	32,805.5	6,097	8,883	14,980	17,825.5	
24	2015	44,509.5	2,598	9,106	11,704	32,805.5	5,445	7,932	13,377	19,428.5	
25	2016	44,509.5	2,598	9,106	11,704	32,805.5	4,730	6,892	11,622	21,183.5	
26	2017	44,509.5	2,598	9,106	11,704	32,805.5	3,948	5,752	9,700	23,105.5	
27	2018	44,509.5	2,598	9,106	11,704	32,805.5	3,091	4,503	7,594	25,211.5	
28	2019	44,509.5	2,598	9,106	11,704	32,805.5	2,153	3,136	5,289	27,516.5	
29	2020	44,509.5	2,598	9,106	11,704	32,805.5	1,125	1,639	2,764	30,041.5	
Total		890,190	51,960	182,120	234,080	656,110	145,068	211,365	356,433	299,677	

Table 13–3 Cash Flow Statement for Yusufeli Project

(Unit: 10^6TL)

No.	Year	Cash Inflow				Cash Outflow						Balance		Remarks
		Funds Procurement	Net Income	Depreciation	Total	Construction	Repayment of Principal			Interest during Construction	Total	Yearly	Accumulated	
							FC	LC	Total					
-2	1990	3,761			3,761	3,761				179	3,940	-179	-179	
-1	1991	3,760			3,760	3,760				536	4,296	-536	-715	
1	1992	21,610			21,610	21,610				1,741	23,351	-1,741	-2,456	
2	1993	29,176			29,176	29,176				4,153	33,329	-4,153	-6,609	
3	1994	23,783			23,783	23,783				6,669	30,452	-6,669	-13,278	
4	1995	33,299			33,299	33,299				9,380	42,679	-9,380	-22,658	
5	1996	43,980			43,980	43,980				13,051	57,031	-13,051	-35,709	
6	1997	43,182			43,182	43,182				17,191	60,373	-17,191	-52,900	
7	1998	42,149			42,149	42,149				21,245	63,394	-21,245	-74,145	
8	1999	30,710			30,710	30,710				24,706	55,416	-24,706	-98,851	
9	2000	5,357			5,357	5,357				26,418	31,775	-26,418	-125,269	
10	2001		6,133.5	9,106	15,239.5		2,112	3,076	5,188		5,188	10,051.5	-115,217.5	
11	2002		6,626.5	9,106	15,732.5		2,313	3,368	5,681		5,681	10,051.5	-105,166	
12	2003		7,166.5	9,106	16,272.5		2,533	3,688	6,221		6,221	10,051.5	-95,114.5	
13	2004		7,757.5	9,106	16,863.5		2,773	4,039	6,812		6,812	10,051.5	-85,063	
14	2005		8,403.5	9,106	17,509.5		3,036	4,422	7,458		7,458	10,051.5	-75,011.5	
15	2006		9,112.5	9,106	18,218.5		3,324	4,843	8,167		8,167	10,051.5	-64,960	
16	2007		9,887.5	9,106	18,993.5		3,639	5,303	8,942		8,942	10,051.5	-54,908.5	
17	2008		10,736.5	9,106	19,842.5		3,985	5,806	9,791		9,791	10,051.5	-44,857	
18	2009		11,667.5	9,106	20,773.5		4,364	6,358	10,722		10,722	10,051.5	-34,805.5	
19	2010		12,688.5	9,106	21,791.5		4,778	6,962	11,740		11,740	10,051.5	-24,754	
20	2011		13,801.5	9,106	22,907.5		5,232	7,624	12,856		12,856	10,051.5	-14,702.5	
21	2012		15,023.5	9,106	24,129.5		5,729	8,349	14,078		14,078	10,051.5	-4,651	
22	2013		16,362.5	9,106	25,468.5		6,274	9,143	15,417		15,417	10,051.5	5,400.5	
23	2014		17,825.5	9,106	26,931.5		6,870	10,010	16,880		16,880	10,051.5	15,452	
24	2015		19,428.5	9,106	27,534.5		7,522	10,961	18,483		18,483	10,051.5	25,503.5	
25	2016		21,183.5	9,106	30,289.5		8,237	12,001	20,238		20,238	10,051.5	35,555	
26	2017		23,105.5	9,106	32,211.5		9,019	13,141	22,160		22,160	10,051.5	45,606.5	
27	2018		25,211.5	9,106	34,317.5		9,876	14,390	24,266		24,266	10,051.5	55,658	
28	2019		27,516.5	9,106	36,622.5		10,814	15,757	26,571		26,571	10,051.5	65,709.5	
29	2020		30,041.5	9,106	39,147.5		11,842	17,254	29,096		29,096	10,051.5	75,761	
Total		280,767	299,677	182,120	762,564	280,767	114,272	166,495	280,767	125,269	686,803	75,761	75,761	

Table 13-4 Funds Procurement and Repayment Schedule for Artvin Project

No.	Year	Artvin Project			Transmission Line (Hopa - Ankara)			Funds Procurement (Total)			Repayment Schedule								
											Foreign Currency				Local Currency				
		Foreign	Local	Total	Foreign	Local	Total	Foreign Currency	Local Currency	Total	Interest	Principal	Total	Outstanding Balance	Interest	Principal	Total	Outstanding Balance	
-2	1993	256	1,082	1,338				256	1,082	1,338	(12)				(52)				Repayment C
-1	1994	255	1,081	1,336				255	1,081	1,336	(36)				(155)				FC and L
1	1995	3,634	12,584	16,218				3,634	12,584	16,218	(221)				(803)				
2	1996	5,505	8,515	14,020	1,816	373	2,189	7,321	8,888	16,209	(741)				(1,824)				
3	1997	7,747	17,046	24,793	4,476	1,599	6,075	12,223	18,645	30,868	(1,670)				(3,130)				Commitme
4	1998	14,200	14,749	28,949	1,987	1,763	3,750	16,187	16,512	32,699	(3,019)				(4,801)				
5	1999	16,049	13,076	29,125	1,187	1,614	2,801	17,236	14,690	31,926	(4,607)				(6,284)				
6	2000	3,290	2,171	5,461				3,290	2,171	5,461	(5,582)			60,402	(7,083)			75,653	Grace pe
7	2001										5,738	1,116	6,854	59,286	7,178	1,398	8,585	74,255	
8	2002										5,632	1,222	6,854	58,064	7,055	1,530	8,585	72,725	Repayment m
9	2003										5,516	1,338	6,854	56,726	6,909	1,676	8,585	71,049	
10	2004										5,389	1,465	6,854	55,261	6,750	1,835	8,585	69,214	20 years
11	2005										5,250	1,604	6,854	53,657	6,575	2,010	8,585	67,204	interest
12	2006										5,097	1,757	6,854	51,900	6,384	2,201	8,585	65,003	
13	2007										4,930	1,924	6,854	49,976	6,175	2,410	8,585	62,593	Capital
14	2008										4,748	2,106	6,854	47,870	5,947	2,638	8,585	59,955	
15	2009										4,547	2,307	6,854	45,563	5,696	2,889	8,585	57,066	Note: Figur
16	2010										4,328	2,526	6,854	43,037	5,421	3,164	8,585	53,902	inter
17	2011										4,088	2,766	6,854	40,271	5,121	3,464	8,585	50,438	perio
18	2012										3,826	3,028	6,854	37,243	4,792	3,793	8,585	46,645	
19	2013										3,538	3,316	6,854	33,927	4,431	4,154	8,585	42,491	
20	2014										3,223	3,631	6,854	30,296	4,037	4,548	8,585	37,943	
21	2015										2,878	3,976	6,854	26,320	3,605	4,980	8,585	32,963	
22	2016										2,499	4,355	6,854	21,965	3,132	5,453	8,585	27,510	
23	2017										2,086	4,768	6,854	17,197	2,613	5,972	8,585	21,538	
24	2018										1,634	5,220	6,854	11,977	2,047	6,538	8,585	15,000	
25	2019										1,137	5,717	6,854	6,260	1,425	7,160	8,585	7,840	
26	2020										594	6,260	6,854	0	745	7,840	8,585	0	
Total		50,936	70,304	121,240	9,466	5,349	14,815	60,402	75,653	136,055	76,678	60,402	137,080	0	24,132	75,653	171,700	0	

Table 13–4 Funds Procurement and Repayment Schedule for Artvin Project

(Unit: 10^6TL)

roject		Transmission Line (Hopa - Ankara)			Funds Procurement (Total)			Repayment Schedule								Remarks
								Foreign Currency				Local Currency				
l	Total	Foreign	Local	Total	Foreign Currency	Local Currency	Total	Interest	Principal	Total	Outstanding Balance	Interest	Principal	Total	Outstanding Balance	
2	1,338				256	1,082	1,338	(12)				(52)				Repayment Conditions:
1	1,336				255	1,081	1,336	(36)				(155)				
4	16,218				3,634	12,584	16,218	(221)				(803)				FC and LC Interest rate: 9.5% per annum
5	14,020	1,816	373	2,189	7,321	8,888	16,209	(741)				(1,824)				
6	24,793	4,476	1,599	6,075	12,223	18,645	30,868	(1,670)				(3,130)				Commitment charge: not considered
9	28,949	1,987	1,763	3,750	16,187	16,512	32,699	(3,019)				(4,801)				
6	29,125	1,187	1,614	2,801	17,236	14,690	31,926	(4,607)				(6,284)				
1	5,461				3,290	2,171	5,461	(5,582)			60,402	(7,083)			75,653	Grace period: 6 years
								5,738	1,116	6,854	59,286	7,178	1,398	8,585	74,255	
								5,632	1,222	6,854	58,064	7,055	1,530	8,585	72,725	Repayment method:
								5,516	1,338	6,854	56,726	6,909	1,676	8,585	71,049	
								5,389	1,465	6,854	55,261	6,750	1,835	8,585	69,214	20 years with principal and interest in equal installment
								5,250	1,604	6,854	53,657	6,575	2,010	8,585	67,204	
								5,097	1,757	6,854	51,900	6,384	2,201	8,585	65,003	
								4,930	1,924	6,854	49,976	6,175	2,410	8,585	62,593	Capital recovery factor: 0.113476
								4,748	2,106	6,854	47,870	5,947	2,638	8,585	59,955	
								4,547	2,307	6,854	45,563	5,696	2,889	8,585	57,066	Note: Figures in parentheses are interest during construction period.
								4,328	2,526	6,854	43,037	5,421	3,164	8,585	53,902	
								4,088	2,766	6,854	40,271	5,121	3,464	8,585	50,438	
								3,826	3,028	6,854	37,243	4,792	3,793	8,585	46,645	
								3,538	3,316	6,854	33,927	4,431	4,154	8,585	42,491	
								3,223	3,631	6,854	30,296	4,037	4,548	8,585	37,943	
								2,878	3,976	6,854	26,320	3,605	4,980	8,585	32,963	
								2,499	4,355	6,854	21,965	3,132	5,453	8,585	27,510	
								2,086	4,768	6,854	17,197	2,613	5,972	8,585	21,538	
								1,634	5,220	6,854	11,977	2,047	6,538	8,585	15,000	
								1,137	5,717	6,854	6,260	1,425	7,160	8,585	7,840	
								594	6,260	6,854	0	745	7,840	8,585	0	
121,240		9,466	5,349	14,815	60,402	75,653	136,055	76,678	60,402	137,080	0	24,132	75,653	171,700	0	

Table 13–5 Income Statement for Artvin Project

(Unit: 10^6TL)

No.	Year	Operating Revenue (A)	Operating Expenses			Operating Income (A)-(B)=(C)	Financial Expenses			Net Income (C)-(D)=(E)	Remarks
			OMA	Depre-ciation	Total (B)		FC	LC	Total (D)		
-2	1993						(12)	(52)	(64)		Operating Revenue:
-1	1994						(36)	(155)	(191)		
1	1995						(221)	(803)	(1,024)		Energy sold : 956.2 x 10^6 KWh
2	1996						(741)	(1,824)	(2,565)		Unit Price : 27 TL/kWh
3	1997						(1,670)	(3,130)	(4,800)		Total : 25,817.4 x 10^6 TL
4	1998						(3,019)	(4,801)	(7,820)		
5	1999						(4,607)	(6,284)	(10,891)		OMA: Operation maintenance and
6	2000						(5,582)	(7,083)	(12,665)		Administration Expenses
7	2001	25,817.4	1,490	4,208	5,698	20,119.4	5,738	7,187	12,925	7,194.4	
8	2002	25,817.4	1,490	4,208	5,698	20,119.4	5,632	7,055	12,687	7,432.4	Project proper : 1,204 x 10^6 TL/year
9	2003	25,817.4	1,490	4,208	5,698	20,119.4	5,516	6,909	12,425	7,694.4	Related Trans.L.: 286 "
10	2004	25,817.4	1,490	4,208	5,698	20,119.4	5,389	6,750	12,139	7,980.4	Total : 1,490 "
11	2005	25,817.4	1,490	4,208	5,698	20,119.4	5,250	6,575	11,825	8,294.4	
12	2006	25,817.4	1,490	4,208	5,698	20,119.4	5,097	6,384	11,481	8,638.4	Depreciation:
13	2007	25,817.4	1,490	4,208	5,698	20,119.4	4,930	6,175	11,105	9,014.4	
14	2008	25,817.4	1,490	4,208	5,698	20,119.4	4,748	5,947	10,695	9,424.4	Project proper : 3,663 x 10^6 TL/year
15	2009	25,817.4	1,490	4,208	5,698	20,119.4	4,547	5,696	10,243	9,876.4	Related Trans.L.: 545 "
16	2010	25,817.4	1,490	4,208	5,698	20,119.4	4,328	5,421	9,749	10,370.4	Total : 4,208 "
17	2011	25,817.4	1,490	4,208	5,698	20,119.4	4,088	5,121	9,209	10,910.4	
18	2012	25,817.4	1,490	4,208	5,698	20,119.4	3,826	4,792	8,618	11,501.4	
19	2013	25,817.4	1,490	4,208	5,698	20,119.4	3,538	4,431	7,969	12,150.4	Note: Figures in parentheses are
20	2014	25,817.4	1,490	4,208	5,698	20,119.4	3,223	4,037	7,260	12,859.4	interest during construction
21	2015	25,817.4	1,490	4,208	5,698	20,119.4	2,878	3,605	6,483	13,636.4	period.
22	2016	25,817.4	1,490	4,208	5,698	20,119.4	2,499	3,132	5,631	14,488.4	
23	2017	25,817.4	1,490	4,208	5,698	20,119.4	2,086	2,613	4,699	15,420.4	
24	2018	25,817.4	1,490	4,208	5,698	20,119.4	1,634	2,047	3,681	16,438.4	
25	2019	25,817.4	1,490	4,208	5,698	20,119.4	1,137	1,425	2,562	17,557.4	
26	2020	25,817.4	1,490	4,208	5,698	20,119.4	594	745	1,339	18,780.4	
Total		516,348	29,800	84,160	113,960	402,388	76,678	96,047	172,725	229,663	

Table 13–6 Cash Flow Statement for Artvin Project

(Unit: 10^6TL)

No.	Year	Cash Inflow				Cash Outflow						Balance		Remarks
		Funds Procure-ment	Net Income	Depre-ciation	Total	Const-ruction	Repayment of Principal			Interest during Construction	Total	Yearly	Accumulated	
							FC	LC	Total					
-2	1993	1,338			1,338	1,338				64	1,402	-64	-64	
-1	1994	1,336			1,336	1,336				191	1,527	-191	-255	
1	1995	16,218			16,218	16,218				1,024	17,242	-1,024	-1,279	
2	1996	16,209			16,209	16,209				2,565	18,774	-2,565	-3,844	
3	1997	30,868			30,868	30,868				4,800	35,668	-4,800	-8,644	
4	1998	32,699			32,699	32,699				7,820	40,519	-7,820	-16,464	
5	1999	31,926			31,926	31,926				10,891	42,817	-10,891	-27,355	
6	2000	5,461			5,461	5,461				12,665	18,126	-12,665	-40,020	
7	2001		7,194.4	4,208	11,402.4		1,116	1,398	2,514		2,514	8,888.4	-31,131.6	
8	2002		7,432.4	4,208	11,640.4		1,222	1,530	2,752		2,752	8,888.4	-22,243.2	
9	2003		7,694.4	4,208	11,902.4		1,338	1,676	3,014		3,014	8,888.4	-13,354.8	
10	2004		7,980.4	4,208	12,188.4		1,465	1,835	3,300		3,300	8,888.4	-4,466.4	
11	2005		8,294.4	4,208	12,502.4		1,604	2,010	3,614		3,614	8,888.4	4,422	
12	2006		8,638.4	4,208	12,846.4		1,757	2,201	3,958		3,958	8,888.4	13,310.4	
13	2007		9,014.4	4,208	13,222.4		1,924	2,410	4,334		4,334	8,888.4	22,198.8	
14	2008		9,424.4	4,208	13,632.4		2,106	2,638	4,744		4,744	8,888.4	31,087.2	
15	2009		9,876.4	4,208	14,084.4		2,307	2,889	5,196		5,196	8,888.4	39,975.6	
16	2010		10,370.4	4,208	14,578.4		2,526	3,164	5,690		5,690	8,888.4	48,864	
17	2011		10,910.4	4,208	15,118.4		2,766	3,464	6,230		6,230	8,888.4	57,752.4	
18	2012		11,501.4	4,208	15,709.4		3,028	3,793	6,821		6,821	8,888.4	66,640.8	
19	2013		12,150.4	4,208	16,358.4		3,316	4,154	7,470		7,470	8,888.4	75,529.2	
20	2014		12,859.4	4,208	17,067.4		3,631	4,548	8,179		8,179	8,888.4	84,417.6	
21	2015		13,636.4	4,208	17,844.4		3,976	4,980	8,956		8,956	8,888.4	93,306	
22	2016		14,488.4	4,208	18,696.4		4,355	5,453	9,808		9,808	8,888.4	102,194.4	
23	2017		15,420.4	4,208	19,628.4		4,768	5,972	10,740		10,740	8,888.4	111,082.8	
24	2018		16,438.4	4,208	20,646.4		5,220	6,538	11,758		11,758	8,888.4	119,971.2	
25	2019		17,557.4	4,208	21,765.4		5,717	7,160	12,877		12,877	8,888.4	128,859.6	
26	2020		18,780.4	4,208	22,988.4		6,260	7,840	14,100		14,100	8,888.4	137,748	
Total		136,055	229,663	84,160	449,878	136,055	60,402	75,653	136,055	40,020	312,130	177,768	137,748	

CHAPTER 14 FURTHER INVESTIGATIONS

CHAPTER 14. FURTHER INVESTIGATIONS

CONTENTS

CHAPTER 14. FURTHER INVESTIGATIONS

In carrying out definite designs for the Yusufeli and Artvin Projects, the further investigations considered to be necessary are as described below.

14.1 Topographical Survey

Preparation of 1/1000 or 1/500 scale of topographical maps of the dam sites and apurtenant structure sites of the Yusufeli and Artvin Projects by surveying or by aerial-photographic surveys and provisions of triangulation datum points and bench marks (B.M.).

14.2 Geological Investigation

Further geological investigations to be carried out on the abovementioned two sites have been planned based on the conditions below.

. The dam type at the Yusufeli dam site is to be rockfill.

. The dam site in the Artvin Project is the site of the downstream plan (about 19 km downstream from Yusufeli damsite) and the dam type to be selected will be concrete arch-gravity or concrete arch.

14.2.1 Yusufeli Project

(1) Reservoir Area

. Preparation of lithofacies geological map giving consideration to landslides.

(2) Dam Site and Appurtenant Structure Sites

(a) Drillhole

Location	Number of holes and length	Objective
Upstream cofferdam	1 hole, 20 m in bed rock	Confirmation of thickness and permeability of river-bed sand-gravel at cofferdam site
Dam right abutment EL. 550 - 710 m	2 holes, length undecided	Confirmation of permeability of basement at right abutment of dam
Spillway toe	1 hole, 10 m in bed rock	Confirmation of surface deposits at spillway toe

(b) Materials Investigations

i) Impervious Soil Material

The investigations below on red soil and black soil from among the soil materials in the vicinity of the Gorgulu Landslide.

(Red Soil)

. Investigation of available quantity

Excavation of pits on 100 m grid in the area of distribution. Depth of pit to be 3 m as a rule.

. Sampling from each pit at every 1 m depth.

. Laboratory test items as in Table 7-4

. Swelling and pinhole tests to be performed in addition to items in Table 7-4. The number of these tests to be determined elsewhere in accordance with circumstances in the field.

(Black Soil)

- Sampling at 5 to 10 scattered locations (ground surface) on Gorgulu landslide.
- X-ray analysis on each sample to determine montmorillonite content, at the same time performing swelling and pinhole tests.
- Other investigations and testing to be decided based on results of above tests.

ii) Filter Material

- The sand-gravel bar developed near the confluence of the Oltu and Coruh rivers is the site intended for obtaining filter materials and concrete aggregates. Pits (depth 2 - 3 m) to be excavated on 100 m grid with sampling done at every 1 m depth.
- Tests on items below to be performed on samples collected: gradation, absorption, compaction, permeability, shear strength.

iii) Concrete Aggregate

- Tests of the items in Table 7-4 to be performed on samples collected in abovementioned filter materials investigations.
- Any test item also in filter material tests may be omitted.

iv) Rock Materials

Rock materials for rockfill to be collected from quarry site planned downstream of dam site. When decided on as quarry site, tests of the items below to be performed on samples collected from the site: specific gravity, absorption, durability, shear strength.

14.2.2 Artvin Project

(1) Reservoir Area and Havuzlu Landslide

- Preparation of lithofacies map considering landslides
- Provision of monitor system on Havuzlu Landslide and long-term observations of that landslide

(2) Dam Site and Appurtenant Structure Site

The exploratory adits and drillhole listed below were recommended by the Survey Team which carried out field investigations in February 1986.

(a) Exploratory Adit

Adit	Coordinate	Direction, Length
IRA-1	$\binom{480635}{533323}$ - portal	N10°E, 35 m
	$\binom{480640}{533360}$ - bend	N60°E, 130 m
	$\binom{480750}{533425}$ - adit end	Total length 165 m
ILA-2	$\binom{480500}{533357}$ - portal	N45°W, 50 m
	$\binom{480465}{533392}$ - adit end	Total length 50 m

(Note) Portal elevations of the adits to be roughly 435 m.

(b) Drillhole

Hole	Coordinate	Direction, Length
SIDI-2	$\binom{480740}{533365}$	N85°W, 50° from horizontal, 150 m
SIDI-3	Same location	Vertical, 200 m
SIDI-4	$\binom{480547}{533460}$	N90°W, 10° from horizontal, 160 m

Total of 3 holes: 510 m

In addition to the three holes above, two inclined drillholes intersecting the river bed will be necessary, but the locations of these holes are undecided so that lengths cannot be determined. The purposes of the two drillholes is to confirm the length and direction of the fault discovered at the time of drilling SID-1, and it will be important for the river bed to be intersected.

(c) Surface Geological Exploration

Preparation of detailed geological map based on new topographic maps.

(d) Concrete Aggregate Tests

Concrete aggregate tests to be performed on river-bed sand-gravel distributed in neighborhood of dam site. Test items as listed in Table 7-4.