Oct. 1990 - Oct. 1992	Feasibility Study
1993 - 1994	Provision and Award of Final Design (1 year)
1994 - 1995	Final Design (2 years)
1996 - 1997	Financial Formulation (1.5 years)
1997 - 1999	Bidding and Award of Contract for Construction (1.5 years)
2000 -	Start of Construction of the Olur and the Ayvalı Project
Dec. 2005	End of Construction of the Olur Project
Jul. 2006	End of Construction of the Ayvalı Project

(1) Olur Project

The outline of the Project is given in Table 9-15, and the quantities of the main civil works are as given in Table 12-1.

The principal construction machinery and facilities expected to be required at the peak of construction are as listed in Table 12-2.

As a result of study of the schedule for construction work of the Olur Project taking into consideration project scale, construction methods, etc., it is determined that a construction period of approximately 6 years including preparatory works will be required.

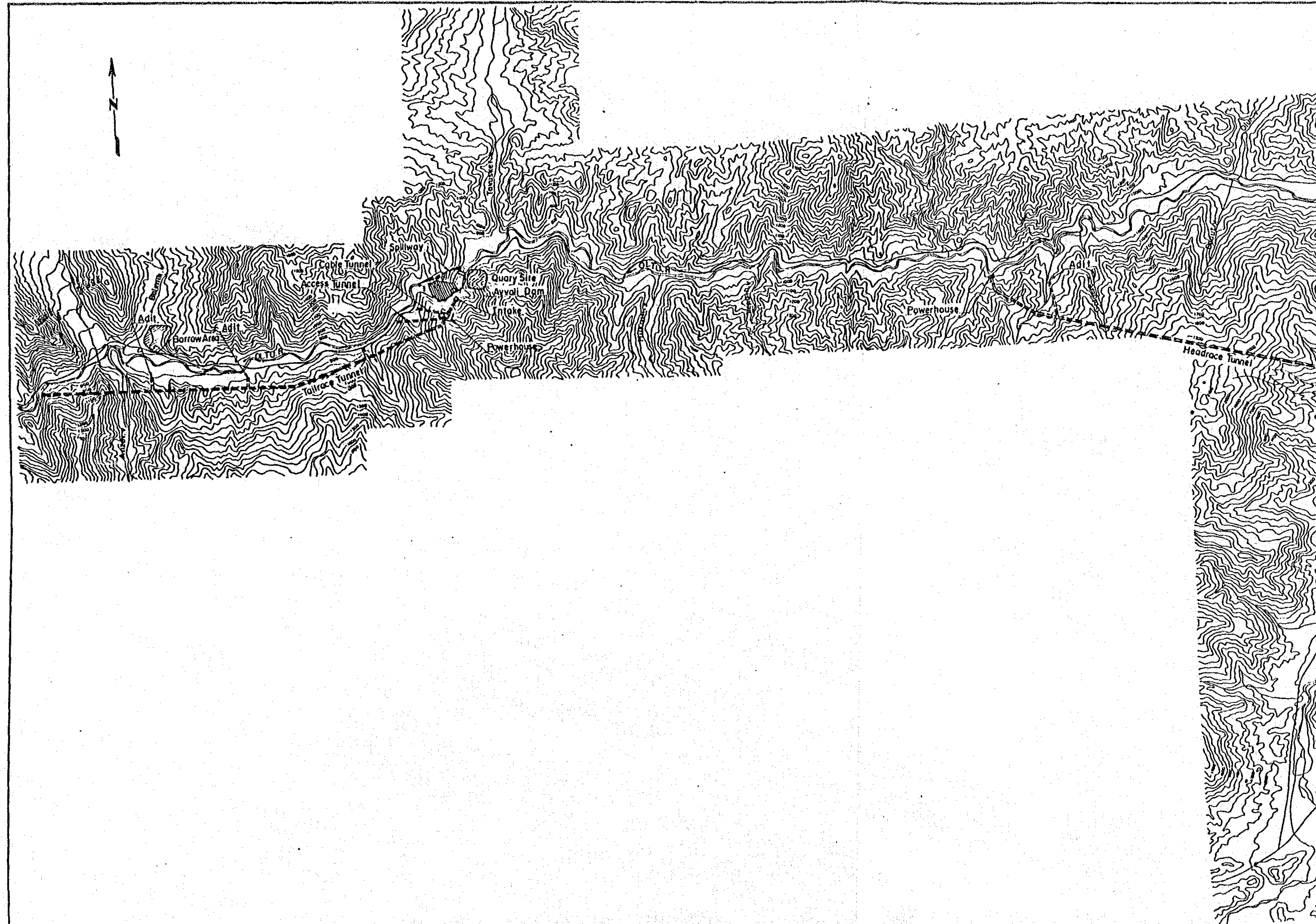
The layout plans and construction schedules for the temporary facilities of the Project are shown in Fig. 12-2 and Fig. 12-3, respectively.

Table 12-1 Main Civil Works of Olur Project

Item	Description	Amount of Works
Diversion Tunnel	Tunnel ex.	22,300 m^3
	Lining Conc.	6,400 m^3
Cofferdam	Embankment	215,000 m^3
Dam	Ex. in open	363,000 m^3
	Em. of Core	549,000 m^3
	Em. of Filter	463,000 m^3
	Em. of Rock	2,572,000 m^3
	Riprap	67,000 m^3
Spillway	Ex. in open	546,000 m^3
	Concrete	51,000 m^3
	Gate	3
Power Intake	Ex. in open	27,200 m^3
	Concrete	5,300 m^3
	Gate	1
Headrace Tunnel	Tunnel Ex.	282,100 m^3
	Lining Conc.	87,200 m^3
Surge Tank	Shaft Ex.	13,000 m^3
	Lining Conc.	3,500 m^3
Penstock	Ex. in open	30,500 m^3
	Concrete	2,200 m^3
	Steel	760 t
Power house	Ex. in open	62,500 m^3
Switchyard	Ex. in open	1,700 m^3
	Banking	10,400 m^3
	Concrete	500 m^3

Table 12-2 Machinery for the Olur Project and Ayvalı Project

Item		Machinery			Nos.
Dam	Core and Filter	Wheel loader	4.5	m^3 class	2
		Dump truck	32	t class	10
		Bulldozer	32	t class	5
		Vibratory roller	15	t class	3
	Rock	Wheel loader	8.5	m^3 class	3
		Dump truck	45	t class	12
		Bulldozer	43	t class	6
		Vibratory roller	15	t class	3
		Shovel	1.2	m^3 class	2
Tunnel	Tunnel Ex.	Jumbo	3	boom	4
		Loader	3.3	m^3	4
	Concrete	Concrete pump	60	m^3/hr	4
		Concrete plant	0.75	m^3/min	1
		Aggregate plant	150	t/hr	1


N
Spillway
Cable Tunnel
Access Tunnel
Quary Site
Ayvali Dam
Intake
Powerhouse
Adit
Borrow Area
Adit
OLTU R.
Tailrace Tunnel
OLTU R.
Powerhouse
Adit
Headrace Tunnel

OLTU RIVER HYDROELECTOLIC POWER DEVELOPMENT PROJECT

LOCATION OF TEMPORARY FACILITIES

Fig. 12-2

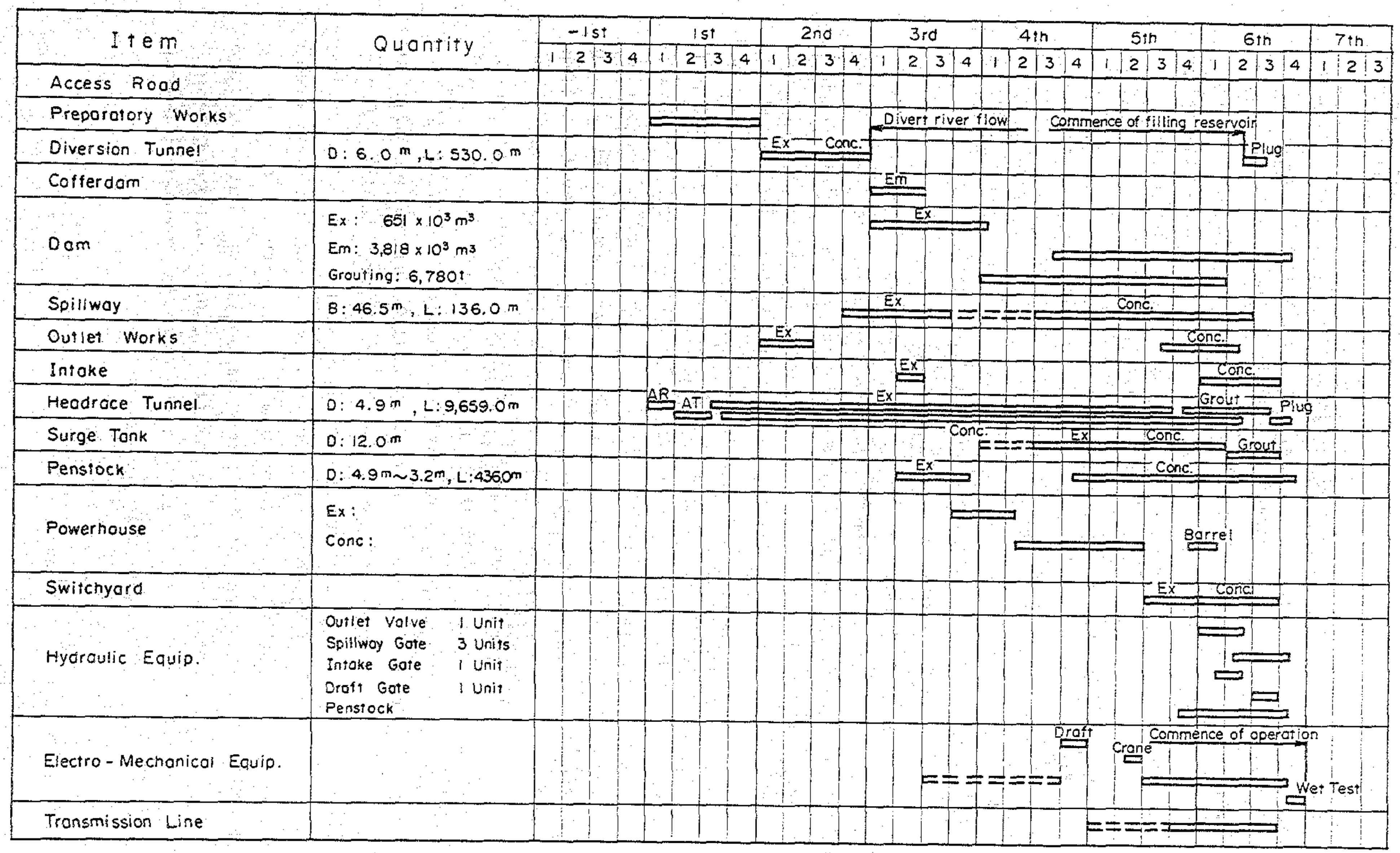


Fig. 12-3 Construction Schedule of the Olur Project

The critical path in the construction schedule of the Olur Project is construction by the headrace tunnel work. Therefore, the first work to be done in this Project is the access roads for the headrace tunnel, in succession to which excavation of work adits is to be started. The construction programs for the various works will be described below, the procedures of the works being indicated in the construction schedule.

1) Construction Program

(a) Diversion Tunnel and Outlet Works

Since the plan is for a single diversion tunnel, open excavation for the orifice of the outlet works which will share part of the flow channel and the vertical shaft portion is to be done and concrete lining provided before the diversion tunnel is put into use. All of the excavation of the waterway part of the outlet works and part of the lining are to be finished and bulkheads provided at the upstream and downstream parts. Excavation of the diversion tunnel is to be carried out from the downstream side by full-face excavation if possible and by half-face excavation if not, using one triple-boom jumbo, crawler shovel, and road haul each. After completing excavation, concrete lining of the arch and side wall portions is to be done in succession, and slightly later, lining of the invert. During and after completion of concrete lining, concrete for the upstream and downstream portals is to be placed. A gate sill is to be embedded at the upstream portal so that a closure gate can be installed. Consolidation grouting and curtain grouting are to be completed before starting diversion.

Plug concrete is to be placed in the diversion tunnel before starting impoundment of water by the dam to terminate the role of the diversion tunnel.

At the outlet works, discharge valves and related equipment are to be installed from the dry season several months prior to closure of the diversion tunnel and completed. The bulkheads installed previously are to be removed immediately before plugging of the diversion tunnel.

(b) Cofferdams

When the diversion tunnel has been completed and it becomes possible for water to be discharged, embankment of cofferdams upstream and downstream of the dam is to be done and diversion of the river flow is to be carried out. It is desirable for diversion of the river flow to be done during the dry season when there is less flow. After the river flow has first been diverted by primary coffering, the core portions of the cofferdams are to be excavated and embankment of the core, filter, and rock zones is to be started. When these embankments have risen to a certain height, water cut-off works by grouting are to be carried out under the cofferdams. When these works have been completed, embankment work is to be resumed until the specified heights have been reached.

(c) Dam

When the height of the cofferdam has reached a certain extent (a height thought will not be overtopped even if there were to be some amount of flood), excavation of the river-bed portion of the dam would be started, but in order that the river-bed excavation work will not be affected by excavation for the spillway and the dam, the fore bay part of the spillway and the dam part are to be roughly excavated beforehand.

The depth of excavation of the river bed will be approximately 45 m and very deep, and therefore, it will be necessary for excavation to be safely executed without seepage of infiltration water at the excavated slope.

Excavation of river-bed sand-gravel is to be carried out providing water cut-off walls under the upstream and downstream cofferdams and installing drainage pumps as necessary. Access roads for future grouting and embankment works are to be installed at this time. After completing excavation of river-bed sand-gravel, excavation of bedrock is to be done to a depth thought to be adequate with cap concrete immediately placed at the river bed. For parts where cap concrete is not placed (even where cap concrete has been placed) blanket grouting and curtain grouting are to be performed. After these grouting works at the river-bed portion have been completed, embankment of soil material, filter material, and rock material is to be immediately done. Prior to these embankment works, the part of the core that will be in contact with rock is to be shaped to have fewer irregularities upon which it is to be cleaned, and on top of which material with adequate plasticity is to be banked. The slopes to be in contact with filter and rock zones are also to have prominent irregularities evened out. Above EL. 1077 m on the upstream side and above

EL. 1027 m on the downstream side, riprap is to be placed on the surfaces of the rock embankments.

Kaledibi Borrow Area and Yolboyu Borrow Area are planned to be used as borrow areas for impervious soil core material. Although Kaledibi Borrow Area is close to the dam site being 2.5 to 3 km away, the material is fairly coarse, and if it were to be used unmodified there will be constituents entailing problems about permeability. The material of Yolboyu Borrow Area is thought to involve almost no problems concerning grain-size distribution and permeability, but the area is far from the dam site being at a distance of 11 km, and there will be the drawback that transportation costs will be fairly high. In the event it is judged that material from Kaledibi Borrow Area cannot be used by itself, a stockpile is to be provided inside Kaledibi Borrow Area and materials from the two borrow areas blended to obtain a suitable gradation, and this blended material is to be transported to the dam site for embankment.

For fine particled filter, material excavated from the river bed at the dam site is to be stockpiled, classified at the time of using, and prepared to have the required properties, or else, it is to be transported directly to the dam site for embankment. For coarse-particled filter, excavated river-bed material of comparatively coarse size and excavated rock of comparatively fine size are to be stockpiled, transported to the dam size as necessary, and banked.

Rock materials are to consist of rock excavated from the dam and spillway sites and stockpiled, and rock obtained by bench cutting at the quarry site on the right bank downstream of the dam, and these are to transported to the dam site and banked. Of materials obtained at the quarry, large blocks are to be used as riprap material. The machinery and equipment to be used in these embankment works are listed in Table 12-1. It is necessary for roads for transporting embankment materials to be planned so that they will be suited to the machinery to be used.

(d) Spillway

Prior to start of river-bed excavation for the dam, the forebay portion of the spillway is to be excavated roughly so that the dam work to be executed later will not be affected. Of excavation related to the spillway, the forebay part is to be excavated by bench cutting of height about 10 m, and later, finish-blasted to depths of about 1 to 1.5 m so that there will not be adverse effects of blasting at the finished surface of excavation, followed by shaping, cleaning, and finishing to be adequate as a foundation for a concrete structure.

Excavation is to be completed in accordance with a detailed construction program, and concrete is to be placed from parts where various preparations for concreting have been completed. Concrete placement is to be done by concrete pump, crane, or chute. After completing concrete placement of the weir portion of the spillway, grouting of this part is to be done in the form of continuation of the grouting at the dam.

After completion of weir concrete, pier concrete, and bridge work, installation of three radial gates is to be done for completion by the time water impoundment is started.

A concrete plant having a capacity of 0.75 m^3/min and an aggregate plant of 150 t/hr are to be planned for the dam and surrounding works (dam, diversion tunnel, spillway, intake, and headrace tunnel).

(e) Intake and Headrace Upstream Portal

The critical path in the work schedule of the Olur Project will be constituted by the headrace tunnel work. Therefore, it is the headrace tunnel work which should be started first. The headrace work is to be carried out divided into three parts consisting of the intake to 4,200 m, from there 4,200 m to the intersecting point with the lower portal adit, and 1,500 m from the adit intersecting point to the penstock.

The headrace tunnel from the intake to 4,200 m is to be constructed from the intake side. The work is to be done first excavating a work adit (approximately 80 m) having its portal at a location not hindering excavation at the intake, followed in succession by headrace tunnel excavation. Excavation of the headrace tunnel is to be doe using a triple-boom junbo, rocker shovel, and shuttle cars or trolleys, with full-face excavation carried out. Excavated muck is to be used for embankment of the dam. Concrete lining work is to be started about one month after excavation. Forms are to be telescopic forms with concrete placed using a concrete placer. When concrete lining of 4,200 m has been completed, invert concrete is to be placed from the farthest point from the portal, and consolidation grouting done from where invert concrete placement has been completed. After the abovementioned works have been completed, the adit is to be plagged with concrete.

The intake is to be excavated in a manner not to hinder headrace tunnel work and placement of concrete is to be done.

The intake is to be excavated firstly in accordance with the design, and concrete placed. In placing concrete, preparations for installation or installation of metal fixtures such as gate sills and screens are to be done. After completion of concrete placement, the intake gate and screen are to be installed in time for start of impoundment of water in the reservoir.

(f) Middle Section of Headrace Tunnel and Headrace Lower Portal (Including Surge Tank)

To perform work on the middle-section 4,200 m of the headrace tunnel, it is necessary to provide a work adit of approximately 400 m and an access road from the public road to the entrance of the adit (length about 1,500 m).

After completion of the abovementioned preparatory works, excavation of the headrace tunnel is to be started in succession. A triple-boom jumbo, rocker shovel, and shuttle cars or trolleys are to be used for excavation of the headrace tunnel, and full-face excavation is to be done. Excavation muck is to be accommodated at a spoil area provided at the portal of the work adit.

Concrete lining work is to be started one month later than excavation. Forms are to be telescopic type, and placement of concrete is to be with a concrete placer. After completing concrete lining of the 4,200 m, invert concrete is to be placed from the innermost part, with consolidation grouting done at parts where placement has been completed. After completion of the these works, the adit is to be plugged with concrete.

Excavation of the headrace tunnel from the intersecting point with this adit to the surge tank and placement of concrete are to be done utilizing this adit.

In the surge tank work, after first completing excavation of rock at the surface portion, when the excavation of the headrace tunnel has reached the point under the vertical shaft of the surge tank, a pilot vertical shaft is to be bored inside the vertical shaft upward from the bottom, followed by enlarging of the vertical shaft making use of this pilot shaft. After completion of widening of the vertical shaft, concrete lining is to be done from the bottom of the vertical shaft, followed also from the bottom by consolidation grouting of the vertical shaft to complete the surge tank work. A concrete plant is to be provided at or near the portal of the work adit of the headrace tunnel for the middle section of the headrace, the lower portal of the headrace, surge tank, penstock, and powerhouse works. If necessary, an aggregate plant is to be provided in the vicinity.

(g) Penstock and Powerhouse

Of the penstock work, above-ground excavation is to be done from the upper part toward the bottom, and after completion of excavation, invert and retaining wall concretes are to be placed. After these works have been completed, penstock pipes are to be installed in succession.

After completion of excavation for the penstock, it is to be followed by excavation for the powerhouse.

After completion of excavation, base concrete, sidewall concrete, and retaining wall concrete are to be placed, followed in succession by construction of the powerhouse superstructure. After completion of the superstructure building, an overhead travelling crane for turbine and generator installation is to be set in accordance with the detailed work schedule. In succession to this, turbine and generator installation works are to be started, various dry tests performed, and after filling the waterway with water, wet tests are to be carried out to reach the stage of start of commercial operation. A steel pipe plant is to be provided in the vicinity of the powerhouse for rolling of penstock pipe, where rolling and welding of steel plates are to be done and installation carried out at the site.

2) Construction Schedule

The critical path in the construction schedule of the Olur Project is construction of the headrace tunnel 9.7 km in length. Therefore, the headrace tunnel work would be started first.

The construction schedule for the Olur Project is as shown in Fig. 12-3.

- First Year

  The headrace tunnel work would be performed using work adits provided in the vicinity of the power intake at the upstream side and in the vicinity of 1.5 km upstream from the surge tank.

  When work has commenced, construction of offices, lodging facilities, and material storage yards of the owner and contractor for the headrace work would first be constructed, and at the same time, it would be necessary for access roads leading from the existing national highway to the power intake and the downstream-side work adit portal to be built.

  After completion of these access roads, excavation of the upstream and downstream work adits is to be started immediately and excavation of the headrace is to be done. Of the excavated muck hauled from the upstream work adit, material utilizable would be diverted for embankment of the dam.

  Lining work of the headrace tunnel would be done parallel to excavation of the tunnel proper. Prior to this, site preparation and equipment assembly would be done for temporary facilities such as aggregate plant, concrete plant, and cement silo, to make it possible for concrete lining to be performed in the latter half of the first year.

- Second Year

  Excavation and concrete lining works of the headrace tunnel would be going on.

  Construction of an access road for diversion tunnel work and open excavation for providing a portal for the diversion tunnel would be performed.

  Construction of offices, loading facilities, and materials storage yards of the owner and contractors for the dam, penstock and powerhouse works, and construction of access roads for such construction would be done.

- Third Year

  The diversion tunnel, headrace tunnel, and temporary facility works would be continued, along with which open excavation would be started for the dam and spillway. Open excavation works of the penstock and powerhouse would also commence.

  The diversion tunnel would be completed by the end of the wet season after which the stream flow would be immediately diverted to the diversion tunnel. Parts higher than the river bed would be excavated prior to stream diversion, and simultaneously with diversion, the upstream and the downstream cofferdam would be constructed. Excavation of the alluvium of the dam and foundation treatment would be performed in step with progress in construction of the cofferdam.

- Fourth Year

For dam construction, embankment work would be done after completion of excavation of the alluvium, and carrying out foundation treatment such as consolidation and curtain grouting of the river-bed portion.

Excavation and concrete work of the headrace tunnel would be continuing.

Meanwhile, open excavation at the upper part of the surge tank, and for the penstock and powerhouse would continue.

At the powerhouse, after finishing open excavation, foundation concrete and side-wall concrete would be placed. Draft tube liner installation would be done while placing foundation concrete.

- Fifth Year

In dam construction, embankment works such as of the impervious core, filter and rock zones would continue to be carried out. At the spillway, concrete of the chute and weir portions would be placed.

Excavation and lining concrete works of the headrace tunnel would continue to go on.

Grouting work of headrace tunnel would be started in parallel with placement of invert concrete.

For the surge tank, excavation of the vertical shaft would be continued, in succession to which lining concrete of the vertical shaft and concrete of the top portion would be placed.

For the penstock, placement of the invert and side-wall concrete would be done, and after this work has been completed, installation of the penstock would be done in succession.

At the powerhouse, work on the side-wall and slab concrete would be almost finished, in succession to which concrete of the building superstructure would be placed, and after installation of the crane girder, the overhead travelling crane would be installed. At the powerhouse, in succession to installation of the crane, equipment installation such as of turbines and generators would be commenced.

- Sixth Year

This is the year when operation of the power station would be started.

In dam construction, embankment work would continue to go on, and the schedule would be for the embankment work to be completed by the end of the year. Impoundment of water in the reservoir would be started in the middle of the year in order that wet tests of turbines and generators can be performed at the end of the year.

At the spillway, placing of concrete for the weir and pier sections would be carried out, in succession to which installation of spillway gates would be done.

At the headrace tunnel, placement of invert concrete would be continued, while consolidation grouting would be done from parts where placement has been completed. After completion, work adits would be plugged and curtain grouting of the surroundings performed.

The surge tank would have its vertical shaft lined with concrete, and after completion, consolidation grouting of the vertical shaft would be done.

Installation of steel pipe would be continued at the penstock.

At the powerhouse, installation of turbine, generator, and control equipment would be under way aiming for the start of operation at the end of the year. Dry tests and wet tests would follow, and after the tests have been passed, start of operation would be done at the end of the year.

Construction of an outdoor switchyard, expansion of Yusufeli Switchyard, and construction of a transmission line are to be completed by the time wet tests of the power station are started.

(2) Ayvalı Project

The outline of this Project is given in Table 9-15, and the quantities of the main civil works are as given in Table 12-3.

The principal construction machinery and facilities expected to be required at the peak of construction are as listed in Table 12-2.

As a result of study of the schedule for construction work of the Ayvalı Project taking into consideration project scale, construction methods, etc., it is determined that a construction period of approximately 6.5 years including preparatory works will be required.

The layout plans and construction schedules for the temporary facilities of the Project are shown in Figs. 12-2 and 12-4, respectively.

Table 12-3 Main Civil Works of Ayvalı Project

Item	Description	Amount of Works
Diversion Tunnel	Tunnel ex.	30,000 m^3
	Lining Conc.	8,800 m^3
Cofferdam	Embankment	190,000 m^3
Dam	Ex. in open	950,000 m^3
	Em. of Core	1,186,000 m^3
	Em. of Filter	1,009,000 m^3
	Em. of Rock	6,183,000 m^3
	Riprap	111,000 m^3
Spillway	Ex. in open	1,015,000 m^3
	Concrete	87,300 m^3
	Gate	3
Power Intake	Ex. in open	24,400 m^3
	Concrete	6,700 m^3
	Gate	1
Penstock	Tunnel Ex.	7,500 m^3
	Plug Conc.	3,300 m^3
	Steel Penstock	800 t
Power house	Ex. in underground	29,100
	Concrete	9,900 m^3
Surge Chamber	Excavation	15,000 m^3
	Concrete	2,700 m^3
Tailrace Tunnel	Tunnel Ex.	343,000 m^3
	Lining Conc.	106,000 m^3
Switchyard	Ex. in open	12,000 m^3
	Banking	4,700 m^3
	Concrete	1,300 m^3

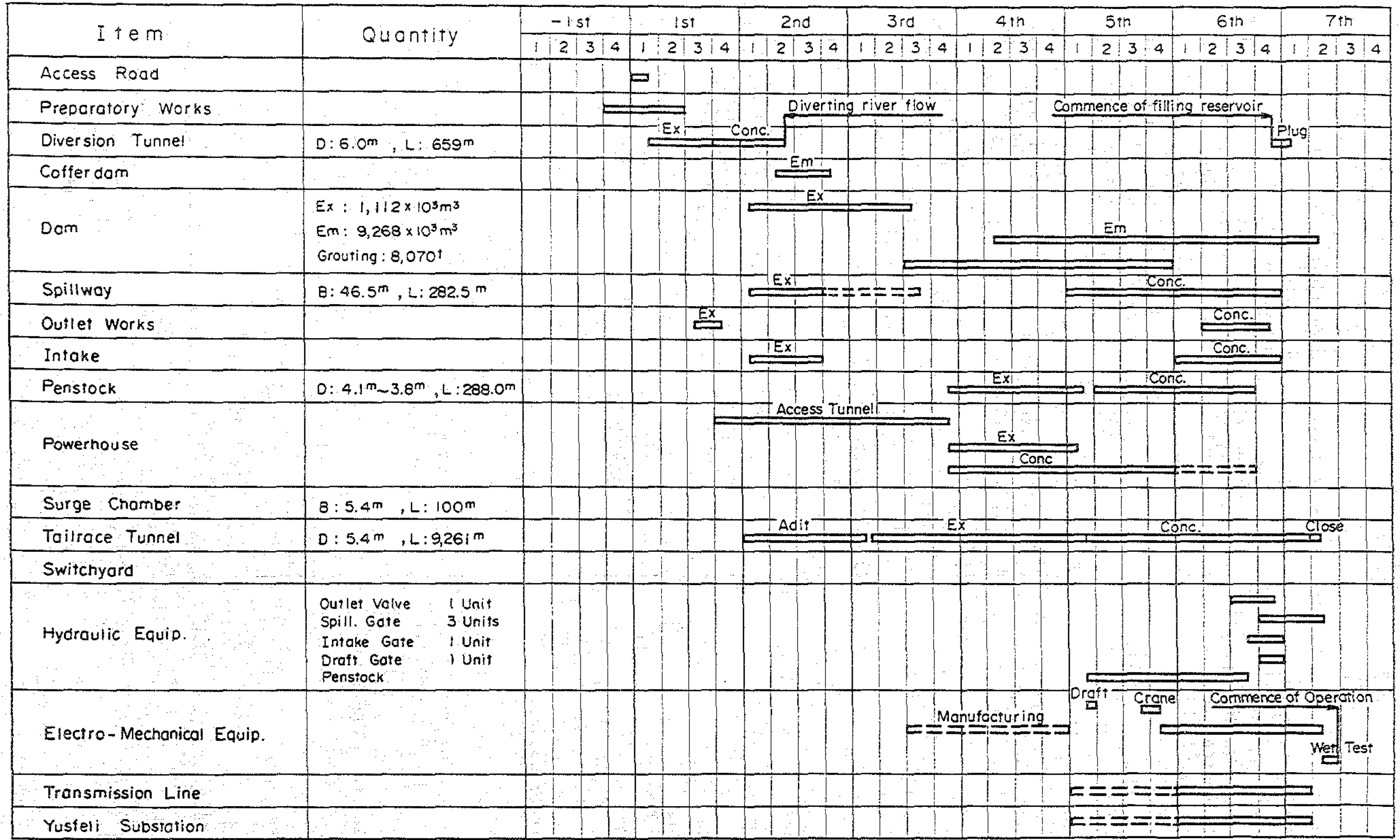


Fig. 12-4 Construction Schedule of the Ayvalı Project

The critical path in the construction schedule of the Ayvalı Project is constituted by the dam work. Therefore, the first works to be done are the excavation of the diversion tunnel for the dam and the construction of access roads around the dam. The construction programs of the various works are described below. The procedures of the various works are given in the construction schedule.

1) Construction Program

(a) Diversion Tunnel and Outlet Facilities

Since the plan is for a single diversion tunnel, surface excavation for the orifice of the outlet facilities which will share part of the flow channel, the vertical shaft portion, and concrete lining are to be completed before the diversion tunnel is put into use. All of the excavation of the waterway part of the outlet works and part of the lining are to be finished and bulkheads provided at the upstream and downstream parts.

Excavation of the diversion tunnel is to be carried out from the downstream side by full-face excavation if possible and by half-face excavation if not, using a combination of one triple-boom jumbo, crawler shovel, and road haul each. After completing excavation, concrete lining of the arch and side wall portions is to be done in succession, and slightly later than this, lining of the invert. During and after completion of tunnel lining, concrete for the upstream and downstream portals is to be placed. A gate sill is to be embedded at the upstream portal so that a closure gate can be installed. Consolidation grouting and curtain grouting are to be carried out before starting diversion.

Plug concrete is to be placed in the diversion tunnel before starting impoundment of water by the dam to terminate the role of the diversion tunnel.

At the outlet facilities, valves and related equipment are to be installed from the dry season several months prior to closure of the diversion tunnel, and the bulkheads installed previously are to be removed immediately before plugging of the diversion tunnel.

(b) Cofferdams

When the diversion tunnel has been completed and it becomes possible for water to be discharged, embankment of cofferdams upstream and downstream of the dam is to be done and diversion of the river flow is to be carried out. It is desirable for diversion of the river flow to be done during the dry season when there is less flow. After the river flow has first been diverted by primary coffering, the core portions of the cofferdams are to be immediately excavated and embankment of the core, filter, and rock zones is to be started. When these embankments have risen to a certain height, water cut-off works by grouting are to be carried out under the cofferdams. When these works have been completed, embankment work is to be resumed until the specified heights have been reached.

(c) Dam

After the height of the cofferdam has reached a certain extent (a height thought not to be overtopped even if there were some amount of flood), excavation of the river-bed portion of the dam proper would be started, but before that, in order that the river-bed excavation work will not be affected by excavation for the spillway and the dam proper, the forebay part of the spillway and the dam proper are to be roughly excavated.

The depth of excavation of the river bed will be approximately 60 m and very deep, and therefore, it will be necessary for excavation to be safely executed without seepage of infiltration water at the excavated slope. Excavation of river-bed sand-gravel is to be carried out providing water cut-off walls under the upstream and downstream cofferdams and installing drainage pumps as necessary. Access roads for future grouting of the river-bed portion and embankment works are to be installed at this time. When excavation of river-bed sand-gravel has been completed, excavation of bedrock is to b done to a depth thought to be adequate, with cap concrete immediately placed at the river bed, followed by performance of blanket grouting and curtain grouting.

After these grouting works at the river-bed portion have been completed, embankment of soil material, filter material, and rock material is to be immediately done. Prior to embankment works, the part of the core to be in contact with rock is to be carefully shaped to have fewer irregularities upon which it is to be cleaned, on top of which material with adequate plasticity is to be banked. The slopes to be in contact with filter and rock zones are also to have prominent irregularities evened out beforehand.

Above EL. 908 m on the upstream side and above El. 811 m on the downstream side, riprap is to be placed on the surface of the rock embankments.

Bulanik Borrow Area and Tavusker Borrow Area are candidate sites for use as borrow areas for impervious soil core material. The material of Bulanik Borrow Area is distributed in layer form with fine-grained material distinctly separate, and in using, the material should be blended by stockpiling to adjust to the required quality for embankment. The area is also fairly distant from the dam.

The material of Tavusker Borrow Area is thought to involve almost no problems concerning grain-size distribution and permeability.

For fine-particled filter, material excavated from the river bed at the dam site is to be stockpiled, classified at the time of using, and prepared to have the required properties, or else, it is to be transported directly to the dam site for embankment. For coarse-particled filter, excavated river-bed material of comparatively coarse size and excavated rock of comparatively fine size are to be stockpiled, transported to the dam size as necessary, and banked.

Rock materials are to consist of rock excavated from the dam and spillway sites and stockpiled, and rock obtained by bench cutting at the quarry site on the right bank downstream of the dam, and these are to be transported to the dam site and banked. Of materials obtained at the quarry, large blocks are to be used as riprap material.

The machinery and equipment to be used in these embankment works are listed in Table 12-   . It is necessary for roads for transporting embankment materials to be planned so that they will be suited to the machinery to be used.

(d) Spillway Work

The forebay portion of the spillway is to be excavated roughly prior to start of river-bed excavation for the dam. In excavation of the spillway, after rough excavation by bench cutting of height about 10 m, finish blasting to depths of about 1 to 1.5 is to be done so that there will not be adverse effects of blasting at the finished surface of excavation, followed by shaping cleaning, and finishing to be adequate as a foundation for a concrete structure. Concrete is to be placed from where excavation has been completed in accordance with the detailed construction program, and where various preparations for concreting have been completed. Concrete placement is to be done by concrete pump, crane, or chute. After completing concrete placement of the weir portion of the spillway, grouting of this part is to be done in the form of continuation of the grouting at the dam.

After completion of weir concrete, pier concrete, and bridge work, installation of three radial gates is to be done for completion by the time water impoundment is started.

A concrete plant having a capacity of 0.75 m^3/min and an aggregate plant of 150 t/hr are to be planned for the dam and surrounding works (dam, diversion tunnel, spillway, intake, and penstock).

(e) Intake and Penstock Works

The pilot tunnel for excavation of the diagonal shaft of the penstock is to be excavated from the powerhouse side and it is desirable for excavation of the above-ground portion of the intake to be completed before the pilot tunnel reaches this part. The respective excavation works are to be completed by such times that river-bed excavation for the dam will not be adversely affected.

Since the concreting work of the intake is to be done in the sixth year, shotcrete application is to be done for protection of the bedrock surface.

Concrete structures are to be finished in sequence from the bottom, at which time preparations for installation of the gate sill and screen are to be made. Since penstock pipes are to be delivered through the intake orifice, planning of concrete for the orifice portion and installation of gate and screen are to be done immediately before start of water impoundment.

Excavation of the penstock route is to be performed extending the diagonal cable shaft excavated for the outdoor switchyard toward the powerhouse as far as immediately below the lower horizontal section of the penstock and using this as the mucking work adit. After this work adit has reached immediately below the penstock, a vertical shaft is to be excavated toward the bottom end of the diagonal shaft part of the penstock, and inside this diagonal shaft part of the penstock is to be excavated upward to the intake by a pilot tunnel of about 2 x 1.5 m. Excavated muck is to be hauled out by a belt conveyor installed inside the cable tunnel. When the pilot tunnel has reached the intake, then enlargement excavation is to be done from the top to the bottom.

After completion of enlargement excavation, steel penstock pipes are to be delivered through the intake and installed, upon which concrete placement around then penstock is to be done sequentially from the bottom upward.

(f) Powerhouse Work and Surge Chamber Work

There are two routes available as approaches for the powerhouse work. One is the delivery road tunnel and the other the cable tunnel. Excavation work will be started for both of these tunnels in the first year of construction. The cable tunnel will be composed of a diagonal shaft to be excavated from the outdoor switchyard toward the spring of the underground powerhouse's arch and a horizontal tunnel at the bottom.

This passage is to be used as the cable tunnel between the powerhouse and the outdoor switchyard after completion of powerhouse construction, but during construction, it is to be used for hauling out excavation muck from the powerhouse arch, and for delivery of materials and for placement of concrete. Also, the diagonal shaft is to be extended further from this cable tunnel to reach under the penstock, and branching from this, a horizontal work adit is to be excavated to directly below the powerhouse and the draft tunnel, and the excavation muck of the powerhouse cavern proper and the draft tunnel is to be hauled outside by a belt conveyor installed in this horizontal adit. For excavation of the powerhouse cavern proper, a vertical shaft is to be excavated from this work adit (under the draft) toward the arch, and the excavation muck of the cavern proper below the arch is to be pushed into this vertical shaft and hauled outside by belt conveyor from the bottom.

The delivery road tunnel which is the other access route will reach the erection bay of the powerhouse. This tunnel is to be used for excavation of the part higher than the erection by, peripheral passages, the arch portion of the surge chamber, and for concreting work. After completion of civil work for the powerhouse, the tunnel is to be used for delivery of turbines, generators, and transformers, and for electrical work.

For the surge chamber work, a work adit is to be excavated branching from the powerhouse delivery passage toward the spring of the surge chamber arch, and this is to be used for excavation of the surge chamber arch and placing of lining concrete for the arch. Meanwhile, tunnel excavation will be done from the draft tunnel side or the tailrace tunnel side, and from this tunnel, two or three vertical shafts of approximately 20 m are to be bored upward for excavation of the surge chamber. When excavation of the chamber has been completed, concrete is to be transported using the delivery route, and placement of the side walls and invert of the chamber is to be done.

(g) Tailrace Tunnel

Two diagonal shafts are to be prepared for the tailrace tunnel work. Accordingly, there will be tunnelling faces at five places.

Excavation of the tailrace tunnel is to be done using a triple-boom jumbo, rocker shovel, and shuttle cars or trolleys, while excavation muck is to be temporarily stored in bins provided at the bottoms of the diagonal shafts and then hauled out-side by belt conveyors. Excavation is to be done by full-face excavation.

Concrete lining work has been planned to be done using telescopic forms with placement done using a concrete placer. After completing placement of arch lining concrete, invert concrete is to be placed, with consolidation grouting performed as necessary.

After completion of the above works, lining of the work adit is to be done in preparation for passage of water.

2) Construction Schedule

The critical path in the construction schedule of the Ayvalı Project is the work on the 175 m high dam.

The construction schedule of the Ayvalı Project is as shown in Fig. 12-4.

- First Year

Construction of an access road for diversion tunnel work and excavation of the diversion tunnel would be done, following which placement of lining concrete of the diversion tunnel would be commenced.

At the powerhouse, excavation of a access tunnel and a inclined adit to be used in excavation for the powerhouse and penstock is to be started.

At tailrace tunnel an access road would be constructed leading to the work adit portal.

In advance of or parallel to these works proper, offices, lodging facilities, and materials storage yards of the owner and contractors, and access roads for the works proper would be constructed.

- Second Year

As soon as lining concrete work of the diversion tunnel has been completed, and before the wet season begins, the flow of the stream would be diverted to the diversion tunnel. Prior to diversion of the stream flow, excavation for the dam and spillway at parts higher than the river bed would be roughly done, and simultaneously with diversion of flow, construction of the downstream cofferdam would be started. Excavation of the river-bed portion of the dam and foundation treatment would be done in step with progress on the cofferdam.

At the powerhouse, excavation of the access tunnel to the powerhouse and the inclined adit would continue to go on.

At the tailrace tunnel, excavation of inclined adits would be commenced.

- Third Year

At the dam, excavation of alluvium would continue to be done. As soon as this excavation reaches rock foundation, placing of cap concrete would be done, along with which consolidation and curtain grouting works would be started.

At the powerhouse, excavation of the access tunnel would reach the powerhouse location. Excavation of the inclined adit would also reach the powerhouse draft location in succession to which this would be utilized and excavation and concreting of the powerhouse arch and excavation of the penstock route started.

At the tailrace tunnel, excavation of the inclined adit would reach the tailrace tunnel location, and after completion of the conveying facilities for excavated material, excavation of the tunnel proper would be commenced.

- Fourth Year

At the dam, grouting work in the vicinity of the river-bed would continue to be carried out, and as soon as this is finished, embankment works of impervious core, filter, and rock zone of the dam would be started.

At the penstock, the inclined shaft would be in the process of excavation.

At the powerhouse, excavation of the arch portion and lining concrete work of the arch portion would be continued, and as soon as the lining of the arch portion has been completed, excavation of the powerhouse proper would be started using the work adit prepared for powerhouse and access tunnel excavation.

At the tailrace tunnel, excavation and concrete lining of the arch portion of the surge chamber would be done, along with which excavation work of the tailrace tunnel would be continued.

- Fifth Year

At the dam, embankment work and grouting work would continue. At the spillway, placing of concrete would be done at the chute and weir portions.

At the penstock, installation of steel pipe would be done in succession to completion of enlargement of the inclined shaft.

At the powerhouse, placing of concrete of the side walls and slab, and installing of steel liners of the drafts would be done. After completion of side-wall concrete placement, and installation of the overhead travelling crane girder, the crane would be used in succession to begin installation of the turbine and generator. Civil works of the outdoor switchyard would also be started during this year.

At the tailrace tunnel, lining concrete work would be started.

- Sixth Year

At the dam, embankment and grouting works would continue to be performed. At the spillway, placing of pier concrete and installation of the bridge would be done.

At the power intake, placing concrete of the intake structure would be done. Upon completion of concreting, screen and gate installation would be done, and would be more or less finished before plugging of the diversion tunnel.

The penstock would have steel pipe being installed and this work is to be finished by the time intake gate installation is started.

At the powerhouse, turbine, generator, and transformer would be in the process of installation. Equipment installation at the outdoor switchyard would be started.

Concrete lining work would continue to go on at the tailrace tunnel. Where considered necessary, grouting work would be performed.

At the end of the year the diversion tunnel is to be plugged in order to begin impoundment of water in the reservoir.

- Seventh Year

The dam would have its embankment work and the spillway gate installation work brought to completion.

At the tailrace tunnel, placing of invert concrete would be done, and prior to discharging water through the tunnel, the work adit is to be plugged. Also, tailrace gate and draft gate installation would be completed by that time.

At the powerhouse and the switchyard, installation of turbine, generator, and outdoor switchyard equipment would be going on to be ready for start of operation. Following installation, dry and wet tests would be conducted, and upon passing the tests, operation would be started in the middle of the year.

Expansion of Yusufeli Switchyard and construction of the transmission line are to be completed by the start of the wet tests at the power station.

12.2 Estimate of Construction Cost

The construction cost of the Project would be estimated assuming that construction methods, materials and products, according to the technological level that can be expected at the present time, would be used, and taking into consideration the run-off discharge, geologies, and regional conditions of the project sites, and in addition, the project scales. The time of estimate is to be taken as the middle of 1991, with the exchange rate between local and foreign currencies being US$1 = TL4,300.

12.2.1 Fundamental Matters

(1) Construction Cost Estimate Items

1) Civil Works

Care of River	Diversion tunnel, and cofferdam
Dam	
Spillway	
Outlet Works	
Power Intake	
Headrace	
Surge Tank	
Penstock	
Tailrace	Tailrace tunnel and surge chamber
Powerhouse & Switchyard	Civil and architectural Works
Access Road	Powerhouse access road, dam connection road, etc.

2) Hydraulic Equipment — Gate, penstock, etc.

3) Electro-mechanical Equipment — Turbine, generator, switchyard equipment, etc.

4) Camp Facilities — Camp for power station operation

5)	Administrative Cost	Engineering service concerning work, coordinating and management of work, etc.
6)	Compensation Cost	Compensation for land buildings, etc. in reservoir
7)	Transmission Line	
8)	Interest during Construction	Interest during period of construction

(2) Criteria of Cost Estimate

1) Civil Works

For unit prices of civil works and hydraulic equipment, the 1991 YILINA AIT, INSAAT BIRIM FIYATLARINA BSAS ISCILIK-ARAC VE GEREC RAYIC LISTELERI, BIRIM FIYAT CETVELI 1991 (DSI) are used or referred to, and the prices are determined upon comparison studies with construction cost unit prices at sites in Turkey of power stations existing, under construction, or for which feasibility studies had been made.

The unit prices are composed of labor, materials, machinery depreciation, and various insurance costs.

(a) Labor and Materials Costs

Labor costs and material costs used are the primary costs in 1991 YILINA AIT, INSAAT BIRIM FIYATLARINA BSAS ISCILIK-ARAC VE GEREC RAYIC LISTELERI.

The principal costs are given in Table 12-4 and Table 12-5.

Table 12-4 Labor Cost

Item	Labor Cost TL/day
Foreman	40,616
Skilled Labor	20,040
Driller	34,416
Operator	32,232
Carpenter	28,312
Welder	28,312
Electrician	28,312
Labor	18,520
Mechanic	40,616

Table 12-5 Construction Material Cost

Item	Price	Cost TL
Cement (bag)	Ton	180,000
Cement (bulk)	Ton	171,000
Dynamite	kg	8,300
ANFO	kg	1,200
Gasoline	kg	2,500
Diesel oil	kg	2,144
Reinforcement	Ton	935,000
Shape steel	Ton	1,045,000
Timber	m^3	900,000

calculated referring to the method of calculating transportation costs given in the DSI BIRIM FIYAT CETVELI 1991.

(b) Construction Machinery

Principal construction machinery such as dump trucks, bulldozers, loading equipment, concrete pumps, aggregate plants, bathing plants, cranes, boring and grouting machines are assumed all to be imported, and the machinery costs are calculated from CIF Prices of Hopa Port.

(c) Relocation Roads and Access Roads

Construction costs of relocation roads and access roads would be calculated based on the unit construction costs of the Highway Department.

2) Hydraulic Equipment

Steel penstock, spillway gates, outlet works, intake gates, outlet gates of tailrace etc. will be manufactured in Turkey.

3) Electro-mechanical Equipment

Electro-mechanical equipment such as turbine, generator, transformer and control equipment would be imported from abroad, while steel structures of switchyard and overhead travelling crane would be procured in Turkey. The costs are to include the transportation costs to the power station sites, installation costs, insurance costs, etc.

4) Camp Facilities

These would include the costs of quarters and other requirements of power station operating personnel.

5) Administrative Cost

The administrative cost for the Project is considered to be 10% of the cost of construction works.

6) Compensation Cost

Compensation costs such as land acquisition costs would be calculated based on data furnished by EIE. The costs of relocated roads would be included separately under costs of civil works.

7) Transmission line Cost

The transmission line costs would be calculated referring to the periodic unit cost of TEK.

8) Interest during Construction

Interest during construction is to be 9.5% for both local and foreign currency funds based on discussions with EIE.

9) Import Duty and Various Taxes

Import duties are not to be included for imported construction machinery and electro-mechanical equipment such as turbine and generator.

Value added taxes of 12% would be considered in the construction cost for both local and foreign currency portions to be used in financial evaluation of the project.

10) Contingency Cost

Based on discussions with EIE, contingency costs are to be 10% for civil works, and 5% for hydraulic equipment and electro-mechanical equipment.

12.2.2 Construction Cost

(1) Construction Cost of Civil Works

The principal materials used for civil works - cement, steel such as reinforcing bars and structural steel, fuel, oils and fats, explosives - are to be domestically procured, and come under local currency requirements.

Of machinery for civil works, such as heavy dump trucks, bulldozers, loading equipment, concrete plants, aggregate plants, cranes, etc. are all to be imported and construction costs calculated in terms of foreign currency.

Drilling machines, grout pumps, compressors, etc. are also to be procured through importation, and come under foreign currency requirements.

(2) Hydraulic Equipment

Hydraulic equipment, except for special types, would all come under local currency.

(3) Electro-mechanical Equipment and Transmission Lines

Principal electro-mechanical equipment would come under foreign currency requirements, while overhead raveling cranes and steel structures of switchyard would be local currency. The inland transportation costs and installation costs of these would be local currency.

(4) Engineering Service Cost

This cost would be 70% local currency and 30% foreign currency.

(5) Compensation Cost

All compensation costs would be in local currency.

(6) Interest during Construction

Interest amounts according to local currency and foreign currency would be respectively allocated.

(7) Estimated Construction Cost

The domestic and foreign currency portions of construction costs and the construction costs by year for the Olur and the Ayvalı Projects are respectively given in Tables 12-6, 12-7 and 12-8.

Table 12-6 Construction Cost of Oltu Project

Item	Olur Project			Ayvalı Project			Oltu Project Total		
	Foreign Currency	Local Currency	Total	Foreign Currency	Local Currency	Total	Foreign Currency	Local Currency	Total
Relocation Road	0	14,000	24,000	0	28,000	28,000	0	42,000	42,000
Camp Facilities	0	5,000	5,000	0	5,000	5,000	0	10,000	10,000
Land Acquisition	0	51,752	51,752	0	34,106	34,106	0	85,858	85,858
Civil Work							0	0	0
Diversion	3,008	6,007	9,015	3,128	6,914	10,042	6,136	12,921	19,057
Care of River	6,592	4,863	11,455	7,389	5,043	12,432	13,981	9,906	23,887
Dam	62,234	51,003	113,237	138,720	108,390	247,110	200,954	159,393	360,347
Spillway	12,105	17,123	29,228	24,058	32,850	56,908	36,163	49,973	86,136
Outlet Works	2,243	4,675	6,918	1,604	3,373	4,977	3,847	8,048	11,895
Intake	731	2,136	2,867	954	2,887	3,841	1,685	5,023	6,708
Headrace Tunnel	35,737	79,264	115,001	0	0	0	35,737	79,264	115,001
Surge Tank	1,500	3,777	5,277	0	0	0	1,500	3,777	5,277
Penstock	786	1,782	2,568	653	1,680	2,333	1,439	3,462	4,901
Powerhouse	3,016	4,015	7,031	6,286	14,198	20,484	9,302	18,213	27,515
Tailrace	0	0	0	38,698	82,562	121,260	38,698	82,562	121,260
Switchyard	328	442	770	2,005	1,000	3,005	2,333	1,442	3,775
Subtotal	128,280	175,087	303,367	223,495	258,897	482,392	351,775	433,984	785,759
Hydraulic Equipment	0	30,965	30,965	0	25,507	25,507	0	56,472	56,472
Electro-Mechanical Equipment	62,738	12,826	75,564	78,283	18,233	96,516	141,021	31,059	172,080
Transmission Line	0	4,454	4,454	0	9,790	9,790	0	14,244	14,244
Total Cost	191,018	294,084	485,102	301,778	379,533	681,311	492,796	673,617	1,166,413
Contingency	15,965	21,821	37,786	26,264	31,866	58,130	42,229	53,687	95,916
Engineering and Administration Cost	19,102	24,233	43,335	30,178	34,543	64,721	49,280	58,776	108,055
Interest During Construction	38,089	73,052	111,142	65,423	88,104	153,527	103,512	161,156	264,668
Grand Total	264,174	413,190	677,364	423,642	534,046	957,688	687,816	947,236	1,635,052

Table 12-7 Fund Requirement of Each Year of the Olur Project

Item	Total			1st Year		2nd Year		3rd Year		4rd Year		5rd Year		6th Year	
	Foreign Currency	Local Currency	Total	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency
Relocation Road	0	14,000	14,000	0	1,400	0	0	0	0	0	4,200	0	4,200	0	4,200
Camp Facilities	0	5,000	5,000	0	5,000	0	0	0	0	0	0	0	0	0	0
Land Acquisition	0	51,752	51,752	0	5,175	0	0	0	0	0	46,577	0	0	0	0
Civil Work															
Diversion	3,008	6,007	9,015	0	0	2,908	5,861	0	0	0	0	0	0	100	146
Care of River	6,592	4,863	11,455	0	0	0	0	6,592	4,863	0	0	0	0	0	0
Dam	62,234	51,003	113,237	0	0	0	0	6,150	3,530	9,145	7,616	25,553	21,696	21,387	18,161
Spillway	12,105	17,123	29,228	0	0	8,673	6,065	0	0	1,716	5,529	1,716	5,529	0	0
Outlet Works	2,243	4,675	6,918	762	805	762	805	0	0	0	- 0	719	3,065	0	0
Intake	731	2,136	2,867	0	0	0	0	0	0	444	586	287	1,550	0	0
Headrace Tunnel	35,737	79,264	115,001	2,145	6,199	5,769	15,858	5,712	15,487	5,712	15,487	6,888	15,686	9,510	10,548
Surge Tank	1,500	3,777	5,277	0	0	0	0	0	0	289	1,631	578	1,451	633	695
Penstock	786	1,782	2,568	0	0	0	0	614	684	14	91	86	549	72	458
Powerhouse	3,016	4,015	7,031	0	0	0	0	1,306	891	1,508	2,005	158	871	45	248
Switchyard	328	442	770	0	0	0	0	0	0	0	0	131	177	197	265
Subtotal	128,280	175,087	303,367	2,907	7,004	18,112	28,589	20,374	25,454	18,828	32,944	36,115	50,575	31,943	30,521
Hydraulic Equipment	0	30,965	30,965	0	0	0	0	0	0	0	422	0	6,299	0	24,244
Electro-Mechanical Equipment	62,738	12,826	75,564	0	0	0	0	6,274	1,283	0	0	0	0	56,464	11,543
Transmission Line	0	4,454	4,454	0	0	0	0	0	0	0	0	0	2,672	0	1,782
Total Cost	191,018	294,084	485,102	2,907	18,579	18,112	28,589	26,648	26,737	18,828	84,142	36,115	63,747	88,407	72,289
Contingency	15,965	21,821	37,786	291	1,340	1,811	2,859	2,351	2,610	1,883	3,735	3,612	5,926	6,018	5,351
Engineering and Administration Cost	19,102	24,233	43,335	291	1,340	1,811	2,859	2,665	2,674	1,883	3,757	3,612	6,375	8,841	7,229
Interest During Construction	38,089	73,052	111,142	166	1,010	1,364	3,649	3,900	6,800	6,477	12,673	9,609	20,638	16,573	28,282
Grand Total	264,174	413,190	677,364	3,654	22,269	23,098	37,956	35,564	38,820	29,072	104,308	52,948	96,686	119,838	113,151

Table 12-8 Fund Requirement of Each Year of the Ayvalı Project

Item	Total			1st Year		2nd Year		3rd Year		4rd Year		5rd Year		6rd Year		7th Year	
	Foreign Currency	Local Currency	Total	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency
Relocation Road	0	28,000	28,000	0	2,800	0	2,800	0	0	0	5,600	0	5,600	0	5,600	0	5,600
Camp Facilities	0	5,000	5,000	0	5,000	0	0	0	0	0	0	0	0	0	0	0	0
Land Acquisition	0	34,106	34,106	0	3,411	0	0	0	0	0	0	0	0	0	30,695	0	0
Civil Work																	
Diversion	3,128	6,914	10,042	2,028	4,500	1,013	2,246	0	0	0	0	0	0	43	84	43	84
Care of River	7,389	5,043	12,432	0	0	7,389	5,043	0	0	0	0	0	0	0	0	0	0
Dam	138,720	108,390	247,110	0	0	6,837	3,590	4,348	2,285	28,440	22,861	42,341	34,034	42,341	34,034	14,412	11,585
Spillway	24,058	32,850	56,908	0	0	9,993	7,095	8,175	5,807	0	0	2,945	9,974	2,945	9,974	0	0
Outlet Works	1,604	3,373	4,977	316	582	316	581	0	0	0	0	972	2,211	0	0	0	0
Intake	954	2,887	3,841	0	0	577	877	0	0	0	0	377	2,010	0	0	0	0
Penstock	653	1,680	2,333	0	0	0	0	20	55	265	729	219	538	150	358	0	0
Powerhouse	6,286	14,198	20,484	0	0	0	0	567	1,029	3,839	7,543	1,178	3,379	702	2,248	0	0
Tailrace	38,698	82,562	121,260	0	0	0	0	8,482	14,009	10,173	16,818	9,028	22,367	8,812	23,497	2,203	5,870
Switchyard	2,005	1,000	38,698	0	0	0	0	0	0	0	0	0	0	2,005	1,000	0	0
Subtotal	223,495	258,897	482,392	2,345	5,081	26,125	19,432	21,593	23,186	42,717	47,951	57,059	74,512	56,997	71,194	16,658	17,540
Hydraulic Equipment	0	25,507	25,507	0	0	0	0	0	0	0	0	0	5,655	0	8,034	0	11,819
Electro-Mechanical Equipment	78,283	18,233	96,516	0	0	0	0	0	0	7,828	1,823	0	0	0	0	70,455	16,410
Transmission Line	0	9,790	9,790	0	0	0	0	0	0	0	0	0	5,874	0	3,916	0	0
Total Cost	301,778	379,533	681,311	2,345	16,292	26,125	22,232	21,593	23,186	50,546	55,375	57,059	91,641	56,997	119,439	87,113	51,368
Contingency	26,264	31,866	58,130	234	1,288	2,613	2,223	2,159	2,319	4,663	5,446	5,706	8,588	5,700	8,277	5,189	3,725
Engineering and Administration Cost	30,178	34,543	64,721	234	1,288	2,613	2,223	2,159	2,319	5,055	5,537	5,706	9,164	5,700	8,874	8,711	5,137
Interest During Construction	65,423	88,104	153,527	134	896	1,756	3,060	4,476	5,649	8,570	10,122	14,685	18,470	21,186	30,155	14,616	19,752
Grand Total	423,642	534,046	957,688	2,947	19,765	33,107	29,739	30,388	33,472	68,833	76,481	83,155	127,863	89,582	166,745	115,629	79,982

Chapter 13 ENVIRONMENT IMPACT AND COMPENSATION

Chapter 13

ENVIRONMENT IMPACT AND COMPENSATION

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Chapter 13 ENVIRONMENT IMPACT AND COMPENSATION

This survey is regarded as the feasibility study of the project. The existence of problems affecting the natural environment and social environment as well as necessary measures for those problems should be investigated in advance by grasping how the execution of the project would affect the planned sites and the surrounding environment. Information obtained in the process of this survey should be reviewed in environment assessment surveys made after the execution of the project is determined. In environment assessment surveys, the situation of the project and the contents of construction works and the sites of construction works should be grasped, the project's environmental impact should be estimated and various measures should be taken further in detail based on the surveying methods prescribed by the Republic of Turkey's environmental law.

13.1 Survey Methods

In carrying out the Oltu Hydraulic Power Plant Development Project, the project's environment impact was predicted and assessed by grasping the present situation of natural environment and social environment.

Items in this survey were selected by making preliminary surveys of the project's outline and the project area according to assessment items shown in the "Guidelines for General Formats of Environment Impact Assessment" prescribed by the Republic of Turkey's environmental law "the Regulations for Environmental Impact Assessment". Documents were collected in making surveys of documents and the project area including its vicinity to grasp the present situation of natural environment and social environment.

The survey items are as follows:

Natural Environment:	metrology, hydrology, topography and geology, flora and fauna, water quality
Social Environment :	natural scenery, preservation of nature, cultural assets and recreation, population, industries, land utilization, water utilization, transportation and public facilities, others (energy, public health)

In compensation object surveying, target compensation objects were selected based on the results of surveying the present situation of social environment. Then the amount of compensation was calculated. In this report, the target survey area is largely divided into two areas such as the project area and its vicinity.

Water quality in Tortum Lake located in the vicinity of the project area was also surveyed and considered to evaluate the environmental impact of this power plant project.

13.2 Outline of the Power Plant Project

13.2.1 Location

The project area is located in Olur District in the northeast of Erzurum Province which is located on the northeastern side of the Republic of Turkey, or the project area is located about 170 km northeast of Erzurum, the provincial capital which is almost in the center of Erzurum Province. In this project, Ayvalı Dam will be constructed about 1.5 km south of Karatas in Taslikõy Village upstream from the confluence of the main course of Oltu River and Çoruh River and Olur Dam will also be constructed about 20 km away from Ayvalı Dam. (Fig. 13-1)

13.2.2 Outline of the Power Plant Project

In this power plant project, two dam and conduit type power plants will be constructed. Olur Dam on the upstream side and Ayvalı Dam on the downstream side will be constructed at a river-bed altitude of 1,025 m and 810 m respectively. Both of them will be constructed as rock-fill dams with a submerged area of 9.03 km^2 and 10.17 km^2 respectively. The outline of the project items is as shown in Table 13-1.

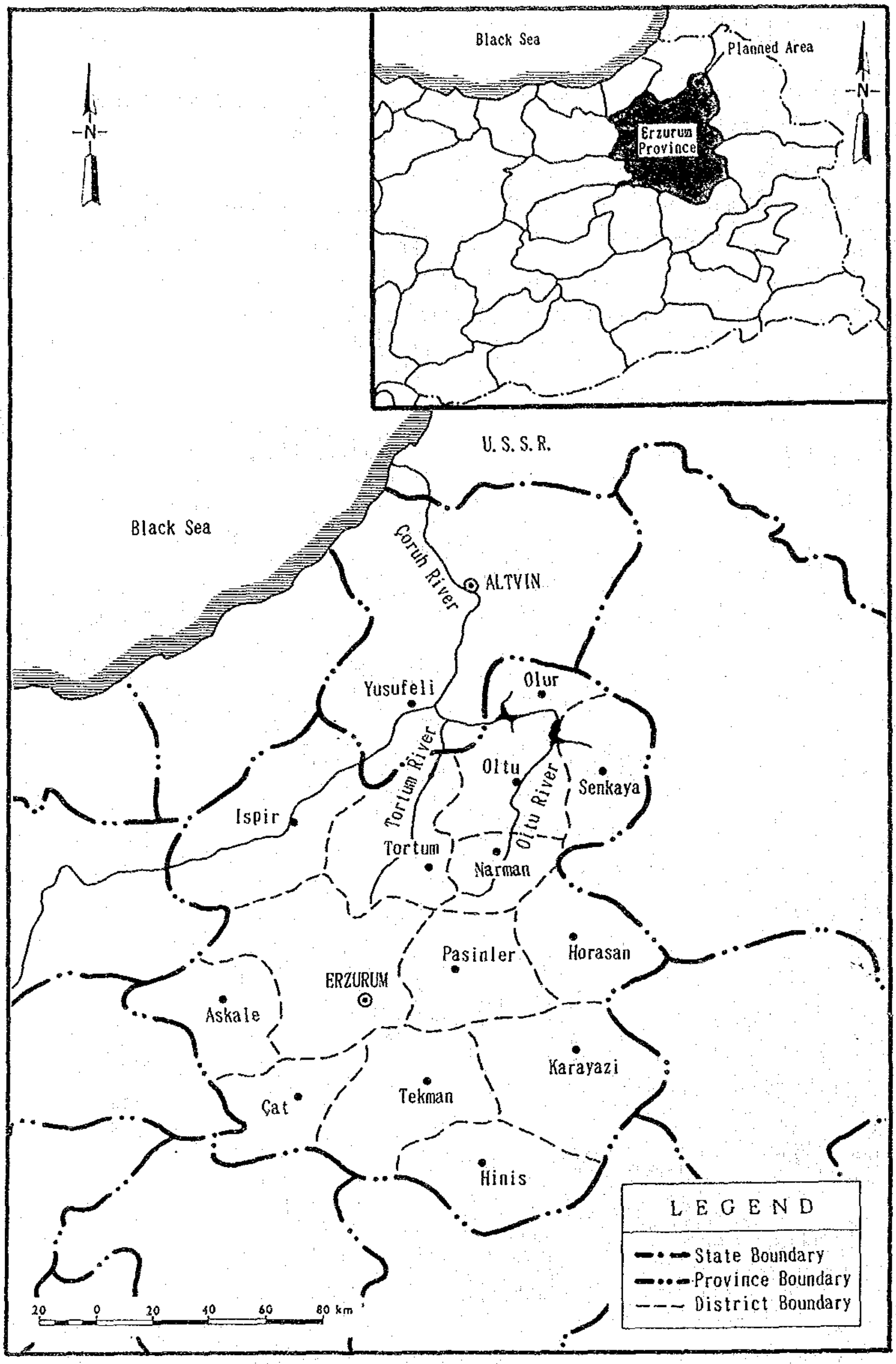

Fig. 13-1(a) Locations of Project Sites

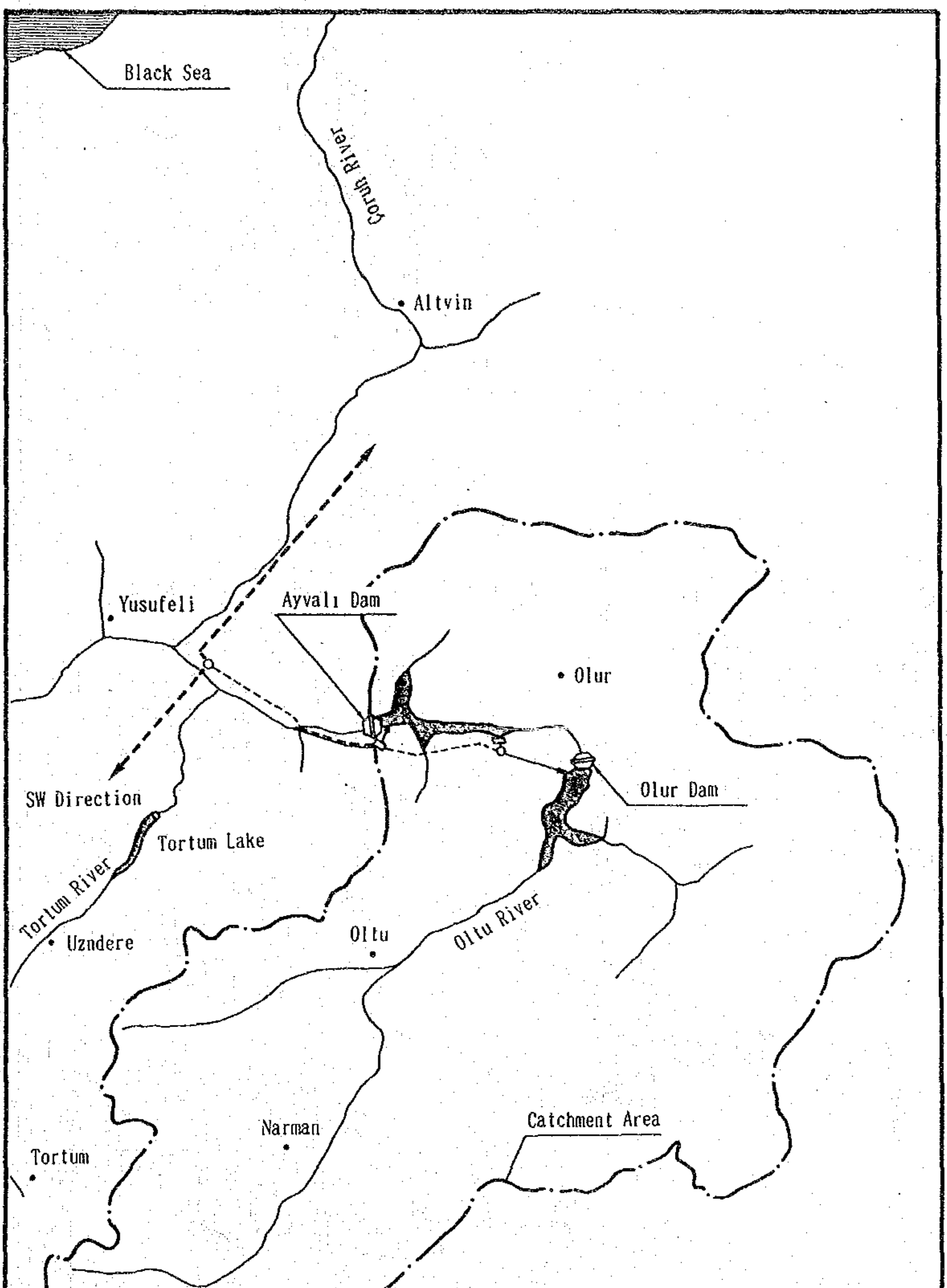

Fig. 13-1(b) Locations of Project Sites

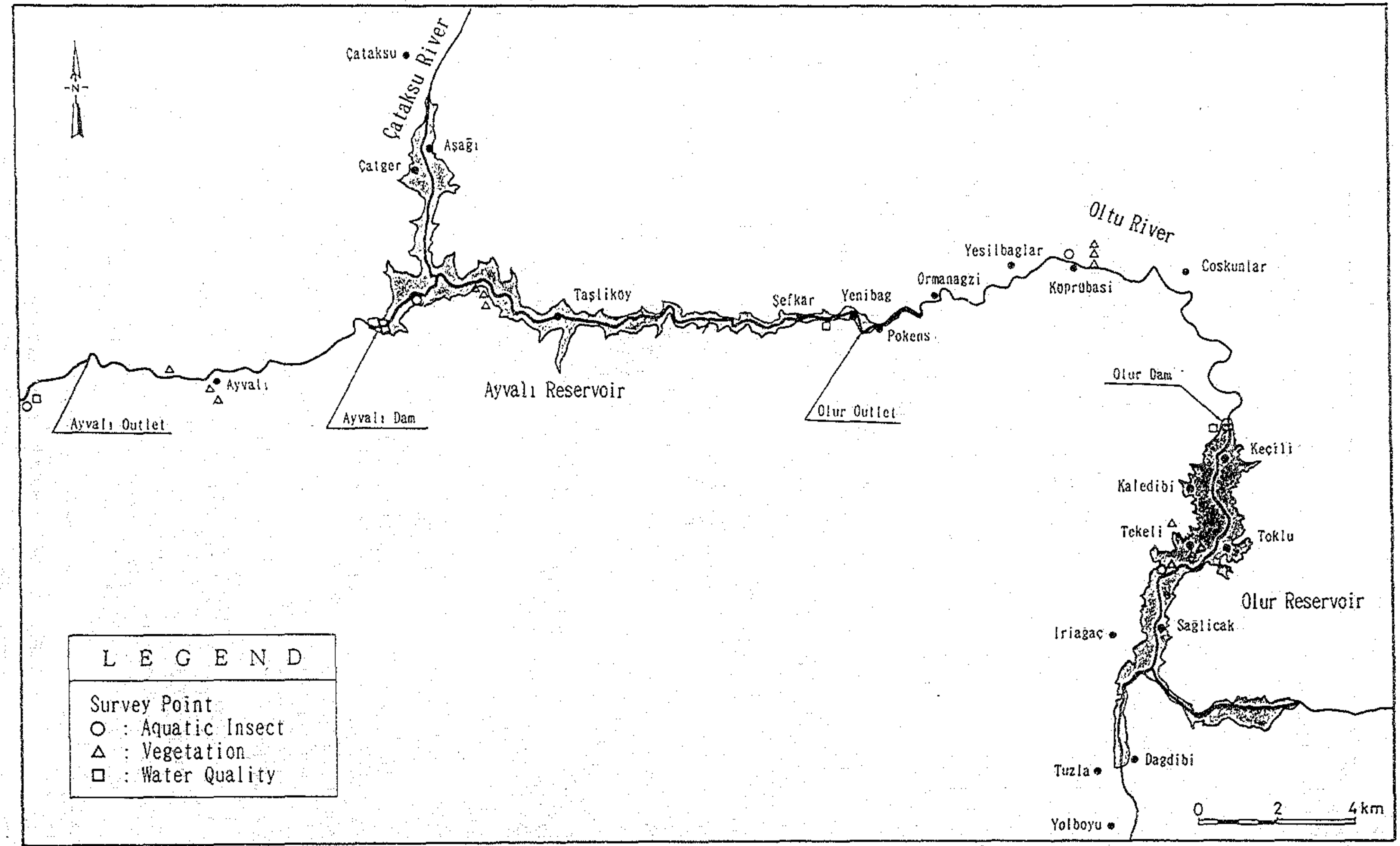

Fig. 13-1(c) Locations of Project Sites

Table 13-1 Project Items

Item	Unit	Name of Project		
		Olur	Ayvalı	Total
Catchment Area	km^2	3,509	4,517	
Annual Inflow	10^6 m^3	655.6	813.0	
Reservoir				
High Water Level	m	1,105.00	930.00	
Low Water Level	m	1,077.00	908.0	
Gross Storage Capacity	10^6 m^3	293.5	354.8	
Effective Storage Capacity	10^6 m^3	200.0	150.0	
Water Surface Area	10^6 m^3	10.7	8.2	
Dam				
Type		Rockfill	Rockfill	
River-bed Elevation	m	1,025.00	908.00	
Crest Elevation	m	1,110.00	935.00	
Crest Length	m			
Height from River-bed	m	136.00	175.00	
Volume	m^3	3,818.00	9,268.00	
Headrace Tunnel			(Tailrace)	
Type		Pressure	Non-Pressure	
Inner Diameter	m	4.90	5.40	
Length	m	9,659	9,261	
Penstock				
Number of Penstock Lines		1	1	
Diameter	m	4.9 ~ 3.2	4.1 ~ 3.8	
Length	m	436	288	
Development Plan				
Tail Water Level	m	929.00	700	
Gross Head	m	166.70	222.70	
Installed Capacity	MW	65	125	190
Annual Average Energy Production	GWh	241.5	409.4	650.9
Annual Firm Energy Production	GWh	126.5	248.0	374.5

13.3 Present Environmental Situation

13.3.1 Meteorology

The project area is located in the inland with an altitude of about 800 m to 1,100 m about 80 km away from the coast of the Black Sea, and it has a harsh inland climate with a little annual rainfall of about 400 mm and a big daily and annual change in temperature.

(1) Rainfall

The basin of Oltu River's rainfall is plentiful near Göllü Mountain Range and Allahükber Mountain Range, annually standing at 300 mm to 500 mm.

According to the results of observation at Oltu Observatory located about 25 km southwest of Olur Dam, the area has an annual rainfall of 393 mm and a relatively-plentiful monthly rainfall of about 40 mm to 60 mm from April to July. The snowfall is relatively plentiful in January and February, standing at a maximum of 61 mm in observational history.

(2) Temperature

According to the results of observation for at Oltu Meteorological Observatory, the area has a minimum temperature of -24.1 °C, a maximum temperature of 39.0 °C and an annual average temperature of 9.8 °C. The monthly average temperature stands at a minimum of -3.8 °C in January and a maximum of 22.4 °C in July. It is characteristic of temperature to rise rapidly in March and April.

13.3.2 Hydrology

(1) Flux

The main course of Çoruh River originates in an area between two mountain chains called Karadenniz Mountain Chain (its highest peak with an altitude of 3,937 m) and Mescit Mountain Chain, and runs east and slightly northward, goes north after the confluence of the main course and Oltu River downstream from Yusufeli Town in the middle reaches of the river, enters the territory of the Soviet Union and flows into the Black Sea. Oltu River has a total length of about 150 km and a basin area of about 7,000 km^2. Olur Dam and Ayvalı Dam have a basin area of 3,509 km^2 and 4,517 km^2 respectively.

According to the investigation of documents, the summary of flux rates at the sites of Olur Dam and Ayvalı Dam from 1941 to 1990 are as reported below.

The Olur Dam site has an annual average flux of 20.8 m^3/s, and the monthly flux stands at a maximum of 200.6 MCM in May and a minimum of 19.2 MCM in February.

The Ayvalı Dam site has an annual average flux of 25.8 m^3/s, and the monthly flux stands at a maximum of 247.7 MCM in May.

(2) Sediment

The sediment storage capacity in the sites of Olur Reservoir and Ayvalı Reservoir for 50 years can be estimated at 47.0×10^6 m^3/50 years and 60.5×10^6 m^3/50 years respectively by giving consideration to the trial calculation of the quantity of suspended sediment.

13.3.3 Topography and Geology

(1) Topography

The neighborhood of Olur Reservoir is largely divided into two types of topography. One area topographically consists of Ayvalı volcanic rocks while the other area consists of the Oltu Tertiary sediment formation.

The former is complicated and continuously steep along the river while the latter is relatively monotonous and consists of gently-sloping hilly land.

There are steep slopes on both sides of Oltu River at Ayvalı Reservoir, its river-bed is narrow in width and the river bed and neighboring mountains consist of solid volcanic rocks.

(2) Geology

1) Vicinity of the Project Area

In the vicinity of the project area, Brown Forest Soil, Brown Soil, Lime Free Brown Forest Soil, Basaltic Soil and Chestnut Colored Soil are mainly distributed.[1)]

In Senkaya District in the upper reaches of Olur River, the above-mentioned five types of soil are distributed. In Narman District, Brown Soil and Basaltic Soil are mainly distributed.

In Oltu District including the project area, there are mainly three types of soil such as Brown Forest Soil, Brown Soil and Basaltic Soil, and in Olur District, Brown Soil and Chestnut Colored Soil are mainly distributed. These areas have an organic matter content of 0% to 4% in soil, and many places in Oltu and Olur Districts have an organic matter content of 2% to 4% in soil.

Soil has a pH of 5.6 to 8.5. The pH of soil in Oltu District and Olur District mostly stands at 7.6 to 8.5 respectively and is higher than that in Senkaya District and Narman District, and its calcium content is also relatively high.[1)]

The outflow of phosphorus (as P_2O_5) in these areas is 0 to 12 kg/Da or above, and some places in Senkaya District have an outflow of 12 kg/Da or above. Most places in Narman District, Oltu District and Olur District have an outflow of 0 to 6 kg/Da.[1)]

2) Project Area

The vicinity of Olur Reservoir consists of stones and rocks covered with a very thin layer of soil and is severely-eroded area.

The vicinity of Ayvalı Reservoir has almost no soil and consists of stones and rocks. In the project area, a scanty alluvial land is seen along the main course of Olur River.

(3) Mineral Resources

There are various kinds of nineteen mines in Olur District and Oltu District around the project area. Most of them are brown coal mines (Lignite), and some of them are chromium, sulfur, copper, iron mines, etc.

There are some mines in the neighborhood of the project area, such as a halite mine near Yolboyu Village, a mine with amber stones used as jewels and ornaments and a brown coal mine in Olur District. Among them, this halite mine is nearest to Olur Reservoir, but does not exist in it.[2)]

13.3.4 Flora and Fauna

(1) Vegetation

1) Vicinity of the Project Area

Vegetation in the vicinity of the project area is considered to belong in the forest zone on the coast of the Black Sea, and the main types of trees are as follows:

The main types of shrubs existing in broad-leaved forests at an altitude of 400 m to 600 m are Carpinus betulus (Betulacaea), Ulmus campestris, Populus tremula (Salicaceae).

The types of trees, which exist in broad-leaved forests at an altitude of 600 m or above, are Castenea sativa (Fagaceae), Carpinus betielus (Fagaceae), Fagus orientalis (Fagaceae), Alders, Firs, Lime trees, Ash trees, etc. Some of them have been planted. They are distributed up to an altitude of 1,300 m.

Forests with a mixture of trees belonging to Fagaceae and Firs and Spruces belonging to coniferous trees are distributed at an altitude of about 1,000 m or above, and forests with firs and spruces exist at an altitude of about 1,200 m and 1,500 m or above. Only Pinus Silvestry belonging to Pinaceae are distributed at an altitude of 2,000 m or above.[3)]

2) Project Area

As for vegetation in the Olur Dam area in the upper reaches of the river including the project area, coniferous trees are seen on the summits of mountains with a high altitude, and forests with a mixture of broad-leaved trees and coniferous trees are seen on the summits of mountains with a slightly-lower altitude. This area consists of wasteland on slopes and flatland with almost no trees.

As for vegetation in the Ayvalı Dam area in the lower reaches of the river, there is mostly wasteland with sporadic shrubs on the northern side while shrubs are seen on the southern side. In the alluvial land of Oltu River, only orchards, cultivated land and windbreak forests (poplars) are seen, and the reservoir area is very poor in natural vegetation as well.

Flora is very poor in this region. Investigation of vegetation were made by Quadrat Method at four points such as Oltu Reservoir and Oltu Dam located in the upstream area and Ayvalı Reservoir and Ayvalı Dam located in the downstream area to recognize the difference in flora roughly. The investigation was started from the four points in three sections with different altitudes, such as the alluvial area (B) along the river, the middle part of hills (M) and the upper part of hills (U). Table 13-2 shows the results of the investigation.

According to the investigation, there are a lot of herbal kinds. Salix sp. in the order of willows, Berberis sp. in the order of buttercups and Zizyphus jujuba are obviously arboreal ones. Among them, only Salix sp. can grow up into tall trees, and are seen only in the alluvial area along the river near Oltu Reservoir. Both Berberis sp. and Zizyphus jujuba are shrubs and seen on the slopes of hills in Oltu and Ayvalı Sections. Seven kinds of vegetation were confirmed to be seen in both Oltu and Ayvalı Sections. Twenty kinds are seen in Oltu Section alone while eighteen kinds are seen in Ayvalı Section alone. The distribution of vegetation in both sections seems to be different from each other.

Vegetation in the alluvial area along the river is different from that on the slopes of hills. Cover degree of vegetation in the alluvial area along the river is higher than that on the slopes of hills and the kinds of vegetation in the alluvial area are also bigger in number than them on the slopes. The rate of land covered with vegetation in the alluvial area near Oltu Reservoir is the highest since the area is suitably humid and covered with developed soil. The kinds of vegetation may not be useful but vegetation in this area is the richest of all in the investigation points. The rate of land covered with vegetation on the slopes of hills is lower than that in the alluvial area, and the rate is getting lower while the altitude of vegetation is getting higher. Tall trees such as beeches and firs are not seen on the summits of mountains. The region shows flora in dry and barren land.

Table 13-2 Result of Vegetation Survey

Order	Class	Species	OLTU						AYVALI					
			P/S			DAM			P/S			DAM		
			U	M	B	U	M	B	U	M	B	U	M	B
Equisetales	Equisetaceae	Equisetum sp.			○									
Salicales	Salicaceae	Salix sp.			○									
Polygonales	Polygonaceae	Polygonum sp.						○						
Centrospermae	Caryophyllaceae	Dianthue sp.				○								
Centrospermae	Amaranthaceae	Amaranthus sp.		○				○						
Centrospermae	Portulacaceae	Portulaca olearaca		○				○						
Ranales	Ranunculaceae	Clematis orientalis									○			
Ranales	Berberidaceae	Berberis sp.							○					
Rhoeadales	Capparidaceae	Cleome sp.							○					
Rhoeadales	Resedaceae	Reseda sp.									○			
Rhoeadales	Cruciferae	Brassicaceae sp.	○	○										
Rosales	Rosaceae	Rosaceae sp.										○		
Rosales	Leguminosae	Trifolium sp.												○
Rosales	Leguminosae	Fabaceae sp.									○			
Rosales	Leguminosae	Lotus corniculatus			○									
Geraniales	Zygophyllaceae	Tribulus terrestris		○				○		○				
Geraniales	Euphorbiaceae	Euphorbia sp.				○								
Rhamnales	Rhamnaceae	Zizyphus jujuba		○					○	○				
Malvales	Malvaceae	Malva sp.						○						
Umbelliflorae	Umbelliferae	Apiaceae sp.			○									○
Tubiflorae	Convolvulaceae	Convolvulus sp.												○
Tubiflorae	Labiatae	Lamiaceae sp.				○	○					○	○	
Tubiflorae	Labiatae	Salvia sp.										○	○	
Tubiflorae	Labiatae	Tenorium polium							○					
Tubiflorae	Polemoniaceae	Cuscuta sp.									○			
Plantaginales	Plantaginaceae	Plantago lanceolata			○			○						
Rubiales	Rubiaceae	Rubiaceae sp.						○						
Campanulatae	Compositae	Centaurea solstitialis	○	○				○						
Campanulatae	Compositae	Asteraceae sp.	○		○			○	○		○	○		
Campanulatae	Compositae	Artemisia sp.									○			
Campanulatae	Compositae	Carthamus sp.										○		
Campanulatae	Compositae	Helichrysum sp.										○		
Campanulatae	Compositae	Hieracium sp.											○	
Campanulatae	Compositae	Xanthium strumarium			○									
Glumiflorae	Gramineae	Poaceae sp.	○		○	○			○	○	○	○	○	
Glumiflorae	Gramineae	Dactylis sp.					○							
Liliiflorae	Juncaceae	Juncaceae sp.			○									
—	—	Actemisia sp.				○								
		Algssum sp.				○								
		Artemisia sp.							○					
		Coasinia sp.											○	
		Consolida sp.											○	
		Bryngrum sp.					○							
		Palioaria dysenterica			○									
		Xeranthemum annum	○	○		○	○		○		○	○		

U : Upper Part, M : Middle Part, B : Bottom Part

(2) Land Animals

1) Vicinity of the Project Area

According to the Coruh-Oltu River Master Plan Report(1990), the types of animals regarded as targets for bird and beast hunting have been reported as follows:

<Mammals (Mammalia)>

Roedeer, Mountain Goat, Wild Goat, Rabbit, Pig, Wolf, Jackal, Fox, Badger, Marten, Otter

<Birds (Aves)>

Partridge, Wild Cock, Duck, Turtle Dove, Golden Oriole, Black Bird, Quail, Bittern, Crane, Turkey

2) Neighborhood of the Project Area

Two villages located in the neighborhood of the project area were surveyed by asking questions.

According to the results of question-answer surveying, eleven types of mammals including domestic animals are distributed in the neighborhood of Olur Reservoir. Among them, the main types of wild animals are rabbits and wild goats, and economically-important badgers and water sables inhabit this area. Rabbits are widely distributed, wolves and martens are distributed on flatland and mountains and badgers and water sables are distributed along rivers. Bears, foxes are wild goats are distributed in mountain areas. As for amphibians and reptiles, snakes as well as water snakes regarded as dangerous are considered to exist and lizards and frogs are often seen. There are nineteen types of birds and the main types of them are sparrows, crows, etc.

There are eleven types of mammals including domestic animals in the neighborhood of Ayvali Dam Reservoir, and the distribution situation of these animals is the same as that in the neighborhood of Olur Dam Reservoir. There are four types of amphibians and reptiles consisting of snakes, water snakes, lizards and frogs. There are eighteen types of birds, and parrots, were reported to exist in the neighborhood of Olur Dam Reservoir, are considered not to exist here, according to question-answer surveying.

However, no information on the existence of precious animals mentioned in the Red Data Book (The 1988 IUCN Red List of Threatened Animals, IUCN) was gained in looking into the results of question-answer surveying.

Martens are regarded as economically valuable.

(3) Aquatic Animals

1) Fishes

a) Vicinity of the Project Area

Rivers in the vicinity of the project area are rich in fishes. Three types of trout, three types of carps, six types of loaches, four types of mullet and six types of other fishes are seen. The main types of fishes regarded as targets for fishery are as follows:

Trout : S.trutta macrostigma
Loaches : B.plebejus escherchi, C.malcordes, C.colchicum

Mullet : L.cephalus, L.borysthenicus, Ratilusrutilus, Tinca tinca

According to other documents, another two types of loaches and five types of other fishes have been reported in addition to the above-mentioned type.[5)]

b) Neighborhood of the Project Area

According to the results of question-answer surveying in villages in the neighborhood of the project area, carps exist in the neighborhood of Olur Dam Reservoir and Ayvalı Dam Reservoir. Only few of them are used as food. No fishery is conducted. According to people living there, the number of carps has recently decreased. Trout have been reported to exist in the upper reaches of Çataksu River, a tributary of Oltu River.

2) Aquatic Insects

According to the results of surveying aquatic insects at four points in the project area, the existence of one type of beetles in the order of Coleoptera, of caddis flies in the family of Hydropsychidae, the order of Trichoptera, of two types of dayflies in the order of Ephemeroptera and of one type of snails (Megastropoda) has been confirmed. The existence of one type of caddis flies in the family of Hydropsychidae, the order of Trichoptera, of two types of dayflies in the order of Ephemeroptera and two types of snails has been confirmed at the point of Olur.

One type of those in the order of Hydropsychidae at the point of Ayvalı Dam Reservoir and of one type of those in the order of Hydropsychidae and one type of those in the order of Trichoptera at the point of Ayvalı Dam can be seen. These types are not used as indexes to water contamination.

According to the results of surveying plankton in Tortum Lake, general types of phyto-plankton such as diatoms, Euglena algae, etc., are mainly seen. Setting volume is small and the number of spices is also small. Minerals are mostly seen at the lower part of the lake.

13.3.5 Water Quality

(1) Water Quality in the Project Area

According to the results of surveying water quality at four points, the present situation of water quality in the project area is as follows:

Water was observed to be very turbid but to have no odor. Mud at the river-bed is clean without being organically contaminated.

According to the results of water quality investigation, the transparency of water is 4 cm or lower and the concentration of suspended solids (SS) is high, standing at 340 to 820 mg/l. The chemical oxygen demand (COD) is 24 to 32 mg/l. The concentration of total nitrogen (T-N) is 0.22 to 0.58 mg/l, including a nitrite nitrogen (NO_2-N) concentration of 0.14 to 0.019 mg/l and a respective ammonia nitrogen (NH_4-N) and nitrate nitrogen (NO_3-N) concentration under detection limit (NH_4-N: 0.01 mg/l, NO_3-N: 0.001 mg/l).

The concentration of total phosphorus (T-P) is high, standing at 0.58 to 2.08 mg/l. The concentration of dissolved oxygen (DO) is 7.2 to 8.7 mg/l. The hydrogen ion concentration (pH) is 8.1 to 8.3.

As for water quality at observation points, SS at the point of Ayvali Dam is 340 mg/l lower than that at other points. COD and T-P are 32 mg/l and 2.08 mg/l respectively and tend to be relatively higher than those at other points. T-N at the point of Olur Dam in the upper reaches of the river is relatively high. It tends to get lower while observation points are shifted toward the lower reaches of the river.

(2) Water Quality and Other Aspects in Tortum Lake

1) Water Quality

According to the results of water quality investigation in Tortum Lake on Tortum River, a tributary of Oltu River, the transparency of water is 1.6 m, SS is 10 to 23 mg/l, COD is 8 mg/l, and T-N is 0.34 to 1.01 mg/l (including NH_4-N concentration of under the detection limit to 1.2 mg/l). T-P is under the detection limit (0.01 mg/l). DO is 8.3 to 8.9 mg/l and pH is 8.0 to 8.4. According to the results of water quality investigation at the inlet and outlet of Tortum Lake, at the inlet, the transparency of water is 4 cm or lower, SS is 118 mg/l, COD is 16 mg/l, T-N is 0.57 mg/l (NH_4-N: 1.58 mg/l), T-P is under the detection limit, DO is 7.9 mg/l and pH is 8.2. And at the outlet, the transparency of water is 12 cm or above, SS is 18 mg/l, COD is 12 mg/l, T-N is 0.56 mg/l (NH_4-N is under detection limit), T-P is under the detection limit, DO is 8.1 mg/l and pH is 8.5. According to these results, it is characteristic of water at the outlet of Tortum Lake that SS, NH_4-N as well as COD is remarkably lower than those at the inlet. The concentration of nutrients such as T-P, T-N and DO is not so different from that at the inlet and pH is slightly higher than that at the inlet.

2) Water Temperature

According to summer water temperature measurement in Tortum Lake the temperature of water is about 25 °C at the surface of the lake. While observation points become deeper in the lake, water temperature tends to become lower, standing at about 19 °C at 5 m in depth and about 7 °C at 15 m in depth and the thermocline is thick, consisting of water with a thickness of 3 m to 13 m.

(3) Situation of Water Quality in Comparison with Water Quality Standards

The results of water quality which was investigated once, are mentioned below in comparison with the classification and water quality standards of surface water sources in the quality classification of water environment prescribed in the "Water Pollution Control Ordinance (proposal)". COD belongs to Class I and Class II and the concentration of nitrogen by Kjeldahl method (K-N, 0.2 to 0.6 mg/l) belongs to Class I and Class II, NH_4-N and NO_3-N belongs to Class I, NO_2-N belongs to Class III, DO belongs to Class I and Class II and pH belongs to Class I. Water utilization purposes in each class are shown in Table 13-3.

In comparing the results of water quality investigation in Tortum Lake with the water quality standards according to water classification in lakes (Table 13-4), SS and COD belong to Class G III, the pH and DO satisfactorily meet the conditions of Class G II. T-P belongs to Class G II and T-N belongs to Class G III.