2) Penstock

A buried-type penstock of a gradient of 45 deg is to be provided from the intake directly to the underground powerhouse. The penstock is to have a length of 290 m, maximum static head of 224 m, and the water-hammer pressure at breaking of load is estimated as a maximum of 280 m. The optimum diameter was determined by economic comparisons, and an average diameter of 4.0 m was adopted.

Further, since sharing of pressure by the bedrock can be considered for a buried-type penstock, enhancement of the safety of steel pipe can be looked forward to.

3) Powerhouse

As described in the part on comparison of waterway routes, the powerhouse was selected to be an underground type. The location of the underground powerhouse would be selected to be optimum giving consideration to execution of work on the powerhouse, delivery of equipment, etc. From these viewpoints, it is conceivable for the Ayvalı site, when providing the powerhouse immediately downstream of the dam, to be near the end of the headrace, and upon study including a work adit, the proposal for immediately downstream of the dam was selected based on the economics (see Table 11-13).

The geology of the powerhouse site, according to the results of surface reconnaissances as described in 7.3.2(4), shows no large fault existing in the vicinity, and no problem is seen in particular. Compared with the geological conditions at underground powerhouses constructed up to the present in various foreign countries and at Hasan Ugurlu in Turkey, it is thought the geological conditions of the powerhouse are not inferior. However, the foundation rock of an underground powerhouse requires strength to sufficiently withstand excavation of a large-scale underground cavern, and confirmation by means such as exploratory drilling and adit will be necessary hereafter.

The underground powerhouse is composed of a main machine hall, an access tunnel which is to be for the transportation of the main hydro electrical equipment and a cable tunnel which is to be for the transmission of the generated power.

These tunnels will be available for the transportation of the excavated muck of the underground at the early stage of the construction.

Further, the access tunnel of the length of 1,174 m, slope 1:13 and inner diameter of 5.0 m is to be provided at 1.5 km downstream of the main dam.

The cable tunnel of the length of 682 m, the width of 3 m and the height of 4 m is to be provided as inclined tunnel at the left bank of the downstream of the main dam.

In design of the powerhouse at present, it is to be a conventional type having a ceiling arch, and being close to the damsite, drainage galleries are to be provided in the surroundings.

The center elevation of the turbine was set at 705.90 m since a static draft head of the turbine of 2 m is required.

4) Tailrace

The tailrace must be of a construction to allow maximum available discharge of 67 m^3/s to be released safely downstream. The tailrace length is large at 9,261 m, and since the construction would greatly affect the economics of the Project, a study was made of the optimum economical diameter, and 5.4 m was selected. The cross-sectional shape, being a non-pressurized tunnel, was made a standard horseshoe type which provides good flow characteristics. The result of the economic comparisons and the Rating Curve in tailrace tunnel are shown in Fig. 11-2 and Fig. 11-3 respectively. Further, a surge chamber of height 11.7 m and length of 100 m is to be provided at the starting point of the tailrace tunnel to cope with load breaking and sudden load increase at the power station.

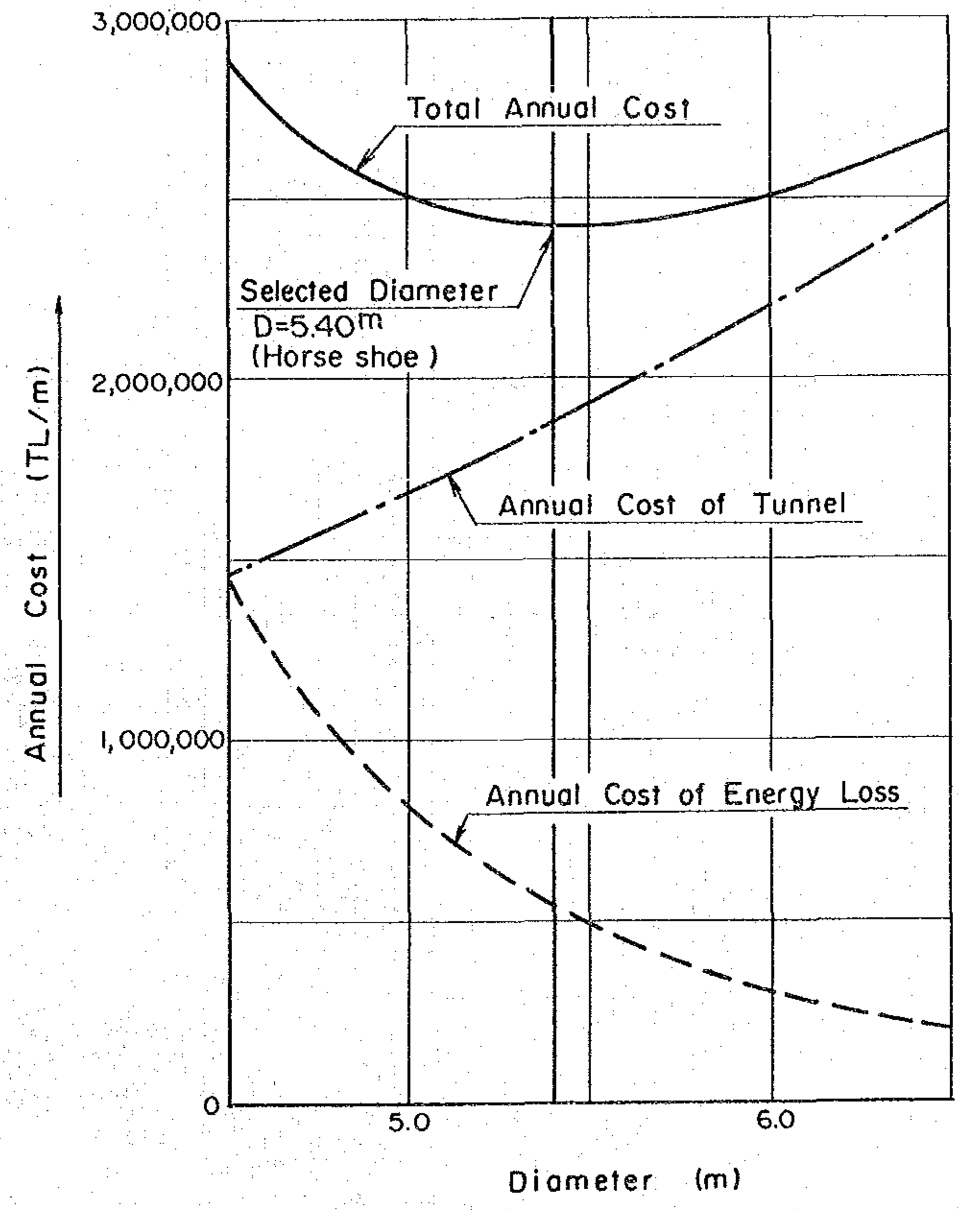
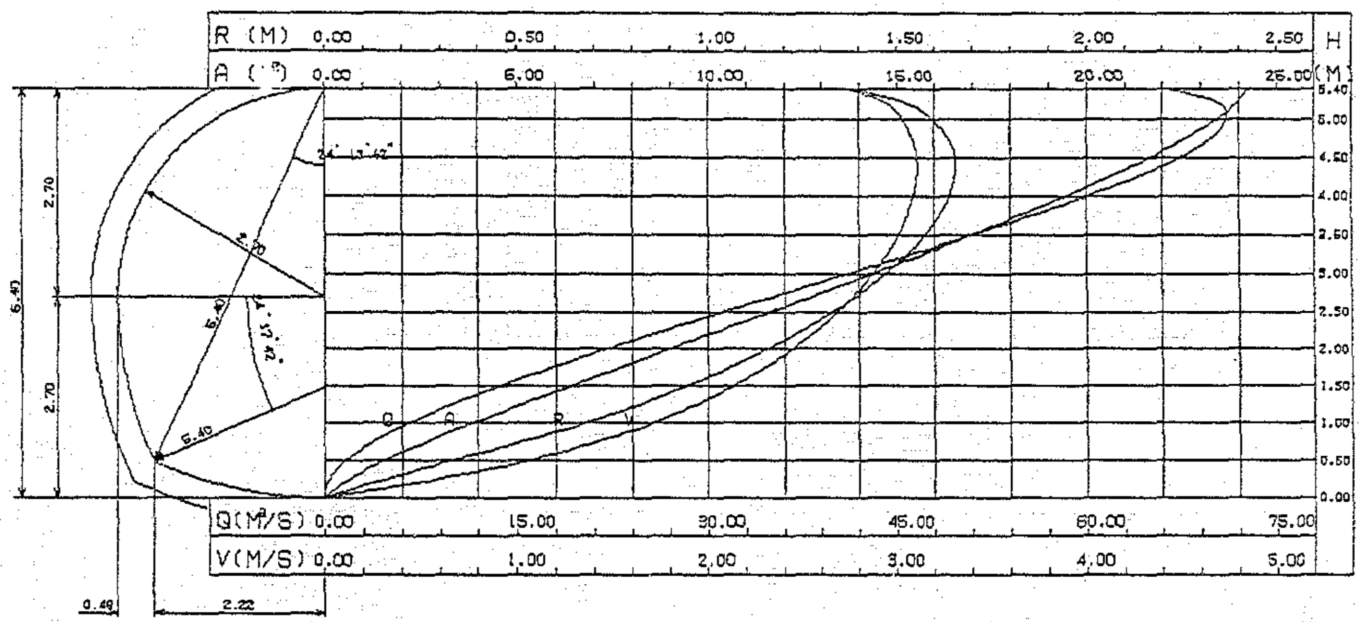


Fig. 11-2 Estimation of Optimum Diameter of Tailrace Tunnel, Ayvalı

Fig. 11-3 Rating Curve in Tailrace Tunnel, Ayvalı



FORMULA

$Q = A \cdot V$

$= A \cdot R^{\frac{2}{3}} \cdot I^{\frac{1}{2}} / N$

V	;VELOCITY	(M/S)
Q	;DISCHARGE	(M³/S)
A	;CROSS-SECTIONAL AREA OF FLOW	(M²)
R	;HYDRAULIC RADIUS	(M)
N	;COEFFCIENT OF ROUGHNESS (NC=0.0130)	
I	;CHANNEL GRADE	(1:1200)
H	;WATER LEVEL	(M)

11.2.3 Electro-mechanical Equipment

(1) Selection of Number of Units

By the same reasons as those for the Olur power station, one is selected as the number of units of the Ayvalı project.

Refer to 11.1.3 of chapter 11.

(2) Type and Ratings of Major Equipment

From the maximum discharge and effective head, vertical shaft Francis turbine is judged as appropriate.

The generator is directly coupled to the turbine shaft, vertical shaft, three phase, alternating current, synchronous generator.

Generator voltage is stepped up to the transmission voltage by main transformer.

The type of main transformer will be single phase, oil-immersed, so as to enable one phase replacement and easy transportation in accordance with TEK's practices.
A spare transformer for one phase will be provided for the Ayvalı power station.

154 kV transmission lines, one from the Olur switchyard and two for the Yusufeli switchyard, will be terminated to the outdoor switchyard at the Ayvalı power station.

The type of switchyard is that of Aluminum pipe bus as of TEK's standard for the time being, but GIS type may be considered as an alternative to catch up with technological aspects.

The ratings of major electro-mechanical equipment are as follows;

Water Turbine

Type	Vertical shaft,Francis
Number of units	1
Normal effective head	213.9 m
Maximum discharge	67 m3/s
Turbine output	126,500 kW
Revolving speed	300 rpm

Generator

Type	Three phase, Alternating current, Synchronous
Number of units	1
Output	140,600 kVA
Power Factor	0.9 lagging
Voltage	14.4 kV
Frequency	50 Hz
Revolving speed	300 rpm

Main Transformer

Type	Outdoor, single phase
Number of units	4 (including 1 spare)
Capacity	47,000 kVA
Voltage primary:	14.4 kV
secondary:	$154/\sqrt{3}$ kV

Outdoor Switchyard

Bus system	double bus
Bus	Aluminum pipe
Number of transmission Lines connected	154kV 1 from Olur 2 for Yusufeli

(3) Main Circuit Equipment

As the powerhouse is in the underground relatively far from outdoor switchyard, the main transformer is equipped in the powerhouse to reduce the cost of power cable connecting between the underground powerhouse and outdoor switchyard.

A parallel-in circuit breaker is equipped at low tension side of main transformer and used for synchronizing generator to the power system.

The type of parallel-in circuit breaker will be of load breaking which is not capable of interrupting the current exceeding the full load current for economical reason.

For interruption of fault current of the generator feeder, the circuit breaker at high tension side of main transformer will serve.

For connection between the main transformer and outdoor switchyard,154 kV XLPE power cable will be adopted.

The number of 154 kV transmission lines which take off from the outdoor switchyard are, one from the Ayvalı switchyard and two for the Yusufeli switchyard, all of which are connected to double bus system .

Between each double bus, one tie-circuit breaker is provided to continue sending power with one bus out of service.

To secure station service power in any failure of transmission line or switchyard equipment, an emergency power source of a diesel engine-generator set will be equipped in this power station.

Fig. 11-20 and Fig. 11-21 indicates the single line diagram of the power station and outdoor switchyard plan, respectively.

(4) Telecommunication Equipment

Power line carrier system (earth return) is provided for composing telecommunication circuits for power generation.

11.3 Power Transmission Line

11.3.1 Transmission Line Route

Whether existing road is available or not for the transportation of tools and materials has much effect on the construction cost of transmission line.

According to the Çoruh river development plan,Yusufeli project is scheduled to be constructed prior to Oltu project, and most of existing road and 154 kV transmission lines which run the bottom of valley are submerged under water at completion of Yusufeli project.

And so, it is necessary to plan the transmission line route among Olur, Ayvalı and Yusufeli switchyard in such a way that the route is parallel and near to the construction road as much as possible avoiding the submerged area under water.

The route between Olur and Ayvalı runs left bank of Oltu river, and that between Ayvalı and Yusufeli also runs left bank and cross and reaches to Yusufeli switchyard at right bank.

As for 34.5 kV transmission line taking off Olur switchyard, they will be connected to transmission line from Yusufeli substation.

11.3.2 Conductor Size and Tower

(1) Transmission Voltage and Number of Circuits

One 154 kV circuit is necessary between Olur and Ayvalı, and two 154 kV circuits between Ayvalı and Yusufeli.

(2) Conductor

Taking into account current capacity, corona discharge characteristics, mechanical strength, practice in Turkey and TEK's scheme, the following conductor will be adopted.

1) Between Olur and Ayvalı approx. 13 km

154 kV, ACSR 636 MCM, 1 conductor, 1 circuit

2) Between Ayvalı and Yusufeli approx. 20 km

154 kV, ACSR 636 MCM, 1 conductor, 2 circuits

(3) Lightning Surge Protection

Two lines of 70 mm^2 overhead ground wire will be equipped on top of transmission tower to obtain 100 percent shielding effect against lightning surge.

(4) Type of Porcelain Insulator and Number of Strings

For insulation co-ordination, maximum system voltage of 170 kV and highest altitude of below 1,000 m asl is considered.

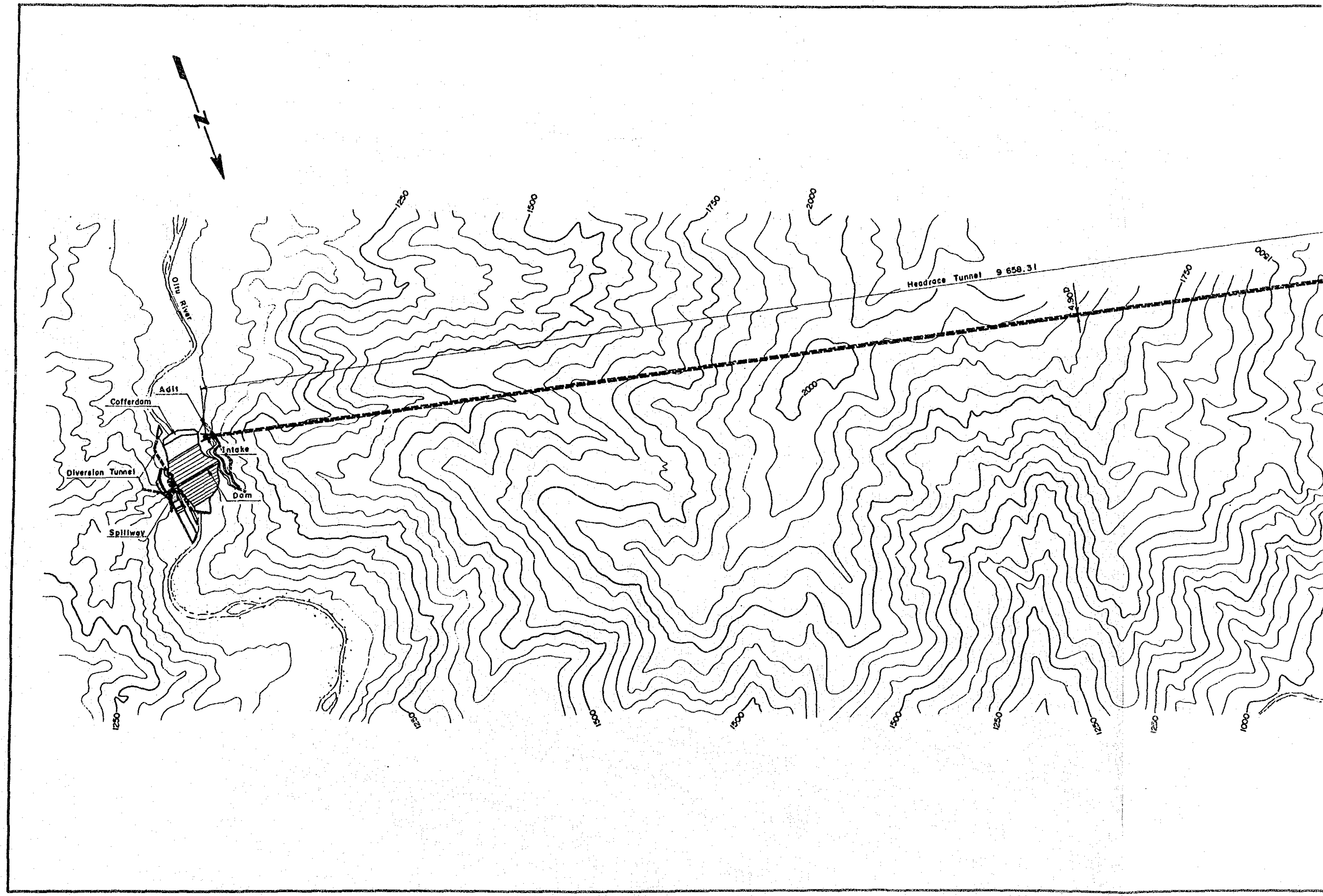
Number of porcelain insulator strings is determined by the voltage level of switching surge, and also it is necessary to cope with the insulation level of existing equipment.

twelve (12) sets of suspension insulator with 250 mm in diameter is adopted for standard use for this project.

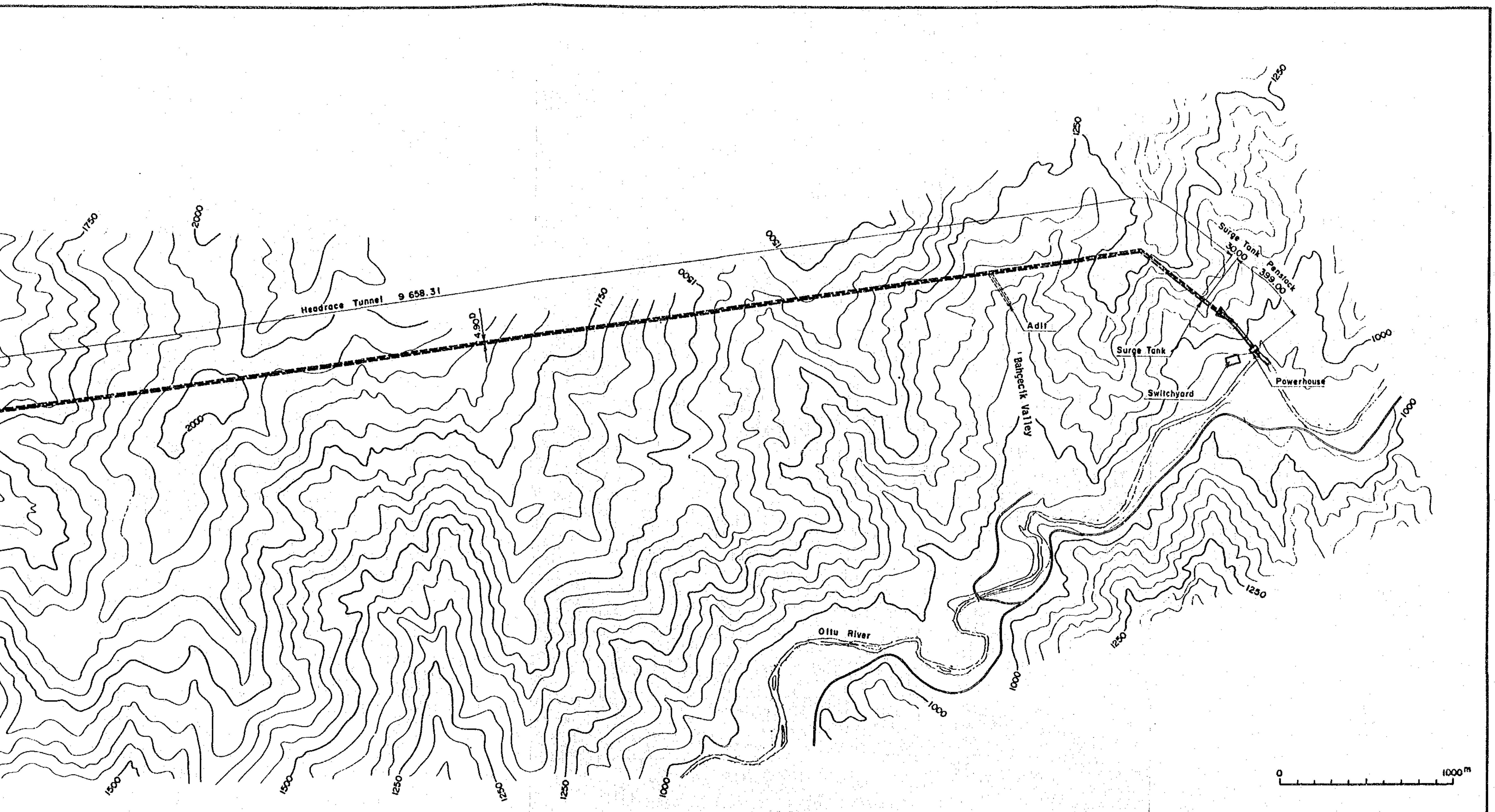
(5) Support

In designing transmission tower, maximum wind pressure of 68 kg/m^2 on conductor, maximum wind pressure of 90 kg/m^2 on tower and snow level in proposed area (region-3, 7.452 kg/m of snow for 636 MCM conductor).

The profile of 154 kV standard suspension tower is shown in Fig. 11-22.



N
Oltu River
Adit
Cofferdam
Intake
Diversion Tunnel
Dam
Spillway
Headrace Tunnel 9 658.31
4.90 D
1250
1500
1750
2000
1000



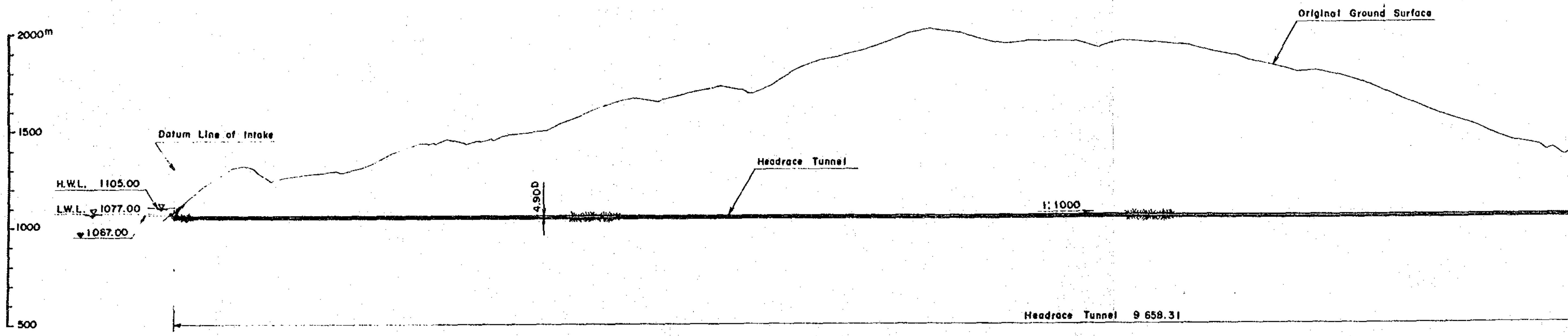
OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

OLUR PROJECT

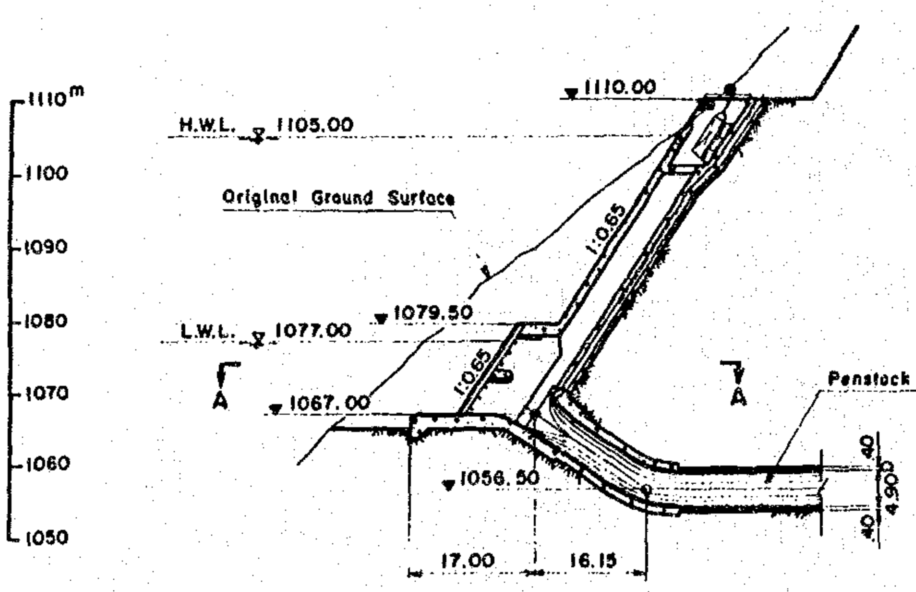
GENERAL PLAN

Fig. 11-4

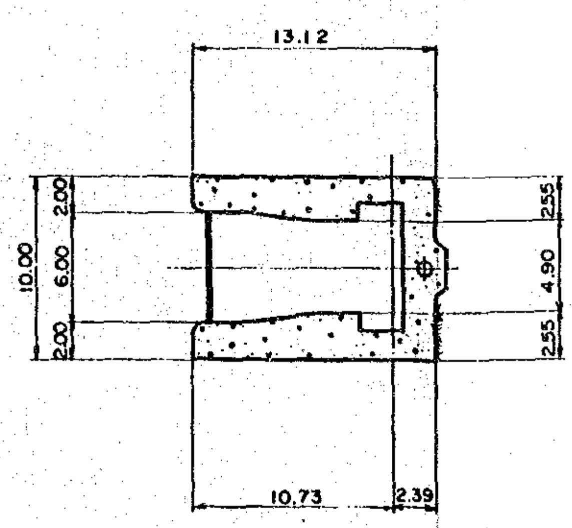
PROFILE



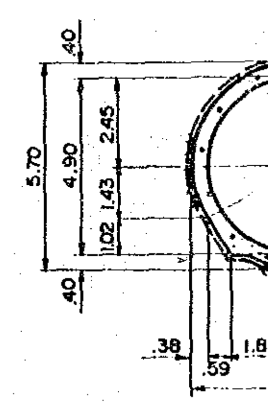
TYPICAL SECTION OF INTAKE



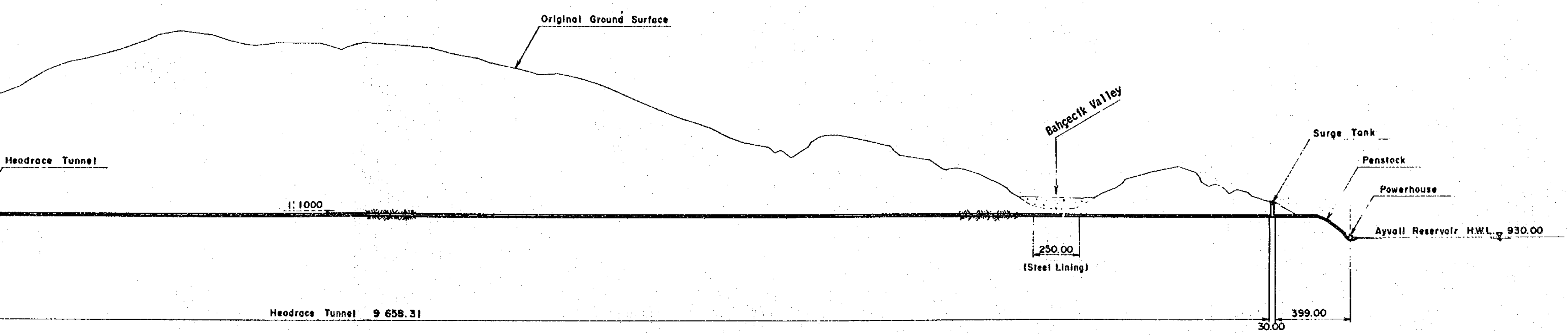
SECTION A - A



TYPICAL SECTION



PROFILE



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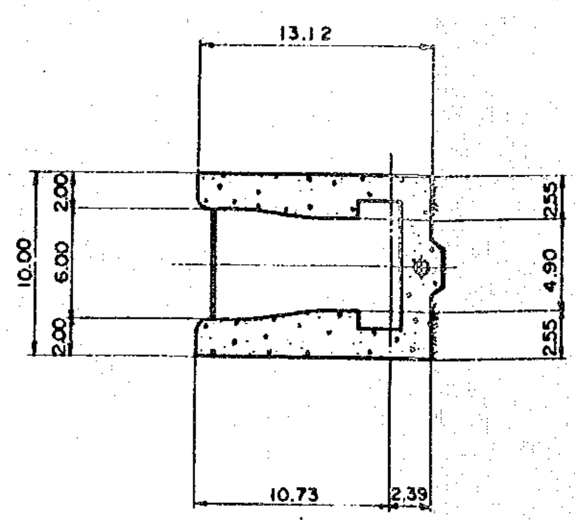
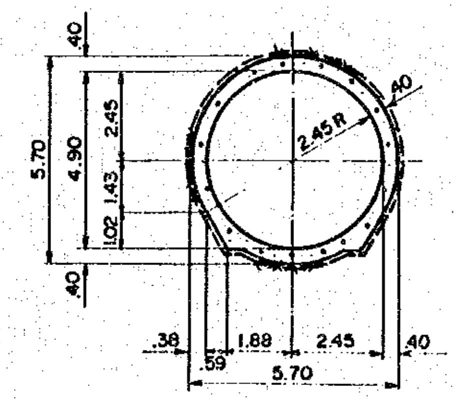
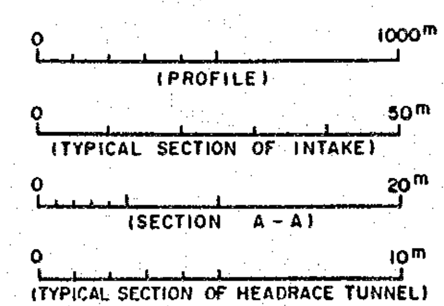


TYPICAL SECTION OF HEADRACE TUNNEL

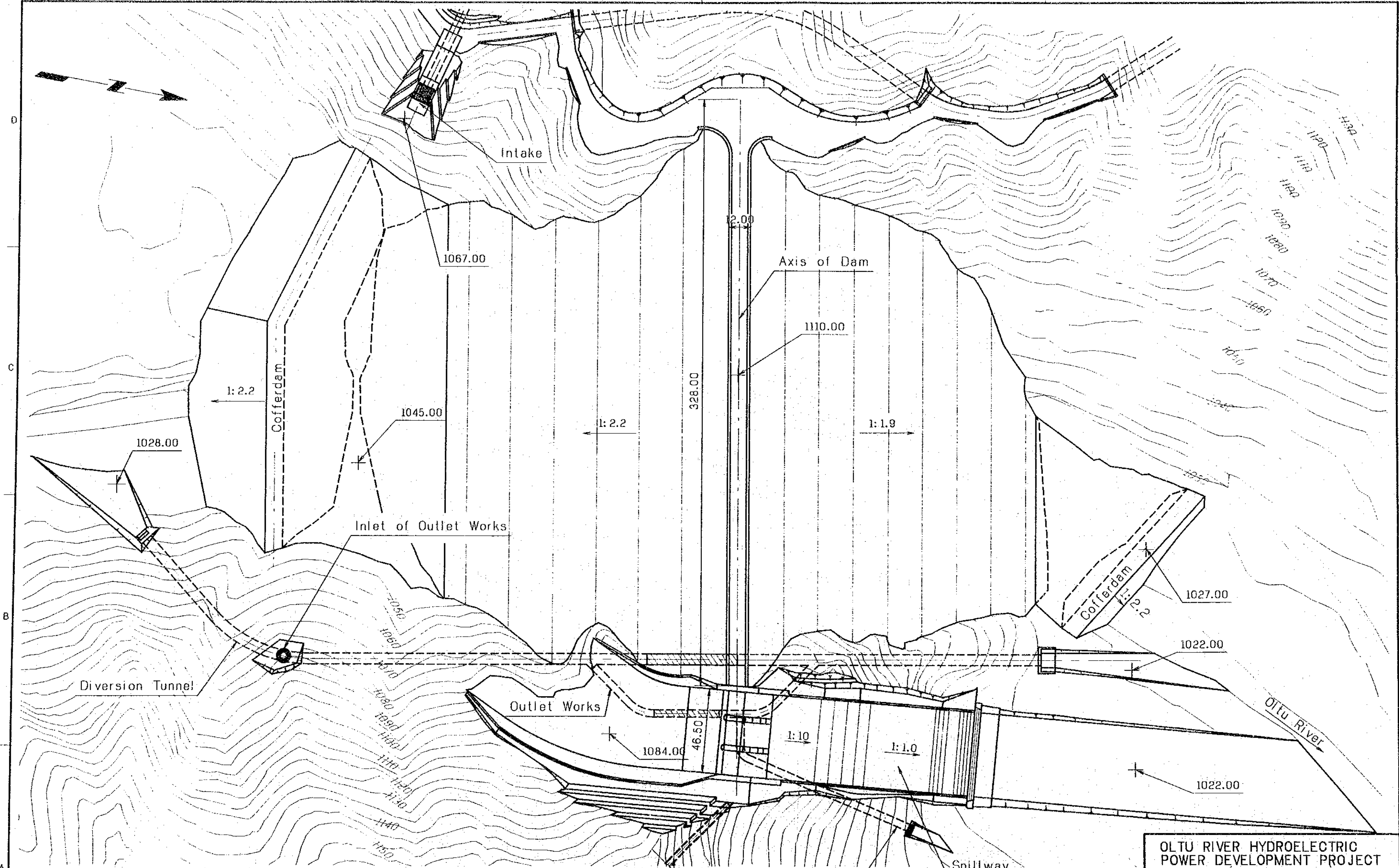




OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

OLUR PROJECT
WATERWAY
PROFILE AND SECTIONS

Fig. 11–5

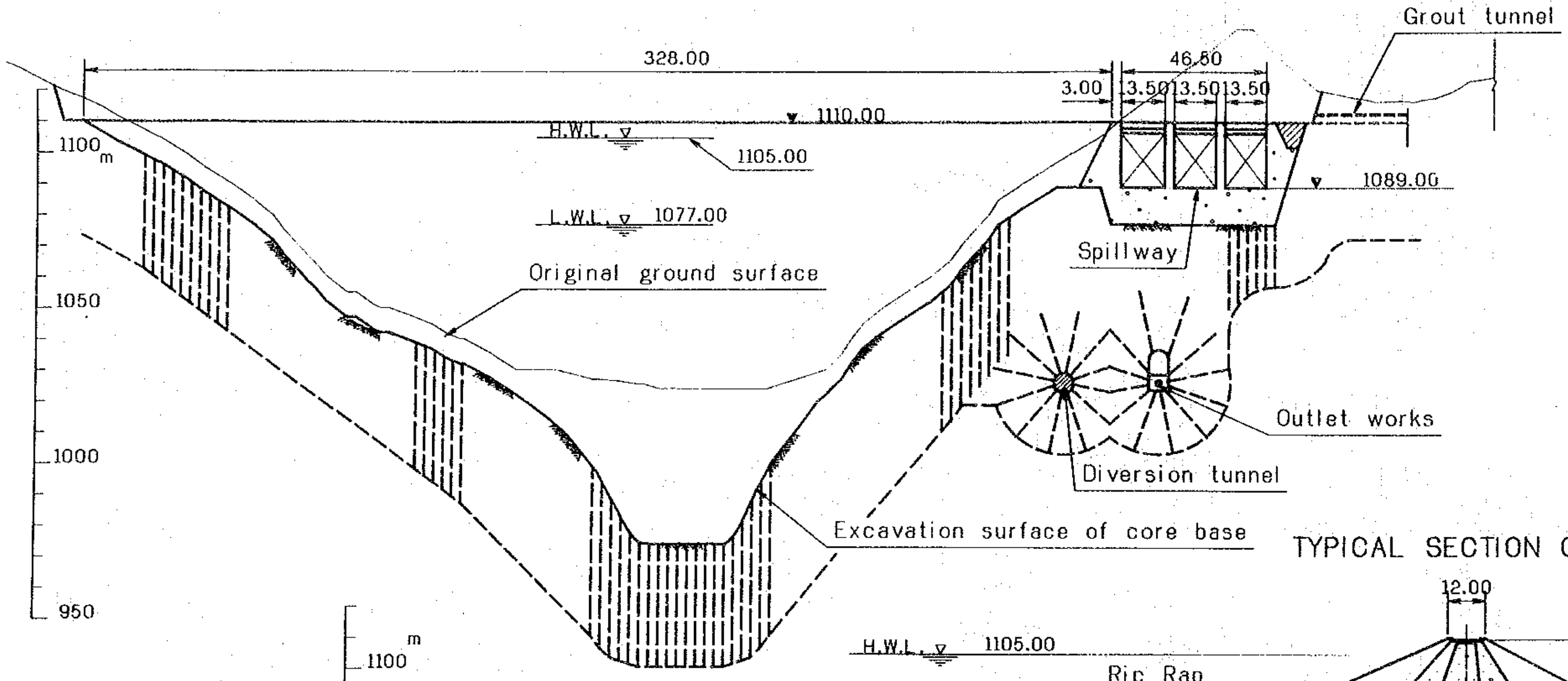


OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

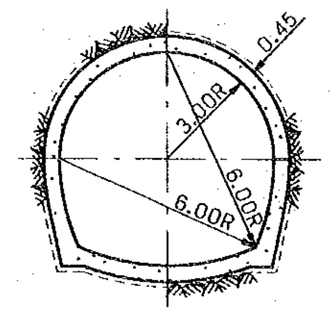
OLUR PROJECT
DAM
GENERAL PLAN

Fig.11-6

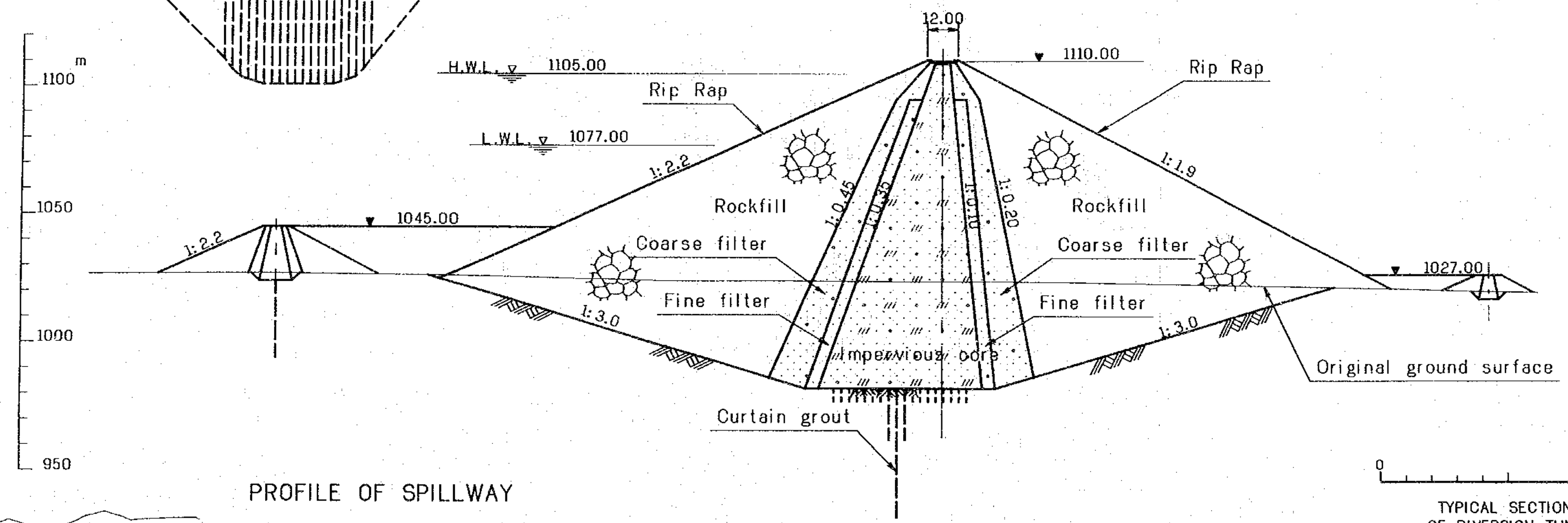
PROFILE OF DAM



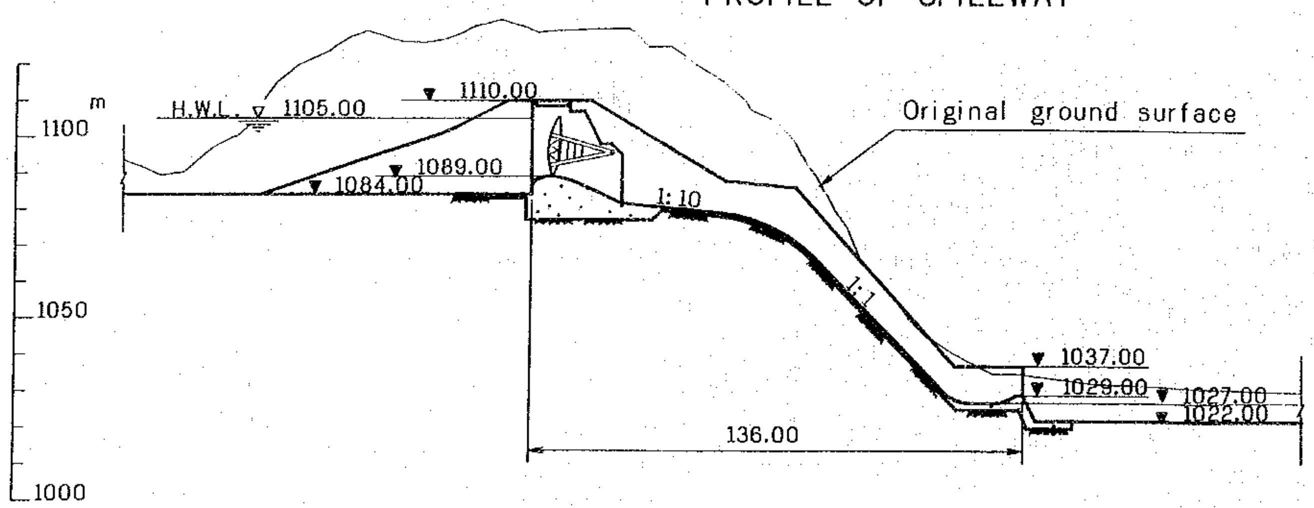
TYPICAL SECTION OF DIVERSION TUNNEL



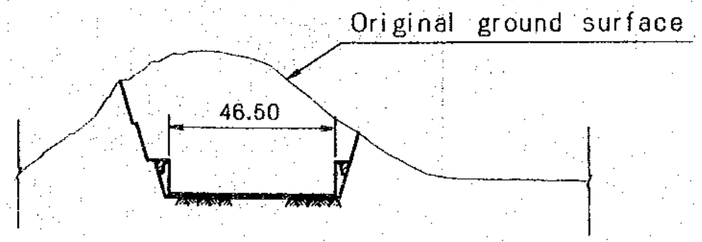
TYPICAL SECTION OF DAM



PROFILE OF SPILLWAY



TYPICAL SECTION OF SPILLWAY



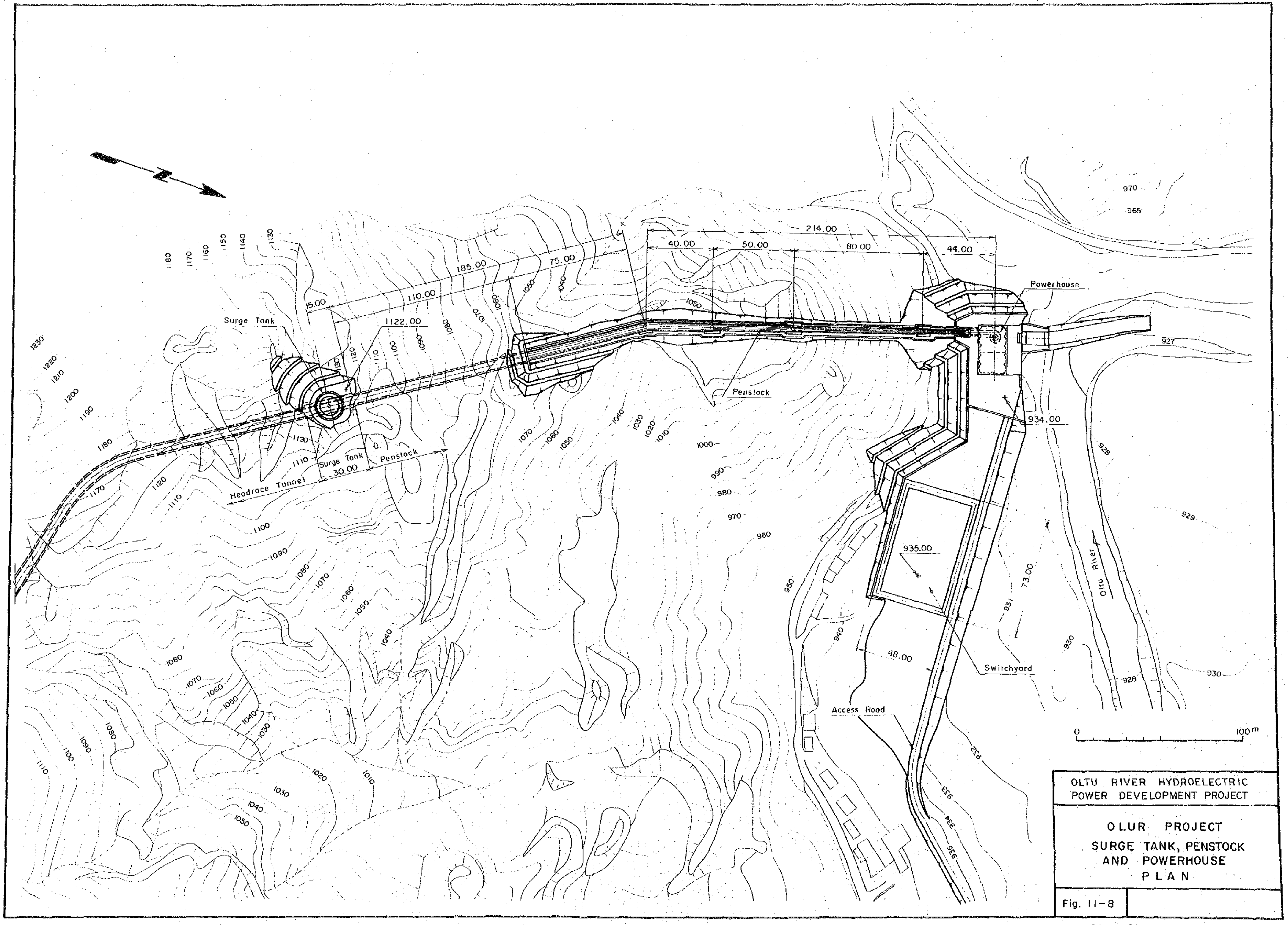
0 — 10m
TYPICAL SECTION OF DIVERSION TUNNEL

0 — 100m
OTHERS

OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

OLUR PROJECT
DAM
PROFILE AND SECTIONS

Fig. 11- 7



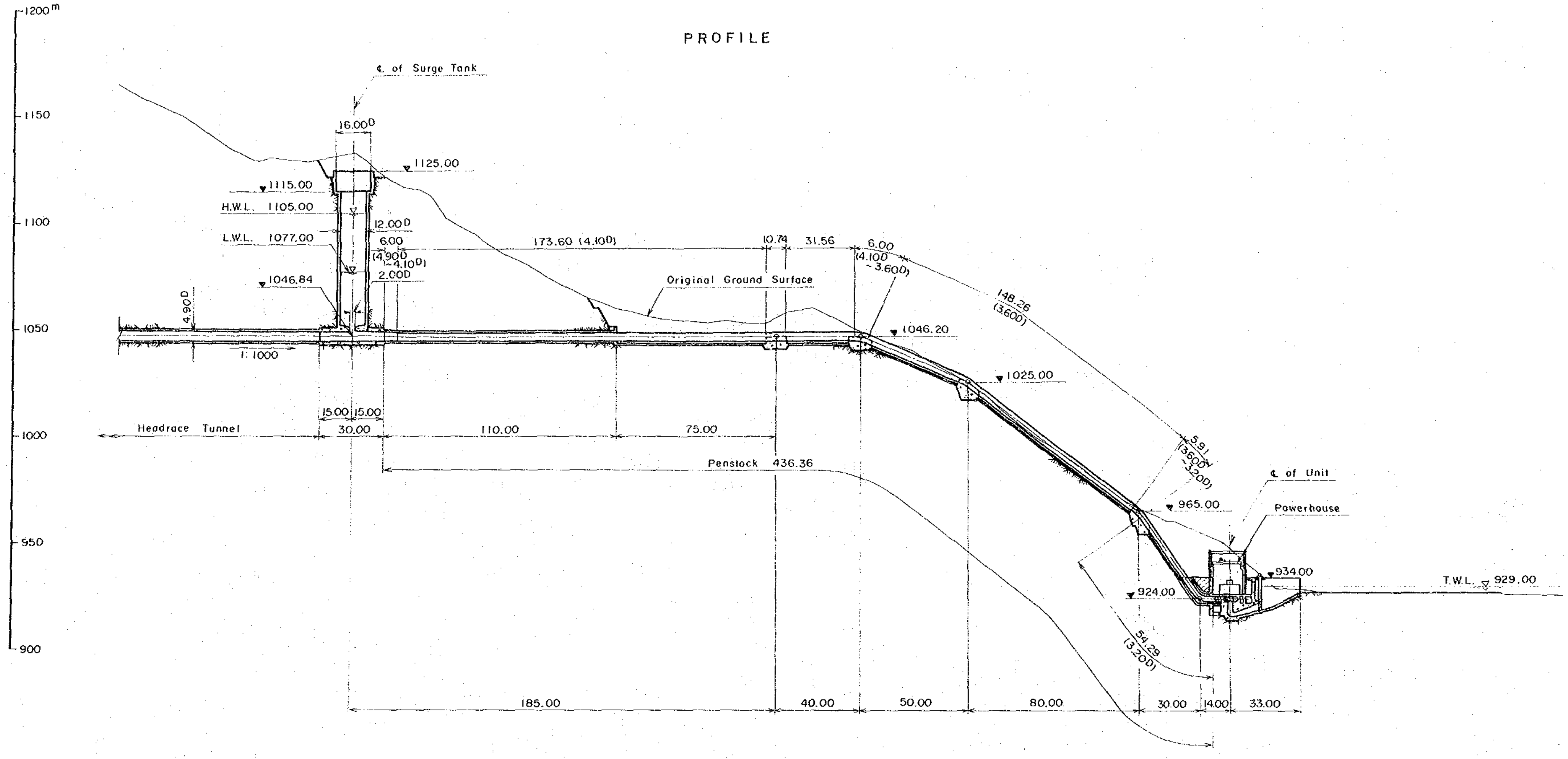
OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

OLUR PROJECT

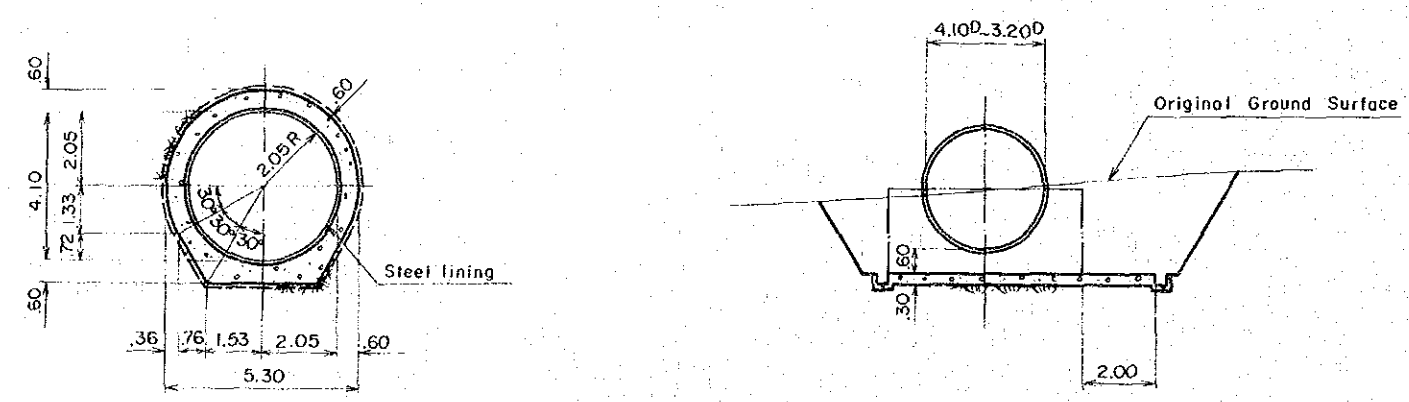
SURGE TANK, PENSTOCK AND POWERHOUSE PLAN

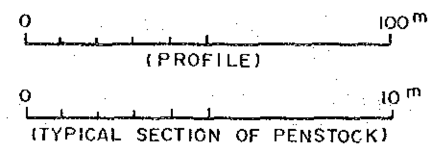
Fig. 11-8

PROFILE



TYPICAL SECTION OF PENSTOCK



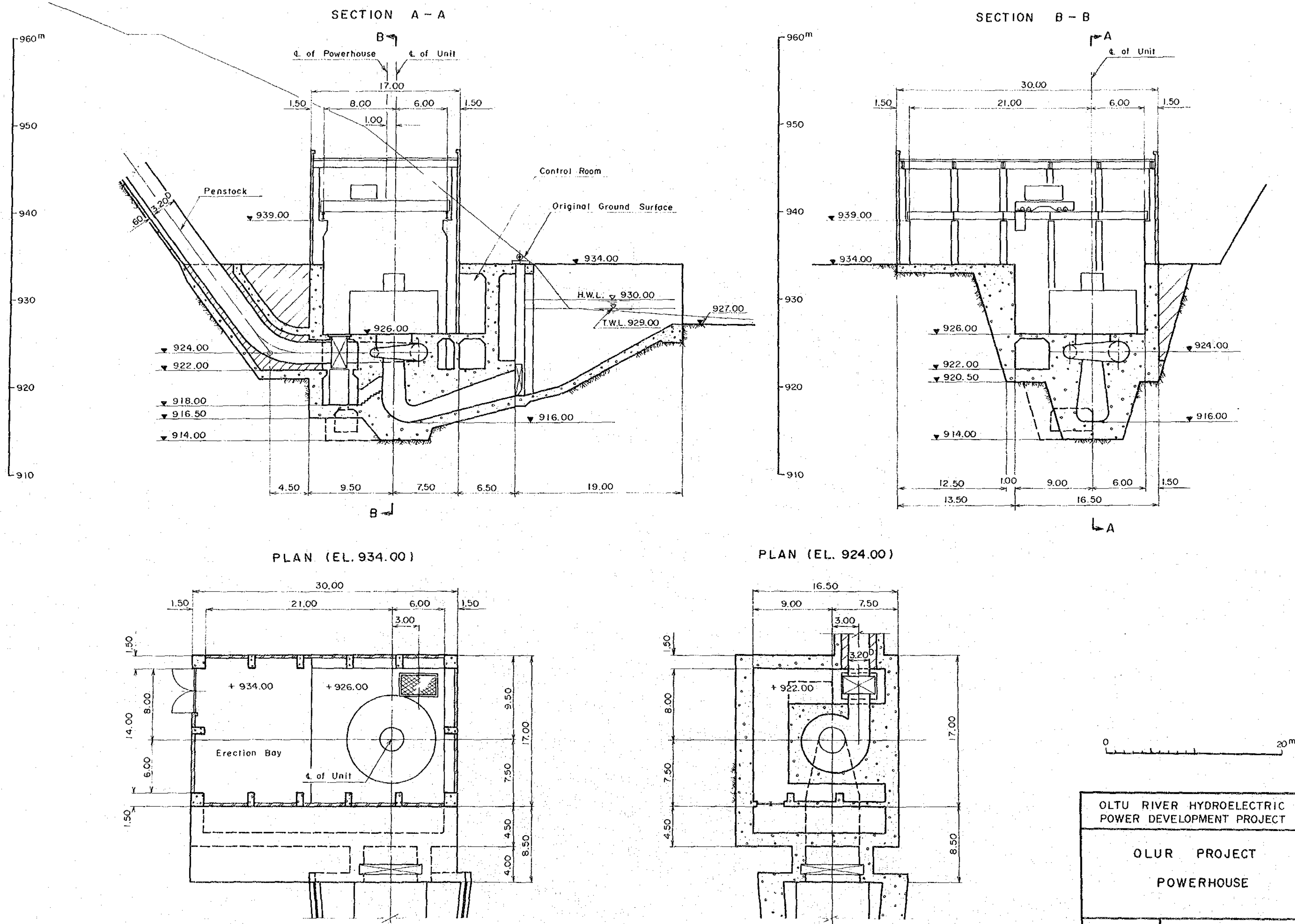


OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

OLUR PROJECT

SURGE TANK AND PENSTOCK PROFILE AND SECTIONS

Fig. 11-9

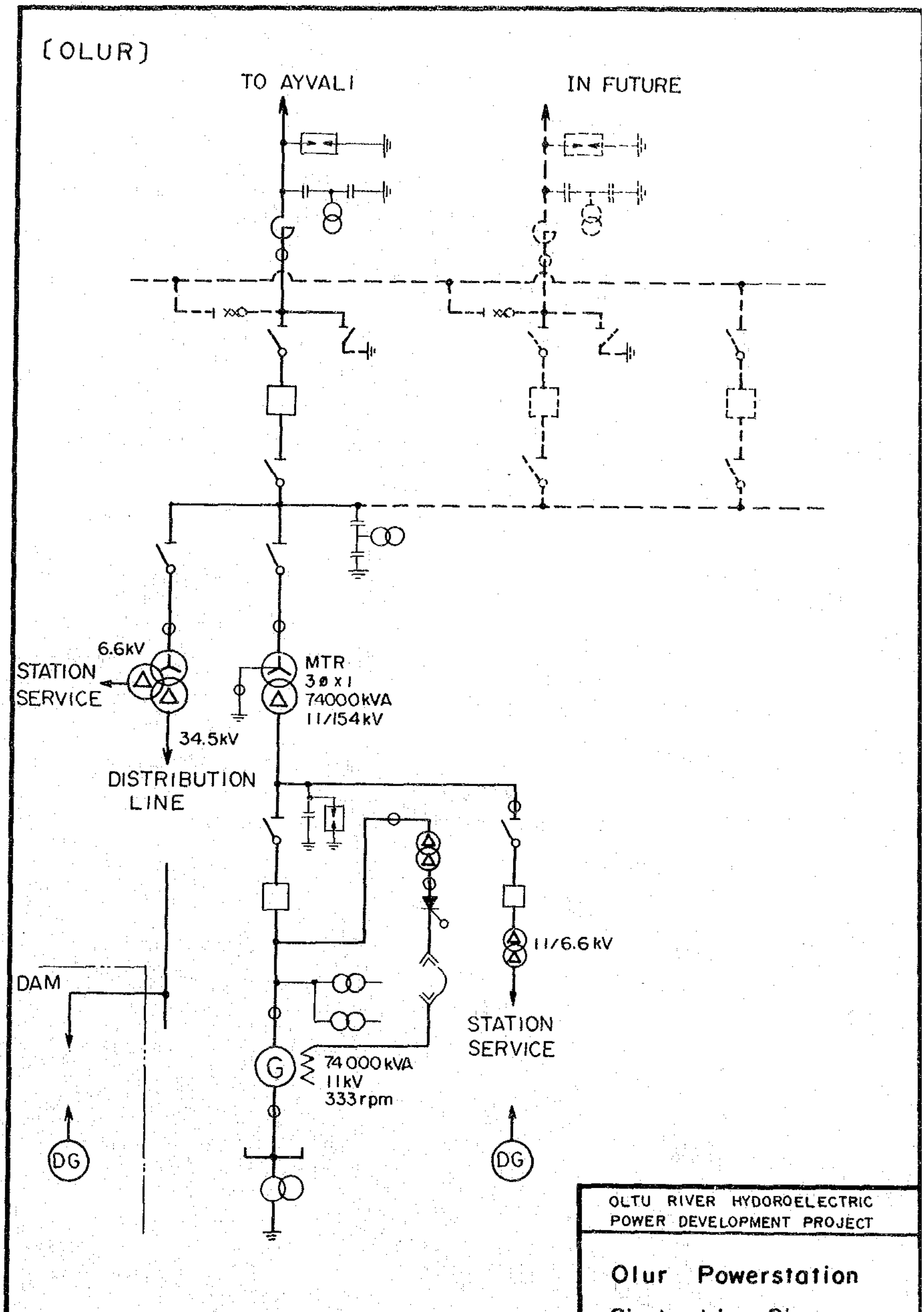


OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

OLUR PROJECT

POWERHOUSE

Fig. 11-10

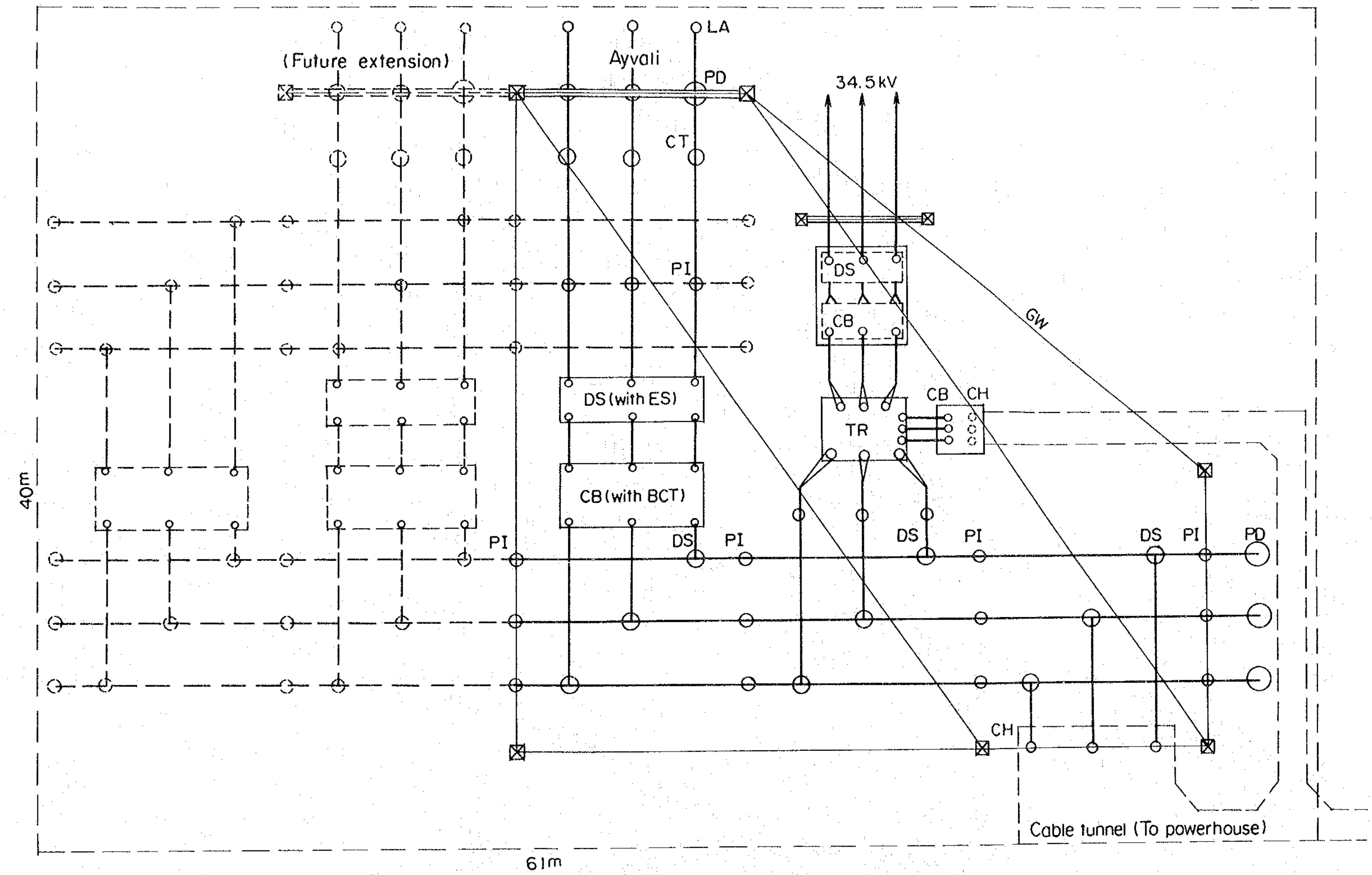


OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

Olur Powerstation

Single Line Diagram

Fig. 11-11



Foot note : Inspection road and fence surrounding the switchyard are not shown in this figure.

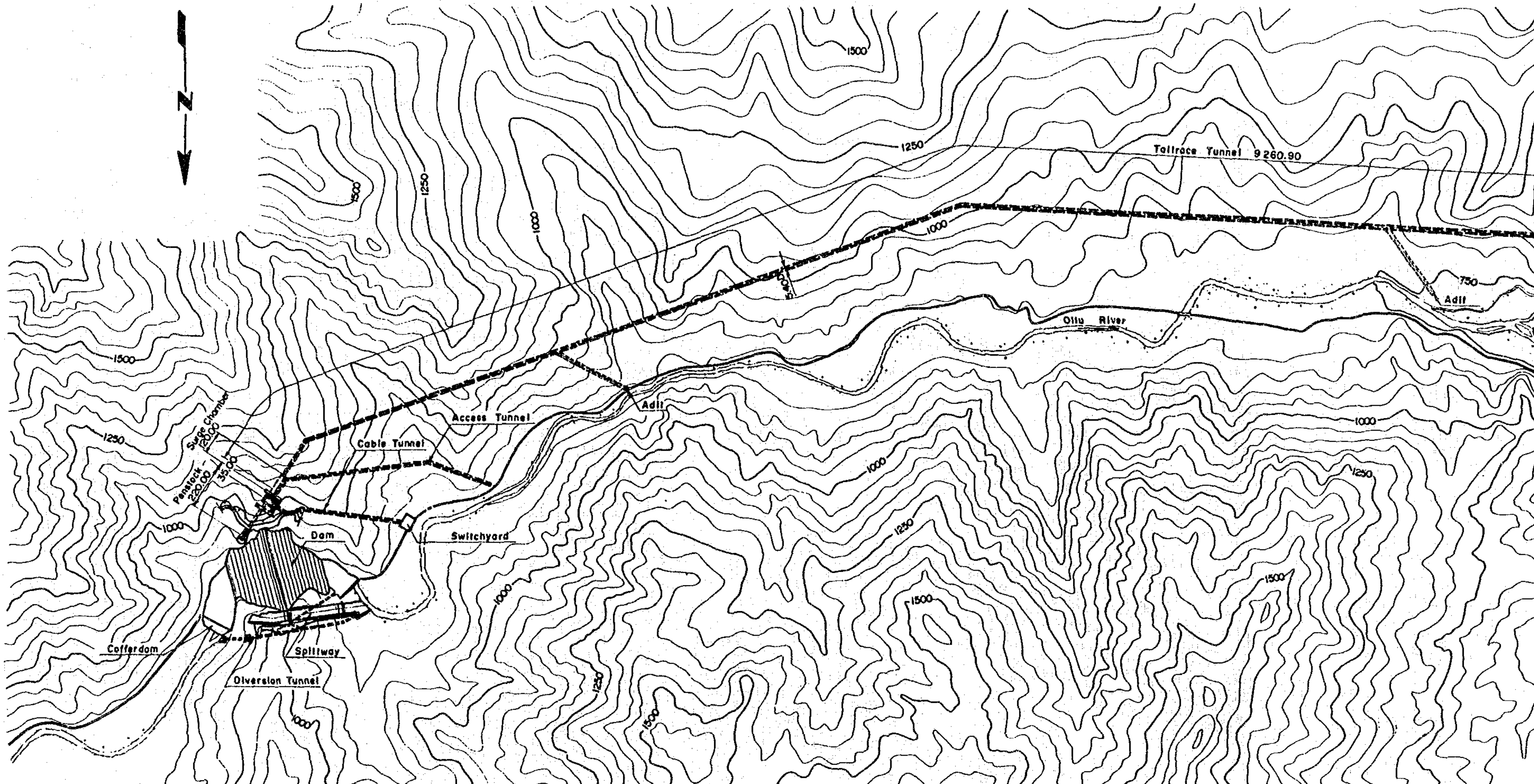
Legend

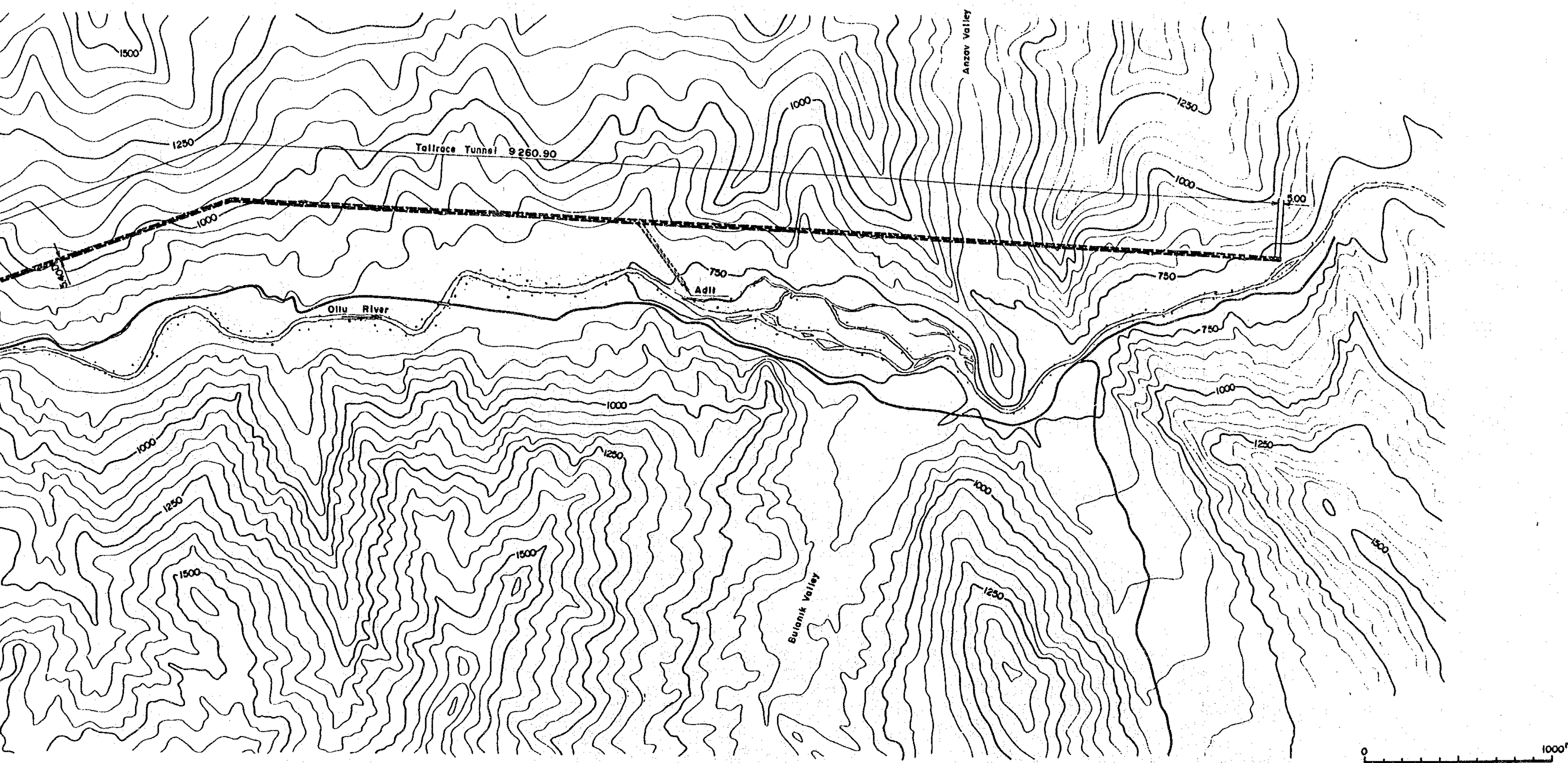
CB : Circuit Breaker
DS : Disconnecting Switch
LA : Lightening Arrester
PD : Potential Device
PI : Post Insulator
CH : Cable Head
ES : Earthing Switch
GW : Ground Wire
BCT : Bushing type Current Transformer
CT : Current Transformer

OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

Olur Powerstation Outdoor Switchyard Plan

Fig. 11-12


N
Tailrace Tunnel 9 260.90
Adit
Oltu River
Access Tunnel
Adit
Cable Tunnel
Surge Chamber
Penstock
220.00
35.00
Dam
Switchyard
Cofferdam
Spillway
Diversion Tunnel
1500
1250
1000
750



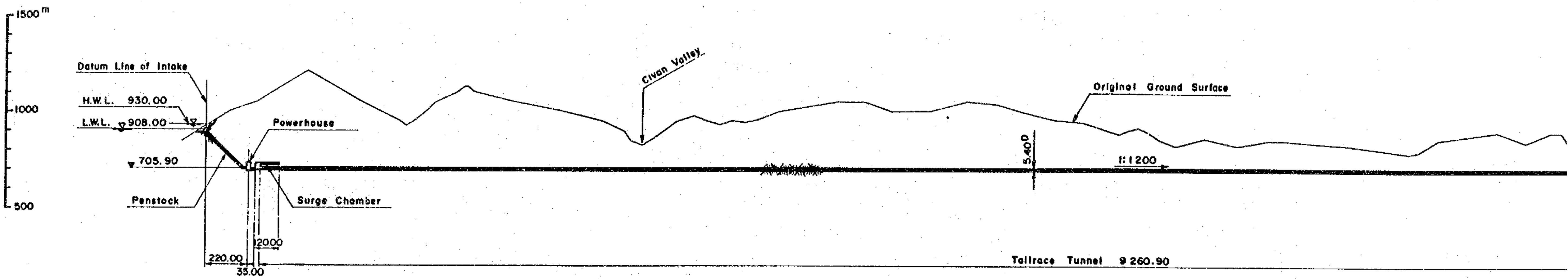
OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

AYVALI PROJECT

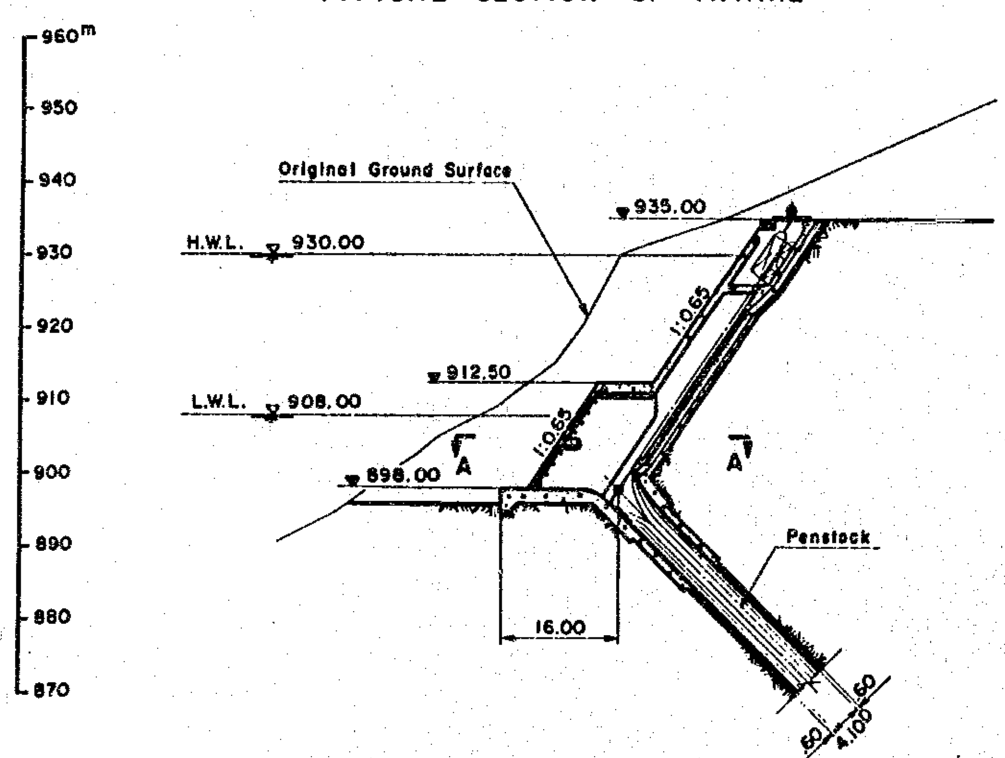
GENERAL PLAN

Fig. 11-13

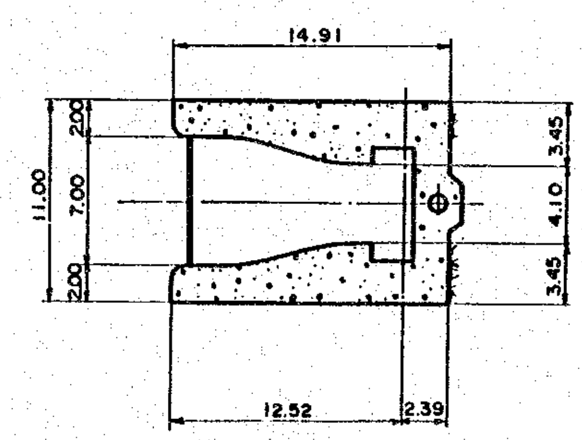
PROFILE



TYPICAL SECTION OF INTAKE

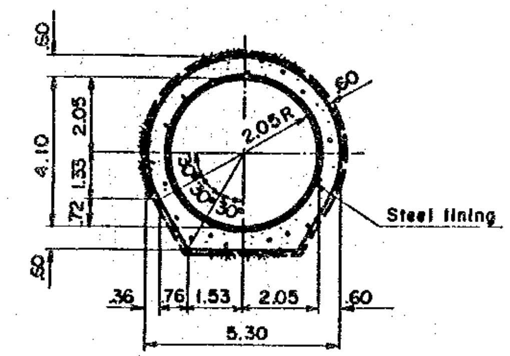


SECTION A – A

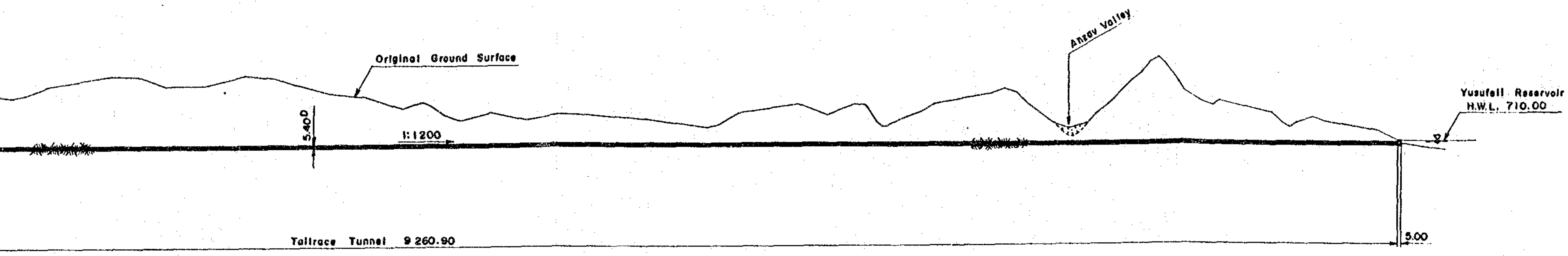


TYPICAL

PENSTOCK



PROFILE



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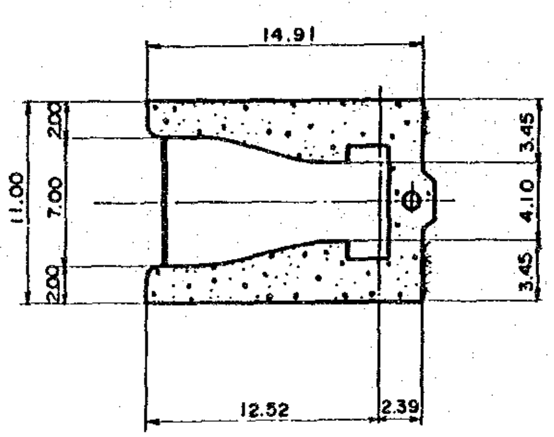
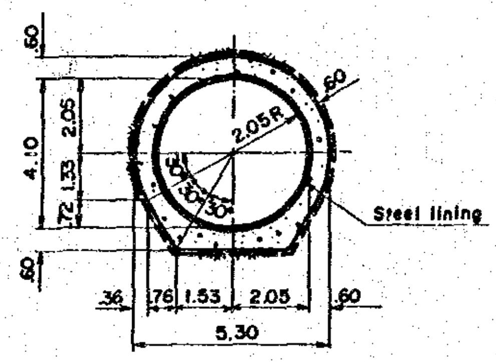
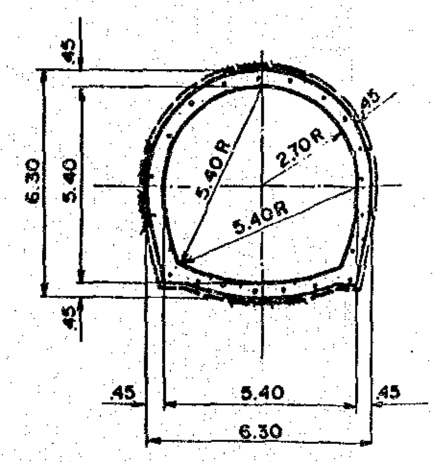


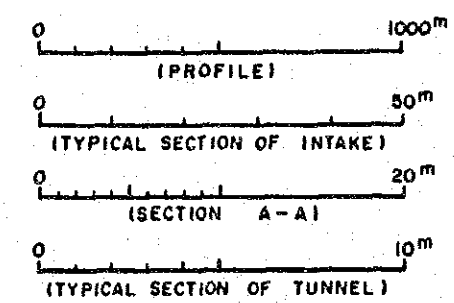
TYPICAL SECTION OF TUNNEL

PENSTOCK



TAILRACE TUNNEL





OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

AYVALI PROJECT

WATERWAY

PROFILE AND SECTIONS

Fig. 11-14

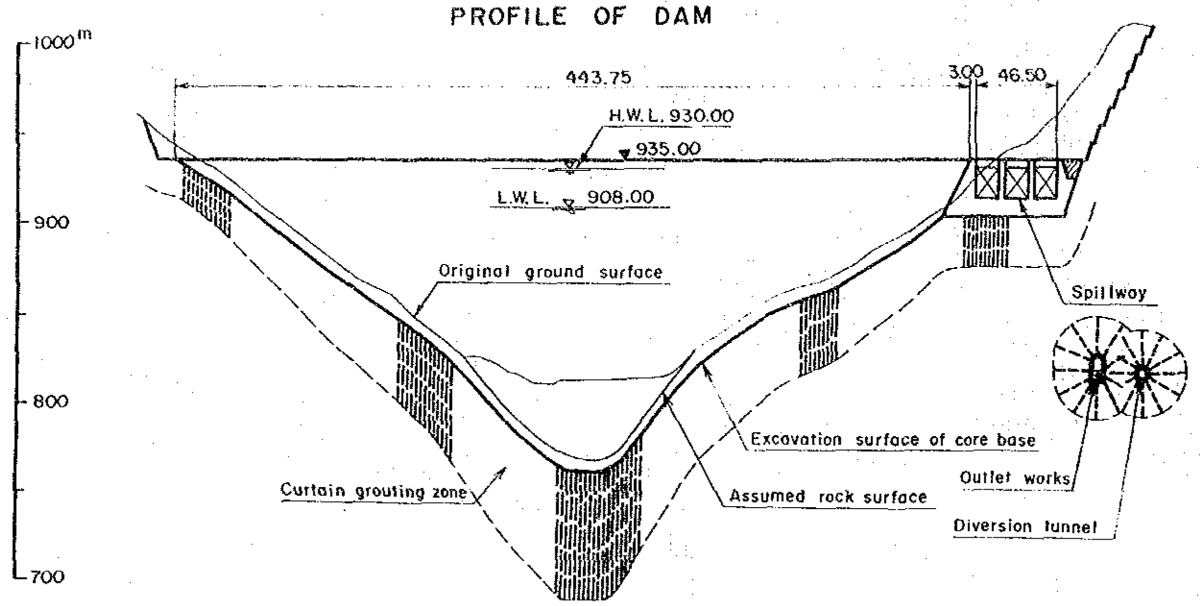

Power Intake
+ 935.00
Axis of Dam
443.75
12.00
935.00
1:2.2
1:1.9
+ 811.00
+ 835.00
Access Tunnel
+ 908.00
1:20
1:1.5
935.00
Spillway
46.50
+ 807
+ 825.00
1:2.2
Inlet of Outlet Works
816.00
888.00
824.00
Diversion Tunnel

OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

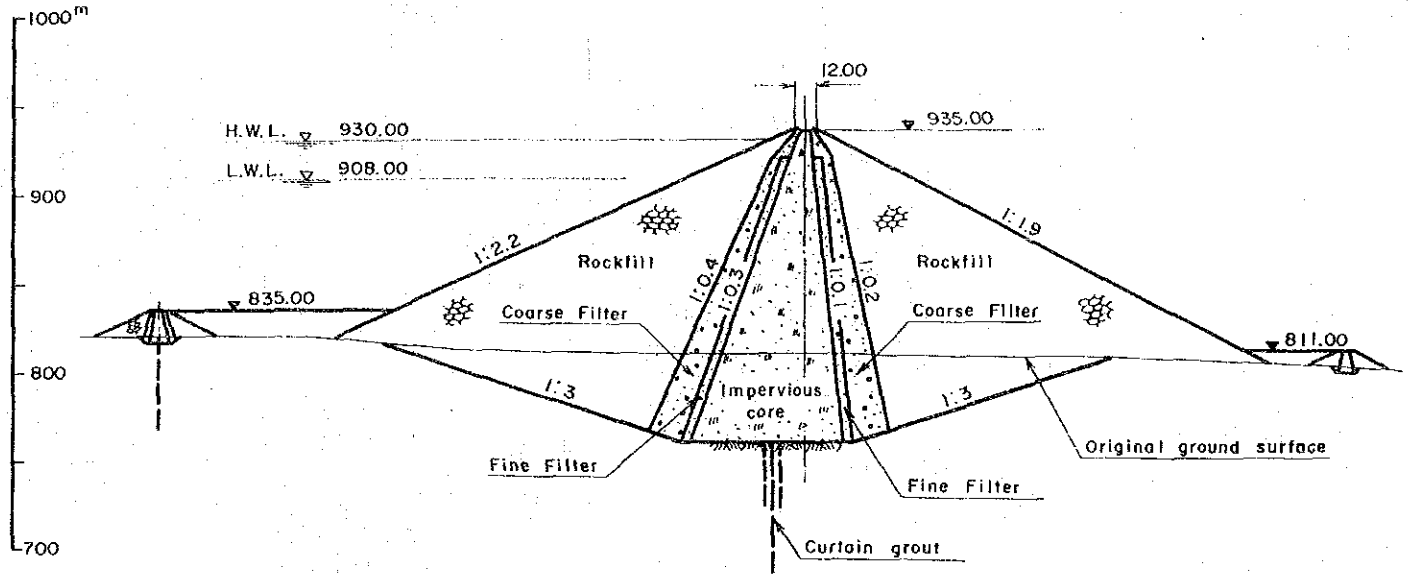
AYVALI PROJECT
DAM
GENERAL PLAN

Fig. 11 - 15

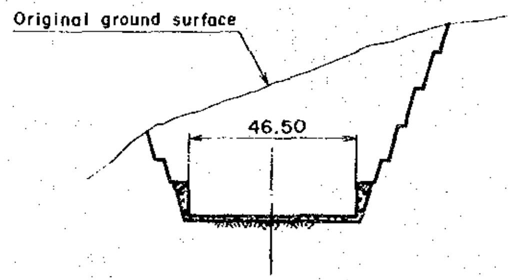
PROFILE OF DAM



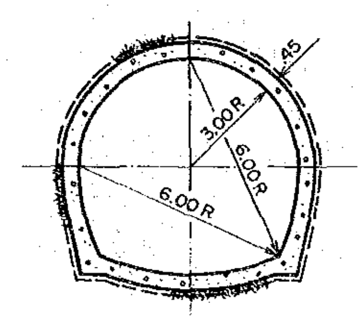
TYPICAL SECTION OF DAM



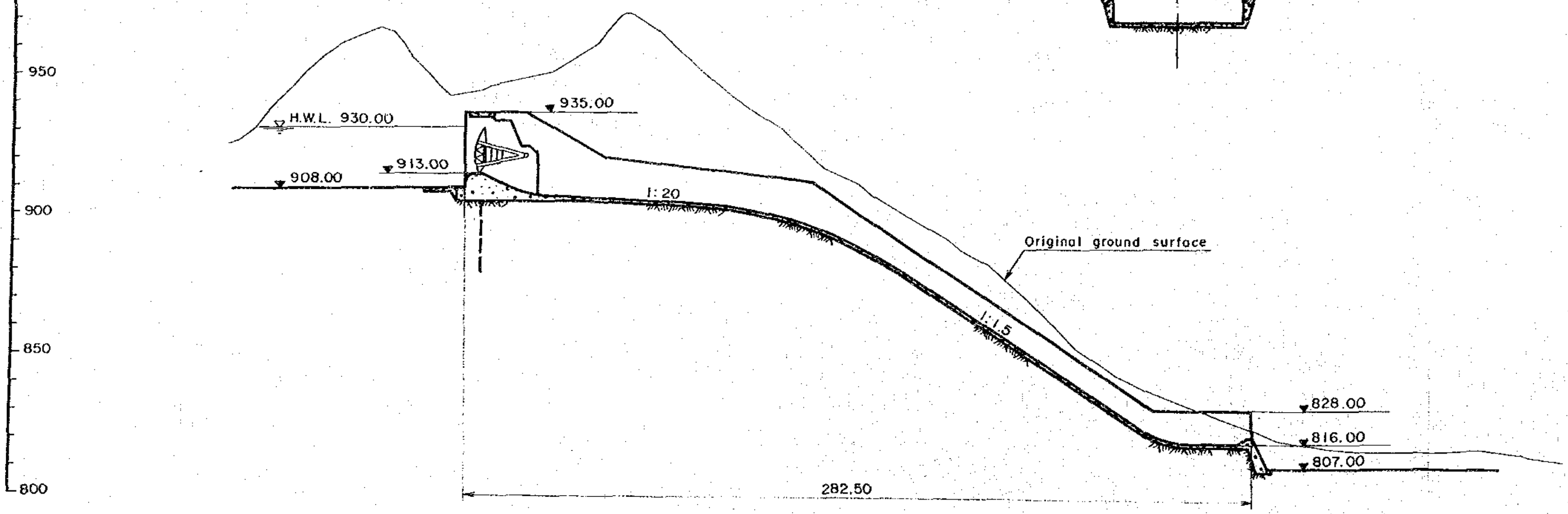
TYPICAL SECTION OF SPILLWAY



TYPICAL SECTION OF DIVERSION TUNNEL



PROFILE OF SPILLWAY



0 200m
PROFILE OF DAM
TYPICAL SECTION OF DAM

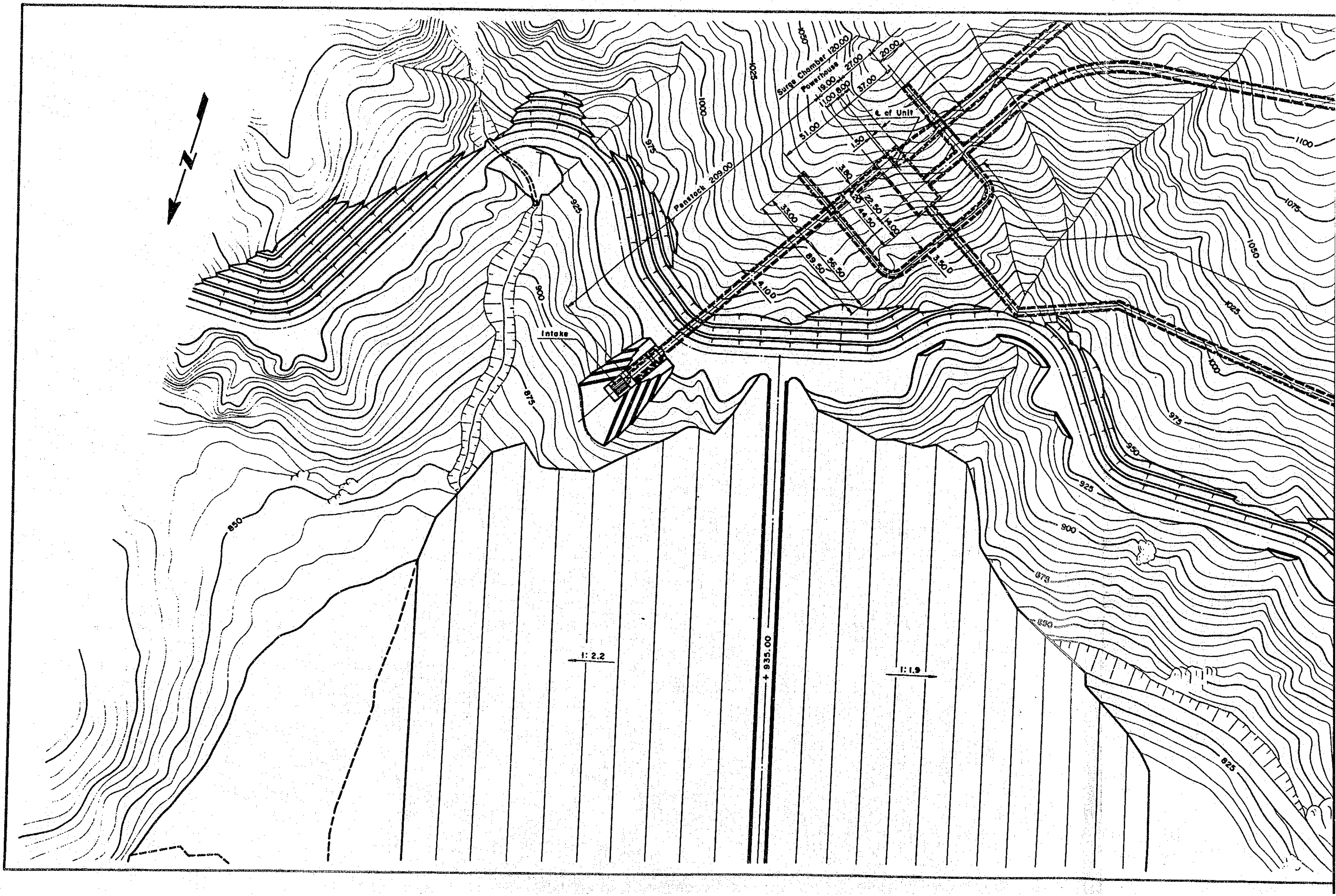
0 100m
PROFIL OF SPILLWAY
TYPICAL SECTION OF SPILLWAY

0 10m
TYPICAL SECTION
OF DIVERSION TUNNEL

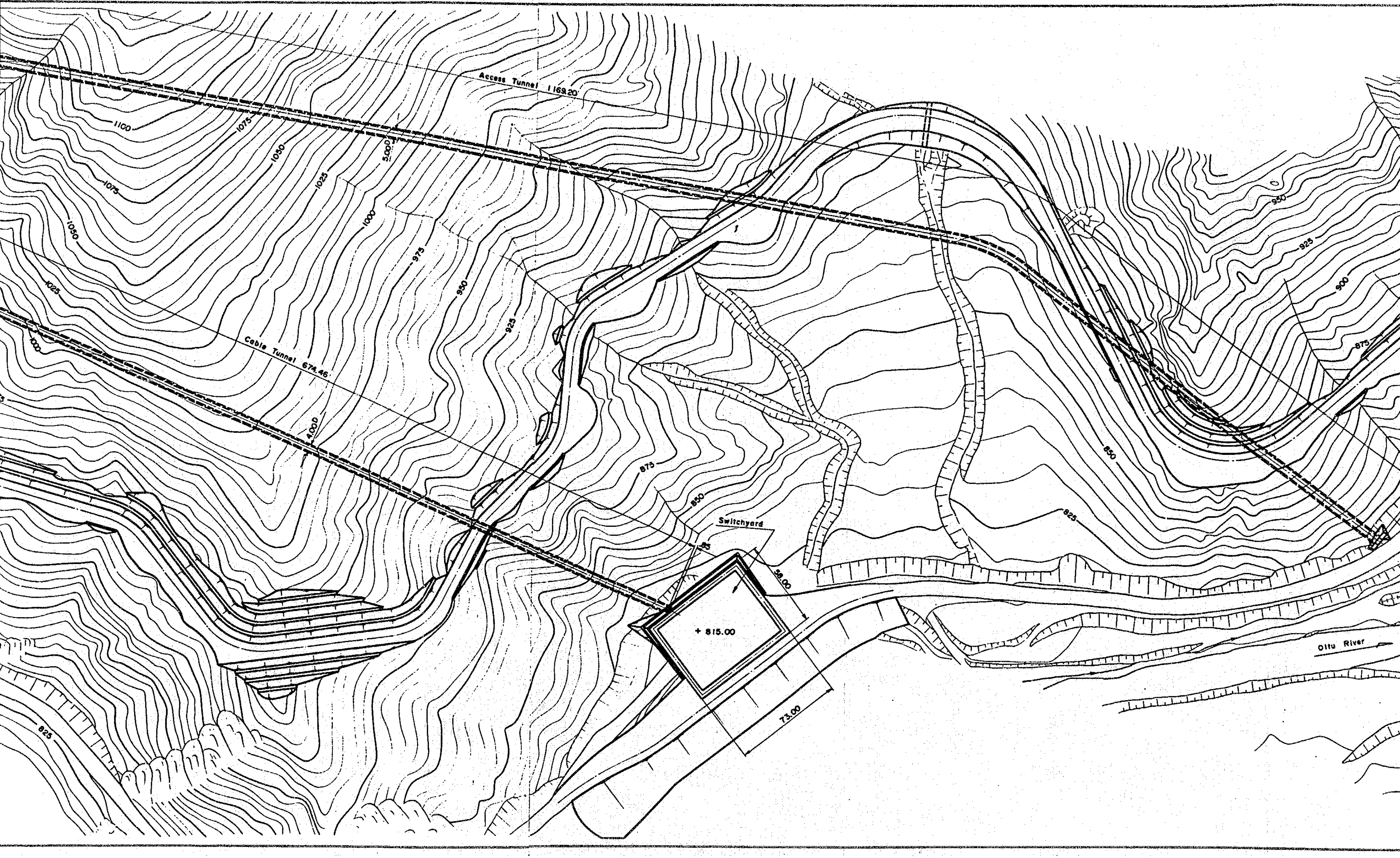
OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

AYVALI PROJECT
DAM
PROFILE AND SECTIONS

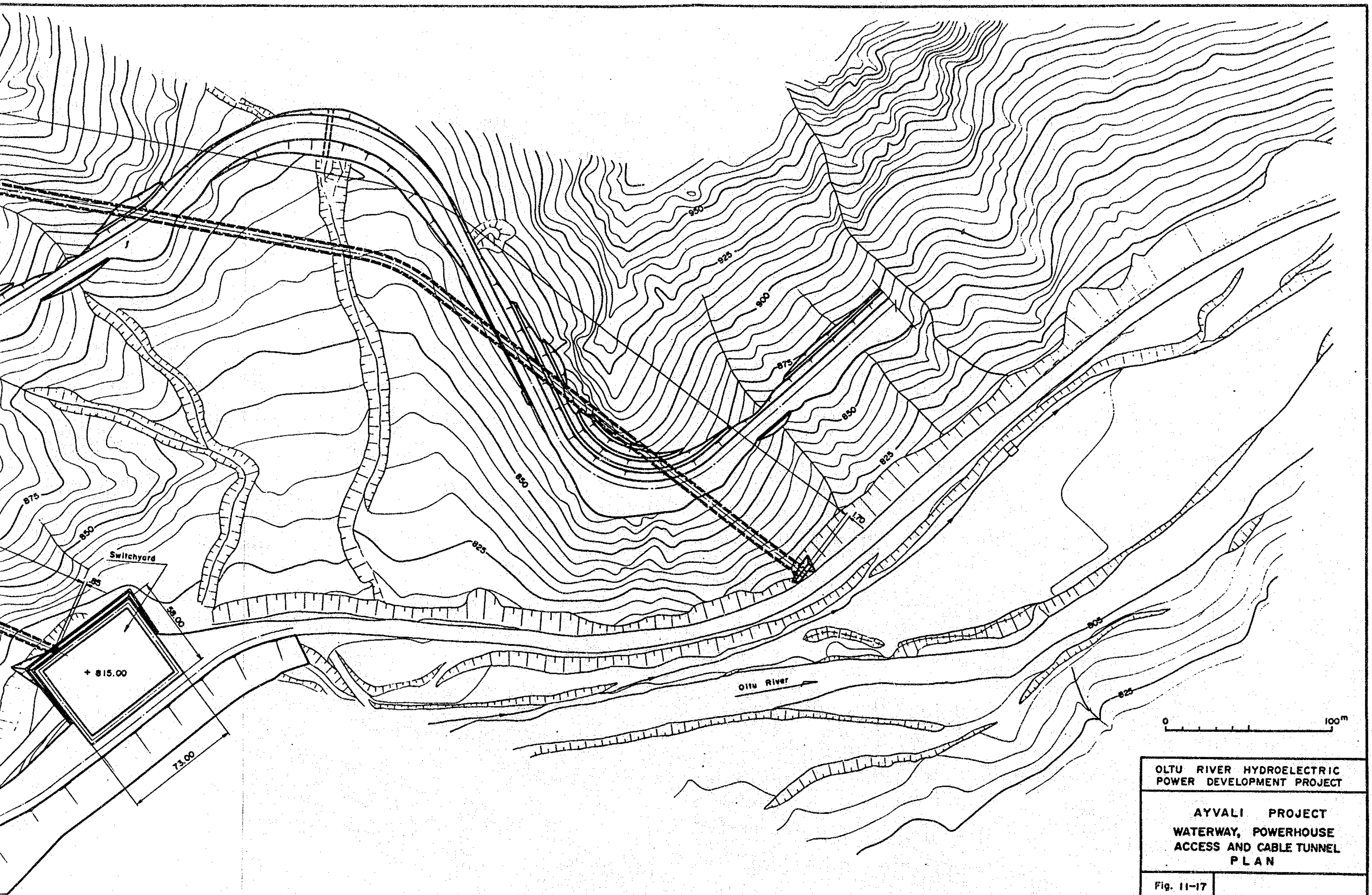
Fig. 11 - 16



N
Surge Chamber 120.00
Powerhouse
19.00
27.00
20.00
11.00
8.00
37.00
51.00
℄ of Unit
1.50
3.80
22.50
46.50
14.00
33.00
89.50
56.50
3.50
4.100
Penstock 209.00
Intake
1: 2.2
+ 935.00
1: 1.9
1100
1075
1050
1025
1000
975
950
925
900
875
850
825



Access Tunnel 1169.20
Cable Tunnel 674.46
Switchyard
+ 815.00
58.00
73.00
Oltu River
1100
1075
1050
1025
1000
975
950
925
900
875
850
825
5.00
4.00

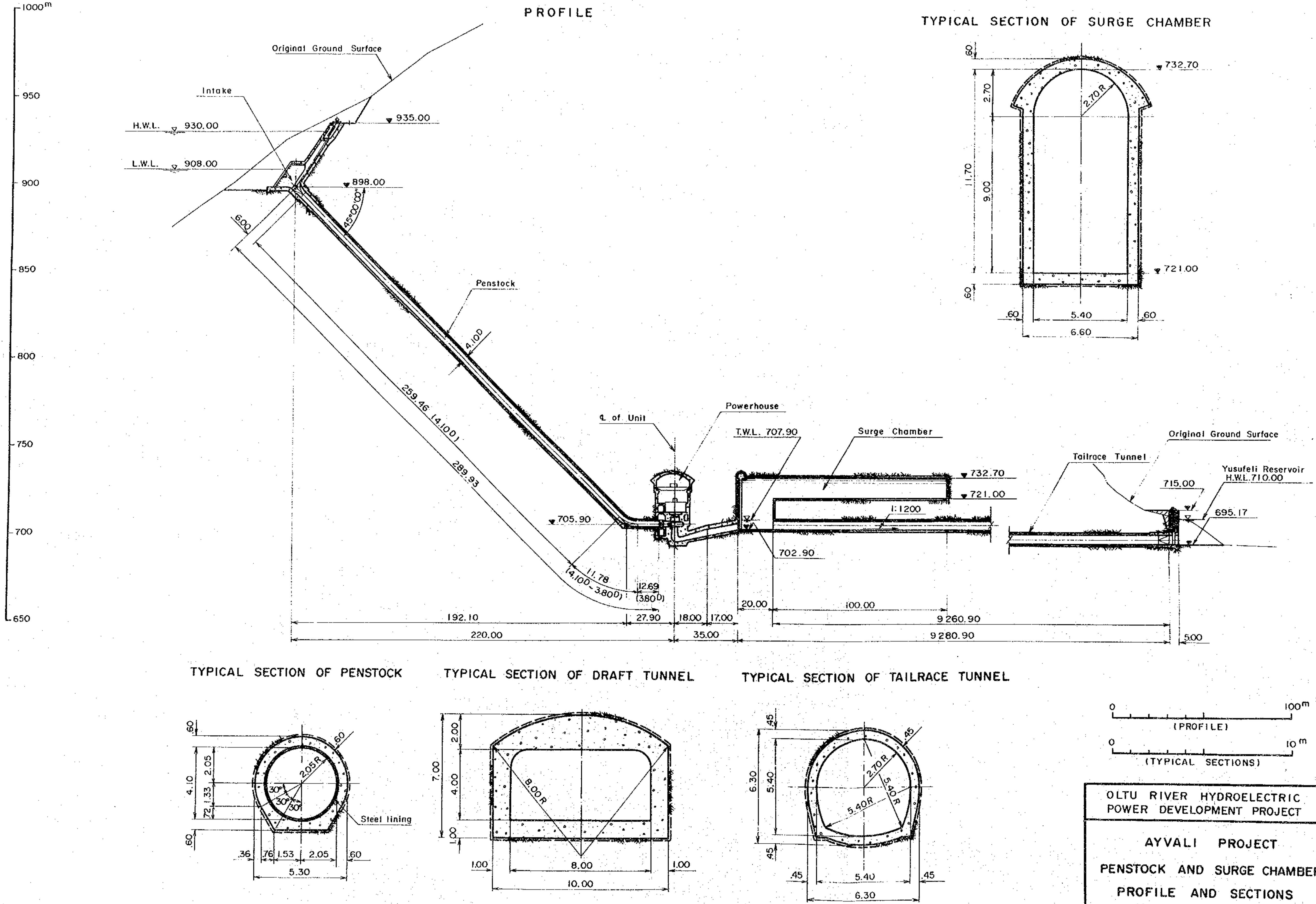


OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

AYVALI PROJECT

WATERWAY, POWERHOUSE ACCESS AND CABLE TUNNEL PLAN

Fig. 11-17

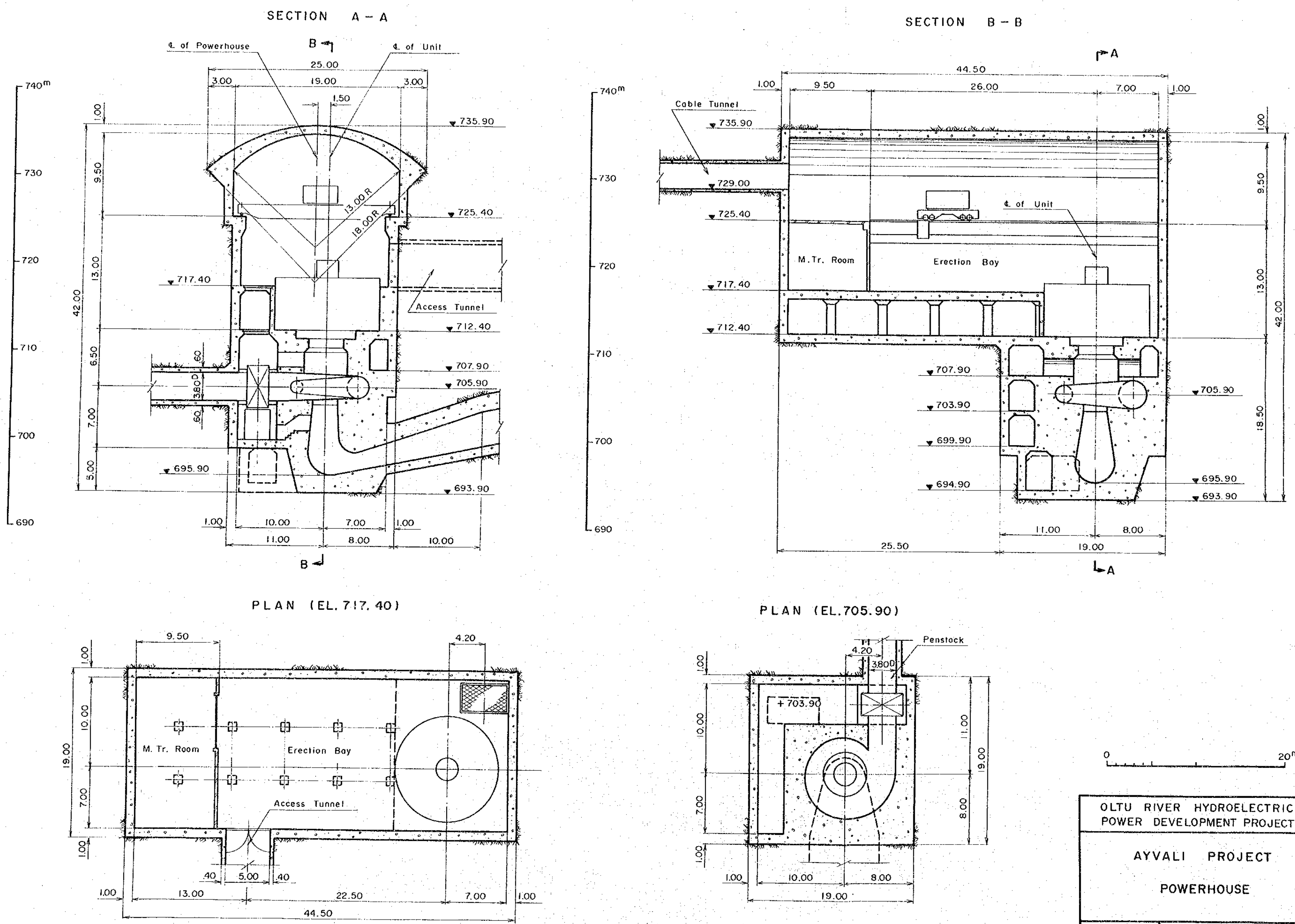


OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

AYVALI PROJECT

PENSTOCK AND SURGE CHAMBER PROFILE AND SECTIONS

Fig. 11-18

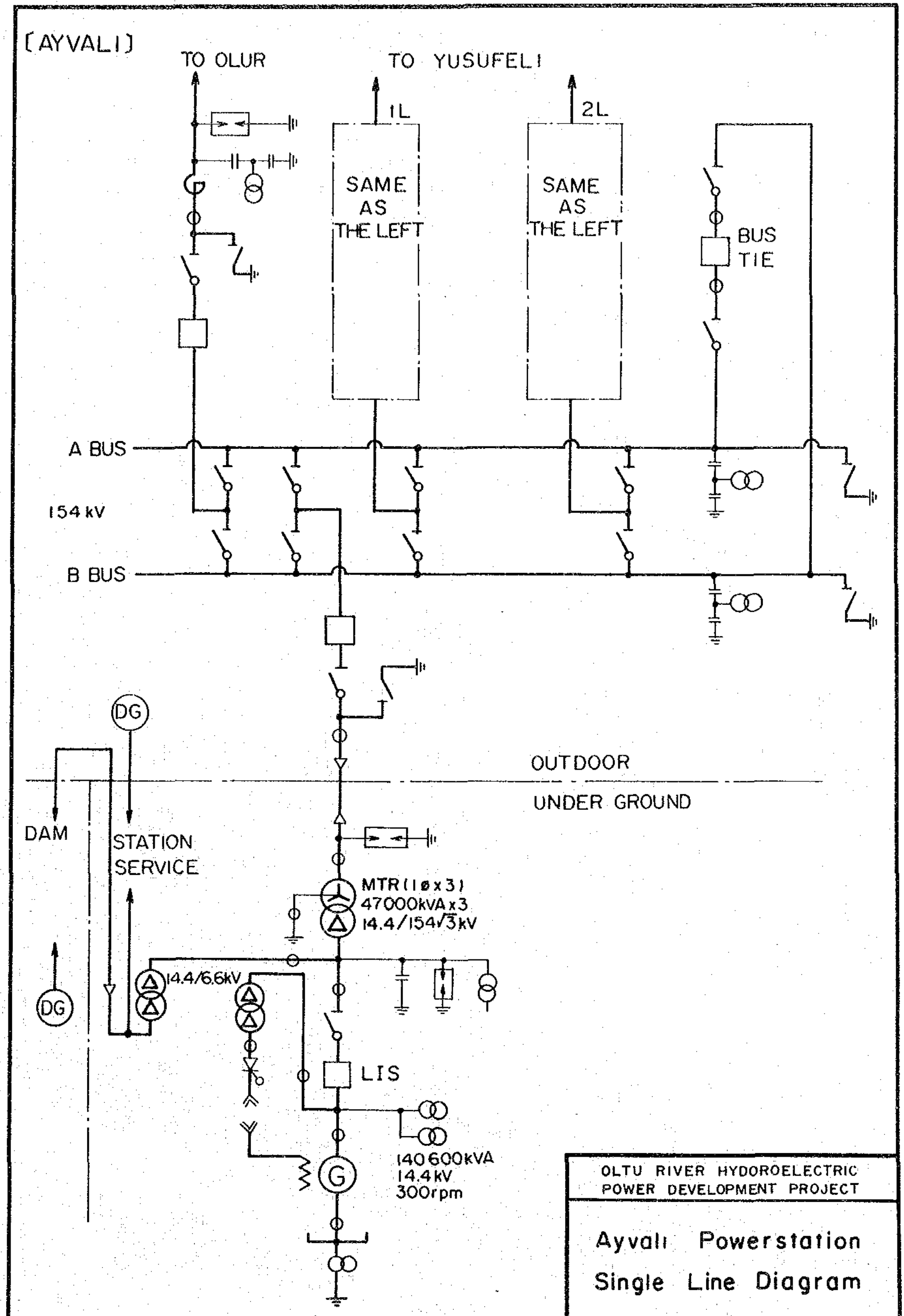


OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

AYVALI PROJECT

POWERHOUSE

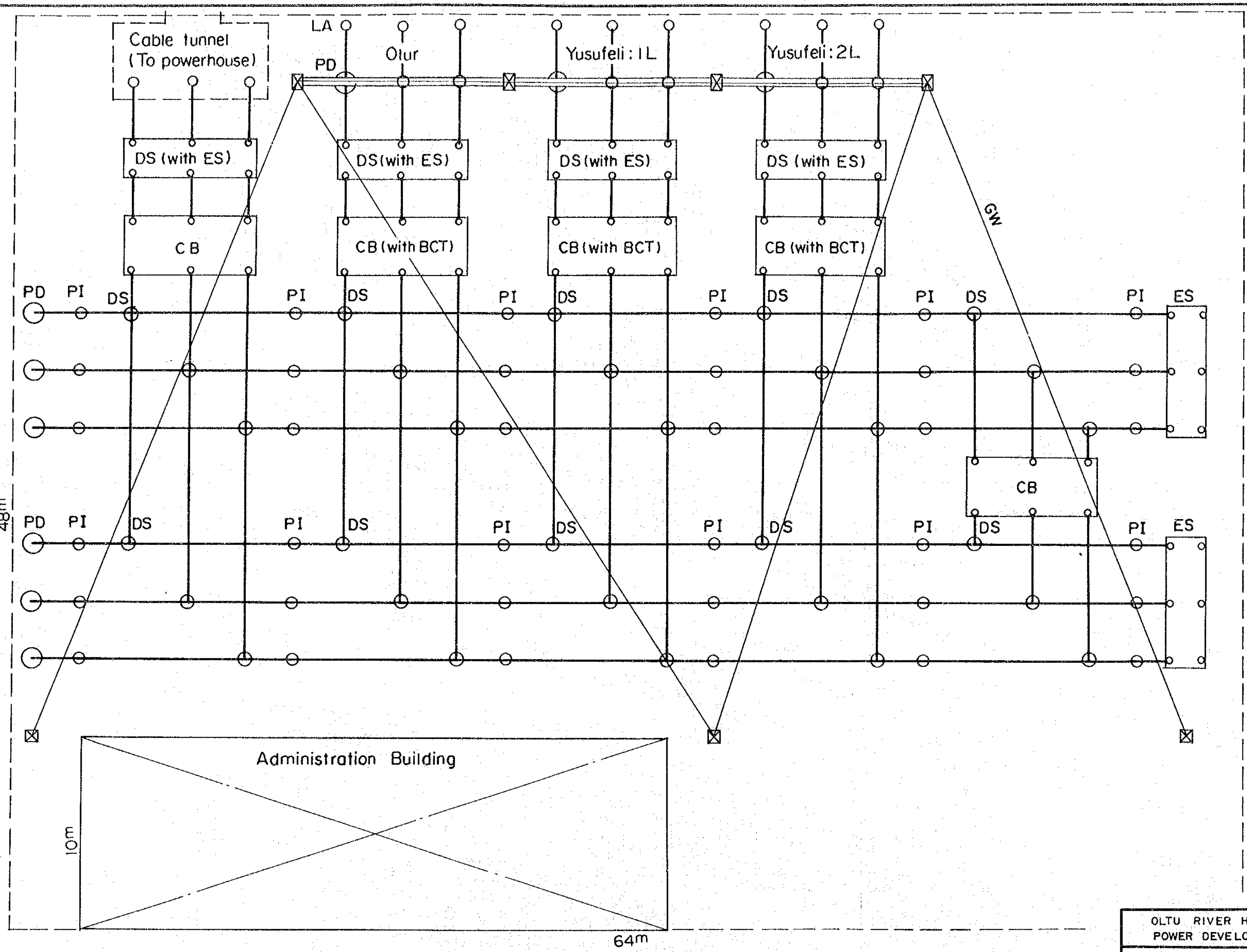
Fig. 11-19



OLTU RIVER HYDOROELECTRIC POWER DEVELOPMENT PROJECT

Ayvalı Powerstation Single Line Diagram

Fig. 11-20



Foot note: Inspection road and fence surrounding
the switchyard are not shown in this figure.

Legend

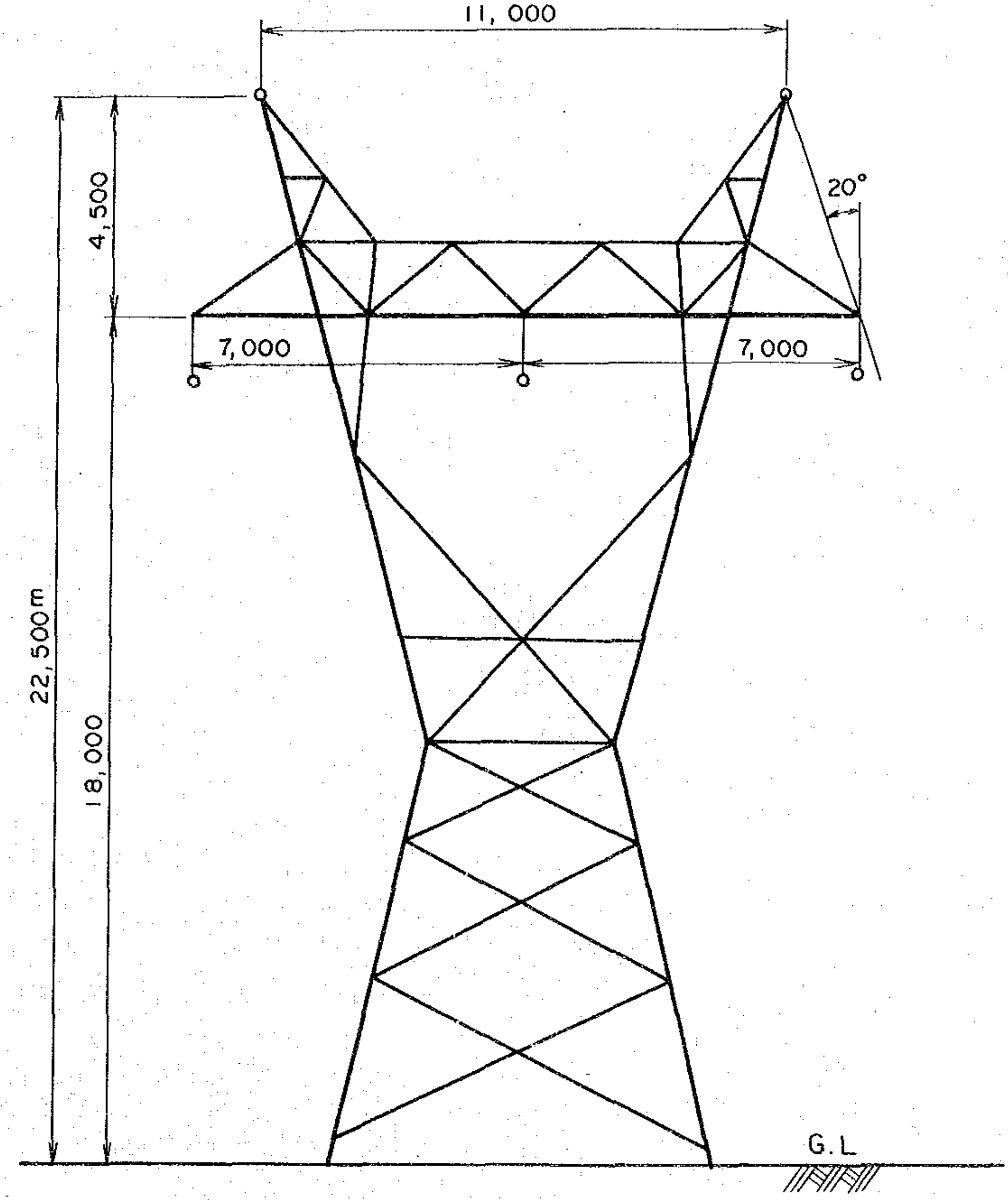
CB : Circuit Breaker
DS : Disconnecting Switch
LA : Lightening Arrester
PD : Potential Device
PI : Post Insulator
CH : Cable Head
ES : Earthing Switch
GW : Ground Wire
BCT : Bushing type Current Transformer

OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

Ayvali Powerstation Outdoor Switchyard Plan

Fig. 11-21

154 kV, 1 CCT, 636 MCMACSR + 70mm² GSW



SUSPENSION TOWER "SD" TYPE

OLTU RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

Standard Suspension Tower

Fig. 11-22

Chapter 12 CONSTRUCTION PROGRAM AND CONSTRUCTION COST

Chapter 12

CONSTRUCTION PROGRAM AND CONSTRUCTION COST

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Chapter 12 CONSTRUCTION PROGRAM AND CONSTRUCTION COST

12.1 Construction Program and Construction Schedule

The Oltu Project consists of the two hydroelectric power development projects of Olur Project and Ayvalı Project. Construction programs and construction schedules will be prepared separately for the two power stations.

12.1.1 Basic Conditions to Affect the Construction Program

Matters in common affecting the construction programs and construction schedules of the two projects are as described below.

(1) Meteorology

The meteorological conditions of this project area are as described in Chapter 6. The construction schedule was set up assuming that core embankment of the rockfill dam and placement of dam concrete would be possible 10 months out of a year, and that other types of work would be possible to perform throughout the year since snow cover is small in the area.

(2) Transportation

Transportation to the project site would be in the form of combinations of airway, ship, railway, and highway.

The nearest airports to the project site are at Trabzon and Erzurum, while the nearest sea cargo landing ports are at Trabzon and Hopa. The nearest railway stations are at Erzurum and Kars.

The roads leading from these nearest points to the project site are shown in Fig. 12-1. From Trabzon and Hopa, the confluence of the Oltu River and the Tortum River is reached via Artvin and Yusufeli by National Highways No. 060 and No. 950, from where the project site is reached by National Highway No. 060.

From the Kars District, the project site is reached by National Highway No. 060 going via Göle.

From the Erzurum District, National Highway No. 950 is taken, and going via Tortum, the confluence of the Tortum and Oltu Rivers is reached, from where the project site is reached similarly by National Highway No. 060.

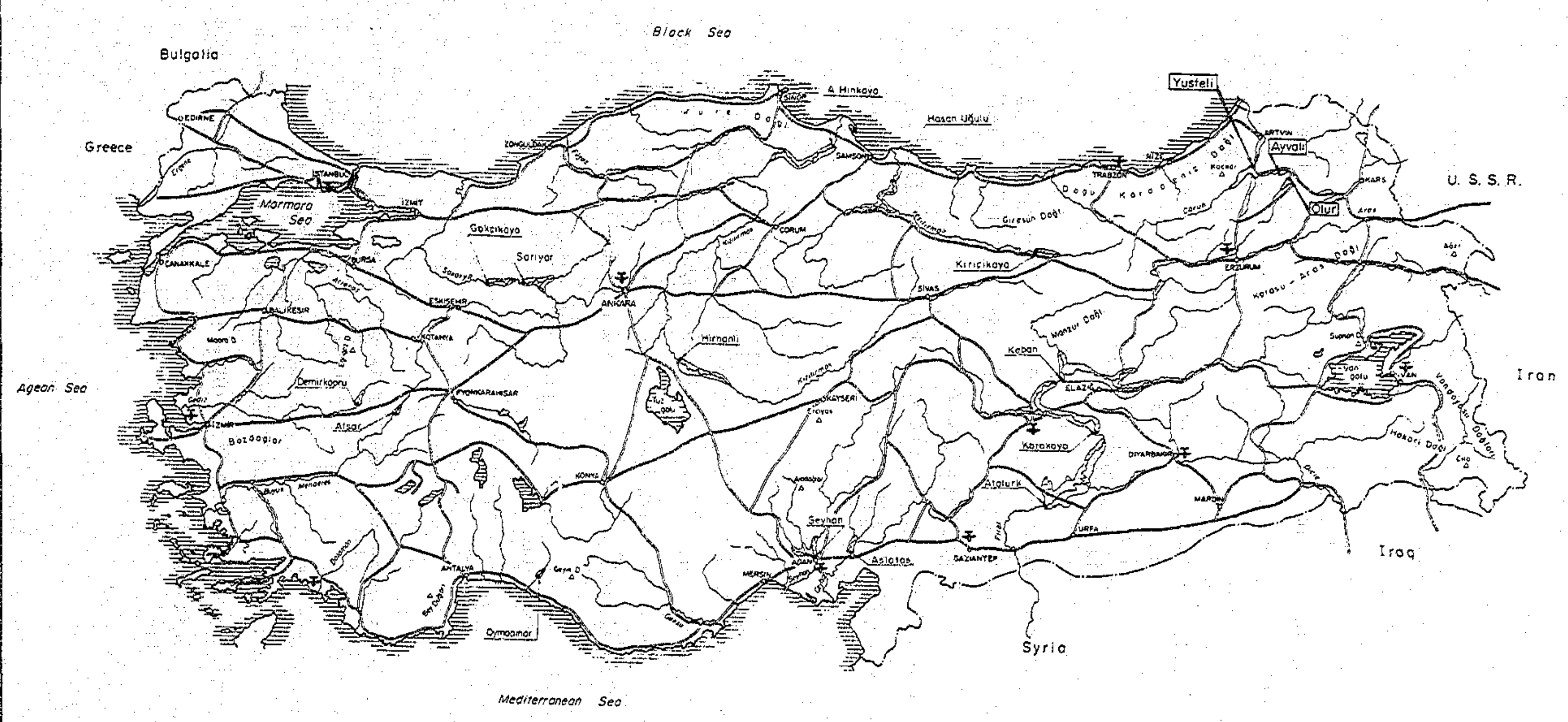

Fig. 12-1 Transportation Route

(3) Construction Materials

1) Cement

The two cement plants at Kars (approximately 170 km from the dam site, approximately 190 km from Ayvalı) and Erzurum (approximately 170 km from Ayvalı, approximately 170 km from Olur) would be the main sources of supply of cement.

2) Steel

Principal steel materials such as reinforcement and structural steel would be supplied mainly from the plant at Iskenderun (approximately 1,050 km from the Oltu project site) or Karabük (approximately 1,110 km from the Oltu project site).

3) Aggregates

Aggregates would be made on collecting sand-gravel excavated from the river-bed at Olur Dam or Ayvalı Dam, and from river-bed sand-gravel distributed upstream and downstream of the two dams.

4) Embankment Materials

(a) Olur Dam

Imperious core materials would be collected from the tableland formed by fan deposits in the vicinity of Kaledibi village at the upstream left bank of the dam, and from Yolboyu village. Those materials would be transported to the dam site for embankment.

Of filter materials, fine filter is to be excavated river-bed sand-gravel used in river-run from or upon classification for embankment of the dam. Coarse filter is to be embanked using river-bed sand-gravel and comparatively fine-particled excavation muck.

Rock materials would be rock excavation muck and rock collected from a quarry planed at the right bank downstream of the dam, transported, and banked.

(b) Ayvalı Dam

Impervious core materials would be materials deposited at the Bulanik Valley at the right bank 8 km downstream from the dam and at the Tavusker Valley (approximately 7 km from the dam) which merges with the Oltu at the right bank 3 km upstream of the dam, and upon transportation and stockpiling, they are to be blended to manufacture the required material, and then used for embankment of the dam.

Of filter materials, fine filter is to be unscreened excavated river-bed sand-gravel or upon classification for embankment of the dam. Coarse filter is to be excavated river-bed sand-gravel and comparatively fine material out of excavated muck used for embankment.

Rock materials are to be supplied from excavated muck and a quarry at the upstream left bank of the dam.

(4) Electric Power for Construction

Electric power for construction would be supplied branching from a transmission line (34.5 kV) which passes by the two project sites.

(5) Hydraulic Equipment

Hydraulic equipment excepting steel penstock pipes and steel conduits are to be fabricated in the vicinity of Istanbul, transported by sea to Hopa and then hauled overland from Hopa to Oltu by trailer, or is to be transported all the way overland from Istanbul (or other factory locale) to Oltu.

For steel penstock pipes and steel conduits a temporary plant is to be constructed in the field, where manufacturing is to be done, with installation carried out at the specified places.

(6) Electrical Equipment

The principal items of electrical equipment are to be manufactured overseas and landed at Hopa Port or Trabzon Port, from where they would be transported by trailer for installation at the powerhouses.

12.1.2 Construction Program and Construction Schedule

If the starts of operation of the two projects are set for the year 2006, it will be necessary for preparations to be made for start of construction more or less according to the schedule below.