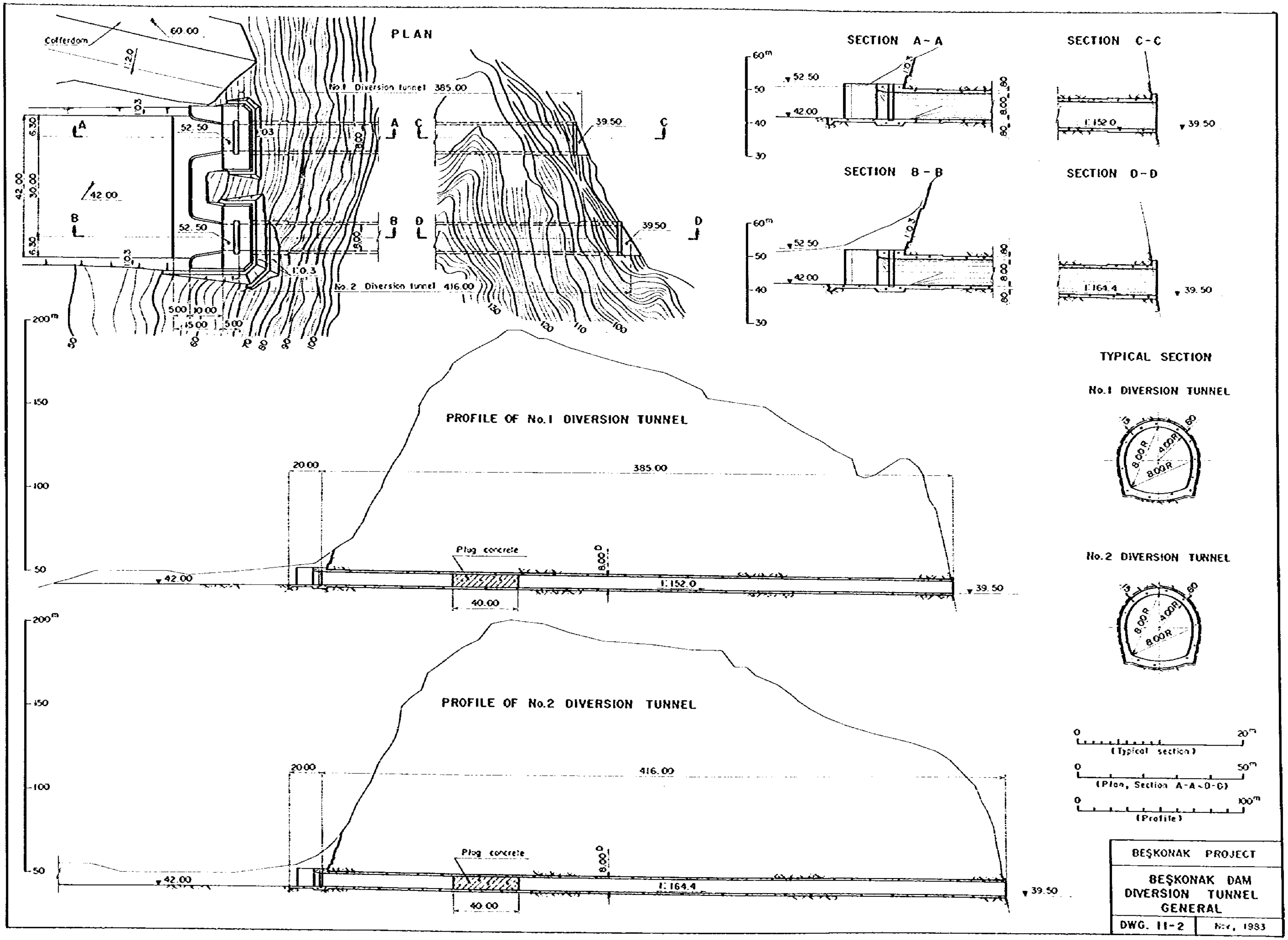
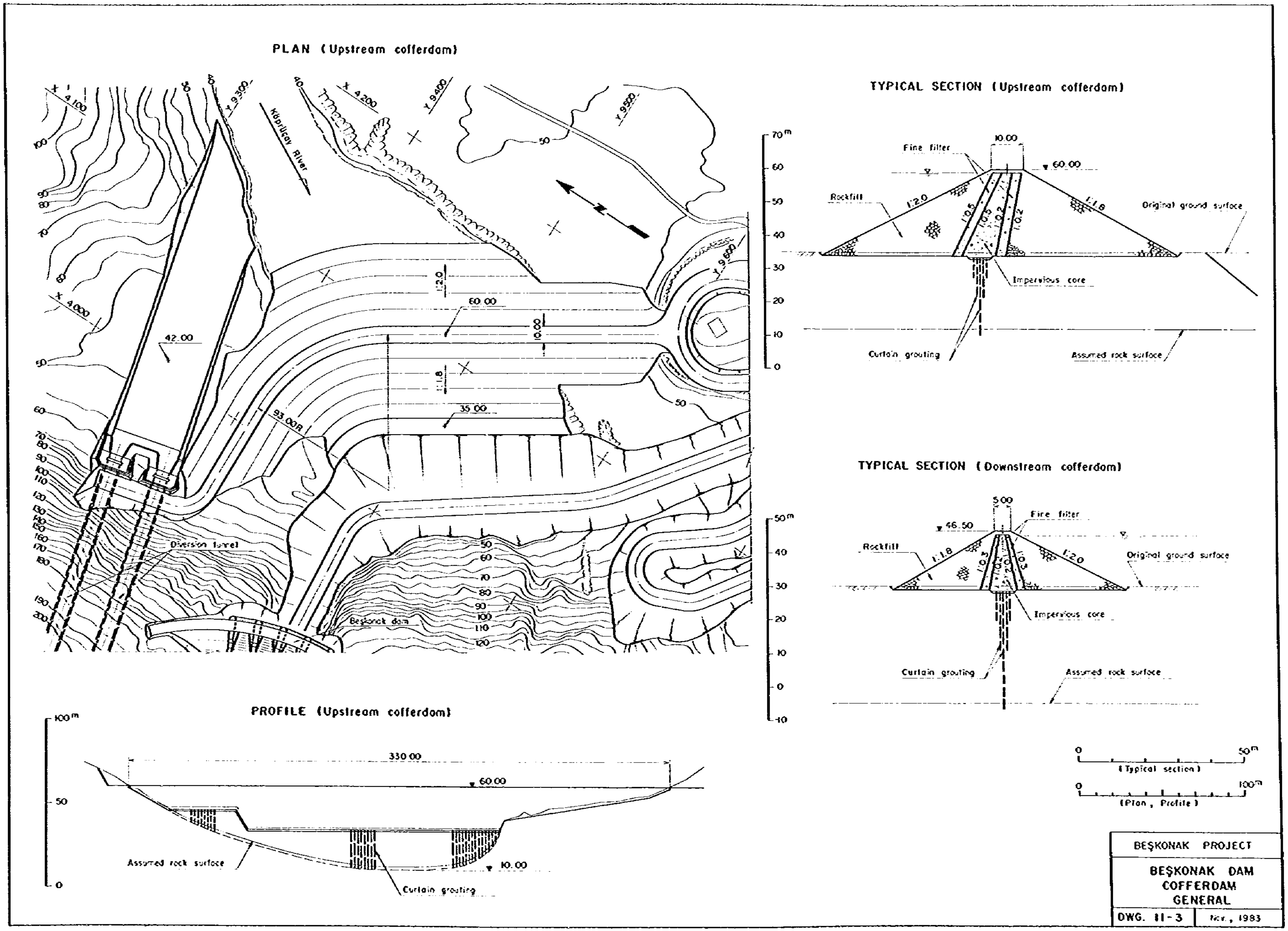
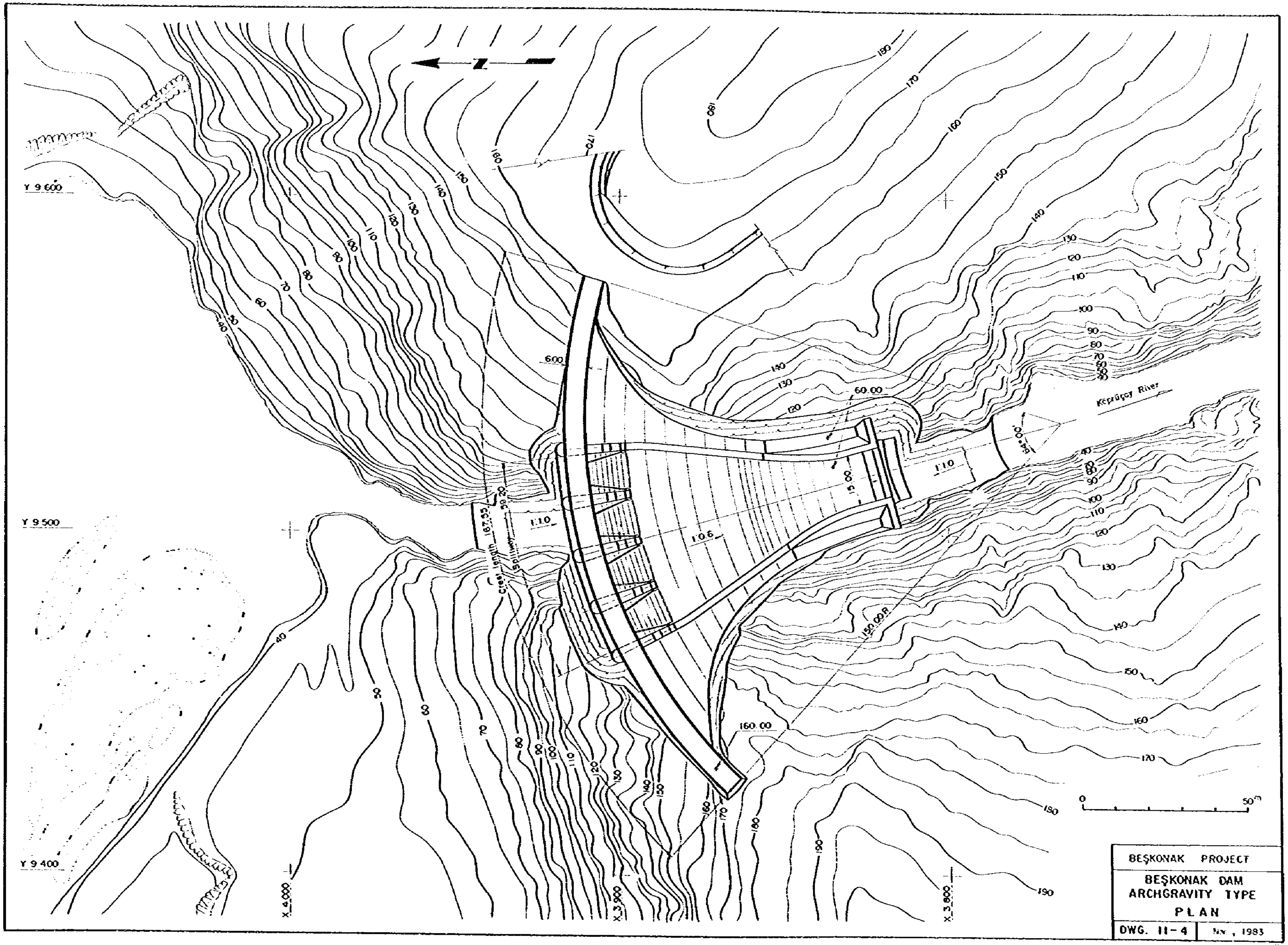
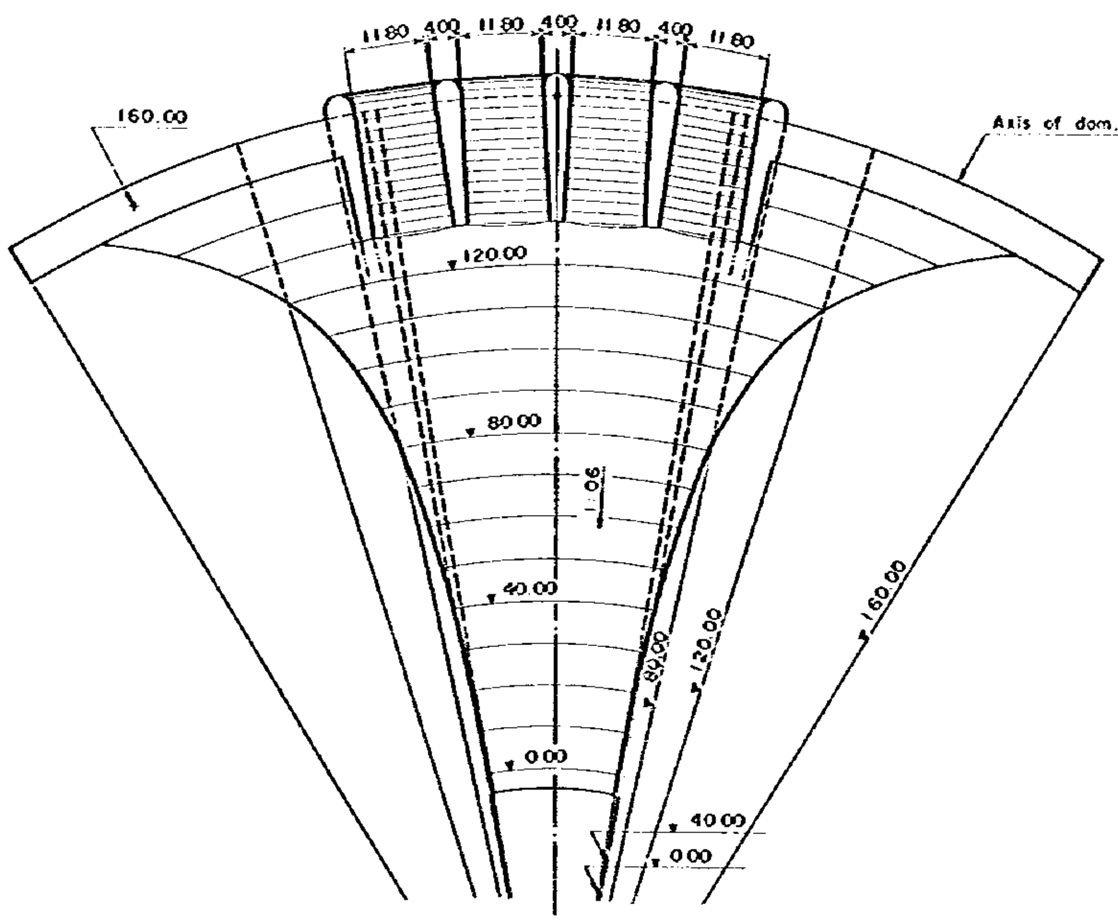

PLAN
Cofferdom
60.00
1:2.0
No.1 Diversion tunnel 385.00
No.2 Diversion tunnel 416.00
1:0.3
52.50
42.00
39.50
5.00 10.00
15.00 5.00
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
52.50
42.00
1:152.0
1:164.4
39.50
TYPICAL SECTION
No.1 DIVERSION TUNNEL
No.2 DIVERSION TUNNEL
8.00R
4.00R
PROFILE OF No.1 DIVERSION TUNNEL
PROFILE OF No.2 DIVERSION TUNNEL
20.00
385.00
416.00
Plug concrete
40.00
8.00D
(Typical section)
(Plan, Section A-A~D-D)
(Profile)
BEŞKONAK PROJECT
BEŞKONAK DAM
DIVERSION TUNNEL
GENERAL
DWG. 11-2
Nov, 1983

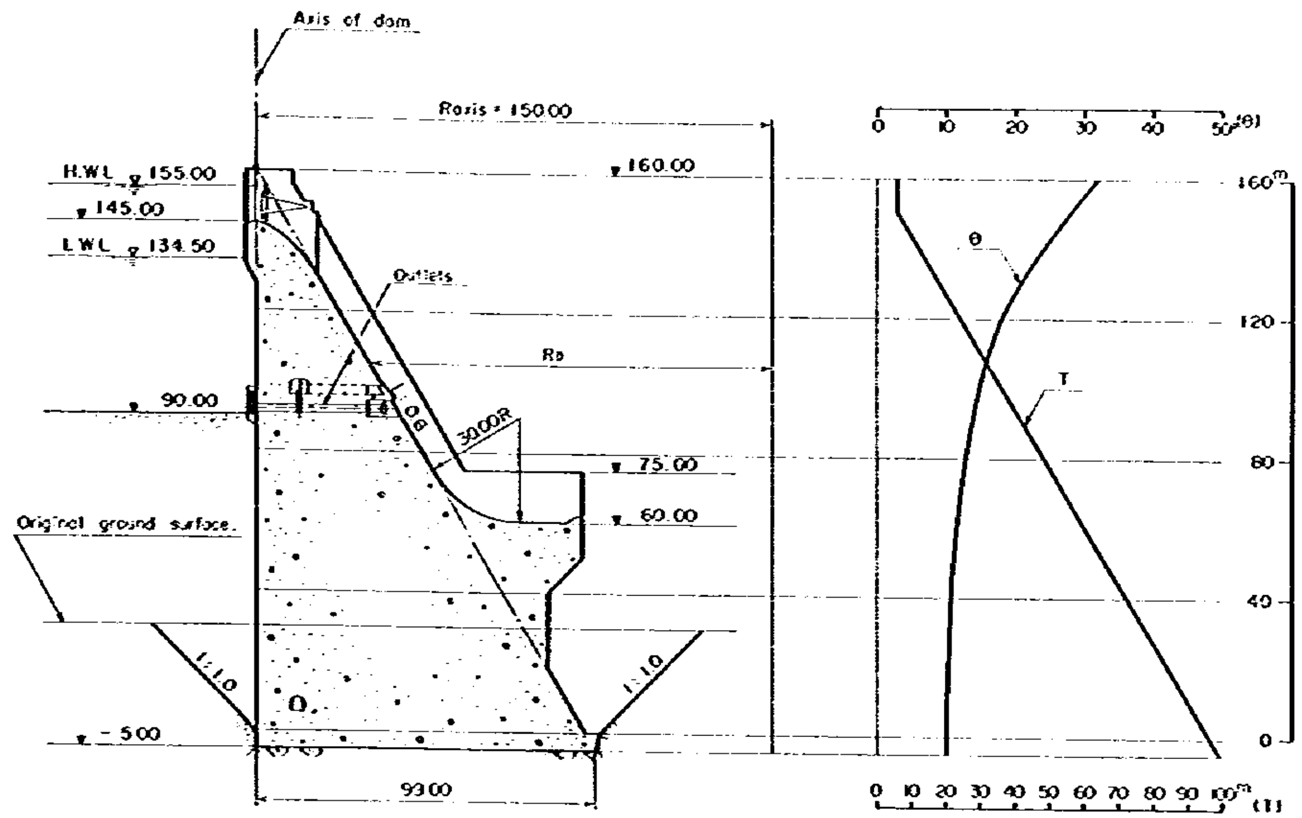

PLAN (Upstream cofferdam)
Köprüçay River
Diversion tunnel
Beşkonak dam
42.00
60.00
35.00
93.00R
10.00
1:2.0
1:1.8
TYPICAL SECTION (Upstream cofferdam)
10.00
Fine filter
60.00
Rockfill
1:2.0
1:0.5
1:0.2
1:1.8
Original ground surface
Impervious core
Curtain grouting
Assumed rock surface
TYPICAL SECTION (Downstream cofferdam)
5.00
Fine filter
46.50
Rockfill
1:1.8
1:2.0
1:0.3
Original ground surface
Impervious core
Curtain grouting
Assumed rock surface
PROFILE (Upstream cofferdam)
330.00
60.00
10.00
Assumed rock surface
Curtain grouting
(Typical section)
(Plan, Profile)
BEŞKONAK PROJECT
BEŞKONAK DAM
COFFERDAM
GENERAL
DWG. II-3
Nov., 1983


BEŞKONAK PROJECT
BEŞKONAK DAM
ARCHGRAVITY TYPE
PLAN
DWG. 11-4
Nv., 1983
Köprüçay River
Crest length 167.55
(Spillway 30.20)
60.00
160.00
150.00 R
15.00
1:1.0
1:0.6
Y 9.600
Y 9.500
Y 9.400
X 4.000
X 3.900
X 3.800
0
50m

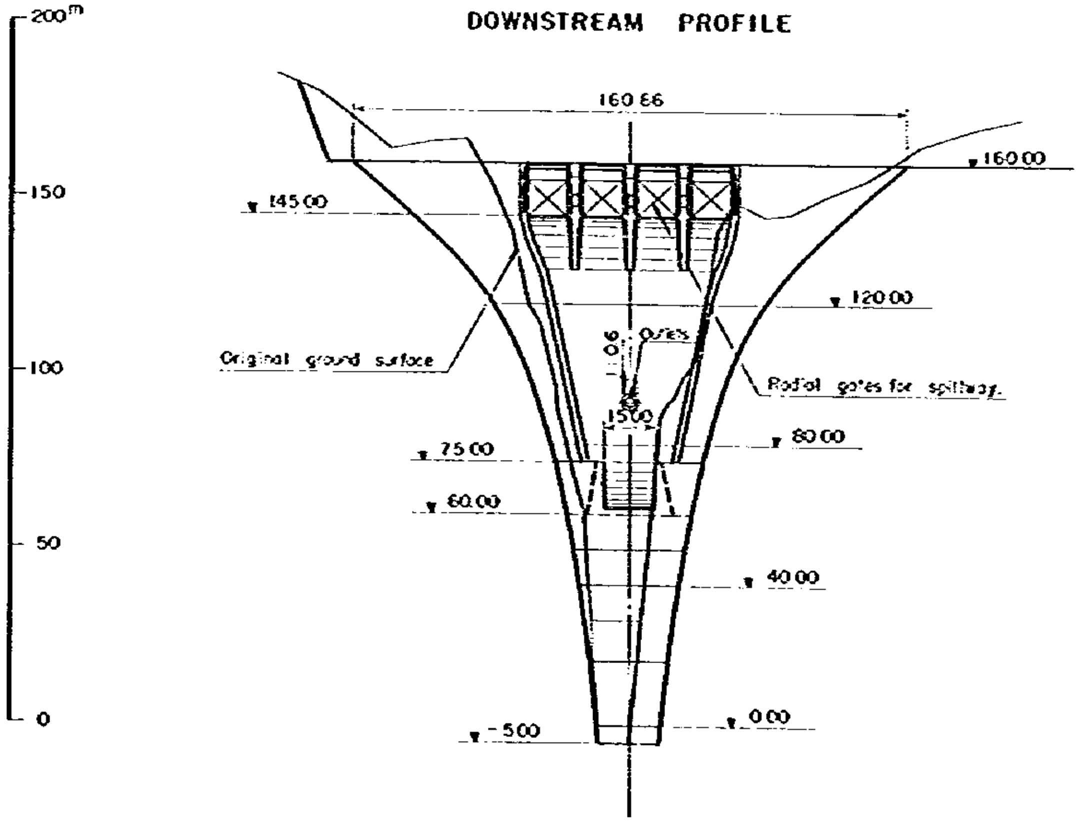
PLAN



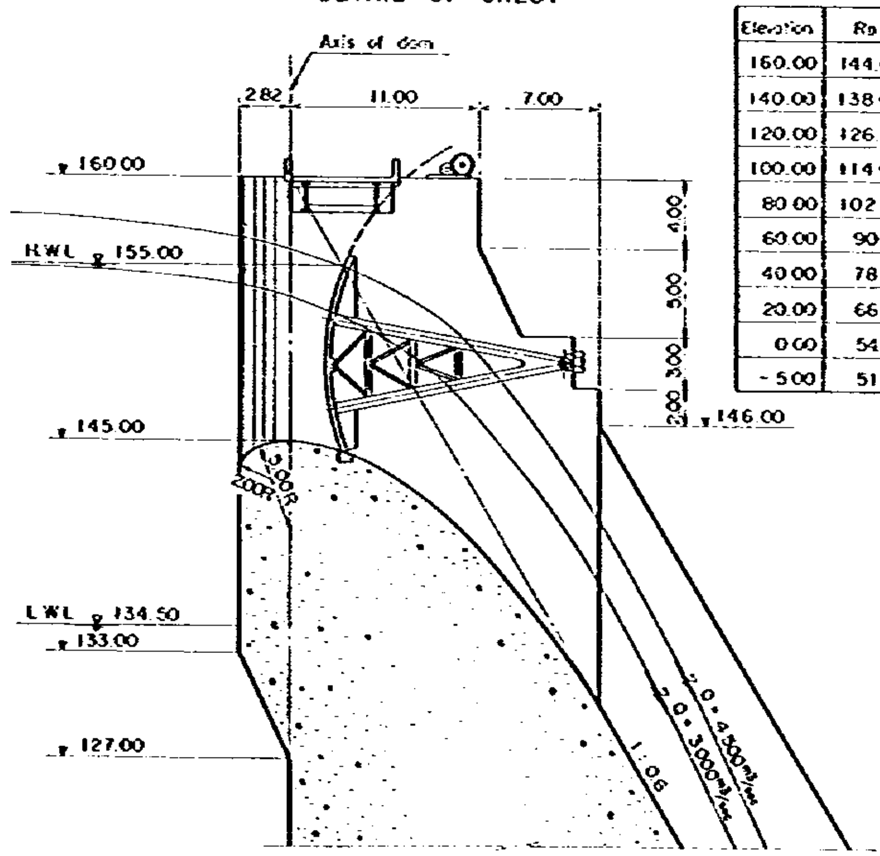
TYPICAL SECTION OF DAM AND GEOMETRICAL DATA DIAGRAM



DOWNSTREAM PROFILE

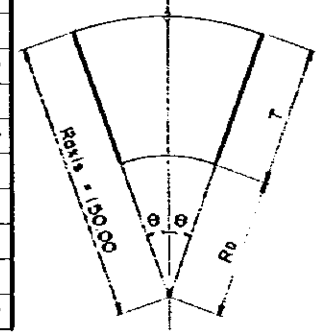


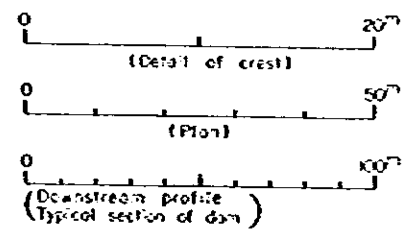
DETAIL OF CREST



GEOMETRICAL DATA

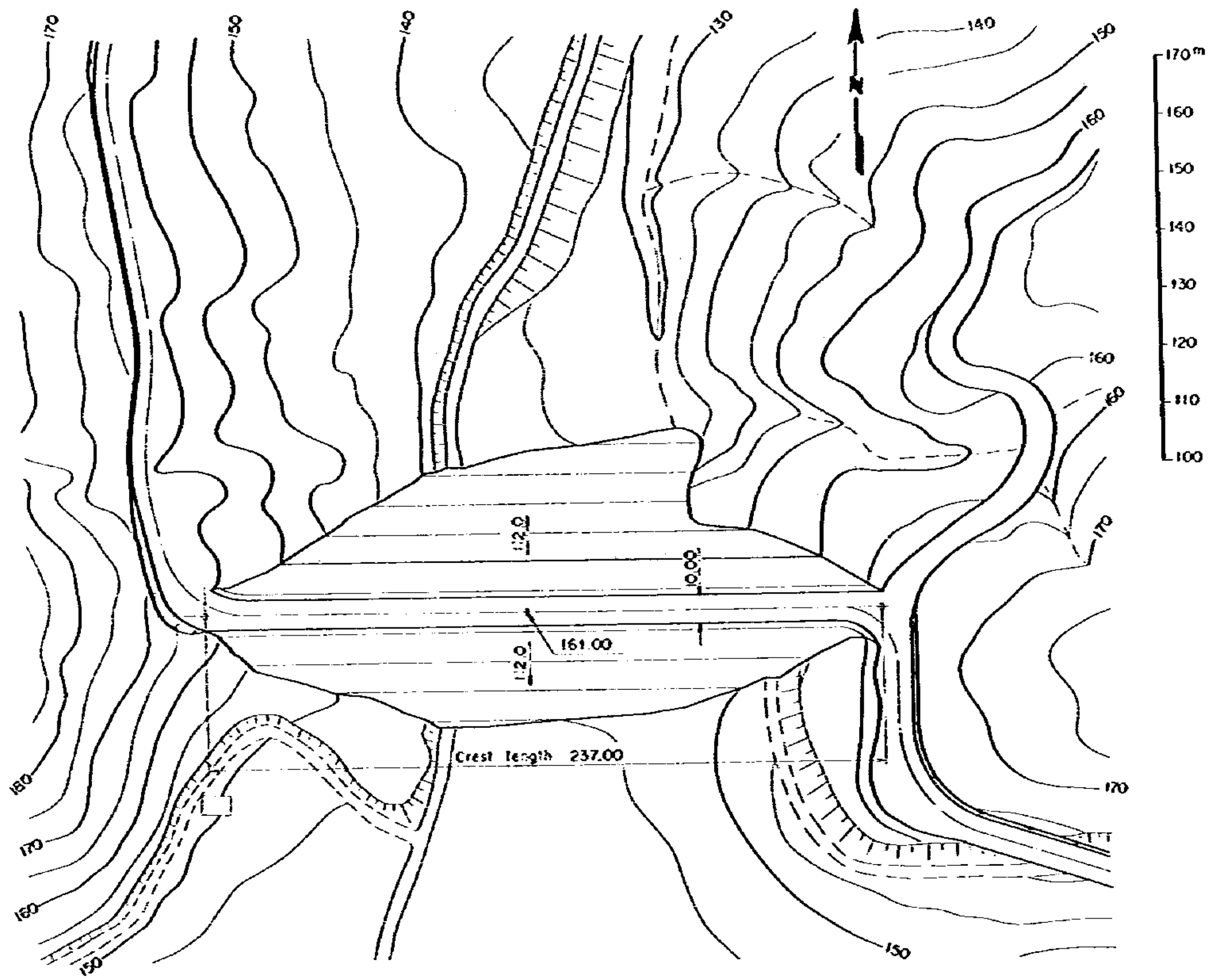
Elevation	Rp	T	θ
160.00	144.00	6.00	32°00'
140.00	138.00	12.00	23°50'
120.00	126.00	24.00	16°00'
100.00	114.00	36.00	14°45'
80.00	102.00	48.00	12°50'
60.00	90.00	60.00	11°40'
40.00	78.00	72.00	10°45'
20.00	66.00	84.00	10°15'
0.00	54.00	96.00	10°00'
-5.00	51.00	99.00	9°55'



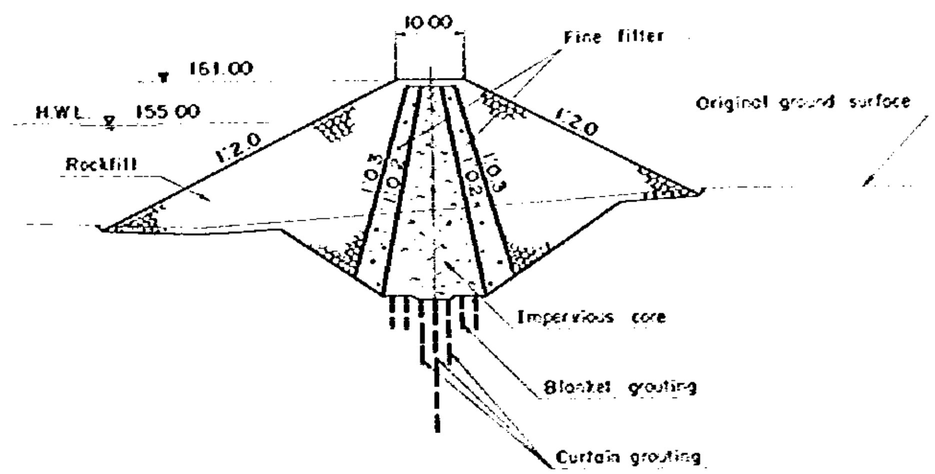


BEŞKONAK PROJECT	
BEŞKONAK DAM ARCHGRAVITY TYPE PLAN, PROFILE & SECTION	
DWG. 11-5	Nov., 1983

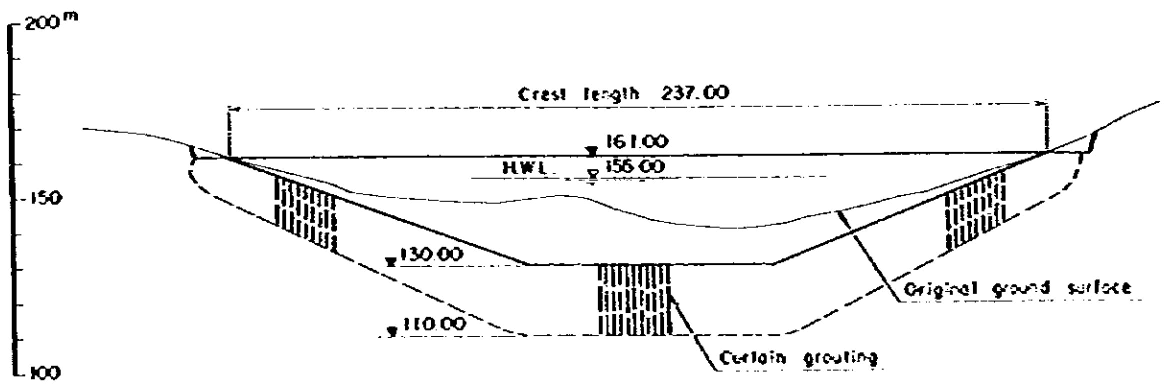
PLAN

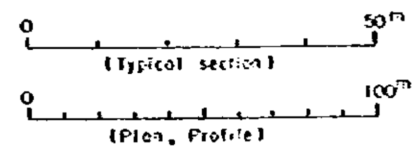


TYPICAL SECTION

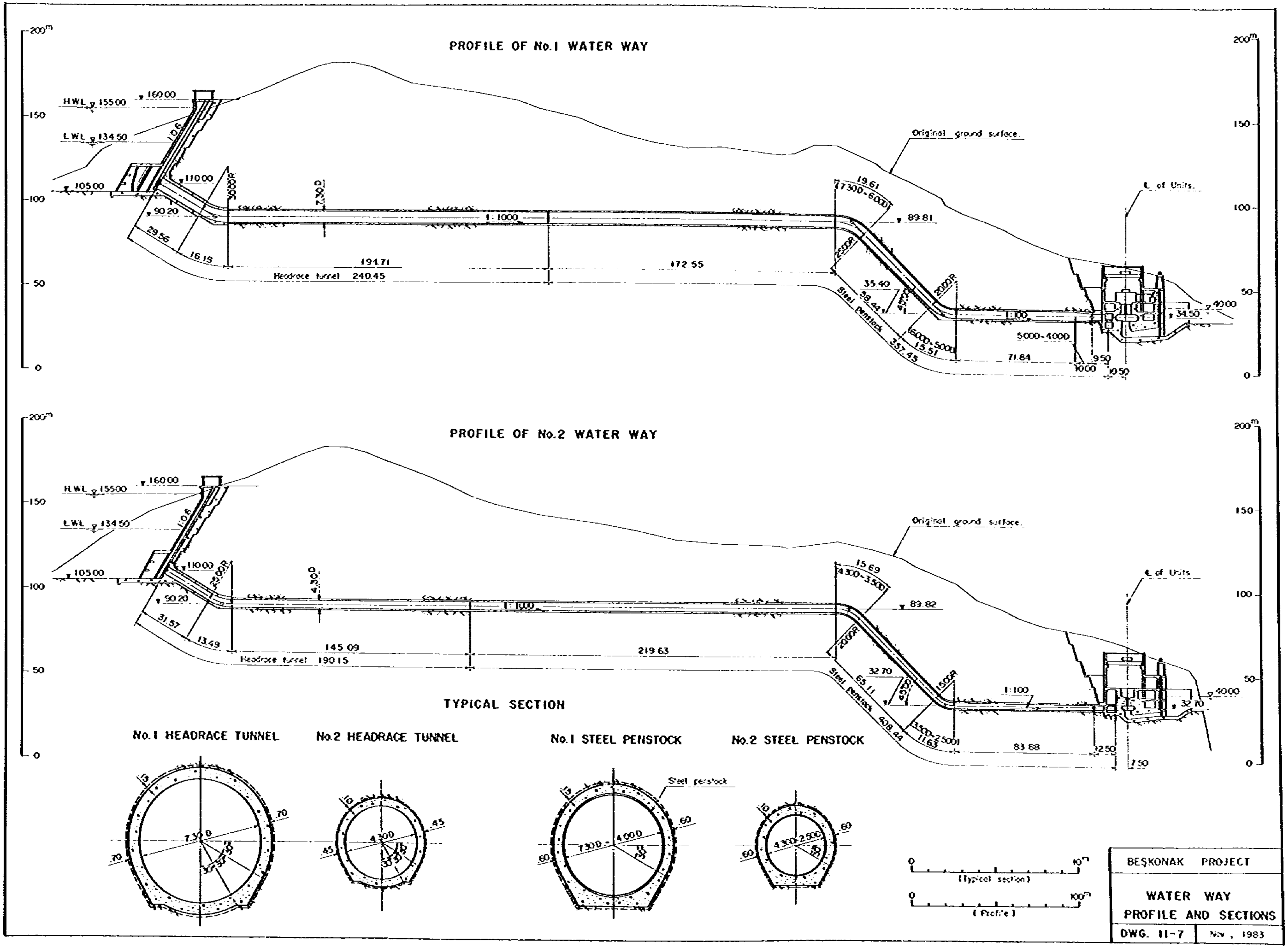


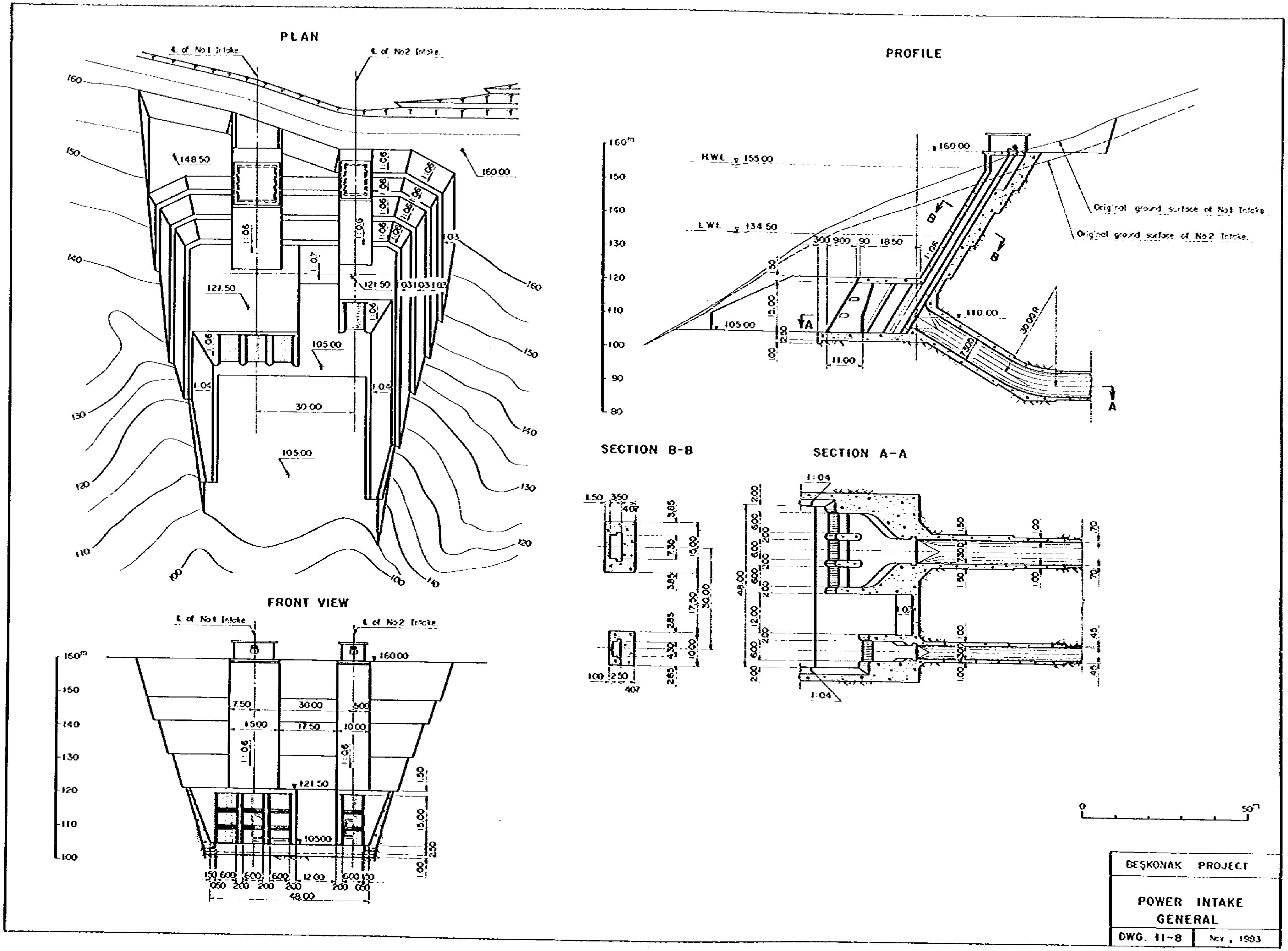
PROFILE

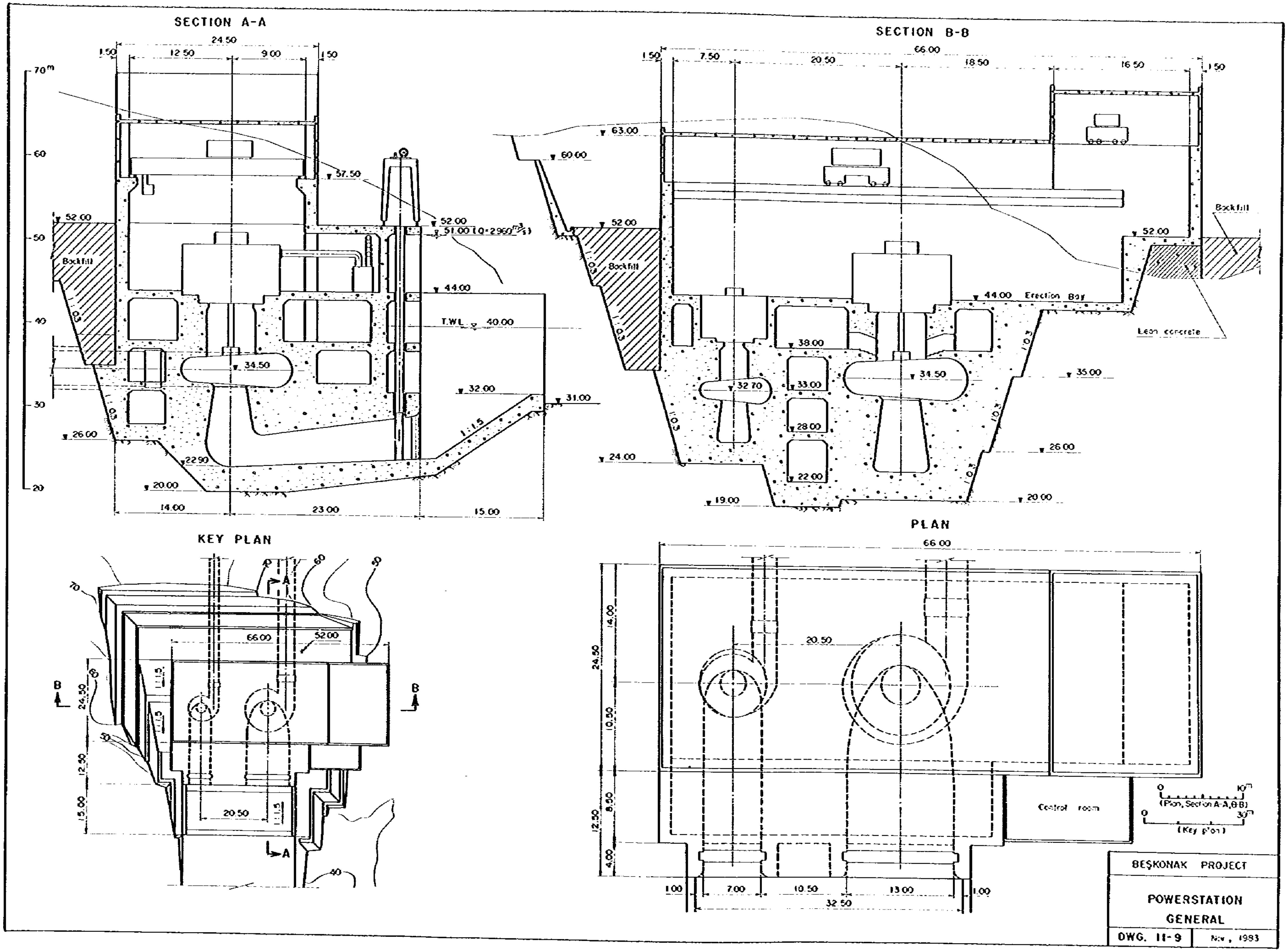


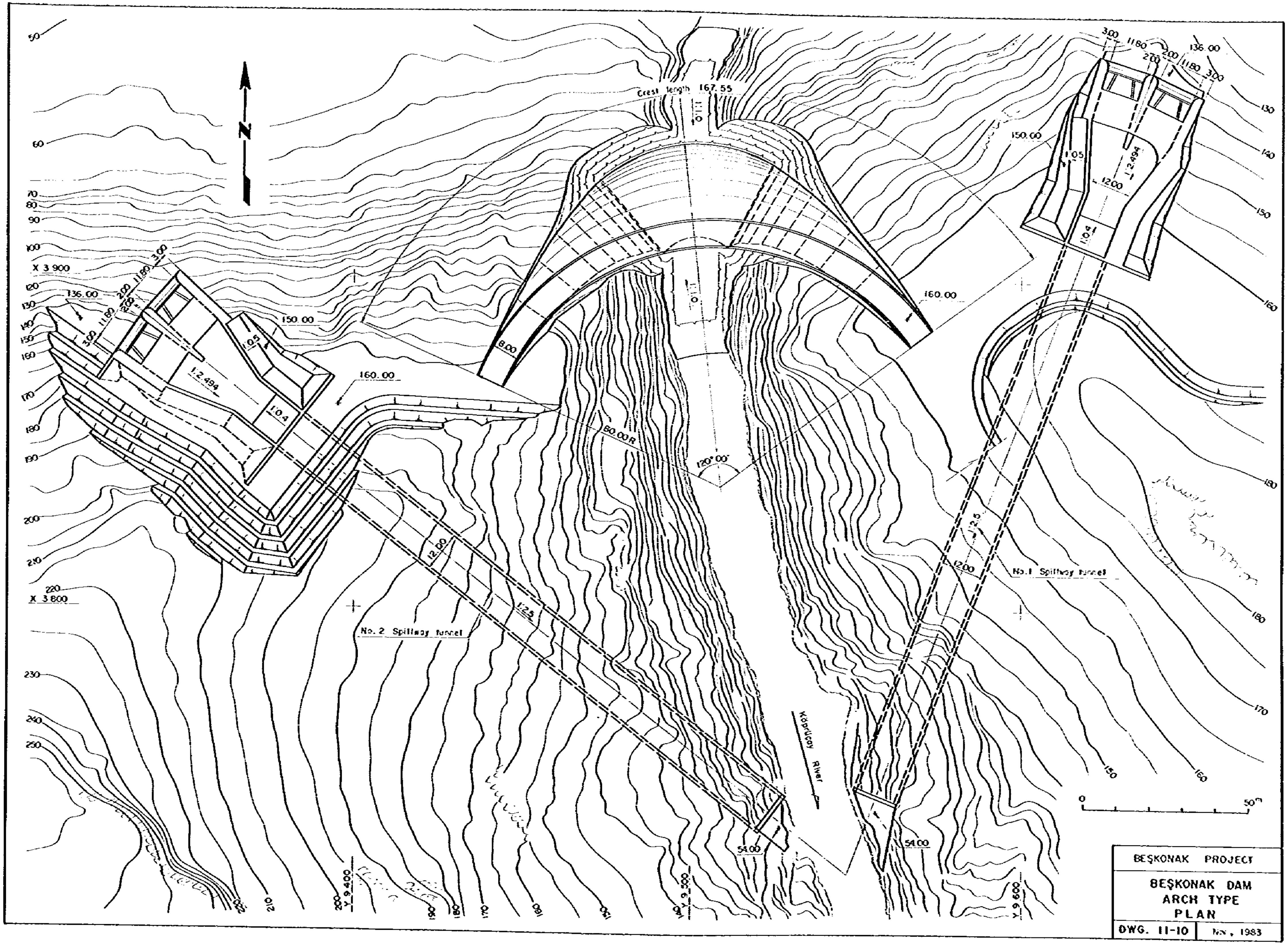


BEŞKONAK PROJECT	
SECONDARY DAM GENERAL	
DWG. 11-6	Nov., 1983

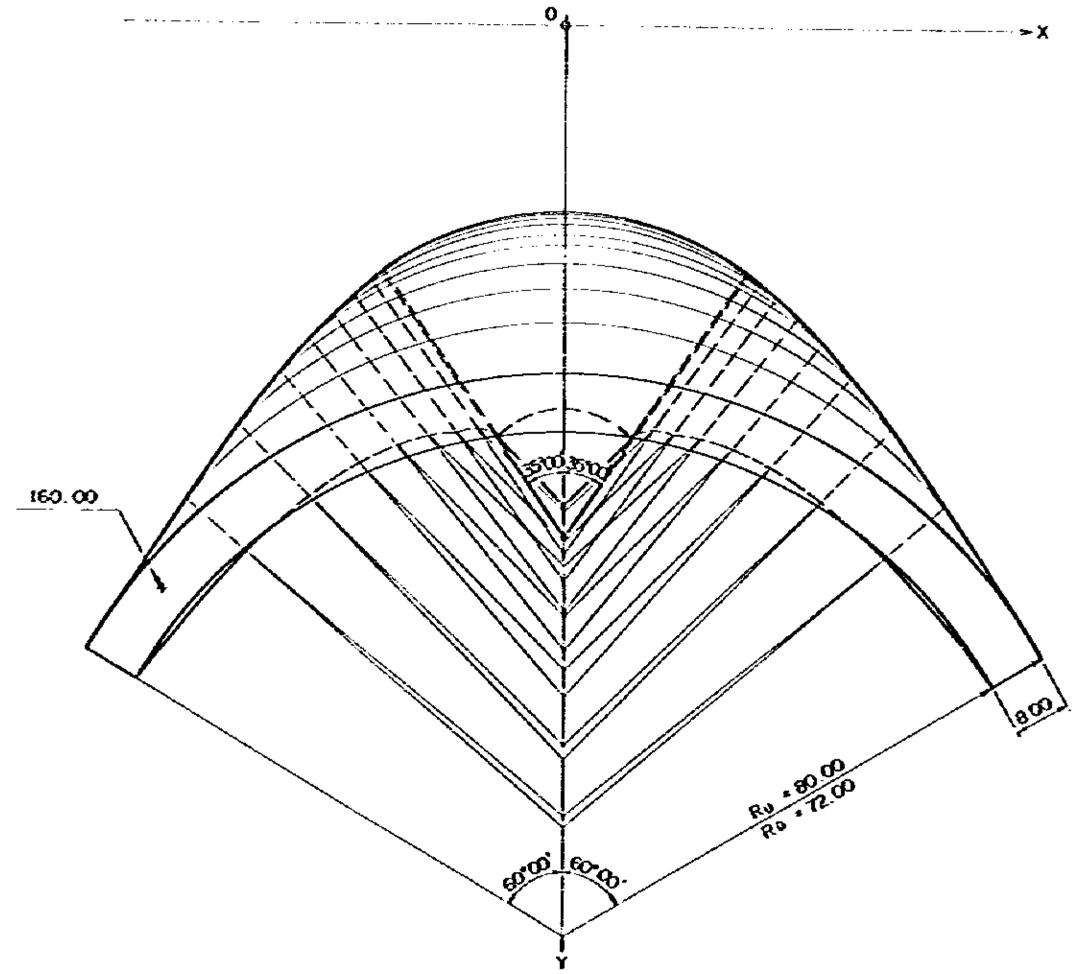

PROFILE OF No.1 WATER WAY
Original ground surface
℄ of Units
Headrace tunnel 240.45
Steel penstock 357.45
PROFILE OF No.2 WATER WAY
Original ground surface
℄ of Units
Headrace tunnel 190.15
Steel penstock 408.44
TYPICAL SECTION
No.1 HEADRACE TUNNEL
No.2 HEADRACE TUNNEL
No.1 STEEL PENSTOCK
No.2 STEEL PENSTOCK
Steel penstock
(Typical section)
(Profile)
BEŞKONAK PROJECT
WATER WAY
PROFILE AND SECTIONS
DWG. II-7
Nov., 1983


PLAN
PROFILE
FRONT VIEW
SECTION B-B
SECTION A-A
℄ of No1 Intake
℄ of No2 Intake
H.W.L. 155.00
L.W.L. 134.50
Original ground surface of No1 Intake
Original ground surface of No2 Intake
BEŞKONAK PROJECT
POWER INTAKE
GENERAL
DWG. II-8
Nov, 1983

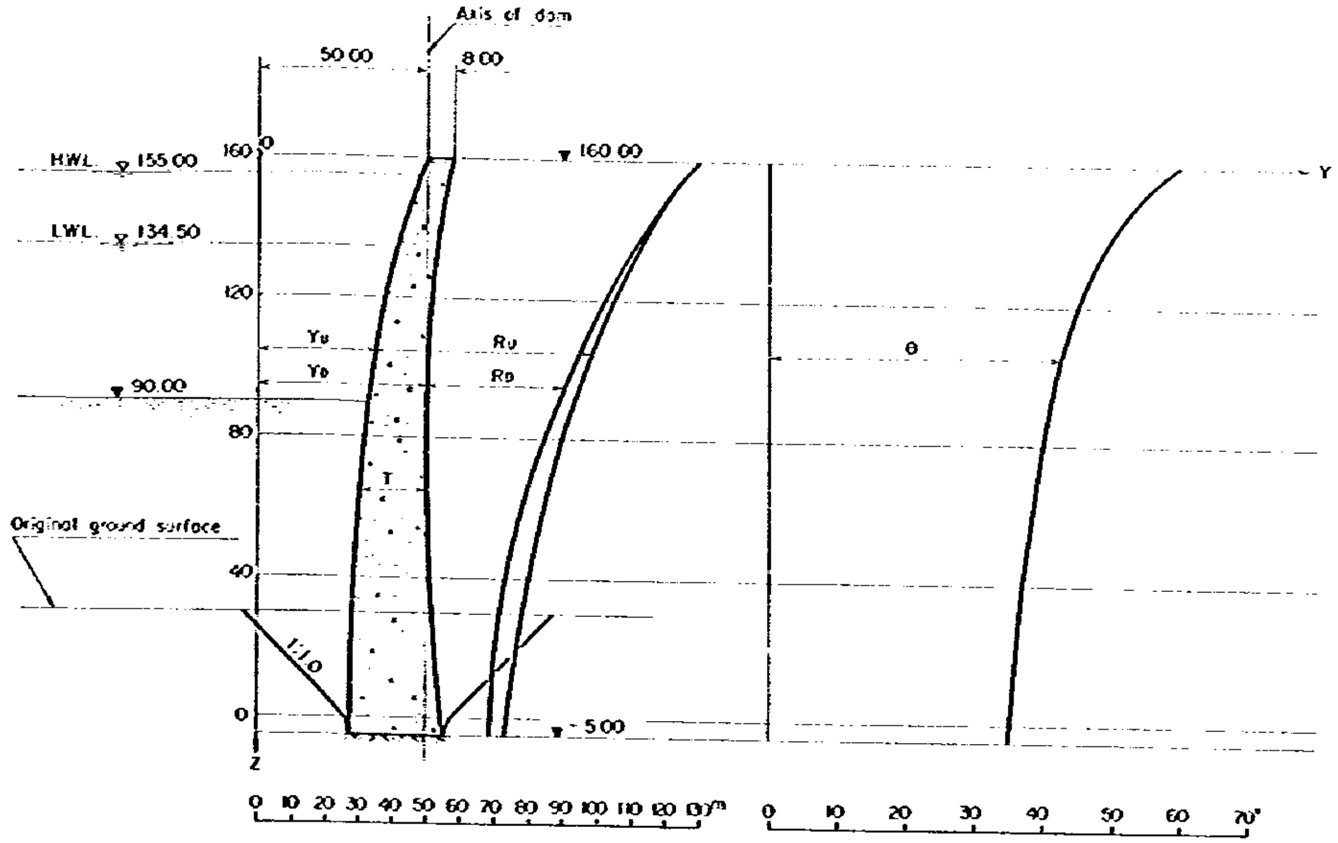

SECTION A-A
SECTION B-B
KEY PLAN
PLAN
Backfill
Lean concrete
Erection Bay
T.W.L. 40.00
51.00 (Q=2960 m³/s)
Control room
(Plan, Section A-A, B-B)
(Key plan)
BEŞKONAK PROJECT
POWERSTATION
GENERAL
DWG. II-9
Nov, 1993


N
Crest length 167.55
136.00
150.00
160.00
1:0.5
1:2.494
1:0.4
1:0.5
1:0.4
8.00
60.00 R
120°00'
12.00
1:2.5
No. 2 Spillway tunnel
No. 1 Spillway tunnel
Köprüçay River
54.00
X 3 900
X 3 800
Y 9 400
Y 9 500
Y 9 600
BEŞKONAK PROJECT
BEŞKONAK DAM
ARCH TYPE
PLAN
DWG. 11-10

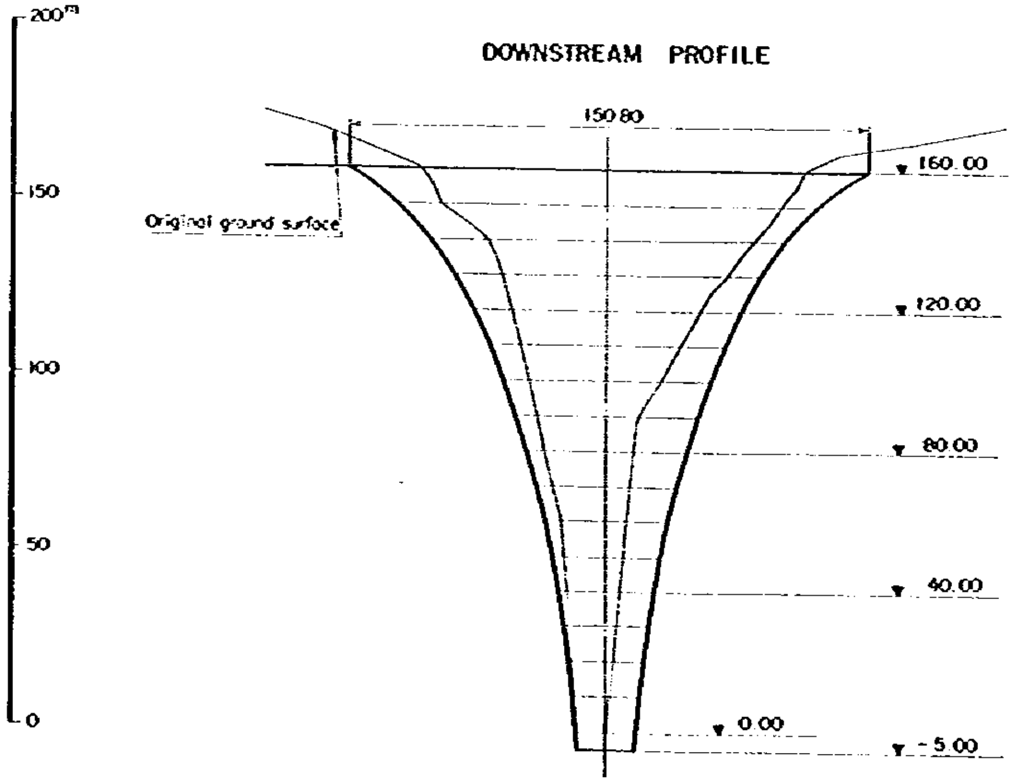
PLAN



TYPICL SECTION OF DAM AND GEOMETRICAL DATA DIAGRAM

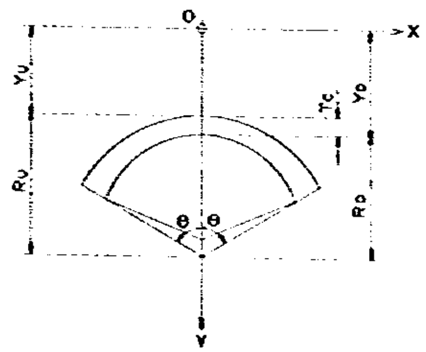


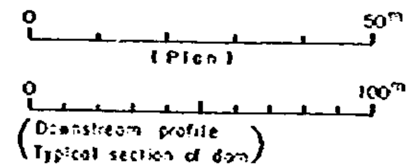
DOWNSTREAM PROFILE



GEOMETRICAL DATA

Elevation	Yu	Ru	Rd	Tc	θ	TA
160.00	50.00	80.00	72.00	8.00	60°00'	8.00
140.00	42.50	72.00	59.63	11.00	50°00'	11.50
120.00	37.80	67.00	50.38	14.00	45°00'	14.80
100.00	34.00	62.00	41.68	16.50	42°00'	17.50
80.00	31.60	58.40	34.63	18.50	40°00'	19.90
60.00	30.00	54.00	27.23	20.00	38°30'	21.60
40.00	28.50	51.00	22.02	23.00	37°00'	24.50
20.00	27.50	49.00	17.52	24.50	36°00'	26.00
0.00	27.10	46.20	14.88	27.00	35°12'	28.00
-5.00	27.00	46.00	13.71	28.00	35°00'	29.00

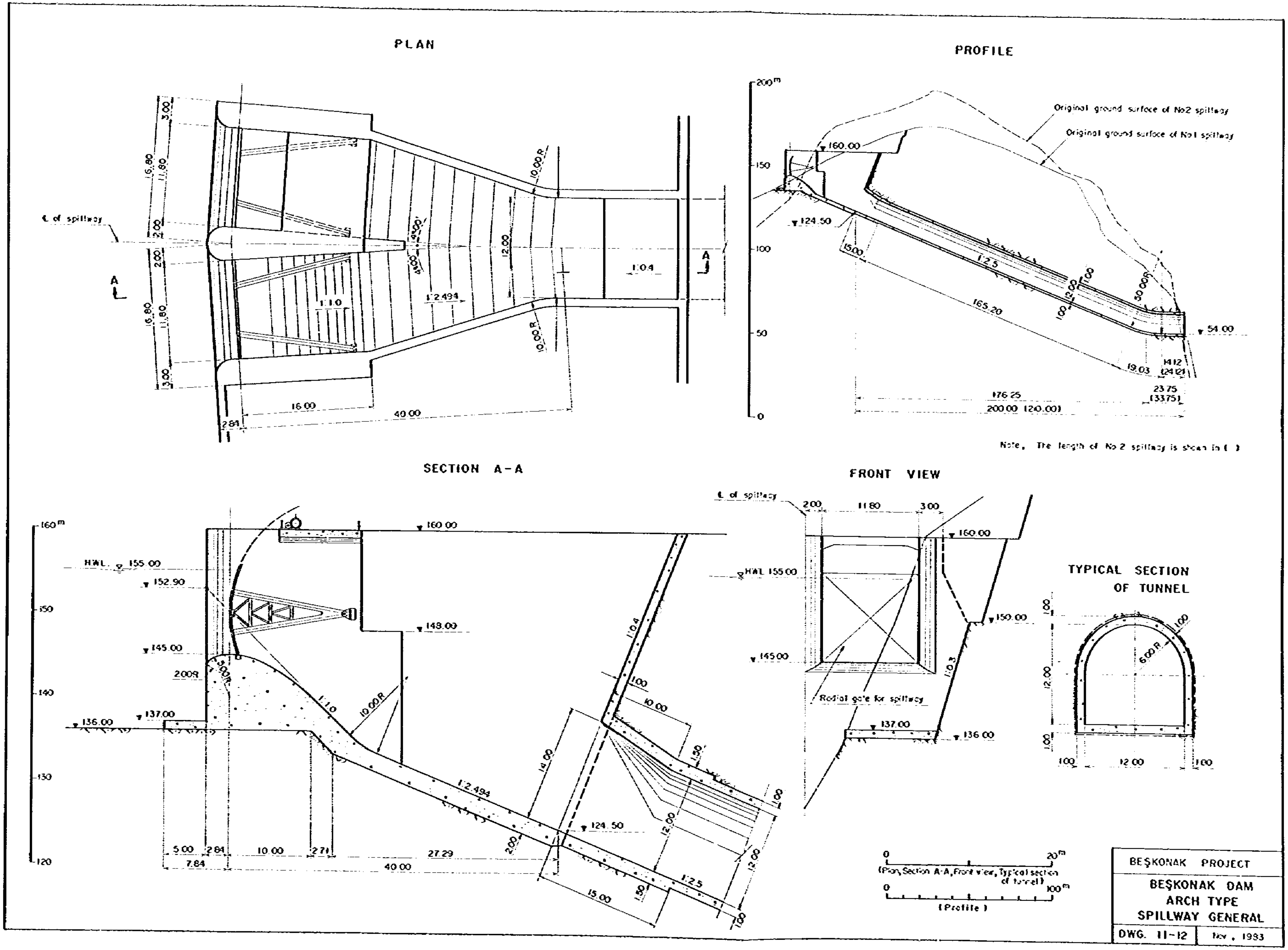


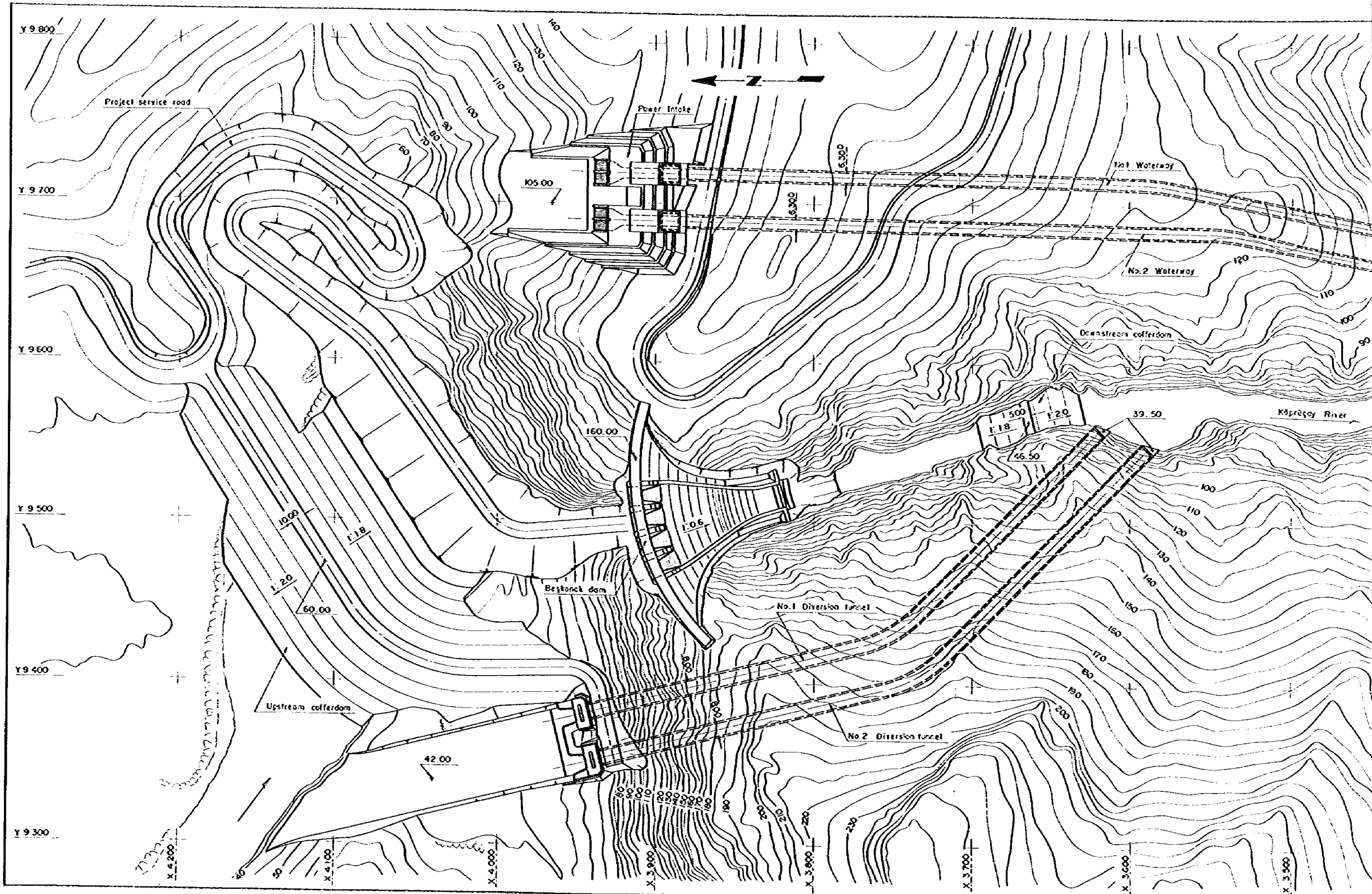


BEŞKONAK PROJECT

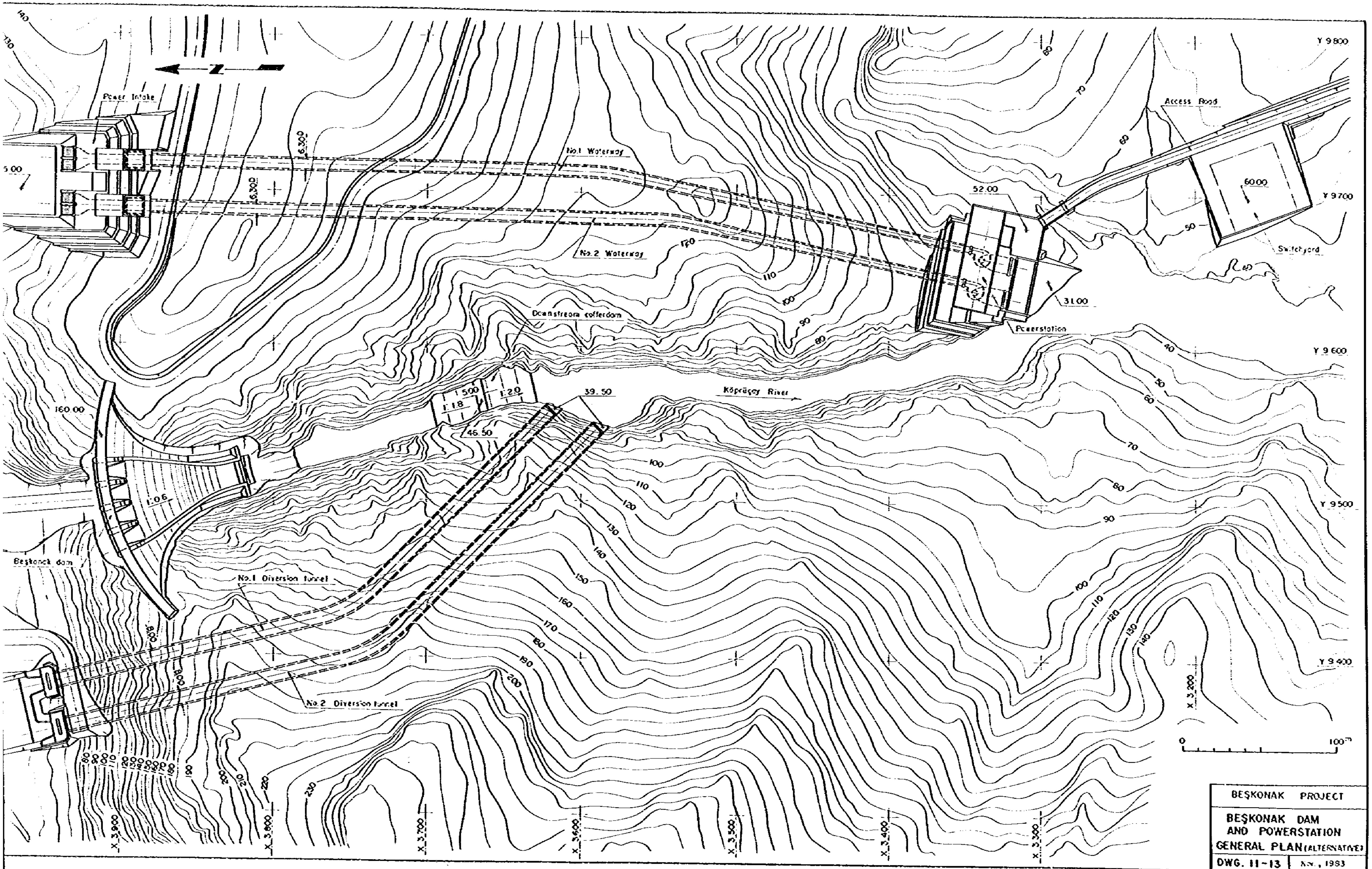
BEŞKONAK DAM
ARCH TYPE
PLAN, PROFILE & SECTION

DWG. II-11	Nov., 1993


PLAN
PROFILE
SECTION A-A
FRONT VIEW
TYPICAL SECTION OF TUNNEL
℄ of spillway
Original ground surface of No2 spillway
Original ground surface of No1 spillway
Note, The length of No 2 spillway is shown in ( )
Radial gate for spillway
HWL 155.00
(Plan, Section A-A, Front view, Typical section of tunnel)
(Profile)
BEŞKONAK PROJECT
BEŞKONAK DAM
ARCH TYPE
SPILLWAY GENERAL
DWG. 11-12
Nov., 1983



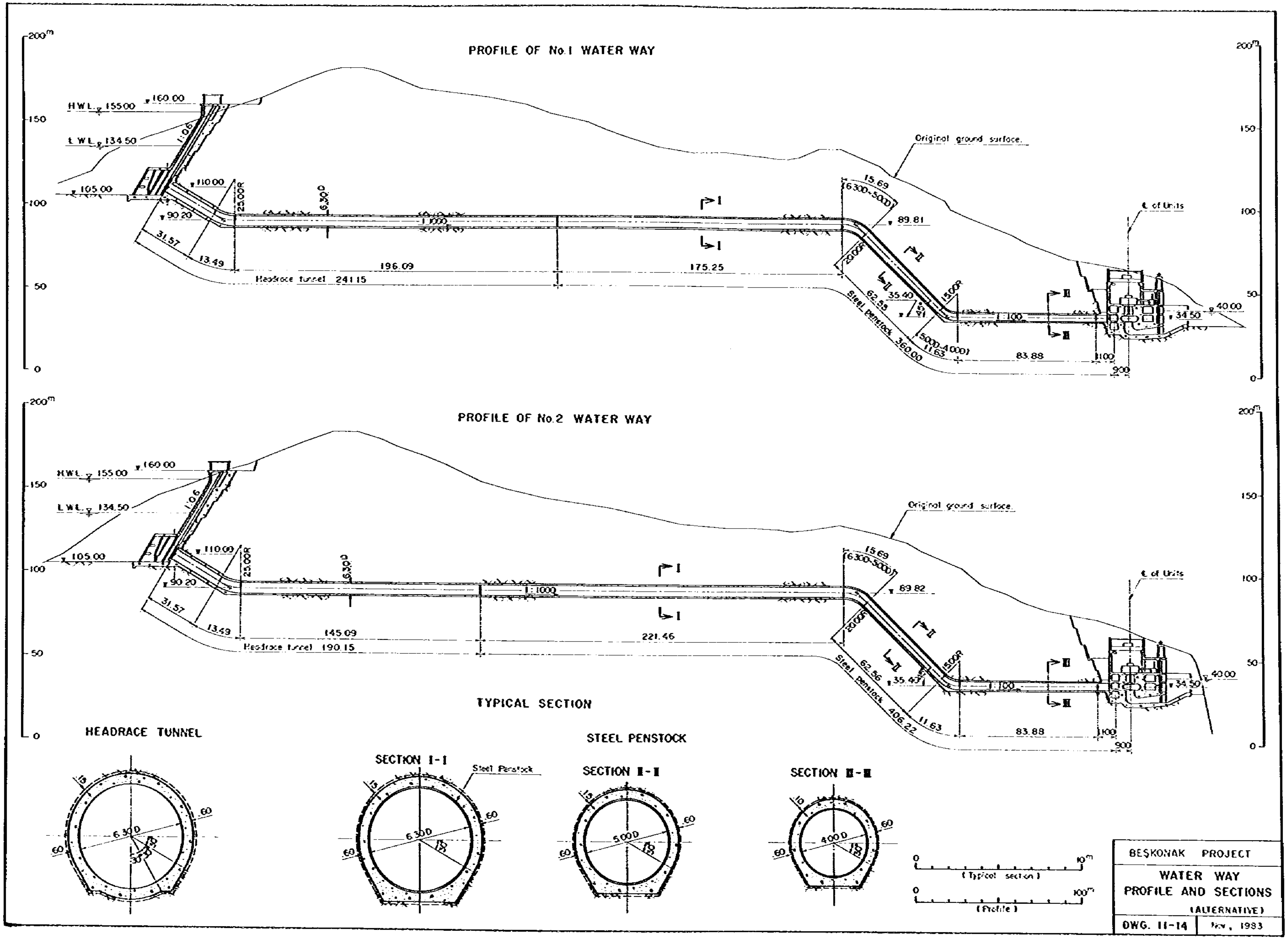
Y 9 800
Y 9 700
Y 9 600
Y 9 500
Y 9 400
Y 9 300
X 4 200
X 4 100
X 4 000
X 3 900
X 3 800
X 3 700
X 3 600
X 3 500
Project service road
Power Intake
105.00
No.1 Waterway
No.2 Waterway
Downstream cofferdam
Köprüçay River
39.50
46.50
1:1.8
1:2.0
160.00
1:0.6
1:1.8
1:2.0
10.00
60.00
Beşkonak dam
No.1 Diversion tunnel
No.2 Diversion tunnel
Upstream cofferdam
42.00

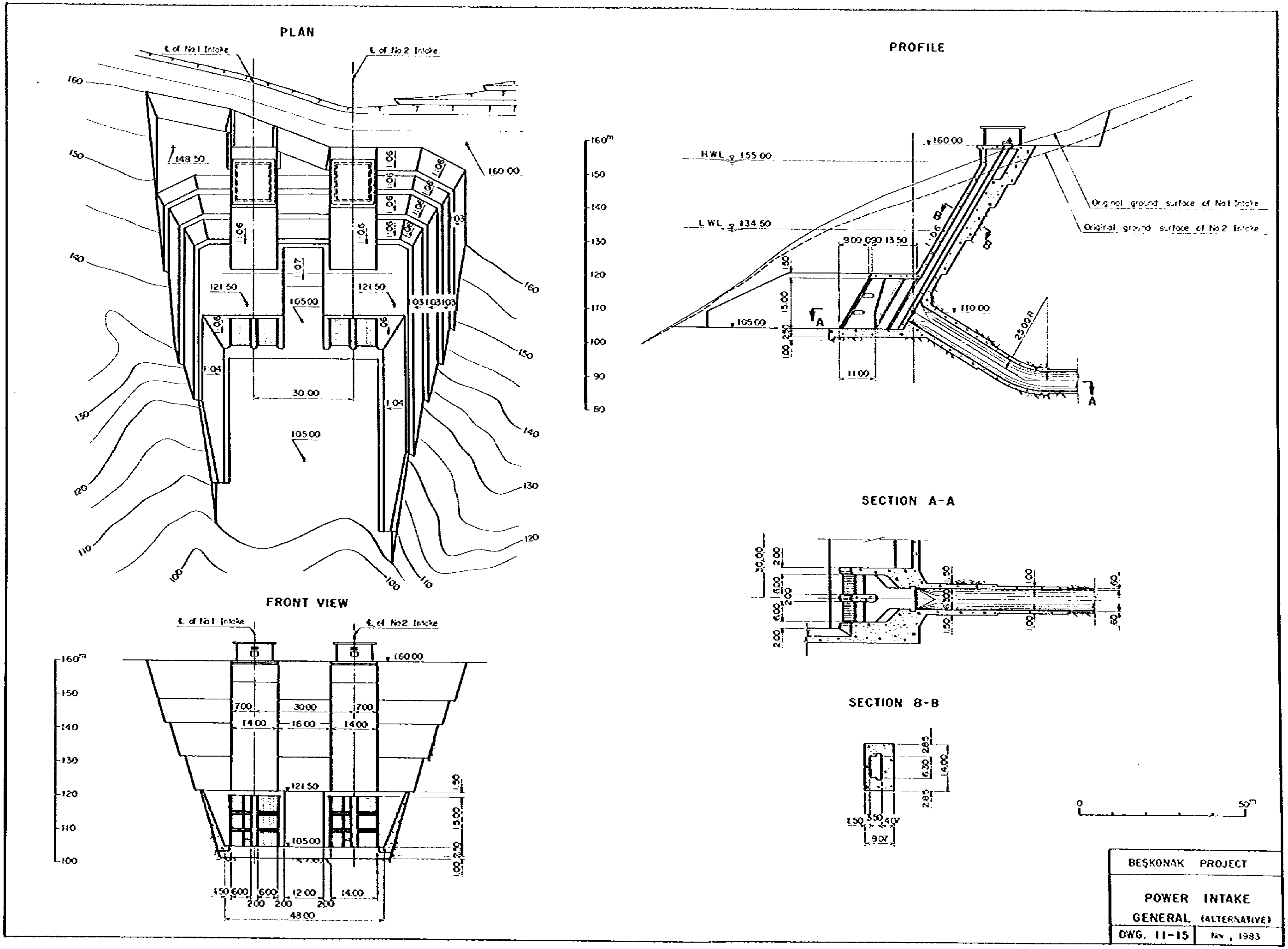


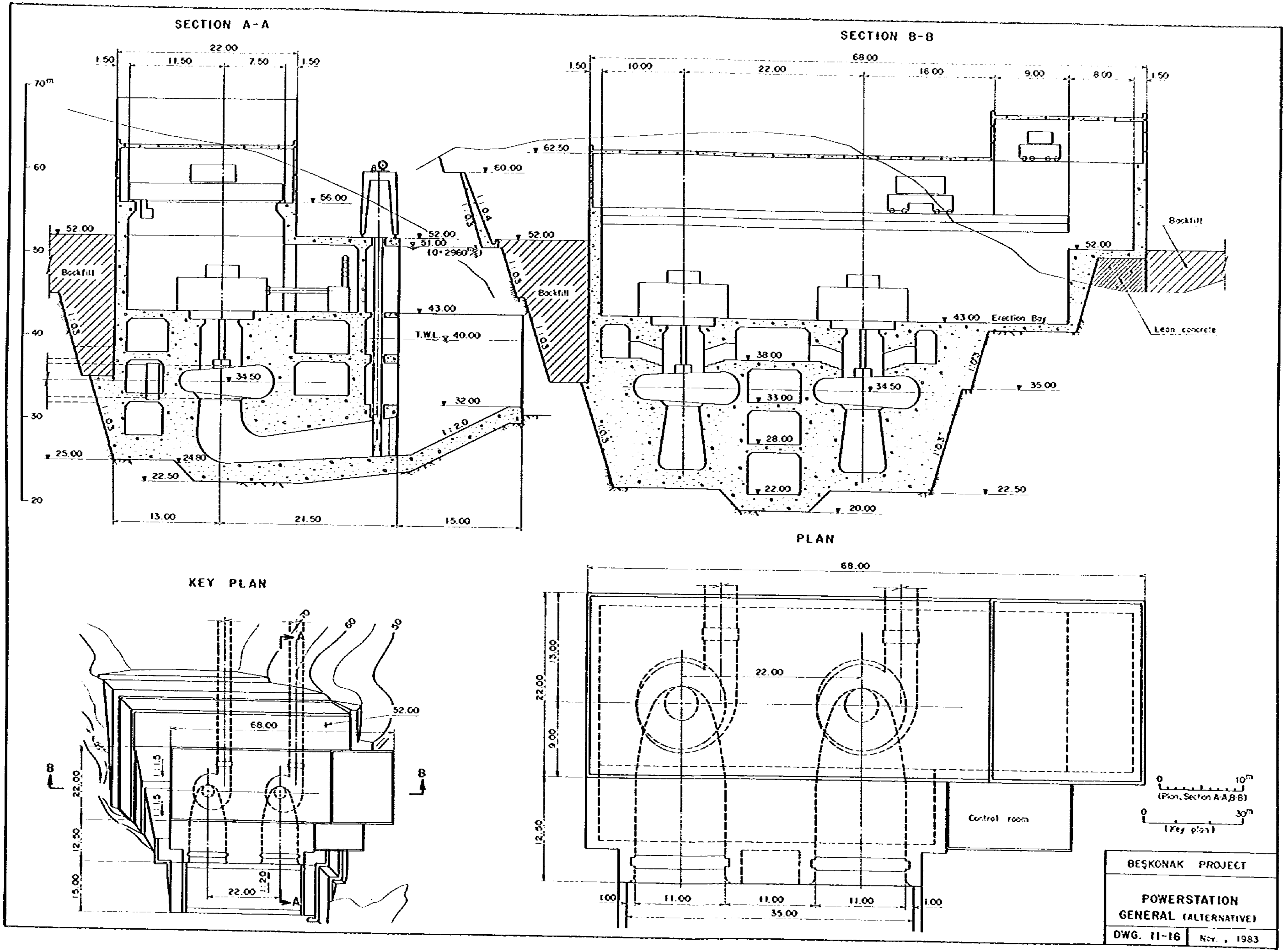
BEŞKONAK PROJECT

BEŞKONAK DAM AND POWERSTATION GENERAL PLAN (ALTERNATIVE)

DWG. 11-13 | 1983


PROFILE OF No.1 WATER WAY
H.W.L. 155.00
L.W.L. 134.50
160.00
105.00
110.00
90.20
1:0.6
25.00R
6.30D
1:1000
31.57
13.49
196.09
175.25
Headrace tunnel 241.15
15.69
(6300-5000)
89.81
20.00R
15.00R
35.40
62.55
Steel Penstock 360.00
(5000-4000)
11.63
83.88
1:100
11.00
9.00
34.50
40.00
Original ground surface.
℄ of Units
PROFILE OF No.2 WATER WAY
H.W.L. 155.00
L.W.L. 134.50
160.00
105.00
110.00
90.20
1:0.6
25.00R
6.30D
1:1000
31.57
13.49
145.09
221.46
Headrace tunnel 190.15
15.69
(6300-5000)
89.82
20.00R
15.00R
35.40
62.56
Steel Penstock 406.22
11.63
83.88
1:100
11.00
9.00
34.50
40.00
Original ground surface.
℄ of Units
TYPICAL SECTION
HEADRACE TUNNEL
6.30D
STEEL PENSTOCK
SECTION I-I
Steel Penstock
6.30D
SECTION II-II
5.00D
SECTION III-III
4.00D
(Typical section)
(Profile)
BEŞKONAK PROJECT
WATER WAY
PROFILE AND SECTIONS
(ALTERNATIVE)
DWG. 11-14
Nov., 1983


PLAN
℄ of No 1 Intake
℄ of No 2 Intake
148.50
160.00
121.50
105.00
30.00
PROFILE
HWL 155.00
LWL 134.50
160.00
110.00
105.00
25.00 R
Original ground surface of No 1 Intake
Original ground surface of No 2 Intake
SECTION A-A
SECTION B-B
FRONT VIEW
℄ of No 1 Intake
℄ of No 2 Intake
160.00
121.50
105.00
48.00
BEŞKONAK PROJECT
POWER INTAKE
GENERAL (ALTERNATIVE)
DWG. 11-15
Nov., 1983



SECTION A-A
SECTION B-B
KEY PLAN
PLAN
Backfill
Leon concrete
Erection Bay
T.W.L. 40.00
Control room
(Plan, Section A-A,B-B)
(Key plan)
BEŞKONAK PROJECT
POWERSTATION
GENERAL (ALTERNATIVE)
DWG. 11-16
Nov., 1983

CHAPTER 12

CONSTRUCTION COST

CHAPTER 12 CONSTRUCTION COST

LIST OF TABLES

CHAPTER 12 CONSTRUCTION COST

12.1 Outline

The construction cost of the Beskonak project was estimated applying designs, construction methods, materials and products according to the technological level expected at the present, and in addition estimated in consideration of the geological, natural and regional conditions and the project scale. The estimate was made as of March 1st, 1982.

12.2 Items for Construction Cost Estimation

The items for construction cost estimation were the following.

(1) Civil Works :

Care of river	;	Diversion tunnels and cofferdam
Dams	;	Beskonak dam and secondary dam
Grout curtain works	;	Grouting and galleries at left and right banks and the dam site
Waterway structures	;	Intakes, headraces, penstocks (excluding gates and steel pipe)
Power station and switchyard	;	Civil and building works
Access road and relocation road	;	Access road to the power station, dam connection road, left bank relocation road, etc.
Camp facilities	;	Office and living quarters, etc.
Temporary facilities	;	Construction roads, electric power for construction, temporary facilities for construction, etc.

(2) Hydraulic Equipment : Spillway gates, outlet, intake gates, tailrace gates, penstocks, etc.

(3) Electro-mechanical Equipment : Main equipment, auxiliary equipment, switchgear, etc.

(4) Transmission Line	:	All costs concerned with transmission line construction
(5) Engineering and Administration Costs	:	Planning, investigation, administration and management costs concerning construction
(6) Compensation	:	Cost of land acquisition within reservoir area
(7) Interest During Construction	:	Interest during construction period

12.3 Direct Construction Costs

(1) The unit prices applied to civil works were taken from "Unit Prices, 1982" prepared by DSI. However, the items below were added separately as transportation costs.

Cement	:	Isparta-Beskonak, 220 km (1,130 TL/ton)
Reinforcing Steel	:	Iskenderun-Beskonak, 650 km (1,940 TL/ton)
Excavation	:	Excavation sites to disposal areas (4.5 L TL/m^3)
Embankment	:	Quarries and borrow areas to embankment sites (4.5 L TL/m^3)

Work quantities were calculated based on the preliminary designs described in Chapter 11.

(2) As temporary works cost, 10% of direct construction costs was estimated upon discussions with DSI.

(3) The unit prices for relocation roads and access roads were given by DSI.

(4) The unit prices applied for hydraulic equipment such as gates and penstocks were indicated by DSI. However, the intake gates and the outlet works are considered as requiring foreign currency, and separated unit prices were used.

(5) Electro-mechanical equipment such as turbines, generators, transformers, etc., are all considered as being imported, and these costs are to include the inland transportation costs and the installation costs.

(6) Unit prices indicated by DSI were applied to the construction cost of transmission line.

(7) Compensation costs for land acquisition, etc., were estimated on the bases of data given by DSI.

12.4 Indirect Costs

(1) For contingencies, 15% of civil works cost and 15% of FOB prices of electro-mechanical equipment were respectively listed.

(2) The administration costs are to consist of 15% of the construction cost including contingency costs.

(3) Interest during construction period is to be estimated considering the period to be 6 years with 8% for the foreign currency portion and 9.5% for the domestic currency portion.

12.5 Separation of Domestic and Foreign Currency Portion

All civil works are to be paid for with domestic currency. Although it is conceivable, as described in 11.5.1, for a part of heavy equipment to be imported, it was decided that most can be procured domestically. Therefore, this item will not be listed under foreign currency.

A part of the hydraulic euqipment and electro-mechanical equipment are to be paid for with foreign currency, but inland transportation costs and installation costs are to come under domestic currency.

The foreign currency exchange rates as of the time of estimation (March 1982) were taken to be US$ 1.00 = 148 TL.

The division of the construction costs into domestic and foreign currency portion are shown in Table 12-1, and the construction costs by year in Table 12-2.

Table 12-1 Estimated Construction Costs

(Unit: 1,000 TL)

Item	Domestic Currency	Foreign Currency	Total
Civil Works			
Care of River	1,184,100	-	1,184,100
Dams	3,894,600	-	3,894,600
Curtain Grouting	3,480,800	-	3,480,800
Water Way	1,104,000	-	1,104,000
Power Station	623,900	-	623,900
Access and Relocation Road	1,658,200	-	1,658,200
Camp Facility	100,000	-	100,000
Preparatory Works	1,204,500	-	1,204,500
Subtotal	13,250,100	-	13,250,100
Contingency (15%)	1,987,500	-	1,987,500
Total	15,237,600	-	15,237,600
Hydraulic Equipment	1,445,700	325,000	1,770,700
Electro-Mechanical Equipment	889,000	5,586,000	6,475,000
Transmission Line	187,500	102,500	290,000
Project Controlling	2,664,000	902,000	3,566,000
Land Acquisition	1,296,500	-	1,296,500
Total	21,720,300	6,915,500	28,635,800
Interest during Construction Period	5,747,700	1,094,500	6,842,200
Grand Total	27,468,000	8,010,000	35,478,000

Table 12-2 Fund Requirement in Each Year

(Unit: 1,000 TL)

Description	1st Year		2nd Year		3rd Year	
	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign
Civil Works	864,300	-	2,482,000	-	3,568,000	-
Hydraulic Works	-	-	-	-	-	-
Electro-mechanical Equipment	-	-	-	-	-	559,000
Transmission Line	-	-	-	-	18,800	20,500
Project Controlling	129,600	-	372,300	-	538,000	85,900
Land Acquisition	1,236,500	-	-	-	-	-
Subtotal	2,230,400	-	2,854,300	-	4,124,800	656,400
Interest during Construction Period	108,800	-	353,300	-	684,800	26,700
Grand Total	2,339,200	-	3,207,600	-	4,809,600	693,100

Description	4th Year		5th Year		6th Year		Total	
	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign
Civil Works	3,499,600	—	3,203,400	—	1,620,300	—	15,237,600	—
Hydraulic Works	289,100	32,500	449,500	269,000	716,100	32,500	1,445,700	325,000
Electro-mechanical Equipment	351,000	2,234,000	269,000	2,235,00	269,000	559,000	889,000	5,586,000
Transmission Line	150,000	41,000	18,700	41,00	—	—	187,500	102,500
Project Controlling	643,500	345,100	589,700	380,30	390,900	88,700	2,664,000	902,000
Land Acquisition	—	—	—	—	—	—	1,255,500	—
Subtotal	4,933,200	2,653,600	4,521,300	2,915,30	2,996,300	680,200	21,720,300	6,915,500
Interest during Construction Period	1,115,100	159,400	1,564,300	382,20	1,921,400	526,200	5,747,700	1,094,500
Grand Total	6,048,300	2,813,000	6,085,600	3,297,50	4,917,700	1,206,400	27,468,000	8,010,000

CHAPTER 13

ECONOMIC EVALUATION

CHAPTER 13 ECONOMIC EVALUATION

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CHAPTER 13 ECONOMIC EVALUATION

13.1 Method of Economic Evaluation

In the case of a project such as hydroelectric power project where calculation of benefit is possible except for education and medical projects and so on, the generally employed techniques are those of obtaining economic internal rate of return (EIRR), net present value (NPV), benefit-cost ratio (B/C), etc., as indices for project evaluation based on cost and benefit.

As a basic consideration of project evaluation, the technique described below, which is generally acceptable for international financial institutions such as the World Bank and the Asian Development Bank and so on, is adopted as the method of economic evaluation of development projects.

(1) Comparison method of economic benefit and cost excluding income transferred to the government based on the market prices [Pre-Economic Evaluation (I)] Phase-2

(2) Method of evaluation using economic prices on making partial modifications of market prices to convert them to border prices [Pre-Economic Evaluation (II)] Phase-3

(3) Method of evaluation with emphasis on optimum utilization of resources using the accounting prices (effective prices) which are compared with opportunity costs [Economic Evaluation] Phase-4

(4) Proceeding further, the method of evaluation based on the socio-effective prices considering savings and income distributions of the nation [Socio-Economic Evaluations] Phase-5

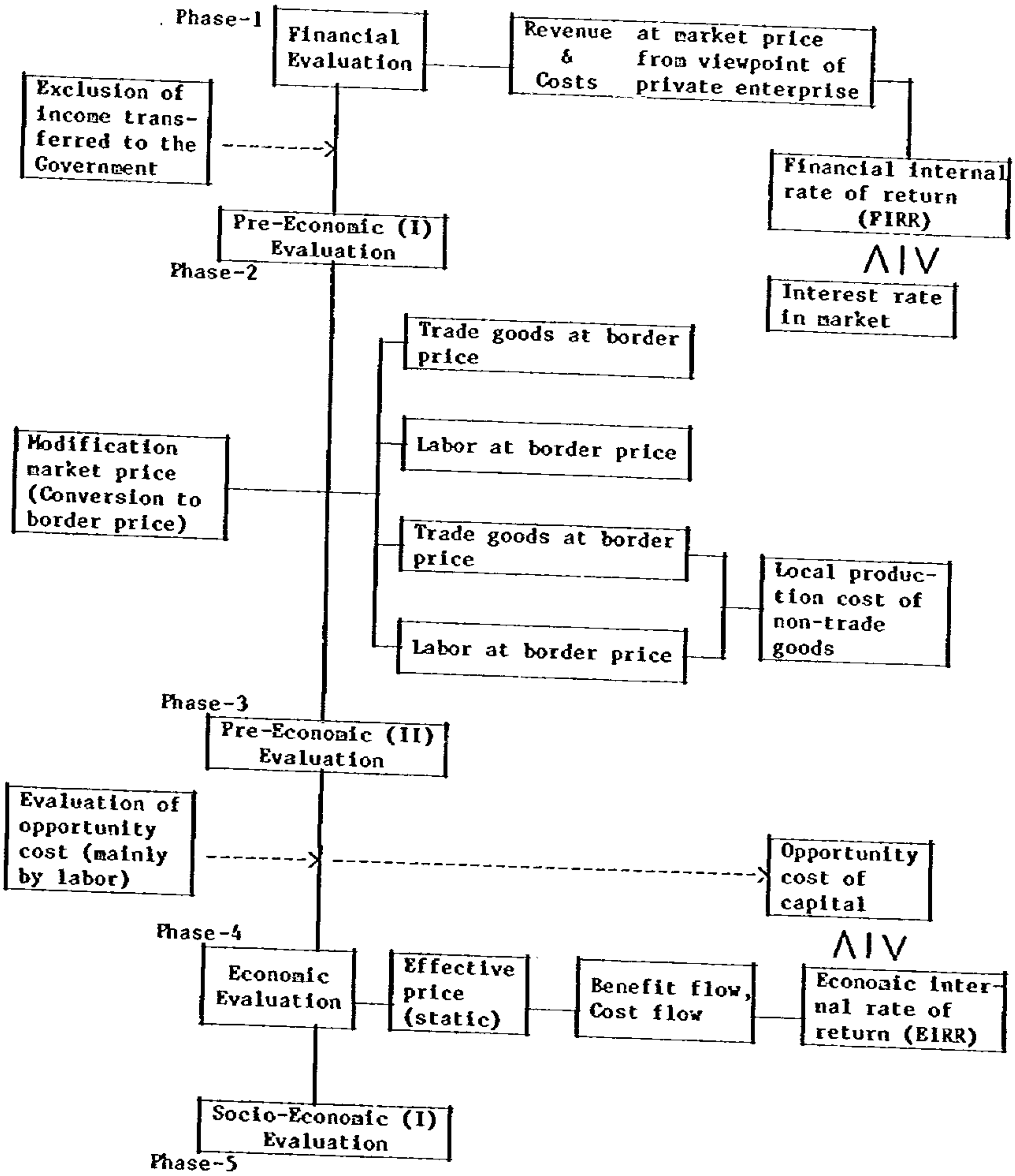
The flow of the above may be graphically expressed shown in

Fig. 13-1.

The economic evaluation of the Beşkonak project is based on the market prices to be used in Chapter 14, "Loan Repayment Plan", and the Project will be evaluated through optimum utilization of resources using the accounting prices indicated in Phase-4. In effect, after the exclusion of income transferred to the government from the project cost, those are performed such as the modification of market prices to border ones, the evaluation of the opportunity costs for major production factors (mainly labor and capital) and the calculation of the economic internal rate of return (EIRR) on the basis of the economic benefit and cost flows. The EIRR is compared with the opportunity cost of capital in Turkey.

In the process of computing EIRR, the calculation of financial internal rate of return (FIRR), and further, the results of a comparison study with an alternative thermal plant, which is most widely used at present for hydroelectric power project evaluation, are also touched upon, giving consideration to making it possible for comparisons to be made with existing reports on hydroelectric power projects in Turkey.

Fig. 13-1 Flow Chart of Economic Evaluation of Project



13.2 Financial Evaluation of the Project

A financial evaluation essentially differs from an economic analysis with respect to price evaluation criteria for projects and is therefore of different nature. Rather, it is something which normally would be contained in the following chapter, but since it will be useful in grasping the flow of economic evaluation which succeeds to the financial evaluation, the bold step of including it in this chapter will be taken.

What comprises the basis of economic evaluation are economic benefit and cost shown in Fig. 13-1. In a financial evaluation, these are firstly estimated from market prices determined from the viewpoint of private enterprises. In economic evaluation of a development project, the effects (influences) on market intervention and price control through the various policies of government presently being implemented are eliminated and it is assumed that the economy is managed with only economic efficiency using accounting prices.

13.2.1 Financial Cost and Revenue

The total expenditure for this Project will be 55,555.6 million TL (total investment amount in 56-year period excluding interest during construction) and the initial investment amount required for construction is 28,635.8 million TL (see Tables 13-1 and 13-2). Of the amounts listed in these tables, items which ordinarily should come under income transferred to the government, such as duties on imports from foreign countries, are excluded since the principal implementing this Project is DSI (General Directorate of State Hydraulic Works) which is a government agency.

On the other hand, the revenue source obtained through realization of the Project is the energy sales income. The averaged unit sales price of TEK as of March 1982 was 6.00 TL/kWh[1/], and the

1/: The electricity rate guarantees a rate of return 8% in terms of rate base for TEK, while seen from the present state of power supply, since there are many waiting customers, this is an appealing electricity rate which makes electric power amply purchasable to customers.

annual average effective energy production is estimated as 631.5 million kWh. Therefore, the averaged electricity charge revenue for the year is estimated to be 3,789 million TL.

Table 13-1 Finaicial Cost Flow of Beskonak Project

Unit: 10^6TL

Year	Investment Cost			O & M	Total
	Dam & Equipment	Trans-mission Line	Sub-Total		
1	2,290.4		2,290.4		2,290.4
2	2,854.3		2,854.3		2,854.3
3	4,746.0	45.1	4,791.1		4,791.1
4	7,367.1	219.7	7,586.8		7,586.8
5	7,368.0	68.7	7,436.7		7,436.7
6	3,676.5		3,676.5		3,676.5
7				382.8	382.8
8				382.8	382.8
~ 27				382.8	382.8
28	642.8	45.1	687.9	382.8	1,070.7
29	2,972.8	219.7	3,192.5	382.8	3,575.3
30	2,878.5	68.7	2,947.2	382.8	3,330.0
31	952.2		952.2	382.8	1,335.0
32				382.8	382.8
~ 56				382.8	382.8
Total Invest-ment Cost	35,748.6	667.0	36,415.6	19,140.0	55,555.6

Note: 1/ Investment cost of 28,635.8 million T.L. in initial stage is estimated based upon the price level of March 1982. These figures exclude interest during construction, import duties, taxes, escalation cost, etc..

2/ Operation and Maintenance Cost

Dam and power facilities; 18,819 x 10^6TL x @1% + 9,482.6 x 10^6TL x @2% = 377.8 x 10^6TL

Transmission line ; 333.5 x 10^6TL x @1.5% = 5.0 x 10^6TL

Total: = 382.8 x 10^6TL

Table 13-2 Financial and Economic Costs in Initial Stage for Beşkonak Project

Unit: 10^6TL

Year	1	2	3	4	5	6	Total
[I] Financial Cost	2,290.4	2,854.3	4,791.2	7,586.8	7,436.6	3,676.5	28,635.8
Foreign Currency							
Machine & Equipment	-	-	579.5	2,307.5	2,535.0	591.5	6,013.5
Engineering Fee	-	-	86.9	346.1	380.3	88.7	902.0
Total of F.C.	-	-	666.4	2,653.6	2,915.3	680.2	6,915.5
Domestic Currency							
Land Acquisition	1,296.5	-	-	-	-	-	1,296.5
Materials	634.0	1,780.9	2,605.0	2,783.7	2,548.0	1,560.0	11,911.6
Transportation	10.0	31.1	10.0	124.9	124.4	123.3	423.7
Labour Cost	220.3	670.0	971.8	1,381.1	1,259.2	922.1	5,424.5
Administration Cost	129.6	372.3	538.0	643.5	589.7	390.9	2,664.0
Total of D.C.	2,290.4	2,854.3	4,124.8	4,933.2	4,521.3	2,996.3	21,720.3
[II] Economic Cost	1,384.9	1,787.7	3,249.2	5,788.7	5,787.8	2,602.1	20,600.4
Foreign Currency							
Machine & Equipment	-	-	579.5	2,307.5	2,535.0	591.5	6,013.5
Engineering Fee	-	-	86.9	346.1	380.3	88.7	902.0
Total of F.C.	-	-	666.4	2,653.6	2,915.3	680.2	6,915.5
Domestic Currency							
Land Acquisition	764.9	-	-	-	-	-	764.9
Materials	348.7	979.5	1,432.8	1,531.0	1,401.4	858.0	6,551.6
Transportation	5.9	18.3	5.9	73.7	73.4	72.7	249.9
Labour Cost	163.0	495.8	719.1	1,022.0	931.8	682.4	4,014.1
Administration Cost	102.4	294.1	425.0	508.4	465.9	308.8	1,283.1
Total of D.C.	1,384.9	1,787.7	2,582.8	3,135.1	2,872.5	1,921.9	13,584.9

13.2.2 Comparison of Financial Internal Rate of Return (FIRR) and Interest Rate

The financial internal rate of return was estimated by the Discounted Cash Flow Method based on the cost and revenue obtained by the market price in 13.2.1.

As a result of calculation, the discount rate at which the financial cost and revenue become equal (financial internal rate of return) is 9.4% (see Appendix A-5.5-1). Consequently, as described in Chapter 14, the loan interest rates of the Project are assumed as being 9.5% for the domestic currency portion, 8% for the foreign currency portion, and 9.14% by weighted average[1/], and therefore, this Project can be evaluated as being a sound plan.

1/:
$$\frac{6,915.5 \times 10^{6}\ \text{TL} \times 8\% + 21,720.3 \times 10^{6}\ \text{TL} \times 9.5\%}{28,635.8 \times 10^{6}\ \text{TL}} = 9.14\%$$

13.3 Comparison of Beskonak Project and Alternative Thermal Power Plant

13.3.1 Comparison Method

In cases of electric power and road projects where the outputs (benefits) of the projects comprise non-trade goods, which themselves are of a nature that they do not readily become objects of export and import, the best is selected out of alternative methods which produce the required output, and its cost is taken to represent the economic benefit of the project in question.

In case of a hydroelectric power development project, the recognized technique in general is to select a thermal power plant as the alternative power facility and to consider the power generating cost of the latter as the benefit of the hydroelectric power plant comparing this with the power generating cost of the subject hydroelectric power project. This technique was adopted for the Beskonak project. In this case, the study will be one of selection between alternatives, whether to construct the hydroelectric power plant or to take the alternative power plant.

The alternative thermal power plant for this Project was taken to be a oil-fired thermal power plant considering the scale and power generation characteristics of the Beskonak power station, and in addition considering the fact that oil-fired thermal power plants are used in Turkey as alternative thermal power plants. The Discounted Cash Flow Method was applied for comparison of the respective facilities costs.

The basic values used for evaluation are shown in Table 13-3.

Table 13-3 Basic Criteria for Comparison Study

Item	Description
Method of Analysis	Discounted Cash Flow Method
Study Period	56 Years (1987 - 2042)
Interest Rate	9.5% for Selection of Optimum Scale of the Project 1/
Escalation	Not Considered
Shadow Price Factor (Conversion Factor)	Considered (Except for Selection of Optimum Scale of the Project 2/)
Service Life of Facility	
Dam & Reservoir	50 Years
Hydro-power Plant	25 Years
Oil Fired Thermal Plant	25 Years
Substation	25 Years
Transmission Line	25 Years
Conversion Rate of Currency (As of March 1982)	US$1.00 = 148T.L

1/ In Turkey, an interest rate of 9.5% is generally used as the evaluation criterion for a hydro-power project.

2/ The labor cost in the kW and kWh of the alternative thermal was considered to be made up in general by skilled labor.

13.3.2 Selection of Alternative Power Plant

Since it becomes clear, as a result of studies on power demand and supply planning and power system analysis based on the data and values presented by TEK, that the electric power generated through the Project would all be supplied to the Antalya region, it was considered that the alternative power plant would be constructed in this region.

In comparison studies of the optimum development scale for the Project, one oil-fired thermal plant of 300 MW, the minimum unit in Turkey, was assumed and the study was made using the unit benefits (costs) per kW and kWh determined from this facility. The particulars are given in Table 13-4. The construction cost of the thermal plant was based on actual performances in Turkey.

Evaluation of the optimum development scale for the Project selected as a result of comparison studies was made using the cost of a hypothetical alternative thermal power plant capable of furnishing equal service in effective output and effective energy to the Beskonak project (see Table 13-5).

Table 13-4 **Alternative Thermal Power Plant for Optimization Study**

Interest Rate = 9.5%
Price Level = As of March, 1982

Item	Unit	Description	
Installed Capacity	MW	300	
Annual Plant Factor	%	76	
Thermal Efficiency	%	35	
Annual Energy Production	10^6kWh	1,997	
Station Service Ratio	%	6	
Construction Cost	10^6T.L	30,160 5/	
Service Life	Years	25	
Capital Recovery Factor		0.10596 (i = 9.5%)	
Fuel Consumption Rate	ℓ/kWh	0.256	
O & M Cost Rate without Fuel Cost	%	2.5	
Unit Fuel Cost	T.L/ℓ	28,930	
Annual Cost		Fixed Cost	Variable Cost
Interest and Depreciation	10^6T.L	3,195.6	-
O & M Cost, Administration Cost	10^6T.L	754.0	79.9
Fuel Cost	10^6T.L	-	14,789.9
Total	10^6T.L	3,949.6	14,869.8
Annual Cost at Sending End			
kW Cost	T.L	15,509 1/	
kWh Cost	T.L		7.58 2/

Note;

1/ $\frac{3,949.6 \times 10^6 \text{T.L}}{300,000 \text{ kW}} \times 1.178^{3/} = 15,509$ T.L/kW (104.8 \$/kW)

2/ $\frac{14,869.8 \times 10^6 \text{T.L}}{1,997 \times 10^6 \text{kWh}} \times 1.018^{4/} = 7.58$ T.L/kWh (0.054 \$/kWh)

3/ & 4/ Adjustment Factor for kW & kWh

Item		Hydro	Thermal
Transmission Loss	(%)	4	0
Station Service Loss	(%)	0.3	6
Failure Loss	(%)	0.3	4
Repair Loss	(%)	2	12

kW Adjustment Factor $= \frac{(1 - 0.04) \times (1 - 0.003) \times (1 - 0.003) \times (1 - 0.02)}{(1 - 0.00) \times (1 - 0.06) \times (1 - 0.04) \times (1 - 0.12)}$

$= 1.178$

kWh Adjustment Factor $= \frac{(1 - 0.04) \times (1 - 0.003)}{(1 - 0.00) \times (1 - 0.06)} = 1.018$

5/ Interest during construction is included in the construction cost

Table 13-5 Alternative Thermal Power Plant for Studying Economic Justification

Item	Unit	Oil-fired Thermal Power Plant
Installed Capacity	MW	190.6
Firm Output Capacity	MW	190.6
Losses	%	20.6
Effective Capacity	MW	151.3
Annual Plant Factor	%	40.2
Annual Energy Production	10^6kWh	671.8
Station Service Ratio	%	6.0
Annual Available Energy	10^6kWh	631.5
Fuel Consumption Rate	ℓ/kWh	0.256
Unit Fuel Price	TL/ℓ	28.93
Construction Cost	10^6TL	15,883
Unit Construction Cost	TL/kW	83,333

Note:

1. Installed Capacity

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

$$= \frac{151.3 \text{ MW}}{(1 - 0.06) \times (1 - 0.05) \times (1 - 0.12)} = 190.6 \text{ MW}$$

2. Investment Cost = Unit Construction Cost 1/ x Installed Capacity
= 83.33×10^6TL/MW x 190.6 MW = $15,883 \times 10^6$TL

1/ Unit Const. Cost
= 25,000* x 10^6TL/300 MW = 83.33×10^6TL/MW
(* interest during construction is not including)

3. Investment Schedule

	1st (0.10)	2nd (0.40)	3rd (0.40)	4th (0.10)	($\times 10^6$TL) Total
Total	1,588.3	6,353.2	6,353.2	1,588.3	15,883.0
F.C.	953.0	3,811.9	3,811.9	953.0	9,529.8
L.C.	635.3	2,541.3	2,541.3	635.3	6,353.2

4. Operation and Maintenance Cost

Investment Cost = 15,883.0 x 10^6TL

Annual Operation and Maintenance Cost

= 15,883 x 10^6TL x 0.025 + 671.8 GWh x 0.04 TL/kWh

= 397.1 x 10^6TL + 26.9 x 10^6TL

= 424.0 x 10^6TL/Annum

5. Fuel Cost

Unit Fuel Cost = (0.86 x 3.01 TL/Kcal)/0.35 = 7.40 TL/kWh

Total Fuel Cost = 7.40 TL/kWh x 671.8 GWh = 4,971.3 x 10^6TL/Annum

13.3.3 Economic Cost of Beskonak Project

The economic cost of the Project was calculated utilizing the national parameters of Turkey shown in Table 13-6 for the financial costs shown in Table 13-2. These parameters were studied by the World Bank in 1980 1/.

In computation of the economic costs, since imported goods to be procured with foreign currency are already estimated with CIF prices as stated in 13.2.1, financial prices can be considered as economic costs directly without using conversion factors.

Meanwhile, conversions to economic costs of financial costs listed under domestic currency requirements were done applying the conversion factors below.

Land acquisition, transportation costs	= 0.59
Materials	= 0.55
Labor, skilled	= 0.79
Labor, unskilled	= 0.56
Administration cost	= 0.79

As a result, an initial investment amount (20,600.4 million TL) was indicated in Table 13-2 [II] as the economic cost, while Table 13-7 shows the investments made yearly and the total of the economic cost of the Project during the 56 years of the project life (total amount; 43,144.6 million TL). The results of calculations for the economic cost of each year are given in Appendix A-5.5-2.

1/ "Shadow Prices for Project Appraisal in Turkey," May 1980, World Bank Staff Working Paper, No. 392.

The followings are the percentages to the total construction costs of each electric power facility used in calculation of operation and maintenance costs:

Facility	Ratio
Dam, reservoir	1.0%
Generating and transforming facilities	2.0%
Transmitting facilities	1.5%

Table 13-6 Summary of National Parameters

Parameters	Value
Standard Conversion Factor (SCF)[1]	0.59
Conversion Factor for Consumption Goods (CF)	0.79
Conversion Factor for Intermediate Goods (CF_I)	0.55
Conversion Factor for Capital Goods (CF_K)	0.52
Marginal Product of Capital, q	12%
Elasticity of Marginal Utility, n	1
Rate of Pure Time Preference,	2
Consumption Rate of Interest (CRI)	4.5%
Value of Public Income, v	3.4
Critical Consumption Level:	
Rural, 1973 TL	1,208
Urban, 1973 TL	4,524
Critical consumption level as a ratio of national per capita average income	37%
Accounting Rate of Interest (ARI)	5%
The Summary Distribution Measure, D	1
Shadow Wage Rates (SPI):	
Rural Sector	0.56
Urban Informal Sector	0.55
Urban Formal Sector	0.57

1/ Standard Conversion Factors

Sensitivity Analysis

		1976	1977	1978	Average
Standard conversion factor (SCF*)[1]					
SCF_1[2]	TM = 0%	0.79	0.80	0.80	0.80
SCF_2	TM = 60%	0.59	0.58	0.60	0.59
SCF_3	TM = 90%	0.52	0.51	0.54	0.52

1/ $SCF^* = \dfrac{M + X}{M\,(1 + tm + TM) + X\,(1 - tx)}$

M = c.i.f. value of imports
X = f.o.b. value of exports
tm = average tariff duty on imports
tx = average tax rebate (subsidy) on exports
TM = premium rate (%)

2/ TM - premium rate (%)

SCF_1: TM = 0
SCF2: TM = 60
SCF_3: TM = 90

Table 13-7 Economic Cost Flow of Beskonak Project

Unit: 10^6TL

Year	Investment Cost			O & M	Total
	Dam & Equipment	Trans-mission Line	Sub-Total		
1	1,384.9		1,384.9		1,384.9
2	1,787.7		1,787.7		1,787.7
3	3,212.4	36.8	3,249.2		3,249.2
4	5,635.5	153.2	5,788.7		5,788.7
5	5,727.4	60.4	5,787.8		5,787.8
6	2,602.1		2,602.1		2,602.1
7				302.4	302.4
∿ 27				302.4	302.4
28	642.8	36.8	679.6	302.4	982.0
29	2,865.2	153.2	3,018.4	302.4	3,320.8
30	2,796.1	60.4	2,856.5	302.4	3,158.9
31	869.7		869.7	302.4	1,172.1
32				302.4	302.4
∿ 56				302.4	302.4
Total	27,523.8	500.8	28,024.6	15,120.0	43,144.6

13.3.4 Benefit

(1) Scale of Alternative Thermal Power Plant Capable of Providing Equivalent Service to Beskonak Project

The outline of the alternative thermal power plant selected as the criterion for evaluation of the Project is as follows:

(a) The location is to be in the Antalya Region where power of the Project is to be supplied.

(b) Construction cost, fuel cost, operating efficiency, etc., were calculated based on recent actual performances with units of 300 MW, which is the minimum size for construction in Turkey.

(c) The scale of the alternative facility is to be that having equal electricity output and energy in available to the Beskonak power station.

The particulars of the alternative thermal power plant selected in accordance with the above conditions are shown in Table 13-5.

(2) Fuel Cost of Alternative Thermal Power Plant

The unit price of fuel for the alternative thermal power plant was determined from the actual figures in Turkey as of March 1982 The unit price per kiloliter of heavy oil having a heating value corresponding to 9,600 kcal/lit was 28,930 TL (excluding tax), and the fuel cost per kWh at the generating end was obtained by the formula below.

$$\text{Unit Fuel Price per kWh} = \frac{0.86 \times \text{Unit Price of Heat}}{\text{Operating Thermal Efficiency}}$$

$$= \frac{0.86 \times 3.01}{0.35} = 7.40 \text{ TL/kWh}$$

$$\text{Unit Price of Heat} = \frac{\text{Unit Price of Fuel}}{\text{Calorific Value of Fuel}} = \frac{28{,}930 \text{ TL}}{9{,}600 \text{ kcal}}$$

$$= 3.01 \text{ TL/kcal}$$

where, operating thermal efficiency = 0.35

station service ratio = 0.06

(3) Salable Energy

Regarding the salable energy of the Project, as described in the power generation scheme in Chapter 9, the probable annual energy production at the generating end will be 659.9 GWh, and the actual salable energy deducting loss in transmission to the consumption area is estimated to be 631.5 GWh.

(4) Benefit of the Beskonak Project

The benefit of the Project, as described in 13.3.1, is to be expressed, considering the cost of an alternative thermal power plant capable of providing equal service to the Project with respect to effective output and effective energy, and the total amount of benefit during the project life is estimated to be 301,531.0 million TL (see Table 13-8). Details of these calculations are given in Appendix A-5.5-3.

Table 13-8 Benefit Flow of Beskonak Project

Unit: 10^6 T.L.

Year	Alternative Thermal Power Plant			Total
	Investment Cost	O & M	Energy Cost	
1				-
2				-
3	1,588.3			1,588.3
4	6,353.2			6,353.2
5	6,353.2			6,353.2
6	1,588.3			1,588.3
7		424.0	4,971.3	5,395.3
∿ 27		424.0	4,971.3	5,395.3
28	1,588.3	424.0	4,971.3	6,983.6
29	6,353.2	424.0	4,971.3	11,748.5
30	6,353.2	424.0	4,971.3	11,748.5
31	1,588.3	424.0	4,971.3	6,983.6
32		424.0	4,971.3	5,395.3
∿ 56		424.0	4,971.3	5,395.3
Total	31,766.0	21,200.0	248,565.0	301,531.0

Note: 1/ Investment cost (15,883 million T.L) is based on 1982 price level without interest during construction, import duties and escalation etc.

2/ Operation and Maintenance Cost

Power facilities; 15,883 x 10^6TL x @2.5% = 397.1 x 10^6TL

Energy; 671.8 x 10^6kWh x @0.04 TL/kWh = 26.9 x 10^6TL

Total = 424.0 x 10^6TL

13.3.5 Results of Comparative Analyses

The economics of a hydroelectric power project is often expressed in terms of benefit-cost ratio. In this case, depending on how the discount rate is taken, there is the drawback that this benefit-cost ratio varies except for the case that the due discount rate for that country is obtained beforehand. Therefore, international financial institutions such as the World Bank and the Asian Development Bank, make it a rule to evaluate the profitability of the project with the economic internal rate of return in order to avoid the abovementioned drawbacks.

In the case of the Project, as shown in Table 13-6, 12% has been determined to be the authorized discount rate in Turkey, and evaluation is done applying this rate. The equalizing discount rate at which benefit and cost of the Project become equal is to be obtained.

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

The economic cost of the Project for the project life of 56 years is shown in Table 13-7. The total present value in the initial year of the Project at a discount rate of 12% is calculated as 14,790.48 million TL (see Table 13-9).

The cost of the alternative thermal power plant as benefit of the Project is obtained from Tables 13-8 and 13-9, and the total present value is 32,842.16 million TL. Consequently, the benefit-cost ratio is estimated as 2.2 and net present value (B - C) as 18,051.67 million TL. As these two economic indices point out, it may be concluded that it will be more advantageous to construct and operate the Beskonak project rather than to build an alternative thermal power plant capable of providing equal service to the Project since the cost will be less.

(2) Equalizing Discount Rate

In the calculation of (1), a discount rate, at which the totals of respective present values of the costs invested of the hydroelectric project and alternative thermal power plant are equal, is called equalizing discount rate. In effect, the equalizing discount rate is a comparison of the cost of hydro and thermal, and the difference with the economic internal rate of return is that EIRR is based on the comparison of cost of hydroelectric power project and the benefit (energy sales revenue) actually produced with the facilities.

The equalizing discount rate obtained using the above cost of (1) is 34.0% shown in Table 13-9. Consequently, until the discount rate reaches 34.0%, the benefit (actually the cost) of the thermal power project exceeds the cost of the hydroelectric power plant, and it can be said it will be more advantageous to implement the hydroelectric project.

13.4 Economic Internal Rate of Return (EIRR) of Beskonak Project

The cost used in examination of the economic internal rate of return has already been obtained in 13.3.3.

On the other hand, the purpose of this examination, as described in 13.3.1, is not to compare the superiorities of hydro and thermal power facilities in case it is wanted to construct power generating facilities, but to search for criteria (indices) when there is a given amount of funds which can be freely used and it is to be judged how the limited resources (funds) can be managed in the most effective manner from the viewpoint of the national economy investing in any one of projects in various sectors. Consequently, because of the necessity to make a comparison with a project in a sector other than hydroelectric power scheme, the benefit must be expressed in terms of revenue which actually would have been obtained when the project was realized.

Accordingly, the revenue to be employed for examination of the economic internal rate of return is to be computed based on the electricity sales charges of TEK. The reasons were already mentioned in foot note of paragraph 13.2.1. The averaged electricity rate in the power system of TEK as of March 1982 was 6.00 TL/kWh. Meanwhile, the annual average effective energy of the Project is 631.5 million kWh. Therefore, the annual average electricity charge revenue is calculated to be 3,789.0 million TL/yr.

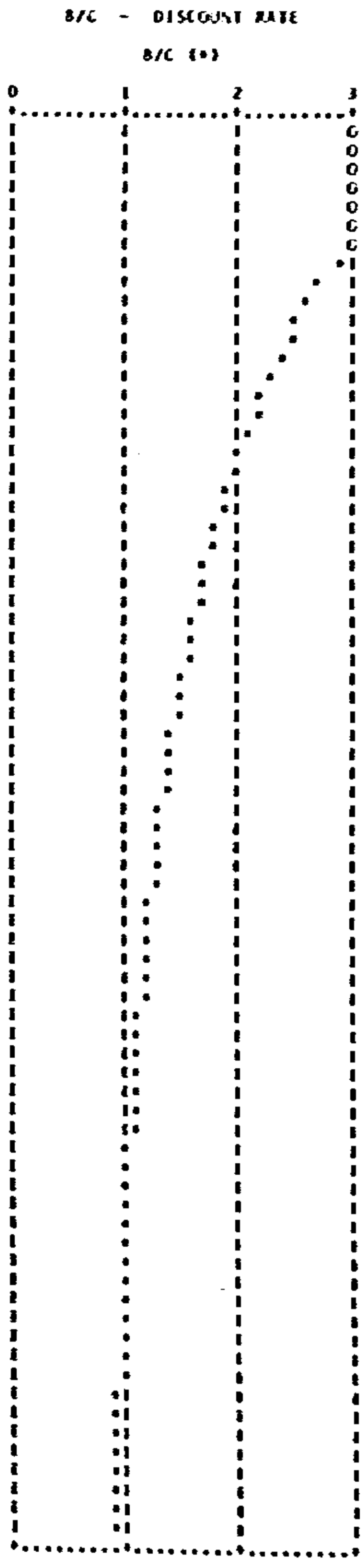
The economic internal rate of return obtained based on the above is 12.9% shown in Table 13-10. This rate exceeds the marginal product of capital of Turkey (marginal economic internal rate of return; 12%). It is also an advantageous value compared with the opportunity cost of capital (10%) considered as the criterion at international financial institutions headed by the World Bank.

Consequently, it is considered that the Beskonak project is amply worthy of investment, both financially and economically.

Further, in Table 13-10, various economic indices, in case of varying the discount rate at intervals of 0.5 percentage in a range from 5% to 40%, are given as references.

Table 13-9 Estimation of Equalizing Discount Rate

DISCOUNT RATE (%)	HYDRO TOTAL INVEST (MIL.TL)	ALT TOTAL INVEST (MIL.TL)	BENEFIT - COST ANALYSYS: COST (MIL.TL)	BENEFIT (MIL.TL)	B-C (MIL.TL)	B/C RATIO
5.0	28024.59	31765.98	22865.12	90033.62	67168.50	3.9376
5.5	28024.59	31765.98	21916.94	82025.37	60108.44	3.7426
6.0	28024.59	31765.98	21060.58	75036.31	53975.73	3.5629
6.5	28024.59	31765.98	20283.18	68907.69	48624.50	3.3973
7.0	28024.59	31765.98	19574.13	63510.96	43936.82	3.2446
7.5	28024.59	31765.98	18924.18	58735.83	39811.65	3.1037
8.0	28024.59	31765.98	18325.97	54494.95	36168.98	2.9736
8.5	28024.59	31765.98	17772.70	50711.03	32938.33	2.8533
9.0	28024.59	31765.98	17259.05	47322.42	30063.37	2.7419
9.5	28024.59	31765.98	16789.41	44276.47	27496.05	2.6356
10.0	28024.59	31765.98	16332.78	41528.70	25195.92	2.5427
10.5	28024.59	31765.98	15912.75	39041.52	23128.77	2.4535
11.0	28024.59	31765.98	15517.29	36782.14	21264.85	2.3704
11.5	28024.59	31765.98	15143.94	34723.45	19579.51	2.2929
12.0	28024.59	31765.98	14790.49	32842.16	18051.67	2.2205
12.5	28024.59	31765.98	14455.03	31117.93	16662.90	2.1527
13.0	28024.59	31765.98	14135.93	29533.60	15397.67	2.0893
13.5	28024.59	31765.98	13831.65	28073.59	14241.94	2.0297
14.0	28024.59	31765.98	13540.95	26724.98	13184.03	1.9736
14.5	28024.59	31765.98	13262.73	25476.41	12213.68	1.9209
15.0	28024.59	31765.98	12995.96	24317.75	11321.79	1.8712
15.5	28024.59	31765.98	12739.80	23240.44	10500.64	1.8242
16.0	28024.59	31765.98	12493.48	22236.81	9743.33	1.7799
16.5	28024.59	31765.98	12256.26	21299.68	9043.42	1.7379
17.0	28024.59	31765.98	12027.49	20423.17	8395.68	1.6980
17.5	28024.59	31765.98	11806.68	19602.04	7795.36	1.6602
18.0	28024.59	31765.98	11593.30	18831.45	7238.15	1.6243
18.5	28024.59	31765.98	11386.93	18107.33	6720.40	1.5902
19.0	28024.59	31765.98	11187.09	17425.54	6238.45	1.5576
19.5	28024.59	31765.98	10993.45	16782.82	5789.37	1.5266
20.0	28024.59	31765.98	10805.66	16176.11	5370.45	1.4970
20.5	28024.59	31765.98	10623.43	15602.71	4979.27	1.4687
21.0	28024.59	31765.98	10446.49	15060.15	4613.66	1.4416
21.5	28024.59	31765.98	10274.51	14545.93	4271.42	1.4157
22.0	28024.59	31765.98	10107.32	14058.21	3950.90	1.3909
22.5	28024.59	31765.98	9944.64	13595.03	3650.45	1.3671
23.0	28024.59	31765.98	9786.30	13154.79	3368.49	1.3442
23.5	28024.59	31765.98	9632.14	12735.87	3103.73	1.3222
24.0	28024.59	31765.98	9481.95	12336.96	2855.01	1.3011
24.5	28024.59	31765.98	9335.56	11956.57	2621.01	1.2808
25.0	28024.59	31765.98	9192.83	11593.64	2400.82	1.2612
25.5	28024.59	31765.98	9053.57	11247.06	2193.49	1.2423
26.0	28024.59	31765.98	8917.72	10915.83	1998.11	1.2241
26.5	28024.59	31765.98	8785.16	10599.05	1813.91	1.2065
27.0	28024.59	31765.98	8655.69	10295.81	1640.12	1.1895
27.5	28024.59	31765.98	8529.24	10005.34	1476.09	1.1731
28.0	28024.59	31765.98	8405.71	9726.87	1321.16	1.1572
28.5	28024.59	31765.98	8285.01	9459.92	1174.91	1.1418
29.0	28024.59	31765.98	8167.04	9203.54	1036.50	1.1269
29.5	28024.59	31765.98	8051.65	8957.31	905.65	1.1125
30.0	28024.59	31765.98	7938.85	8720.74	781.89	1.0985
30.5	28024.59	31765.98	7828.51	8493.25	664.74	1.0849
31.0	28024.59	31765.98	7720.53	8274.39	553.86	1.0717
31.5	28024.59	31765.98	7614.89	8063.71	448.82	1.0589
32.0	28024.59	31765.98	7511.49	7860.82	349.34	1.0465
32.5	28024.59	31765.98	7410.27	7665.29	255.02	1.0344
33.0	28024.59	31765.98	7311.15	7476.79	165.64	1.0227
33.5	28024.59	31765.98	7214.07	7294.97	80.90	1.0112
33.8	28024.59	31765.98	7156.79	7188.96	32.17	1.0045
33.9	28024.59	31765.98	7137.86	7154.11	16.26	1.0023
*34.0	28024.59	31765.98	7118.95	7119.47	0.52	1.0001
34.1	28024.59	31765.98	7100.21	7085.16	-15.04	0.9979
34.2	28024.59	31765.98	7081.49	7051.04	-30.45	0.9957
34.5	28024.59	31765.98	7025.85	6950.15	-75.70	0.9892
35.0	28024.59	31765.98	6934.59	6786.53	-148.06	0.9786
35.5	28024.59	31765.98	6845.14	6628.44	-216.70	0.9683
36.0	28024.59	31765.98	6757.48	6475.59	-281.89	0.9583
36.5	28024.59	31765.98	6671.56	6327.81	-343.75	0.9485
37.0	28024.59	31765.98	6587.32	6184.87	-402.46	0.9389
37.5	28024.59	31765.98	6504.71	6045.49	-459.22	0.9294
38.0	28024.59	31765.98	6423.69	5912.53	-511.16	0.9204
38.5	28024.59	31765.98	6344.23	5782.78	-561.45	0.9115
39.0	28024.59	31765.98	6266.28	5657.07	-609.21	0.9028
39.5	28024.59	31765.98	6189.81	5535.24	-654.57	0.8943
40.0	28024.59	31765.98	6114.79	5417.14	-697.65	0.8859

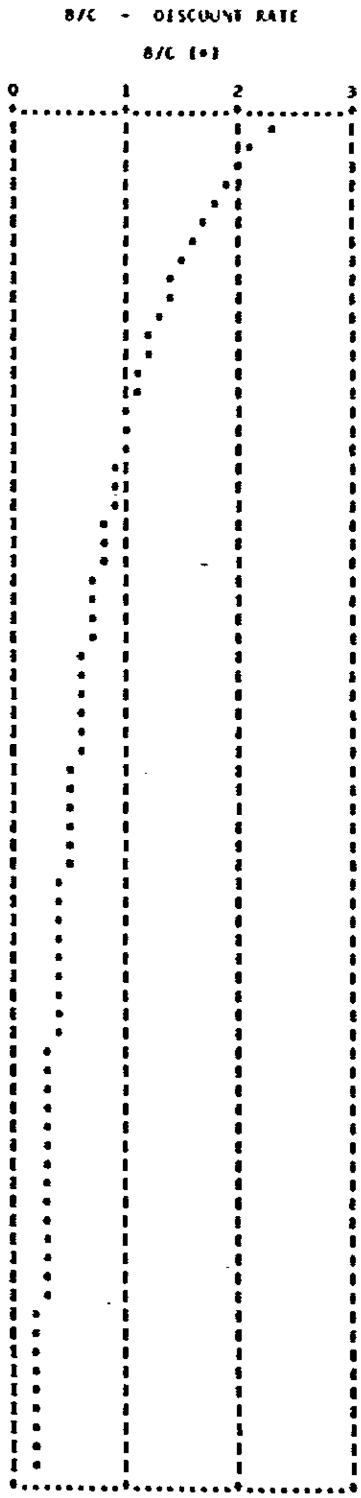


* --- I.R.R (HYDROPOWER)

Table 13-10 Estimation of Economic Internal Rate of Return (EIRR)

			BENEFIT - COST ANALYSYS			
DISCOUNT RATE (%)	HYDRO TOTAL INVEST (MIL.TL)	ALT TOTAL INVEST (MIL.TL)	COST (MIL.TL)	BENEFIT (MIL.TL)	B-C (MIL.TL)	B/C RATIO
5.0	28024.59	0.0	22865.12	51618.03	28752.91	2.2575
5.5	28024.59	0.0	21916.94	46528.11	24611.17	2.1229
6.0	28024.59	0.0	21060.58	42102.17	21041.59	1.9991
6.5	28024.59	0.0	20283.18	38235.94	17952.76	1.8851
7.0	28024.59	0.0	19574.13	34844.16	15270.03	1.7801
7.5	28024.59	0.0	18924.18	31854.95	12930.77	1.6833
8.0	28024.59	0.0	18325.97	29210.70	10884.73	1.5940
8.5	28024.59	0.0	17772.70	26861.02	9088.32	1.5114
9.0	28024.59	0.0	17259.05	24765.59	7506.54	1.4349
9.5	28024.59	0.0	16780.41	22890.20	6109.78	1.3641
10.0	28024.59	0.0	16332.78	21205.93	4873.16	1.2984
10.5	28024.59	0.0	15912.75	19688.43	3775.68	1.2373
11.0	28024.59	0.0	15517.29	18316.50	2799.21	1.1804
11.5	28024.59	0.0	15143.94	17072.61	1928.66	1.1274
12.0	28024.59	0.0	14790.49	15941.72	1151.23	1.0778
12.5	28024.59	0.0	14455.03	14910.77	455.74	1.0315
* 12.9	28024.59	0.0	14198.46	14150.36	-48.11	0.9966
13.0	28024.59	0.0	14135.93	13968.66	-167.27	0.9882
13.5	28024.59	0.0	13831.65	13105.41	-726.24	0.9475
14.0	28024.59	0.0	13540.95	12312.71	-1228.23	0.9093
14.5	28024.59	0.0	13262.73	11583.30	-1679.43	0.8734
15.0	28024.59	0.0	12995.96	10910.63	-2085.33	0.8395
15.5	28024.59	0.0	12739.80	10289.20	-2450.59	0.8076
16.0	28024.59	0.0	12493.48	9714.15	-2779.33	0.7775
16.5	28024.59	0.0	12256.26	9180.84	-3075.41	0.7491
17.0	28024.59	0.0	12027.49	8685.53	-3341.96	0.7221
17.5	28024.59	0.0	11806.68	8224.83	-3581.85	0.6966
18.0	28024.59	0.0	11593.30	7795.64	-3797.66	0.6724
18.5	28024.59	0.0	11386.93	7395.39	-3991.54	0.6495
19.0	28024.59	0.0	11187.09	7021.39	-4165.70	0.6276
19.5	28024.59	0.0	10993.45	6671.58	-4321.87	0.6069
20.0	28024.59	0.0	10805.66	6344.00	-4461.66	0.5871
20.5	28024.59	0.0	10623.43	6036.89	-4586.54	0.5683
21.0	28024.59	0.0	10446.49	5748.70	-4697.79	0.5503
21.5	28024.59	0.0	10274.51	5477.82	-4796.69	0.5331
22.0	28024.59	0.0	10107.32	5223.08	-4884.23	0.5168
22.5	28024.59	0.0	9944.64	4983.26	-4961.37	0.5011
23.0	28024.59	0.0	9786.30	4757.24	-5029.06	0.4861
23.5	28024.59	0.0	9632.14	4544.07	-5088.08	0.4718
24.0	28024.59	0.0	9481.95	4342.90	-5139.05	0.4580
24.5	28024.59	0.0	9335.56	4152.79	-5182.77	0.4448
25.0	28024.59	0.0	9192.83	3973.10	-5219.73	0.4322
25.5	28024.59	0.0	9053.57	3803.01	-5250.56	0.4201
26.0	28024.59	0.0	8917.72	3641.95	-5275.77	0.4084
26.5	28024.59	0.0	8785.16	3489.35	-5295.80	0.3972
27.0	28024.59	0.0	8655.69	3344.63	-5311.06	0.3864
27.5	28024.59	0.0	8529.24	3207.31	-5321.93	0.3760
28.0	28024.59	0.0	8405.71	3076.92	-5328.79	0.3661
28.5	28024.59	0.0	8285.01	2953.05	-5331.96	0.3564
29.0	28024.59	0.0	8167.04	2835.31	-5331.73	0.3472
29.5	28024.59	0.0	8051.66	2723.30	-5328.36	0.3382
30.0	28024.59	0.0	7938.85	2616.71	-5322.14	0.3296
30.5	28024.59	0.0	7828.51	2515.20	-5313.31	0.3213
31.0	28024.59	0.0	7720.53	2418.50	-5302.03	0.3133
31.5	28024.59	0.0	7614.89	2326.32	-5288.56	0.3055
32.0	28024.59	0.0	7511.49	2238.43	-5273.05	0.2980
32.5	28024.59	0.0	7410.27	2154.56	-5255.71	0.2908
33.0	28024.59	0.0	7311.15	2074.50	-5236.65	0.2837
33.5	28024.59	0.0	7214.07	1998.04	-5216.03	0.2770
34.0	28024.59	0.0	7118.98	1924.99	-5193.99	0.2704
34.5	28024.59	0.0	7025.85	1855.18	-5170.67	0.2641
35.0	28024.59	0.0	6934.59	1788.41	-5146.18	0.2579
35.5	28024.59	0.0	6845.14	1724.54	-5120.61	0.2519
36.0	28024.59	0.0	6757.48	1663.41	-5094.07	0.2462
36.5	28024.59	0.0	6671.56	1604.90	-5066.66	0.2406
37.0	28024.59	0.0	6587.32	1548.86	-5038.46	0.2351
37.5	28024.59	0.0	6504.71	1495.17	-5009.54	0.2299
38.0	28024.59	0.0	6423.69	1443.71	-4979.98	0.2247
38.5	28024.59	0.0	6344.23	1394.37	-4949.86	0.2198
39.0	28024.59	0.0	6266.28	1347.05	-4919.23	0.2150
39.5	28024.59	0.0	6189.81	1301.65	-4888.16	0.2103
40.0	28024.59	0.0	6114.19	1258.09	-4856.10	0.2057

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



CHAPTER 14

LOAN REPAYMENT PLAN

CHAPTER 14 LOAN REPAYMENT PLAN

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CHAPTER 14 LOAN REPAYMENT PLAN

14.1 Fundamental Consideration

In general, in case of constructing an electric power facility (power generating, transmitting or transforming facility), an enormous amount of advance investment is required in a relatively short period (about 4 - 8 years). Contrastedly, revenue as a return on the investment cannot be obtained at the initial stage of the construction period, and will be realized only after construction is completed. The recovery period is fairly long compared with durable consumer goods in general. Accordingly, it is not an overstatement to say that, procurement of funds of low interest rate, long deferment period and long repayment period determines the success or failure of the electtric power project.

With respect to the sources of funds required for realization of the Project, as a result of discussions with the Turkish Government (DSI), it was considered that the portion requiring foreign currency would be borrowed from an international financing institution and the portion requiring domestic currency from a domestic financing institution. A study was then made on setting the loan conditions for such a case.

Revenue as a return on investment would consist of electricity charges. The loan repayment plan was studied based on the electricity rates of TEK as of March 1982.

Required funds for the Project were estimated based on consumer price levels as of March 1982. Commissioning of this Project in the electric power system is scheduled to be around in 1993 (start of construction around in 1987). The funding plan ordinarily should be established adding the increase in expenses due to price escalations until start of operation, but price escalations in Turkey in recent years have indicated extremely abnormal values shown in Table 14-1 compared with those in major industrialized countries (see Table

14-2). The Survey Mission judged it to be difficult to estimate future price escalations, and it was decided that the present study should be made based on the fund requirements as of March 1982[1/]. Therefore, at the stage that the Project has become a step close to realization, it will be necessary for reexamination to be made of the construction cost and the loan repayment plan.

Table 14-1 Trends in Wholesale Price Indices and Consumers Price Indices in Turkey

Year	Wholesale Price		Consumer Price	
	Index	(%)	Index	(%)
1975	100		100	
		16.0		17.5
1976	116.0		117.5	
		27.3		30.5
1977	143.3		148.0	
		71.7		91.6
1978	215.0		239.6	
		139.4		152.2
1979	354.4		391.8	
		381.1		369.3
1980	735.5		761.1	
		275.9		286.3
1981	1,011.4		1,047.4	
Ave.		47.0		47.9

1/ The project cost will increase in proportion to price escalation, while electricity charge revenue constituting the benefit of the Project will also be proportional to price escalation. Accordingly, no question should arise concerning the financial practicability of the Project even if the financial evaluation were to be made based on the Project cost and electricity rates as of March 1982.

Table 14-2 Trends in Wholesale Price Indices of Manufactured Goods in Major Industrial Countries

Country	1975 Index	End 1981 Index	Annual Average Escalation Rate
Japan	100	128.1	4.2
U.S.A.	100	177.3	10.0
West Germany	100	128.0	4.2
France	100	161.7	8.3
Canada	100	177.1	10.0
Ave.			7.34

14.2 Fund Requirement and Fund Procurement

The fund requirement (initial investment amount) of the Project is estimated to be a total of 35,478 million TL based on consumer price levels as of March 1982. Of this amount the foreign currency requirement corresponds to 8,010 million TL and the domestic currency requirement 27,468 million TL (see Table 12-1). The fund requirements by year are also shown in Table 12-2. These totals include interest during construction and contingencies for variations in quantities, but not contingencies for price escalations for the reasons described in 14.1.

The sources for funds procurement are mentioned in 14.1, with is e interest rates and terms of repayment assumed as follows:

Interest rate ; 8% (commitment charge not considered)

Repayment method ; 6 years grace period, 15 years repayment of capital and interest in equal installments

Domestic currency:

Interest rate ; 9.5%

Repayment method ; 6 years grace period, 10 years repayment of capital in equal installments

14.3 Revenue and Expenses

It is planned for the electric power of the Project to be supplied to the Antalya region through the power system of TEK. The present electricity charge system of TEK, as described in Chapter 4, consists of two rates (single and double terms tariff), and the customer has the option to choose either of the two, however, detail of the averaged sales price, by customer is not clear. Therefore, it was decided to use the averaged energy sales price, which is estimated on the basis of income and sold energy of the TEK system as of March 1982. The estimated price per kWh is 6.0 TL1/. The revenue from electric power of the Project was computed based on this unit electricity price (see Table 14-3).

The annual operation and maintenance costs of electric power facilities of the Project were obtained from ratios to the construction costs of the facilities. In effect, 1.0% was used for mainly dam and reservoir, 2.0% for hydraulic and electromechanical equipment, and 1.5% for transmission facilities.

1/ $\frac{\text{Income}}{\text{Sold Energy}} = \frac{11,315.3 \times 10^6 \text{ TL}}{1,893 \times 10^6 \text{ kWh}} = 5.98 \text{ TL/kWh} = 6.0 \text{ TL/kWh}$

Depreciation cost was calculated by the straight line method with residual values as zero, and with service lives of facilities 50 years for dam and reservoir, and 25 years for electro-mechanical equipment and transmission facilities. Based on the above conditions, the operating income was obtained deducting operation, maintenance and administration costs and depreciation cost from the revenue of each year for a 21-year period (the longer of grace period + repayment period), while further, deducting interest paid on borrowings, the net operating income after start of operation was obtained. Table 14-3 shows the electricity charge revenue obtained each year during the 15-year period from start of operation.

14.4 Repayment Plan

Depreciation of fixed assets among power generating facilities is handled as expense in accounting procedures, but properly speaking, it is not an expense which is actually disbursed, and is a reserve fund. Consequently, in a loan repayment plan, this reserve can be counted as part of the funds for repayment. Therefore, the net profit (operating income) in the balance of current accounts of the Project and the abovementioned depreciation cost combined will be the funds applicable to repayment, and these values are given under (A) in Table 14-4.

Meanwhile, based on the financing terms described in 14.2, the yearly expenses to be repaid lenders is shown under (B) in Table 14-4. As can be seen in Table 14-4, it will be the twenty-third year after start of operation that the capital invested for the Project and the profit produced from the capital invested will become balanced, and the capital invested will have been fully recovered at that point, with profit subsequently produced.

Table 14-3 Income Statement for Beşkonak Project

Unit: 10^6TL

Description \ Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
(A) Gross Revenue from																					
Sales (10^6TL)							3,789.0	3,789.0	3,789.0	3,789.0	3,789.0	3,789.0	3,789.0	3,789.0	3,789.0	3,789.0	3,789.0	3,789.0	3,789.0	3,789.0	3,789.0
Annual Sales of Energy (10^6kWh)							631.5	631.5	631.5	631.5	631.5	631.5	631.5	631.5	631.5	631.5	631.5	631.5	631.5	631.5	631.5
Unit Sales Price (TL/kWh)							6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
(B) Total Operation Cost							1,273.0	1,273.0	1,273.0	1,273.0	1,273.0	1,273.0	1,273.0	1,273.0	1,273.0	1,273.0	1,273.0	1,273.0	1,273.0	1,273.0	1,273.0
Operation & Maintenance							382.8	382.8	382.8	382.8	382.8	382.8	382.8	382.8	382.8	382.8	382.8	382.8	382.8	382.8	382.8
Depreciation							890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2
(C) Operation-Income (A) - (B)							2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0
(D) Financial Expenditure							3,250.3	2,965.7	2,679.3	2,390.8	2,100.2	1,807.0	1,511.5	1,213.0	911.7	607.0	298.9	248.0	192.9	133.5	69.3
Foreign Loan							640.8	617.2	591.7	564.2	534.5	502.3	467.7	430.2	389.8	346.1	298.9	248.0	192.9	133.5	69.3
Domestic Loan							2,609.5	2,348.5	2,087.6	1,826.6	1,565.7	1,304.7	1,043.8	782.8	521.9	260.9					
(E) Net Income (C) - (D)							-743.3	-449.7	-163.3	125.2	415.8	709.0	1,004.5	1,303.0	1,604.3	1,909.9	2,217.1	2,268.0	2,323.1	2,382.5	2,446.7

Table 14-4 Cash Flow Statement for Beşkonak Project

Description \ Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
(A) Cash Credit	2,399.2	3,207.6	5,502.7	8,861.3	9,383.1	6,124.1	3,406.2	3,406.2	3,406.2	3,406.2	3,406.2	3,406.2	3,406.2	3,406.2	3,406.2	3,406.2	3,406.2	3,406.2	3,406.2	3,406.2	3,406.2	3,406.2	3,406.2
1. Operation Income before Interest							2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0	2,516.0
2. Depreciation							890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2	890.2
3. Exterior Borrowing																							
Foreign Fund			693.1	2,813.0	3,297.5	1,206.4																	
Domestic Fund	2,399.2	3,207.6	4,809.6	6,048.3	6,085.6	4,917.7																	
(B) Cash Disbursement	2,399.2	3,207.6	5,502.7	8,861.3	9,383.1	6,124.1	6,292.1	6,031.1	5,770.2	5,509.2	5,248.3	4,987.3	4,726.4	4,455.4	4,204.5	3,943.5	935.8	935.8	935.8	935.8	935.8	0	0
1. Construction Expenditure	2,399.2	3,207.6	5,502.7	8,861.3	9,383.1	6,124.1																	
2. Interest							3,250.3	2,965.7	2,679.3	2,390.8	2,100.2	1,807.0	1,511.5	1,213.0	911.7	607.0	298.9	248.0	129.9	133.5	69.3		
3. Amortization of Debit (Principal)							3,041.8	3,065.4	3,090.9	3,118.4	3,148.1	3,180.3	3,214.9	3,252.4	3,292.8	3,336.5	636.9	687.8	742.9	802.3	866.6		
Foreign Fund							295.0	318.6	344.1	371.6	401.3	433.5	468.1	505.6	546.0	589.7	636.9	687.8	742.9	802.3	866.6		
Domestic Fund							2,746.8	2,746.8	2,746.8	2,746.8	2,746.8	2,746.8	2,746.8	2,746.8	2,746.8	2,746.8							
(c) Cash Balance (A)-(B)							-2,885.9	-2,624.9	-2,364.0	-2,103.0	-1,842.1	-1,581.1	-1,320.2	-1,059.2	-798.3	-537.3	2,470.4	2,470.4	2,470.4	2,470.4	2,470.4	3,406.2	3,406.2
(D) Accumulated Total							-2,885.9	-5,510.8	-7,874.8	-9,977.8	-11,819.9	-13,401.0	-14,721.2	-15,780.4	-16,578.7	-17,116.0	-14,645.6	-12,175.2	-9,704.8	-7,234.4	-4,764.0	-1,357.1	2,048.4

CHAPTER 15

STUDY ON KISIK DAM AND POWER STATION PROJECT

CHAPTER 15 STUDY ON KISIK DAM AND POWER STATION PROJECT

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CHAPTER 15 STUDY ON KISIK DAM AND POWER STATION

15.1 Outline

On condition that river flows are regulated by a reservoir, the water utilization in the downstream will be interfered with due to the fluctuation of river flows. In order to ease the interference, a regulating pondage is constructed in the downstream. By utilizing the pondage, river flows are re-regulated after being regulated by the upstream reservoir and as a result natural river flows are discharged.

When the peak load operation is exclusively done at the Beskonak power station during the irrigation season, the irrigation water necessary for the downstream area cannot be secured due to the fluctuation of river flows. Therefore, various studies were made regarding construction of a regulating pond with the purpose of storing and regulating the peak power discharge and releasing it uniformly to the downstream area.

Köprücay diversion dam was constructed by DSI for irrigation purposes 18 km downstream of the Beskonak dam. It is considered to utilize this diversion dam as a regulating pondage for the Beskonak reservoir. However, it is necessary for the diversion dam to be rebuilt so as to possess the required regulating capacity. Based on the reason stated in 9.1.1 of chapter 9, studies were not performed regarding the rebuilding of the diversion dam.

As the dam site of the regulating pond, the Kisik site was selected 2 km upstream of the diversion dam and it was decided to provide a power station utilizing the low head.

The flat land spreads out in the vicinity of the confluence of the Koprucay River and the Sagirin River, where cotton and wheat are cultivated. The Kisik dam site is located in the downstream of the confluence and is favorable as a dam site due to being relatively narrow. By construction of Kisik dam, this cultivated land will be inundated in a regulating pond over a broad area. This area is also included in the irrigation plan of DSI, a part of which has been already implemented. Accordingly, it is judged that the implementation of the Kisik project will conflict greatly with the irrigation program while the effects of the accompanying problems of land acquisition will be substantial.

The Kisik project, as described in 9.4, is premised on starting power genertion at the same time as Beskonak project (installed capacity 200 MW = 100 MW @2). In case of simultaneous development of two projects, the benefit-cost ratio (B/C) of Beskonak/Kisik projects will be 1.784, and the net present value (B - C) 4,039 x 10^6 TL.

Since it is considered that the above problems will interfere with the realization of the Kisik project, it is difficult to develop the Beskonak/Kisik projects at the same time and it is thought desirable to implement the Beskonak project independently. In this case the installed capacity of the Project is to be 200 MW (= 155 MW + 45 MW).

On condition that the Kisik project will be realized in future after the resolution of the problems regarding irrigation plans and land aequisition, it will become possible to carry out the peak load operation exclusively at the Beskonak power station during irrigation season. As a consequence the annual energy production of the Beskonak project is expected to increase by 43.1 GWh. When the increased benefit of the Beskonak project is included, the economics of the Kisik project will be B/C of 1.701 and (B-C) of 719 x 10^6TL.

Summary of the Kisik project is shown in Table 15-1.

Table 15-1 Summary of Kisik Dam and Power Station

Item	Unit	Description
Location	-	On the Köprücay River
Catchment Area	km^2	2,375
Annual Inflow	$10^6 m^3$	3,270
Design Flood	m^3/sec	5,100
Reservoir		
High Water Level	m	EL. 35.00
Low Water Level	m	EL. 34.00
Reservoir Area	km^2	8.6
Gross Storage Capacity	$10^3 m^3$	55,800
Effective Storage Capacity	$10^3 m^3$	8,000
Dam		
Type	-	Concrete Gravity and Rock-fill Type Dam
Elevation of Crest	m	EL. 40.00
Height of Dam	m	40.00
Length of Crest	m	262.80
Volume of Dam	m^3	Rock-fill 300,300 Concrete 32,800
Spillway		
Type	-	Horizontal Apron Dissipator
Capacity	m^3/sec	5,100
Power Intake		
Control Gate	-	Roller Gates with Transrack
Powerhouse		
Type	-	Semi-underground Type
Power Generation Facilities		
Number of Units	unit	2
Unit Capacity	kW	8,000
Turbine		
Number	unit	2
Type	-	Tubular
Normal Effective Head	m	15.1
Maximum Discharge	m^3/sec	123
Standard Output	kW	8,200
Revolving Speed	rpm	250

Item	Unit	Description
Generator		
Number	unit	2
Type	-	3 Phase, Alternating Current Synchronous Generator
Output	kVA	8,900
Voltage	kV	6.3
Power Factor	%	90 (Lagging)
Frequency	Hz	50
Revolving Speed	rpm	250
Main Transformer		
Number	unit	1
Type	-	Outdoor, 3-Phase, Oil-immersed, Self-cooled
Capacity	kVA	17,800
Voltage	kV	154/6.3 kV
Switchyard		
Nominal Voltage	kV	154
Type of Circuit Breaker	-	Outdoor, AC, 3-Phase, Gas Blast Circuit Breaker
Transmission Line		
Number of Circuit	unit	1
Nominal Voltage	kV	154
Annual Energy Production		
Total Energy	GWh	95.9
Project Cost		
Investment	10^6TL	8,910

15.2 Geology

15.2.1 Outline of Investigations

Collection and examination of existing data and field reconnaissances have been carried out regarding the Kisik project area. Investigations by core boring and test adits have not been carried out on this site.

(1) Existing Data

Geological data related to the Kisik project area obtained and studied are the following:

Eroskay, S.O., and Caglayik, V., (1968)
"Geologic Map of Köprücay-Beskonak Reservoir Area (1:100,000)"

Tarimci, T., (1982)
"Geological Study Report of Beskonak Project"

(2) Field Reconnaissances

Field reconnaissances by the Survey Mission were made twice in February-March and October 1982, and the dam site and surroundings of the regulating pond were explored.

15.2.2 Regulating Pond and Its Surrounding Area

(1) Topgraphy

The surroundings of the pond present a topography of gentle relief as a whole. A series of alluvial lowlands extending northwest-southeast is distributed along the Koca Dele which joins the Köprücay River at the right bank and the Sagirin Dele at the left bank, and these comprise the main part of the pond. Along the Köprücay River downstream from the confluences with these two tributaries there are terraces developed at locations approximately 10 to 30 m above the present river bed.

In the vicinity of the dam site the Köprücay River meanders through mountainland which is not very rugged, and the valley is relatively narrowed in width.

(2) Geology

The foundtion rocks in the project area and its surroundings in order from the bottom consist of ophiolite and limestone of the Cretaceous Period, and conglomerate and alternating beds of shale and sandstone of the Miocene Epoch.

The ophiolite is distributed from the dam site vicinity to the downstream area, while the limestone is at scattered locations in the ophiolite distribution area. The conglomerate is called Köprücay Conglomerate and Tasagil Conglomerate, with the former widely distributed at the upstream right bank of the pond and the latter distributed in a narrow belt in the vicinity of the dam site in a north-northwest to south-southwest direction. The sandstone and shale are called the Beskonak Formation, which is widely distributed at the right bank of the pond and along the Koca Dele.

A geological structure in the northwest-southeast direction is predominant in this project area. In effect, fold and faults extend in this direction.

(3) Hydrogeology

Of the streams in the project area, other than the Köprücay River mainstream, only the Koca Dele has surface flow throughout the year.

With regard to springs, besides the M1-M3 springs upstream (see 7.3.6), there are a number of springs scattered in the Beskonak Formation distribution area.

Of the formation distributed in the project area, there is a possibility that limestone and conglomerate will have high permeability,while the other strata may be judged to be not readily permeable.

(4) Watertightness of the Regulation Pond

Of the formation of high permeability, Köprücay Conglomerate is distributed in the pondage area. This Conglomerate distributed at the right bank upstream of the water impoundment area has been karstified as described in 7.3 and its permeability is high. However, there are springs at EL. 35-36 m (design high water level: 35.0 m) and there is no possibility of leakage from this area. Consequently, it is judged that the pondage is watertight enough.

15.2.3 Dam Site

(1) Topography

The dam site has been selected where the valley of the Köprücay River is the narrowest with a small ridge protruding toward the river from the right bank. The river-bed width at the dam site is approximately 60 m, and the valley width at the design high water level is approximately 270 m.

(2) Geology

Alluvium and talus deposits are distributed on the dam site. The alluvium consists of sand and gravel, and although the thickness has not been confirmed, it is judged to be more than 20 m from the bedrock elevation (approximately 0 m) of the river bed of the upstream Beskonak Formation. The talus deposits are distributed on the right bank, and the thickness is probably about 5 m at most.

The foundation rock is comprised of Tasagil Conglomerate and ophiolite. The Tasagil Conglomerate is distributed at the left bank and part of the right bank, and is massive and relatively hard, but mudstone is intercalated. Ophiolite is distributed at the right bank, cracky in general and weathered strongly, weathering at the surface portion.

(3) Engineering Geology

This dam site does not involve any geological problem as a foundation for a concrete dam, but it will be necessary for further clarification to be made of the mudstone intercalated in the Tasagil Conglomerate and the distribution and properties of the weathered portion of the ophiolite.

15.2.4 Construction Materials

The total volumes of concrete and embankment materials scheduled to be used for construction of the Kisik project are approximately 64,400 m^3 and approximately 300,000 m^3, respectively.

It has been confirmed in the field investigations by DSI and the Survey Mission that all of the materials for the above are available in the vicinity of the dam site. That is, alluvium at the dam site and immediately upstream are planned to be used as concrete aggregates and filter materials. The borrow area for impervious core materials is to be the flat piece of land on the left bank upstream of the dam. The quarry for rock materials is to be a limestone distribution area on the left bank downstream of the dam.

Although it is judged that these materials are adequate both in quality and quantity, it will be necessary for further detailed investigations to be made at the stage of the definite study.

15.3 Power Generation Scheme

15.3.1 Basic Matters

The Kisik dam site is located approximately 2 km upstream of Köprücay diversion dam, and since the catchment areas of the two dams are judged to be approximately the same, the catchment area of Kisik dam was taken to be 2,375 km^2.

The pondage capacity and area curve of the Kisik dam site are shown in Fig. 15-1.

The runoff at the Kisik dam site was computed by the following method based on runoff data of Beskonak dam site and Kisik gaging station, considering the effect of regulation by the Beskonak reservoir.

(1) Calculation of Residual Runoff Between Beskonak Dam and Kisik Dam

The residual runoff between Beskonak dam and Kisik dam was computed using the runoffs at the Beskonak dam site (October 1940-September 1980) and the data of Kisik gaging station (October 1940-May 1964; closed down upon construction of Köprücay diversion dam). The period for which measurement data of Kisik G.S. were lacking (June 1964-September 1980) was filled in based on the correlation between the Beskonak dam site runoff and the Kisik gaging station runoff. The Beskonak dam site runoff RQ_{BGS} (R: catchment area ratio, Q_{BGS}: Beskonak gaging station runoff) calculated in 6.3.4 was used in order to obtain the runoff correlation. The correlation between the two runoffs is shown in Fig. 15-2.

The residual runoff between Beskonak dam and Kisik dam was computed by the equation below.

$$Q_{BK} = Q_{KG} - Q_{IN}$$

where,

Q_{BK} : residual runoff between Beskonak dam and Kisik dam

Q_{KG} : runoff at Kisik gaging station

Q_{IN} : runoff at Beskonak dam site

(2) Regulation by Beskonak Reservoir (Calculations of Available Discharge of Beskonak Power Station and Dam Overflow)

Referring to Chapter 9, the dimensions of Beskonak dam and power station were selected as reservoir high water level of EL.155 m, effective storage capacity of 275×10^6 m^3, maximum available discharge of 216 m^3/sec, installed capacity of 200 MW and two units of 100 MW.

The operation plan for Beskonak reservoir was calculated by electronic computer using the monthly average runoffs given in Table 6-1.

(3) Calculation of Kisik Dam Site Runoff

Taking into consideration the residual runoffs and discharges from Beskonak reservoir and power station, the runoffs at the Kisik dam site were determined by the equation below.

$$Q_{KIN} = Q_{BP} + Q_{BO} + Q_{BK}$$

where,

Q_{KIN} : Kisik dam site runoff

Q_{BP} : Discharge from Beskonak power station

Q_{BO} : Overflow from Beskonak dam

Q_{BK} : Residual runoff between Beskonak dam and Kisik dam.

The runoffs at the Kisik dam site are shown in Table 15-2.

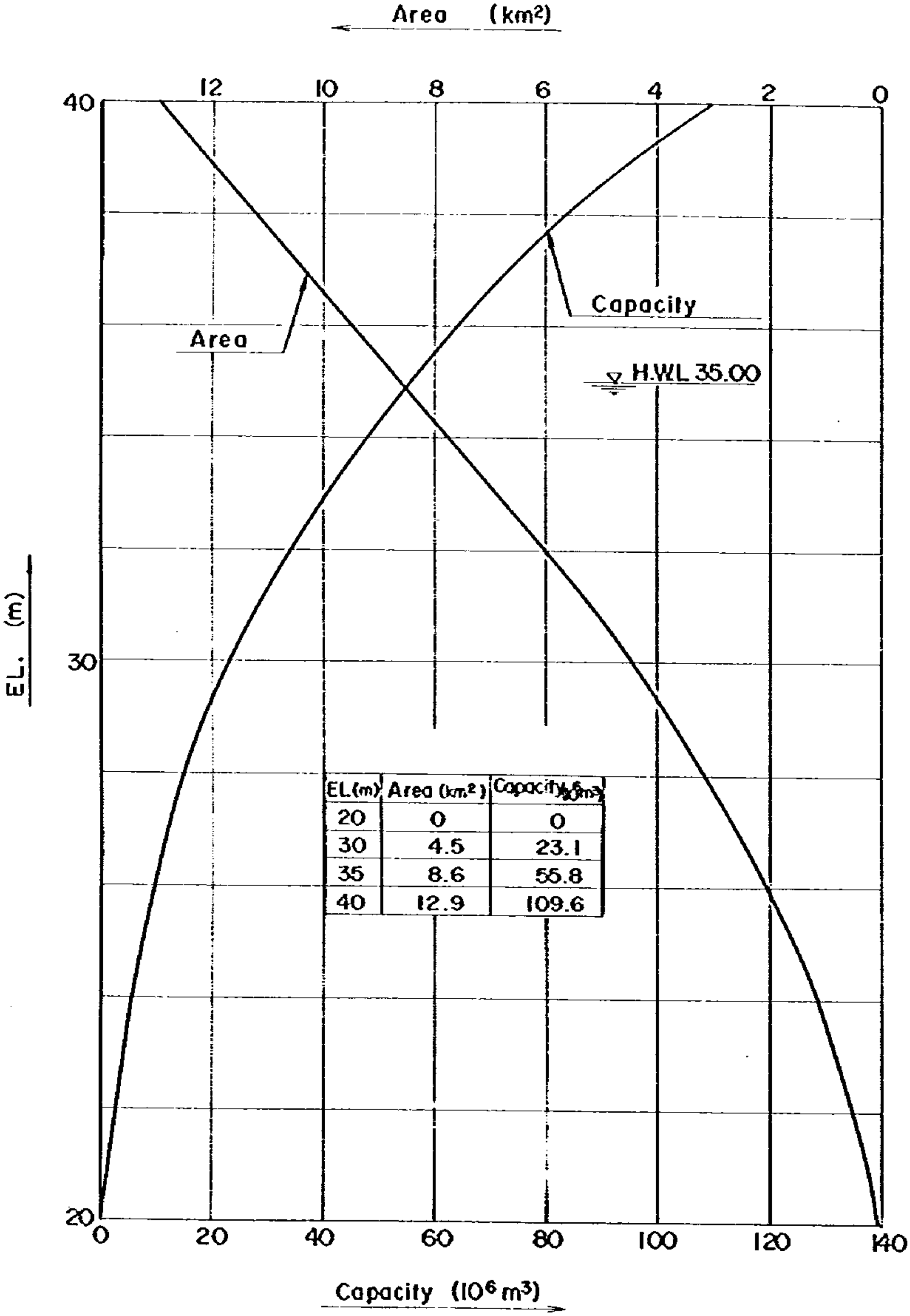
15.3.2 Development Scale

The high water level of Kisik dam was selected to be at EL.35 m taking into account the upstream irrigation scheme and the tailrace water level of the Beskonak project. According to the pondage capacity curve of the Kisik dam site, it was decided for the Kisik pondage to perform a daily regulations.

The maximum available discharge of Kisik power station, considering the runoff duration at the Kisik dam site, was taken to be 123 m^3/sec at which about 80% of the total annual inflow can be utilized, and installed capacity was made 16 MW.

Calculation of energy production was done by electronic computer using runoff data of the 40-year period from October 1940 to Septmber 1980. The energy productions by month of Beskonak and Kisik power stations are shown in Tables 15-3 and 15-4.

Fig. 15 - 1 Kısık Regulating Pondage Capacity and Area Curve



EL.(m)	Area (km²)	Capacity ($10^6 m^3$)
20	0	0
30	4.5	23.1
35	8.6	55.8
40	12.9	109.6

Fig. 15-2 Correlation between Kısık G.S and Beşkonak Dam Site

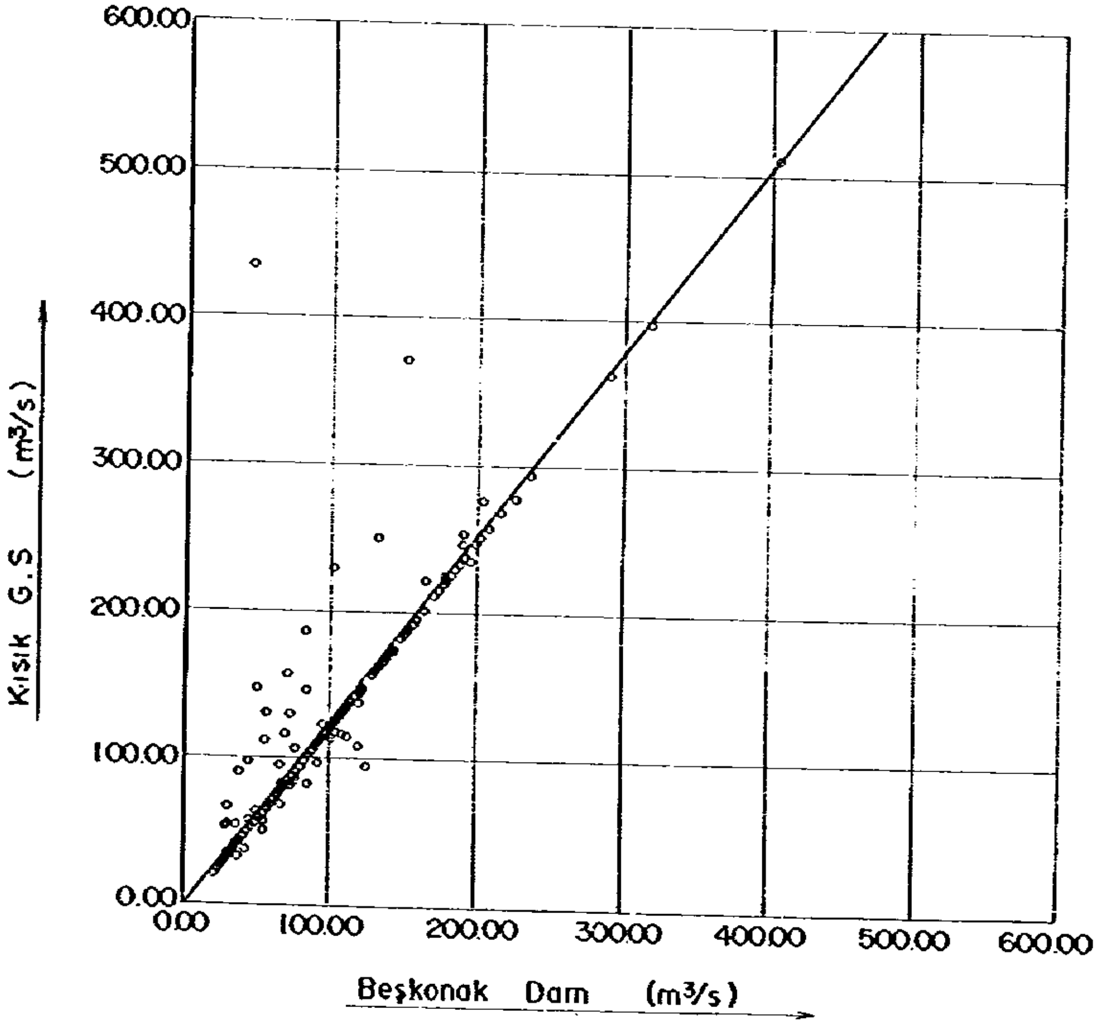


Table 15-2 Monthly Inflow at Kisik Dam Site

Unit: $10^6 m^3$

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total
1941	150.64	162.67	659.16	718.32	460.13	469.34	357.57	282.04	188.59	151.20	141.75	135.86	3,868.27
1942	150.06	155.35	194.29	613.59	572.93	575.55	449.95	341.71	207.10	147.10	141.20	135.65	3,684.36
1943	145.92	212.94	341.44	568.04	288.18	269.45	406.01	331.91	198.18	144.83	139.65	134.23	3,174.79
1944	145.27	151.92	182.93	427.74	642.61	621.25	470.06	374.33	359.23	177.69	144.26	135.91	3,842.46
1945	142.04	182.06	359.71	539.94	387.36	335.82	497.00	395.16	228.02	159.79	142.38	135.09	3,415.28
1946	149.93	149.99	622.62	350.84	452.82	438.44	493.17	452.54	311.27	245.96	167.91	135.46	3,970.28
1947	142.93	142.08	499.61	453.79	594.93	335.01	260.29	237.47	147.36	121.48	128.42	129.25	3,232.65
1948	122.53	162.29	374.07	531.60	553.96	281.45	305.44	252.94	192.09	157.49	136.64	135.53	3,306.04
1949	127.93	120.91	120.74	130.60	123.62	316.76	384.89	343.00	171.18	125.24	128.66	125.95	2,219.51
1950	114.42	134.17	129.90	143.67	112.03	137.48	189.78	297.62	151.76	103.95	112.49	111.35	1,769.64
1951	112.49	114.20	117.85	201.84	178.91	449.03	425.53	400.66	291.86	229.16	185.79	169.35	2,876.69
1952	203.02	143.23	156.26	306.16	457.55	370.29	326.26	237.03	195.99	142.52	138.33	135.06	2,872.70
1953	140.91	198.10	1,363.40	1,067.42	532.01	468.43	406.61	390.19	274.05	184.69	141.83	133.90	5,301.59
1954	139.29	141.78	134.86	152.35	274.72	318.69	331.65	320.82	217.31	125.32	136.21	132.98	2,426.17
1955	135.50	159.25	284.96	602.40	350.65	302.93	282.42	210.39	140.32	103.77	130.47	135.52	2,877.58
1956	189.74	273.27	383.28	343.40	817.87	659.12	593.36	495.83	327.29	243.95	219.58	190.13	4,744.63
1957	119.52	140.91	134.76	135.62	124.73	230.65	197.95	219.07	160.98	103.97	112.49	121.13	1,790.59
1958	120.58	136.02	149.47	808.74	341.06	524.59	412.41	292.24	201.50	143.94	137.23	135.99	3,402.77
1959	126.71	125.27	206.31	720.59	303.56	195.49	212.47	183.99	159.08	152.64	117.21	118.15	2,628.38
1960	137.88	132.82	249.91	435.72	265.67	345.22	305.13	229.38	137.05	117.42	129.86	136.14	2,622.20
1961	133.83	134.77	153.35	214.49	539.31	215.08	324.86	182.80	114.73	112.49	115.63	131.89	2,433.28
1962	130.01	135.94	147.93	190.45	399.69	440.14	235.33	224.26	139.63	123.39	137.33	135.60	2,439.72
1963	141.23	134.56	411.49	658.38	665.47	357.91	239.83	307.61	217.18	143.43	135.89	133.22	3,616.40
1964	140.03	155.94	184.08	1,475.41	177.71	312.44	212.75	292.92	157.08	132.34	147.46	144.94	3,238.08
1965	142.81	150.58	161.08	212.51	659.54	558.45	569.64	517.23	264.18	159.35	152.62	147.45	3,724.44
1966	153.97	158.00	522.78	1,308.18	513.60	491.62	516.40	369.47	239.02	175.76	155.27	149.13	4,752.41
1967	152.49	159.26	357.35	437.17	292.07	344.31	538.95	379.90	217.29	163.86	154.92	149.53	3,345.12
1968	155.75	204.30	459.77	724.83	412.40	684.01	354.70	316.63	195.08	157.39	154.11	153.66	4,001.66
1969	155.26	173.19	453.45	726.81	388.40	474.24	475.37	445.60	250.65	178.84	155.61	149.32	4,028.53
1970	153.55	157.59	510.29	721.69	692.24	583.86	375.37	317.95	219.55	172.57	155.02	149.86	4,199.37
1971	156.90	166.93	184.18	245.92	388.31	422.57	350.13	300.49	193.34	150.92	151.32	145.95	2,861.97
1972	150.56	165.32	221.93	189.93	272.63	289.70	245.20	234.55	173.17	155.16	151.59	147.31	2,397.25
1973	152.70	162.61	155.65	140.40	209.67	630.93	297.24	254.37	158.14	138.97	149.53	145.63	2,415.80
1974	152.23	151.33	161.37	197.93	231.18	418.33	247.90	222.79	149.26	126.15	155.06	145.71	2,409.40
1975	153.44	157.69	260.97	557.64	417.49	637.76	473.40	450.90	277.32	173.43	155.06	145.71	3,689.80
1976	156.55	263.85	334.02	397.23	300.47	245.71	436.78	305.20	197.33	155.99	152.41	145.90	3,094.73
1977	165.84	163.69	551.02	285.08	264.64	305.26	332.04	295.91	165.40	138.63	150.39	148.07	3,026.95
1978	154.02	155.07	159.05	545.27	877.54	483.59	445.69	390.64	230.35	159.66	153.26	149.40	3,907.64
1979	162.09	175.49	457.76	875.22	529.61	311.90	284.09	309.70	269.65	164.24	152.37	145.77	3,838.85
1980	158.48	184.39	368.59	570.63	309.77	375.81	424.18	329.36	187.22	150.20	150.97	145.77	3,350.76
Ave.	145.24	162.15	322.02	493.21	413.95	355.90	359.99	321.77	207.03	152.86	145.25	140.84	3,270.18

Table 15-3 Energy Production at Kiski P.S.

Unit: GWh

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total
1941	5.8	6.3	10.7	10.9	10.1	11.3	11.2	10.4	7.3	5.8	5.4	5.2	100.4
1942	5.8	6.0	7.5	11.0	9.9	11.2	11.0	11.6	7.9	5.6	5.6	5.2	98.1
1943	5.6	8.1	11.6	11.2	10.4	9.8	11.1	11.7	7.6	5.6	5.4	5.1	103.1
1944	5.6	5.8	7.4	11.1	10.2	11.0	11.0	11.5	11.2	6.9	5.5	5.2	102.0
1945	5.4	7.0	11.6	11.2	10.3	11.7	11.1	11.5	8.6	6.2	5.5	5.2	105.2
1946	5.8	5.8	10.9	11.5	10.1	11.4	10.9	11.4	11.2	8.2	6.5	5.2	108.8
1947	5.5	5.5	10.7	11.3	9.9	11.7	9.7	9.0	5.7	4.6	4.9	5.0	93.5
1948	4.7	6.3	10.1	11.1	10.4	10.6	11.1	10.8	7.4	6.1	5.2	5.2	98.8
1949	4.9	4.6	4.5	5.0	4.7	9.3	11.1	11.6	6.5	4.8	4.9	4.8	76.9
1950	4.3	5.1	4.9	5.5	4.2	5.3	7.2	10.9	5.8	4.3	4.2	4.2	65.1
1951	4.2	4.4	4.5	7.7	6.9	11.4	11.0	11.5	10.7	8.7	7.2	6.5	94.6
1952	7.8	5.5	6.9	11.1	10.6	11.5	11.3	10.9	7.6	5.5	5.3	5.2	98.2
1953	5.4	7.6	10.0	10.4	10.0	11.3	11.1	11.5	10.1	7.1	5.4	5.1	105.1
1954	5.3	5.5	5.2	5.9	8.8	11.5	11.2	11.6	8.3	4.8	5.2	5.1	88.4
1955	5.2	6.1	9.3	11.1	10.4	11.1	10.4	8.0	5.4	4.3	5.0	5.2	91.6
1956	7.3	10.1	11.4	11.5	9.9	10.9	10.7	11.2	11.2	9.2	8.3	7.3	119.1
1957	6.5	5.4	5.1	5.2	4.8	8.3	7.6	8.4	5.4	4.3	4.2	4.6	67.9
1958	6.5	5.2	5.7	10.8	10.4	11.2	11.0	10.8	7.7	5.5	5.2	5.2	93.4
1959	4.8	4.7	7.9	10.7	10.6	7.6	8.1	7.3	6.1	5.7	4.5	4.5	82.7
1960	5.3	5.1	9.4	10.8	9.8	11.6	11.1	8.7	5.3	4.5	4.9	5.2	91.7
1961	5.1	5.2	5.9	8.2	9.9	8.2	11.3	7.3	4.4	4.2	4.4	5.0	79.0
1962	5.0	5.2	5.6	7.4	8.9	11.4	10.8	8.6	5.3	4.7	5.2	5.2	83.6
1963	5.4	5.2	10.4	10.9	9.7	11.5	10.9	11.2	8.3	5.5	5.2	5.1	98.4
1964	5.6	6.0	7.1	10.2	6.8	11.4	8.1	10.9	6.1	5.0	5.7	5.5	88.3
1965	5.5	5.8	6.2	8.1	9.7	11.2	10.7	11.2	9.9	6.1	5.9	5.7	96.0
1966	5.9	6.1	10.7	10.0	10.1	11.3	10.9	11.5	9.0	6.8	6.0	5.7	104.1
1967	5.9	6.1	10.1	11.4	10.5	11.6	10.9	11.5	8.3	6.3	6.0	5.7	104.3
1968	6.0	7.8	11.3	10.8	10.6	10.9	11.1	11.4	7.5	6.1	6.0	5.9	105.4
1969	6.0	6.7	11.0	10.8	10.3	11.3	11.0	11.6	9.4	6.9	6.0	5.8	106.5
1970	5.9	6.1	10.8	10.9	9.7	11.1	11.2	11.5	8.3	6.7	6.0	5.7	103.9
1971	6.0	6.5	7.1	9.2	10.3	11.5	11.2	11.0	7.6	5.8	5.8	5.7	97.7
1972	5.8	6.4	8.4	7.3	10.0	10.6	9.2	8.9	6.7	6.0	5.8	5.7	93.8
1973	6.3	6.3	6.0	5.4	7.5	11.4	10.9	9.5	6.5	5.3	5.8	5.6	86.6
1974	5.9	5.8	6.3	7.6	9.7	11.5	9.3	8.5	5.7	4.8	5.6	5.7	85.2
1975	5.9	6.1	9.1	11.2	10.2	11.4	11.9	11.3	10.2	6.7	6.0	5.6	104.7
1976	6.0	9.3	11.7	11.5	10.8	9.1	11.9	11.2	7.6	6.0	5.9	5.7	105.9
1977	6.4	6.3	10.8	10.6	9.7	11.2	11.1	10.9	6.4	5.3	5.8	5.7	100.1
1978	5.9	6.0	6.2	10.7	9.5	11.3	11.0	11.5	8.7	6.2	5.9	5.8	98.6
1979	6.3	6.8	11.3	10.6	10.0	11.3	10.4	11.3	10.0	6.3	5.9	5.7	105.9
1980	6.1	7.1	11.3	11.2	10.9	11.5	11.9	11.7	7.2	5.8	5.8	5.7	105.3
Ave.	5.6	6.2	8.5	9.7	9.4	10.8	10.5	10.5	7.8	5.9	5.6	5.4	95.9

Table 15-4 Energy Production at Beskonak P.S.

Unit: GWh

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total
1941	36.6	35.5	128.7	148.8	103.2	103.2	80.9	64.8	46.3	38.3	37.2	36.0	859.4
1942	37.1	36.0	44.7	136.3	127.5	128.4	100.8	77.6	50.3	37.4	37.2	35.9	848.8
1943	37.0	45.9	77.6	126.4	65.1	60.8	92.6	75.5	48.4	37.2	37.2	35.8	760.6
1944	36.8	35.5	36.9	94.9	139.2	137.9	105.3	84.0	58.8	44.0	37.2	36.0	846.5
1945	37.1	39.7	81.9	120.5	87.5	76.4	91.6	89.3	54.8	40.1	37.2	36.0	792.0
1946	37.1	35.9	135.3	85.1	104.2	93.5	108.0	101.5	72.7	52.2	41.9	36.0	939.4
1947	37.2	35.8	107.0	103.1	132.2	76.0	60.0	55.1	37.4	33.0	34.8	33.8	765.3
1948	31.0	33.6	75.1	131.5	123.5	64.7	69.7	67.1	47.0	39.6	37.1	35.6	755.6
1949	32.4	29.1	26.3	26.4	24.6	60.2	85.8	77.9	42.5	33.9	34.8	33.0	508.0
1950	29.1	31.7	26.9	27.8	25.9	29.2	38.5	68.2	38.2	31.5	30.5	29.3	406.8
1951	28.6	27.6	26.2	30.8	41.1	100.8	95.6	90.3	69.4	55.1	45.0	41.9	652.3
1952	49.5	36.0	37.2	68.9	102.7	83.8	76.2	68.0	48.8	37.2	37.1	35.6	678.5
1953	35.8	35.4	149.8	149.8	118.6	105.0	91.5	88.1	64.6	65.5	37.2	35.9	955.2
1954	36.9	35.2	32.5	29.0	57.9	87.6	75.4	73.1	52.5	33.8	36.7	34.7	585.2
1955	34.1	33.3	54.7	133.9	86.0	69.3	64.8	49.3	36.0	31.4	35.3	35.3	663.4
1956	33.2	32.5	29.8	28.7	73.2	97.3	72.0	60.5	39.5	31.9	35.1	34.5	568.1
1957	30.0	32.2	28.3	27.8	26.0	45.2	45.6	51.2	36.0	31.5	30.5	31.7	418.1
1958	30.5	31.8	28.5	119.9	77.5	117.1	92.8	67.0	49.0	37.2	37.1	35.5	723.9
1959	32.0	29.4	34.8	134.3	69.5	45.4	49.7	44.9	36.0	31.2	31.8	31.0	571.8
1960	33.2	32.1	30.2	77.5	52.2	53.3	72.5	55.4	36.0	31.6	35.1	35.5	544.5
1961	33.7	31.7	30.9	36.9	122.9	53.9	89.3	48.2	31.3	31.1	31.4	34.6	578.7
1962	32.8	31.7	26.7	27.5	83.3	100.5	72.4	56.5	38.6	34.1	37.1	35.6	576.4
1963	36.0	33.3	77.6	140.2	134.6	87.9	77.8	82.0	59.7	33.4	37.2	35.9	841.6
1964	35.8	34.9	36.3	34.8	36.4	77.3	47.1	40.5	36.7	32.5	37.0	35.5	455.7
1965	33.8	31.9	28.7	36.1	134.4	122.4	124.7	113.3	60.0	37.2	37.2	35.8	735.6
1966	36.7	34.9	105.4	148.8	112.5	107.8	113.2	81.3	54.3	40.8	37.2	36.0	928.8
1967	37.0	35.5	71.5	96.0	64.6	75.8	118.1	83.5	49.8	38.3	37.2	35.9	742.8
1968	37.0	40.7	100.9	148.8	90.5	145.8	84.5	69.3	65.2	37.2	37.2	35.9	876.0
1969	37.0	37.8	97.5	148.8	85.3	104.0	104.2	93.0	57.0	41.5	37.2	36.0	882.4
1970	37.0	35.6	106.0	149.8	134.4	127.9	82.5	70.0	50.4	40.1	37.2	35.9	905.9
1971	37.0	35.7	37.1	54.1	85.3	92.8	77.0	66.2	45.7	35.3	37.1	35.6	640.1
1972	36.0	33.8	38.3	42.3	60.1	63.9	54.2	51.9	40.2	37.2	37.4	35.7	530.7
1973	36.6	35.2	33.8	28.4	36.5	94.6	65.5	56.2	39.1	33.9	37.1	35.5	532.5
1974	35.7	32.5	29.7	34.5	62.0	91.9	54.8	49.3	35.1	31.2	36.1	35.5	528.2
1975	35.8	33.2	45.0	122.2	91.6	96.1	103.8	105.2	62.9	40.3	37.2	35.9	809.2
1976	36.9	53.1	73.6	87.3	65.2	54.6	95.9	67.2	45.5	37.2	37.2	35.7	693.3
1977	35.8	35.6	115.4	63.1	59.4	67.3	86.3	55.2	38.5	33.8	37.1	35.6	673.0
1978	35.2	33.5	31.1	104.0	134.6	106.1	93.6	85.8	52.6	37.3	37.2	35.9	792.7
1979	37.0	36.0	100.2	149.8	116.0	68.8	62.6	69.2	41.2	38.3	37.2	35.8	810.1
1980	35.8	35.8	80.3	125.0	68.2	82.6	93.1	71.2	49.3	36.2	37.1	35.6	765.3
Ave.	35.4	34.9	61.5	89.5	85.4	85.7	81.9	70.9	47.7	37.2	36.4	35.3	703.0

15.4 Preliminary Design

15.4.1 Dam and Power Station

(1) Layout

There is already the Köprücay diversion dam for irrigation on the Köprücay River approximately 18 km downstream of the Beskonak dam. Therefore, the site for a regulating pond would be limited to the upstream side of this diversion dam. The dam site was selected at the Kisik site 2 km upstream of the diversion dam as shown in Dwg. 15-1. The site is at a bend where the width of the river is comparatively narrow, and a layout with dam, spillway and power station as one is conceivable.

The dam is to be a combination of rockfill and concrete gravity types. The spillway is to be provided short-cutting across the peninsular ridge adjacent to the dam at the right bank.

The power station and switchyard would be provided at the right bank.

(2) Dam and Spillway

The dam axis was selected as shown in Dwg. 15-3 in consideration of the spillway location. Since the elevation of the dam foundation rock is estimated to be at 0 m, approximately 17 m of river-bed sand-gravel are to be excavated. Water cut-off of the foundation is to be treated by curtain grouting. The crest elevation of the dam, in contrast to the high water level of EL.35 m, was made EL. 40 m considering flood water level.

The spillway is to be provided on bedrock by open-cutting of the right-bank bend. The capcity of the spillway was made such that maximum flood of 5,100 m^3/sec can be discharged with four gates. Energy dissipation is to be achieved by a horizontal apron with discharge made to the natural stream after energy dissipation.

This spillway is planned to be constructed in advance and used as a diversion waterway during construction work of the rockfill dam proper.

(3) Power Station and Switchyard

The effective head of Kisik power station is 15.10 m, and an installed capacity would be 16 MW. In accordance with this scale, two tubular type turbines as described in 15.4.2 were planned. The power station is to be provided at the right bank side in consideration of the topography and the dam and spillway. The intake is to be at the right bank, while the waterway is to connect directly with the turbines without providing penstocks.

Outlines of the intake and power station are shown in Dwg. 15-4.

The switchyard was planned at EL. 40 m on the roof-top of the power station.

15.4.2 Electro-mechanical Equipment

Kisik power station is planned with installed capacity of 16 MW. For this capacity, the two alternatives of one unit or two units would be concievable.

In case of one unit, reduction in construction cost can be expected, but this would be outweighed by the problem of reduction in flexibility of operation.

In view of the above, the power station is provided with two units, with each unit composed of an 8,200 kW tubular turbine and an 8,900 kVA synchronous generator.

The composition of main equipment is given below.

Electro-mechanical Equipment of Kisik Power Station

— Outline Specifications —

Installed Capacity : 16 MW

Turbine

Type	Tubular turbine
Number	2 units
Normal effective head	15.10 m
Maximum discharge	123 m^3/sec
Standard output	8,200 kW
Revloving speed	250 rpm

Generator

Type	3-ph., A.C. generator
Number	2 units
Output	8,900 kVA
Frequency	50 Hz

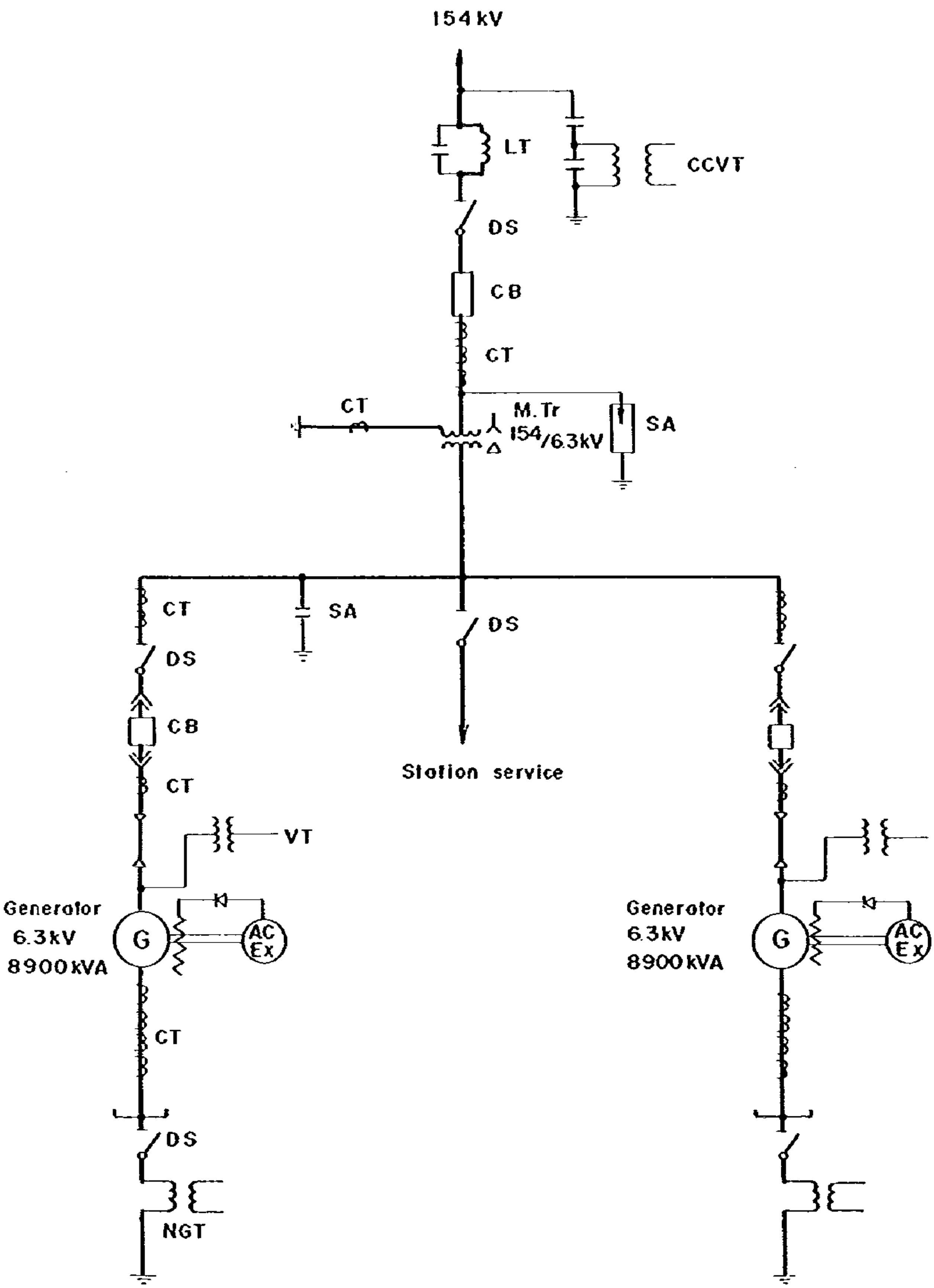
Main Transformer

Type	Outdoor, 3-Phase, Oil-immersed, Self-cooled
Number	1 unit
Capacity	17,800 kVA
Frequency	50 Hz

Switchyard

Type	Conventional
Number of line connections	1 cct

Fig. 15-3 Single Line Diagram



15.4.3 Transmission Line Scheme

The Kepez power system centered at Antalya city is scheduled to construct 380 kV transmission lines in the future, but at present it is composed of the voltage classes of 154 kV, 66 kV, and 30 kV. Of these, the transmission lines passing the vicinity of Kisik power station are 154 kV and 30 kV lines, 66 kV lines existing only at Antalya city, and about 60 km distant from this project site. In case the output of the power station is made 16 MW, it is expected that the power produced will be consumed by local demand in the eastern part of Antalya.

Accordingly, the following is recommended as the transmission method for the Kisik project.

(1) To join Kisik P.S by a 154 kV transmission line to the existing 154 kV transmission line connecting Kepez and Manavgat

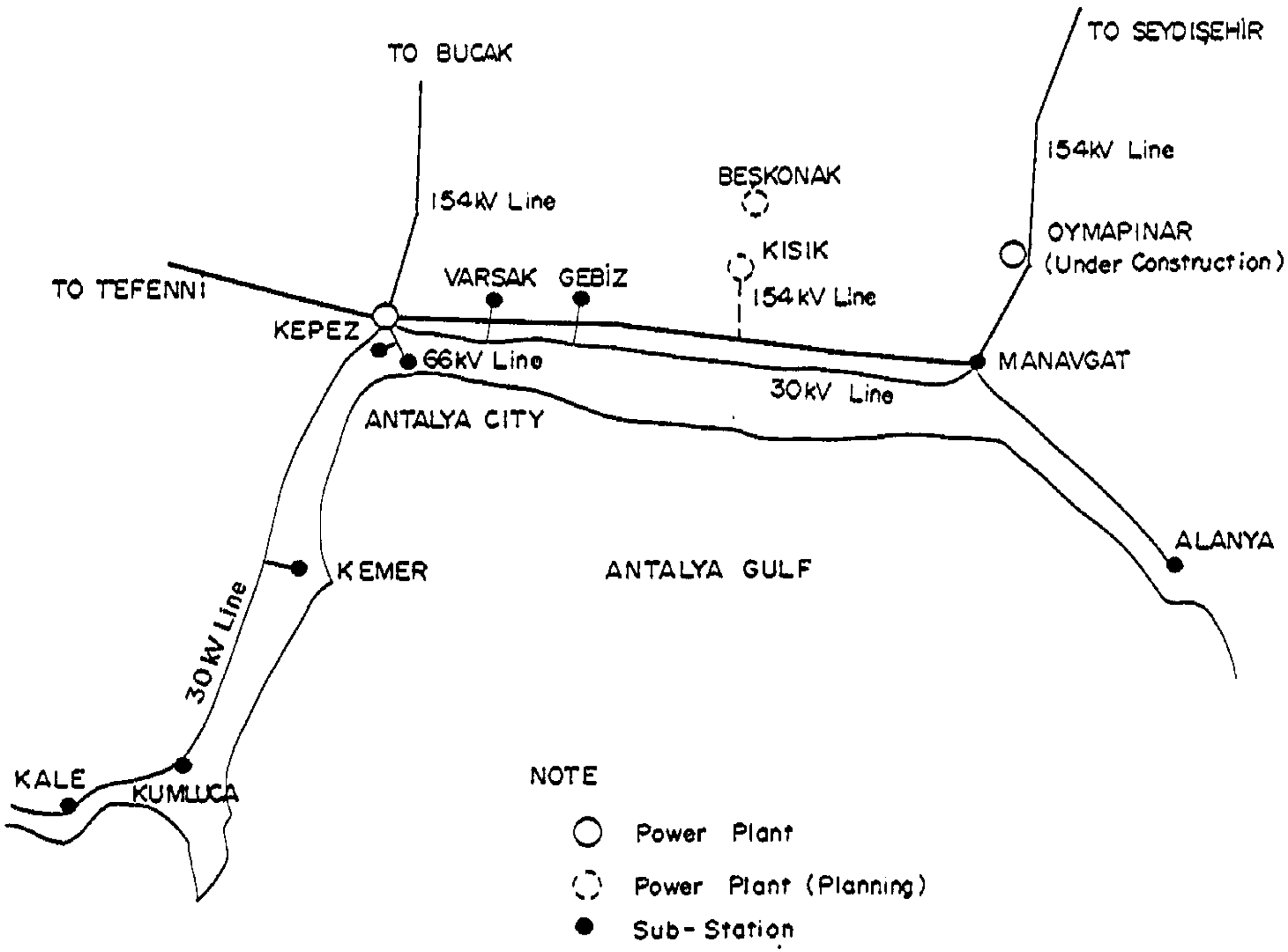
(2) Outline of transmission line plan:

Transmission voltage	:	154 kV
Number of circuit	:	2
Length	:	Approx. 10 km
Conductor size	:	ACSR 477 MCM
Lead-in point	:	Existing 154 kV transmission line (Kepez -Manavgat)

The transmission system diagram in the vicinity of Antalya is shown in Fig. 15-4.

In the event the plan for Kisik power station becomes realized, demand in the eastern part of Antalya and the situation of expansion of the 66 kV transmission lines should be investigated and a restudy made of the two proposals for 66 kV and 154 kV transmission lines.

Fig. 15-4 Transmission System (in 1982)



15.5 Construction Cost

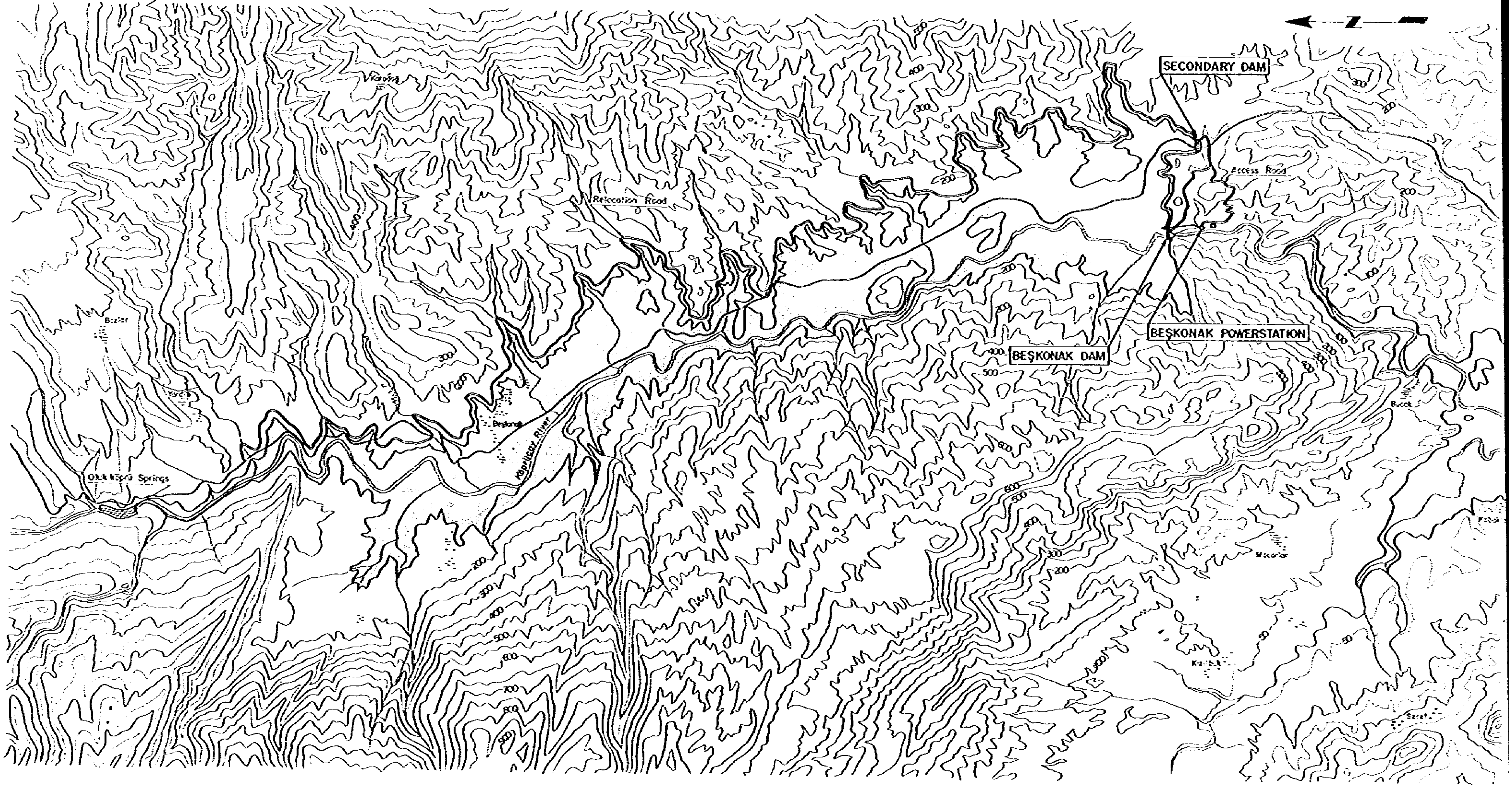
The construction cost of the Kisik project was calculated on the basis of the same estimation criteria as for the Beskonak project described in Chapter 12.

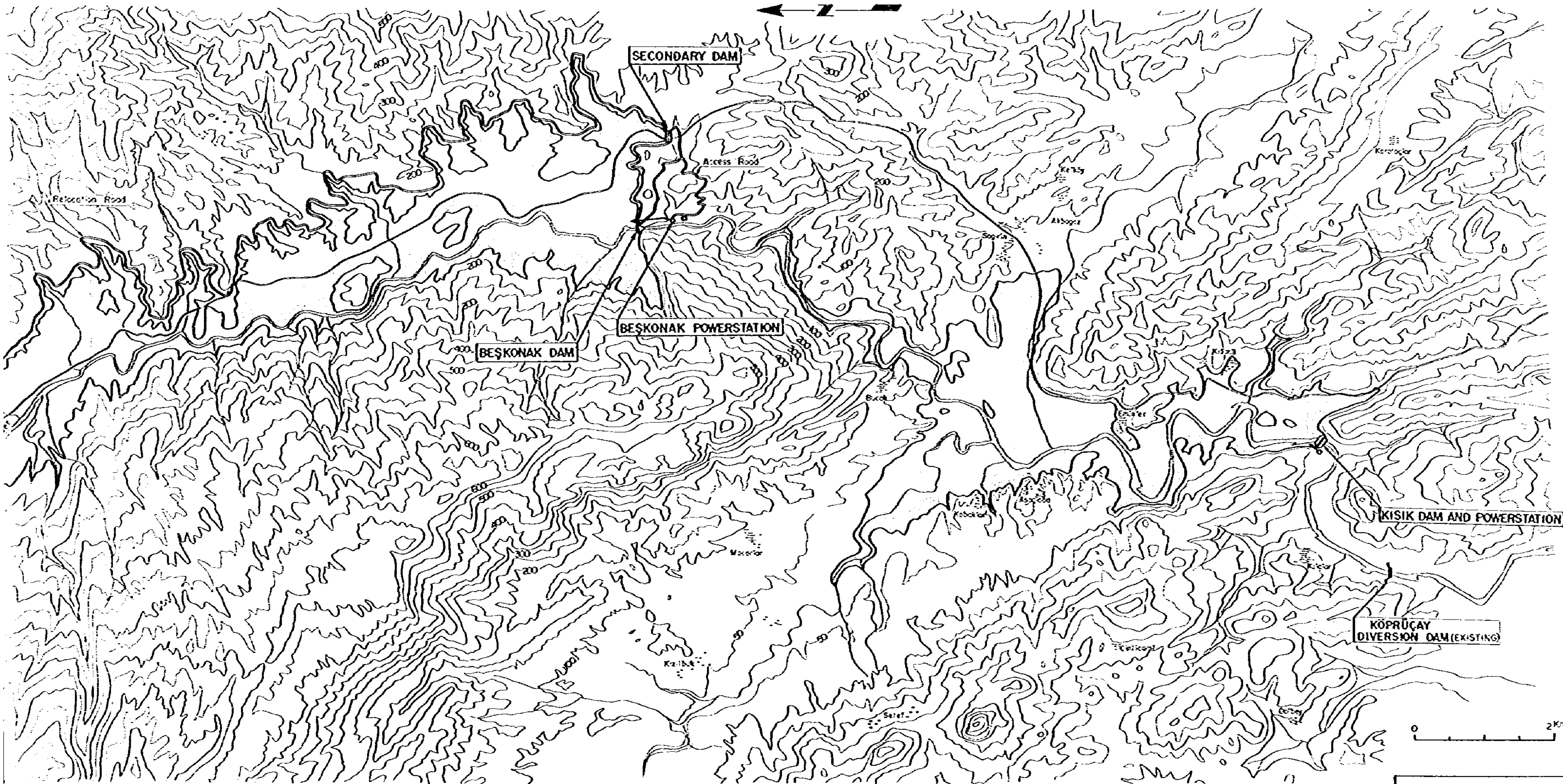
The compilation of the construction cost is given in Table 15-5.

Table 15-5 Estimated Construction Costs

(Unit: 1,000 TL)

Item	Domestic Currency	Foreign Currency	Total
Civil Works			
Dam and Spillway	740,900	-	740,900
Power Station	496,500	-	496,500
Access and Relocation Road	1,263,500	-	1,263,500
Preparatory Works	250,100	-	250,100
Subtotal	2,751,000	-	2,751,000
Contingency (15%)	412,700	-	412,700
Total	3,163,700	-	3,163,700
Hydraulic Equipment	349,400	300,000	649,400
Electro-Mechanical Equipment	321,000	2,012,000	2,333,000
Transmission Line	40,000	-	40,000
Project Controlling	581,200	346,800	928,000
Land Acquisition	926,900	-	926,900
Total	5,382,200	2,658,800	8,041,000
Interest during Construction Period	613,800	255,200	869,000
Grand Total	5,996,000	2,914,000	8,910,000

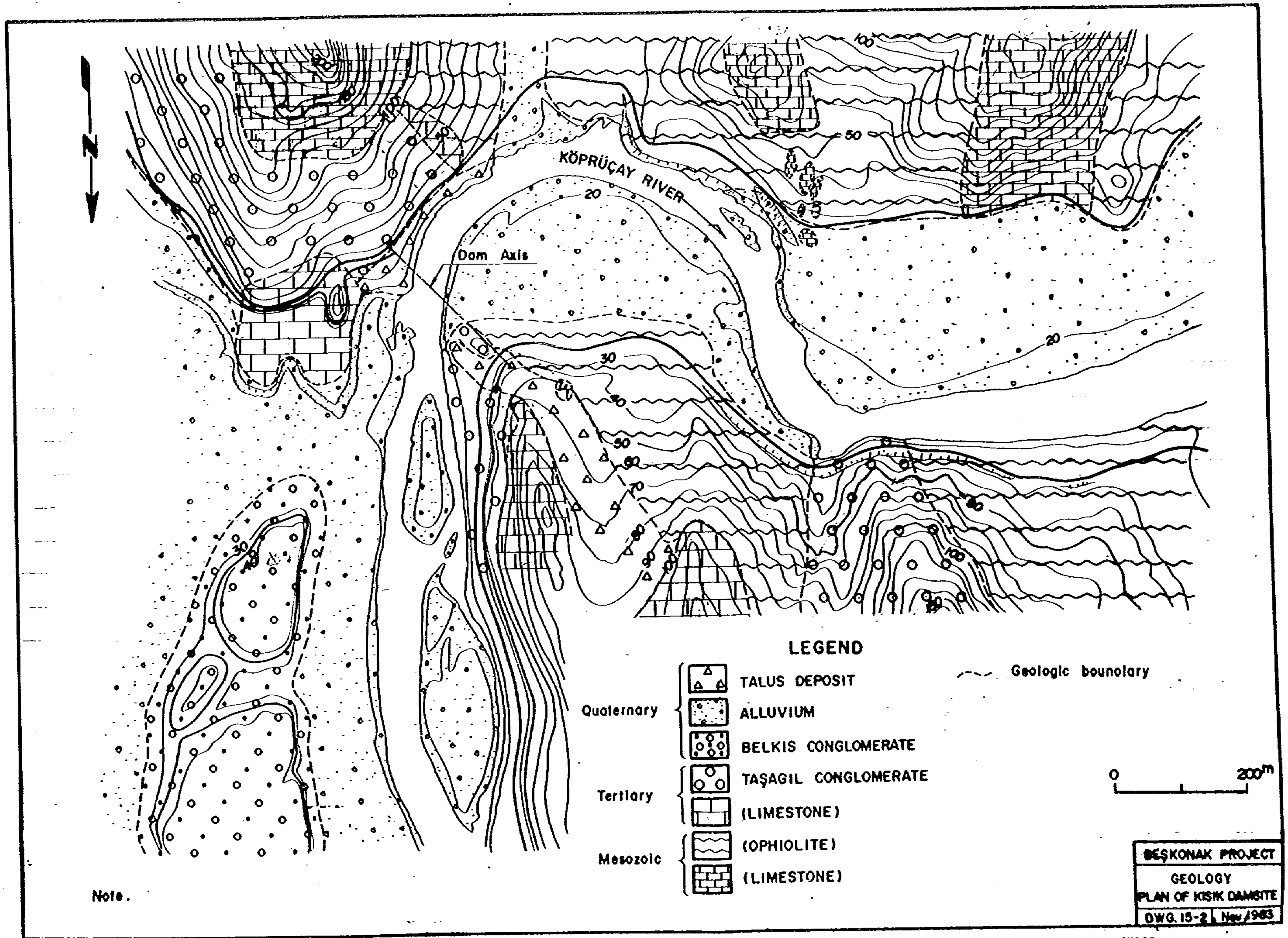

SECONDARY DAM
Access Road
Relocation Road
BEŞKONAK DAM
BEŞKONAK POWERSTATION
Springs
River



BEŞKONAK PROJECT

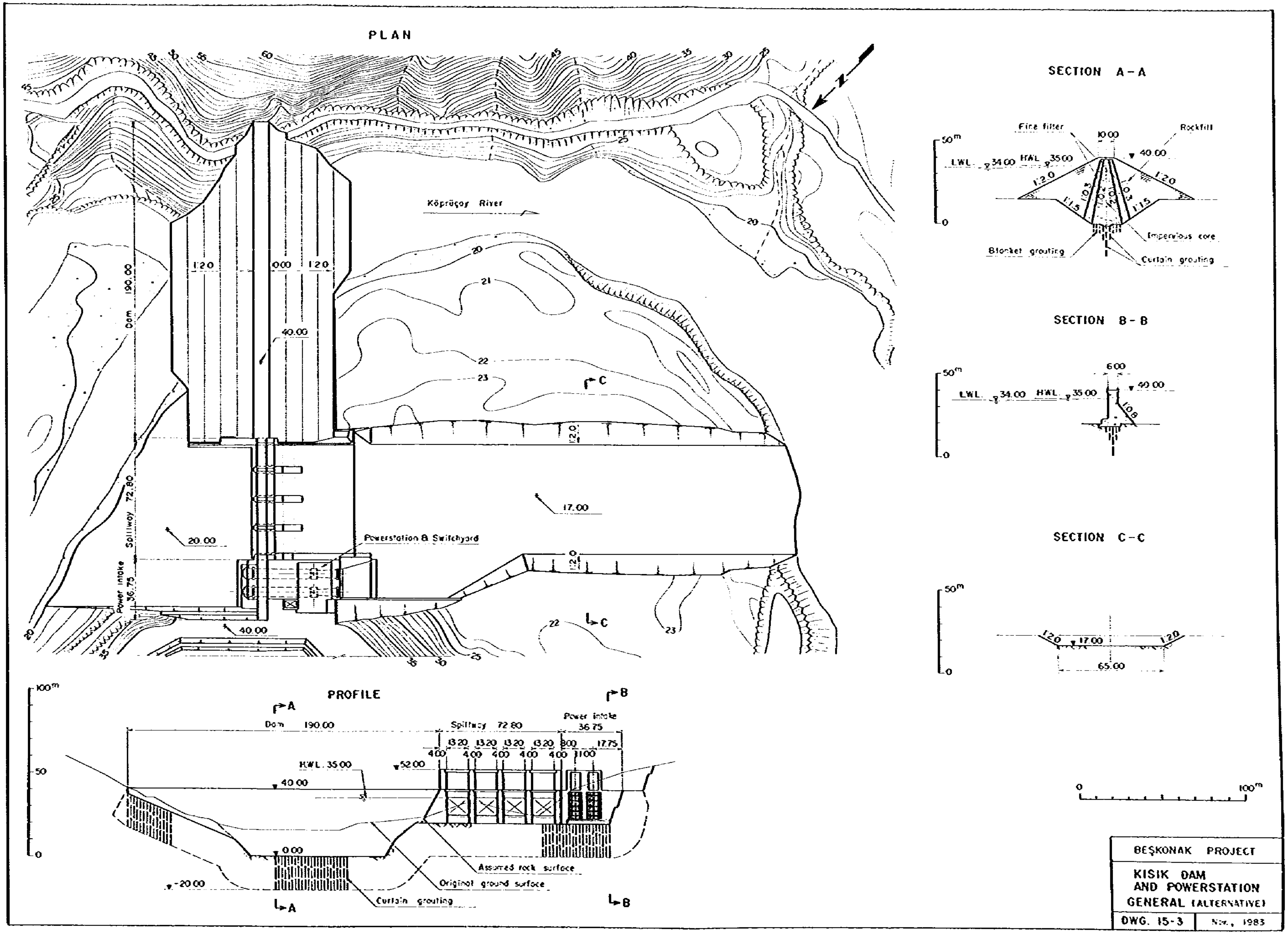
GENERAL LAYOUT
(ALTERNATIVE)

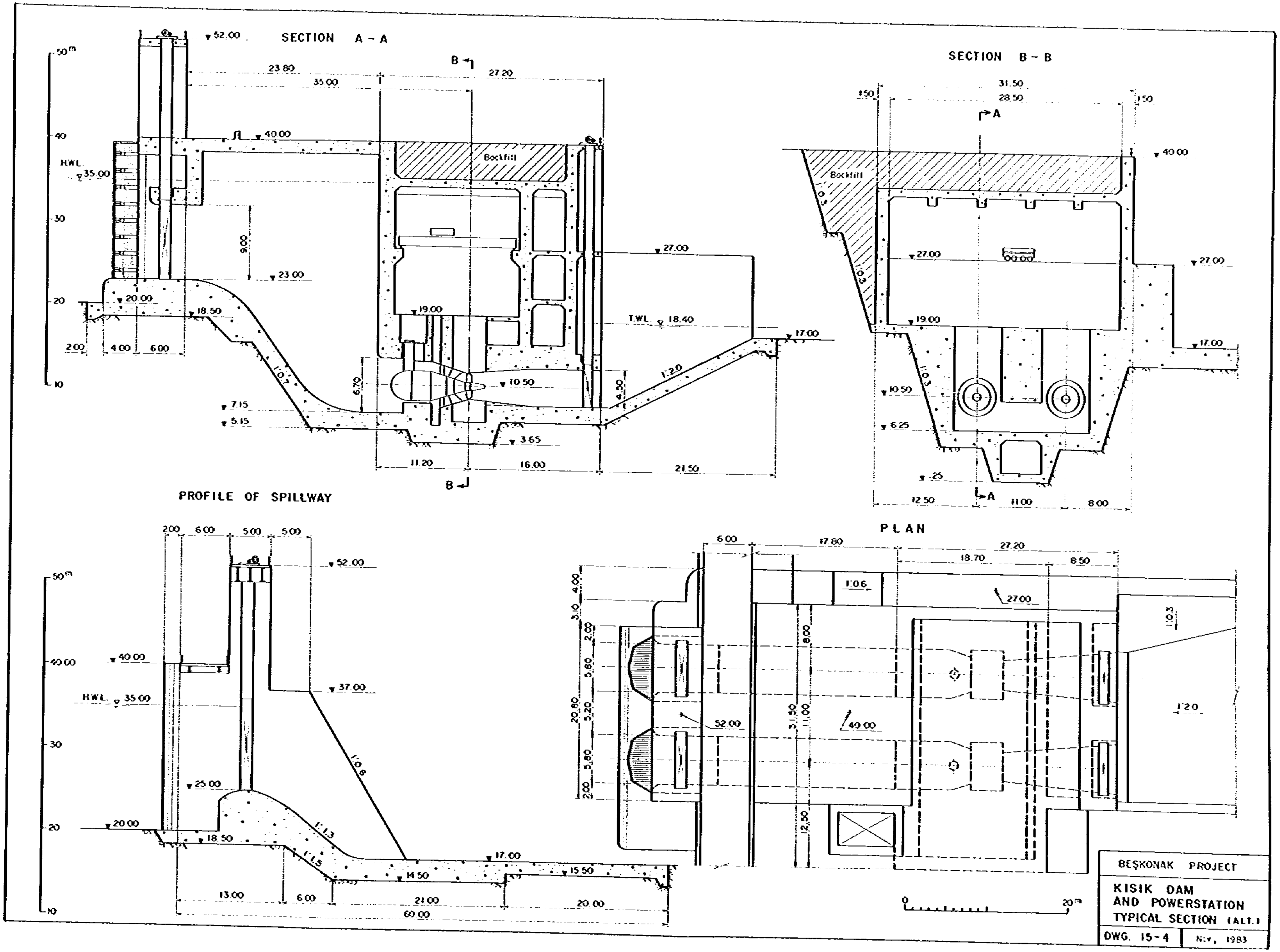
DWG. 15-1	Nov. 1983



KÖPRÜÇAY RIVER
Dam Axis
N
LEGEND
Quaternary
TALUS DEPOSIT
ALLUVIUM
BELKIS CONGLOMERATE
Tertiary
TAŞAGIL CONGLOMERATE
(LIMESTONE)
Mesozoic
(OPHIOLITE)
(LIMESTONE)
Geologic bounolary
0
200m
BEŞKONAK PROJECT
GEOLOGY
PLAN OF KISIK DAMSITE
DWG. 15-2
Nov/1963

Note.


PLAN
Köprüçay River
Dam 190.00
Spillway 72.80
Power intake 36.75
1:2.0
10.00
1:2.0
40.00
20.00
17.00
40.00
Powerstation & Switchyard
SECTION A-A
Fine filter
Rockfill
LWL. 34.00
HWL. 35.00
40.00
Impervious core
Blanket grouting
Curtain grouting
SECTION B-B
6.00
LWL. 34.00
HWL. 35.00
40.00
SECTION C-C
17.00
65.00
PROFILE
Dam 190.00
Spillway 72.80
Power intake 36.75
HWL. 35.00
52.00
40.00
0.00
-20.00
Assumed rock surface
Original ground surface
Curtain grouting
BEŞKONAK PROJECT
KISIK DAM AND POWERSTATION GENERAL (ALTERNATIVE)
DWG. 15-3
Nov., 1983


SECTION A - A
SECTION B - B
PROFILE OF SPILLWAY
PLAN
Bockfill
H.W.L. 35.00
T.W.L. 18.40
52.00
40.00
27.00
23.00
20.00
19.00
18.50
17.00
10.50
7.15
5.15
3.65
23.80
35.00
27.20
11.20
16.00
21.50
31.50
28.50
12.50
11.00
8.00
1:0.7
1:2.0
1:0.3
1:0.8
1:1.3
1:1.5
37.00
25.00
15.50
14.50
13.00
6.00
21.00
20.00
60.00
17.80
18.70
8.50
1:0.6
BEŞKONAK PROJECT
KISIK DAM
AND POWERSTATION
TYPICAL SECTION (ALT.)
DWG. 15-4
Nov, 1983

JICA